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THE VIRGINIA MASTER GARDENER HANDBOOK

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BASIC BOTANY

BASIC BOTANY, PHYSIOLOGY AND ENVIRONMENTAL EFFECTS ON PLANT GROWTH

INTRODUCTION

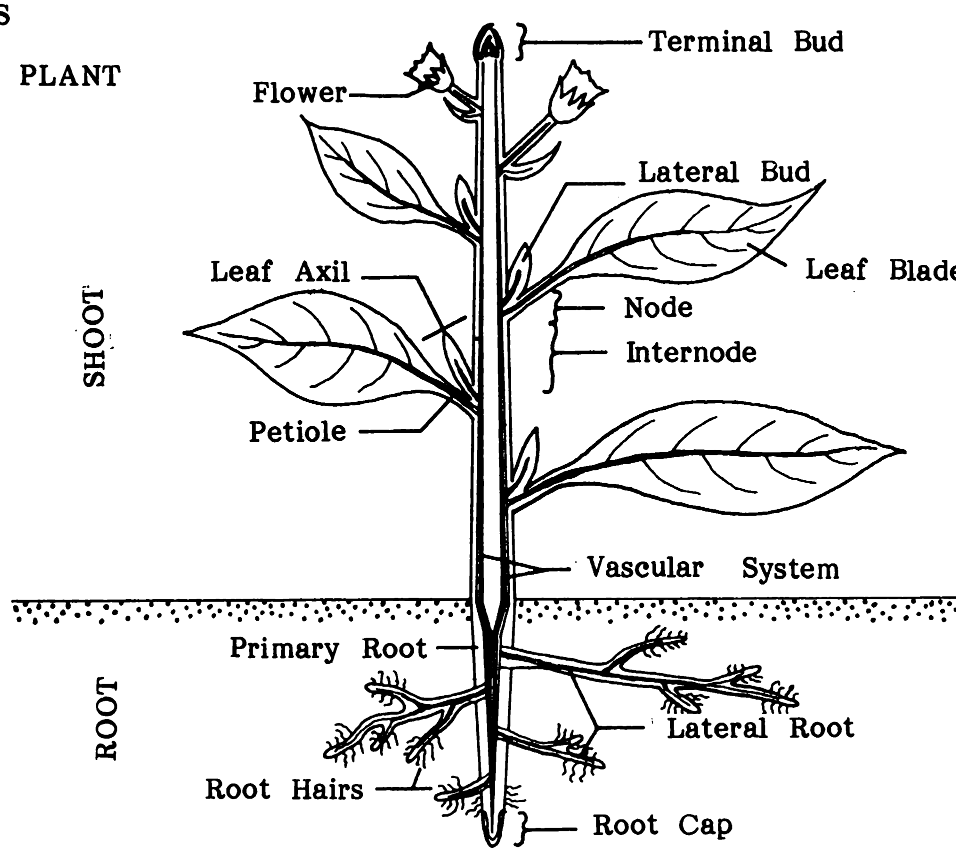
In order to gain a working knowledge of horticulture, it is necessary to understand the structure and function of plants and the environmental factors that affect plant growth. In the greatly diversified kingdom of plants, all flowering plants have certain structures and functions in common. These similarities are the basis for this chapter. Higher flowering plants are divided into two groups, monocotyledons (monocots) and dicotyledons (dicots). Although monocots and dicots are similar in many ways, differences with respect to number of seed leaves, number of flower parts, leaf vein pattern and root structure exist. In addition, physiological dissimilarities exist which, for example, result in different responses to herbicides (weed killers).

PLANT PARTS AND FUNCTIONS

The parts of a plant can be divided into two groups, sexual reproductive and vegetative parts. Sexual reproductive parts are those involved in the production of seed. They include flowers, fruit, flower buds, and seeds. The vegetative parts include leaves, roots, shoot buds, and stem and are not directly involved in sexual reproduction. However, they are often used in asexual or vegetative forms of reproduction such as cuttings.

PRINCIPLE PARTS

OF A VASCULAR PLANT

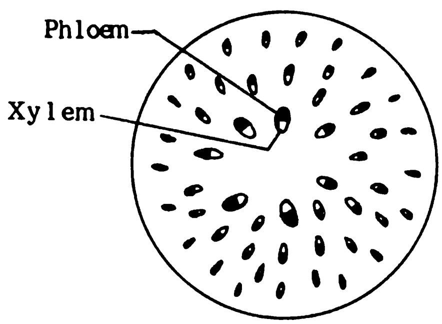


Stems

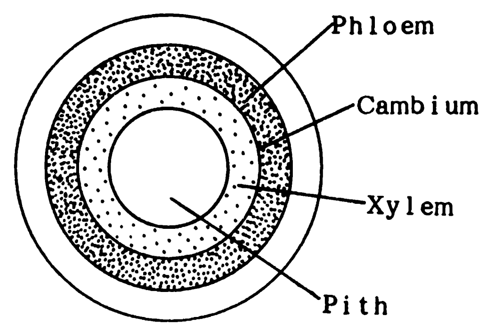
Stems are structures which support buds and leaves and serve as conduits for carrying water, minerals, and sugars. Three major internal parts of a stem are the xylem, phloem, and cambium. The xylem and phloem are the major components of a plant's vascular system. The vascular system transports food, water, and minerals and offers support for the plant. Xylem tubes are the water and mineral conducting channels while phloem tubes are the food conducting channels.

The vascular systems of monocots and dicots differ. While both contain xylem and phloem, they are arranged differently. In the stem of a monocot, the xylem and phloem are paired into bundles; these bundles are dispersed throughout the stem. The vascular system in a dicot is said to be continuous because it forms rings inside the stem. The ring of phloem is near the bark or external cover of the stem and is a component of the bark in mature stems. The xylem forms the inner ring and is the sapwood and heartwood in woody plants. The difference in the vascular system of the two groups is of practical interest to the horticulturist because certain herbicides are specific to either monocots or dicots. An example is 2,4,-D, which only kills plants with a continuous vascular system or dicots.

CROSS-SECTION OF STEM



Discontinuous vascular system of a monocotyledonous stem.



Continuous vascular system of a dicotyledonous stem.

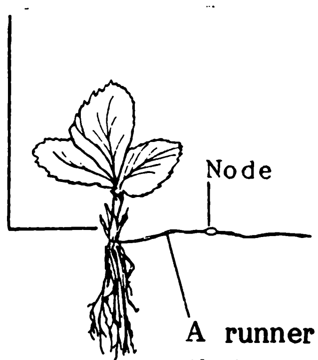
The cambium is a meristem which is a site of cell division and active growth. It is located between the xylem and phloem inside the bark of a stem and is the tissue responsible for a stem's increase in girth, as it produces both the xylem and phloem tissues.

Stems may be long, with great distances between leaves and buds (branches of trees, runners on strawberries) or compressed with short distances between buds or leaves (fruit spurs, crowns of strawberry plants, dandelions). Stems can be above the ground like most stems with which we are familiar, or below the ground (potatoes, tulip bulbs). All stems must have buds or leaves present to be classified as stem tissue.

DIVERSIFIED STEM DEVELOPMENT

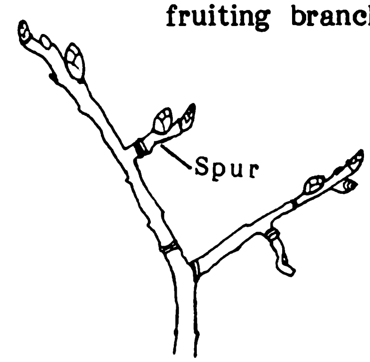
ABOVE GROUND MODIFICATIONS

A crown is a region of compressed stem tissue from which new shoots are produced, generally found near the surface of the soil.



A runner is a specialized stem that grows on the soil surface and forms a new plant at one or more of its nodes.

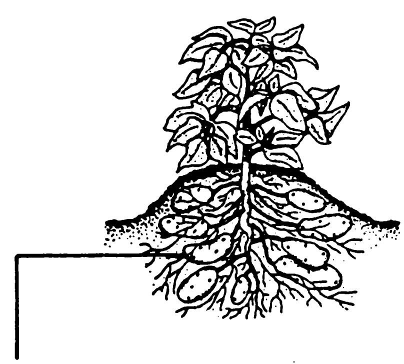
Spur is a compressed fruiting branch.



Branch is a stem which is more than one year old.

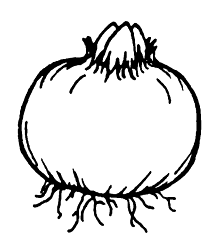
BELOW GROUND MODIFICATIONS

Rhizome is a specialized stem which grows horozontally at or just below the soil surface and acts as a storage organ and means of propagation in some plants.



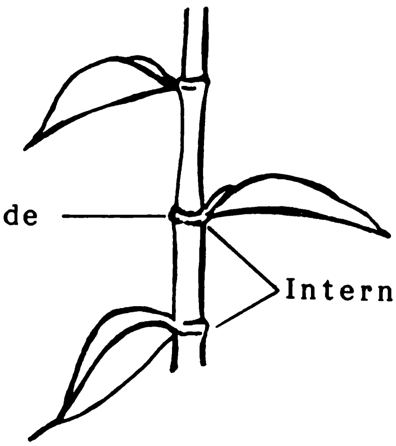
Tuber is an enlarged portion of an underground stem.

Corm is a compressed stem with reduced scaly leaves.



Bulb is composed of a short stem plate and closely spaced buds and fleshy leaves.

An area of the stem where leaves are located is called a node. Nodes are areas of great cellular activity and growth, at which point, buds develop into leaves, or flowers. The area between nodes is called an internode.



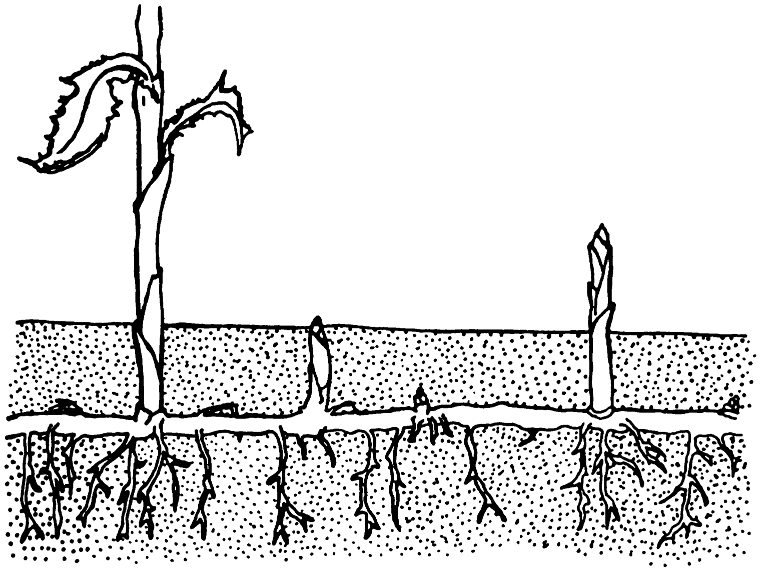
Parts of a Stem

The length of an internode may depend on many factors. Decreasing fertility will decrease internode length. Internode length varies with the season. Too little light will result in a long internode, causing a spindly stem. This situation is known as stretch or etiolation. Growth produced early in the season has the greatest internode length. Internode length decreases as the growing season nears its end. Vigorously growing plants tend to have greater internode length than less vigorous plants. Internode length will vary with competition with surrounding stems or developing fruit. If the energy for a stem has to be divided between three or four stems, or if the energy is diverted into fruit growth, internode length will be shortened.

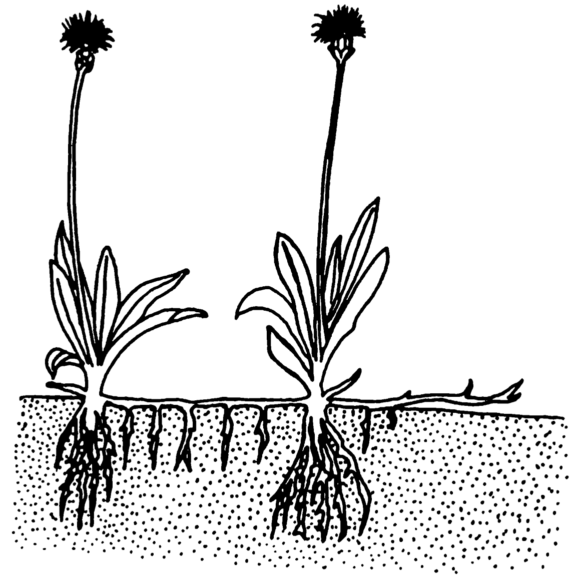
Although typical stems are above ground trunks and branches, there are modified stems which can be found above ground and below ground. The above ground modified stems are crowns, stolens, runners, or spurs and the below-ground stems are bulbs, corms, rhizomes and tubers.

Above-ground stems called crowns (strawberries, dandelions, African violets) are compressed stems having leaves and flowers on short internodes. Spurs are short, stubby, side stems that arise from the main stem and are common on such fruit trees as pears, apples, and cherries where they may bear fruit. If severe pruning is done close to fruit bearing spurs, the spurs can revert to a nonfruiting long stem. A stolon is a horizontal stem that is fleshy or semiwoody and lies along the top of the ground. Strawberry runners are examples of stolons. Remember, all stems have nodes and buds or leaves. The leaves on strawberry runners are small but are located at the nodes, which are easy to see. The nodes on the runner are the points where roots begin to form. The spider plant has stolons that can produce an entirely new plant.

Rhizomes are similar to stolons, but grow underground rather than above ground. Some rhizomes are compressed and fleshy such as Iris; they can also be slender with elongated internodes such as bentgrass. Johnsongrass is an insidious weed principally because of the spreading capability of its rhizomes.



Rhizome



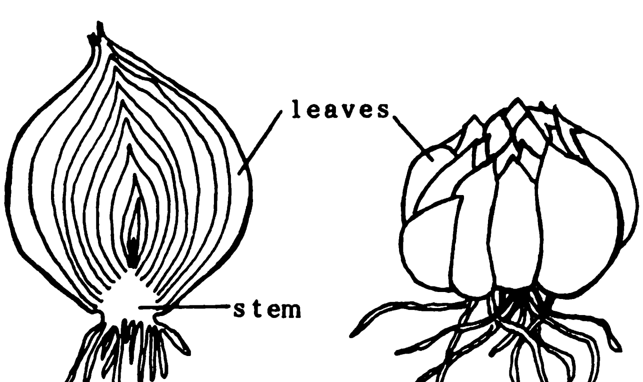
Stolon

Below-ground stem variations such as the potato tuber, the tulip bulb and the iris rhizome are underground stems that store food for the plant. The tuber, like any other stem, has nodes that produce buds. The eyes of a potato are actually the nodes on the stem. Each eye contains a cluster of buds.

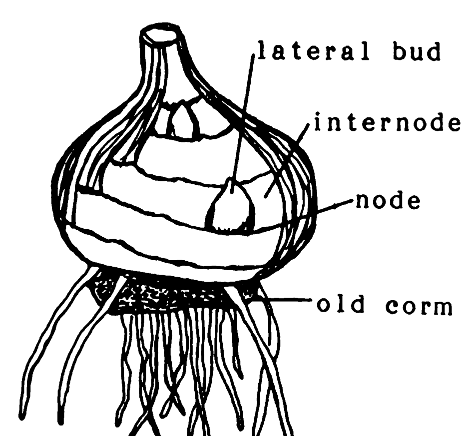
Tulips, lilies, daffodils, and onions are plants that produce bulbs which are shortened compressed underground stems surrounded by fleshy scales (leaves) that envelop a central bud located at the tip of the stem. In November, if you cut through the center of a tulip or daffodil bulb, you can see all the flower parts in miniature within the bulb.

Many bulbs require a period of low temperature exposure before they begin to send up the new plant. Both the length of this treatment and the temperature are of critical importance to commercial growers who force bulbs for holidays. Easter lilies are especially tricky to time since the date of Easter may vary by six weeks.

Bulbs and corms are not the same. Corms have shapes similar to bulbs, but do not contain fleshy scales. A corm is a solid, swollen stem whose scales have been reduced to dry, scale-like leaves.



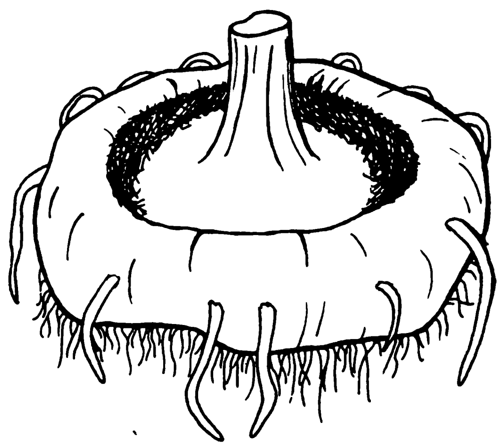
BULB



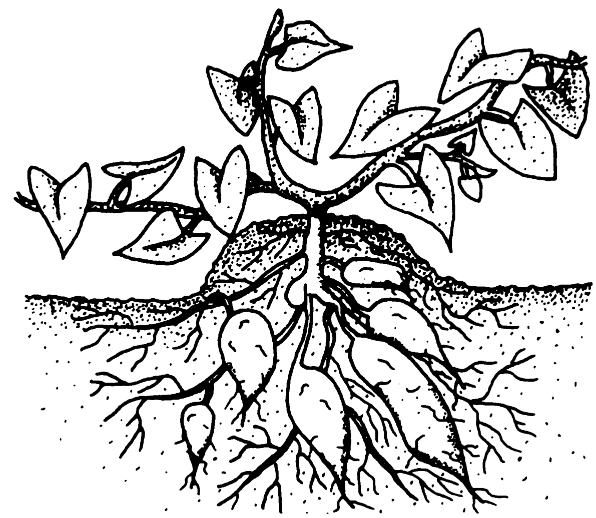
CORM

Some plants produce a modified stem that is refered to as a tuberous stem. Examples are tuberous begonia and cyclamen. The stem is shortened, flattened, enlarged, and underground. Buds and shoots arise from the top or crown and fibrous roots are found on the bottom of the tuberous stem.

In addition, some plants such as the dahlia and the sweet potato produce an underground storage organ called a tuberous root which is often confused with bulbs and tubers. However, these are roots, not stems, and have neither nodes nor internodes.



Tuberous Begonia



Sweet Potato

Stems are one of the most commonly used parts for plant propagation purposes. Above ground stems can be divided into sections that contain internodes and nodes. They are referred to as cuttings and will produce roots thus giving rise to new plants. Below gound stems are also good propagative tissues: rhizomes can be divided into pieces; bulbs form small bulblets at the base of the parent bulb; cormels are miniature corms that form under the parent corm; and tubers can be cut into pieces containing eyes and nodes. All of these will produce new plants.

It may sometimes be difficult to distinguish between roots and stems but one sure way is to look for the presence of nodes. Stems have nodes, roots do not.

<u>Types of Stems</u> A SHOOT is a young stem with leaves present. A TWIG is a stem which is one-year old or less and has no leaves. It is still in the winter dormant stage. A BRANCH is a stem which is more than one-year old, and typically has lateral stems. A TRUNK is a main stem of a woody plant. Most trees have a single trunk.

Trees are perennial woody plants with one, or sometimes several main trunks which at maturity are usually more than 12 feet tall.

Shrubs are perennial woody plants which may have one or several main stems which at maturity are usually less than 12 feet tall.

A vine is a plant which develops long trailing stems that grow along the ground, or must be supported by another plant or structure. Some twining vines circle the support clockwise (hops or honeysuckle) while others circle counter-clockwise (pole beans or Dutchman's pipe vine). Climbing vines are supported by aerial roots as in English ivy or poison ivy, or by slender tendrils which encircle the supporting object such as in cucumber, gourds, grapes, and Passion-flowers, or by tendrils with adhesive tips such as Virginia and Japanese Creeper.

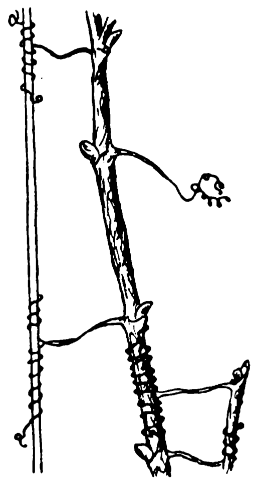


Figure 1. Some vines have tendrils which wrap around any type of support.

Figure 2. The twining vines climb by winding their stems around any available support.

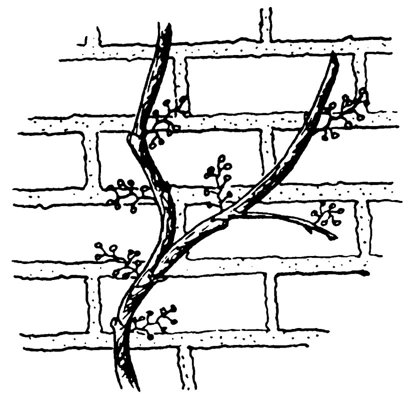


Figure 3. Some clinging vines climb by means of tendrils with disk-like adhesive tips which attach to any surface.

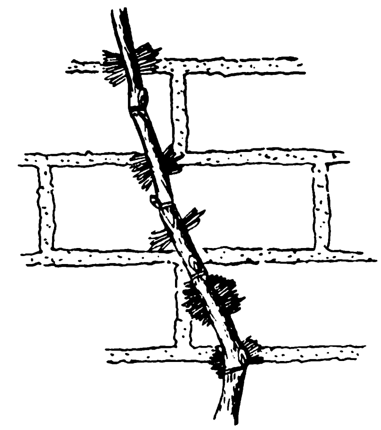


Figure 4. Other clinging vines attach themselves to surfaces with small aerial rootlets along the stem.

Texture and Growth of Stems   Woody stems contain relatively large amounts of hardened xylem tissue in the central core, and are typical of most tree fruits and ornamental trees and shrubs.

A cane is a stem which has a relatively large pith (the central strength giving tissue of stem) and usually lives only one or two years. Examples of plants with canes include rose, grape, blackberry, and raspberry.

Herbaceous or succulent stems contain only small amounts of xylem tissue and usually live for only one growing season. If the plant is perennial, it will develop new shoots from the root.

Plants are classified by the number of growing seasons required to complete a life cycle. Annuals pass through their entire life cycle from seed germination to seed production in one growing season, and then die.

Biennials are plants which start from seeds, produce vegetative structures and food storage organs the first season. During the first winter a hardy evergreen rosette of basal leaves persists. During the second season, flowers, fruit and seed develop to complete the life cycle. The plant then dies. Carrots, beets, cabbage, celery, and onions are biennial plants which produce seed by flowers that develop the second year of growth. Hollyhock (Althaea rosea), Centerbury bells (Campanula Medium), and Sweet William (Dianthus barbatus) are biennials which are commonly grown for their attractive flowers.

Plants which typically develop as biennials may in some cases complete the cycle of growth from seed germination to seed production in only one growing season. This situation occurs when drought, variations in temperature, or other climatic conditions cause the plant to pass through the equivalent of two growing seasons physiologically, in a single growing season. This phenomenon is referred to as bolting.

Perennial plants live for many years and after reaching maturity typically produce flowers and seeds each year. Perennials are classified as herbaceous if the top dies back to the ground each winter and new stems grow from the roots each spring. They are classified as woody if the top persists, as in shrubs or trees.

Stems as Food   The edible portion of several cultivated plants such as asparagus and kohlrabi is an enlarged succulent stem. The edible parts of broccoli are composed of stem tissue, flower buds and a few small leaves. The edible part of the white or Irish potato, is a fleshy underground stem called a tuber. Although the name suggests otherwise, the edible part of the cauliflower is proliferated stem tissue. The flower of this biennial develops from buds in the compact branched stem tissue.

Leaves

The principal function of leaves is to absorb sunlight for the manufacture of plant sugars in a process called photosynthesis. Leaves develop into a flattened surface to present a large area for efficient absorption of light energy. The leaf is supported away from the stem by a stem-like appendage called a petiole. The base of the petiole is attached to the stem at the node. The smaller angle formed between the petiole and the stem is called the leaf axil. An active or dormant bud or cluster of buds is usually located in the axil.

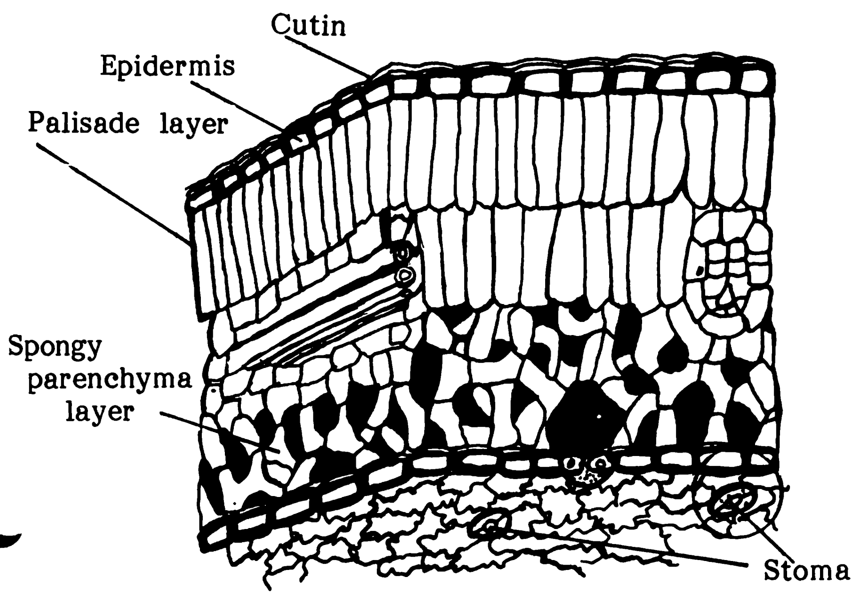
The leaf blade is composed of several layers. On the top and bottom, is a layer of thickened tough cells called the epidermis. The primary function of the epidermis is protection of leaf tissue. The way in which the cells in the epidermis are arranged determines the texture of the leaf surface. Some leaves have hairs that are an extension of certain cells of the epidermis. The African violet has so many that the leaf feels like velvet.

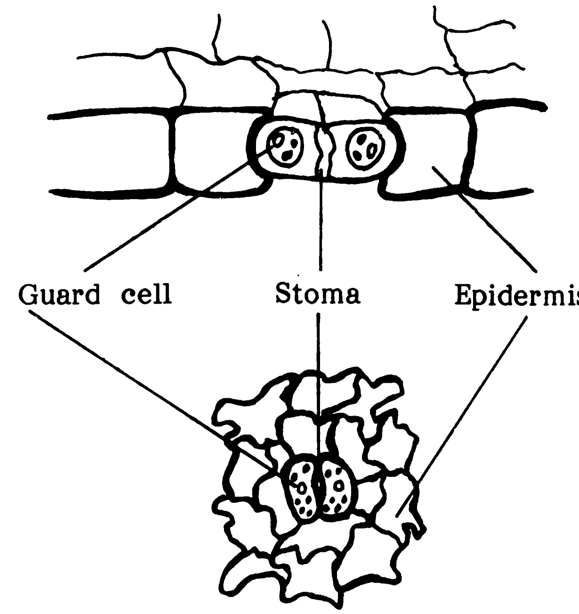
Part of the epidermis is the cuticle which produces a waxy layer called cutin that protects the leaf from dehydration and prevents penetration of some diseases. The amount of cutin is a direct response to sunlight, increasing with increasing light intensity. For this reason, plants grown in the shade should be moved into full sunlight gradually, over a period of a few weeks to allow the cutin layer to build and to protect the leaves from the shock of rapid water loss or sunscald. The waxy cutin also repels water and can shed pesticides if spreadersticker agents or soaps are not used. This is the reason many pesticide manufacturers include some sort of spray additive to adhere to or penetrate the cutin layer.

On the underside of leaves some epidermal cells are capable of opening and closing. These cells guard the interior of the leaf and regulate the passage of water, oxygen, and carbon dioxide through the leaf. These regulatory cells are called guard cells. They protect openings in the leaf surface called stomata. The opening and closing of the cells are determined by the weather. Conditions that would cause large water losses from plants (high temperature, low humidity) stimulate guard cells to close. Mild weather conditions leave guard cells in an open condition. Guard cells will close in the absence of light.

The middle layer of the leaf is the mesophyll and is located between the upper and lower epidermis. This is the layer in which photosynthesis occurs. The mesophyll is divided into a dense upper layer called the palisade and a lower layer of cells that contains lots of air space, the spongy parenchyma layer. The cells in these two layers contain chloroplasts which are the actual site of the photosynthetic process.

LEAF PARTS

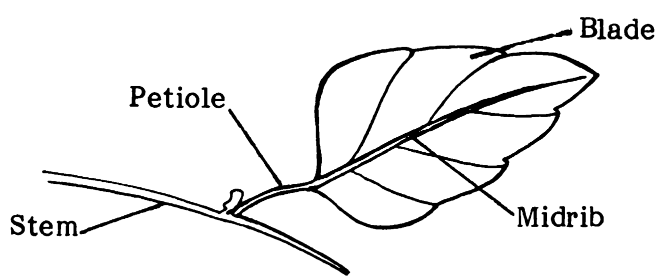




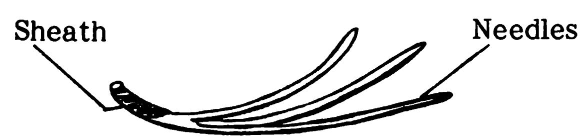
Types of Leaves A number of rather distinct types of leaves occur on plants. Leaves commonly referred to as foliage are the most common and conspicuous, and as previously stated, serve as the manufacturing centers where the photosynthetic activity of the plant occurs. Scale leaves or cataphylls are found on rhizomes and are also the small leathery protective leaves which enclose and protect the bud. Seed leaves or cotyledons are modified leaves which are found on the embryonic plant and commonly serve as storage organ. Spines and tendrils as found on barberry and pea are specialized modified leaves which protect the plant or assist in supporting the stems. Storage leaves as are found in bulbous plants and succulents serve as food storage organs. Other specialized leaves include bracts which are often brightly colored. The showy structures on dogwood and poinsettias are bracts, not petals.

Parts of a Leaf The blade of a leaf is the expanded thin structure on either side of the midrib. The blade usually is the largest and most conspicuous part of a leaf.

The petiole is the stalk which supports the leaf blade. It varies in length or may be lacking entirely in some cases where the leaf blade is described as sessile or stalkless.



Broadleaf



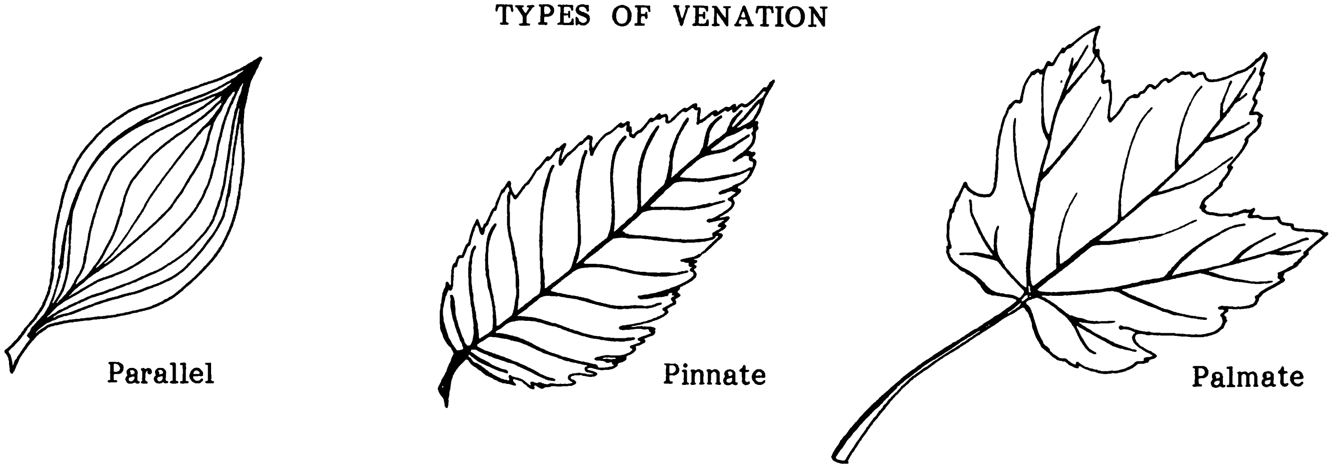
Conifer leaves

Venation of Leaves The vascular bundles from the stem extend through the petiole and spread out in the blade. The term venation refers to the patterns in which the veins are distributed in the blade. Two principal types of venation are parallel veined and net veined.

Parallel veined leaves are those in which there are numerous veins which run essentially parallel to each other and are connected laterally by minute straight veinlets. Possibly the most common type of parallel veining is that found in plants of the grass family where the veins run from the base to the apex of the leaf. Another type of parallel venation is found in plants such as banana, calla, and pickrel-weed where the parallel veins run laterally from the midrib. Parallel veined leaves occur on plants which are part of the monocotyledon group.

Net veined leaves, also called reticulate veined, have veins which branch from the main rib or ribs and then subdivide in finer veinlets which then unite in a complicated network. This system of enmeshed veins gives the leaf more resistance to tearing than is true for most parallel veined leaves. Net venation may be either pinnate or palmate. In pinnate venation the veins extend laterally from the midrib to the edge such as in apple, cherry and peach. Palmate venation occurs in grape and maple leaves where the principle veins extend outward, like the ribs of a fan, from the petiole near the base of the leaf blade. Net veined leaves occur on plants which are part of the dicotyledon group.

TYPES OF VENATION



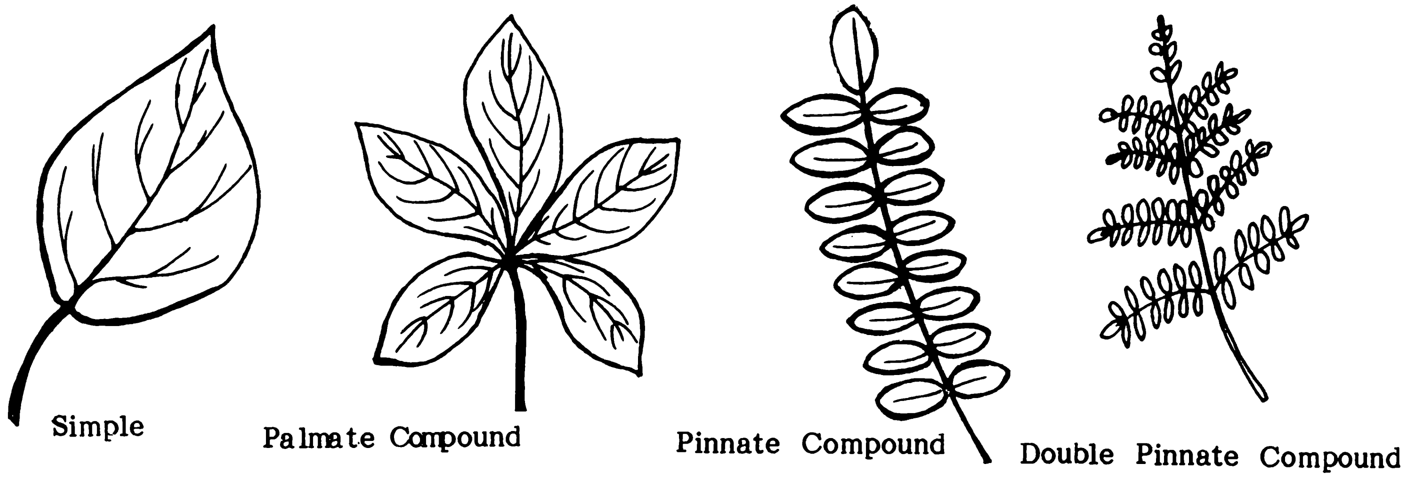
Parallel veined

Net veined

Leaves as a Means of Identifying Plants Leaves are useful in identifying species and varieties of horticultural plants. The shape of the leaf blade, and the type of margin, are of major importance in identifying characteristics.

Leaf shape: The leaves of plants have characteristic shapes which may be used in identifying species and varieties. Simple leaves are those in which the leaf blade is a single continuous unit. A compound leaf is composed of several separate leaflets arising from the same petiole. A deeply lobed leaf may appear similar to a compound leaf but if the leaflets are connected by narrow bands of blade tissue it may be classified as a simple leaf. If the leaflets have separate stalks and particularly if these stalks are jointed at the point of union with the main leaf-stalk, the leaf is considered to be compound. Some leaves may be doubly compound, having divisions of the leaflets.

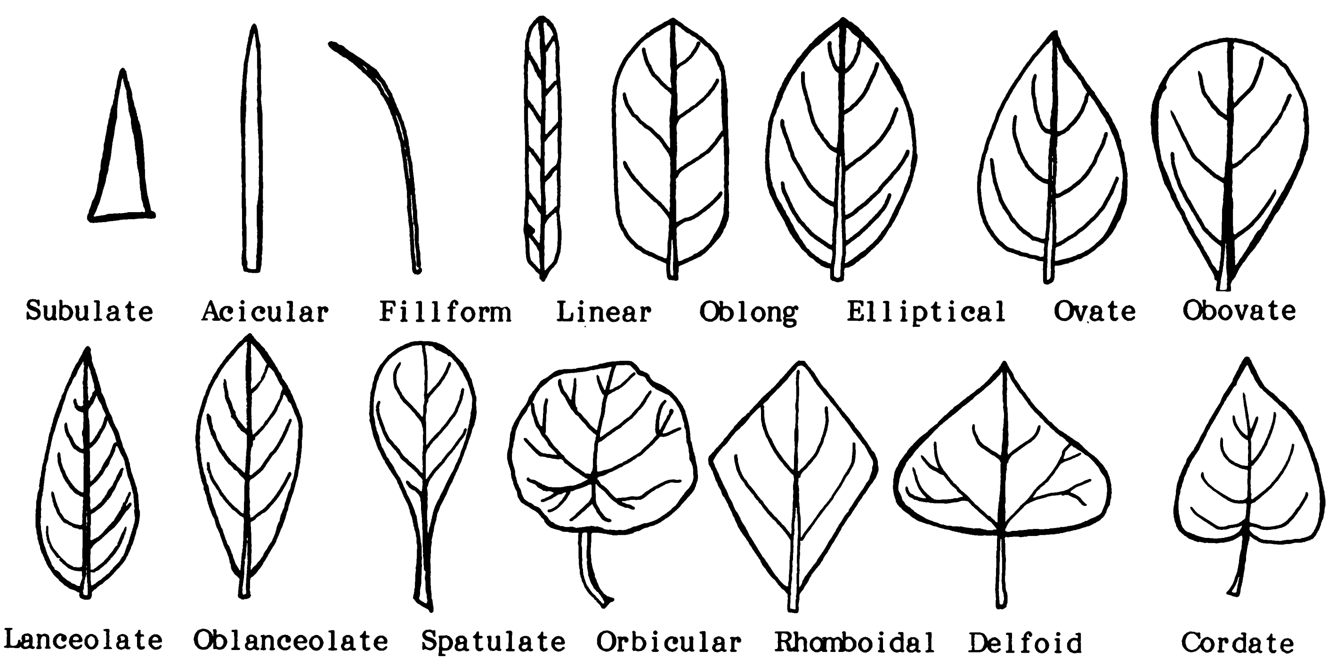
TYPE OF LEAF



Types of Compound Leaves

Shape of the leaf blade: The following are some common shapes which are found in leaves and leaflets.

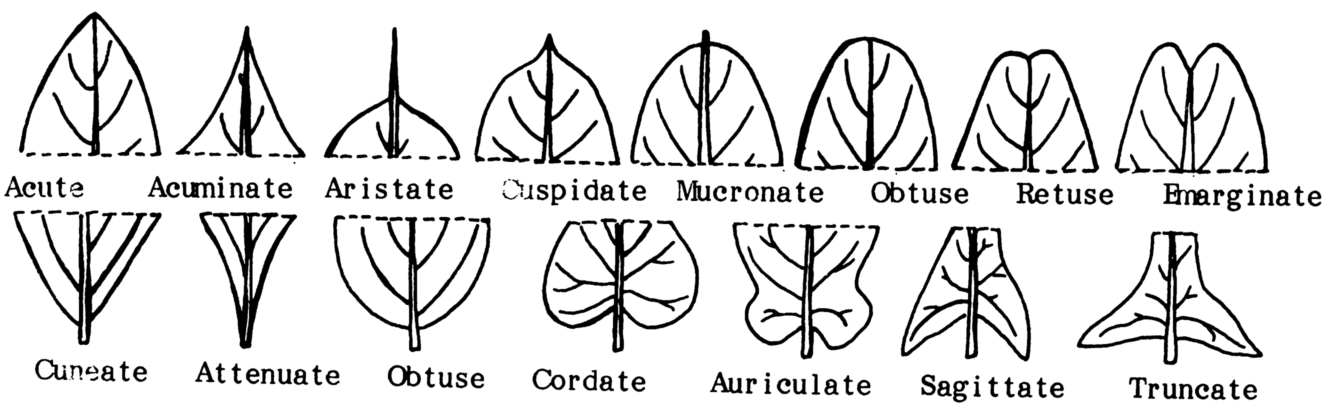
- Linear - narrow, several times longer than wide and of approximately the same width throughout.
- Lanceolate - longer than wide and tapering toward the apex and base.
- Elliptical - about 2 or 3 times as long as wide, tapering to acute or rounded apex and base.
- Ovate - egg-shaped, basal portion wide, tapering toward the apex.
- Cordate or Heart-shaped - broadly ovate tapering to acute apex, with the base turning in and forming a notch where the petiole is attached.



LEAF BLADE SHAPE

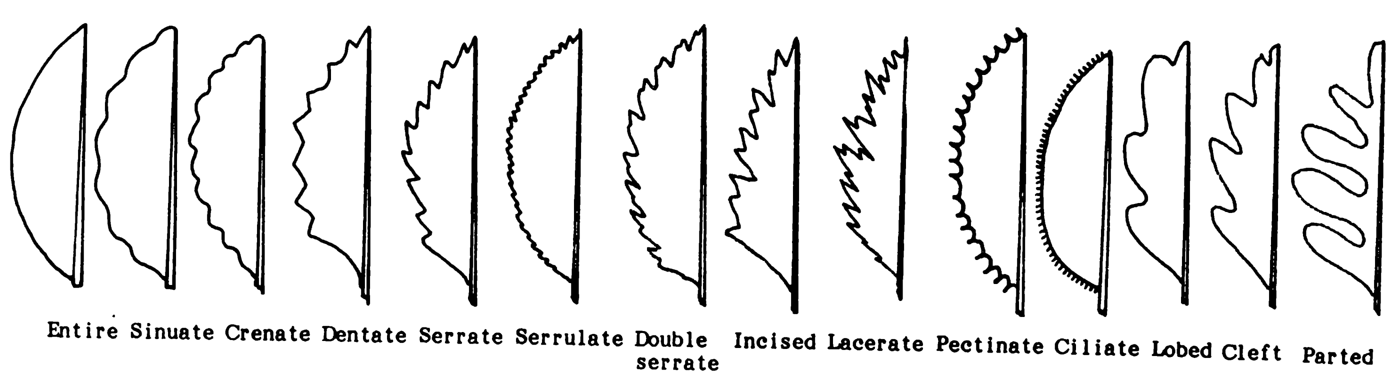
Shape of the leaf apex and base: The following are common shapes found in leaves.

- Acuminate - tapering to a long, narrow point.
- Acute - ending in an acute angle, with sharp but not acuminate point.
- Obtuse - tapering to a rounded edge.
- Sagittate - Arrowhead shaped, two pointed lower lobes.
- Truncate - having a relatively square end.

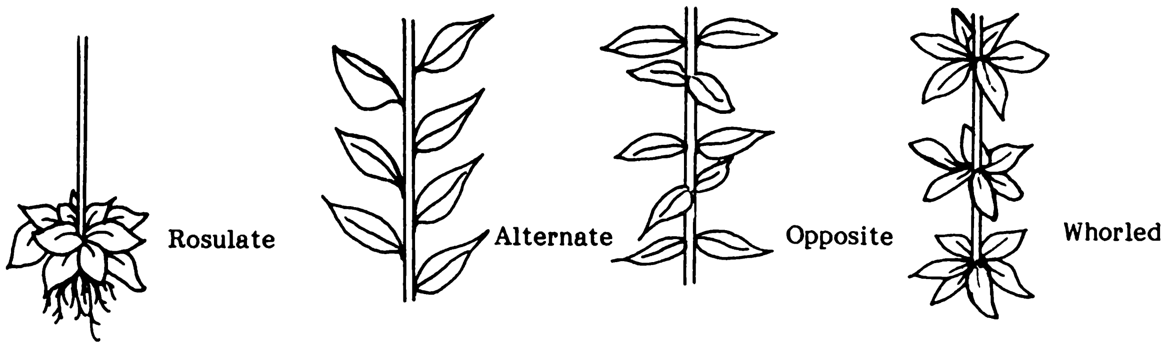


Leaf margins: The type of margin of a leaf is especially useful in the identification of certain varieties of fruit plants. The following are the most common forms of leaf margins.

- Entire - a smooth edge with no teeth or notches.
- Serrate - having small sharp teeth pointing toward the apex.
- Dentate - having teeth ending in an acute angle pointing outward.
- Crenate - having rounded teeth.
- Sinuate - having a pronounced sinuous or wavy margin.
- Incised - margin cut into sharp, deep, irregular teeth or incisions.
- Lobed - incisions extend less than halfway to the midrib.
- Cleft - when incisions extend deeper than halfway to the midrib.



Leaf arrangement along a stem: The various ways leaves are arranged along a stem is also used to help identify plants. Rosulate arrangement is one in which the basal leaves form a rosette around the stem with extremely short nodes. Opposite leaves are positioned across the stem from each other, two leaves at each node. Alternate or spiral leaves are arranged in alternate steps along the stem with only one leaf at each node. Whorled leaves are arranged in circles along the stem.



Leaves as Food The leaf blade is the principal edible part of several horticultural crops including chive, collard, dandelion, endive, kale, leaf lettuce, mustard, parsley, spinach, and Swiss chard. The edible part of leek, onion, and Florence Fennel is a cluster of fleshy leaf bases. The petiole of the leaf is the edible product in celery and rhubarb. In plants like Brussel sprout, cabbage and head lettuce, the leaves in the form of a large naked bud, are the edible product.

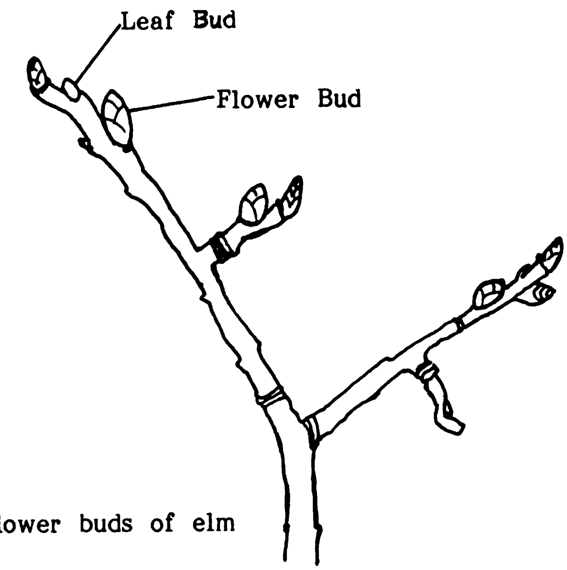
Buds

A bud is an undeveloped shoot from which embryonic leaves or flower parts arise. The buds of trees and shrubs of the temperate zone typically develop a protective outer layer of small leathery bud scales. Annual plants and herbaceous perennials have naked buds in which the outer leaves are green and somewhat succulent.

Buds of many plants require exposure to a certain number of days below a critical temperature (rest) before they will resume growth in the spring. This time period varies for different plants. The flower buds of forsythia require a relatively short rest period and will grow at the first sign of warm weather. Many peach varieties require from 700 to 1000 hours of temperatures below 45 F (7C) before they will resume growth. During rest, dormant buds can withstand very low temperatures, but after the rest period is satisfied, buds become more susceptible to weather conditions and can be damaged easily by cold temperatures or frost.

A Leaf Bud is composed of a short stem with embryonic leaves, with bud primordia in their axils and at the apex. Such buds develop into leafy shoots. Leaf buds are often less plump and more pointed than flower buds.

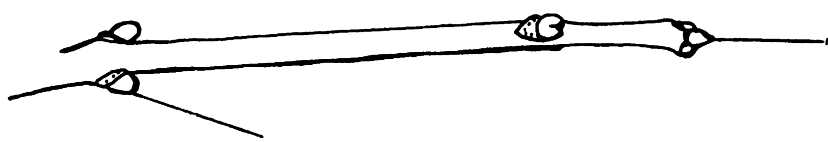
A Flower Bud is composed of a short stem with embryonic flower parts. In some cases the flower buds of plants which produce fruit crops of economic importance are called fruit buds. This terminology is objectionable because, although flowers have the potential for developing into fruits, this development may never occur because of adverse weather conditions, lack of pollination, or other unfavorable circumstances. The structure is a flower bud, and should be so designated since it may never set fruit.



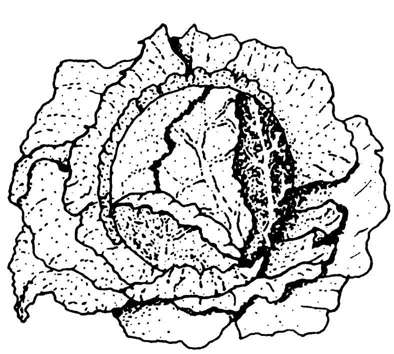
Leaf and flower buds of elm

<u>Location of Buds</u> Buds are named for the location which they inhabit on the stem surface. <u>Terminal buds</u> are those which are located at the apex of a stem. <u>Lateral buds</u> are borne on the sides of the stem. Most lateral buds arise in the axis of a leaf and are called <u>axillary buds.</u> In some instances more than one bud is formed. <u>Adventitious buds</u> are those which arise at sites other than in the terminal or axillary position. Adventitious buds may develop from the internode of the stem, at the edge of a leaf blade, from callus tissue at the cut end of a stem or root, or laterally from the roots of plants.

Twig



<u>Buds as foods</u> Enlarged buds or parts of buds form the edible portion of some horticultural crops. Cabbage and head lettuce are examples of unusually large terminal buds. Succulent axillary buds of Brussels sprouts become the edible part of this plant. In the case of Globe Artichoke, the fleshy basal portion of the bracts of the flower bud are eaten along with the solid stem portion of the bud. Broccoli is the most important horticultural plant in which edible flower buds are consumed. In this case portions of the stem as well as small leaves associated with the flower buds, are eaten.



Roots

A thorough knowledge of the root system of plants is essential if their growth, flowering, and fruiting responses are to be understood. The structure and growth habits of roots have a pronounced effect on the size and vigor of the plant, method of propagation, adaptation to certain soil types, and responses to cultural practices and irrigation. The roots of certain vegetable crops are important as food.

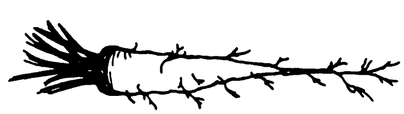
Roots typically originate from the lower portion of a plant or cutting. They possess a root cap, have no nodes, and never bear leaves or flowers directly. The principal functions of roots are to absorb nutrients and moisture, anchor the plant in the soil, furnish physical support for the stem and serve as food storage organs. In some plants, they may be used as a means of propagation.

A primary root originates at the lower end of the embryo of a seedling plant. A taproot is formed when the primary root continues to elongate downward into the soil and becomes the central and most important feature of the root system with a somewhat limited amount of secondary branching. Some trees, especially nut trees like pecan, have a long taproot with very few lateral or fibrous roots which causes them to be difficult to transplant and necessitates that they be planted only in deep well-drained soil. The taproot of carrot, parsnip, and salsify, is the principal edible part of these crops.

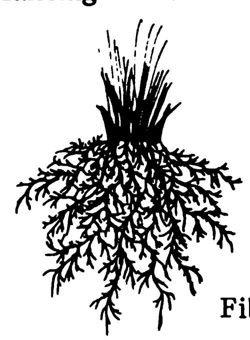
A lateral or secondary root is a side or branch root which arises from another root. A fibrous root is one which remains small in diameter because of very little cambial activity. One factor which causes shrubs and dwarf trees to remain smaller than standard or large size trees is the inactivity of the cambium tissue in the roots.

A fibrous root system is one in which the primary root ceases to elongate, and numerous lateral roots develop, which branch repeatedly and form the feeding root system of the plant.

If plants that normally develop a taproot are undercut so that the taproot is severed early in the plant's life, the root will lose its taproot characteristic and develop a fibrous root system. This is done commercially in nurseries so trees have a compact, fibrous root system. This allows for high transplanting success in the field.



Taproot of Carrot



Fibrous Root of Grass

The quantity and distribution of plant roots is very important because it has a major influence on the absorption of moisture and nutrients. The depth and spread of the roots is dependent on the inherent growth characteristics of the plant, and the texture and structure of the soil. Roots will penetrate much deeper in a loose well-drained soil, than in a heavy, poorly-drained one. A dense compacted layer in the soil will restrict or terminate root growth.

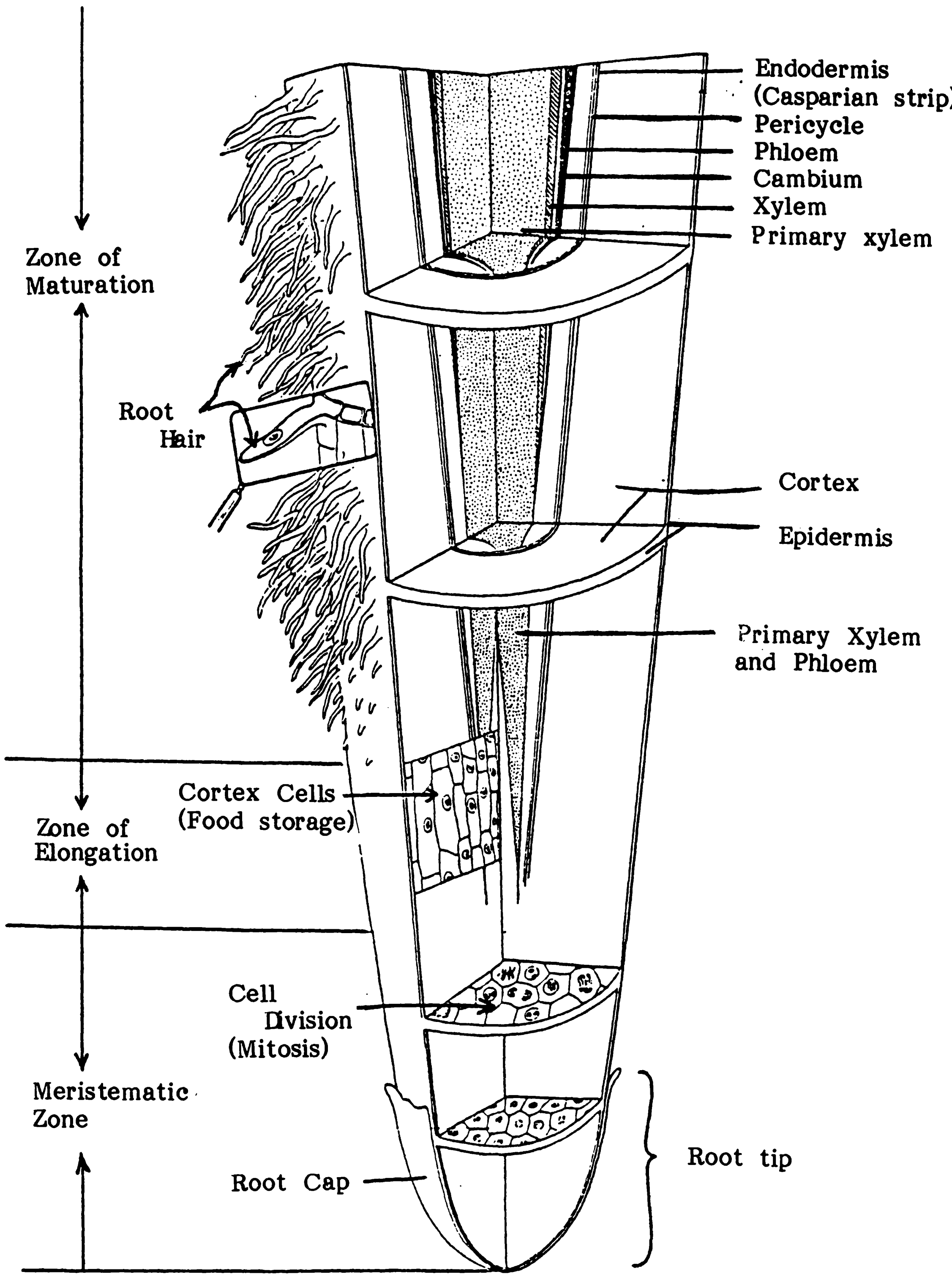
During the early development of a seedling plant, it absorbs nutrients and moisture from the soil which is within a few inches of the location of the seed from which the plant grew. Therefore, the early growth of most horticultural crops which are seeded in rows, benefits from band application of fertilizer several inches on each side and slightly below the location of the seeds.

As plants become well established, the root system develops laterally and usually extends somewhat beyond the spread of the branches. For most cultivated crops, roots meet and overlap between the rows. The greatest concentration of fibrous roots occurs in the top foot of soil, but significant numbers of laterals may grow downward from these roots to provide an effective absorption system several feet deep.

Parts of a Root   Internally there are three major parts of a root. The meristem is at the tip and manufactures new cells; it is an area of cell division and growth. Behind it, is the zone of elongation. In this area, cells increase in size through food and water absorption. These cells, by increasing in size, push the root through the soil. The third is the maturation zone where cells undergo changes to become specific tissues such as epidermis, cortex, or vascular tissue. The epidermis is the outermost layer of cells surrounding the root. These cells are responsible for the absorption of water and minerals dissolved in water. Cortex cells are involved in the movement of water from the epidermis and in food storage. Vascular tissue is located in the center of the root and conducts food and water.

Externally, there are two areas of importance. Root hairs are found along the main root and perform much of the actual work of water nutrient absorption. The root cap is the outermost tip of the root. The meristem, the area of cell devision, is behind the root cap and is protected by it. The root cap consists of cells that are sloughed off as the root grows through the soil. The parts of a root are illustrated on the next page.

Roots as Food Crops   The enlarged root is the edible portion of several vegetable crops. The sweet potato is a swollen root called a tuberous root which serves as a food storage for the plant. Carrot, parsnip, salsify, and the radish, are elonged taproots.



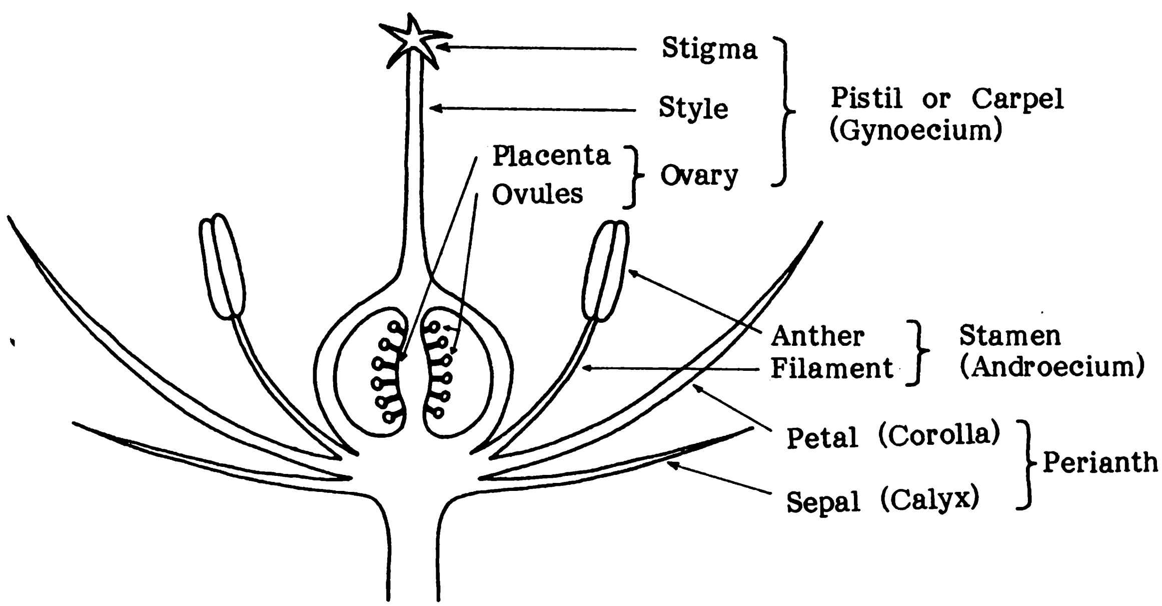
ROOT STRUCTURE

Flowers

The flower, which is generally the showiest part of the plant has as its sole function, sexual reproduction. Its attractiveness and fragrance have not evolved to please man but to ensure the continuance of the species. Fragrance and color are devices to attract pollinators, insects that play an important role in the reproductive process.

Binominal nomenclature is the scientific system of giving a double name to each plant or animal. The first or genus name is followed by a descriptive or species name. Modern plant classification or taxonomy, is based on a system of binomial nomenclature developed by the Swedish physician, Carl von Linne (Linneanus). Prior to Linneaus people had tried to base classification on the leaf shape, plant size, flower color, etc. None of these systems proved workable. Linneaus's revolutionary approach was to base classification on the flowers and/or reproductive parts of a plant and to give plants a genus and species name. This has proved to be the best system since flowers are the plant part least influenced by environmental changes. For this reason, a knowledge of the flower and its parts is essential for anyone who is interested in plant identification.

Parts of the Flower   As the reproductive part of the plant, the flower contains the male pollen and/or the female ovule plus accessory parts such as petals, sepals, and nectar glands.



Sepals are small green leaf-like structures on the base of the flower to protect the flower bud. The sepals collectively are called the calyx.

Petals are highly colored portions of the flower. They may contain perfume as well as nectar glands. The number of petals on a flower is often used in the identification of plant families and genera. The petals collectively are called the corolla. Flowers of dicots typically have sepals and/or petals in numbers of four, five or multiples thereof. Monocots typically have these floral parts in threes or multiples of three.

The pistil is the female part of the plant. It is generally shaped like a bowling pin and located in the center of the flower. It concicts of the stigma, style, and ovary. The stigma is located at the top and is connected by the style to the ovary. The ovary contains the eggs which reside in the ovules. After the egg is fertilized the ovule develops into a seed.

The stamen is the male reproductive organ and consists of a pollen sac called the anther and a long supporting filament which holds the anther in position so that the pollen it contains may be disbursed by wind or carried to the stigma by pollinating insects or birds.

If a flower has stamen, pistils, petals, and sepals, it is called a complete flower. If one of these parts is missing, the flower is designated incomplete. If a flower contains functional stamens and pistils, it is called a perfect flower. These are considered the essential parts of a flower and are involved in the seed producing process. If either of the essential parts are lacking, the flower is imperfect. Pistillate (female) flowers are those which possess a functional pistil or pistils but lack stamens. Staminate (male) flowers contain stamens but no pistils.

Because cross fertilization combines different genetic material and produces stronger seed, cross pollinated plants are usually more successful than self pollinated plants. Consequently, more plants reproduce by cross pollination than self pollination.

There are plants which bear only male flowers (staminate plants) or bear only female flowers (pistillate plants). Species in which the sexes are separated into staminate and pistillate plants are called dioecious. Most holly trees are either male or female plants. Therefore, to get berries it is necessary to have a female tree and a male tree near by that will provide pollen. Monecious plants are ones which have separate male and female flowers on the same plant. Corn plants and pecan trees are examples. Some plants bear only male flowers at the beginning of the growing season but later develop both sexes; for example, cucumbers and squash.

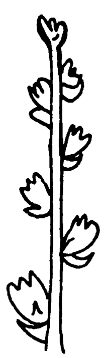
<u>How Seeds Form</u> Pollination is the transfer of pollen from an anther to a stigma. This may occur by wind or by pollinators. Wind pollinated flowers lack showy floral parts and nector since they don't need to attract a pollinator. Flowers are brightly colored or patterned and contain a fragrance or nectar when they must attract insects, animals or birds. In the process of searching for nectar, these pollinators will transfer pollen from flower to flower.

The stigma contains a chemical which excites the pollen, causing it to grow a long tube down the inside of the style to the ovules inside the ovary. The sperm is released by the pollen grain and fertilization typically occurs. Fertilization is the union of the male sperm nucleus from the pollen grain and the female egg found in the ovary. If fertilization is sucessful, the ovule will develop into a seed.

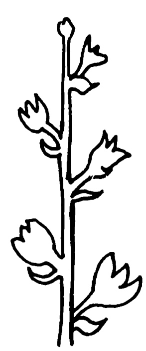
<u>Inflorescence</u> Some plants bare only one flower per stem and are called solitary flowers. Many produce an inflorescence, a term which refers to a cluster of flowers and how they are arranged on a floral stem, called a peduncle. Most inflorescences may be classified into two groups. In the racemose group, the florets, which are individual flowers in an inflorescence, bloom from the bottom of the stem and progress toward the top. Some examples of racemose inflorescence include spike, raceme, corymb, umbel and head. A spike is an inflorescence in which many stemless florets are attached to an elongated flower stem or peduncle, an example being gladiolus. A raceme is similar

to a spike except the florets are borne in small stems attached to the peduncle. An example of a raceme inflorescence is the snapdragon. A corymb is made up of florets whose stalks, pedicals, are arranged at random along the peduncle in such a way that the florets create a flat round top. Yarrow has a corymb inflorescence. An umbel is similar except that the pedicles all arise from one point on the peduncle. Dill has an umbel inflorescence. A head or composite inflorescence if made up of numerous stemless florets which is characteristic of daisy inflorescence.

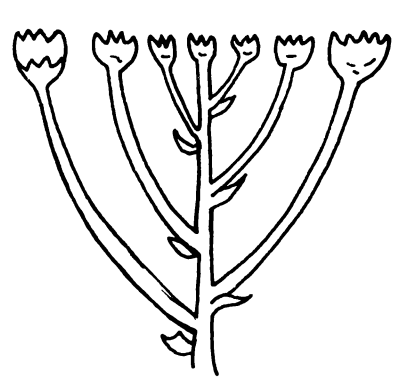
The second group of inflorescences is called a cyme. In this case the top floret opens first and blooms downward along the peduncle. A dischasium cyme has florets opposite each other along the peduncle. Baby's breath inflorescence is an example. A hilicoid cyme is one in which the lower florets are all on the same side of the peduncle, examples being freesia and statice inflorescences. A scorpiocle cyme is one in which the florets are alternate to each other along the peduncle. Examples are tomatoes and potatoes inflorescences.



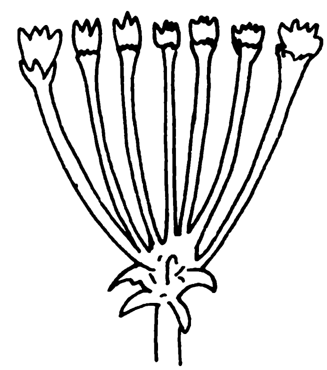
Spike



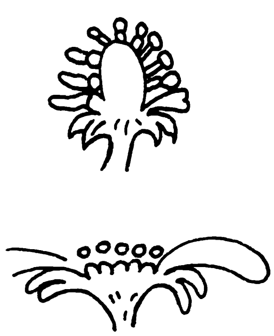
Raceme



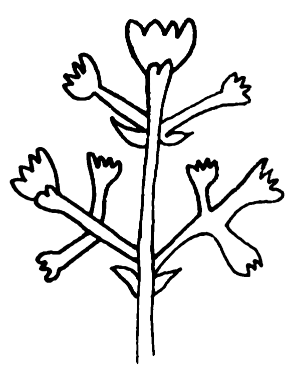
Corymb



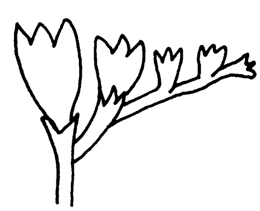
Umbel



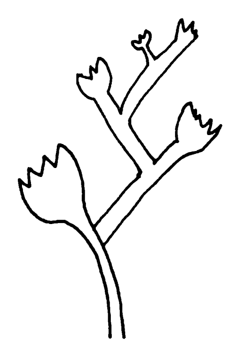
Head



Dischasium cyme



Helicoid cyme



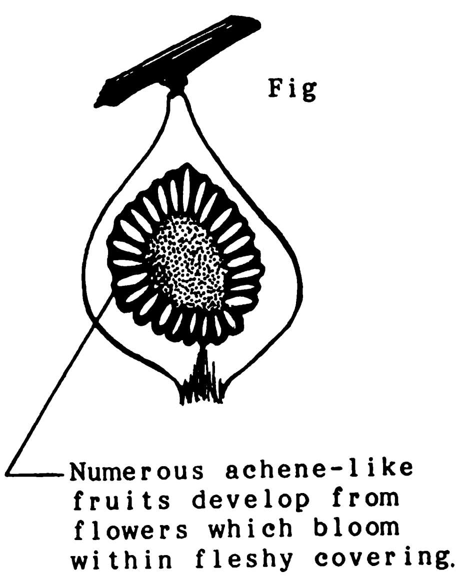
Scorpioid cyme

Fruits

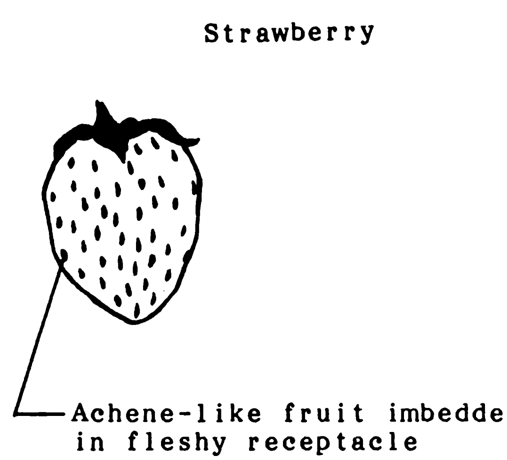
Fruit consists of the fertilized and mature ovules called seeds and the ovary wall which may be fleshy as in the apple or dry and hard as in a maple fruit. The only parts of the fruit which are genetically representative of both the male flower and female flower are the seeds (mature ovules). The rest of the fruit arises from the maternal plant and is therefore genetically identical to that parent plant. Some fruits have seeds enclosed within the ovary (apples, peaches, oranges, squash, cucumbers). Other have seeds that are situated on the periphery of fruit tissue (corn cob, strawberry flesh).

Fruits can be classified as simple fruits, aggregate fruits, or multiple fruits. Simple fruits are those which develop from a single ovary. These include fruits such as cherries, and peaches (drupe), pears, and apples (pome), and tomatoes (berries). Tomatoes are a botanical fruit since they develop from the flower as do squash, cucumbers, eggplant. All of these fruits develop from a single ovary. Other types of simple fruit are dry. The fruit wall in these fruits becomes papery or leathery and hard as opposed to the fleshy examples just mentioned. Examples are peanut (legumes) poppy (capsule) maple (samara) and walnut (nut). An aggregate fruit comes from a single flower which has many ovaries. The flower appears as a simple flower with one corolla, one calyx, and one stem but with many pistils or ovaries. Examples are strawberry, raspberry, and blackberry. The ovaries are fertilized separately and independently. If ovules are not pollinated successfully, the fruit will be misshapen and imperfect.

Multiple Fruit

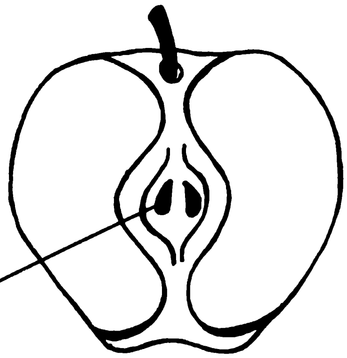


Aggregate Fruit



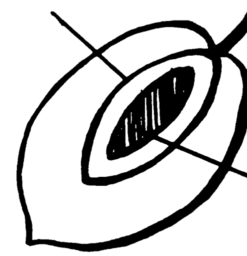
Multiple fruits are derived from a tight cluster of separate, independent flowers borne on a single structure. Each flower will have its own calyx and corolla. Examples of multiple fruits are pineapple, fig, and the beet seed. Multiple fruits are not common in Virginia.

KINDS OF FRUIT



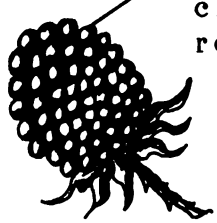
Pome

Simple



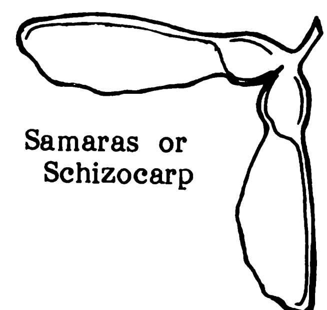
Drupe

Simple



Berry

Aggregate

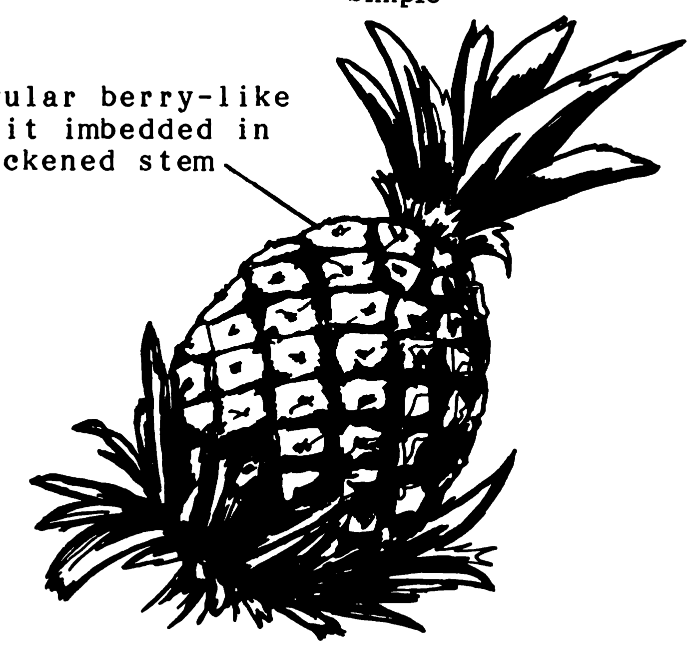


Samaras or Schizocarp

Dry Fruit

Simple

Cone composed of leaf-like vegetative material and dry fruit

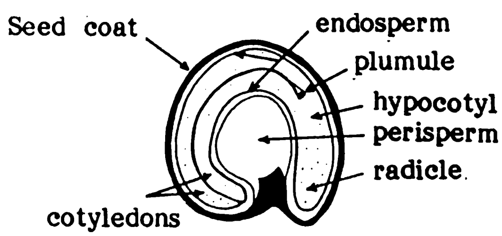


Pineapple

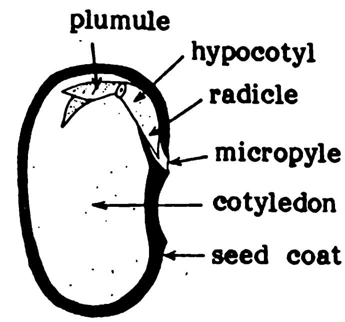
Multiple

The seed or matured ovule is made up of 3 parts. The embryo is a miniature plant in an arrested state of development. Most seeds contain a built-in food supply called the endosperm (orchid is an exception). The endosperm can be made up of proteins, carbohydrates or fats. The third part is the hard outer covering, called a seed coat, which protects the seed from disease and insects and prevents water from entering the seed and initiating the germination process before the proper time.

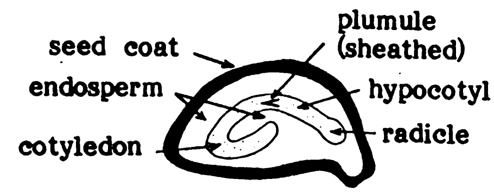
Parts of a Seed



Beta vulgaris



Phaseolus vulgaris
(one cotyledon removed)



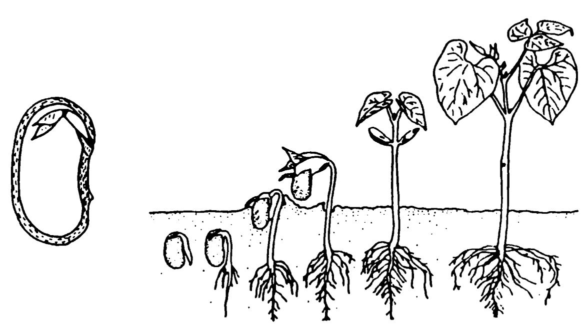
Allium cepa

Seedlings

Germination is the resumption of active growth of the embryo. Prior to any visual signs, the seed must imbibe water through the seed coat. In addition, the seed must be in the proper environmental conditions; that is, exposed to oxygen, favorable temperatures and for some, correct light. The radicle is the first part of the seedling to emerge from the seed. It will develop into the primary root from which root hairs and lateral roots will develop. The portion of the seedling between the radicle and the first leaf-like structure is called the hypocotyl. The seed leaves, cotyledons, encase the embryo and are usually different in shape from the leaves that the mature plant will produce. Plants producing one cotyledon fall into the group of monocotyledons. Plants producing two seed leaves are called dicotyledon.

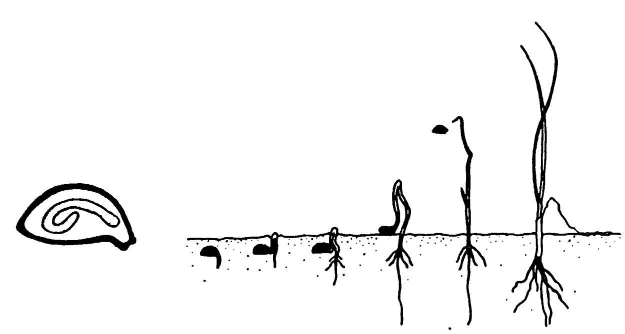
Germination of a Dicot

Phaseolus vulgaris



Germination of a Monocot

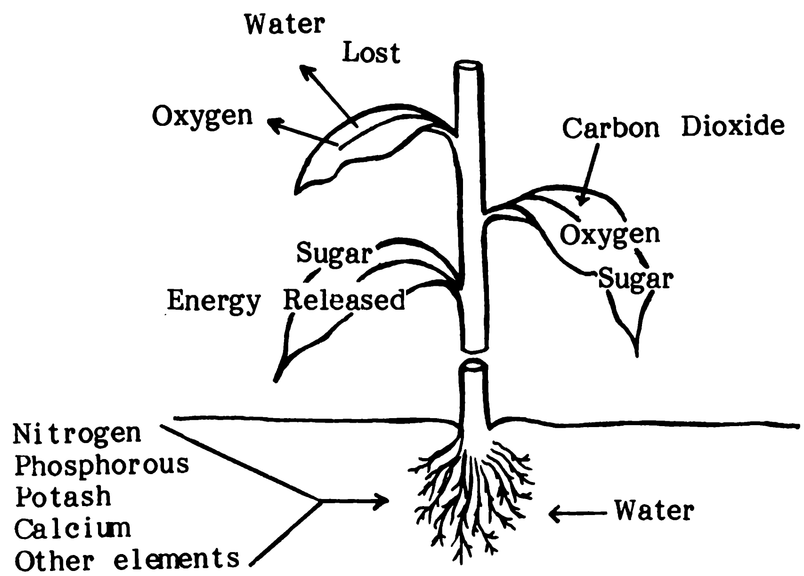
Allium cepa



PLANT GROWTH AND DEVELOPMENT

The three major plant functions that are the basics for plant growth and development are photosynthesis, respiration, and transpiration.

Photosynthesis = water + energy from sun + carbon dioxide



HOW A PLANT GROWS

Photosynthesis

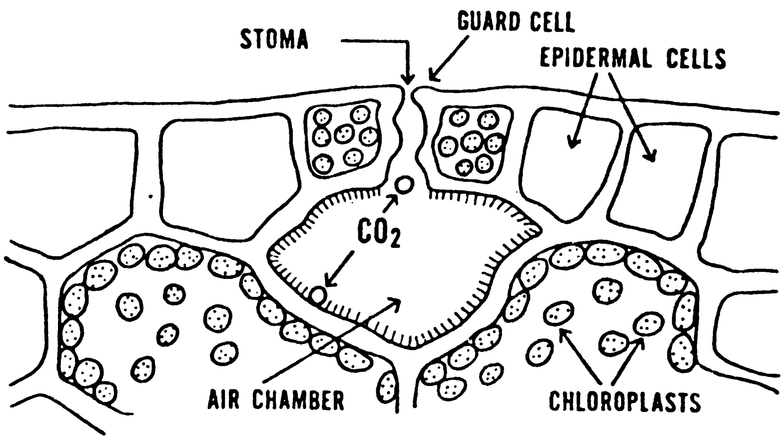
One of the major differences between plants and animals is the plant's ability to manufacture its own food. To produce food for itself, a plant requires energy from sunlight, carbon dioxide from the air, and water from the soil. If any of these ingredients is lacking, photosynthesis, or food production will stop. If any factor is removed for a long period of time, the plant will die. Photosynthesis literally means "to put together with light."

$$\text{CARBON DIOXIDE} + \text{WATER} \xrightarrow[\text{CHLOROPHYLLOUS CELLS}]{\text{673 kg.-cal. of radiant energy}} \text{SUGAR} + \text{OXYGEN}$$

$$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

Plants can store the energy from light in carbohydrates such as sugars and starches for use during days when light is limited or they can transport these chemicals to the roots. Sugars and starches are converted back to water and carbon dioxide and the stored energy is released to perform activities necessary for growth in a process called respiration.

Only cells in the mesophyll layer of the plant leaves and stems can manufacture energy. These cells, which contain chloroplasts, are located between, and protected by, the upper and lower epidermis (skin) of the leaf. The green pigment, chlorophyll, that is found in the chloroplasts of these cells traps light energy so it can be used to manufacture sugar and starches.



LEAF CROSS SECTION

Photosynthesis is dependent on the availability of light. Generally speaking, as sunlight increases in intensity, photosynthesis increases. This means greater food production. Many garden crops, such as tomatoes, respond best to maximum sunlight. Tomato production is cut drastically as light intensities drop. Only two or three varieties of tomatoes will produce any fruit at all in greenhouses in late fall and early spring months when sunlight is minimal.

Water plays an important role in photosynthesis in several ways. First, it maintains a plant's turgor or the firmness or fullness of a plant tissue. Turgor pressure in a cell can be compared to air in an inflated balloon. Water pressure or turgor is needed in plant cells to maintain their shape and insure cell growth. Second, water is split into hydrogen and oxygen by the energy of the sun that has been absorbed by the chlorophyll in the plant leaves. The oxygen is released to the atmosphere and the hydrogen is used in the manufacture of charbohydrates. Third, water dissolves minerals from the soil, transports them from the roots and throughout the plant where they serve as raw materials in the growth of new plant tissues. The soil surrounding a plant should be moist but not too wet or too dry. Water is pulled through the plant by evaporation of water through the leaves, a process called transpiration. When the guard cells in leaves shrink thus opening the stomata, water is lost from the leaf.

The photosynthesis also requires carbon dioxide (CO2) which enters the plant through the stomata. Carbon dioxide is split into carbon and oxygen which are used in the manufacture of carbohydrates. Carbon dioxide in the air is plentiful enough so that it is not a limiting factor in plant growth. However, since carbon dioxide is consumed in making sugars and is not replenished by plants at a rapid rate, a tightly closed greenhouse in midwinter may not allow enough outside air to enter the greenhouse to maintain an adequate carbon dioxide level. Under these conditions improved crops of roses, carnations, tomatoes, and certain other crops are produced if the carbon dioxide level is raised with carbon dioxide generators or, in small greenhouses, dry ice.

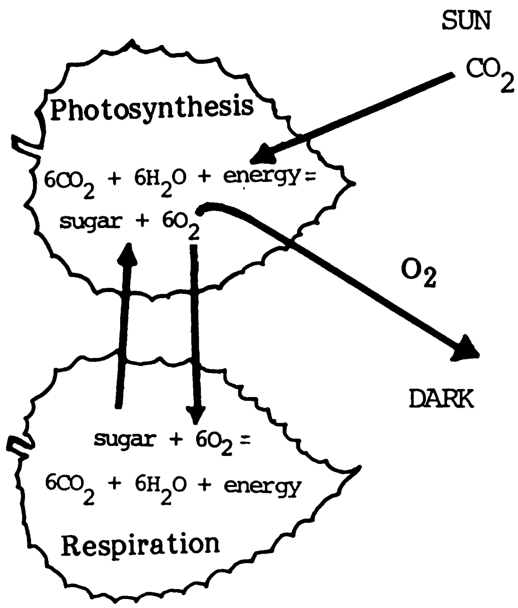
Although not a direct component in photosynthesis, temperature is an important factor. Photosynthesis occurs at its highest rate in a temperature range of 65 to 85 degrees F (18 to 27 degree C) and decreases with temperatures above or below this range.

Respiration

The foods made during photosynthesis are of value to the plant when they are converted to energy. This energy is used in the process of building new tissues or growth of the plant. The chemical process by which the sugars and starches produced by photosynthesis are converted to energy is called oxidation. It is similar to the burning of wood or coal to produce heat. The controlled oxidation in a living cell is known as respiration and is shown most simply by this equation:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Heat}$$

This equation is just the opposite of that used to illustrate photosynthesis. Therefore, photosynthesis may be called a building process, while respiration is a breaking down process.



PHOTOSYNTHESIS AND RESPIRATION

Photosynthesis	Respiration
1. Produces food	1. Uses food for plant energy
2. Energy is stored	2. Energy is released
3. Occurs in cells that contain chloroplasts	3. Occurs in all cells
4. Oxygen is released	4. Oxygen is used
5. Water is used	5. Water is produced
6. Carbon dioxide is used	6. Carbon dioxide is produced

By now it should be clear that respiration is the reverse of photosynthesis. Unlike photosynthesis, respiration occurs at night as well as during the day. Respiration occurs in all life forms and in all cells. The release of accumulated carbon dioxide and the uptake of oxygen occurs at the cell level. In animals, blood carries both carbon dioxide and oxygen to and from the atmosphere by means of the lungs or gills. In plants, there is simple diffusion into the open spaces within the leaf and exchange through the stomates.

Transpiration

Transpiration is the process by which a plant loses water primarily from leaf stomata. Transpiration is a necessary process that involves the use of about 90% of the water that enters the plant through the roots. The other 10% of the water is used in chemical reactions and in plant tissues. Transpiration is necessary for mineral transport from the soil to the plant parts, for the cooling of plant parts through evaporation, to move sugars and plant chemicals, and for the maintenance of turgor pressure. The amount of water lost from the plant depends on several environmental factors such as temperature, humidity, and wind or air movement. As temperatures or air movement increase, transpiration increases. As humidity decreases, transpiration increases.

ENVIRONMENTAL FACTORS THAT AFFECT PLANT GROWTH

Plant growth and distribution are limited by the environment. If any one environmental factor is less than ideal, it will become a limiting factor in plant growth. Limiting factors are also responsible for the geography of plant distribution. For example, only plants adapted to limited amounts of water can live in deserts. Most plant problems are caused by environmental stress, either directly or indirectly. Therefore, it is important to understand the environmental aspects that affect plant growth. These factors are light, temperature, water, humidity, and nutrition.

Effect of Light on Plant Growth

Light has three principal characteristics that affect plant growth. These are light quantity, light quality, and light duration. Light quantity refers to the intensity or concentration of sunlight and varies with the season of the year. The maximum is present in the summer and the minimum in winter. The more sunlight a plant receives, up to a point, the better capacity it has to produce plant food through photosynthesis. As the sunlight quantity decreases, the photosynthetic process decreases. Light quantity can be decreased in a garden or greenhouse by using cheesecloth shading above the plants. It can be increased by surrounding plants with reflective material, white backgrounds, or supplemental lights.

Light quality refers to the color or wavelength reaching the plant surface. Sunlight can be broken up by a prism into respective colors of red, orange, yellow, green, blue, indigo, and violet. On a rainy day, raindrops act as tiny prisms and break the sunlight into these colors, producing a rainbow. Red and blue light have the greatest effect on plant growth. Green light is least effective to plants as they reflect green light and absorb none. It is this reflected light that makes them appear green to us. Blue light is primarily responsible for vegetative growth or leaf growth. Red light, when combined with blue light, encourages flowering in plants. Fluorescent light or cool white is high in the blue range of light quality and is used to encourage leafy growth. Such light would be excellent for starting seedlings. Incandescent light is high in the red or orange range, but generally produces too much heat to be a valuable light source. Fluorescent grow lights have a mixture of red and blue colors that attempts to imitate sunlight as closely as possible, but they are costly and generally not of any greater value than regular fluorescent lights.

Light duration refers to the amount of time that a plant is exposed to sunlight or the lack of it and is designated photoperiod. When photoperiod was recognized it was thought that the length of periods of light triggered flowering. The various categories of response were named according to the light length (i.e., short day and long day). It was then discovered that it is not the length of the light period but the length of uninterupted dark periods that is critical to floral development. The ability of many plants to flower is controlled by photoperiod. Plants can be classified into three categories, depending upon their flowering response to the duration of light or darkness. These are short-day, long-day, or day-neutral plants. Short-day plants form their flowers only when the day length is less than about 12 hours in duration. Short-day plants include many spring and fall flowering plants such as chrysanthemums and poinsettia. Long-day plants form flowers only at day lengths exceeding 12 hours (shortnights). They include almost all of the summer flowering plants such as rudbeckia and California poppy, as well as many vegetables including beet, radish, lettuce, spinach, and potato. Day-neutral plants form flowers regardless of day length. Some plants do not really fit into any category but may be responsive to combinations of day lengths. The petunia will flower regardless of the day length, but flowers earlier and more profusely under long daylight. Since chrysanthemums flower under the short days of spring, or fall, the method of manipulating the plant into experiencing short days is very simple. If long days are predominant, a shade cloth is drawn over the chrysanthemum for 12 hours daily to block out light until flower buds are initiated. To bring a long-day plant into flower when sunlight is not longer than 12 hours, artificial light is added until flower buds are initiated.

Effect of Temperature on Plant Growth

Temperature affects the productivity and growth of a plant, depending upon whether the plant is a warm or cool season crop. If temperatures are high and day length is long, cool season crops such as spinach will flower. Temperatures that are too low for a warm season crop such as tomato will prevent fruit set. Adverse temperatures also cause stunted growth and poor quality vegetable production; for example, bitterness in lettuce which is caused by high temperatures.

Sometimes temperatures are used in connection with daylength to manipulate the flowering of plants. Chrysanthemums will flower for a longer period of time if daylight temperatures are 59 degrees F (15 degrees C). The Christmas cactus forms flowers as a result of short days and low temperatures. Temperatures alone also influence flowering. Daffodils are forced to flower by putting the bulbs in cold storage in October at 35 to 40 degrees F (2 to 4 degrees C). The cold temperatures allow the bulb to mature. The bulbs are transferred to the greenhouse in midwinter where growth begins. The flowers are then ready for cutting in 3 to 4 weeks.

Thermoperiod refers to a daily temperature change. Plants respond to and produce maximum growth when exposed to a day temperature that is about 10 to 15 degrees higher than a night temperature. This allows the plant to photosynthesize (build up) and respire (break down) during an optimum daytime temperature and to curtail the rate of respiration during a cooler night. Temperatures higher than needed cause increased respiration, sometimes above the rate of photosynthesis. This means that the products of photosynthesis are being more rapidly used than they are being produced. For growth to occur, photosynthesis must be greater than respiration.

Too low temperatures can produce poor growth. Photosynthesis is slowed down at low temperatures. Since photosynthesis is slowed, growth is slowed, and this results in lower yields. Not all plants grow best under the same temperature range. For example, snapdragons grow best at nighttime temperatures of 55 degrees F (12 degrees C) and the poinsettia at 62 degrees F (17 degrees C). Florist cyclamen does very well under very cool conditions while many bedding plants prefer a higher temperature. Recently it has been found that roses can tolerate much lower nighttime temperatures than previously believed. This has meant a conservation in energy for greenhouse growers.

However, in some cases, a certain number of days of low temperature are needed by plants in order to grow properly. This is true of crops growing in cold regions of the country. Peaches are a prime example: most varieties require 700 to 1,000 hours below 45 degrees F (7 degrees C) but above 32 degrees F (0 degrees C) before they break their rest period and begin growth. Lilies need 6 weeks of temperatures at 33 degrees F (1 degree C) before blooming.

Plants can be classified as either hardy or nonhardy depending upon their ability to withstand cold temperatures. Winter injury can occur to nonhardy plants if temperatures are too low or if unseasonably low temperatures occur early in the fall or late in the spring. Winter injury may also occur because of desiccation or drying out. Plants need water during the winter. When the soil is frozen, the movement of water into the plant is severely restricted. On a windy winter day, broadleaf evergreens can become water-defficient in a few minutes and the leaves or needles then turn brown. Wide variations in winter temperatures can cause premature bud break in some plants and consequent fruit bud freezing damage. Late spring frosts can ruin entire peach crops. If temperatures drop too low during the winter, entire trees of some species are killed by freezing and splitting plant cells and tissue.

Review of Temperature Effects on Plant Growth:

Photosynthesis: increases with temperature to a point
Respiration: rapidly increases with temperature
Transpiration: increases with temperature
Flowering: may be partially triggered by temperature
Sugar storage: low temperatures reduce energy use and increase sugar storage
Break dormancy: after a period of low temperature, dormancy will be broken and the plant will resume active growth

Importance of Water

As mentioned earlier, water is a primary component in photosynthesis. It maintains the turgor pressure or firmness of a tissue and transports nutrients throughout the plant. In maintaining turgor pressure, water is the major constituent of the protoplasm of a cell. By means of turgor pressure and other changes in the cell, water regulates the opening and closing of the stomates, thus regulating transpiration. Water also provides the pressure to move a root through the soil. Among water's most critical roles is that of solvent for minerals moving into the plant and for carbohydrates moving to their site of use or storage. It is important in the chemical reactions of photosynthesis and respiration. By its gradual evaporation around the surface of the leaf near the stomate it helps to stabilize the temperature of the plant.

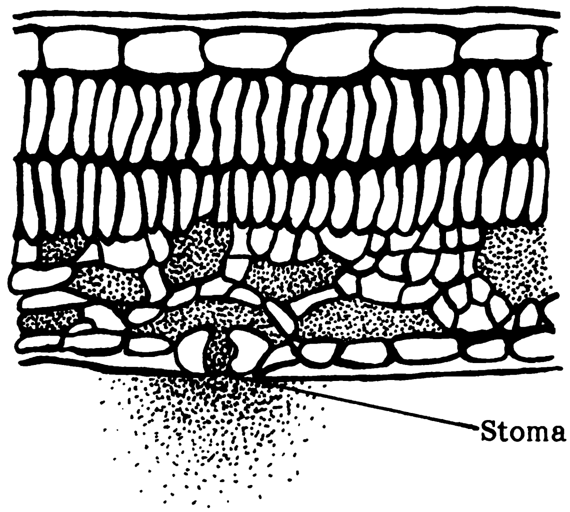
<u>Relative Humidity</u> is the ratio of water vapor in the air at a given temperature and pressure, to the amount of water the air could hold at that temperature and pressure, expressed as a percent. For example, if a pound of air at 75 degrees F could hold 4 grams of water vapor and there are only 3 grams of water in the air, then the relative humidity (RH) is :

RH=water in air/ water air could hold (at constant temperature and pressure)
or RH = 3/4 =.75 expressed as a % = 75%

Warm air can hold more water vapor than cold air, therefore, if the amount of water in the air stays the same and the temperature increases, the relative humidity decreases.

Water vapor will move from an area of high relative humidity to one of low relative humidity. The greater the difference in humidity the faster water will move.

The relative humidity in the air space between the cells within the leaf approaches 100%, therefore when the stomate is open the water vapor rushes out. As water moves out a bubble of high humidity is formed around the stomate. This "bubble" of humidity helps slow down transpiration and cool the leaf. If winds blow the humidity bubble away, transpiration will increase.



Cross section of leaf
Dots represent relative humidity

PLANT NUTRITION

Many people confuse plant nutrition with plant fertilization. Plant nutrition refers to the needs and uses of the basic chemical elements in the plant. Fertilization is the term used when these materials are supplied to the environment around the plant. A lot must happen before a chemical element, supplied in a fertilizer, can be taken up and used by the plant.

Plants need 17 elements for normal growth. Carbon, hydrogen, and oxygen are found in air and water. Nitrogen, potassium, magnesium, calcium, phosphorous, and sulfur are found in the soil. The above six elements are used in relatively large amounts by the plant and are called macronutrients. There are eight other elements that are used in much smaller amounts and are called micronutrients or trace elements. The micronutrients, which are found in the soil, are iron, zinc, molybdenum, manganese, boron, copper, cobalt, and chlorine. All 17 elements, both macronutrients and micronutrients, are essential for plant growth.

Most of the nutrients that a plant needs are dissolved in water and then absorbed by the roots. Ninety-eight percent of these plant nutrients are absorbed from the soil solution and only about 2% are actually extracted from the soil particles by the root. Most of the nutrient elements are absorbed as charged ions, or pieces of molecules (which are the smallest particle of a substance that can exist and still retain the characterictics of the substance). Ions may be positively charged cations or negatively charged anions. Positive and negative are equally paired so that there is no overall charge. For example, nitrogen may be absorbed as nitrate (NO_3^-) which is an anion with one negative charge. The potassium ion (K^+) is a cation with one positive charge. Potassium nitrate ($K^+NO_3^-$) would be one nitrate ion and one potassium ion. However, calcium nitrate ($Ca^{++}(NO_3^-)_2$) would have two nitrate ions and one calcium ion because the calcium cation had two positive charges.

The balance of ions in the soil is very important. Just as ions of the opposite charges attract each other, ions of similar charges compete for chemical interactions and reactions in the environment. Some ions are more active than others or can compete better. For example, both calcium (Ca^{++}) and magnesium (Mg^{++}) are cations with two charges, however, magnesium is more active. If both are in competition to be absorbed, the magnesium will be absorbed. This explains why the results of a soil test may indicate that while there is sufficient calcium in the soil the plant may still exhibit a calcium deficiency because of an excess of the more active magnesium. What may be expressed as a deficiency in one micronutrient may really be caused by an excess of another.

In order for the ions to be easily absorbed, they must first be dissolved in the soil solution. Some combinations of ions are easily dissolved, such as potassium nitrate. When other ions combine, they may precipitate or fall out of solution and thus become unavailable to the plant. Many of the micronutrients form complex combinations with phosphorous and calcium and precipitate out of the soil solution so the nutrients cannot be easily taken up by the plant. The pH, which is a measurement of acidity or alkalinity, greatly affects these chemical reactions. If the soil pH is extremely high (alkaline), many of the micronutrients precipitate out of the solution and are unavailable to the plant. When the soil pH is extremely low (acid), some of the micronutrients become extremely soluble and ion levels may become high enough to injure the plant. The effect of pH varies with the ion, the types of ions in the soil, and the type of soil. Therefore, not only is the amount of the nutrient important, but also the soil pH.

The water and oxygen in the soil must also be in available form. Since nutrients are taken up with water, there must be sufficient water for the plant to absorb. Water is taken into the plant both passively and actively. Water that is taken in passively requires no energy output by the plant. It flows through the plant due to differences in concentration between the soil solution and the liquid within the cell. Water that is actively absorbed requires energy from the plant. If there is no oxygen available, sugar cannot be burned to produce energy and therefore the nutrients cannot be absorbed.

Anything that lowers or prevents the production of sugars in the leaves can lower nutrient absorption. If the plant is under stress, due to low light or extremes in temperature, nutrient deficiency problems may develop. The stage of growth or how actively the plant is growing may also affect the amount of nutrients absorbed. Many plants go into a rest or dormancy during part of the year. During this rest period, few nutrients are absorbed. Plants may also absorb different nutrients just as flower buds begin to develop.

Nutrients transported from the root to the cell by the vascular system move into the cell across a cell membrane. There are three different ways this happens. First, an entire molecule or ion pair may move through the membrane. If the cell is using energy or active transport to absorb the ions then only one of the ions of the pair is pulled into the cell. The other will follow to keep the number of positive and negative charges even. Most anions (negative ions) are actively absorbed.

The second way of keeping the charges inside the cell balanced and absorbing a new ion is to exchange one charged ion for another one of the same charge. The hydrogen ion (H^+) is often released from the cell so that the cell can absorb another positive ion such as the potassium ion (K^+). Since this is a simple exchange or passive, absorption energy may not be required. Cations or positive ions may be passively absorbed by this method.

Both of the methods mentioned above may be passive or active. However, the third method, the carrier system, is always active absorption, requiring energy. Scientists have discovered that within the cell membrane there are specialized chemicals that act as carriers. The carrier, through chemical changes, attracts an ion outside the cell membrane and releases it inside the cell. Once the ion is inside the cell, it is attached to other ions so that it does not move out of the cell. Complex chemical reactions are involved in the entire process.

Although nutrients can be absorbed passively, research has shown that active absorption must take place if the plant is to grow and be healthy. The factors we discussed earlier about absorption by the root are also true for absorption by the cell. Here is a quick review of some of the factors that affect nutrient absorption: type of ion, pH, solubility of ion pairs, water, soil oxygen, sugar supply, plant stress, and temperature.

<u>Foliar Absorption: A Special Case</u> Under normal growing conditions, plants absorb most nutrients, except carbon, hydrogen and oxygen, from the soil. However, some nutrients can also be absorbed by the leaves if a dilute solution is sprayed on the leaves. The factors that affect absorption by the cell are still important because the nutrient must enter the cell to be used by the plant. Care must be taken that the concentration of the nutrient is not too high or the leaf will be injured. Also, the leaf is covered by a thin layer of wax called the cuticle that the nutrient must get around or through before it can enter the cell.

MACRONUTRIENT OUTLINE

Nitrogen(N)

absorbed as NO_3^-, NH_4^+
leaches from soil especially NO_3^-
mobile in plant.

Nitrogen excess:
succulent growth, dark green color, weak spindly growth, few fruits, may cause brittle growth especially under high temperatures.

Nitrogen deficiency:
reduced growth, yellowing (chlorosis), reds and purples may intensify with some plants, reduced lateral breaks. Symptoms appear first on older growth.

action notes:
in general best NH_4^+/NO_3^- ratio is 1/1.
high NH_4^+ under low sugar conditions (low light) can cause leaf curl.
uptake inhibited by high P levels.
N/K ratio extremely important.
indoors best N/K ratio is 1/1 unless light is extremely high.
in soils with high CHO/N ratio more N should be supplied.

Phosphorus (P)

absorbed as $H_2PO_4^-$, HPO_4^-
does not leach from soil readily
mobile in plant.

Phosphorus excess:
shows up as micronutrient deficiency of Zn, Fe, or Co

Phosphorus deficiency:
reduced growth, color may intensify, browning or purpling in foliage in some plants, thin stems, reduced lateral breaks, loss of lower leaves, reduced flowering.

action notes:
rapidly "fixed" on soil particles when applied under acid conditions fixed with Fe,Mg and Al. Under alkaline conditions fixed with Ca. Important for young plant and seedling growth. High P interferes with micronutrient absorption and N absorption. Used in relatively small amounts when compared to N and K. May leach from soil high in bark or peat.

Potassium (K)

absorbed as K^+
leaches from soil.
mobile in plant.

Potassium excess:
causes N deficiency in plant and may affect the uptake of other positive ions

Potassium deficiency:
reduced growth, shortened internodes, marginal burn or scorch (brown leaf edges), necrotic (dead) spots in the leaf, reduction of lateral breaks and tendency to wilt readily.

action notes:
N/K balance is important.
high N/low K favors vegetative growth; low N/high K promotes reproductive growth (flower, fruit).

Magnesium (Mg)

absorbed as Mg^{++}
leaches from soil.
mobile in plant.

Magnesium excess:
interferes with Ca uptake.

Magnesium deficiency:
reduction in growth, marginal chlorosis, interveinal chlorosis (yellow between the veins) in some species. May occur with middle or lower leaves, reduction in seed production, cupped leaves.

action notes:
Mg is commonly deficient in foliage plants because it is leached and not replaced. Epson salts at a rate of 1 teaspoon per gallon may be used 2 times a year. Mg can also be absorbed by leaves if sprayed in a weak solution. Dolomitic limestone can be applied in outdoor situations to rectify a deficiency.

Calcium (Ca)

absorbed as Ca^{++}
moderately leachable.
limited mobility in plant.

Calcium excess:
interferes with Mg absorption
high Ca usually causes high pH which then precipitates many of the micronutrients so that they become unavailable to the plant.

Calcium deficiency:
inhibition of bud growth, death of root tips, cupping of maturing leaves, weak growth, blossom end rot of many fruits, pits on root vegetables.

action notes:
Ca is important to pH control and is rarely deficient if the correct pH is maintained. Water stress, too much or too little, can affect Ca relations within the plant causing deficiency in the location where Ca was needed at the time of stress.

Sulfur (S)

absorbed as SO_4^-
leachable.
not mobile.

Sulfur excess:
sulfur excess is usually in the form of air pollution.

Sulfur deficiency:
S is often a carrier or impurity in fertilizers and rarely deficient. It may be also absorbed from the air and is a by-product of combustion. Symptoms are a general yellowing of the affected leaves or the entire plant.

MICRONUTRIENT OUTLINE

The majority of the micronutrients are not mobile thus the deficiency symptoms are usually found on new growth. Their availability in the soil is highly dependant upon the pH and the presence of other ions. The proper balance between the ions present is important as many microelements are antagonistic to each other. This is especially true of the heavy metals where an excess of one element may show up as a deficiency of another. If the pH is maintained at the proper level and a fertilizer which contains micronutrients is used once a year, deficiency symptoms are rarely found on indoor plants, with the exception of iron. Many of the microelements are enzyme activators.

Iron (Fe)
- absorbed as Fe^{++}, Fe^{+++}

Iron deficiencies:
- Interveinal chlorosis primarily on young tissue which may develop to white.
- Fe deficiency may be found under the following conditions even if Fe is in the soil:
  - soils high in Ca, poorly drained soil, soil high in Mn, high pH, high P, soil high in heavy metals (Cu,Zn) oxygen deficient soils or when nematodes attack the roots.
- Fe should be added in the chelate form, the type of chelate needed depends upon the soil pH.

Iron toxicity:
- rare except on flooded soils.

Boron (B)
- absorbed as $BO3^{-}$

Boron deficiency:
- failure to set seed, internal breakdown, death of apical buds.

Boron excess:
- blackening or death of tissue between veins.

Zinc (Zn)
- absorbed as Zn^{++}

Zinc deficiency:
- "little leaf," reduction in size of leaves, short internodes, distorted or puckered leaf margins, interveinal chlorosis.

Zinc excess:
- appears as Fe deficiency.
- interferes with Mg.

Copper (Cu)
- absorbed as Cu^{++}, Cu^{+}

Copper deficiency:
- new growth small, misshappen, wilted. May be found in some peat soils.

Copper excess:
- can occur at low pH. Shows up as Fe deficiency.

Manganese (Mn)
absorbed as Mn^{++}
Manganese deficiency:
interveinal chlorosis of leaves followed by brown spots producing a checkered effect
Manganese excess:
reduction in growth, brown spotting on leaves. Shows up as Fe deficiency. Found under acid conditions.

Molybdenum (Mo)
absorbed as $MoO4^{-}$
Molybdenum deficiency:
interveinal chlorosis on older or midstem leaves, twisted leaves (whiptail)

Chlorine (Cl)
absorbed as Cl^{-}
Chlorine deficiency:
wilted leaves which become bronze then chlorotic then die; club roots.
Chlorine toxicity:
salt injury, leaf burn, may increase succulence.

Cobalt (Co)
absorbed as Co^{++}
need by plants recently established
essential for Nitrogen fixation
little know about deficiency or toxicity symptoms

FERTILIZERS

Fertilizers are materials containing plant nutrients, that are added to the environment around the plant. Generally, they are added to the water or soil, but some can also be added to the air or sprayed on the leaves. Fertilizers are not plant food! Although it is common practice for many fertilizers to be called plant food, this is a misnomer. Plants produce their own food using water, carbon dioxide, and energy from the sun. This food, sugars and carbohydrates, is combined with the plant nutrients to produce protein, enzymes, vitamins and other elements essential to plant growth. For more information see the fertilizer section of soils.

ENTOMOLOGY

BASICS OF ENTOMOLOGY

INTRODUCTION

Insects and mites are among the oldest and most numerous animals on earth. Nobody knows just how many types of insects there are, but it is estimated that over 100,000 different kinds live in North America. In the typical backyard, there are probably 1,000 insects at any given time. While those insects which cause problems for man are the ones you hear about, the vast majority are either beneficial or harmless. Insects pollinate most fruits and vegetables. They provide food for birds and fishes. Some produce such useful products as: honey, wax, shellac, and silk. They feed upon other insects.

The insects that cause damage eat about one tenth of our crops each year and spread plant diseases to an unknown portion. They spread diseases among people as well. If it were not for chemical and cultural control methods, our losses would be much greater than they are.

This chapter is designed to acquaint you with the basic principles that apply to identification of insects and mites on horticultural crops, and to familiarize you with the more commonly encountered insects.

BASICS OF CLASSIFICATION

The Animal Kingdom has major divisions known as phyla. Several of the phyla which contain agricultural pests are:

- Arthropoda (insects, spiders, crayfish, millipedes)
- Aschelminthes (roundworms, trichina)
- Platyhelminthes (flatworms, flukes, tapeworms)
- Mollusca (snails, slugs, clams)

We are primarily concerned with the Arthropoda, which represents more than three fourths of the animal species known to exist. Arthropods have certain characteristics in common; they are segmented and their skeletons are on the outside of their bodies.

The Arthropods are divided into classes. Table 1 describes a few of the more important classes. The more important orders of the class Insecta are described in Table 2.

Most of the names of insect orders have the ending "ptera" which means that the insect possesses wings in the adult stage. The characteristics which separate insects into various orders are easily seen without magnification. Mouthparts, wings, and type of metamorphosis are identifying characteristics.

Each order consists of several families. The family is the next and more finite grouping of very closely related insects. Family names end with "idae." Aphidae (aphids), Muscidae (house flies), and Blattidae (cockroaches) are examples of families of insects.

Classes of the Phylum Arthropoda

Table 1.

Class	Examples	Body Segments	Pairs of Legs	Agricultural Importance
Crustacea	Crayfish Sowbugs	2	5	Sowbugs can be minor pests
Arachnida	Spiders, Mites, Ticks Daddy Longlegs	2	4	Some mites are major plant pests
Symphyla	Symphalans	2	12	Symphylans can be serious pests
Insecta	Bugs, Beetles Butterflies	3	13	Large number are pests

Table 2. Orders of the Class Insecta

Order	Common Name	Metamorphosis	Mouthparts	Wings
Collembola	Springtales	none	chewing	none
Orthoptera	Crickets, Grasshoppers	gradual	chewing	2 pair
Isoptera	Termites	gradual	chewing	2 pair
Thysanoptera	Thrips	gradual	rasping-sucking	2 pair
Hemiptera	True Bugs	gradual	piercing-sucking	2 pair
Homoptera	Aphids Scale	gradual	piercing-sucking	2 pair
Coleoptera	Beetles, Weevils	complete	chewing	2 pair
Lepidoptera	Butterflies Moths	complete	chewing or siphoning	2 pair
Hymenoptera	Bees, Wasps Ants	complete	chewing	2 pair or none
Diptera	Flies	complete	chewing or piercing-sucking	1 pair
Siphonoptera	Fleas	complete	chewing or piercing-sucking	none
Dermoptera	Earwig	gradual	chewing	2 pair
Thysamera	Silverfish	gradual	chewing	none

Families are further divided into Genus and Species. The most commonly found insects also acquire common names by which most people know them. Sometimes one species will have several common names. Heliothis zea is an example; on corn it is called the corn earworm, but when it is a pest on tomatoes it is the tomato fruitworm. The house fly, Musca domestica, serves here as an example of classification:

Phylum: Arthropoda
Class: Insecta
Order: Diptera
Family: Muscidae
Genus: Musca
Species: domestica
common name: house fly

Most common names of insects refer to large groups, such as families or orders, rather than individual species. The term beetle refers to the entire order Coleoptera, which includes thousands of different species. However, the name fly and bug are used for insects in more than one order. When the bug of an insect's name is written separately (for example, stink bug or lace bug), the insect belongs to the order Hemiptera, which is often referred to as the true bugs.

Since there are many insect species, and because many of them are small and seldom encountered, relatively few have common names. Those which do are either particularly showy insects, such as the luna moth and tiger swallowtail, or they are economically important species like the honey bee and the southern pine beetle.

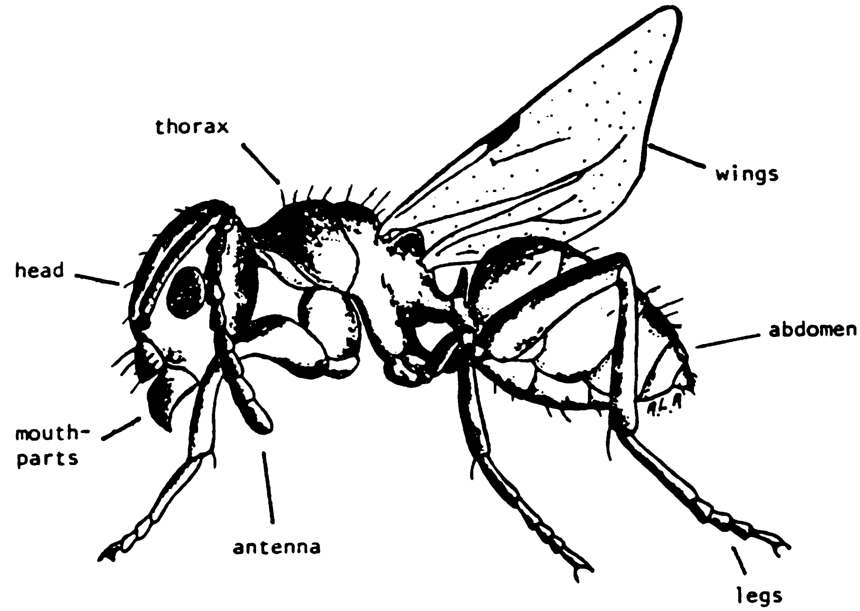
INSECT FORM AND STRUCTURE - MORPHOLOGY

Insects possess the following characteristics: a) three body regions; b) three pairs of legs; c) one pair of antennae; and d) none, one or two pairs of wings. Legs and other appendages are often greatly modified to suit the environment in which the insect lives.

The Insect Body

Head, Thorax, Abdomen While the adult insect's body is made up of three parts (head, thorax, and abdomen), the division is not always obvious between thorax and abdomen. An insect's body is not supported by a bony skeleton but by a tough body wall or exoskeleton. The tough covering of skin is referred to as the cuticle. The cuticle contains a layer of wax which determines its permeability to water (even to insecticides) and prevents desiccation or drying. The cuticle of each segment is formed into several hardened plates called sclerites, separated by infolds or sutures which give it flexibility. The cuticle of the larva is not usually as hardened as that of the adult.

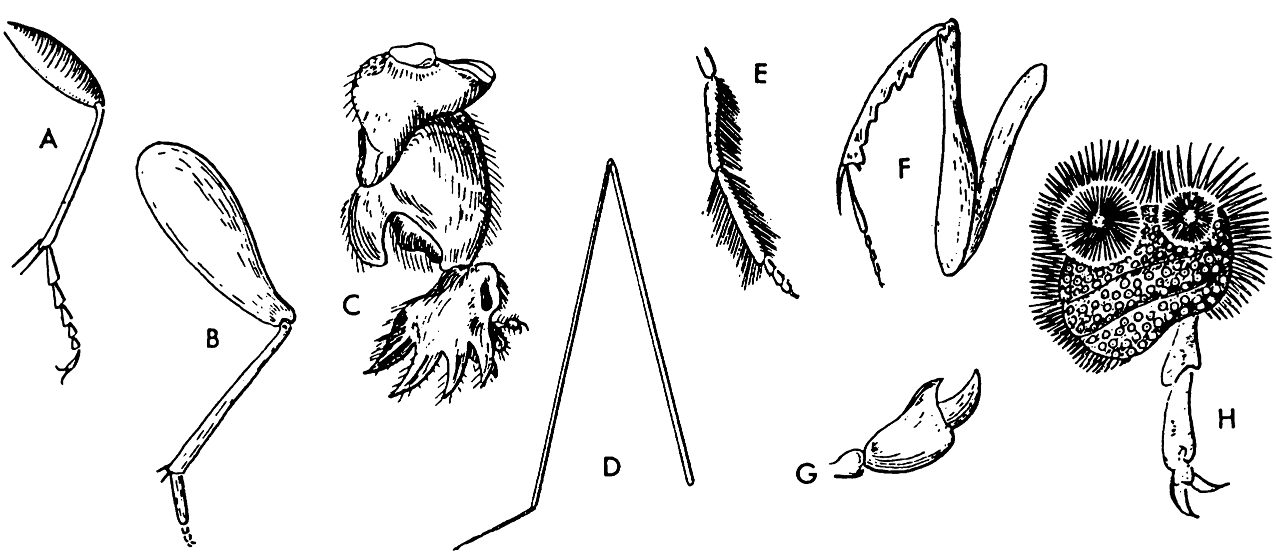
The thorax is made up of three segments: prothorax, mesothorax, and metathorax. Each of these segments bears a pair of legs. The wings are attached to the mesothorax and metathorax, never to the prothorax or first segment. The thickened front wings of beetles serve as protective covering, and cover the wings when not flying.



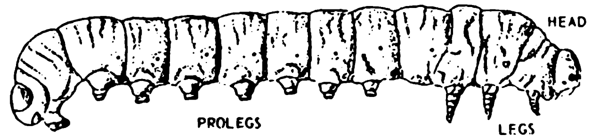
PARTS OF AN INSECT

The abdomen may have eleven or twelve segments, but in most cases they are difficult to distinguish. Some insects have a pair of appendages at the tip of the abdomen. They may be short, as in grasshoppers, termites, and cockroaches; or extremely long, as in mayflies; or curved, as in earwigs.

<u>Legs</u> The most important characteristic of insects is the presence of three pairs of jointed legs. These are almost always present on adult or mature insects and are generally present in the other stages as well. In addition to walking and jumping, insects often use their legs for digging, grasping, feeling, swimming, carrying loads, building nests, and cleaning parts of the body. The legs of insects vary greatly in size and form and are much used in classification.

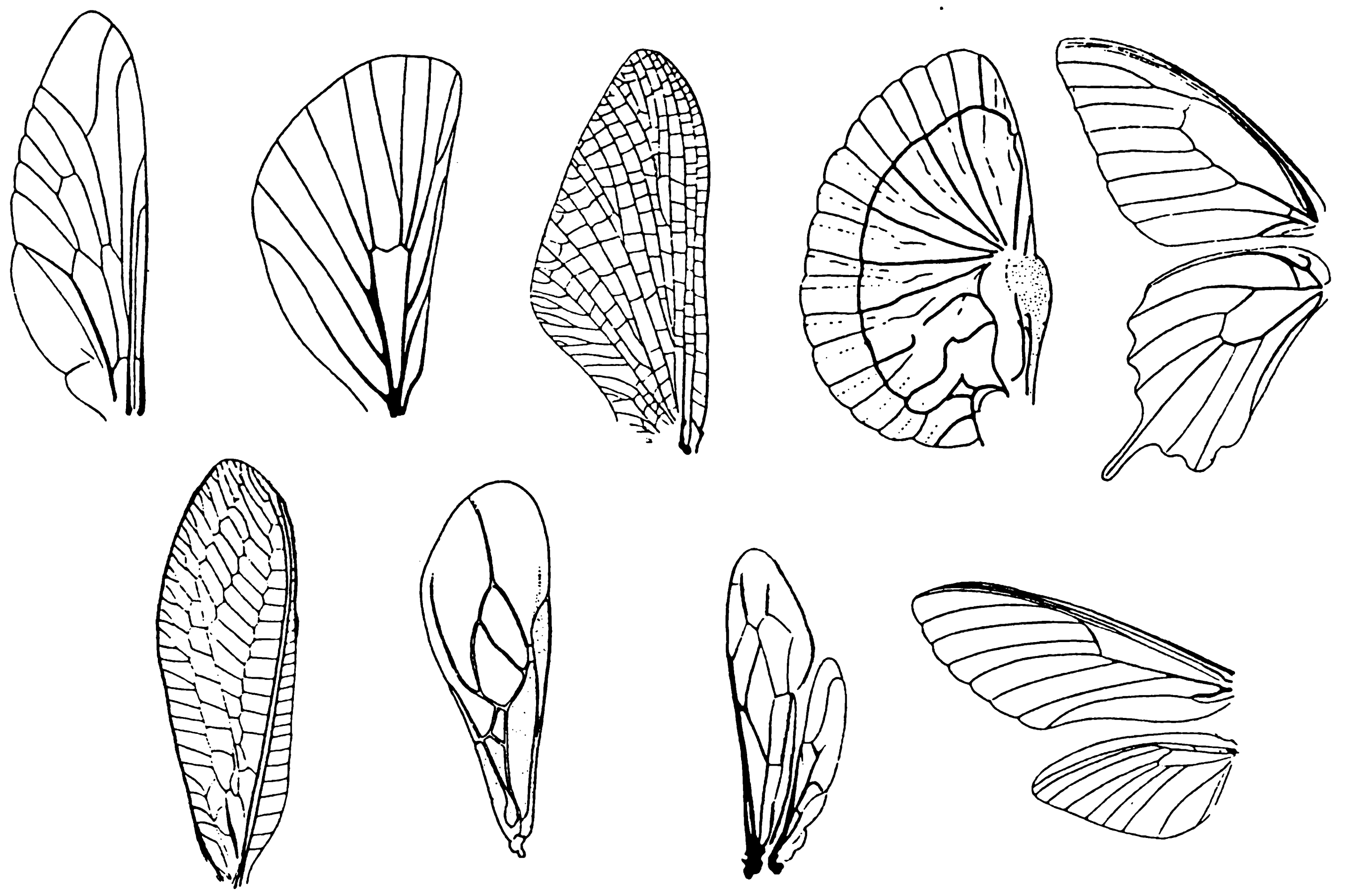


Leg Adaptations of Some Insects.
A. Running (ground beetle); B. Jumping (cricket); C. Digging (mole cricket); D. Walking on grass (walkingstick); E. Swimming (whirligig beetle); F. Grasping (praying mantid); G. Hanging on to hairs (louse); H. Suction cups (diving beetle).



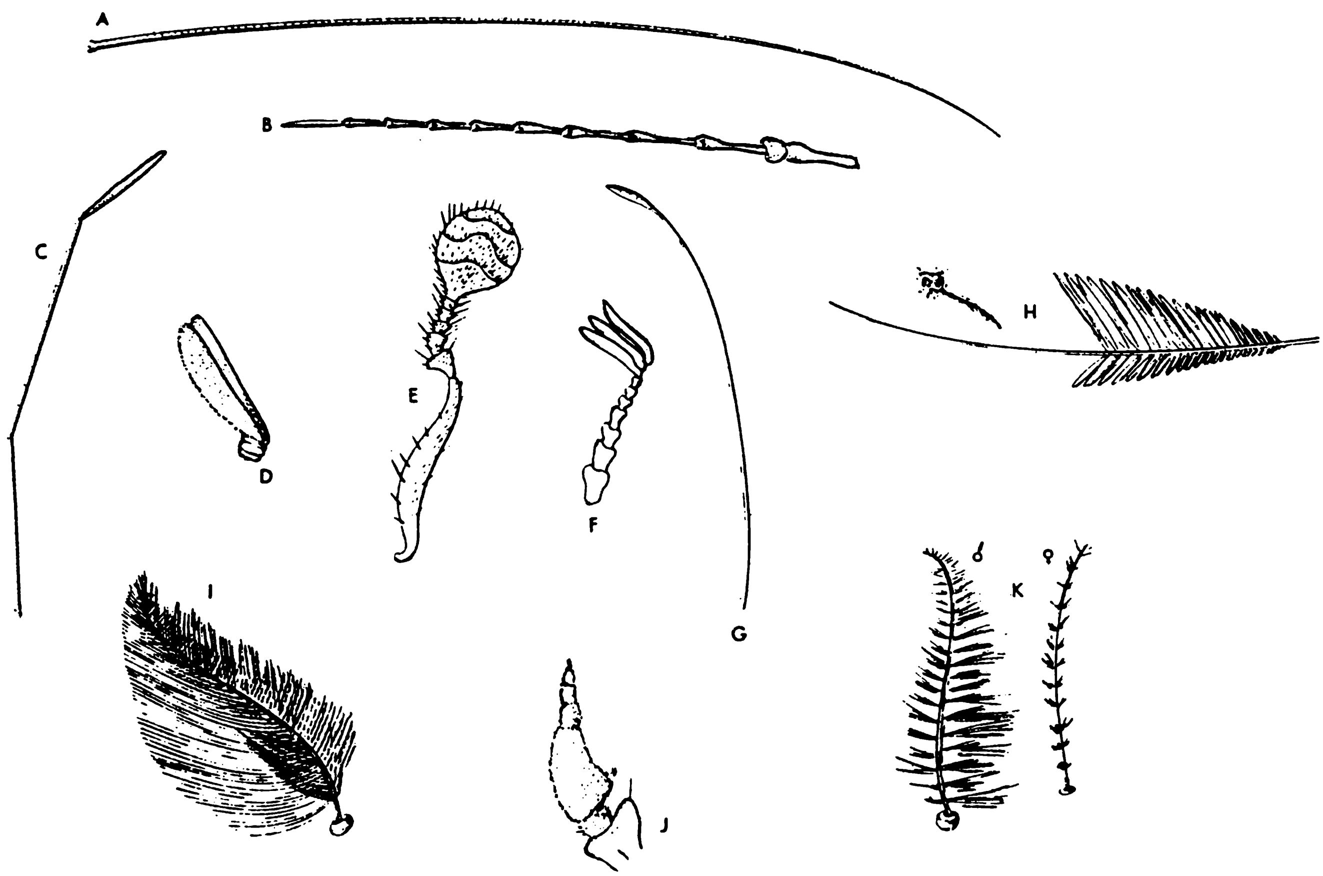
Prolegs (fleshy body projections) occur only in larvae and are used for clinging to plants.

<u>Wings</u> Venation, or arrangement of the veins of the wings, is different for each species of insect; thus, it serves as a means of identification. Systems have been devised to designate the venation for descriptive purposes. Wing surfaces are covered with fine hairs or scales, or they may be bare. It will be noted that the names of the orders in the majority of cases end in "ptera", which comes from the Greek word meaning wing. Thus, each of these names denotes some feature of the wings. Hemiptera means half winged; Hymenoptera means membrane winged; Diptera means two winged.



Some Insect Wings Showing Venation

Antennae and Mouthparts The main features of the insect's head are the eyes, antennae, and mouthparts. The antennae are a prominent and distinctive feature of insects, and one pair is always present on the adult's head (except in the scale insects at times); they are usually located between or in front of the eyes. Antennae are segmented, vary greatly in form and complexity, and are often referred to as horns or feelers, which is misleading. They are primarily organs of smell but serve other functions in some insects.

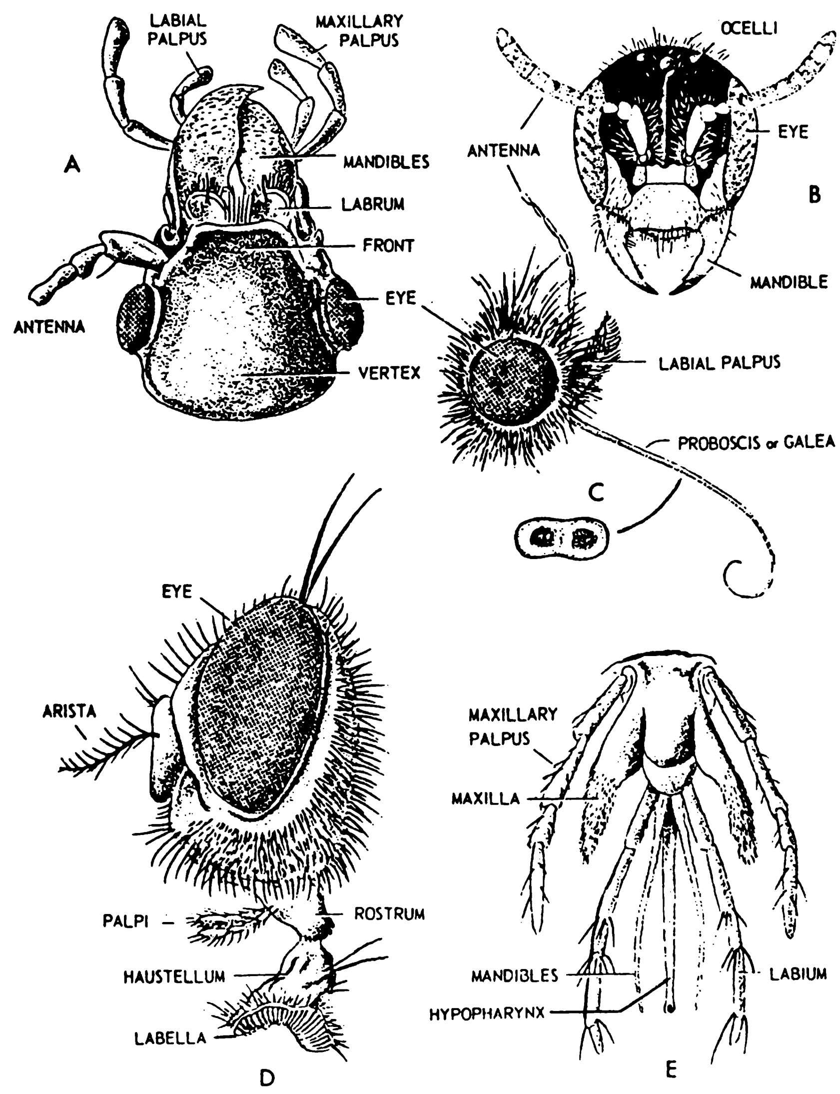


Some Types of Insect Antennae
A. Cockroach (ciliate); B. Longhorn Beetle; C. Assassin Bug (filiform); D. Stylopid; E. Bark Beetle (capitate); F. Scarab Beetle (lamellate); G. Butterfly (clubbed); H. Moth (bipectinate); I. Chironomid Fly (plumosa); J. Horse Fly; K. Mosquito: male on left, female on right.

The most remarkable structural feature of insects and the most complicated is the mouth. There are many variations in form and function of the mouthparts, but they fall into two basic types: those for chewing and those for sucking. The chewing type is the more primitive and is better developed. While they differ considerably in appearance, the same basic parts are generally found in both types, (though sucking types may be greatly modified).

There are intermediate types of mouthparts: rasping-sucking, as found in thrips; and chewing-lapping, as found in honey bees, wasps, and bumble bees. Sucking types are greatly varied. Piercing-sucking mouthparts are typical of the Hemiptera (bugs), Homoptera (aphids, scales, mealybugs), blood-sucking lice, fleas, mosquitoes, and the so-called biting flies. In the siphoning types, as seen in butterflies and moths, the mandibles are wanting and the labium and maxillary palpi greatly reduced. House flies have sponging mouthparts.

The mouthparts of immature insects tend to be more varied than in the adults, although nymphs have mouthparts similar to those of the adults. Larval forms generally have the chewing type regardless of the kind possessed by the adults. For some adult insects the mouthparts are vestigial (no longer used for feeding).



Some Types of Insect Mouthparts
A. Chewing (beetle-top view); B. Chewing-lapping (bee-front view), with proboscis retracted; C. Siphoning (butterfly-side view), with proboscis uncoiled; D. Sponging (house fly-side view); E. Piercing-sucking (flea-front view).

INSECT DEVELOPMENT - METAMORPHOSIS

One of the distinctive features of insects is the phenomenon called metamorphosis. The term is a combination of two Greek words: meta, meaning change and morphe, meaning form. It is commonly defined as a marked or abrupt change in form or structure and refers to all stages of development. In the case of complete or complex metamorphosis the stages are: egg, nymph, and adult. In some insects, fertilization of the egg by sperm is not necessary for reproduction. This type of reproduction is known as parthenogenesis. Bees, ants, wasps, and aphids are notable examples of insects that can reproduce by parthenogenesis. In higher animals, the most important development takes place before birth (in the embryonic stage); in insects, it occurs after birth. The larval period is primarily one of growth, of feeding and storing up food for the pupal and adult stages which follow. Many insects feed very little, some not at all, during their adult lives.

The young insect (larva or nymph) sheds its coat (molts) at various stages of growth, since it outgrows the hard covering or cuticle more than once. Most insects do not grow gradually as many other animals do. They grow by stages. When the old coat gets too tight, it splits open and the insect crawls out, protected by a new and larger coat that has grown underneath the old one. The stage of life between each molt is called an instar. Following each molt, the insect increases its feeding. This is noticeable in the damage done to plants and in the size of the insect's fecal pellets. The number of instars, or frequency of molts, varies considerably with species and to some extent with food supply, temperature, and moisture.

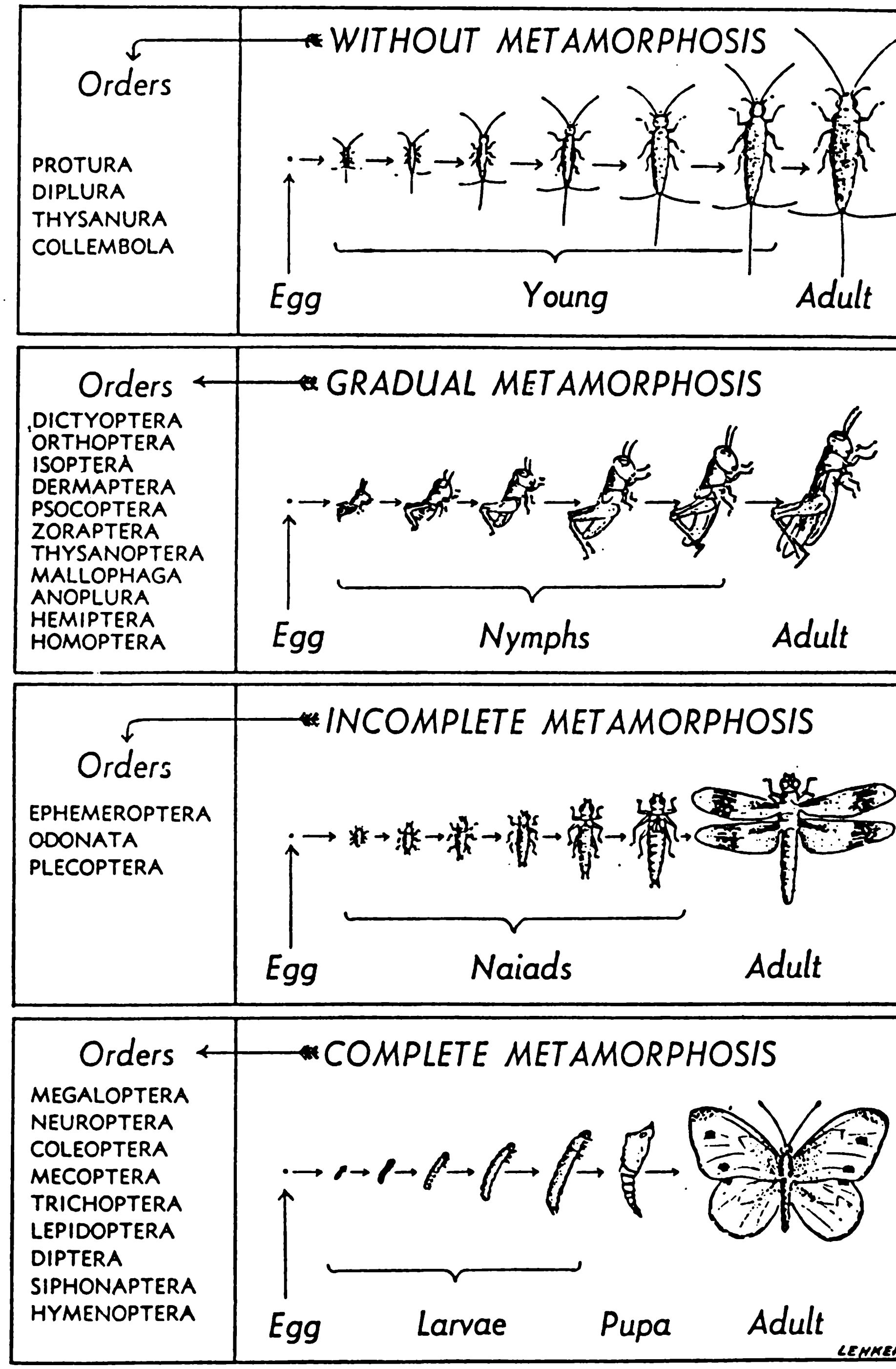
The pupal stage is one of profound change, a transformation from larva to adult. Many tissues and structures, such as prolegs, are completely broken down and true legs, antennae, wings, and other structures of the adult are formed.

Hibernation takes place during the winter season. It may occur in the egg, larval, pupal, or adult stage, according to species. It is the insect's way of adjusting to low temperatures and dwindling food supply. Many insects start preparing for winter before the end of summer. This behavior is triggered by seasonal variation in the amount of daylight (photoperiod).

The adult insect does not grow in the usual sense, but it does change since many insects are not mature when they emerge from the pupa. The adult period is primarily one of reproduction and is sometimes of short duration. Their food is often entirely different from that of the larval stage.

Some insects do not go through an metamorphosis but rather gradually increasein size while mantaining the same characteristics. Others experience a gradual metamorphosis, going through a nymph stage.

Different Types of Insect Metamorphosis



IDENTIFYING INSECTS

Most home gardeners can classify an insect by the common name of its order, identifying it as a beetle or wasp or butterfly. Knowing the insect orders allows access to much valuable information typical to many insects in the same order. This information would include the type of mouthparts the insect has (this tells us how it feeds and gives clues towards methods of control), its life cycle (and proper timing for best control), and type of habitation. As the interested person leaves the category of family, however, it becomes very difficult to identify all but the most common of the insect correctly without a magnifying instrument such as a dissecting microscope and a good insect key. A key is a list of traits used to facilitate identification.

SPECIFIC INSECT ORDERS

This section will be concerned with identifying insect orders. These orders will be divided into two sections: those orders that contain insects important to the home gardener and orders that contain insects of lesser importance to the home gardener.

Insect Orders Important to the Gardener

a. Coleoptera - Beetles, Weevils.

(1) Adults have hardened, horny outer skeleton.

(2) Adults have two pairs of wings, the outer pair hardened and the inner pair membranous. A few beetles are practically wingless, and some have only an outer hard pair of wings.

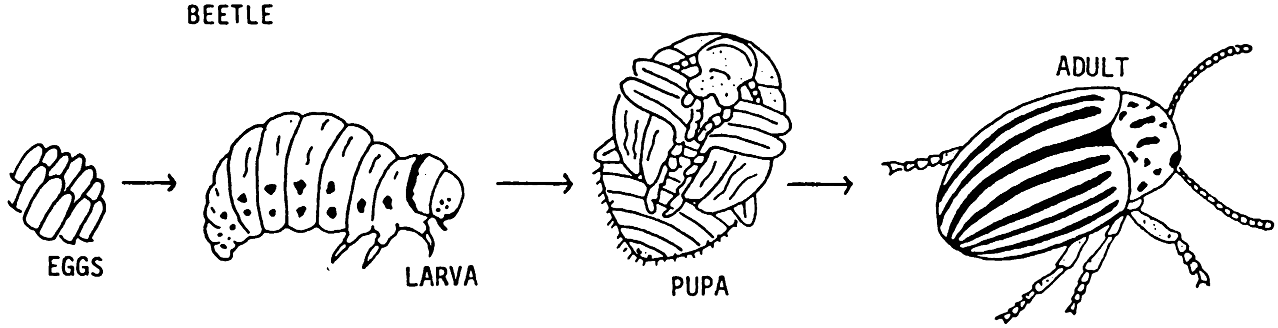
(3) Chewing mouthparts.

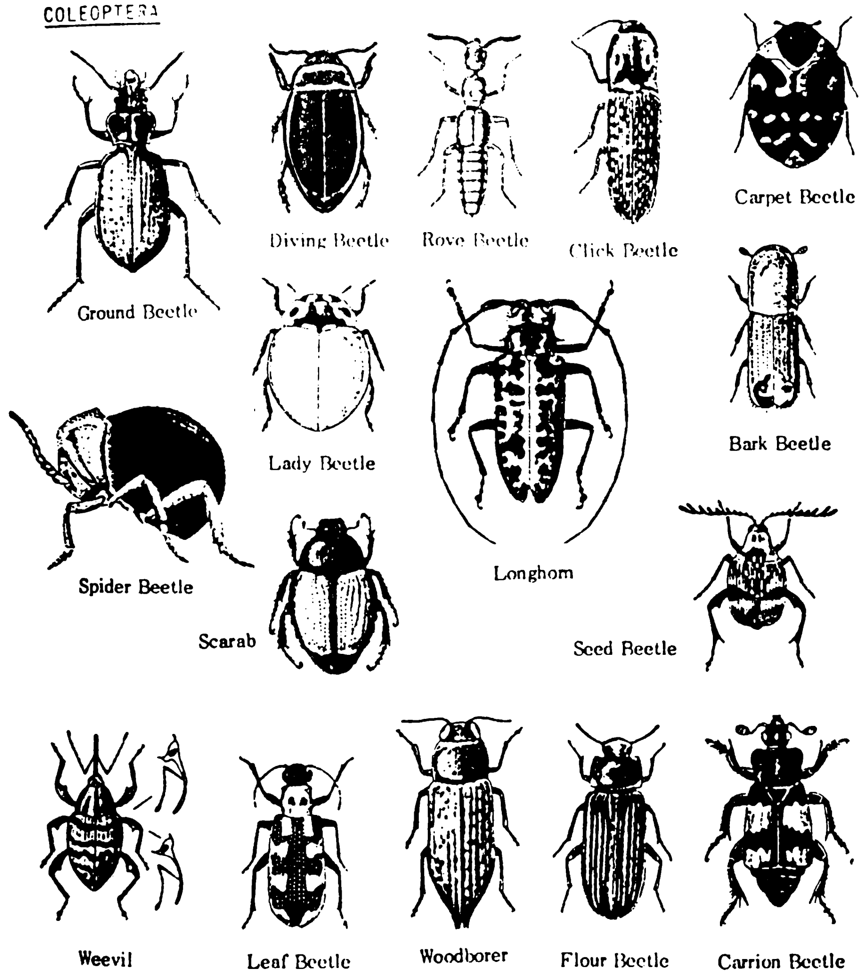
(4) Adults usually have noticeable antennae.

(5) Larvae with head capsule, 3 pairs of legs on the thorax with no legs on the abdomen. (Weevil larvae lack legs on the thorax).

(6) Complete metamorphosis.

METAMORPHOSIS
OF A
BEETLE





b. Dermaptera - Earwigs.

(1) Adults are moderately sized insects.

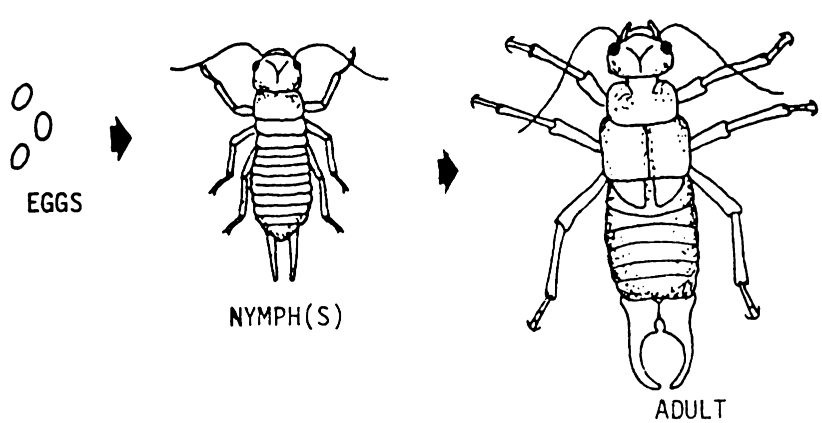
(2) Chewing mouthparts.

(3) Gradual metamorphosis.

(4) Elongate, flattened insects with strong, movable forceps on the rear end.

(5) Short, hardened outer wings and folded, membranous inner wings.

(6) Adults and nymphs similar in appearance.



METAMORPHOSIS OF AN EARWIG

c. Diptera - Flies, Mosquitoes, Gnats, Midges.

(1) Adults have only one pair of wings, are rather soft-bodied and often hairy.

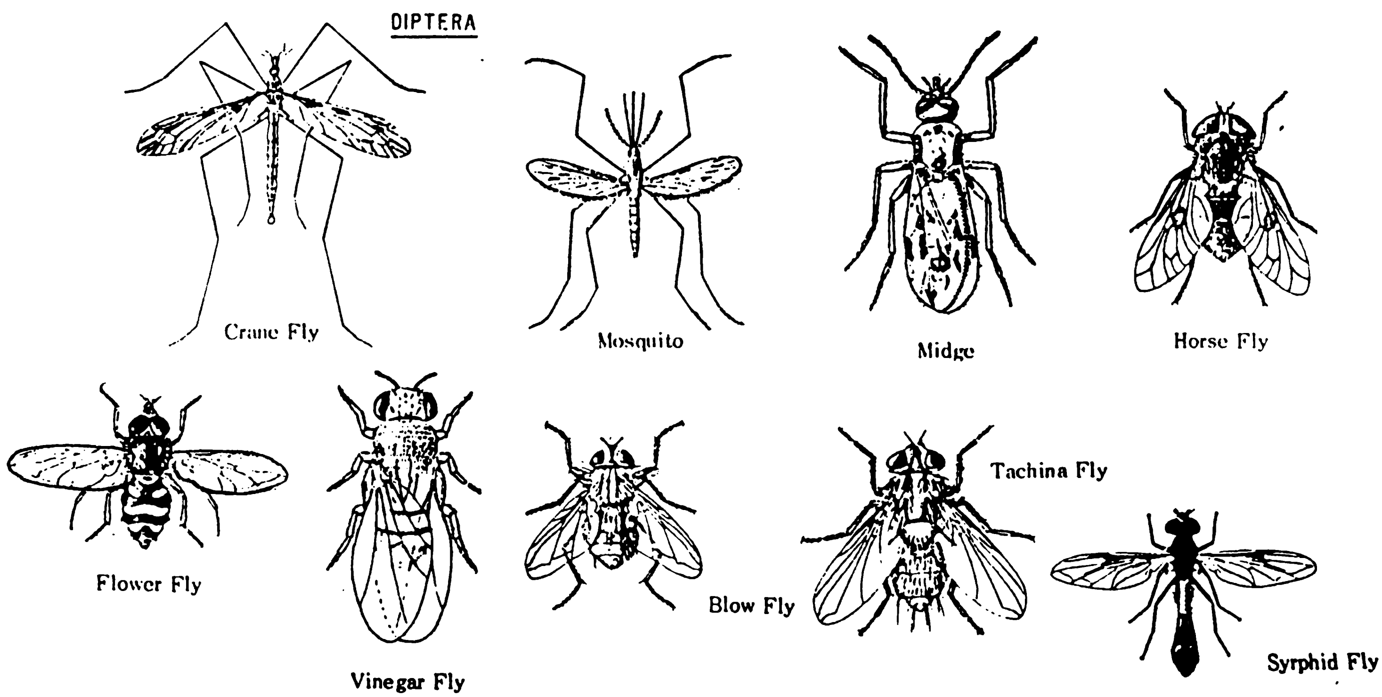
(2) Adults have sponging (housefly) or piercing (mosquito) mouthparts.

(3) Larvae may have mouth hooks or chewing mouthparts.

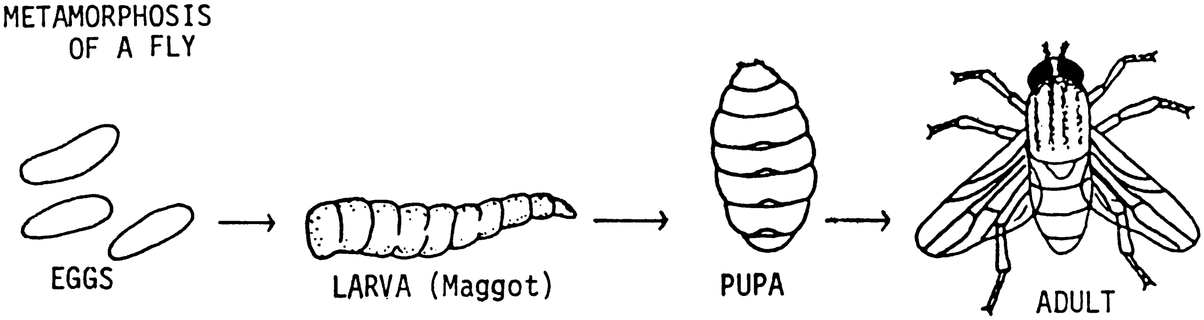
(4) Most larvae are legless.

(5) Larvae of advanced forms, housefly and relatives, have no head capsule, possess mouth hooks, and are called maggots; lower forms such as mosquito larvae and relatives have a head capsule.

(6) Complete metamorphosis.



METAMORPHOSIS
OF A FLY



d. Hemiptera - Stinkbug, Plant Bug, Squash Bug, Boxelder Bug.

(1) Have gradual metamorphosis. Stages are egg, nymph, adult.

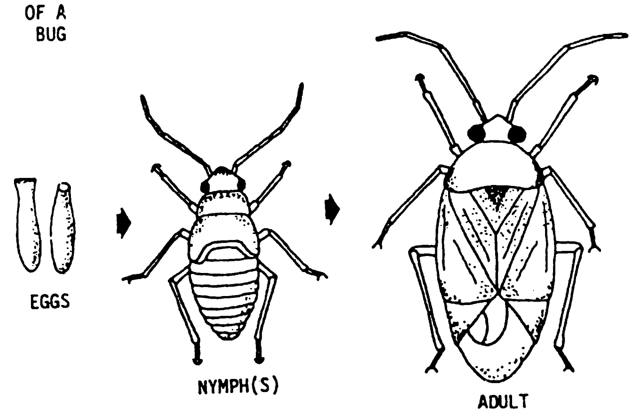
(2) Have two pairs of wings; the second pair is membranous, the first pair membranous and thickened on basal half.

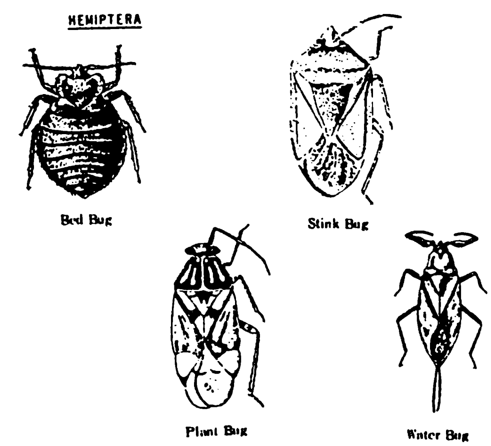
(3) Adults and nymphs usually resemble one another.

(4) Have piercing-sucking mouthparts.

(5) Adults and nymphs are both damaging stages.

METAMORPHOSIS OF A BUG





e. Homoptera - Scale Insects, Mealybugs, Whiteflies, Aphids, Cicadas, Leafhoppers.

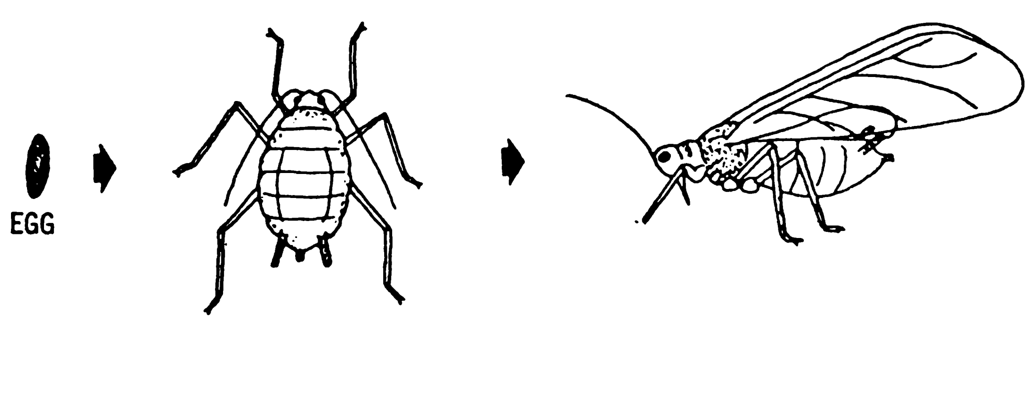
(1) Generally small, soft bodied insects; cicadas may be large and hard bodied.

(2) Winged and unwinged forms.

(3) All stages have sucking mouthparts.

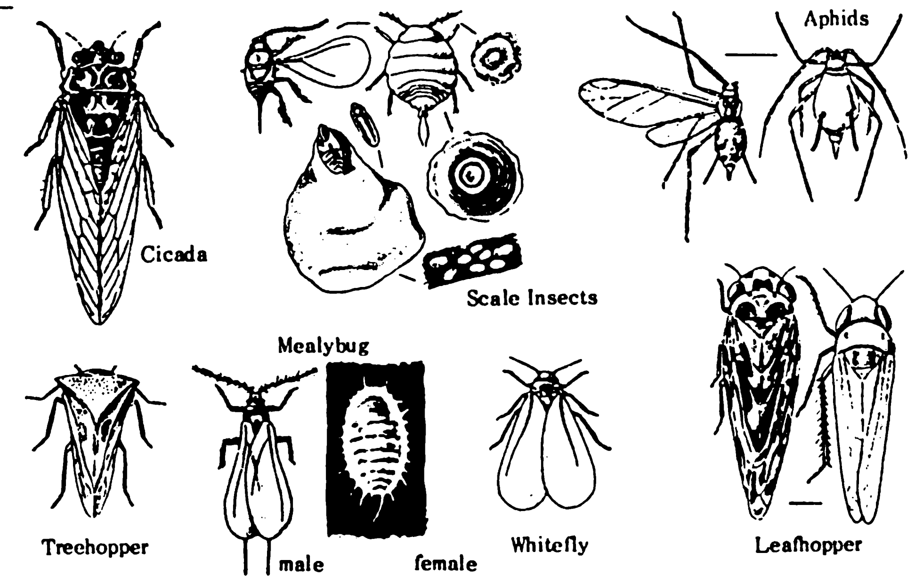
(4) Have gradual metamorphosis.

(5) Many are carriers of plant pathogens.



METAMORPHOSIS OF AN APHID

HOMOPTERA



f. Hymenoptera - Bees, Ants, Wasps, Sawflies, Horntails.

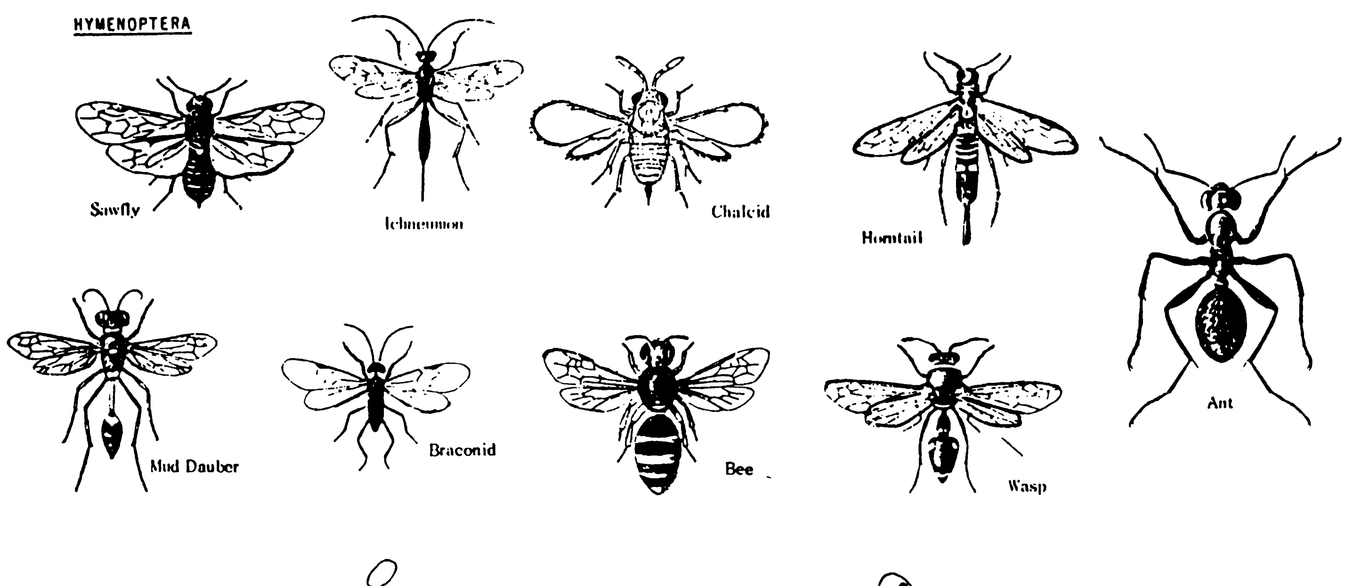
(1) Adults with two pairs of membranous wings.

(2) Larvae with no legs (wasps, bees, ants), or with legs on thorax and abdomen (some sawflies).

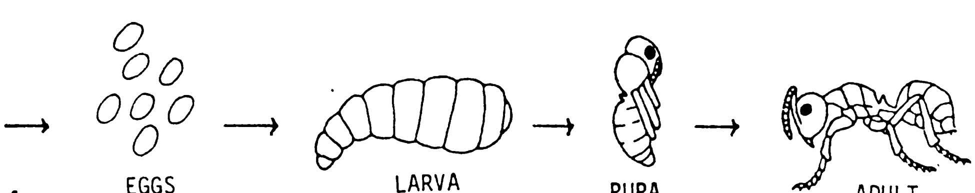
(3) Generally with chewing mouthparts.

(4) Rather soft bodied or slightly hardened bodied adults.

(5) Complete metamorphosis.



METAMORPHOSIS OF AN ANT



g. Lepidoptera - Butterflies, Moths.

(1) Adults soft bodied with four well developed membranous wings covered with small scales.

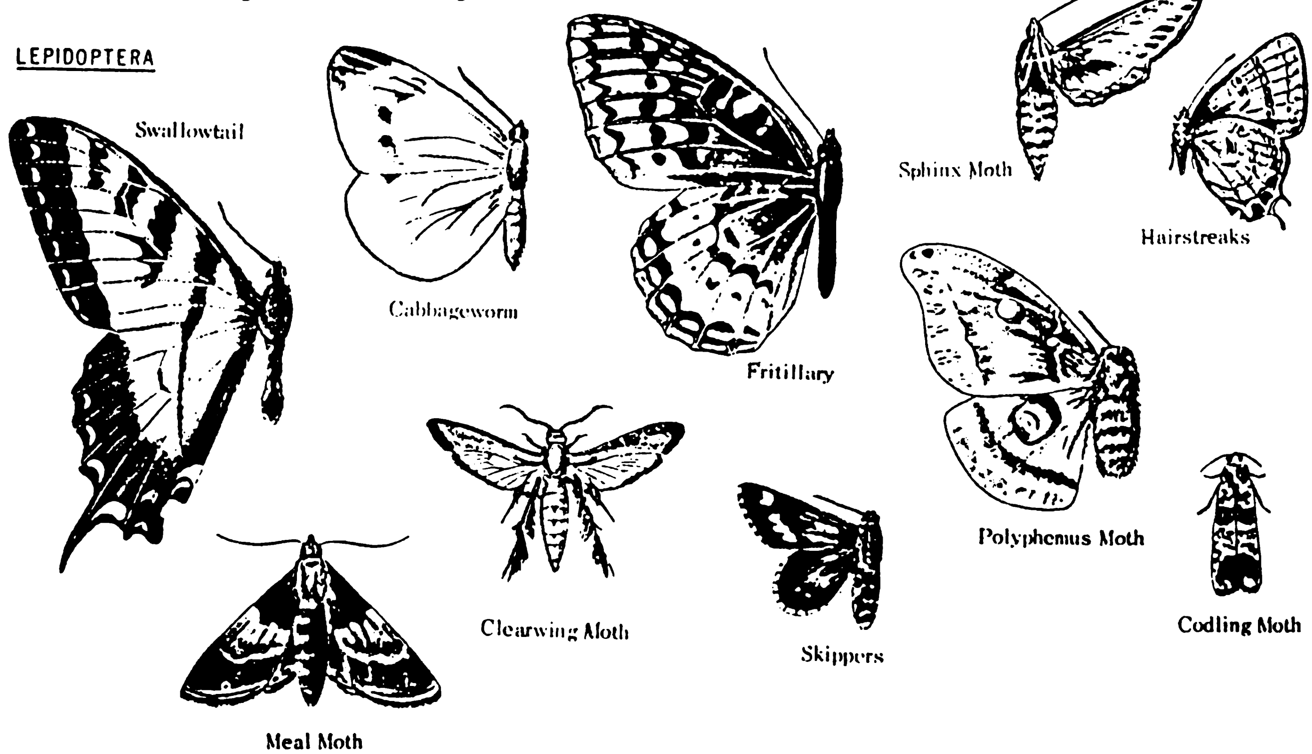
(2) Larvae with chewing mouthparts.

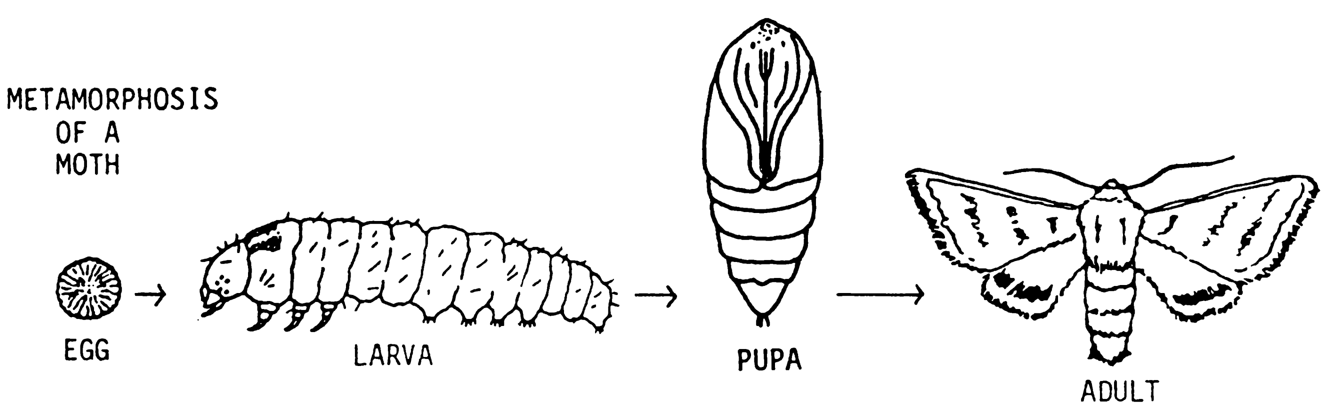
(3) Adult mouthparts a coiled, sucking tube, and feed on nectar.

(4) Larvae are caterpillar, worm like, variable in color and voracious feeders.

(5) Larvae generally have legs on the abdomen, as well as the thorax.

(6) Complete metamorphosis.





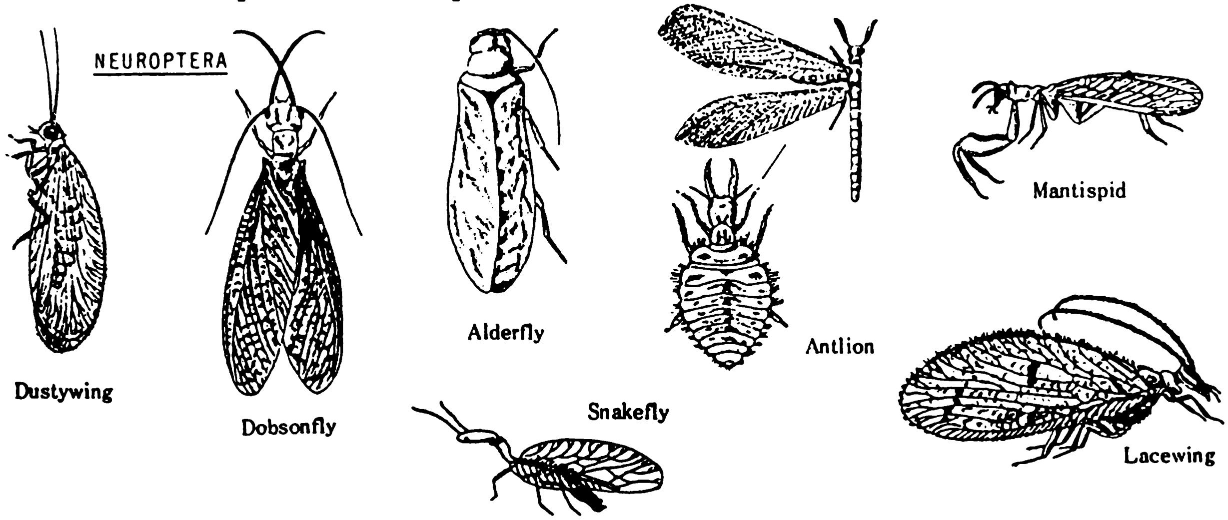
h. Neuroptera - Lacewings, Antlions, Snakeflies, Mentispids, Dobsonfly, Dustywing, Alderfly.

(1) Insect predators, many are aquatic.

(2) Two pair of similar wings.

(3) Chewing mouthparts.

(4) Complete metamorphosis.



i. Orthoptera - Grasshopper, Cricket, Praying Mantid.

(1) Adults are moderate to large, often rather hard bodied.

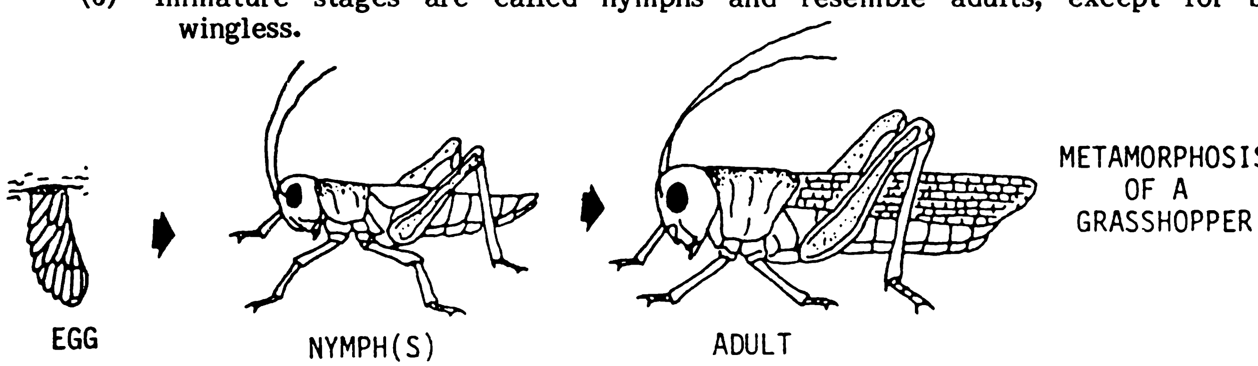
(2) Have simple metamorphosis.

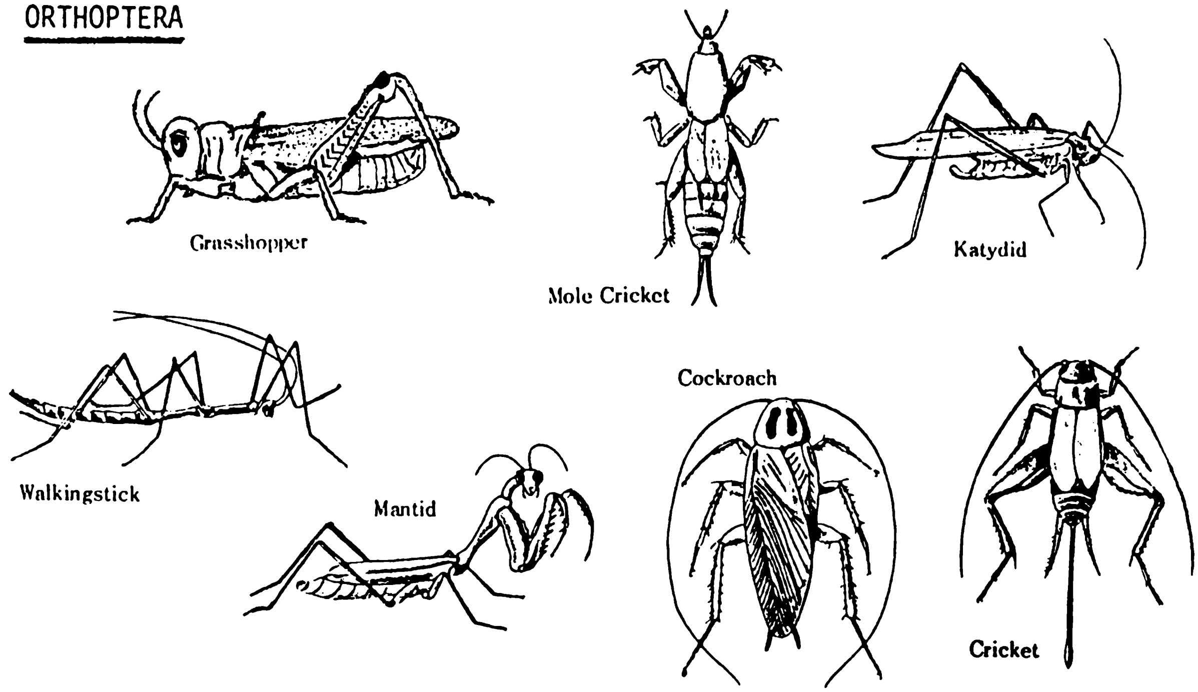
(3) Adults usually have two pairs of wings. Forewings are elongate, narrow and hardened; hindwings are membranous with extensive folded area.

(4) Chewing mouthparts. Both adults and nymphs are damaging.

(5) Hind legs of forms other than cockroaches and walking sticks enlarged for jumping.

(6) Immature stages are called nymphs and resemble adults, except for being wingless.





j. Thysanoptera - Thrips.

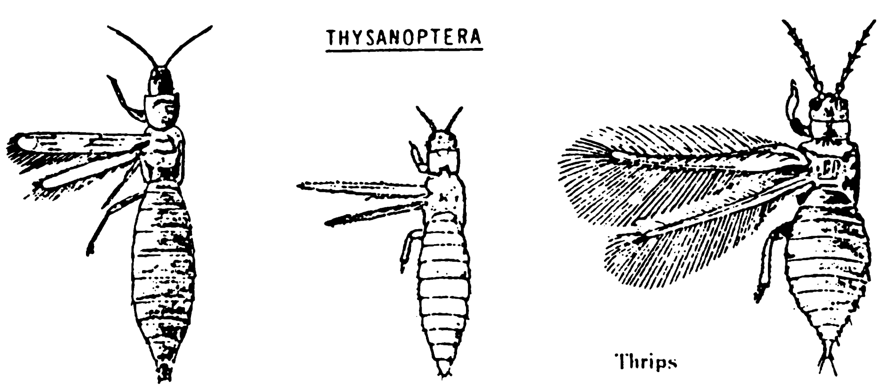
(1) Adults are small, soft bodied insects.

(2) Mouthparts are rasping-sucking.

(3) Varied metamorphosis (a mixture of complete and gradual).

(4) Found on flowers or leaves of plants.

(5) Wings in two pairs, slender, fringed with hairs.



Insect Orders of Lesser Importance to the Home Gardener

Order	Examples
(1) Anoplura	sucking lice
(2) Collembola	springtails
(3) Diplura	no common examples
(4) Ephemeroptera	Mayflies
(5) Embioptera	webspinners
(6) Isoptera	termites
(7) Mallophaga	chewing lice
(8) Mecoptera	scorpionflies
(9) Odonata	dragonflies and damselflies
(10) Plecoptera	stoneflies
(11) Protura	no common examples
(12) Psocoptera	booklice
(13) Siphoneptera	fleas
(14) Strepsiptera	no common examples
(15) Thysanura	silverfish and bristletails
(16) Trichoptera	caddisflies
(17) Zoraptera	no common examples

Other Insect Like Creatures

A number of noninsect pests may be found in the field and home. These include:

1. Spiders, Spider Mites, Ticks, and Scorpions - ARACHNIDA

   a. Spider mites: tiny, soft bodied animals with two body regions, thick waists, four pairs of legs, and are without antennae.

   Common species:

   (1) The two spotted mite and near relatives, the Pacific, Atlantic, and McDaniel spider mites: the mites have two spots on the back and have tail end spots in some species. They may be clear, green, orange, or reddish. Usually hard to observe without a hand lens.

   (2) The European red mite: This mite is carmine red with white spines.

   (3) The brown mite and clover mite: these mites are brownish or grayish, flat and have very long front legs.

   b. Spiders: Resemble mites except that most are larger and the two body regions are more clearly distinct from one another (thin waist). Most spiders are beneficial predators.

   Common pest species:

   (1) The black widow spider: This is a dangerous spider. It is a shy individual that likes dank, dark places and spins a characteristically messy

web. It is normally a shiny black, moderately sized spider with a reddish or orange hourglass marking on the underside of the abdomen. Males and immature females can have stripes of red, yellow, and black on the abdomen.

(2) The brown recluse spider: This is a very poisonous spider which is often confused with harmless wolf spiders and other hunting spiders. It can easily be recognized by a distinct brown fiddle case on a light brown or grayish background.

c. Ticks: Resemble large mites and are important in agriculture and medicine in that they are parasites of man and animals.

2. Millipedes - DIPLODA

These are elongate invertebrates with two visible body regions, a head and a body. They are generally rounded in cross section and, with the exception of the first four or five segments, all of the body segments possess two pairs of legs. They are also relatively slow moving. Millipedes are generally inoffensive creatures that feed on fungus and decaying plant material. At times, they can be fairly destructive to vegetables or other plants in greenhouses.

3. Centipedes - CHILOPODA

Centipedes strongly resemble millipedes. They are different in that they have longer antennae, are flattened in cross section, have but one pair of legs on each body segment, and move rapidly. They are beneficial in that they are predators on other arthropods.

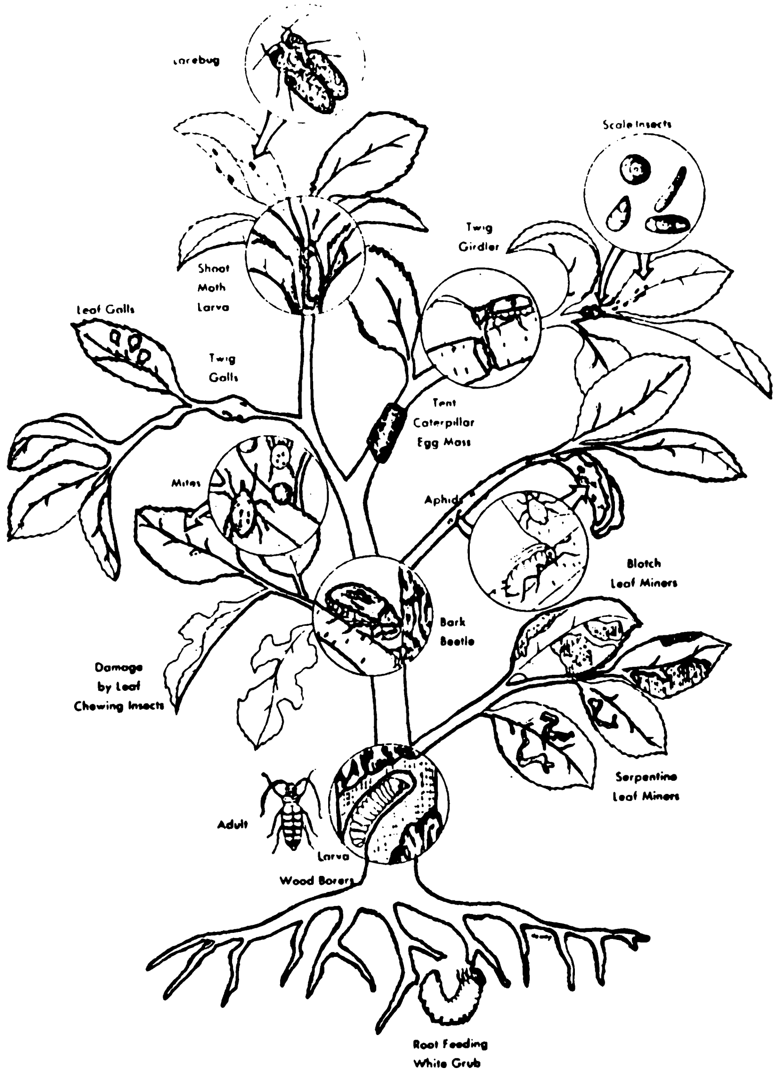
4. Sowbugs and Pillbugs - CRUSTACEA

These are oval with a hard convex outer shell made up of a number of plates. Sowbugs are highly dependent on moisture. Generally, they feed on decaying plant material, but they will attack young plants in greenhouses and gardens.

5. Garden Centipede or Symphylan - SYMPHYLA

Members of this group resemble tiny centipedes. Generally, they are a pest of plants that grow in damp soils rich in organic matter.

TYPES OF INJURY



Injury by Chewing Insects

Insects take their food in a variety of ways. One method is by chewing off the external parts of a plant. Such insects are called chewing insects. It is easy to see examples of this injury. Perhaps the best way to gain an idea of the prevalence of this type of insect damage is to try to find leaves of plants which have no sign of injury from chewing insects. Cabbageworms, armyworms, grasshoppers, the Colorado potato beetle, the pear slug, and the cankerworm are common examples of insects that cause injury by chewing.

Injury by Piercing Sucking Insects

A second important way in which insects feed on growing plants is by piercing the epidermis (skin) and sucking out the sap from the cells within. In this case, only internal and liquid portions of the plant are swallowed, although the insect itself remains externally on the plant. These insects have a slender and sharp pointed portion of the mouthpart which is thrust into the plant and through which sap is sucked. This results in a very different looking, but nonetheless severe injury. The hole made in this way is so small that it cannot be seen with the unaided eye, but the withdrawal of the sap results in either minute spotting of white, brown, or red on leaves, fruits or twigs; curling of the leaves; deforming of the fruit; or a general wilting, browning and dying of the whole plant. Aphids, scale insects, the squash bug, leafhoppers, and plant bugs are well known examples of piercing sucking insects.

Injury by Internal Feeders

So long as an insect feeds externally upon crops, it can usually be destroyed by application of the proper insecticide. But many of our worst pests feed within the plant tissues during a part or all of their destructive stages. They gain entrance to the plant either by having the egg thrust into the tissues by the sharp ovipositor of the parent insect or by eating their way in after they hatch from the eggs. In either case, the hole by which they enter is almost always minute, often invisible. A large hole in a fruit, seed, nut, twig, or trunk generally indicates where the insect has come out and not the point where it entered.

The chief groups of internal feeders are indicated by their common group names: (a) borers in wood or pith; (b) worms or weevils in fruits, nuts or seeds; (c) leaf miners; and (d) gall insects. Each group, except the third, contains some of the foremost insect pests of the world. In nearly all of them, the insect lives inside the plant during only a part of its life stages, sooner or later emerging, usually as an adult. Control internal insects by dusting or spraying of adults before their progeny gain entrance to the plant.

A number of internal feeders are small enough to find comfortable quarters and an abundance of food between the upper and lower epidermis of a leaf. These are known as leaf miners, injurious examples include the beet leaf miner and the spinach leaf miner.

The gall insects sting the plant which causes the plant to produce a structure of deformed tissue, within which they find not only shelter but also suitable and abundant food. We do not know as yet exactly what it is that makes the plants, when attacked by the insect, grow these curious, often elaborate structures which are absolutely foreign to them in the absence of the gall insect. However, it is clear that the growth of the gall is initiated by the oviposition of the adult and its continued development results from the secretions of the developing larva. The same species of insect on different plants causes galls that are similar, while several species of insects attacking the same plant cause galls that are greatly different in appearance. Although the gall is entirely plant tissue, the insect controls and directs the form and shape it takes as it grows.

Injury by Subterranean Insects

Almost as secure from man's attack as the internal feeders are those insects that attack plants below the surface of the soil. These include chewers, sap suckers, root borers, and gall insects. The attacks differ from the above ground forms just described, only in their position with reference to the soil surface. Subterranean insects may spend their entire life cycle below ground, e.g., the woolly apple aphid. This insect, as both nymph and adult, sucks the sap from the roots of apple, causing the development of tumors and the subsequent decay of roots at the point of attack. More often there is at least one life stage of the insect that has not taken up the subterranean habit, as in the case of wireworms, root maggots, pillbugs, strawberry root weevil, and grape and corn rootworms. The larvae are root feeders while the adults live above ground.

Injury by Laying Eggs

Probably 95% or more of direct injury to plants is caused by insects feeding in the various ways just described. In addition, most insects lay their eggs in exactly the right place so that their young will have the best chance to survive. Sometimes this provision for the young leads to serious injury to plants. The periodical cicada deposits her eggs in the one year old growth of fruit and forest trees, splitting the wood so severely that the entire twig beyond this point often dies. It is interesting to note that these are purely egg laying sites. As soon as the young hatch, they desert the twigs and injure the plant no further. In other cases, the young subsequently feed upon the plant attacked by the egg laying act. For example, the plum curculio ruins the fruits of apple, plum, peach, and cherry by her characteristic egg laying procedures.

Use of Plants for Nest Materials

Besides laying eggs in plants, insects sometimes remove parts of the plant for the construction of nests or for provisioning nests elsewhere, though they do not feed on these materials. This injury is more interesting than it is serious. Leaf cutter bees nip out rather neat circular pieces of rose and other foliage which are carried away and fashioned together to form thimble shaped cells one above the other in a tunnel previously made in the stem of a plant.

Insects as Disseminators of Plant Diseases

Since 1892, when it was first proved that a plant disease (fire blight of fruit trees) may be spread by an insect (the honeybee), the knowledge of this subject has grown rapidly. At present there is evidence that more than 200 plant diseases are disseminated by insects. The majority of them, about 150, belong to the group known as viruses, 25 or more are due to parasitic fungi, 15 or more are bacterial diseases, and a few are caused by protozoa.

Insects are responsible for spreading plant diseases in a number of different ways: (a) by feeding or laying eggs or boring into plants, they make an entrance point for a disease that is not actually transported by them; (b) they have been found to disseminate the pathogens on or in their bodies, from one plant to a susceptible surface of another plant, such as a blossom or to a wound made by some other agent; (c) they carry pathogens on the outside or inside of their bodies and inject plants hypodermically as they feed; (d) they harbor pathogens inside their bodies during adverse periods, such as winter or a period of drought or host plant scarcity, protecting them from the adverse climatic condition and from natural enemies; (e) they may be essential hosts for an incubation period, for increase in numbers of the pathogen, or for some part of its life cycle that cannot be completed elsewhere.

Examples of Insect Vectored Plant Diseases

Disease	Vector
Dutch Elm Disease (fungus)	Small Beetle
Fireblight (bacterial)	Pollinating Insects
Tomato Curly Top (virus)	Beet Leafhopper
Cucumber Mosaic (virus)	Aphids

BENEFITS AND VALUE OF INSECTS

We need to study insects carefully, in order that we may be able to distinguish the beneficial from the harmful. People have often gone to great trouble and expense to destroy quantities of insects, only to learn later that the insect destroyed was not only harmless but was actually engaged in saving their crops by eating the destructive insects. Most entomologists have had correspondents send in the larvae of lady beetles with the complaint that they were injuring plants; at the same time overlooking the smaller aphids which were causing the injury and which these larvae were continually devouring.

Insects are beneficial to the gardener in several ways:

1. Insects aid in the production of fruits, seeds, vegetables, and flowers, by pollinizing the blossoms. Most of our common fruits are pollinized by insects. Melons, squash, and many other vegetables require insects to carry their pollen before fruits set. Many ornamental plants, both in the greenhouse and out of doors, are pollinated by insects (chrysanthemums, iris, orchids, and yucca).

2. Parasitic insects destroy other injurious insects by living on or in their bodies and their eggs. Insects also act as predators, capturing and devouring other insects.

3. Insects destroy various weeds in the same ways that they injure crop plants.

4. Insects improve the physical condition of the soil and promote its fertility by burrowing throughout the surface layer. Also, the dead bodies and droppings of the insects serve as fertilizer.

5. Insects perform a valuable service as scavengers by devouring the bodies of dead animals and plants and by burying carcasses and dung.

Many of the benefits from insects enumerated above, although genuine, are insignificant compared with the good that insects do fighting among themselves. There is no doubt that the greatest single factor in keeping plant feeding insects from overwhelming the rest of the world is that they are fed upon by other insects. It is easy to see how the industry of insects and their devotion to purpose, when coupled with almost unlimited numbers , can benefit us when their they seek and devour myriads of pests scattered over a farm or a forest.

Insects that eat other insects are considered in two groups known as predators and parasites. Predators are insects (or other animals) that catch and devour smaller or more helpless creatures (called the prey), usually killing them in getting a single meal. The prey is generally smaller, weaker, or less intelligent than the predator. Parasites are forms of living organisms that live on or in the bodies of living organisms (called the hosts) from which they get their food, during at least one stage of their existence. The hosts are usually larger, stronger, or more intelligent than the parasites and are not killed promptly but continue to live during a period of close association with the parasite. Predators are typically very active and have long life cycles; parasites are typically sluggish and tend to have very short life cycles.

PEST CONTROL WITH A MINIMUM OF CHEMICALS

Home gardeners often use more pesticides per square foot in their gardens than farmers do in the fields, thinking that if a little is good, more will be better. This is a mistake, and a serious misuse of pesticides. Overuse of pesticides has a number of adverse effects: it makes food less safe to eat, especially if there are residues at harvest time; it makes handling the plants dangerous; beneficial insects, earthworms, birds, even pets may be harmed or killed along with harmful insects. Each time gardeners spray, they are exposed to the dangers of inhalation or absorption of the toxin. Pesticides used near water may contaminate water supplies; continuous use of certain pesticides may induce resistance in the pests, thus requiring the use of more toxic substances; some pesticides break down slowly and can remain in the environment for years.

Growing public concern over the use and misuse of pesticides has led increasing numbers of home gardeners to seek means of natural pest control. Although some people do not have the time or knowledge to practice all available alternative methods for controlling pests, there are many cultural practices which will help reduce losses. Because the gardener does not have to live up to perfect market standards, pesticide use may be reduced to a minimum with a little research and effort. If the choice is between minor insect damage and a possible pesticide residue, consider accepting the visible blemish you can remove. Proper soil preparation,careful plant selection and good garden practices can be combined with biological and mechanical controls to reduce the need for chemical pesticides.

Soil Preparation

Maintain a slightly acid soil (around pH 6.5). If in doubt, have a soil analysis done of through your local Extension Office, by a private lab, or with a soil test kit. The appropriate pH allows vegetable plants to have access to all the necessary soil nutrients and provides a suitable environment for earthworms and microorganisms. Follow recommended fertilizer practices. Supplement chemical fertilizers with organic material or compost (see Pub. 426-313, Soil Preparation) to help assure that all trace elements are available, as well as major nutrients. Feed the soil, not just the plants; providing an appropriate environment for all soil life will result in healthier plants which are more resistant to pests and diseases.

If you use manure and compost, be sure they are well worked into the soil. Otherwise, millipedes, white grubs, and other pests may be encouraged. If these insects become a problem, you may be using too much; consider other means of adding organic matter, such as cover cropping or mulching.

When diseased plant material is added to compost to be used on your garden, delay using the compost until all material has decayed beyond recognition. Compost piles must be hot (140 degrees F.) to kill disease organisms, insect eggs, and weed seeds.

Till in the fall to expose those stages of pests which live near the surface of the soil to natural enemies and weather, and to destroy insects in crop residues. If you do not till in the fall, do so early enough in the spring to give remaining vegetation time to degrade before planting time.

Plant Selection

Plant crops that are suited to the soil and climate. If you do plant vegetables or fruits that are not normally grown in your area, do your best to provide necessary conditions. For example, watermelon prefers a light, warm, well drained soil; don't try to plant in heavy clay without first adding copious amounts of compost or other soil lightening material, and allow the soil to warm up before seeding or setting plants out.

Use disease and insect free, certified seed, if available.
Select disease and insect resistant or tolerant species and varieties (see Table 1 for examples of vegetables).

Table 3. Vegetable varieties that show some resistance to specific insect pests.

Vegetable	Variety	Insect resistance
Beans (snap)	Wade	Mexican bean beetle
Broccoli	De Cicco	Striped flea beetle
Cabbage	Early Globe	Cabbage looper, imported cabbageworm
	Red Acre	Cabbage looper, imported cabbageworm
	Round Dutch	Cabbage looper, imported cabbageworm
Cabbage (Chinese)	Michili	Diamondback moth
Collard	Georgia	Striped flea beetle, Harlequin bug
Corn (sweet)	Golden Security	Corn earworm
Cucumbers	Ashley	Pickleworm, spotted cucumber beetle
	Piccadilly	Pickleworm
	Poinsett	Spotted cucumber beetle
Kale	Vates	Diamondback moth
Mustard	Florida Broadleaf	Diamondback moth, striped flea beetle
Potato (sweet)	Centennial	Sweetpotato flea beetle, Southern potato wireworm
	Jewel	Sweetpotato flea beetle, Southern potato wireworm
Radish	Cherry Belle	Diamondback moth, Harlequin bug
	White Icicle	Harlequin bug
Squash	Early Prolific (straightneck)	Pickleworm, striped cucumber beetle
	White Bush Scallop	Pickleworm, striped cucumber beetle
	Zucchini	Striped cucumber beetle
Turnip	Seven Top	Diamondback moth, striped flea beetle
Rutabaga	American Purple Top	Diamondback moth, striped flea beetle
Watermelons	Crimson Sweet	Pickleworm, spotted cucumber beetle

Resistance in plants is likely to be interpreted by the layman as meaning immune to damage. In reality, it distinguishes plant varieties that exhibit less insect or disease damage when compared with other varieties under similar circumstances. Some varieties may not taste as good to the pest or may possess certain physical or chemical properties which repel or discourage insect feeding or egg laying, or may be able to support insect populations with no appreciable damage or alteration in quality or yield.

Select plants that are sturdy and have well developed root systems. Diseases and insects in young seedlings may start in greenhouses or plant beds and cause heavy losses in the garden. Buy plants from a reputable grower who can assure you that they are disease and insect free, or grow your own from seed.

Avoid accepting houseplants, shrubs, etc. from friends if there is any chance of their containing insects and/or disease.

Garden Practices

The most effective and most important of all practices is to observe what is going on in the garden! Many serious disease or insect problems can be halted or slowed down early by the gardener who knows what to look for and regularly visits the garden for the purpose of trouble shooting.

Rotation Do not grow the same kind of produce in the same place each year. Use related crops in one site only once every three or four years. Some related crops are as follows: (a) chives, garlic, leeks, onions, shallots; (b) beets, Swiss chard, spinach; (c) cabbage, cauliflower, kale, collards, Brussels sprouts, broccoli, kohlrabi, turnips, rutabagas, Chinese cabbage, mustard; (d) peas, broad beans, snap beans, lima beans; (e) carrots, parsley, celery, celeriac, parsnips; (f) potatoes, eggplant, tomatoes, peppers; (g) pumpkins, squash, watermelons, cucumbers, muskmelons; and (h) endive, salsify, lettuce.

Interplantings Use interplantings as opposed to solid plantings of a crop. Avoid placing all plants of one kind together by alternating groups of different plants within rows or patches. If an insect lays eggs or otherwise attacks a specific species, the presence of other species in the area can interrupt progress of the attack by such methods as diluting the odor of the preferred plants. This can slow the spread of diseases and pests, giving you more time to deal with them.

Thinning Thin young plants to a proper stand. Overcrowding causes weak growth and subsequent insect and disease problems.

Watering Water in the morning so that plants have time to dry before the cool evening. Drip irrigation prevents foliage from getting wet at all when watering. For plants susceptible to fungus infections, such as late blight on tomatoes, leave extra space between plants to allow good air flow; orient rows so that prevailing winds will help foliage dry quickly after a rain or watering. While this may reduce the number of plants per square foot, you may still get higher yields because of reduced disease problems.

Stay out of the garden when the plants are wet with rain or dew to prevent spreading diseases.

Time Planting Time plantings in such a way that the majority of your crop will avoid the peak of insect infestations. For example, plant squash as early as possible to avoid borers, which lay eggs in July. Keep a record of the dates insect problems occur. Also, by planting warm weather crops after the soil has warmed, you will avoid problems with seed and root rots; growth will be more vigorous, as well.

Sanitation Do not use tobacco products such as cigarettes or cigars when working in the garden. Tomatoes, pepper, and eggplant are susceptible to a mosaic virus disease common in tobacco and may be spread by your hands. Remove infected leaves from diseased plants as soon as you observe them. Dispose of severely diseased plants before they contaminate others. Clean up crop refuse as soon as you are finished harvesting if possible. Old sacks, baskets, decaying vegetables, and other rubbish which may harbor insects and diseases should be kept out of the garden.

Staking plants or planting them in wire cages prevents the fruit from touching the soil. This also helps prevent fruit rots. Caging helps reduce sun scald often seen in staked tomatoes, since caged plants do not require as much pruning, leaving a heavier foliage cover. Boards or a light, open mulch such as straw placed beneath melons will prevent rotting.

Avoid injury to plants Cuts, bruises, cracks and insect damage are often the site for infection by disease causing organisms. In cases where fruits are difficult to remove (such as cucumbers and watermelons) cut them off instead of pulling them off the plant. If you cultivate your garden, avoid cutting into the plant roots.

Mulching Use a mulch to reduce soil splash, which brings soil borne diseases into contact with lower leaves.

Weed control Keep down weeds and grass. They often harbor pests and compete for nutrients and water. They provide an alternate source of food and can be responsible for pest build up. They provide cover for cut worms and slugs.

Mechanical Control

Handpicking Inspect plants for egg clusters, bean beetles, and caterpillars and other insects as often as possible. Hand pick as many as possible. Knocking insects and egg clusters into a coffee can with a small amount of water in it and then pouring boiling water over them is a way to kill insects if you don't like squashing them. Kerosene is often recommended, but there is a disposal problem once you have finished; besides, water is cheaper.

Traps Use various insect traps to reduce insect population. A simple, effective Japanese beetle trap can be made from two one gallon milk jugs or a gallon milk jug and a plastic bag. The bait used to attract the beetles is available at most farm and garden supply centers. Place traps away from desirable plants.

To trap night flying insects place a shaded light bulb outdoors with a pan of kerosene (or water with a thin film of oil on top) underneath; insects will be attracted to the light and will fall into the pan.

Light traps, particularly blacklight or bluelight traps (special bulbs that emit a higher proportion of ultraviolet light that is highly attractive to nocturnal insects) are a good insect monitoring tool but provide little or no protection for the garden.

True, they usually capture a tremendous number of insects, however, a close examination of light trap collections shows that they attract both beneficial and harmful insects that would ordinarily not be found in that area. Those insects attracted but not captured remain in the area, and the destructive ones may cause damage later. Also some species that are wingless and those active only during the day (diurnal, as opposed to nocturnal) are not caught in these traps. Consequently, the value of a blacklight or simple light trap in protecting the home garden is generally of no benefit and in some instances, detrimental.

A screen box with a screen cone in the center leading to a pan of sweet bait; sugar water, molasses, fruit wastes, oil of sassafras, beer; will attract and trap many insects. Upturned flower pots, bamboo length, boards, etc. will trap earwigs and sowbugs; collect them every morning and feed to pet frogs, toads, turtles, and fish, or destroy with boiling water. Slugs can also be caught by these means and can be killed. Indoors, white flies can be caught with sticky yellow traps, made with boards painted yellow and lightly coated with oil or grease. There are also commercial sticky traps available through some catalogs.

Barriers   Aluminum foil and other reflective mulch has been proven to repel aphids. However, the environmental impact and energy consumption involved in making aluminum foil deserves consideration. Where slugs are a problem, use methods described under trapping above, and try to create drier conditions. Heavy mulches will encourage slugs. Spread crushed eggshells or hydrated lime around affected plants.

Exclusion   Various materials can be used to physically block or repel insects and keep them from damaging plants. Place wood ash, cardboard tubes or orange juice cans around seedlings to keep cutworms away from plant stems. Use paper bags over ears of corn to keep birds and insects out; do not cover until pollination is complete. Net covered cages over young seedlings will help prevent insect, bird and rabbit damage. Cheesecloth screens for cold frames and hot beds will prevent insect egg laying; sticky barriers on the trunks of trees and woody shrubs will prevent damage by crawling insects.

Biological Controls

Predators, Parasites and Pathogens   The garden and immediate surroundings are alive with many beneficial organisms that are there naturally; however, they may not be numerous enough to control a pest before its damage is done. Actually, parasites and predators (usually other types of insects) are most effective when pest populations have stabilized or are relatively low. Their influence on increasing pest populations is usually minimal since any increase in parasite and predator numbers depends on an even greater increase in pest numbers. Disease pathogens, however, seem to be most effective when pest populations are large.

Take advantage of the biological control already taking place in your garden by encouraging natural predators, such as preying mantises, ladybugs, lacewings, ground beetles, and others. Purchased natural predators are often ineffective, however, since they tend not to remain in the place where they are put. Research the likes and dislikes of these helpers as to foods, habitat, etc. Provide these conditions where possible.

Learn to recognize the eggs and larvae of the beneficial insects and avoid harming them. You can often find preying mantis egg cases in weedy lots; just bring the twig with the cluster into your garden and set it in a place where it will not be disturbed. Spiders, toads, and dragonflies are also beneficial and should not be a source of fright to the gardener; in most cases they are harmless to people.

Learn to recognize parasites and their egg cases; for example, the tomato hornworm is often seen with a number of white egg cases, a little larger than a grain of rice, on its back. These were laid by a parasitic wasp. The hornworm will die and more wasps will emerge. Obviously, it is to your advantage to leave the worm in the garden.

PESTICIDES

Nonsynthetic

Botanicals Natural pesticidal products are available as an alternative to synthetic chemical formulations. Some of the botanical pesticides are toxic to fish and other cold blooded creatures and should be treated with care. Safety clothing should be worn when spraying these even though their toxicity is low to warm blooded animals. Botanical insecticides break down readily in soil and are not stored in plant or animal tissue. Often their effects are not as long lasting as those of synthetic pesticides.

Insecticide	Use Against
White Hellebore	Sawflies, slugs, onion maggots, cabbageworm
Pyrethrum	Pickleworms, aphids, leaf- hoppers, spider mites, harlequin bugs, cabbageworms.
Nicotine	Aphids, leafhoppers, psyllids, whiteflies, thrips.
Quassia	Greenflies, leafhoppers, slugs, mealybugs, thrips.
Derris	Aphids, mosquito larvae, caterpillars.
Rotenone	Spittlebugs, aphids,potato beetles, harlequin bugs, chinch bugs, spider mites, carpenter ants.
Ryania	Codling moths, Japanese beetles, squash bugs, potato aphids, onion thrips, corn earworms, silkworm.
Sabadilla	Grasshoppers, codling moths, moths, armyworms, aphids, cabbage loopers, blister loopers, blister beetles,

Some of these products may be very difficult to find.

In addition to botanical insecticides, some biological products can help in the battle against insects. Bacillus thuringiensis is an effective product commonly used against moth larvae; B.t., as it is known, is a bacterium that gives the larvae a disease, and is most effective on young larvae. Presently, there is research underway to develop strains that work against other types of insect larvae. Several formulations are available to the homeowner under different trade names which provide effective control of several caterpillars but which are harmless to man and domestic animals. More than 400 insect species are known to be affected by this important insect pathogen. Bacillus thuringiensis is quite slow in its action. For example, caterpillars that consume some of the spores will stop eating within 2 hours, but may continue to live and move around until they die, which may be as long as 72 hours. When this occurs the untrained gardener may assume the material was ineffective because of the continued pest activity and impatiently apply a chemical pesticide to correct his mistake. Nosema locustae is a disease organism which shows some promise for controlling grasshoppers. There are claims that this parasite may be effective for up to five years after initial application. In some areas, this parasite is available commercially under different trade names.. It is still too early to make extensive claims about its effectiveness in home gardens.

Enlist the aid of birds in your garden. In rural areas, chickens, guineas, and other domestic fowl are released in unused areas of the garden to eat grubs and insects. Wild birds will also help, but aren't as controllable. Provide appropriate conditions (i.e.,shelter, nesting material, water) to encourage insect eating birds.

Soaps Commercial insecticidal soap (a special formulation of fatty acids) has been proven effective against aphids, leafhoppers, mealybugs, mites, pear psylla, thrips, and whiteflies. Homemade soap sprays also work to some extent: use three tablespoons of soap flakes (not detergent) per gallon of water and spray on plants till dripping. Repellent sprays, such as garlic sprays and bug sprays (made from a puree of bugs) have been found useful by some gardeners, but their effectiveness is questionable. Some researchers believe that bug sprays may work if a disease is present in the insect, which is spread through the spray to other insects.

Synthetic

Synthetic pesticides, by their simplest definition, are those made or synthesized by man in chemical laboratories or factories. Examples of these include the insecticides such as malathion and methoxychlor. The real surge of development came with World War II and began with the discovery of DDT. More will be covered in the unit called Pesticides.

SUMMARY

Insects constitute one order of the phylum, Arthropoda, and yet they are one of the largest groups in the animal kingdom. The insect world is made up of individuals that vary greatly in size, color, and shape. Although most insects are harmless or beneficial to man, the few that cause damage have a tremendous impact due to their number. The harmful species can usually be recognized with some basic knowledge of their host plants, habits, life cycle, and the type of damage they inflict. Feeding damage varies with the type of mouthparts an insect has. Harmful insects can be checked in many ways before resorting to the use of pesticides. Good cultural practices and proper selection of plant varieties coupled with mechanical and biological controls are all measures that will control insect populations.

Abdomen: The hindmost of the three major divisions of the body, composed of not more than 11 segments and without either legs or wings.

Antennae: Segmented appendages on the head, carrying sense organs and acting as feelers.

Compound eye: An eye of an arthropod composed of many individual elements or ommatidia, each of which is represented externally by a facet.

Honeydew: Anal secretions of aphids and other Homoptera; exudate of some galls.

Larva: The active feeding and growing stages of one of the higher insects, preceding the pupal or resting stage.

Mandibles: The strong, chewing pair of mouthparts.

Metamorphosis: The changes through which an insect passes from the young form to the adult.

Molt: The shedding of the skin during growth. The cast skin is called the exuvia; the intervals between molts are called stages or stadia; the form assumed during a particular stage is known as an instar.

Nymph: The active feeding and growing young stage of one of the less highly evolved insects. Insects with nymphs do not have a resting or pupal stage.

Ovipositor: Tube or valves from which the female deposits (oviposits) eggs.

Parthenogenesis: A form of asexual reproduction; development of egg without fertilization.

Parasite: an organism that lives on or in another (host) organism and obtains all of its nutrients from that host, contributing nothing of benefit to the host.

Pheromone: Substance emitted by an animal which causes a specific response from others of the same species (or colony in the case of honey bees).

Predator: An animal living at the expense of others; an insect predator differs from a parasite in that it usually requires more than one host.

Prolegs: Fleshy unjointed false legs of caterpillars and the larvae of some sawflies, used in clinging to surfaces and for support in locomotion.

Pupa: The transformation stage between larva and adult of the more advanced insects.

Thorax: Group of three segments behind the head and in front of the abdomen and known, respectively, as the prothorax, mesothorax and metathorax. Each segment has one pair of legs; in addition the mesothorax and metathorax each may carry one pair of wings. The large shield-like top side of the prothorax is known as the pronotum. The thorax is largely filled with powerful flight muscles.

Vector: An insect that carries a disease organism from one plant to another.

UNDERSTANDING PESTICIDES

TERMINOLOGY

Pesticides may be useful when nonchemical methods fail to provide adequate control of pests and when pest populations reach a level of economic injury. The suffix "cide" literally means kill. The term pesticide refers to a chemical substance that will kill pests. Since it is physically impossible to eradicate an entire population of pests, pesticides are used as a tool to control or manage pest populations to a level of tolerance. Because of government regulations, chemicals used to attract or repel pests and to regulate plant growth or function are also classed as pesticides. The wording "insecticides and pesticides" is incorrect because insecticides are pesticides. Types and functions of pesticides include the following:

Insecticides - control insects
Miticides - control mites
Acaricides - control mites, ticks and spiders
Nematicides - control nematodes
Fungicides - control fungi
Bactericides - control bacteria
Herbicides - control plants (herbicides kill plants, not just weeds)
Rodenticides - control rodents
Avicides - control birds
Piscicides - control fish
Molluscicides - control mollusks, such as slugs and snails
Predacides - control pest animals
Repellents - keep pests away
Attractants - lure pests
Plant growth regulators - stop, speed up, or otherwise change normal plant processes
Desiccants and defoliants - used to remove or kill leaves and stems
Antitranspirants or antidesiccants - reduce water loss from plants; used to protect plants from winter damage, drought, wind burn, and transplant shock. However, effectiveness is being questioned by recent research.

Pesticides can be grouped according to how they work. Many work in more than one way. For example:

Contact poisons kill pests simply by touching them.
Stomach poisons kill when swallowed.
Systemics kill best by being taken into the blood of the animal or sap of the plant upon which the pest is feeding.
Translocated herbicides move from the point of initial application to circulate throughout the plant. The circulation of toxin insures the kill of the entire plant.
Fumigants are gasses which kill when they are inhaled or otherwise absorbed by pests.
Selective pesticides kill only certain kinds of plants or animals, for example, 2,4,-D used for lawn weed control, kills broadleaf plants but leaves the grass unharmed.
Nonselective pesticides kill most plants or animals.

The following terms describe when to apply pesticides:

Preemergence - use before plants emerge from soil
Preplant - use before crop is planted by applying to the soil
Postemergence - use after the crop or weeds have germinated

Terms which describe how to use pesticides:

Band - application to a strip over or along each crop row
Broadcast - uniform application to an entire, specific area by scattering a pesticide
Dip - immersion of a plant in a pesticide.
Directed - aiming the pesticide at a portion of a plant, animal or structure
Drench - saturating the soil with a pesticide.
Foliar - application to the leaves of plants
In-furrow - application to or in the furrow in which a plant is growing
Sidedress - application along the side of a crop row
Spot treatment - application of a pesticide to a small section or area of a crop

PESTICIDE FORMULATIONS

The formulation describes the physical state of a pesticide and determines how it will be applied. Pesticides are rarely applied full strength. The chemical in the pesticide formulation that actually kills the pest(s) is termed the active ingredient. The added chemical(s), those which make the product easy and safe to formulate or apply, are termed the inert ingredients. Common pesticide formulations follow.

Emulsifiable concentrates (EC or E): The active ingredient is mixed with an oil base (often listed as petroleum derivatives) forming an emulsion which is diluted with water for application. ECs are common in the home garden trade, being easy to mix and use. They can cause a minor surface bronzing of light colored fruit. They should be protected from freezing temperatures which can break down the emulsifer.

Solutions (S): These formulations are premixed, ready to use. They are often used in household pest products.

Flowables (F or L): A flowable, or liquid, can be mixed with water to form a suspension in a spray tank.

Aerosols (A): These are very low concentrate solutions, usually applied as a fine spray or mist. They are generally sold in aerosol cans and are a very expensive source of pesticide.

Dusts (D): Dust formulations are made by adding the active ingredients to a fine inert powder or talc. They are generally used dry.

Granules (G): Granular formulations are made by adding the active ingredient to coarse particles (granules) of inert material like fired clay particles.

Wettable powders (WP or W): Wettable powder formulations are made by combining the active ingredient with a fine powder. They look like dusts, but they are made to mix with water. These formulations need continuous agitation to maintain a suspension and are thus difficult for home gardeners to use. When mixing a WP, first mix the measured quantity with a small amount of water, forming a slurry, (a paper cup with a popsicle stick makes a good disposable mixing container) then add it and the additional water to the spray tank. The spray tank must be frequently shaken to maintain the suspension.

Soluble powders (SP): A soluble powder formulation is made from an active ingredient in powder form that dissolves in water.

Baits (B): A bait formulation is made by adding the active ingredient to an edible or attractive substance. They are ofter used to control slugs, snails, or small ground insects and rodents.

Gardeners often attempt to compare, a spray with a dust. It should be noted that dusts are a type of formulation, but sprays are not a formulation, they are one means of applying several different formulations such as, wettable powders or emulsifiable concentrates that are mixed with water. Dusts are a formulation.

SURFACTANTS, ADDITIVES OR ADJUVANTS

When added to a pesticide, a surfactant reduces the surface tension between two unlike materials, such as a spray film and a solid surface. For example, by adding a surfactant to a sprayer, oil and water will mix and can be sprayed on plant surfaces. With increasing emphasis on safe application of pesticides, such factors as droplet size, spray pattern, and pesticide drift have focused more attention on surfactants to give ideal coverage for pesticides.

Surfactants include: activators, compatibility agents, deflocculators, detergents, dispersants, emulsifiers, foam and drift suppressants and, spreading, sticking and wetting agents. These materials are added to a spray mix to help keep the pesticide in suspension; improve cohesiveness and dispersion of the spray; and increase the wetting (or coverage) of the leaves, fruits, and stems.

This section focuses on surfactants that act as spreading, sticking and wetting agents. They are most useful when spraying the hard-to-wet foliage of such plants as azalea, boxwood, camellia, carnation, conifers, euonymus, gardenia, gladiolus, holly, iris, narcissus, peony, rose, and yew. Whether a spray rolls off or sticks to a plant surface depends on the physical and chemical properties of the spray mixture and the physical properties of the surface itself. If the surface tension of the mixture is high, or if the plant surface is waxy, the spray droplets will roll off.

<u>Spreader or Film Extender (spreader-activator)</u> A spreader is a substance that, when added to a pesticide mix, increases the area that a given volume of spray will cover and improves the contact between the pesticide and the plant surface. A spreading agent builds spray deposits and improves weatherability. Most wettable powder insecticides benefit from the addition of a spreader.

<u>Sticker or Adhesive</u> A sticker is a material that, when added to a spray mix or dust, improves the adherence (tenacity) to a plant surface rather than increasing the initial deposit. Commercial sticking agents are oily in consistency and increase the amount of suspended solids retained on plant surfaces by coating the particles in a resin or varnish-like film. Most fungicides, especially wettable powders, benefit greatly from the use of stickers. Stickers may be judged in terms of resistance to wind and water, length of adherence and mechanical or chemical action.

Wetting Agent A wetting agent is a material that, when added to a pesticide, lowers the interfacial tension between a liquid and a solid; in this case, a plant surface. The effectiveness is measured by the increase in spread of a liquid over a solid surface and the ability of the spray film to make complete contact with it. When a wetting agent reduces surface tension, spreading naturally occurs.

The pesticide label should state whether a surfactant is needed or should be added to a spray mix for certain applications and should indicate restrictions in the selection of compatible surfactants. In many cases, surfactants have been designed specifically for use with fungicides, insecticides, or herbicides.

All commercial spreading, sticking and wetting agents should be mixed strictly according to label directions. Adding more surfactant than recommended may cause excessive runoff, resulting in a poor spray deposit and reduced pest control. In general, if the spray mix contains one or more pesticides produced or formulated by the same company, use a surfactant sold or recommended by that company. Surfactants are sold separately from pesticides and are not subject to EPA registration.

Although choosing an effective surfactant to accompany a specific pesticide is no simple task, the label will state whether a surfactant is needed and the brand that should be used.

THE PESTICIDE LABEL

All the printed information including the label on the product, brochures and flyers from the company or its agent about a pesticide product is called labeling. The label printed on or attached to a container of pesticides will tell you how to use the product correctly and what special safety measures you should take. Specific parts of the label include the following:

Brand name: Each company uses brand names to identify its products. The brand name shows up plainly on the front panel of the label.

Type of formulation: The same pesticide may be available in more than one formulation.

Ingredient statement: Each pesticide label must list the names and amounts of the active ingredients and the amount of inert ingredients in the product.

Common name and chemical name: Pesticides have complex chemical names derived from their chemical composition. Some have also been given a shorter name, or common name, to make them easier to identify. Pesticides may be sold under several brand names, but you may find the same common name or chemical name on all of them.

Net contents: The net contents tells how much is in the container. This can be expressed in gallons, pints, pounds, quarts, or other units of measure.

Name and address of manufacturer: The law requires the maker or distributor of a product to print the name and address of the company on the label.

Registration number: A registration number must be on every pesticide label. It shows that the product has been approved by the E.P.A. for the uses listed on the label.

Establishment number: The establishment number tells which factory made the chemical.

Precautionary statements: A section with a title similar to "Hazards to Humans and Domestic Animals" will tell you the ways in which the product may be poisonous to man and animals. It also will tell you of any special steps you should take to avoid poisoning, such as the kind of protective equipment needed. If the product is highly toxic, this section will inform physicians of the proper treatment for poisoning.

Environmental hazards: The label tells you how to avoid damage to the environment. Some examples are: "This product is highly toxic to bees exposed to direct treatment or residues on crops." "Do not contaminate water when cleaning equipment or when disposing of wastes," and "Do not apply where runoff is likely to occur."

Physical and Chemical Hazards: lists specific fire, explosion, or chemical hazards that the product may have.

Signal words and symbols: Some pesticides may be hazardous to people. You can tell how toxic a product is by reading the Signal Word and Symbol on the label.

Signal Words	Toxicity	Approximate amount needed to kill average person	Symbol
Danger Poison	Highly toxic	A taste to a teaspoonful	Skull and Crossbones
Warning	Moderately toxic	A teaspoonful to a tablespoonful	
Caution	Low toxicity or relatively non toxic	An ounce to more than a pint	

Highly toxic pesticides are generally not sold in the home garden trade. All products must bear the statement "Keep Out of Reach of Children." In some pesticide literature, the term LD50 is used to give an indication of toxicity. LD50 stands for lethal dosage necessary to kill 50% of a test population of animals. The LD50 values are measured from 0 up, for example an LD50 of 5. The numbers after the 50 represent the mgs. of the substance per Kg of body weight necessary to kill 50% of the test population. The lower the LD50 value the more poisonous a pesticide is, for example an LD50 of 5 is more poisonous than an LD50 of 20 because only 5 mgs. per kg of body weight are necessary to kill 50% of the test population.

Statement of practical treatment: If swallowing or inhaling the product or getting it in your eyes or on your skin would be harmful, the label contains emergency first aid measures and what types of exposure require medical attention.
The pesticide label is the most important information you can take to the physician when someone has been poisoned. Without the label, it is difficult for the physician to help.

Directions for use will include:

The pests the product will control
The crops, animal or other item the product can be used on safely
How the product should be applied
How much to use
Where and when the material should be applied

Application to harvest periods: When used on fruits or vegetables, there may be a period of time that must pass from the time of application until it is safe to pick and use the crop. Known as the application to harvest period and expressed as "days to harvest," this is the time required for the residue to drop to safe levels. It is often listed as a number in parentheses following the crop name. It is a mistake to assume that a residue can be washed off.

Misuse statement: This section will remind you that it is a violation of Federal law to use a product in a manner inconsistent with its labeling.

Storage and disposal directions: Every pesticide should be stored and disposed of correctly. This section will tell you how to store and dispose of the product

APPLICATION EQUIPMENT

Using the same sprayer equipment for weed control and then for insect control is neither safe nor desirable. No matter how well a tank is rinsed after use of a herbicide, a residue will be left in the tank and in the gaskets, hoses and parts. If the same tank is then used with an insecticide to spray a plant, it is possible to kill the plant with the herbicide left in the tank. The wisest policy is to maintain two sprayers, one for herbicides and another for insecticides and fungicides. Have them clearly labeled according to use. Always wash after each use.

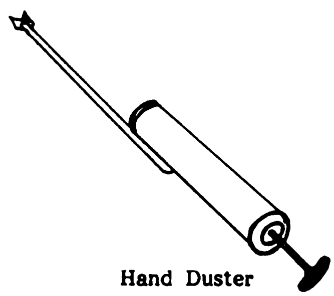
Pesticide application equipment comes in all shapes, sizes, types and prices. Select equipment according to common sense.

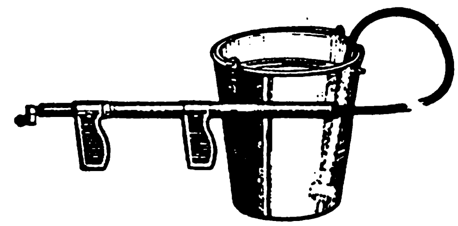
Proportioner or Hose-End Sprayer: These inexpensive small sprayers are designed to be attached to a garden hose. A small amount of pesticide is mixed with water, usually no more than a pint, and placed in the recepticle that is attached to the hose. A tube connects this concentrate to the opening of the hose. When the water is turned on, the suction created by the water passing over the top of the tube pulls the pesticide concentrate up and into the stream of hose water. They can reach into medium high trees if water pressure is high. Problems are encountered from poor spray distribution, and clogging of nozzles. The metering out of the concentrate into the stream of hose water is very inaccurate, since it is determined by the water pressure. They put out an excessively high volume of spray for most needs, using excessive pesticide. They are popular due to inexpensive price, but the gardener will quickly override the lower purchase price with the cost of excessive pesticides used. All hose-end proportioners should be equipped with an antisiphon device to prevent back siphoning of toxic chemicals into the water system.

Trombone Sprayer: The trombone sprayer is a medium size hand held piece of equipment. A spray mixture at the correct dilution is prepared in a container such as a bucket. The intake tube of the sprayer is inserted into the pesticide in the bucket. Pump pressure is created by operating the sprayer in a trombone like motion. The pesticide is pulled up the hose and out the end of the sprayer. A uniform concentration of the spray can be maintained since the pesticide is mixed with a known quantity of water. If you are using a wettable powder, frequently agitate the spray mixture. The trombone sprayer is excellent for spraying trees and shrubs. It is easy to wash and keep clean, but does require some effort to operate.

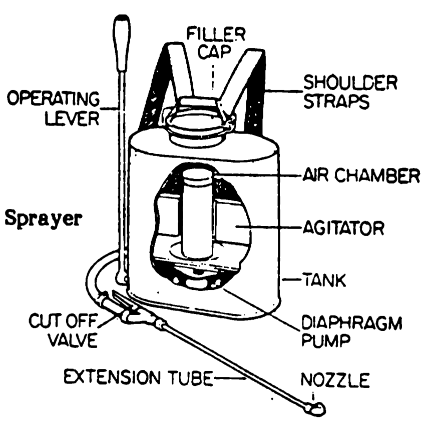
Compressed Air Sprayer (Knapsack or tank sprayer): Spray is mixed in a small tank (generally 1 to 5 gallons) and the tank is carried over the shoulders. The hand operated pump supplies the pressure during application. A uniform concentration spray can be maintained since the pesticide is mixed with a known quantity of water. Frequent agitation of the spray mixture is necessary when using a wettable powder formulation. Applicator has excellent control over coverage making this sprayer a good choice for treating dwarf fruit trees, vegetables and ornamentals. Spray will not reach into tall trees. As water weighs approximately 8.23 lbs per gallon small tanks are easier for most persons to use.


Compressed Air Sprayer

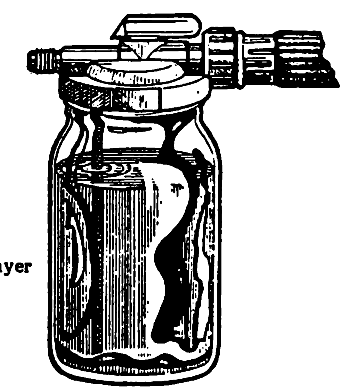

Hand Duster


Trombone Sprayer

Backpack Sprayer



Hose End Sprayer



Small Power Sprayers: These have the advantage of being motor driven so the operator does not have to stop to pump up the tank. They are light weight since the spray in the tank is concentrated, it is diluted with air as it is sprayed. They also provide uniform even pressure. They are generally too expensive for home garden use.

Hand Duster: The duster may consist of a squeeze tube or shaker, a plunger that slides through the tube or a fan powered by a hand crank. Uniform coverage of foliage is difficult to get with many dusters. Dusts are more subject to drift than liquid formulations due to their light weight and poor sticking qualities.

CALIBRATING SPRAYERS AND SPRAY PATTERNS

The usual approach homeowners use when applying a pesticide over a given area is to mix a tablespoon or two of a certain pesticide and apply it to a problem area. This is acceptable if the label gives recommended rates in teaspoons or tablespoons per gallon. But some pesticides, specifically herbicides and insecticides for lawns, do not give rates in tablespoons or teaspoons per gallon. Instead, they give rates of application in teaspoons or tablespoons per 100 or 500 square feet. Unfortunately the homeowner all to often solves this problem by guessing how much to use. This can be dangerous; too concentrated may be too toxic; too little will not control the problem. It is irresponsible of the homeowner to apply chemicals at improper rates. It is dangerous to himself, his neighbors, and the environment.

A better approach is to calibrate the sprayer. The calibration of a home sprayer is relatively easy. Once it has been done, it has been done for the life of the sprayer provided the nozzle remains unchanged, clean, and adequate pressure is used. It must be kept in mind that the rate at which the liquid is applied varies with the pressure and size of the opening in the nozzle. High pressure and a large opening in the nozzle permits more liquid to be applied over a given area than lower pressure and/or smaller size nozzle. For calibrating a sprayer, the procedure is as follows:

1) Fully pressurize the sprayer and determine delivery time. This can be done by spraying water through the sprayer into a pint jar. Let's say that after 30 seconds of spray there is 1/2 cup in the jar. Mark this delivery time on the sprayer for future use.

2) Calculate the area to be treated. Measure the area that is to be sprayed. Multiply length times width to determine the area of a rectangle. The area of a triangle is calculated by multiplying the base times the height and dividing by 2. Most areas can be calculated by combining rectangles and triangles or subtracting triangles from rectangles.

3) If the area is large divide the area into equal pieces, equal to the size of the delivery area.

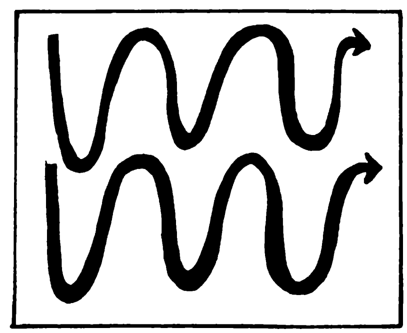
4) Spray an area at a normal speed with water for 30 seconds. Measure the area you've sprayed. This tells you how much area you can spray in 30 seconds. Let's say it covers 100 square feet.

For example, assuming that it has been established: 30 seconds of spraying delivers 1/2 cup and 30 seconds of spraying will cover 100 square feet. If the label calls for 3 tablespoons of pesticide for 1000 square feet; then, 1000 square feet= 5 cups spray delivered or, 1 quart + 1 cup or, 40 ounces. Then, 3 tablespoons of pesticide must be mixed with 40 ounces of water to achieve the proper spray coverage.

Many commercial type chemicals are given in pounds to the acre or quarts to 100 gallons of water. To convert rates to equivalents used by a homeowner, consult the pesticide conversion chart at the end of this chapter. The spray pattern best used to cover an area of ground is one which will give uniform coverage with little spray overlap. Overlap can be a problem, causing certain areas to end up with an extra dose of pesticide. The spray pattern used to apply the pesticide should be continuous and uninterrupted. Otherwise, if a herbicide is being applied, the sprayer should not be slowed down or stopped at each weed. If the herbicide has been mixed correctly and the sprayer is properly calibrated, the continuous uninterrupted flow of chemical will be sufficient for good pest control. There is a time when overlap may be beneficial. If good spray coverage is questionable such as when using hose end sprayers, cut the application rate in half and apply the pesticide first in an east-west pattern, then in a north-south direction. This gives better coverage with devices typically poor in their metering capabilities. The spray pattern should be directed so that the applicator does not walk through it as he sprays. The spray pattern should form an arc no more than 3-4 feet on either side of the operator. The covered area should have a small amount of overlap to insure coverage but limited to as little as possible.

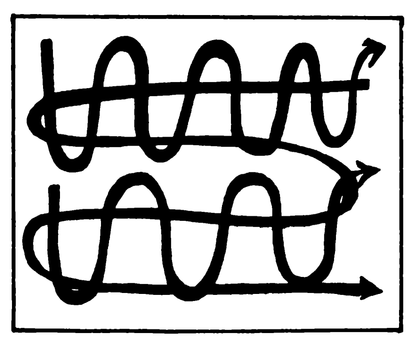
Either compressed air sprayers or hose end sprayers can be used. However, remember that hose end sprayers do not meter out the pesticide as evenly as a compressed air sprayer. Compressed air sprayers, on the other hand, do not maintain pressure as evenly as hose end sprayers unless frequent pumping stops are made. Some hose end sprayers will not continue to spray water if the thumb hole is not covered. Other hose end sprayers use a trigger device to apply the pesticide mixture. The trigger type would be more suitable in this case.

When the mixture on the label is in teaspoons or tablespoons per gallon and the plants are upright such as shade trees, fruit trees, shrubs and vegetables, spray the leaves until run off. This is the point where the pesticide solution begins to drip from the leaves. Don't forget to spray the underside of leaves for good coverage.



Single Application (A)

Spray Pattern with a
Single Application (A)
and a Double Application (B)



Double Application (B)

PESTICIDE APPLICATION

When applying pesticides wear the protective clothing and equipment the label recommends. To prevent spillage of chemicals, always check application equipment for leaking hoses or connections and plugged, worn or dripping nozzles. Then add pesticide. Before spraying, clear all people, pets, and livestock from the area. To minimize drift, apply pesticides only on days with no breezes. If moderate winds come up while you are working, stop immediately. You can also reduce drift by spraying at a low pressure and using a large nozzle opening. Generally the safest times of day to spray to reduce the hazard of drift are early morning or late evening.

Vaporization is the evaporation of an active ingredient during or after application. Pesticide vapors can cause injury. High temperatures increase vaporization. You can reduce vaporization by choosing pesticide formulations that do not evaporate easily, and spraying during the cool part of the day. Some products, like 2,4,-D, are very volatile and can move for miles under favorable conditions. They should not be used around highly sensitive plants like grapes and tomatoes. Do not apply when it is windy nor when temperatures following application will reach above 85 degrees F.

Cleaning Equipment

Thoroughly clean all equipment immediately after use. Pesticides should not be stored mixed. If you have excess pesticide mixed which cannot be used, spray it over an area that you know it will not harm. Add Clorox or lime to the surplus to help break it down. Thoroughly clean all spray equipment inside and out with clean water. Don't forget to flush the hoses and nozzles. Use precautions that your cleaning water does not damage crops. Do not dump the rinse water in one place where it will be concentrated and may become a pollutant. Spray the rinse water over a broad area so that the pesticide will be further diluted. NEVER RINSE PESTICIDES DOWN THE DRAIN!

To clean 2,4,-D type herbicides from hand spray equipment such as a 3-gallon garden sprayer, use household ammonia. Thoroughly rinse the equipment with fresh water after spraying. Fill the spray equipment with an ammonia solution, using one-half cup of ammonia to 3 gallons of water. Let the equipment soak for 18 to 24 hours. Always spray part of this mixture through the pump, hose and nozzles at the beginning and end of the soaking period. NOTE: 2,4-D cannot be completely removed from a sprayer once used in it. Do Not Use This Sprayer to Apply Other Pesticides to Desirable Plants.

Storage and Disposal

Gardeners should store all pesticides in their original containers, in a locked cabinet No Exceptions If You Are Concerned about Children's Lives! They should be protected from temperature extremes, some can be damaged upon freezing, others can be altered by heat. Do not store pesticides in the home! Empty containers are best placed in refuse cans destined for a sanitary landfill. Wrap containers in newspaper and secure before disposal. Some states have special chemical dumps for pesticides; however, Virginia does not have such dump sites. The bottle should be rinsed out first, pouring the rinse water into the spray tank. Rinse three times allowing 30 seconds to drain between each rinse. Never use empty pesticide containers for other uses, never allow children to play with empty containers. If possible, break the containers before disposal. Do not burn paper containers.

USING PESTICIDES SAFELY

Protective Clothing

If special protective clothing is required, the label will tell you the kind of protection to use. Pesticides sold in the home garden trade generally do not require special protective clothing. Many professionally used and highly toxic chemicals do. Anytime you handle pesticides, you should wear a long sleeved shirt and long legged trousers, or coverall type garment and shoes. Additional protection is available by wearing unlined neoprene or rubber gloves, a wide-brimmed plastic hard hat that covers the back of the neck and goggles or face shield to protect the eyes. Rubber gloves and goggles are particularly important when mixing or pouring pesticides. Toxic commercial pesticides may also require neoprene boots, chemical cartridge respirators, face masks, neoprene suit, or even gas masks. These more toxic chemicals should not be used in a home garden setting. After using any pesticide, wash your hands and arms thoroughly with soap and water. Never eat, drink or smoke before washing your hands. If you have been doing a lot of spraying or dusting, remove your clothes, take a shower, and put on clean clothes. Clothing should be laundered separately from the family wash. The washer should be run empty with detergent after cleaning pesticide contaminated clothing. If you get sprayed, change and shower immediately. Use first aid procedures if necessary.

Safety Precautions

Most pesticides can cause severe illness, or even death, if misused. But every registered pesticide can be used safely if you use it correctly. Many accidental pesticide deaths are caused by eating or drinking the product, particularly by young children. Some applicators die or are injured when they breathe a pesticide vapor or get a pesticide on their skin. Pesticides can poison you in two ways. Acute poisoning or toxicity measured by an LD50 number, can kill or injure you after one exposure. Chronic toxins will not produce an effect until there have been a sufficient number of exposures. However, the number of exposures necessary to produce an effect, varies with the kind of pesticide and the health and size of the person exposed. LD50 is not a measure for chronic toxicity. If an applicator uses organophosphate (diazinon, malathion) or carbamate (carbaryl, furadan) insecticides with any regularity, it would be wise to ask a physician about a test to check the cholinesterase level of the blood. These pesticides destroy this enzyme, which is necessary to carry nerve impulses to the brain. Although chronic toxicity is not poisonious immediately, over the long run it can be serious. Always use safety precautions and treat all pesticides with respect. To prevent accidents with pesticides, use and store pesticides away from children, keep pesticides in their original containers, and take care to always follow label directions.

Symptoms of Pesticide Poisoning

Awareness of the early symptoms and signs of pesticide poisoning is important. Unfortunately, all pesticide poisoning symptoms are not the same. Each chemical family (organophosphates, carbamates, chlorinated hydrocarbons, etc.) attacks the human body in a different way. Fumigants and solvents can make a person appear to be drunk. The symptoms are poor coordination, slurring of words, confusion and sleepiness. Common pesticides like organophosphates and carbamates injure the nervous system. The symptoms develop in stages, usually occuring in this order:

<u>Mild Poisoning or Early Symptoms of Acute Poisoning</u> Fatigue, headache, dizziness, blurred vision, excessive sweating and salivation, nausea and vomiting, stomach cramps or diarrhea.

Moderate Poisoning or Early Symptoms of Acute Poisoning Unable to walk, weakness, chest discomfort, muscle twitches, constriction of pupil of the eye, earlier symptoms become more severe.

Severe or Acute Poisoning Unconsciousness, severe constriction of pupil of the eye, muscle twitches, convulsions, secretions from mouth and nose, breathing difficulty, death if not treated. Illness may occur a few hours after exposure. If symptoms start more than 12 hours after exposure to a pesticide, you probably have some other illness. Check with your physician to be sure.

First Aid Procedures

Read the "Statement of Practical Treatment" on each label. The directions listed can save lives. If a pesticide gets on the skin remove the pesticide as quickly as possible. Remove all contaminated clothing. Prompt washing may prevent sickness even when the spill is very large. Detergents work better than soap in removing pesticides. Don't forget the hair and fingernails. If a pesticide is inhaled get to fresh air right away. Loosen all tight fitting clothing. If needed give artificial respiration immediately. Do not stop until victim is either breathing well or medical help arrives. Get to a physician. Do not administer anything to a poison victim unless you are trained in first aid, otherwise you may compound the injury.

In case of poisoning, call a physician and give the following information: describe the victim by name, age and sex, identify yourself and your relationship to the victim. Have the package or poison in your hand and identify what the victim took and how much he took. Keep calm, you have enough time to act, but don't delay unnecessarily. For information about poison control centers in Virginia contact your extension agent about publication 456-103 entitled, "Poison Control Centers." Poisoning information is also available by contacting your local poison center.

PESTICIDES AND THE ENVIRONMENT

Direct Kill

Fine mists of herbicides can drift to nearby crops or landscape plants and kill them. You can kill bees and other pollinators if you treat a crop with a pesticide when they are in the field. Or you could kill the natural enemies of pest insects. Life in streams or ponds can be wiped out by accidental spraying of ditches and waterways, runoff from sprayed fields, and careless container disposal. If more than one pesticide will control the pest, choose the one that is the least hazardous to the environment and most useful for your situation. To protect beneficial insects, avoid excessive use of insecticides, spray only when crop and pest populations require.

Protecting Insect Pollinators

Gardeners should give special consideration to protecting insect pollinators, such as the honey bee, from insecticide poisoning. Insecticides highly toxic to bees have restricted application times when being applied to crops frequented by honey bees. Bees are not active in late evening and early morning. Do not apply insecticides when temperatures are unusually low because residues will remain toxic much longer.

Persistence and Accumulation

Although most pesticides break down quickly, remaining in the environment only a short time before being changed into harmless products, some pesticides break down slowly and stay in the environment for a long time. These are called persistent pesticides. Some persistent pesticides can build up in the bodies of animals, including man. These pesticides are called accumulative. Most persistent pesticides have very limited usage or have been removed from the market. For example, chlordane is a persistent pesticide and its use is limited to termite and fire ant control.

Pesticides Move in the Environment

Pesticides become problems when they move off target. This may mean drifting off the target if in the form of dust or mist, moving with soil particles by erosion, leaching through the soil, being carried out as residues on crops or livestock, or evaporating and moving with air currents.

Safe Use Precautions

You can prevent harm from pesticides if you follow safety precautions and use common sense. Here are the minimum safety steps you should take.

Before buying a pesticide identify the pest to be controlled. Then find out which pesticide will control it. If there is a choice of several, choose the least hazardous product.

At the time of purchase read the label of the pesticide you intend to buy to find out the following: that the host plant (and pest) are listed on the pesticide label; the pesticide is not phytotoxic to the plant being protected; safety conditions for use, such as special equipment, protective clothing, restrictions on use, and environmental precautions needed.

Before applying pesticide read the label again to find out: the safety measures including protective clothing and equipment needed, the specific warning and precautions, with what it can be mixed, mixing instructions, application to harvest period for fruit and vegetables, crops to which it can or cannot be applied, and other special instructions.

Compatibility

Compatibility occurs when two or more pesticides can be mixed together without reducing their effectiveness or harming the target. For instance, carbaryl or Sevin is often combined with a miticide such as Kelthane in order to kill both insects and mites at one time. Synergism is the action of two materials of the same type which used together produce a greater effect than the sum of the materials when used alone. One of the materials when used alone may not affect the pest, but greatly increases the total effect of the two when used together. Example: Chemical A kills 60%, Chemical B kills 20%, Chemical A and B together kill 98% of the pests. Synergism may increase control or require less chemical. It may also be more harmful to a nontarget organism. A synergistic effect can also be undesirable causing death or damage to the organism that is being protected. It should be stressed that no chemicals should be mixed together unless the label specifically says they are compatible.

HOME GARDEN VS COMMERCIAL PESTICIDES

Some pesticides are packaged specifically for home garden use. These products are packaged in small quantities like pints, quarts, ounces or pounds. They are seldom highly toxic pesticides and are usually in low concentrations. The label rate is given in spoonfuls per gallon or pounds per 1000 square feet.

Because of the small label size, home garden products may not list all of the plants and/or pests for which the product may be registered for use. For example, one manufacturer sells Diazinon 25% EC as Fruit and Vegetable Insect Control and Diazinon Insect Spray. Both are basically the same product, but plants and pests listed vary greatly. This situation causes some confusion in pesticide application and stimulates the purchase of excessive amounts of pesticides.

Products packaged for the commercial grower may appear to be less expensive but homeowners should not be tempted to use them. They are generally more toxic than those for home use and require special protective clothing and equipment for application. They are more concentrated and in larger size containers than the homeowner could expect to use or safely store. These are much more difficult to calibrate and mix correctly since rates are usually based on a per acre system.

A few products extremely toxic to humans or the environment are classified by the E.P.A. as RESTRICTED USE PESTICIDES. The label will state "restricted use pesticides for retail sale to and application only by certified applicators, or person under their direct supervision." A license from the State Department of Agriculture is required by law for purchase and use of restricted use pesticides. This licensing is intended for commercial growers and does NOT automatically clear the use of these products by the home gardener. If you use pesticides from the commercial trade, use extra caution to protect yourself, your family and the environment.

PESTICIDES AND ORGANIC GARDENING

Although it is questionable whether we could raise all crops without the use of pesticides, it is certainly true that we can reduce the amount of pesticides we use by careful and efficient use. There are some steps to consider before automatically turning to a pesticide. First, determine if any control measures are really needed. Is the problem severe enough to warrant treatment? If the cost of treatment is less than the predicted loss, the economic threshold has been reached and treatment is necessary. Consider alternative control measures. Some examples are cultivating weeds instead of using a herbicide, and removing and destroying diseased plant parts rather than using a pesticide.

The next step is integrated control. This is probably the best answer to pest control. In this situation the wise use of pesticides is used in conjunction with alternative methods such as conservation practices to encourage natural enemies of the pest.
For example, a simple integrated control program could be used on a golf course for grub proofing against Japanese beetle larvae. A chemical pesticide would be used to protect the more valuable sodded areas of the fairways. Milky spore disease, which is a commercially produced biological control for Japanese beetle larvae, would be applied in the roughs. The chemical pesticide would give immediate protection to the sodded areas while the milky spore disease becomes established in the rough. Then, as the chemical breaks down in the more valuable areas, milky spore disease would move in. Once milky spore diesease is established, no more chemical treatment is usually needed to protect the turf.

PESTICIDES AND THE LAW

The registration and use of pesticides are governed by the E.P.A. and the Virginia Department of Agriculture and Consumer Services. Under the amended Federal Insecticide, Fungicide and Rodenticide Act (Federal Environmental Control Act of 1972) it is illegal to use a pesticide on a crop, unless the crop is listed on the label. You may not exceed the given rate of application on the label. Fines and other penalties change and vary according to laws broken.

Under the law you are liable for misuse of pesticides on your property. Recent court rulings extend your liability to include misuse by commercial applicators you hire. Serious misuse by gardeners usually results from drift, or leaching of a pesticide onto non-target plants or the direct treatment of the plant by a wrong pesticide.

PESTICIDE CONVERSION CHART

Given below are approximate measurements and should be used as a guideline if the directions for mixing small quantities are not given elsewhere.

LIQUID MEASURE:

Amount per 100 gallons	Amount per gallon
1/4 pint	1/4 teaspoon
1 pint	1 teaspoon
1 quart	2 teaspoons
1 gallon	2 1/2 tablespoons
2 gallons	5 tablespoons
4 gallons	1/3 pint
11 gallons	7/8 pint

DRY WEIGHT

Amount per 100 gallons	Amount per gallon
1/2 pound	1/12 ounce
1 pound	1/6 ounce
2 pounds	1/3 ounce
3 pounds	1/2 ounce
4 pounds	2/3 ounce
6 pounds	4/5 ounce
16 pounds	2 3/5 ounce
20 pounds	3 1/5 ounce

PRUNING

PRUNING

INTRODUCTION

To prune or not to prune? This is a question that faces gardeners often. Most feel they ought, but are not sure why or how. Pruning is accepted practice for the orchard, fairly frequently carried out in the rose garden, but rather haphazard elsewhere. Most often it is only performed when a shrub or tree begins to encroach on its neighbor, a path or a building.

Pruning is often looked upon as the answer to make a barren tree fruitful. Carried out correctly, it will, eventually. However, years of neglect cannot be rectified in one season. The unknowing pruner who cuts because he or she thinks that it ought to be done but does not know how, often ends up with no flowers at all due to excessive pruning or carrying out the operation at the wrong time of the year.

What then is pruning? Why, when and how should it be done? Pruning can be described as the removal of a part or parts of a woody plant for a specific purpose. This chapter explains the reasons for pruning, the proper techniques and tools to use, and when various types of plants should be pruned.

REASONS FOR PRUNING

The reasons for pruning can be grouped under the four following categories:

- to train the plant
- to maintain plant health
- to improve the quality of flowers, fruit, foliage or stems
- to restrict growth

Training the plant

The first pruning after trees and shrubs are received consists of removing broken, crossing, and pest infested branches.

<u>Trees</u> With trees, the rule of pruning away one-third of the top growth at transplanting to compensate for root loss is not necessary for properly pruned nursery grown plants. Excessive pruning at transplanting, according to research, reduces plant size and does not aid in plant survival.

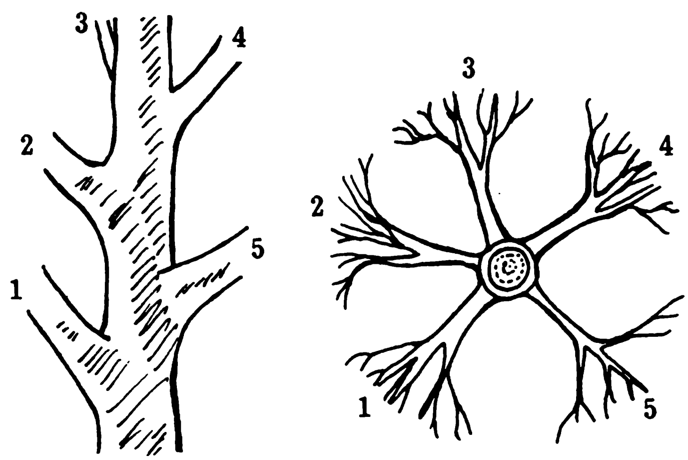
As a rule, the central leader of a tree should not be pruned, unless a leader is not wanted, as is the case with some naturally low-branched trees or where multiple-stemmed plants are desired. Trees with a central leader such as linden, sweet gum, or pin oak may need little or no pruning except to eliminate branches competing with the central leader; these should be shortened. Some pruning may be necessary to maintain desired shape and shorten extra-vigorous shoots.

The height of the lowest branch can be from a few inches above the ground for screening or windbreaks, to seven to twelve feet or more above the ground as needed near a street or patio. The removal of lower limbs is usually done over a period of years beginning in the nursery and continuing for several years after transplanting until the desired height of trimming is reached.

For greatest strength, branches selected for permanent scaffolds must have wide angle of attachment with the trunk. Branch angles of less than 30 degrees from the main trunk result in a very high percentage of breakage while those between 60 and 70 degrees have a very small breakage rate.

Vertical branch spacing and radial branch distribution are important. If this has not been done in the nursery it can at least be started at transplanting.

Major scaffold branches of shade trees should be spaced at least eight inches and preferably twenty to twenty-four inches vertically. Closely spaced scaffolds will have fewer lateral branches. The result will be long, thin branches with poor structural strength.



Scaffold branches of trees should have proper vertical and radial spacing on the trunk.

Radial branch distribution should allow five to seven scaffolds to fill the circle of space around a trunk. Radial spacing prevents one limb from overshadowing another, which in turn reduces competition for light and nutrients. Remove or prune shoots that are too low, too close, or too vigorous in relation to the leader and branches selected to become the scaffold branches.

<u>Shrubs</u> When deciduous shrubs are planted bare root, some pruning may be necessary. Light pruning of roots may be needed if any are broken, damaged, or dead. The branches of shrubs should be pruned by the thinning method (covered later), not shearing, to reduce overall plant size by one-half or more.

Shrubs transplanted with a ball of soil or from a container require little if any pruning. Occasionally, branches may have been damaged in transit, and these should be removed at the time of planting. Prune only to maintain desired size and shape.

Most evergreen trees and shrubs are sold B & B (balled and burlapped) or in a container and, as with deciduous shrubs, require little pruning of branches.

Maintaining Plant Health

In pruning to maintain plant health, first consider sanitation, which includes the elimination of dead, dying, or diseased wood. Any dying branch or stub can be the entry point or build-up chamber for insects or fungi that could spread to other parts of the tree. When removing wood infected with a disease, such as a fungal canker or fire blight, it is important that the cut be made back in healthy wood beyond the point of infection.

As was mentioned under training, the development of a sound framework will help prevent branches from shading out other, lower branches on the plant. Evergreen shrubs usually will benefit from an occasional thinning of foliage. This thinning will allow penetration of light and air throughout the shrub, resulting in even growth of the foliage.

Improving the Quality of Flowers, Fruit, Foliage or Stems

The more flowers and fruit a plant produces, the smaller they become, as can be witnessed on an unpruned rose bush or fruit tree. Pruning reduces the amount of wood and so diverts energy into the production of larger, though possibly fewer, flowers and/or fruit. Most flowering shrubs will bloom either on last year's growth, or on new growth. Properly timed pruning will increase the production of wood that will bear flowers.

Some deciduous shrubs have colored barks which are especially delightful in winter. The best color is produced on young stems and the greatest stem length and most intense color results from hard pruning.

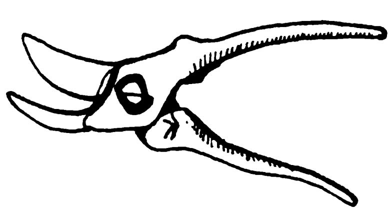
Restricting Growth

Over time, trees and shrubs will often grow to sizes that exceed the space allowed for them. Where space is limited, regular pruning becomes necessary to keep plants in bounds. Regular pruning is necessary on formal hedges to maintain a uniform growth rate. To reduce labor, select plants that will not exceed allotted space.

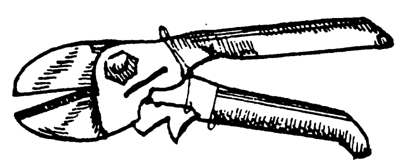
PRUNING TOOLS

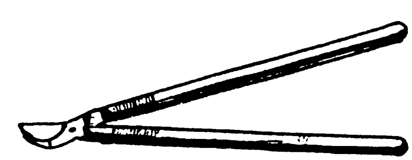
Hand pruning shears are good for branches up to one-half inch in diameter. Attempting to cut larger branches risks making a poor cut and/or ruining the shears.

There are two styles of hand shears: 1) the scissor action; and 2) the anvil cut. In the second style, a sharpened blade cuts against a broad, flat blade. In the first, a thin, sharp blade slides closely past a thicker but also sharp blade. The first one usually costs more, but makes cleaner, closer cuts.



Pruning shears



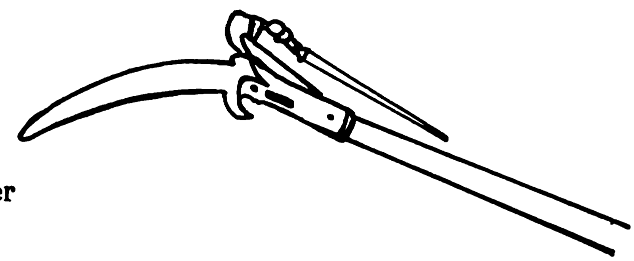


Lopping shears

Lopping shears have long handles and are operated with both hands. Even the cheapest can cut one-half inch diameter material. The better ones can slice through branches of two inches or more, depending on species and condition (e.g., pin oak is tougher than linden and dead wood is tougher, until decay sets in, than live wood).

Pole pruners have a cutter with one hooked blade above and a cutting blade beneath. The cutter is on a pole and is operated by a lanyard pulled downward. The poles can either be in sections, that fit together or telescoping and can be made of several materials. Wooden poles are heavy. Aluminum poles are light but can conduct electricity if they touch an overhead wire. Fiberglass, or some type of plastic compound is probably the best answer. Poles can be fitted with saws, but these usually are very frustrating to use.

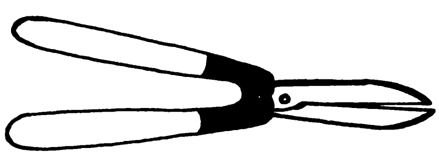
Use of pole pruners can be dangerous, as material cut overhead can fall on the operator (unless it hangs up in other branches). The user should exercise caution and wear head and eye protection.

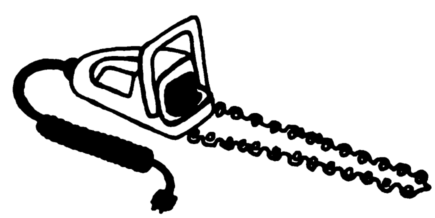


Combination pole saw-pruner

Manual hedge shears have long, flat blades and relatively short handles, one for each hand. Heavy duty shears with one blade serrated are good for difficult jobs.

Power hedge shears are also available. The most common for home use are electric models.





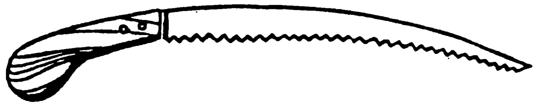
Hedge shears

There are many makes and models of hand pruning saws. Fineness of cutting edge is measured in points (teeth per inch). An 8 point saw is for delicate, close work on small shrubs and trees. Average saws are about 5 1/2 to 6 points, while 4 1/2 point saws are for fairly heavy limbs.

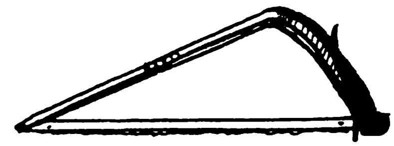
Folding saws either require a screwdriver (for a slotted-head holding screw) or will have a protruding wingnut which can scar the trunk when a limb is cut. If the saw suddenly folds while in use the operator's fingers can be damaged. A fixed blade saw with a leather scabbard is safer.

Blades can be either straight or curved. Many prefer a curved blade that cuts on the draw stroke. A double-edged saw has fine teeth on one side, coarse on the other. These are difficult to use in densely branched plants.

Bow saws are good only where no obstruction exists for a foot or more above the area to be cut.



Pruning saw



Bow saw

Chain saws come in a variety of sizes, both gas and electric. However, in general, chainsaws are not appropriate for pruning of live plant material. They are better suited to the removal of trees and cutting of firewood.

Care of Tools Clean and oil tools regularly, including wiping an oily cloth on blades and other surfaces. Keep cutting edges sharp. Several passes with a good oil stone will usually suffice. Wooden handles should be either painted, varnished, or regularly treated with linseed oil. Use tools properly. Don't twist or strain pruners or loppers. Keep the branch to be cut as deeply in the jaws and near the pivot, as possible. Don't cut wires with pruning tools.

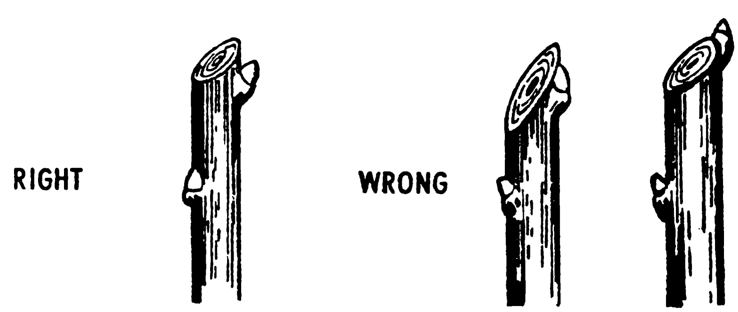
PRUNING TECHNIQUES

Twigs and Small Branches

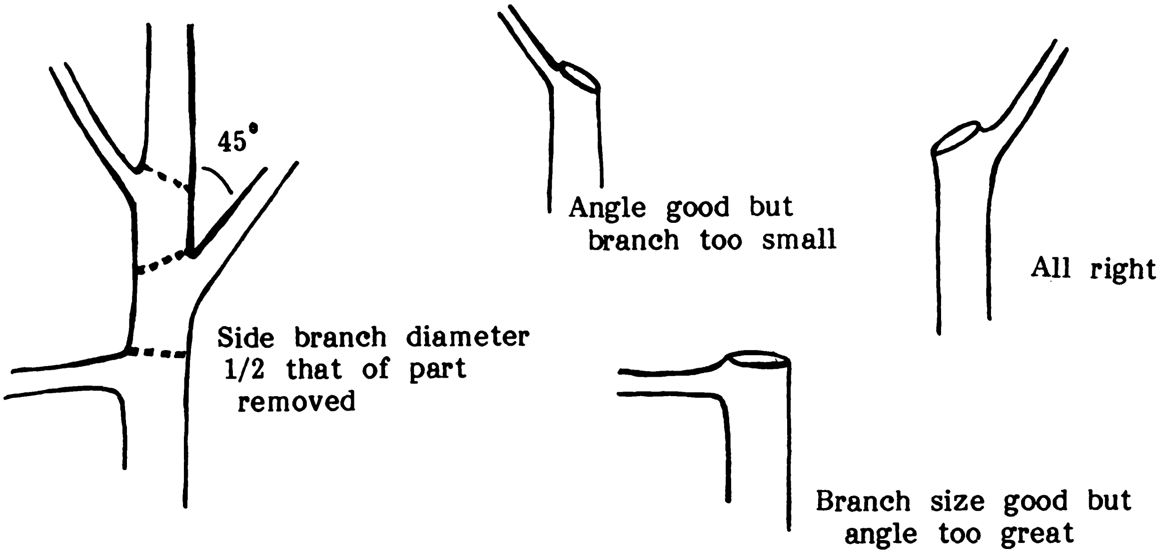
When pruning twigs and small branches, always cut back to a vigorous bud or an intersecting branch.

When cutting back to a bud, choose a bud that is pointing in the direction you wish the new growth to take. Be sure not to leave a stub over the bud or cut too close to the bud.

PROPER PRUNING ANGLE



When cutting back to an intersecting (lateral) branch, choose a branch that forms an angle of no more than 45 degrees with the branch to be removed. Also, the branch that you cut back to should have a diameter of at least one-half that of the branch to be removed.



Make slanting cuts when removing limbs that grow upward; this prevents water from collecting in the cut and expedites healing.

Thick, Heavy Branches

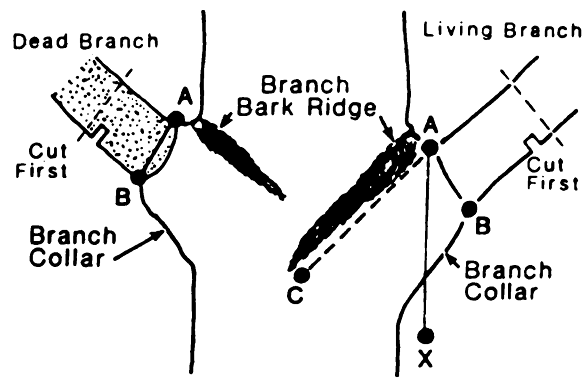
According to Dr. Alex Shigo of the Northeast Forest Experimental Station, United States Department of Agriculture, thick heavy branches should be removed flush to the collar at the base of the branch, not flush with the tree trunk.

The collar is an area of tissue that contains a chemically protective zone. In the natural decay of a dead branch, when the decay advancing downward meets the internal protected zone, an area of very strong wood meets an area of very weak wood. The branch then falls away at this point leaving a small zone of decayed wood within the collar. The decay is walled off in the collar. This is the natural shedding process when all goes according to nature's plan. When the collar is removed, the protective zone is removed, causing a serious trunk wound. Wood decay fungi can then easily infect the trunk. If the pruned branch is living, removal of the collar at the base still causes injury.

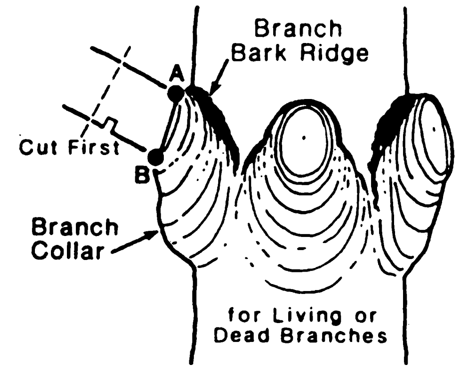
For over half a century the recommendations for pruning have been to flush cut and paint. These recommendations have no basis in scientific fact. The flush cut increases the tree injury which the paint hides. The paint is primarily cosmetic, a psychological treatment for the person doing the pruning, to show that he or she has done something to help the tree. In fact, paints or wound dressings may trap moisture and increase disease problems.

When cutting branches over 1.5" in diameter, use a 3-part cut. This is accomplished by first sawing an undercut from the bottom of the branch about six to twelve inches out from the trunk and about 1/3 of the way through the branch. Next, make a second cut from the top, about three inches further out from the undercut, until the branch falls away. The resulting stub can then be cut back to the collar of the branch. If there is danger of the branch damaging other limbs below, or objects on the ground, it must first be properly roped and supported, then carefully lowered to the ground after the second cut.

Hardwoods



Conifers



Root Pruning

A tree growing in the woods or landscape for a long time may develop long roots running fifteen to twenty-five feet or more away from the plant. These are sufficient because of many-branched side roots, to physically support the tree, but if one were to investigate the area in a three-foot radius about the trunk of that tree one would undoubtedly find very few of the small feeding roots so essential to gathering nourishment for the tree. These would probably be at quite some distance from the trunk, branching off the long main roots. As a consequence, if the tree were to be balled and moved, a major part of the necessary feeding roots would be cut off in the balling operation and the tree might easily die when transplanted. This is the reason nuserymen root prune nursery plants, to force them to grow a large number of small feeding roots near the base of the plant which are moved in the balling operation and insure growth after transplanting.

To make it possible to safely dig small trees or shrubs in the woods, such trees should be root pruned a year or so before they are moved. This is done by forcing a sharp spade into the soil around the plant in a circle slightly smaller than the size of the ball that will eventually be dug. Thus cutting all the roots that are at a depth of a foot or more. The operation can be done in the very early spring and, if the plant does not suffer too much, it might be moved late in the fall.

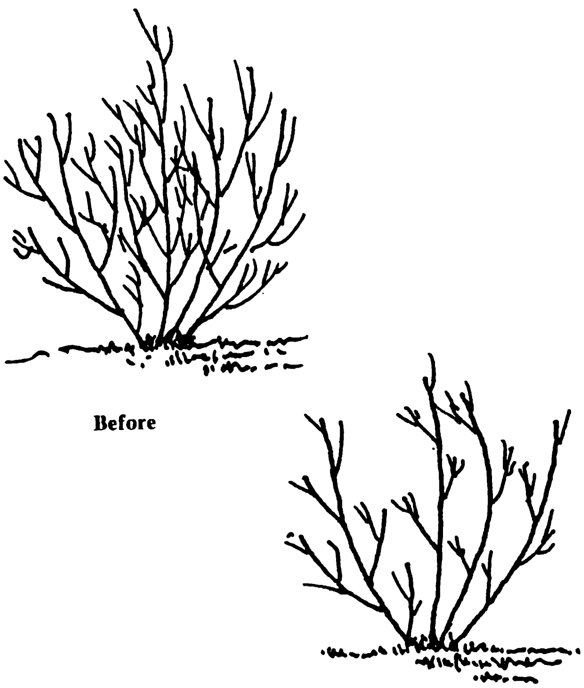
Another way of accomplishing the same thing is to cut the roots all on one side in the spring, then on the other side the following spring, moving it that fall. Recent reasearch indicates that most of the new roots grow from the cut end. Therefore a root ball 4-6 inches larger than the rootpruned area must be dug to get the newly developed roots.

Root pruning is also used to force a vigorous-growing fruit tree, Wisteria vine, or flowering dogwood into bloom. Using a spade to cut the roots in a circle about the plant early in the spring, as explained above, is all that is sometimes necessary to force a tree, shrub or vine into bloom the following year.

PRUNING SHRUBS

Deciduous Shrubs

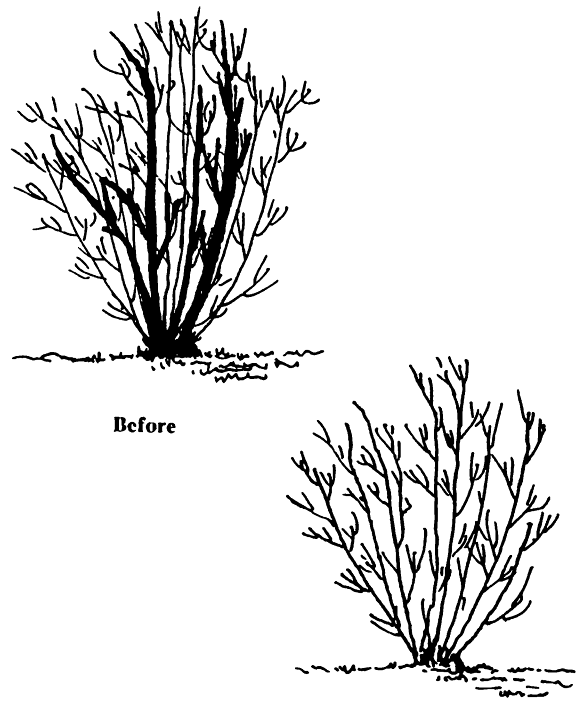
The recommended pruning most deciduous shrubs consists of thinning out, gradual renewal and rejuvenation pruning. In thinning out, a branch or twig is cut off at its point of origin from the parent stem, to a lateral side branch, to be "Y" of a branch junction, or at ground level. This method of pruning results in a more open plant and does not stimulate excessive new growth. Considerable growth can be cut off without changing the plant's natural appearance or habit of growth. Plants can be maintained at a given height and width for years by thinning out. This method of pruning is best done with hand pruning shears, loppers, or saw, but no hedge shears. Thinning allows room for growth of side branches. Thin out the oldest and tallest stems first.



Before

After

THINNING



Before

After

GRADUAL RENEWAL

In gradual renewal pruning, a few of the oldest and tallest branches are removed at or slightly above ground level on an annual basis. Some thinning out pruning may be necessary to shorten long branches or maintain a symmetrical shape.

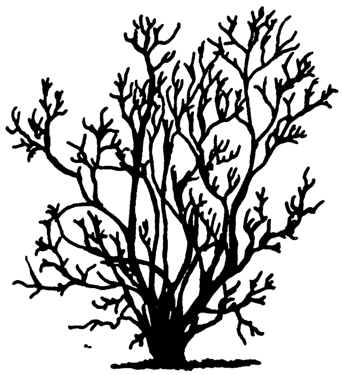
To rejuvenate an old, overgrown shrub, one-third of the oldest, tallest branches can be removed at or slightly above ground level before new growth starts.

When the shrub to be pruned is grown for its flowers, the pruning must be timed to minimize disruption of the blooming.

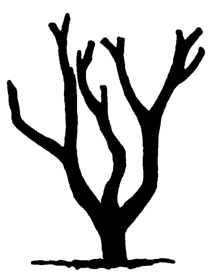
Spring flowering shrubs bloom on last season's growth and should be pruned soon after they bloom. This allows for vigorous growth during the summer to provide flower buds for the following year.

The general pruning procedure, illustrated below for crape-myrtle, applies to many other large shrubs and small trees of similar structure

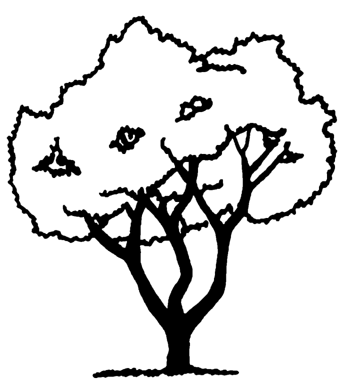
Proper Method of
Pruning Crape-myrtle



This plant, pictured before pruning, needs to have all weak and dead stems removed.

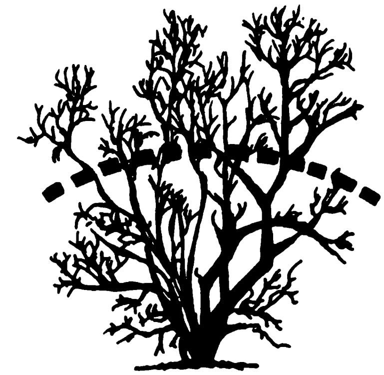


Same shrub after removal of weak and interfering wood, also base sucker growth.



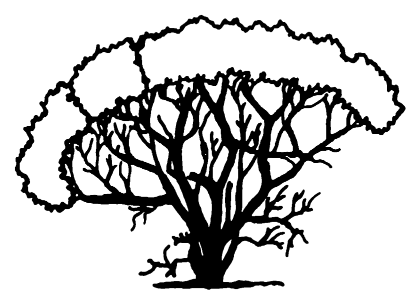
Results of proper pruning graceful, vigorous growth with distinctive shape.

Improper Method of
Pruning Crape-myrtle



Cutting at the dotted line is the usual course taken by those who prune shrubs.

The same plant after bad pruning, as indicated above. The sucker growth remains.



Result: the lovely natural shape of the shrub is lost, and bloom will be sparse.

Some examples of shrubs that bloom on last season's growth:

Cercis chinensis	Chinese redbud
Chaenomeles japonica	Japanese quince
Chionanthus virginicus	Fringe tree
Deutzia spp.	Spring flowering deutzias
Exochorda racemosa	Pearlbush
Forsythia spp.	All forsythia species
Kerria japonica	Kerria
Lonicera spp.	Honeysuckle
Magnolia stellata	Star magnolia
Philadelphus spp.	Mockorange species
Pieris spp.	Andromeda species
Rhododendron spp.	Azaleas and rhododendrons
Rosa spp.	Rambling rose species
Spiraea spp.	Early white spirea species
Syringa spp.	Lilac species
Tamarix parviflora	Small flowered tamarix
Virbunum spp.	Virburnum species
Weigela florida	Old fashioned weigela

Some shrubs that bloom after June usually do so from buds which are formed on shoots that grow the same spring. Such shrubs should be pruned in late winter to promote vigorous shoot growth in the spring.

Some examples of shrubs that bloom on current season's growth:

Abelia x grandiflora	Glossy abelia
Buddleia davidii or globosa	Butterfly bush
Callicarpa japonica	Japanese beauty bush
Caryopteris x clandonensis	Bluebeard
Clethra alnifolia	Summersweet
Hibiscus syriacus	Shrub althea
Hydrangea arborescens	Hills of Snow
Hydrangea paniculata	Peegee Hydrangea
Hypericum spp.	St. Johnswort
Lagerstroemia indica	Crape myrtle
Rosa spp.	Bush rose
Spiraea bumalda	Anthony Waterer Spirea
Spiraea japonica	Mikado Spirea
Symphoricarpos	Coralberry and Snowberry
Tamarix hispida	Kashgar
Tamarix odessana	Odessa
Vitex agnus-cactus	Chaste tree

Evergreen Shrubs

For most evergreen shrubs, a thinning out type of pruning as described earlier is the most desirable procedure. Some evergreens can be sheared when a stiff, formal appearance is desired; however, they will still need to be thinned occasionally.

Both evergreen and deciduous shrubs grown for foliage should be pruned in late winter before new growth starts. Minor corrective pruning can be done at any time.

Hedges

Hedges consist of plants set in a row so as to merge into a solid linear mass. They have served gardeners for centuries as screens, fences, walls and edgings.

Well-shaped hedge is no accident. It must be trained from the beginning. The establishment of a deciduous hedge begins with the selection of nursery stock. Choose young trees or shrubs one to two feet high, preferably multiple-stemmed. When planting, cut the plants back to six or eight inches. This will induce low branching. Late in the first season or before bud-break in the next, prune off half of the new growth. In the following year, again trim off half.

In the third year, start shaping. Trim to the desired shape before the hedge grows to the desired size. Never allow the plants to grow untrimmed to the final height before shearing. By that time it will be too late to get maximum branching at the base. Lower branches must not be allowed to be shaded out. After the hedge has reached the dimensions desired, trim closely in order to keep within chosen bounds.

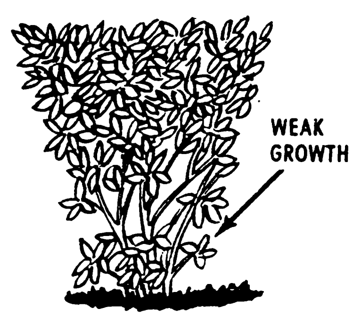
Evergreen nursery stock for hedging need not be as small as deciduous material and should not be cut back when planted. Trim lightly after a year or two. Start shaping as the individual plants merge into a continuous hedge. Do not trim too closely because many needle-bearing evergreens do not easily generate new growth from old wood.

Hedges are often shaped with flat tops and vertical sides. This unnatural shaping is seldom successful. The best shape, as far as the plant is concerned, is a natural form, rounded or slightly pointed top with sides slanting to a wide base.

After plants have been pruned initially to induce low branching, the low branching will be maintained by trimming the top narrower than the bottom, so that sunlight can reach all of the leaves on the plant.

HEDGE PRUNING

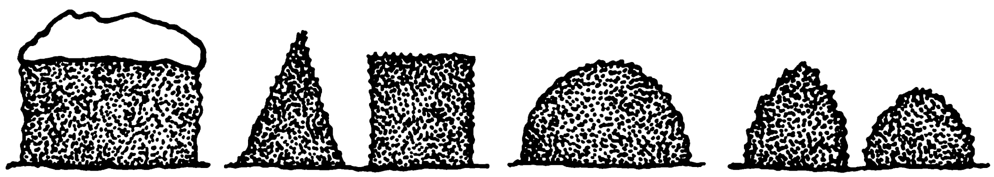
Correct



Incorrect

Rounded or peaked tops aid in the shedding of snow, which if left, may break branches. Before shaping, some thought should be given to the shape of the untrimmed plant. For example, naturally conical arborvitae does particularly well in a Gothic arch shape. Common buckthorn, a spreading plant, is more easily shaped to a Roman arch.

These questions often arise: "How often should this hedge be trimmed?" and "When should I trim?" Answers depend to some extent on how formal an appearance is desired. In general, trim before the growth exceeds one foot. Hedges of slow-growing plants such as boxwood need trimming sooner. Excessive untrimmed growth will kill leaves beneath, and also pull the hedge out of shape. This is especially true with weak-stemmed shrubs. In the mountain areas of Virginia, yews and other evergreens may need shearing only once annually and then not before July; in milder areas two or even three shearings may be necessary. Deciduous material should be trimmed earlier than July, but after the spring flush of new growth, and will often need to be trimmed once or twice more. Frequency depends on the kind of shrub, season, and degree of neatness desired.



Snow accumulates on broad flat tops

Straight lines require more frequent trimming

Peaked and rounded tops hinder snow accumulation

Rounded forms, which follow nature's tendency, require less trimming

What can be done with a large, overgrown, bare-bottomed and misshapen hedge? If it is deciduous, the answer is fairly simple. In the spring, before leaves appear, prune to one foot below the desired height. Then trim carefully for the next few years to give it the shape and fullness desired. Occasionally hedge plants may have declined too much to recover from this treatment and replacing them may be necessary.

Rejuvenating evergreen hedges is more difficult. As a rule, evergreens cannot stand the severe pruning described above. Arborvitae and yew are exceptions. Other evergreen hedges may have to be replaced.

Tools What tools should be used to trim hedges? The traditional pair of scissor-action hedge shears is still the best all-round tool. It will cut much better and closer than electric trimmers which often break and tear twigs. Hand shears can be used on any type of hedge, while electric trimmers do poorly on large-leaved and wiry-twigged varieties, and sometimes jam on thick twigs. Hand shears are also quieter and safer, less likely to gouge the hedge or harm the operator.

Hand pruners are useful in removing a few stray branches, and are essential if an informal look is desired. Large individual branches can be removed with loppers and/or a pruning saw. Chain saws are not recommended for use on hedges.

Roses

All roses need some type of pruning. If roses are not pruned for a number of years, plants deteriorate in appearance and often develop more than the usual disease and insect problems, while the flowers become smaller and smaller.

Hybrid Tea, Grandiflora and Floribunda roses require annual pruning in the spring after winter protection has been removed. As a guide line follow the old saying that roses are pruned when the forsythia blooms. If rosebushes are pruned too early, injury from repeated frost may make a second pruning necessary.

Tools and Supplies For small pruning jobs, the only tools necessary are sharp hand pruning shears and gloves. If the rose collection is large, a small saw with pointed blade and loppers will help. Loppers are used to reach in and cut out large dead canes.

To discourage borers, apply tree surgery paint or rose wound dressing to seal cuts. Where roses are infected with brown canker, carry a can of denatured alcohol to sterilize shears after each cut.

Reasons for Pruning Prune to remove branches that are dead, damaged, diseased, thin, weak and growing inward, and branches that cross or interfere with other branches. Proper prunning encourages new growth from the base making the plant healthy and attractive and resulting in large blossoms.

Steps in Pruning Remove all dead and diseased wood by cutting at least one inch below the damaged area. Remove all weak shoots. If two branches rub or are close enough that they will do so soon, remove one. On old, heavy bushes, cut out one or two of the oldest canes each year.

Cut back the remaining canes. The height to which a rose should be cut back will vary depending upon the normal habit of the particular cultivar. The average pruning height for Floribundas and Hybrid Teas is between twelve and eighteen inches, but taller growing Hybrids and most Grandifloras may be left at two feet.

Make cuts at a 45 degree angle above a strong outer bud. Aim the cut upward from the inner side of the bush to push growth outward and promote healthy shoots and quality flowers.

Standard or Tree Roses A tree rose is a Hybrid Tea, Grandiflora, or Floribunda budded at the top of a tall trunk. Tree roses usually require winter protection in the North. Prune tree roses as you do Hybrid Teas, cutting the branches to within six to ten inches of the base of the crown in order to encourage rounded, compact, vigorous new growth.

Miniature Roses Miniatures are six to twelve inches high, with tiny blooms and foliage. Minature roses do not need special pruning. Just cut out dead growth and remove the hips.

Ramblers Old-fashioned Rambler roses have clusters of flowers, each usually less than two inches across. They often produce pliable canes ten to fifteen feet long in one season. Ramblers produce best on year-old wood, so that this year's choice blooms come on last year's growth. Prune immediately after flowering. Remove entirely some of the larg old canes. Tie new canes to a support for the next year.

Large-Flowering Climbers Climbing roses have large flowers, more than two inches across, borne on wood that is two or more years old. Canes are larger and sturdier than those of Ramblers. Some flower just once in June, but some, called ever-blooming climbers, flower more or less continuously. This group should be pruned in autumn, any time before cold weather sets in. First cut out dead and diseased canes. After this, remove one or two of the oldest canes each season at ground level to make room for new canes. The laterals, or side shoots, are shortened three to six inches after flowering. If the plant is strong, keep five to eight main canes, which should be tied to the trellis, fence, wall, or other support. If it is not strong, leave fewer canes.

PRUNING SHADE TREES

Young shade trees may not need to be pruned to develop a good framework. Mature trees are generally pruned only for sanitation, safety, or reasons of size restriction. Trees can be pruned at any time of the year. A few trees bleed profusely when pruned in late winter. Among these are the sugar maple, birch, black walnut, and flowering dogwood. The bleeding has no harmful effect but is unsightly.

In winter, an experienced tree professional can easily distinguish between live and dead wood. Winter pruning is often preferred because it is easy to visualize shaping when folliage is gone. Such work can also be done at lower cost in winter because fewer precautions are necessary to avoid, garden and flower bed damage and cleanup is easier.

PRUNING VINES AND GROUNDCOVERS

The pruning of ornamental vines is similar to the pruning of ornamental shrubs. Flowering vines are pruned according to flower production; those that flower on new wood are pruned before new growth begins, those that flower on last season's growth are pruned immediately after flowering.

Vines that are grown for foliage are pruned to control growth and direction. Timing is less critical than for flowering vines.

Ground cover plants require very little pruning. Dead or damaged stems should be removed whenever observed. Some trailing ground covers, such as English ivy, may need pruning to prevent encroachment on lawn areas or other plants. With liriope, a grass-like ground cover, appearance is improved by an annual pruning. Before the new leaves are one inch tall in each clump, remove the dead leaves from the previous year. For large liriope plantings a lawnmower set to cut above the new leaf tips will speed this early spring job.

PRUNING APPLE TREES

Training and Pruning of Nonbearing Apple Trees

The objectives of training, the directing or modification of growth into a desired tree form, include early fruit production and development of an optimum tree structure for support of future crops and optimum fruit quality conditions. These objectives can be met by maintaining a proper balance between vegetative and potential fruiting wood. Excess shoot growth will delay the onset of fruiting. Thus, excess pruning of young, nonbearing trees will delay the beginning of fruit production in the life of that tree. Training should be emphasized in the development of trees with pruning used as a tool in the training process to redirect limbs, stimulate branching when desired, or to remove growth that is in an undesirable location. Pruning should not be used to invigorate growth in an attempt to compensate for poor fertilization, poor weed control, or drought conditions.

Future pruning of an apple tree is greatly affected by early training. Much of the pruning of young bearing trees is the result of errors made in training in the early life of the tree. Thus, it is imperative that training begin early. A delay for the first 3-4 years will result in a poorly-developed, weak tree. Correction of such a problem, usually with heavy pruning, will only further delay and decrease fruit production.

An integral part of a tree training program is limb spreading. Limb orientation affects vigor in various ways (Fig. 1): a) An upright or vertical limb produces the longest shoots near the apex and tends to exhibit high vegetative vigor. Often, fruit hang down against the limb and are subject to rub. b) As limbs are oriented away from vertical, they exhibit reduced vigor of shoots near the apex, more uniform branching along the shoot, and favor development of fruiting spurs. Fruit hang along the limb and are less prone to rub. A limb orientation around 60 degrees from vertical is desired. c) However, horizontal orientation of limbs results in the development of vigorous watersprouts along the upper surface of the limb, at the expense of potential fruiting spurs.

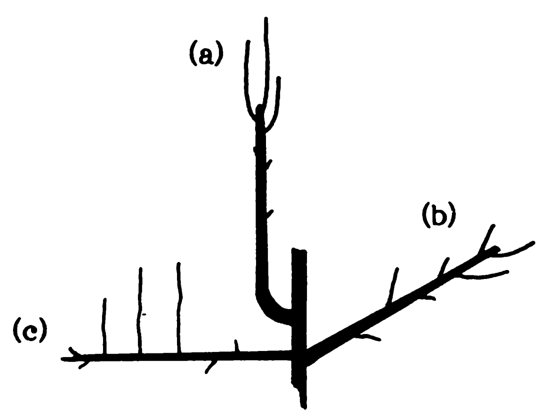


Fig. 1 Limb orientation affects vigor.

Thus, correct limb spreading (near 60 degrees from vertical) can be used to develop a proper balance between vegetative and fruiting growth. Limb spreading should begin early as many cultivars, such as Red Delicious (particularly spur types), naturally develop narrow crotch angles. If these narrow crotch angles are not widened (greater than 35 degrees), a situation can quickly develop in which bark is trapped between the trunk and scaffold (bark inclusion) (Fig. 2). This bark inclusion prevents layers of annual wood from growing together and creates the potential for splitting. If these narrow crotch angles with bark inclusions are allowed to develop, later attempts at limb spreading may result in splitting of the crotch, Thus, two objectives exist for limb spreading: 1) development of a strong wide crotch angle (greater than 35 degrees) free of bark inclusion and 2) limb orientation at 60 degrees from vertical to balance vegetative and fruiting growth. To derive the benefits of limb spreading, the crotch must be physically strong to undergo spreading without splitting.

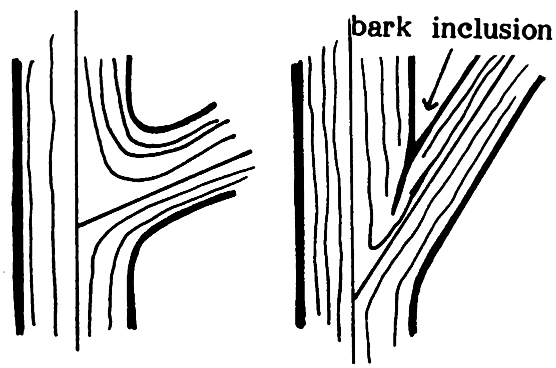


Fig. 2 Wide crotch angles are strong.

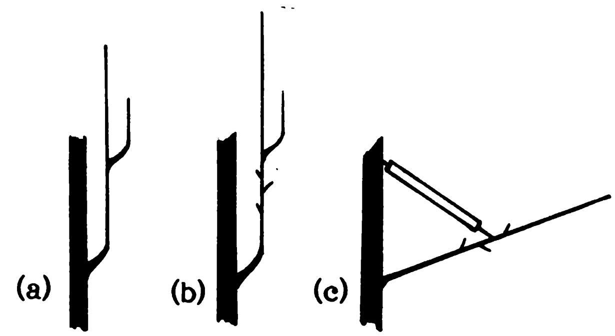


Fig. 3. Avoid bench cuts in tree training.

Poor pruning practices are not a wise substitute for proper limb spreading in the training of upright scaffolds (Fig. 3, a). Improper pruning cuts will not change the crotch angle, improve limb position, or aid in the control of vegetative vigor. c) Scaffolds should be spread and lower lateral removed if necessary.

<u>At Planting</u> Trees must be pruned at planting for several reasons. The top of the tree must be brought into balance with the root system which is usually damaged in the nursery digging operation. Pruning forces the growth of laterals from which future scaffolds will be selected.

Head spur types and semi-dwarfs to a height of 30 to 35". Standards are headed to 40". If feathered (branched) trees are planted, they should be headed to a strong bud to stimulate growth of the central leader. Feathers desirably located can be retained as scaffolds and should be headed. Undesirable feathers should be removed.

<u>First Growing Season</u> Scaffold selection can begin in the early summer, especially on cultivars developing narrow crotch angles. Shoots developing below the lowest desired scaffold should be removed. Generally, in the first year, 2-4 good scaffolds can be selected that are evenly distributed and not directly above one another (Fig. 4).
The vertical spacing between scaffolds can vary from 3-6 inches to 12 inches depending on the ultimate size of the tree. Limbs with crotch angles less than 35 degrees should be spread or removed. Hardwood toothpicks and clothespins can be used if training is done in early summer while shoots are soft. Short pieces of wire (#9) can also be used. Shoots undesirably located can be completely removed at this time.

First Year Dormant Season Select shoots to be retained as scaffolds if not done earlier. Spread selected scaffolds before any pruning is done. Spreading changes the shape of the tree and may influence pruning decisions. Remove shoots that were not selected as scaffolds. The central leader should be headed to maintain dominance and induce branching. This is done 3-5 inches above the point where the next "layer" or tier of scaffolds is desired. Refrain from heading scaffolds unless they need to be shortened or stiffened. Generally a one-year-old shoot naturally branches in the season after development (Fig. 5). Spreading of that scaffold will encourage uniform branching. However, a scaffold will often exhibit excess vigor and upset the balance of the tree. Heading can also be used to encourage growth and branching on spur types.

Second Growing Season Limbs not previously trained can be easily spread early in the growing season as wood is flexible then. Fruit developing on the central leader should be removed to maintain vigor in the center of the tree. The new tier of scaffold limbs can be selected and trained at this time. These should be well spaced with the lower scaffolds in mind.

Second Year Dormant Season Some of the scaffolds that were selected and spread in the first year may "turn up" and resume vertical growth. Longer spreaders can be used to spread the limbs back to the desired orientation. The smaller spreaders can be moved further up into the tree. Again, scaffolds should be spread before any pruning is done. The central leader should be headed again to maintain vigor and stimulate branching.

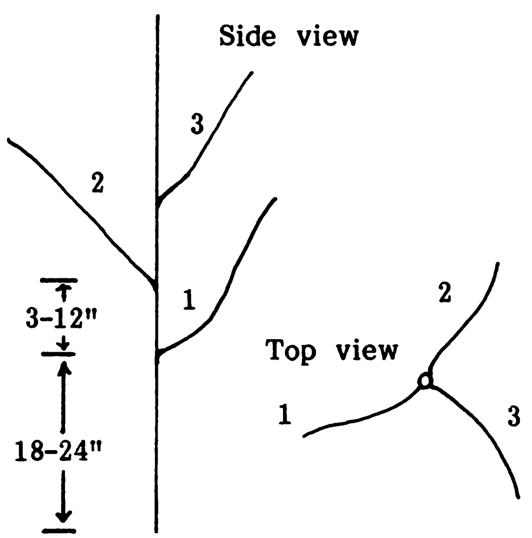


Fig. 4. Select well spaced scaffolds.

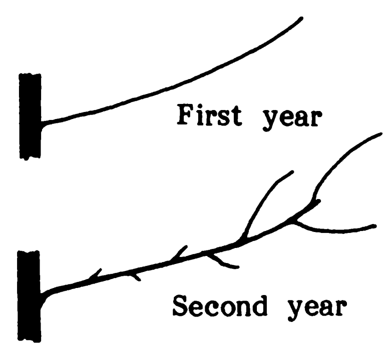


Fig. 5. Natural branching of a shoot.

Succeeding Years Continue training and pruning following the previously discussed principles of central leader dominance and proper scaffold selection and training. Scaffolds should be maintained in a 60 degree from vertical orientation. A conical tree shape should be maintained. Thus, the upper scaffold should be shorter than the scaffold below it. After the third year, upper scaffolds can be shortened with the use of thinning cuts (Fig. 6). Thinning cuts remove the entire shoot or branch at its junction with a lateral scaffold or trunk. Thinning cuts are less invigorating than heading cuts, improve light penetration, and can redirect the limb.

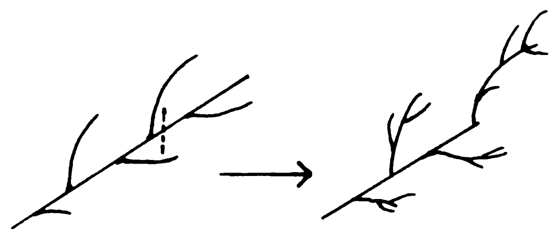


Fig. 6. Shorten limbs with thinning cuts.

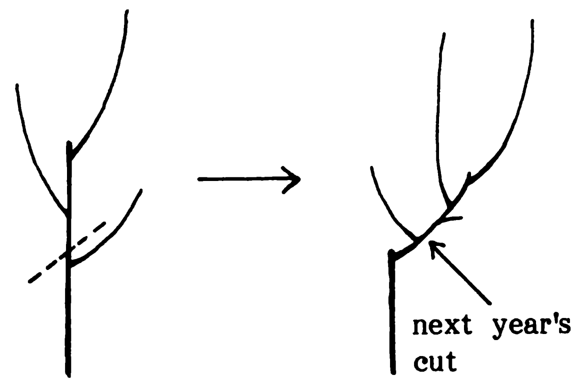


Fig. 7. Prune to lateral to maintain height.

Remove crossing branches and vigorous watersprouts. Shoots growing up into the tree or shaded "hangers" should be removed.

Once the desired tree height is reached, the tree can be maintained by annually cutting back to a weak lateral on the central leader (Fig. 7). This will maintain vigor in the center top of the tree while maintaining desired tree height.

Pruning Bearing Apple Trees

When pruning is underway, older bearing trees should be pruned first. Young nonbearing apple trees and stone fruits should not be pruned until after February 1 to minimize chances of winter injury.

The balance between vegetative and fruiting growth is influenced by the crop load, fertilization, and pruning. Fruiting may be poor because vigor is too high or too low. Excessive vigor can be the result of inadequate fertilization, no pruning, excessive cropping, or shading of fruiting wood. Good fruiting wood requires moderate vigor and exposure to good light levels.

Light is the source of energy that produces the crop. Bearing wood that is shaded is low in vigor and produces small, poorly colored fruits. Good light exposure is necessary for the development of flower buds as well as optimum size, color, and sugar content of the fruit. Studies have shown that a typical tree canopy is composed of different layers or zones in respect to light exposure (Fig. 8): (a) an outside zone of leaves and fruit receives a high proportion of direct light and light levels above those required for good growth and fruiting; (b) a second zone receives adequate light exposure; and (c) a third, inner zone receives inadequate light exposure and is unproductive.

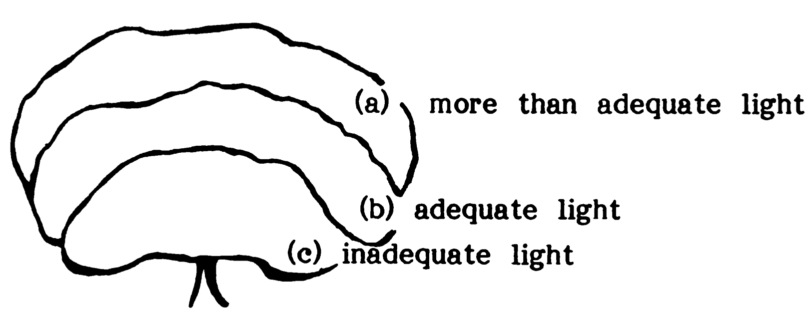


Fig. 8. Light distribution zones in large apple tree.

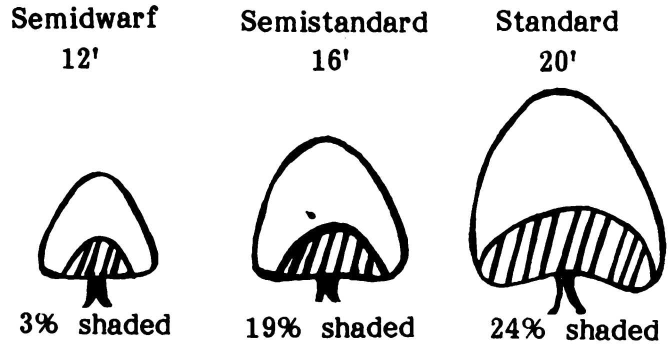


Fig. 9. Percent shade area increases as tree size increases.

Fig. 10. Tree shape influences shaded areas.

The relative proportion of these zones in a tree is influenced by tree size and shape. As tree size increases, the percentage of the tree that is shaded and unproductive (third zone) increases (Fig. 9). Trees that have wide tops and narrow bottoms also have a high percentage of shaded areas in the tree canopy (Fig. 10). Trees should be cone shaped or larger at the bottom than the top to maximize adequate light exposure.

Good light exposure in the tree canopy can also be maintained by a good pruning program. Ideally, pruning should remove unproductive wood and develop a uniform distribution of vigor and light exposure throughout the tree. Proper pruning can also help to maintain desired tree size and shape.

When pruning, a few basic concepts should be kept in mind:

(1) Pruning invigorates and results in strong growth close to the pruning cut. Pruning reduces the number of shoots so remaining shoots are stimulated. However, total shoot growth and size of the limb is reduced.

(2) Two types of pruning cuts are heading back and thinning out (Fig. 11): (a) Heading is the cutting off of part of a shoot or branch. Heading stimulates branching and stiffens the limb. (b) Thinning cuts remove the entire shoot or branch at its junction with a lateral, scaffold, or trunk. Thinning cuts are less invigorating, improve light penetration, and can redirect the limb.

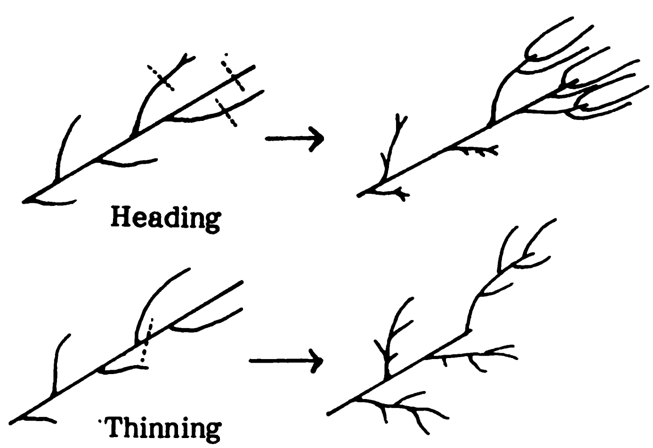


Fig. 11. Types of pruning cuts.

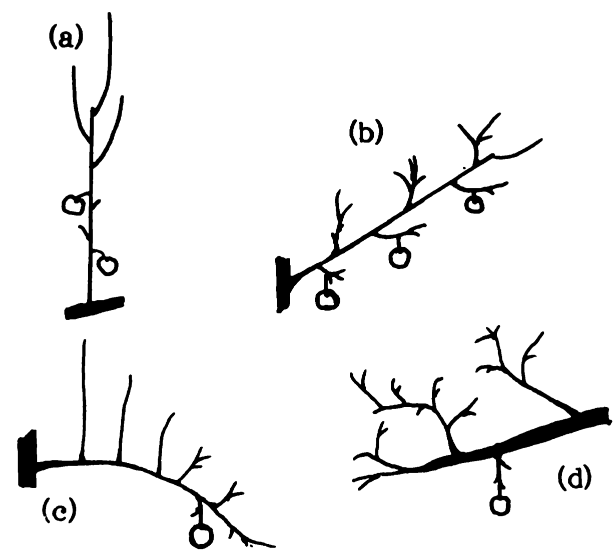


Fig. 12. Limb position affects fruiting and vigor.

(3) Limb position affects vigor and fruitfulness (Fig. 12): (a) Vertical or upright branches, typical in the tops of trees produce the longest shoots near the end of the limb and tend to be excessively vigorous and not very fruitful. Fruit are often of poor quality and subject to limb rub. (b) Limbs growing slightly above horizontal are more apt to develop a uniform distribution of vigor and fruitfulness. Light distribution tends to be even and because fruit hang along the branch, they are less prone to limb rub. (c) Limbs growing below horizontal tend to develop suckers along the upper surface. Excess sucker growth will result in shading. (d) "Hangers" or limbs developing on the underside of branches or scaffolds are heavily shaded and low in vigor. Fruit developing on such wood is of poor size and color.

(4) Invigoration from pruning is, in part, a nitrogen response. Pruning alters the balance between the tree top and root system. Removal of part of the tree top increases the amount of nitrogen available for the remaining growing points. Thus, a pruning program should be developed along with a good fertilization program. Severe pruning and/or excess amount of fertilization can disrupt the vigor of the tree and decrease fruiting.

Pruning should be on a regular basis and consist of moderate cuts made throughout the tree to distribute vigor and provide good light penetration. Heading cuts should only be used where branching is desired or in areas where vigor is low. Drooping or low hanging branches should be removed or pruned to a lateral that is positioned above horizontal (Fig. 13). Remove crossing, dead, or damaged limbs. Watersprouts should be removed unless one is needed for the development of new bearing surface. Watersprouts can be easily removed by gloved hand as they develop in the summer.

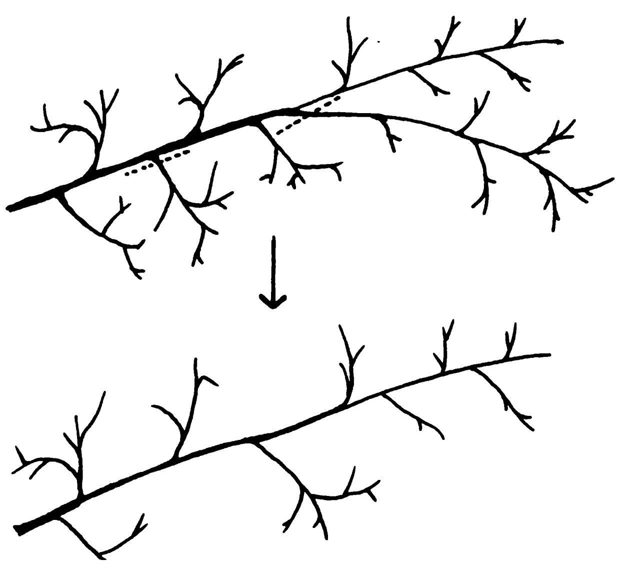


Fig. 13. Thin out low hanging branches.

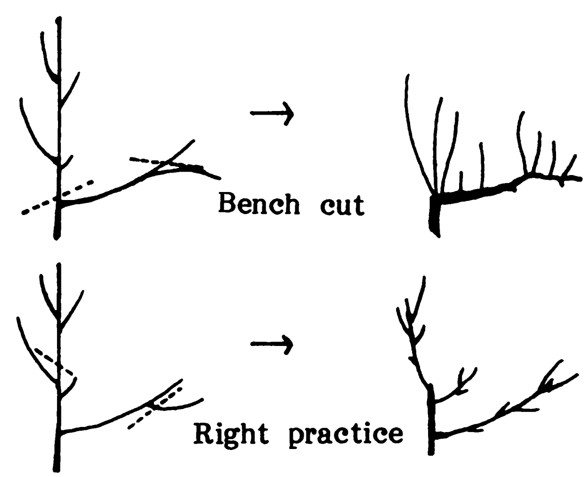


Fig. 14. Avoid bench cuts.

Without regular annual pruning trees often become overly thick and irregular bearing may occur. Spray penetration is reduced and problems such as scale may develop in the dense areas of the tree. With this type of tree, make many thinning cuts throughout the tree with emphasis on the upper, outer portions of the tree. This will open up areas into the tree canopy as well as re-establish good tree shape.

Avoid bench cuts to outward growing limbs unless necessary. Such cuts result in weak limbs and an umbrella shape that creates a sucker problem (Fig. 14).

Remove no more than one to two large limbs per year. If large amounts of pruning are required, it should be spread over a 2-3 year period. In addition, such pruning should be preceded and followed for 1-2 years by a reduction or elimination of nitrogen application, depending on soil type, variety, and grower experience.

The excess vigor that can result from such severe pruning can decrease fruit quality. The effect is much the same as from excessive nitrogen application and may include excessively large, poorly colored apples which are soft and will not store well. Vegetative growth competes with fruit for calcium; thus under conditions of excessive vigor, cork spot may develop.

Hedging and topping should only be used to maintain tree size when trees are at or near desired size. Such pruning is often used in an attempt to reduce tree size. Misuse can result in a disruption of vigor and loss of yield which may take several years to control. Hedging and topping (mainly heading cuts), especially of one-year shoots, induce masses of shoots close to the plane where cutting takes place. This localized invigoration of shoots can shade and weaken inner areas of the tree.

PRUNING OTHER FRUIT TREES

The general purpose of pruning fruit trees is to regulate growth, increase yields, improve fruit size and quality, and reduce production costs. Pruning is necessary to shape the trees for convenience of culture and for repair of damage.

Most pruning is done during the dormant season, preferably just before active growth begins in the spring. At this time, pruning wounds heal quickly, flower buds can be easily recognized, and injury from low winter temperature is avoided. Summer pruning may be done to help train trees to the desired growth, and maintain small tree size. It should be remembered, however, that all pruning has a dwarfing effect. For maximum yield of high quality fruit, prune only as necessary to establish a tree with a strong framework capable of supporting heavy crops annually without damage and to maintain a tree sufficiently open to allow penetration of sunlight, air, and spray material for good fruit development and pest control.

Pear trees are trained along the same general lines as those recommended for apples. Tipping or heading back the long shoots slightly will encourage development of side branches. Heading back after the framework has been developed is undesirable because of the tendency of the tree to throw out soft terminal shoots, which are highly susceptible to fire blight. It is best to limit pruning to thinning-out cuts.

Sweet cherry trees are trained to the modified leader system recommended for the apple. Special attention should be given to the selection of scaffold limbs because sweet cherry is subject to winter injury and splitting at the point where the limbs join the main stem of the tree. It is essential that the crotch angles be as wide as possible to ensure a strong framework.

A sour cherry tree, with no strong branches at the time of planting, should be headed to about twenty-four inches above the ground. Selection of laterals can be made at the beginning of the second year's growth. If it has some good laterals when planted, remove those lower than sixteen inches from the ground. Select about three permanent lateral or scaffold limbs along the leader, four to six inches apart and not directly over one another. Do not head them back since this tends to stunt terminal growth.

In the following years, select side branches from the leader until there is a total of five or six scaffold limbs well distributed above the lowest branch along three or four feet of the main stem. The leader is then usually modified by cutting to an outward growing lateral. After fruiting begins, pruning consists mainly of thinning out excessive and crowded growth each year to allow sunlight to filter through the tree.

The plum may also be pruned in a manner similar to the apple. European and prune types generally develop into well shaped trees, even if little pruning is done. Thinning out excessive growth constitutes the bulk of pruning after heading back to thirty to thirty-six inches at the time of planting. Varieties of the Japanese type are usually a little more vigorous, and may need some heading back as well as thinning of excessive growth after they come into bearing.

Peach trees are usually trained to the open center system. Newly planted trees should be headed to about thirty inches in height, just above a lateral branch or bud. If the tree is branched when it comes from the nursery, select three or four laterals well spaced up and around the trunk for the permanent scaffold limbs. The lowest limb should be about fifteen inches and the highest about thirty inches from the ground. Cut these back to two buds each, and remove all other laterals.

If no desirable laterals are available head the tree to the desired height and cut out all side branches to one bud. A number of shoots will develop during the season from which you can select scaffold limbs. Selection can be made during the summer or delayed until just before growth begins the second season.

Once the scaffold system of the young peach tree is established, prune as little as possible until the tree begins to bear. Remove all strong, upright shoots growing in the center of the tree, and lightly head back terminal growth on the scaffold limbs to outward-growing laterals. This aids in the development of an open center tree.

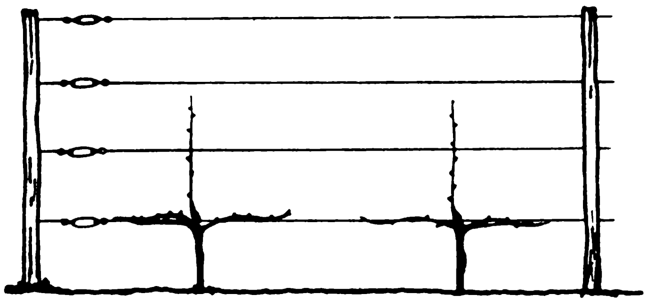
As fruit is borne on wood of the previous year's growth, it is necessary that the peach be pruned annually to stimulate new growth and maintain production near the main body of the tree. Pruning of the mature peach tree consists mainly of moderate thinning and heading back to outward growing laterals to keep the tree low and spreading. A height of eight or nine feet is usually preferred.

Special Training System The foregoing suggestions for pruning fruit trees are concerned with training for maximum production of high quality fruit. In addition, many home gardeners prune for decorative purposes.

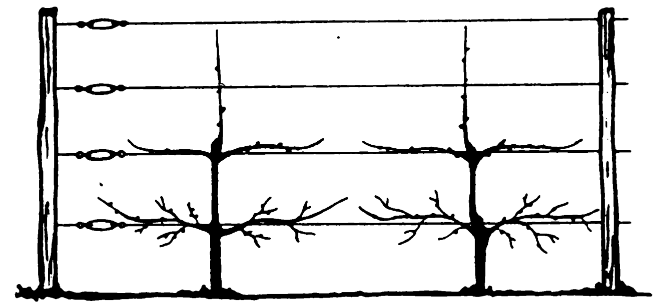
Numerous training systems, based on the art of espalier, originating in France and Italy about 400 years ago, have been devised. Some are quite elaborate, requiring considerable time and patience as well as detailed knowledge of the plant's growth characteristics. The easiest espalier system is the horizontal cordon. Apples, pears, and plums adapt well to this system. The trees are usually supported by a wall, a fence, or a wire trellis. Training to the four tier cordon or four wire trellis is relatively easy.

An espalier system can serve to separate yard areas and to provide an effective way of producing a large volume of high quality fruit in a limited area. Trees trained in this fashion should be on dwarfing rootstock. Otherwise, they tend to grow too large and are difficult to hold within bounds.

A simple four wire trellis may be constructed by setting eight foot posts two feet in the ground, spacing them twelve feet apart, and running wires through the posts at heights of 18, 36, 54, and 72 inches. Plant two unbranched whips of the desired variety six feet apart between each two posts.



First winter



Second winter

Before growth begins in the spring, cut off the whip just above the first bud below the point where the whip crosses the lowest wire. Usually three or more shoots will develop near the point of the cut. Retain the uppermost shoot and develop it as the central leader. The other two can be developed into main scaffold branches to be trained along the lower wire, one on each side of the central stem. Remove all other growth.

The two shoots selected for scaffold limbs should be loosely tied to the wire as soon as they are ten to twelve inches long. Twine, plastic chainlink ties, or other suitable material may be used. Tie the shoots so that they are nearly horizontal. This reduces vegetative vigor and induces flower bud formation. If the end of the shoot is tied below the horizontal, however, new growth at the end will stop and vigorous shoots will develop along the upper side. At the end of the first season, the lateral branches on the lower wire should be established and the central leader should have grown above the second wire.

During the dormant pruning at the end of the first winter, cut the central leader off at a bud just below the second wire. Repeat the process of the previous spring by developing two scaffold branches to tie to the second wire and allow the central leader to grow above the third wire.

This process is repeated during the next two seasons, at which time a total of eight scaffolds, four on each side of the tree, should be firmly established. The leaders should be bent to form one of the scaffolds rather than being cut off at the level of the top wire.

By the end of the fourth season, the trees should be in heavy production. All pruning is then done during the spring and summer months. After new growth in the spring is about two inches long, cut it off and also remove about one-fourth of the previous season's growth. Terminals of the scaffold are left untouched.

About the first of August or as soon as new growth reaches ten to twelve inches in length, cut it back to two or three buds. Repeat about a month later, if necessary. This encourages fruit bud formation and prevents vigorous growth from getting out of bounds.

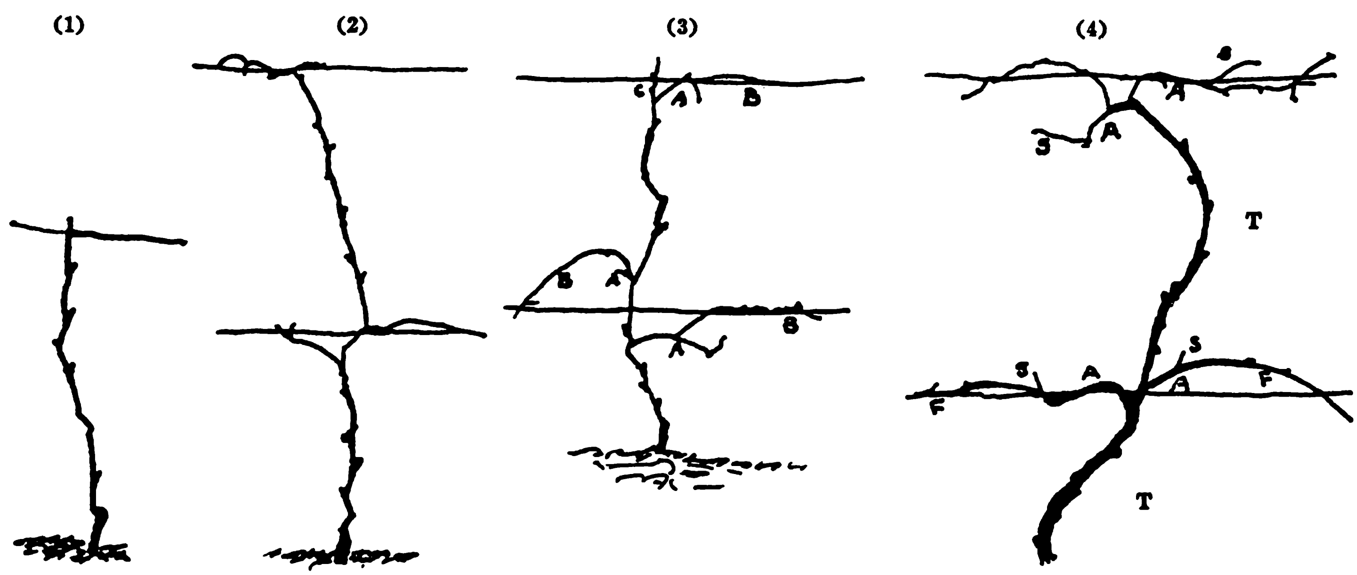
Training and Pruning Grapes

For grapes to be most productive, they must be trained to a definite system and pruned rather severely. There are several training systems used. The two most common are the vertical trellis and the overhead arbor. Both of these are satisfactory in the home planting if it is kept well pruned.

One of the many variations of the vertical trellis, the single trunk, four-arm Kniffin system is the most popular. Posts are set fifteen to twenty feet apart and extend five feet above the ground. Two wires are stretched between the posts, the lower being about two and a half feet above the ground and the upper wire, at the top of the posts. Set between the posts, the vine is trained to a single trunk with four semipermanent arms, each cut back to six to ten inches in length. One arm is trained in each direction on the lower wire.

During annual winter pruning, one cane is saved from those that grew from near the base of each arm the previous summer. This cane is cut back to about ten buds. The fruit in the coming season is borne on shoots developing from those buds. Select another cane from each arm, preferably one that grew near the trunk, and cut it back to a short stub having two buds. This is a renewal spur. It should grow vigorously in the spring and be the new fruiting cane selected the following winter. All other growth on the vine should be removed. This leaves four fruiting canes, one on each arm with eight to ten buds each, and four renewal spurs, one on each arm cut back to two buds each.

The same training and pruning techniques may be effectively used in training grapes to the arbor system. The only difference is that the wires supporting the arms are placed overhead and parallel with each other instead of in a horizontal position. Overhead wires are usually placed six to seven feet above the ground.



Stages in training the young vine to the single trunk, four-arm Kniffen system.

(1) After pruning the first winter. The single cane is cut back and tied to the lower wire. If the cane has grown less than 3' during the first summer, it should again be cut back to two buds.

(2) After pruning the second winter. Two new canes of four or five buds each are tied on the bottom wire. A third new cane is tied up to the top wire and cut off.

(3) After pruning the third winter. Three of the arms (A) and the fruiting canes (B) have been formed. A cane (C) with four or five buds is left to establish the fourth arm.

(4) A fully formed vine after pruning the fourth winter. The arms (A) should be shorter than those shown. The vine consists of a single permanent trunk (T), four semipermanent fruiting arms (A), four annual fruiting canes (F), and four renewal spurs (S), with two new buds on each.

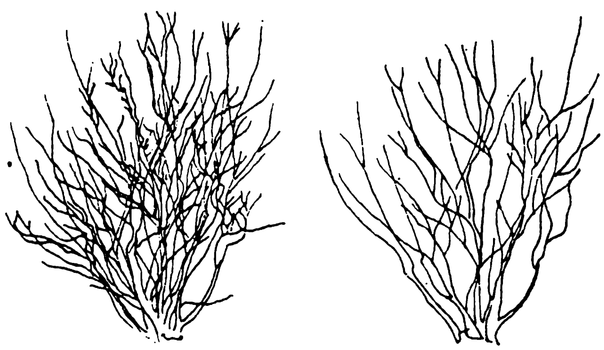
If an arm dies or for any reason needs to be replaced, choose the largest cane that has grown from the trunk near the base of the dead arm and train it to the trellis wire. To renew the trunk, train a strong shoot from the base of the old trunk to the trellis as though it were the cane of a new vine. Establish the arms in the same manner as for a new vine, and cut off the old trunk.

Pruning may be done anytime after the vines become dormant. In areas where there is danger of winter injury, pruning may be delayed until early spring. Vines pruned very late may bleed excessively, but there is no evidence that this is permanently injurious.

Blueberries

Until the end of the third growing season, pruning consists mainly of the removal of low spreading canes and dead and broken branches. As the bushes come into bearing, regular annual pruning will be necessary. This may be done any time from leaf fall until growth begins in the spring. Select six to eight of the most vigorous, upright growing canes for fruiting wood and remove all others.

After about five or six years of age, the canes begin to lose vigor, and fruit production is reduced. At the dormant pruning, remove the older canes of declining vigor, and replace with strong, vigorous new shoots that grew from the base of the bush the previous season. Keep the number of fruiting canes to six or eight, and remove the rest. Head back excessive terminal growth to a convenient berry picking height.



Pruning blueberries, before and after.

Training and Pruning Brambles

Trailing blackberries need some form of support. They may be grown on a trellis, trained along a fence, or tied to stakes. The other brambles may either be trained to supports, or with more severe pruning, grown as upright, self-supporting plants. Red raspberries and erect-growing blackberries are frequently grown in hedgerows.

A simple trellis, used in many home gardens, consists of two wires stretched at three and five foot levels between posts set fifteen to twenty feet apart. Fruiting canes are tied to these wires in the spring. The erect varieties are tied where the canes cross the wires. Canes of trailing varieties are tied horizontally along the wires or fanned out from the ground and tied where they cross each wire.

Where stakes are used for support, they are driven into the ground about one foot from each plant and allowed to extend four or five feet above the ground. Canes are tied to the stake at a point about midway between the ground and the tips of the canes, and again near the ends of the canes.

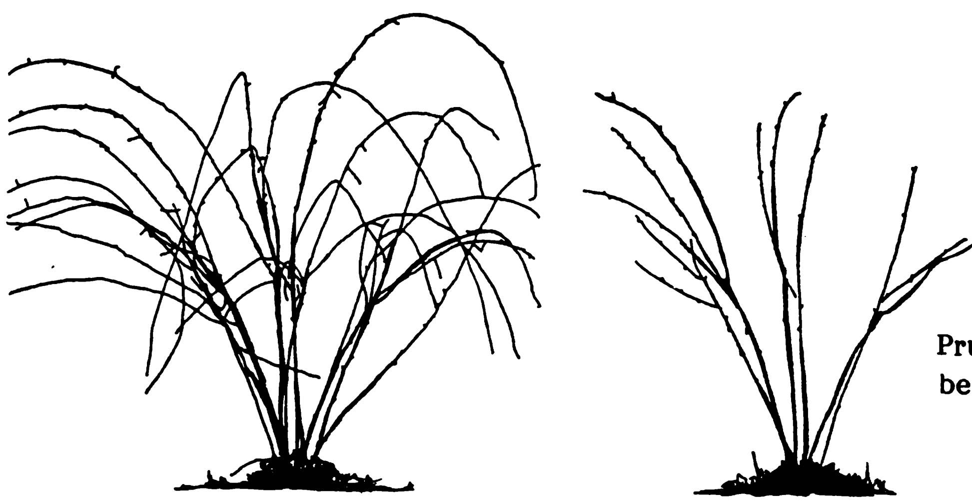
Canes of bramble fruits are biennial in nature; the crowns are perennial. New shoots grow from buds at the crown each year. Late in the summer, the new canes develop lateral branches with fruit buds on them. Early in the second season, fruit-bearing shoots grow from these buds. After fruiting, the old canes die, and new shoots spring up from the crowns.

These fruiting canes may be removed any time after harvest. They should be cut off close to the base of the plant, removed from the planting, and destroyed. Some growers, as a sanitation practice, do this immediately after harvest. Most, however, wait until the dormant pruning.

The dormant pruning is usually delayed until danger of severe cold is past and accomplished before the buds begin to swell. It consists of the removal of all dead, weak, and severely damaged canes, and the selection and pruning of the fruiting canes for the coming season. Where possible, fruiting canes one-half inch or more in diameter are selected.

Black raspberries should be summer topped when the young shoots are about 24" high; purple raspberries, when about 30" high. Summer topping consists of removing the top three to four inches of the new shoots by snapping them off with the fingers or cutting them with shears or a knife. Where trained to supports, let them grow six to eight inches taller before topping.

At the dormant pruning, thin each plant until only four or five of the best canes remain. Cut the lateral branches of the black raspberry to nine to twelve inches long; those of the purple raspberry to twelve to fifteen inches long.

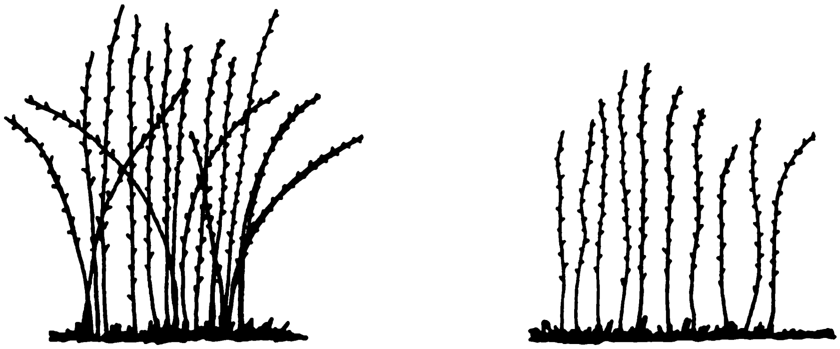


Pruning black raspberries, before and after.

The following comments concerning red raspberries do not apply to the Heritage variety.

Red raspberries should not be summer topped. Canes of everbearing varieties are handled in the same manner as those of ordinary varieties. At the dormant pruning, where the hill system of culture is used, thin until only seven or eight of the best canes remain per hill.

If the plants are grown in hedgerows, keep the width of the rows to eighteen inches or less, and remove all plants outside the row areas. Thin the number of canes within the hedgerows to six to eight inches apart, saving the best canes.



Pruning red raspberries, before and after.

Where the canes are supported either by a trellis or stakes, cut the canes back to a convenient height for berry picking, usually four or five feet. Grown as upright, self-supporting plants, whether in hills or in hedgerows, the canes should be cut back to about three feet in height. Any lateral branches should be cut to about ten inches in length.

The new shoots of erect blackberries should be summer topped when they are 30" to 36" high. To prevent the planting from becoming too thick and reducing yields, it may be necessary to remove excess sucker plants as they appear. This can be done either with a hoe or by hand. In the hedgerow type of culture, leave only three or four shoots per running foot of row. Grown in hills, four to five new shoots may be allowed to develop in each hill.

At the dormant pruning, where supports are used, head the canes to four or five feet in height. Canes grown without support should be headed to three feet. Cut lateral branches back to fifteen or eighteen inches long.

Trailing blackberries require little pruning. All dead and weak canes should be removed after harvest or at the dormant pruning. They should be thinned to seven or eight of the best canes per hill, cut to about five feet in length, and tied to either a stake or trellis.

SUMMARY

Pruning is the removal of a part or parts of a woody plant for a specific purpose. These purposes include: training the plant; maintaining plant health; improving the quality of flowers, fruit, foliage or stems; and restricting growth.

The basic pruning tools include: hand pruning shears, lopping shears, pole pruning shears, hedge shears and hand saws.

When pruning small branches, always cut back to a vigorous bud or intersecting branch. When pruning a large branch, it is necessary to use a 3-part cut. The three ways to prune shrubs are thinning out, gradual renewal, and rejuvenation pruning. Shrubs grown for flowers are pruned either after flowering (spring flowering shrubs) or before they start to grow (summer flowering shrubs).

PLANT PROPAGATION

PLANT PROPAGATION

INTRODUCTION

Plant propagation is the process of multiplying the numbers of a species, perpetuating a species or maintaining youthfulness of a plant. There are two types of propagation, sexual and asexual. Sexual reproduction is the union of the pollen and egg, drawing from the genes of two parents to create a third new individual. Sexual propagation involves the floral parts of a plant. Asexual propagation involves taking a part of one parent plant and causing it to regenerate itself into a new plant. Genetically it is identical to its one parent. Asexual propagation involves the vegetative parts of a plant: stems, roots or leaves.

The advantages of sexual propagation are that it may be cheaper and quicker than other methods; it may be the only way to obtain new varieties and hybrid vigor; in certain species it is the only viable method for propagation; and it is a way to avoid transmission of certain diseases. Asexual propagation has advantages, too. It may also be easier and faster in some species; it may be the only way to perpetuate some cultivars and it bypasses the juvenile characteristics of certain species.

SEXUAL PROPAGATION

Sexual propagation involves the union of the pollen from the male with the egg of the female to produce a seed. The seed is made up of three parts, the outer seed coat which protects the seed, the endosperm which is a food reserve, and the embryo which is the young plant itself. When a seed is mature and put in a favorable environment it will germinate, or begin active growth. In the following section, seed germination and transplanting of seeds will be discussed.

Seeds

To obtain quality plants, start with good quality seeds from a reliable dealer. Select varieties to provide the size, color and habit of growth desired. Choose varieties adapted to your area which will reach maturity before an early frost. Many new vegetable and flower varieties are hybrids which cost a little more than openpollinated types. However, hybrid plants usually have more vigor, more uniformity, and better production than nonhybrids and sometimes specific disease resistance or other unique cultural characteristics as well.

Although some seeds will keep for several years if stored properly, it is advisable to purchase only enough seed for the current year's use. Good seed will not contain any seed of any other crop or weeds and will have little debris. Printing on the seed packet usually indicates essential information about the variety, the year for which the seeds were packaged, and percentage of the germination you may typically expect and notes of any chemical seed treatment. If you obtain seeds well in advance of the actual sowing date or are attempting to store surplus seeds, keep them in a cool, dry place. Laminated foil packets help ensure dry storage. Paper packets are best kept in tightly closed jars or containers and maintained around 40 degrees F. with a low humidity.

Some gardeners save seed from their own gardens; however, such seed is the result of random pollination by insects or other natural agents and may not produce plants typical of the parents. This is especially true of the many hybrid varieties. (See Vegetables page 13 for information on saving vegetable seed.)

Most seed companies take great care in handling seeds properly. Generally, you should not expect more than 65 to 80 percent of the seeds sown to germinate. From those seeds germinating, you should expect about 60 to 75 percent to produce satisfactory, vigorous and sturdy seedlings.

Factors Affecting Germination

There are four environmental factors which affect germination: water, oxygen, light and heat.

Water: The first step in the germination process is the imbibition or absorption of water. Even though seeds have great absorbing power due to the nature of the seed coat, the amount of available water in the germination medium affect the uptake of water. An adequate, continuous supply of water is important to ensure germination. Once the germination process has begun, a dry period will cause the death of the embryo.

Light: Light is known to stimulate or to inhibit the germination of some seed. The light reaction involved here is a complex process. Some crops which have a requirement for light to assist seed germination are ageratum, begonia, browallia, impatiens, lettuce, and petunia. Conversely, calendula, centaurea, annual phlox, verbena and vinca are examples of plants the seed of which will germinate best in the dark. Other plants are not specific at all. Seed catalogs and seed packets often list germination or cultural tips for individual varieties. When sowing light requiring seed, do as nature does and leave them on the soil surface. If they are covered at all, cover them lightly with fine peat moss or fine vermiculite. These two materials, if not applied too heavily, will permit some light to reach the seed and will not limit germination. When starting seed in the home, supplemental light can be provided by fluorescent lights suspended 6 to 12 inches above the seeds for 16 hours a day.

Oxygen: In all viable seed, respiration takes place. The respiration in nongerminating seed is low but some oxygen is required. The respiration rate increases during germination, therefore, the medium in which the seeds are placed should be loose and well aerated. If the oxygen supply during germination is limited or reduced, germination can be severely retarded or inhibited.

Heat: A favorable temperature is another important requirement of germination. It not only affects the germination percentage but also the rate of germination. Some seeds will germinate over a wide range of temperatures, whereas others require a narrow range. Many seed have minimum, maximum and optimum temperatures at which they germinate. For example, tomato seed has a minimum germination temperature of 50 degrees F. and a maximum temperature of 95 degrees, but an optimum germination temperature of about 80 degrees. Where germination temperatures are listed, they are usually the optimum temperatures unless otherwise specified. Generally, 65 to 75 degrees F. is best for most plants. This often means the germination flats may have to be placed in special chambers or on radiators, heating cables or heating mats to maintain optimum temperature. The importance of maintaining proper medium temperature to achieve the maximum germination percentages cannot be over emphasized.

Germination will begin when certain internal requirements have been met. A seed must have a mature embryo, contain a large enough endosperm to sustain the embryo during germination process and contain sufficient hormones or auxins to initiate the process.

Methods of Breaking Dormancy

One of the functions of dormacy is to prevent a seed from germinating before it is surrounded by a favorable environment. In some trees and shrubs dormacy is difficult to break, even when the environment is ideal. Various treatments are performed on the seed to break dormacy and begin germination.

Seed Scarification Seed scarification involves breaking, scratching or softening the seed coat so that water can enter and begin the germination process. There are several methods of scarifing seeds. In acid scarification, seeds are put in a glass container and covered with concentrated sulfuric acid at about twice the volume of seed. The seeds are gently stirred and allowed to soak from 10 minutes to several hours, depending on the hardness of the seed coat. When the seed coat has become thin, the seeds can be removed, washed and planted. Another scarification method is mechanical. Seeds are filed with a metal file, rubbed with sandpaper or cracked with a hammer to weaken the seed coat. Hot water scarification involves putting the seed into hot water (170 - 212 degrees F). The seeds are allowed to soak in the water, as it cools, for 12 to 24 hours and then planted. A fourth method is one of warm moist scarification. In this case, seeds are stored in nonsterile warm damp containers where the seed coat will be broken down by decay over several months.

Seed Stratification Seeds of some fall ripening trees and shrubs of the temperate zone will not germinate unless chilled underground as they overwinter. This so called "after ripening" may be accomplished artificially by a practice called stratification.

The following procedure is usually successful. Put sand or vermiculite in a clay pot to about 1 inch from the top. Place the seeds on top of the medium and cover with 1/2 inch of sand or vermiculite. Wet the medium thoroughly and allow excess water to drain through the hole in the pot. Place the pot containing the moist medium and seeds in a plastic bag and tie the bag using a twist tie or rubber band. Place the bag in a refrigerator. Periodically check to see if the medium is moist but not wet. Additional water will probably not be necessary. After 10-12 weeks, remove the bag from the refrigerator. Take the pot out and set it in a warm place in the house. Water often enough to keep the medium moist. Soon the seedlings should emerge. When the young plants are about 3 inches tall, transplant them into pots to grow until time for setting outside.

Another procedure that is usually successful uses sphagnum moss or peat moss. Wet the moss thoroughly, then squeeze out the excess water with your hands. Mix seed with the sphagnum or peat and place in a plastic bag. Use a twist tie or rubber band to secure the top and put the bag in a refrigerator. Check periodically. If there is condensation on the inside of the bag, the process will probably be successful. After 10-12 weeks remove the bag from the refrigerator. Plant the seeds in pots to germinate and grow. Handle seeds carefully. Often the small roots and shoots are emerging at the end of the stratification period. Care must be taken not to break these off. Temperatures in the range of 35-45 degrees F (2 -7°C) are effective. Most refrigerators operate in this range. Seeds of most fruit and nut trees can be successfully germinated by these procedures. Seeds of peaches should be removed from the hard pit. Care must be taken when cracking the pits. Any injury to the seed itself can be an entry path for disease organisms.

Starting Seeds

Media A wide range of materials can be used to start seeds, from straight vermiculite or mixtures of soilless artificial media to the various amended soil mixes. With experience, you will learn to determine what works best under your conditions. However, keep in mind what the good qualities of a germinating medium are. It should be rather fine and uniform, yet well aerated and loose. It should be free of insects, disease organisms and weed seeds. It should also be of low fertility or total soluble salts and capable of holding and moving moisture by capillary action. One mixture which supplies these factors is a combination of 1/3 sterilized soil, 1/3 sand or vermiculite or perlite, and 1/3 peat moss.

The importance of using a sterile medium and container cannot be over emphasized. The home gardener can treat a small quantity of soil mixture in an oven. Place the slightly moist soil in a heat resistant container or pan which can be covered, in an oven set at about 250 degrees F. Use a candy or meat thermometer to ensure that the mix reaches a temperature of 180 degrees F. for at least 1/2 an hour. Avoid over heating as this can be extremely damaging to the soil and be aware that the process results in very unpleasant odors. This treatment should prevent damping-off and other plant diseases as well as eliminate potential plant pests. Wood or plastic growing containers and implements should be washed to remove any debris, then rinsed in a solution of 1 part chlorine bleach to 10 parts of water. Avoid recontamination of the medium and your tools.

An artificial, soilless mix also provides the desired qualities of a good germination medium. The basic ingredients of such a mix are sphagnum peat moss and vermiculite, both of which are generally free of diseases, weed seeds and insects. The ingredients are also readily available, easy to handle, light weight and produce uniform plant growth.

Ready made "peat-lite" mixes or similar products are commercially available or can be made at home using this recipe: 4 quarts of shredded sphagnum peat moss, 4 quarts of a fine grade vermiculite, 1 tablespoon of superphosphate and 2 tablespoons of ground limestone. Another recipe is 50 percent vermiculite or perlite and 50 percent milled sphagnum moss with fertilizer. Mix thoroughly. These mixes have little fertility so seedlings must be watered with a diluted fertilizer solution soon after they emerge. Do not use garden soil by itself to start seedlings as it is not sterile, is too heavy and will not drain well, and will shrink from the sides of containers if allowed to dry out.

Containers Wooden or plastic flats and trays can be purchased or you can make your own from scrap lumber. A convenient size to handle would be about 12 to 18 inches long and 12 inches wide with a depth of about 2 inches. Leave cracks of about 1/8 of an inch between the boards in the bottom or drill a series of holes to ensure drainage.

Flower pots of either clay or plastic can be used. You can also make your own containers for starting seeds by recycling such things as cottage cheese containers, the bottoms of milk cartons or bleach containers and pie pans, as long as good drainage is provided.

Numerous types of pots and strips made of compressed peat are also on the market which can be utilized to start seeds. Plant bands and plastic cell packs are also available. Each cell or minipot holds a single plant which reduces the risk of root injury when transplanting. Peat pellets, peat or fiber based blocks and expanded plastic foam cubes can also be used for seeding. Here the growing medium itself forms the container unit.

Seeding The proper time for sowing seeds for transplants depends upon when plants may safely be moved out-of-doors in your area. This period may range from 4 to 12 weeks prior to transplanting depending upon the speed of germination, the rate of growth and the cultural conditions provided. A common mistake is to sow the seeds too early and then attempt to hold the seedlings back under poor light or improper temperature ranges. This usually results in tall, weak and spindly plants which do not perform well in the garden.

After selecting a container, fill it to within 3/4 of an inch from the top with the moistened medium you have chosen. For very small seeds, at least the top 1/4 of an inch should be of a fine, screened mix or a layer of vermiculite. Firm the medium at the corners and edges with your fingers or a block of wood to provide a uniform, flat surface.

For medium-to-large seeds, make furrows about 1 to 2 inches apart and 1/8 to 1/4 of an inch deep across the surface of the container using a narrow board or pot label. By sowing in rows, good light and air movement results and, if damping off fungus does appear, there is less chance of it spreading. Seedlings in rows are easier to label and to handle at transplanting time than those which have been sown in a broadcast manner. Sow the seeds thinly and uniformly in the rows by gently tapping the packet of seed as it is moved along the row. Lightly cover the seed with dry vermiculite or sifted medium if they require darkness for germination. A suitable planting depth is usually about twice the diameter of the seed.

Do not plant seeds too deeply. Extremely fine seed such as petunia, begonia and snapdragon are not covered but lightly pressed into the medium or watered in with a fine mist spray. If these seeds are broadcast, strive for a uniform stand by sowing half the seeds in one direction, then sowing the other way with the remaining seed.

Large seeds are frequently sown into some sort of a small container or cell pack which eliminates the need for early transplanting. Usually 2 or 3 seeds are sown per unit and later thinned to allow the strongest seedling to grow.

Seed Tape Most garden stores and seed catalogs offer indoor and outdoor seed tapes. Seed tape has precisely spaced seeds enclosed in an organic, water soluble material. When planted, the tape dissolves and the seeds germinate normally. Seed tapes are especially convenient for tiny, hard-to-handle seeds. However, tapes are much more expensive per seed. Seed tapes allow uniform emergence of seedlings, eliminate overcrowding of seedlings and permit sowing in perfectly straight rows. The tapes can be cut at any point for multiple row plantings, and thinning is rarely necessary.

Pregermination Another method of starting seeds is pregermination. Pregermination involves sprouting the seeds before they are planted in pots or in the garden. This speeds up the time to germination as the temperature and moisture are easy to control. This also guarantees a high percent of germination since none will be lost to environmental factors. Lay seeds between the folds of cotton cloth on a layer of vermiculite or similar material in a pan. Keep moist in a warm place. When roots begin to show, place the seeds in containers or plant them directly in the garden. While transplanting seedlings be careful not to break off tender roots. Continued attention to watering is critical.

When planting seeds in a container that will be set out in the garden later, place 1 seed in a 2-3" container. Plant the seeds only 1/2 the recommended depth. Gently press a little soil over the sprouted seed and then add about 1/4" of milled sphagnum or sand to the soil surface. These materials will keep the surface uniformly moist and are easy for the shoot to push through. Keep the pots in a warm place and care for them just as for any other newly transplanted seedlings.

A convenient way to plant small delicate pregerminated seeds is to suspend them in a gel. You can make a gel by blending cornstarch with boiling water to a consistency that is thick enough so the seeds will stay suspended. Be sure to cool thoroughly before use. Place the gel with seedlings in a plastic bag with a hole in it. Squeeze the gel through the hole along a premarked garden row. Spacing of seeds is determined by the number of seeds in the gel. If the spacing is too dense, add more gel; if too wide, add more seeds. The gel will keep the germinating seeds moist until they establish themselves in the garden soil.

Watering After the seed has been sown, moisten the planting mix thoroughly. Use a fine mist spray or place the containers in a pan or tray which has about 1 inch of warm water in the bottom. Avoid splashing or excessive flooding which might displace small seeds. when the planting mix is saturated, set the container aside to drain. The soil should be moist but not wet.

Ideally the seed flats should remain sufficiently moist during the germination period without having to add more water. One way to maintain the moisture is to slip the whole flat or pot into a clear plastic bag after the initial watering. The plastic should be at least 1-1 1/2 inches from the soil. Keep the container out of direct sunlight otherwise the temperature may rise to the point where the seeds will be harmed. Many home gardeners cover their flats with panes of glass instead of using a plastic sleeve. Be sure to remove the plastic bag or glass cover as soon as the first seedlings appear. Surface watering can then be practiced if care and good judgement are used.

Lack of uniformity, overwatering or drying out are problems related to hand watering. Excellent germination and moisture uniformity can be obtained with a low pressure misting system. Four seconds of mist every 6 minutes or 10 seconds every 15 minutes during the daytime in spring seems to be satisfactory. Bottom heat is an asset with a mist system. Subirrigation or watering from below may work well, keeping the flats moist. However, as the flats or pots must sit in a constant water level, the soil may absorb too much water and the seeds may rot due to lack of oxygen.

Temperature and Light Several factors assuring good germination have already been mentioned. The last item, and by no means the least important, is temperature. Since most seeds will germinate best at an optimum temperature that is usually higher than most home night temperatures, special warm areas must often be provided. The use of thermostatically controlled heating cables are an excellent method of providing constant heat.

After germination and seedling establishment, move the flats to a light, airy, cooler location, at a 55 to 60 degree F. night temperature and a 65 to 70 degree F. day reading. This will prevent soft, leggy growth and minimize disease troubles. Some crops, of course, may germinate or grow best at a different constant temperature and must be handled separately from the bulk of the plants.

Seedlings must receive bright light after germination. Place them in a window facing south, if possible. If a large, bright window is not available, place the seedlings under a fluorescent light. Use two 40-watt, cool, white fluorescent tubes or special plant growth lamps. Position the lights 6 inches from the tubes and keep the lights on about 16 hours each day. As the seedlings grow, the lights should be raised.

SEED REQUIREMENTS

Plant	Approximate Time To Seed Before Last Spring Frost	Approximate Germination Time (Days)	Germination Temperature (0°F)	Germination in Light (L) or Dark (D)
Begonia	12 weeks	10 - 15	70	L
Browallia	or more	15 - 20	70	L
Geranium		10 - 20	70	L
Larkspur		5 - 10	55	D
Pansy (Viola)		5 - 10	65	D
Vinca		10 - 15	70	D
Dianthus	10 weeks	5 - 10	70	-
Impatiens		15 - 20	70	L
Petunia		5 - 10	70	L
Portulaca		5 - 10	70	D
Snapdragon		5 - 10	65	L
Stock		10 - 15	70	-
Verbena		15 - 20	65	D
Ageratum	8 weeks	5 - 10	70	L
Alyssum		5 - 10	70	-
Broccoli		5 - 10	70	-
Cabbage		5 - 10	70	-
Cauliflower		5 - 10	70	-
Celosia		5 - 10	70	-
Coleus		5 - 10	65	L
Dahlia		5 - 10	70	-
Eggplant		5 - 10	70	-
Head Lettuce		5 - 10	70	L
Nicotiana		10 - 15	70	L
Pepper		5 - 10	80	-
Phlox		5 - 10	65	D
Aster	6 weeks	5 - 10	70	-
Balsam		5 - 10	70	-
Centurea		5 - 10	65	D
Marigold		5 - 10	70	-
Tomato		5 - 10	80	-
Zinnia		5 - 10	70	-
Cucumber	4 weeks	5 - 10	85	-
Cosmos	or less	5 - 10	70	-
Muskmelon		5 - 10	85	-
Squash		5 - 10	85	-
Watermelon		5 - 10	85	-

Transplanting and Handling

If the plants have not been seeded in individualized containers, they must be transplanted to give them proper growing space. One of the most common mistakes made by plant growers is leaving the seedlings in the seed flat too long. The ideal time to transplant young seedlings is when they are small and there is little danger from setback. This is usually about the time the first true leaves appear above or between the cotyledon leaves (the cotyledons or seed leaves are the first leaves the seedling produces). Don't let plants get hard and stunted or too tall and leggy.

Seedling growing mixes and containers can be purchased or prepared similar to those mentioned for germinating seed. The medium should contain more plant nutrients than a germination mix, however. Some commercial soilless mixes have fertilizer already added. When fertilizing, use a soluble house plant fertilizer, at the dilution recommended by the manufacturer about every 2 weeks after the seedlings are established. Remember that young seedlings are easily damaged by too much fertilizer, especially if they are under any moisture stress.

To transplant, carefully dig up the small plants with a knife or wooden plant label. Let the group of seedlings fall apart and pick out individual plants. Gently ease them apart in small groups which will make it easier to separate individual plants. Avoid tearing roots in the process. Handle small seedlings by their leaves, not their delicate stems. Punch a hole in the medium into which the seedling will be planted. Make it deep enough so the seedling can be put at the same depth it was growing in the seed flat. Small plants or slow growers should be placed 1 inch apart and rapid-growing, large seedlings about 2 inches. After planting, firm the soil and water gently. Keep newly transplanted seedlings in the shade for a few days or place them under fluorescent lights. Keep them away from direct heat sources. Continue watering and fertilizing as was done in the seed flats.

Most plants normally transplant well and can be started indoors but a few plants are difficult to transplant. These are generally directly seeded outdoors or sown directly into individual containers indoors. Examples include zinnias and cucurbits such as melons and squash.

Containers for transplanting There is a wide variety of containers from which to choose for transplanting seedlings. These containers should be economical, durable, and make good use of space. The type selected will depend on the type of plant to be transplanted and individual growing conditions. Standard pots may be used. But they waste a great deal of space and may not dry out rapidly enough for the seedling to have sufficient oxygen for proper development.

There are many types of containers available commercially. Those made out of pressed peat can be purchased in varying sizes. Individual pots or strips of connected pots fit closely together, are inexpensive, and can be planted directly in the garden. When setting out plants grown in peat pots, care should be used to cover the pot completely. If the top edge of the peat pot extends above the soil level, it may act as a wick and draw water away from the soil in the pot. To avoid this, tear off the top lip of the pot and then plant flush with the soil level.

Community packs are containers in which there is room to plant several plants. These are generally made of a pressed paper or fiber and are inexpensive. The main disadvantage of a community pack is that the roots of the individual plants must be broken or cut apart when separating them to put out in the garden.

Compressed peat pellets, when soaked in water, expand to form little compact individual pots. They waste no space, don't fall apart as badly as peat pots, and can be set directly out in the garden. If you wish to avoid transplanting seedlings altogether, compressed peat pellets are excellent for direct sowing.

Community packs and cell packs, which are strips of connected individual pots, are also available in plastic and are frequently used by commercial bedding plant growers as they withstand frequent handling.

In addition, many homeowners find a varity of materials from around the house useful for containers. These homemade containers should be deep enough to provide adequate soil and have plenty of drainage holes in the bottom.

Hardening Plants Hardening is the process of altering the quality of plant growth to withstand the change in environmental conditions which occurs when plants are transferred from a greenhouse or home to the garden. A severe check in growth may occur if plants produced in the home are planted outdoors without a transition period. Hardening is more critical with early crops when adverse climatic conditions can be expected than it is for crops planted later in the season.

Hardening can be accomplished by gradually lowering temperatures and relative humidity and reducing water. This procedure results in an accumulation of carbohydrates and a thickening of cell walls. A change from a soft, succulent type of growth to a firmer, harder type is desired.

This process should be started at least 2 weeks before planting in the garden. If possible, plants should be moved to a 45 to 50 degree temperature indoors or outdoors in a shady location. A coldframe is excellent for this purpose. When first put outdoors, plants should be shaded then gradually moved into sunlight. Each day, gradually increase the length of exposure. Don't put tender seedlings outdoors on windy days or when temperatures are below 45 degrees F. Reduce the frequency of watering to slow growth but don't allow plants to wilt. Even cold hardy plants will be hurt if exposed to freezing temperatures before they are hardened. After proper hardening, however, they can be planted outdoors and light frosts will not damage them.

The hardening process is intended to slow plant growth. If carried to the extreme of actually stopping plant growth, significant damage can be done to certain crops. For example, cauliflower will make thumb size heads and fail to develop further if hardened too severely. Cucumbers and melons will stop growth if hardened.

Propagation of Ferns by Spores

Though ferns are more easily propagated by other methods, some gardeners like the challenge of raising ferns from spores. One tested method for small quantities is as follows.

Put a solid, sterilized brick (bake at 250 degrees F. for 30 minutes) in a pan and fill with water to cover the brick. When the brick is wet throughout, squeeze a thin layer of moist soil and peat (1:1) into the top of the brick. Pack a second layer (about an inch) on top of that. Sprinkle spores on top. Cover with plastic (not touching the spores) and put in a warm place in indirect light. It may take up to a month or more for the spores to germinate. Keep moist at all times. A prothallus (one generation of the fern) will develop first from each spore, forming a light green mat. Mist lightly once a week to maintain high surface moisture; the sperm must be able to swim to the archegonia (female parts). After about three weeks, fertilization should have occurred. Pull the mat apart with tweezers in 1/4 inch squares and space them 1/2 inch apart in a flat containing a two inch layer of sand, 1/4 inch of charcoal and about two inches of soil/peat mix. Cover with plastic and keep moist. When fern fronds appear and become crowded, transplant to small pots. Gradually reduce the humidity until they can survive in the open. Light exposure may be increased at this time.

ASEXUAL PROPAGATION

Asexual propagation as mentioned earlier, is the best way to maintain some species particularly an individual that best represents that species. Clones are groups of plants that are identical to their one parent and that can only be propagated asexually. The 'Bartlett' pear (1770) and the 'Delicious' apple (1870) are two examples of clones that have been asexually propagated for many years.

The major methods of asexual propagation are cuttings, layering, budding and grafting. Cuttings involve rooting a severed piece of the parent plant; layering involves rooting a part of the parent and then severing it; and budding and grafting is joining two plant parts from different varieties.

Cuttings

Many types of plants, both woody and herbaceous, are frequently propagated by cuttings. A cutting is a vegetative plant part which is severed from the parent plant in order to regenerate itself, thereby forming a whole new plant.

Take cuttings with a sharp knife or razor blade to reduce injury to the parent plant. Dip the cutting tool in rubbing alcohol or a mixture of one part bleach and nine parts water to prevent transmitting diseases from infected plant parts to healthy ones. Remove flowers and flower buds from cuttings to allow the cutting to use its energy and stored carbohydrates for root and shoot formation rather than fruit and seed production. To hasten rooting, increase the number of roots, or to obtain uniform rooting except on soft fleshy stems, use a rooting hormone, preferably one containing a fungicide. Prevent possible contamination of the entire supply of rooting hormone by putting some in a separate container for dipping cuttings.

Insert cuttings into a rooting medium such as coarse sand, vermiculite, soil, water or a mixture of peat and perlite. It is important to choose the correct rooting medium to get optimun rooting in the shortest time. In general, the rooting medium should be sterile, low in fertility, drain well enough to provide oxygen, and retain enough moisture to prevent water stress. Moisten the medium before inserting cuttings, and keep it evenly moist while cuttings are rooting and forming new shoots.

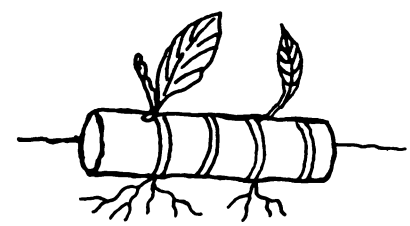
Place stem and leaf cuttings in bright but indirect light. Root cuttings can be kept dark until new shoots appear.

<u>Stem Cuttings</u> Numerous plant species are propagated by stem cuttings. Some can be taken at any time of the year, but stem cuttings of many woody plants must be taken in the fall or in the dormant season.

Tip cuttings: Detach a 2-6" piece of stem, including the terminal bud. Make the cut just below a node. Remove lower leaves that would touch or be below the medium. Dip the stem in rooting hormone if desired. Gently tap the end of the cutting to remove excess hormone. Insert the cutting deeply enough into the media to support itself. At least one node must be below the surface.

Medial cuttings: Make the first cut just above a node, and the second cut just above a node 2-6" down the stem. Prepare and insert the cutting as you would a tip cutting. Be sure to position right side up. Axial buds are always above leaves.

Cane cuttings: Cut cane-like stems into sections containing one or two eyes, or nodes. Dust ends with fungicide or activated charcoal. Allow to dry several hours. Lay horizontally with about half of the cutting below the media surface, eye facing upward. Cane cuttings are usually potted when roots and new shoots appear but new shoots from dracaena and croton are often cut off and rerooted in sand.

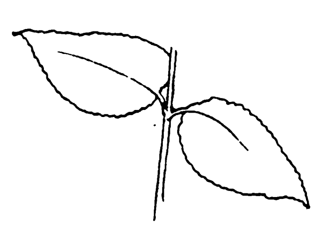


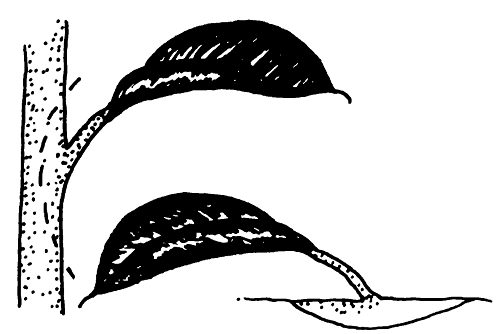
TIP MEDIAL CANE

Single Eye: The eye refers to the node. This is used for plants with alternate leaves when space or stock material are limited. Cut the stem about 1/2" above and 1/2" below a node. Place cutting horizontally or vertically in the medium.

Double Eye: This is used for plants with opposite leaves when space or stock material is limited. Cut the stem about 1/2" above and 1/2" below the same node. Insert the cutting vertically in the medium with the node just touching the surface.

Heel cutting: This method uses stock material with woody stems efficiently. Make a shield-shaped cut about halfway through the wood around a leaf and axial bud. Insert the shield horizontally into the medium.





SINGLE EYE DOUBLE EYE HEEL

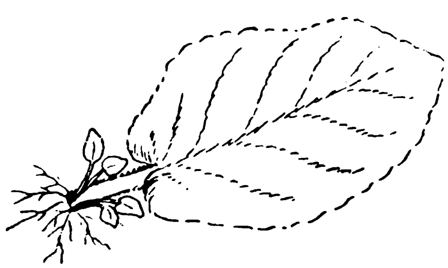
Leaf Cuttings Leaf cuttings are used almost exclusively for a few indoor plants. Leaves of most plants will either produce a few roots but no plant, or just decay.

Whole leaf with petiole: Detach the leaf and 1/2-1 1/2" of petiole. Insert the lower end of the petiole into the medium. One or more new plants will form at the base of the petiole. The leaf may be severed from the new plants when they have their own roots, and the petiole reused.

Whole leaf without petiole: This is used for plants with sessile or petioleless leaves. Insert the cutting vertically into the medium. A new plant will form from the axillary bud. The leaf may be removed when the new plant has its own roots.

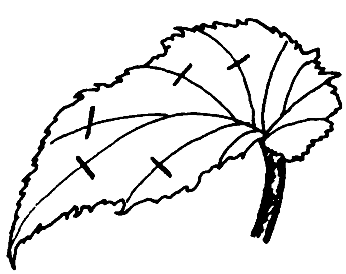
Split vein: Detach a leaf from the stock plant. Slit its veins on the lower leaf surface. Lay the cutting, lower side down, on the medium. New plants will form at each cut. If the leaf tends to curl up, hold it in place by covering the margins with the rooting medium.

Leaf sections: This method is frequently used with snake plant and fibrous rooted begonias. Cut begonia leaves into wedges with at least one vein. Lay leaves flat on the medium. A new plant will arise at the vein. Cut snake plant leaves into 2" sections. Consistently make the lower cut slanted and the upper cut straight so you can tell which is the top. Insert the cutting vertically. Roots will form fairly soon, and eventually a new plant will appear at the base of the cutting. These and other succulent cuttings will rot if kept too moist.

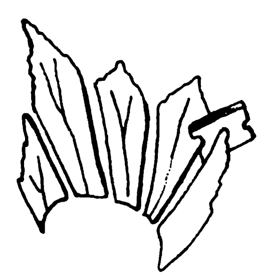


WHOLE LEAF WITH PETIOLE

WHOLE LEAF WITHOUT PETIOLE



SPLIT VEIN

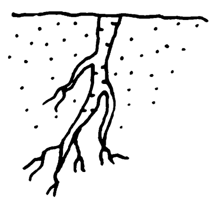


LEAF SECTION

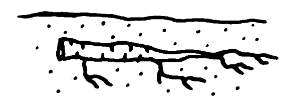
Root Cuttings Root cuttings are usually taken from 2-3 year old plants during their dormant season when they have a large carbohydrate supply. Root cuttings of some species produce new shoots, which then form their own root systems, while root cuttings of other plants develop root systems before producing new shoots.

Plants with large roots: Make a straight top cut. Make a slanted cut 2-6" below the first cut. Store about 3 weeks in moist sawdust, peat moss or sand at 40 degrees F. Remove from storage. Insert the cutting vertically with the top approximately level with the surface of the rooting medium. This method is often done outdoors.

Plants with small roots: Take 1-2" sections of roots. Insert the cuttings horizontally about 1/2" below the medium surface. This method is usually done indoors or in a hotbed.



PLANTS WITH LARGE ROOTS



PLANTS WITH SMALL ROOTS

Layering

Stems still attached to their parent plants may form roots where they touch a rooting medium. Severed from the parent plant, the rooted stem becomes a new plant. This method of vegetative propagation, called layering, promotes a high success rate because it prevents the water stress and carbohydrate shortage that plague cuttings.

Some plants layer themselves naturally, but sometimes plant propagators assist the process. Layering is enhanced by girdling the stem where it is bent, by wounding one side of the stem, or by bending it very sharply. The rooting medium should always provide aeration and a constant supply of moisture.

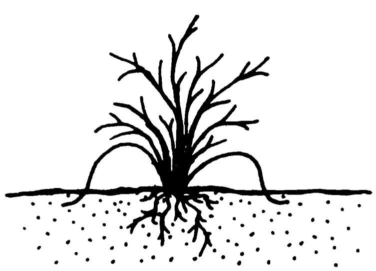
Tip layering Dig a hole 3-4" deep. Insert the shoot tip and cover it with soil. The tip grows downward first, then bends sharply and grows upward. Roots form at the bend and the recurved tip becomes a new plant. Remove the tip layer and plant it in the early spring or late fall. Examples: purple and black raspberries, trailing blackberries.

Simple layering Bend the stem to the ground. Cover part of it with soil, leaving the last 6-12" exposed. Bend the tip into a vertical position and stake in place. The sharp bend will often induce rooting, but wounding the lower side of the branch or loosening the bark by twisting the stem may help. Examples: rhododendron, honeysuckle.

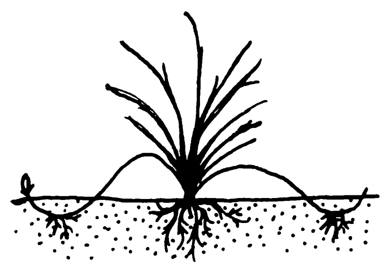
Compound layering This method works for plants with flexible stems. Bend the stem to the rooting medium as for simple layering, but alternately cover and expose stem sections. Wound the lower side of the stem sections to be covered. Examples: heart-leaf philodendron, pothos.

Mound (stool) layering Cut the plant back to 1" above the ground in the dormant season. Mound soil over the emerging shoots in the spring to enhance their rooting. Examples: gooseberries, apple rootstocks.

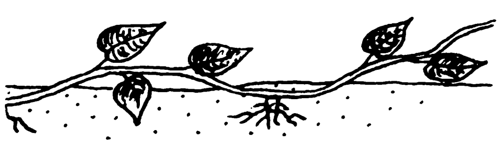
Air layering Air layering is used to propagate some indoor plants with thick stems, or to rejuvenate them when they become leggy. Slit the stem just below a node. Pry the slit open with a toothpick or moist sphagnum moss. Surround the wound with wet unmilled sphagnum moss. Wrap plastic or foil around the sphagnum moss and tie in place. When roots pervade the moss, cut the plant off below the root ball. Examples: dumbcane, rubber tree.



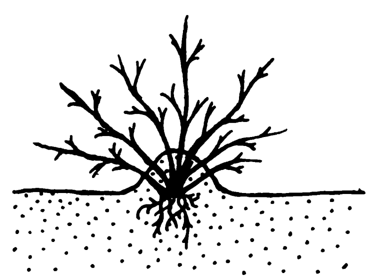
TIP LAYERING



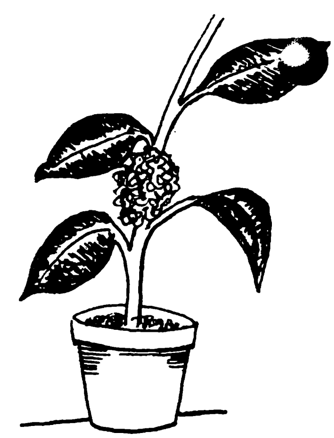
SIMPLE LAYERING



COMPOUND LAYERING



MOUND LAYERING



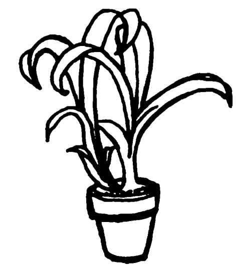
AIR LAYERING

The following propagation methods can all be considered types of layering, as the new plants form before they are detached from their parent plants.

Stolons and runners A stolon is a horizontal, often fleshy, stem that can root, then produce new shoots where it touches the medium. A runner is a slender stem that originates in a leaf axil and grows along the ground or downward from a hanging basket, producing a new plant at its tip. Plants that produce stolons or runners are propagated by severing the new plants from their parent stems. Plantlets at the tips of runners may be rooted while still attached to the parent, or detached and placed in a rooting medium. Examples: strawberry, spider plant.

Offsets Plants with a rosetted stem often reproduce by forming new shoots at their base or in leaf axils. Sever the new shoots from the parent plant after they have developed their own root system. Unrooted offsets of some species may be removed and placed in a rooting medium. Some of these must be cut off, while others may be simply lifted off of the parent stem. Examples: date palm, haworthia, bromeliads, many cacti.

STOLONS AND RUNNERS

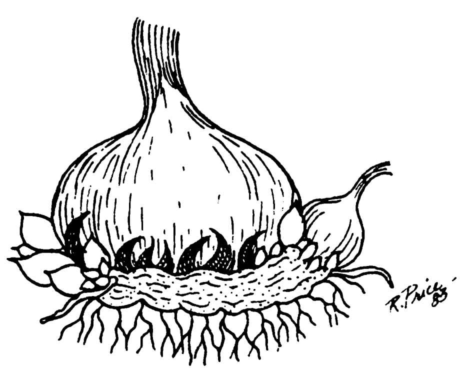


OFFSETS

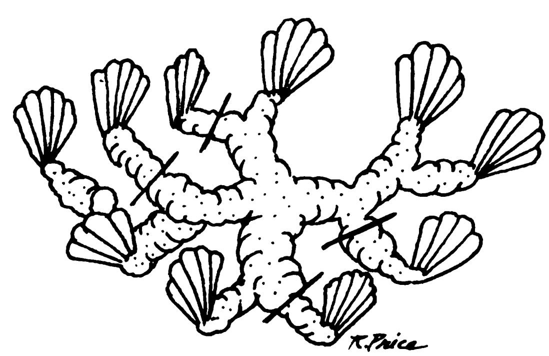
Separation Separation is a term applied to a form of propagation by which plants that produce bulbs or corms multiple.

Bulbs New bulbs form beside the originally planted bulb. Separate these bulb clumps every 3 to 5 years for largest blooms and to increase bulb population. Dig up the clump after the leaves have withered. Gently pull the bulbs apart and replant them immediately so their roots can begin to develop. Small new bulbs may not flower for 2 or 3 years, but large ones should bloom the first year. Examples: tulip, narcissus.

Corms A large new corm forms on top of the old corm, and tiny cormels form around the large corm. After the leaves wither, dig up the corms and allow them to dry in indirect light for 2 or 3 weeks. Remove the cormels, then gently separate the new corm from the old corm. Dust all new corms with a fungicide and store in a cool place until planting time. Examples: crocus, gladiolus.



SEPARATION
CORMS



DIVISION

Division Plants with more than one rooted crown may be divided and the crowns planted separately. If the stems are not joined, gently pull the plants apart. If the crowns are united by horizontal stems, cut the stems and roots with a sharp knife to minimize injury. Division of some outdoor plants should be dusted with a fungicide before they are replanted. Examples: snake plant, iris, prayer plant, daylilies.

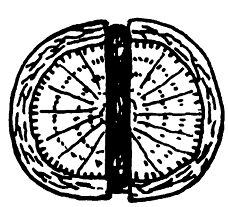
Grafting

Grafting and budding are methods of asexual plant propagation that join plant parts so they will grow as one plant. These techniques are used to propagate cultivars that will not root well as cuttings or whose own root systems are inadequate. One or more new cultivars can be added to existing fruit and nut trees by grafting or budding.

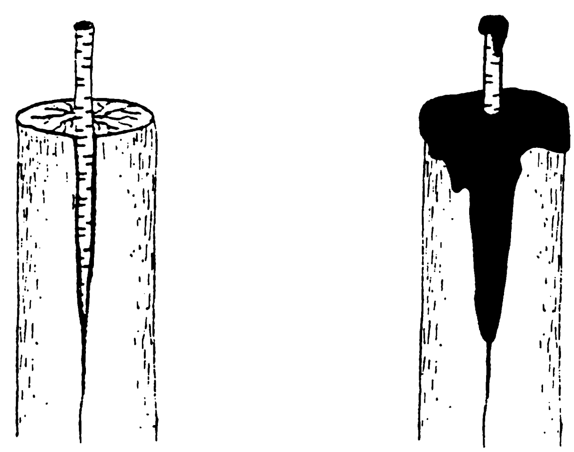
The portion of the cultivar that is to be propagated is called the scion. It consists of a piece of shoot with dormant buds that will produce the stem and branches. The rootstock, or stock, provides the new plant's root system and sometimes the lower part of the stem. The cambium is a layer of cells located between the wood and bark of a stem from which new bark and wood cells originate. (See Fruit page 3 for discussion of apple rootstock).

Four conditions must be met for grafting to be successful: the scion and rootstock must be compatible; each must be at the proper physiological stage; the cambial layers of the scion and stock must meet; and the graft union must be kept moist until the wound has healed.

Cleft grafting Cleft grafting is often used to change the cultivar or top growth of a shoot or a young tree (usually a seedling). It is especially successful if done in the early spring. Collect scion wood 3/8-5/8" in diameter. Cut the limb or small tree trunk to be reworked perpendicular to its length. Make a 2" vertical cut through the center of the previous cut. Be careful not to tear the bark. Keep this cut wedged apart. Cut the lower end of each scion piece into a wedge. Prepare two scion pieces 3-4" long. Insert the scions at the outer edges of the cut in the stock. Tilt the top of the scion slightly outward and the bottom slightly inward to be sure the cambial layers of the scion and stock touch. Remove the wedge propping the slit open and cover all cut surfaces with grafting wax.

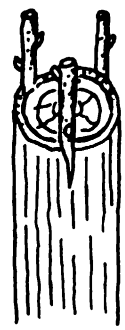


CLEFT GRAFT

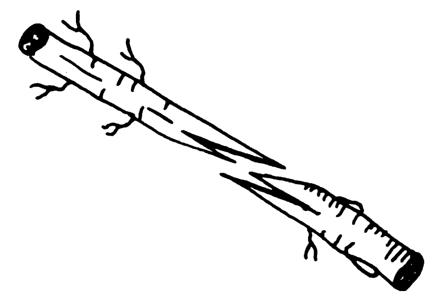


Bark grafting Unlike most grafting methods, bark grafting can be used on large limbs, although these are often infected before the wound can completely heal. Collect scion wood 3/8-1/2" in diameter when the plant is dormant, and store the wood wrapped in moist paper in a plastic bag in the refrigerator. Saw off the limb or trunk of the rootstock at a right angle to itself. In the spring when the bark is easy to separate from the wood, or slipping, make a 1/2" diagonal cut on one side of the scion, and a 1-1/2" diagonal cut on the other side. Leave two buds above the longer cut. Cut through the bark of the stock a little wider than the scion. Remove the top third of the bark

from this cut. Insert the scion with the longer cut against the wood. Nail the graft in place with flat headed wire nails. Cover all wounds with grafting wax.
<u>Whip or tongue grafting</u> This method is often used for material 1/4-1/2" in diameter. The scion and rootstock are usually of the same diameter, but the scion may be narrower than the stock. This strong graft heals quickly and provides excellent cambial contact. Make one 2-1/2" long sloping cut at the top of the rootstock and a matching cut on the bottom of the scion. On the cut surface, slice downward into the stock and up into the scion so the pieces will interlock. Fit the pieces together, then tie and wax the union.



BARK GRAFT



WHIP OR TONGUE GRAFT

<u>Care of the Graft</u> Very little success in grafting will be obtained unless proper care is maintained for the following year or two. If a binding material such as strong cord, or nursery tape is used on the graft, this must be cut shortly after growth starts to prevent girdling and later dying of the graft. Rubber budding strips have some advantages over other materials. They expand with growth and usually do not need to be cut as they deteriorate and break after a short time. It is also an excellent idea to inspect the grafts after a 2- to 3-week period to see if the wax has cracked, and if necessary rewax the exposed areas at this time. After this the union will probably be strong enough and no more waxing will be necessary.

Limbs of the old variety which are not selected for grafting should be cut back at the time of grafting. The total leaf surface of the old variety should be gradually reduced as the new one increases until at the end of 1 or 2 years the new variety has completely taken over. Completely removing all the limbs of the old variety at the time of grafting increases the shock to the tree and causes excessive suckering. Also, the scions may grow too fast making them susceptible to wind damage.

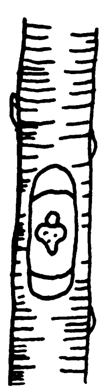
Budding

Budding, or bud grafting, is the union of one bud and a small piece of bark from the scion with a rootstock. It is especially useful when scion material is limited. It is also faster and forms a stronger union than grafting.

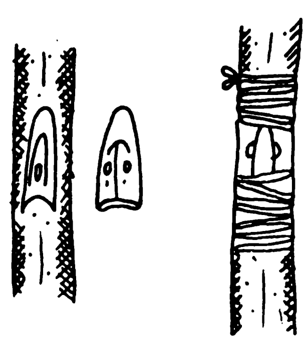
Patch budding Plants with thick bark should be patch budded. This is done while the plants are actively growing so their bark slips easily. Remove a rectangular piece of bark from the rootstock. Cover this wound with a bud and matching piece of bark from the scion. If the rootstock's bark is thicker than that of the scion, pare it down to meet the thinner bark so that when the union is wrapped the patch will be held firmly in place.

Chip budding This budding method can be used when the bark is not slipping. Slice downward into the rootstock at a 45 degree angle through 1/4 of the wood. Make a second cut upward from the first cut, about one inch. Remove a bud and attending chip of bark and wood from the scion shaped so that it fits the rootstock wound. Fit the bud chip to the stock and wrap the union.

T-budding This is the most commonly used budding technique. When the bark is slipping, make a vertical cut (same axis as the root stock) through the bark of the rootstock, avoiding any buds on the stock. Make a horizontal cut at the top of the vertical cut (in a T shape) and loosen the bark by twisting the knife at the intersection. Remove a shield-shaped piece of the scion, including a bud, bark, and a thin section of wood. Push the shield under the loosened stock bark.
Wrap the union, leaving the bud exposed.

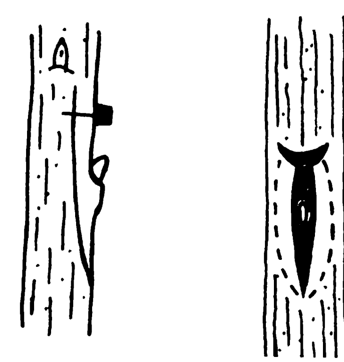


PATCH BUD



scion rootstock

CHIP BUD



scion rootstock

T-BUD

Care of buds Place the bud in the stock in August. Force the bud to develop the following spring by cutting the stock off 3 to 4 inches above the bud. The new shoot may be tied to the resulting stub to prevent damage from the wind. After the shoot has made a strong union with the stock, cut the stub off close to the budded area.

Plant Tissue Culture for the Home

Although technical procedures for aseptic culture of plant cells, tissues and organs are as diverse as the plant material on which they are practiced, a simplified general procedure can be followed in the home. All that is needed are a few basic supplies which can easily be obtained at the local grocery store. The procedures outlined in this article can be used in the home to propagate various species of plants which are either easy (African violets, coleus, chrysanthemums) or difficult (orchids, ferns, weeping figs) to propagate.

<u>Medium Preparation</u> For 2 pints of medium, mix the following ingredients in a one quart home canning jar:

- 1/8 cup sugar

- 1 tsp. all purpose soluble fertilizer mixture. Check the label to make sure it has all of the major and minor elements, especially ammonium nitrate. If the latter is lacking, add 1/3 tsp. of a 35-0-0 soluble fertilizer.

- 1 tablet (100 mg) of inositol (myo-inositol) which can be obtained at most health food stores

- 1/4 of a pulverized vitamin tablet which has 1 to 2 mg of thiamine

- 4 Tbsp. coconut milk (cytokinin source) drained from a fresh coconut. The remainder can be frozen and used later.

- 3 to 4 grains (1/400 tsp.!) of a commercial rooting compound which has 0.1 active ingredient IBA

- Fill the jar with distilled or deionized water. If purified water is not available, water that has been boiled for several minutes can be substituted.

- Shake the mixture and make sure all materials have dissolved.

Baby food jars with lids, or other heat resistant glass receptacles with lids can be used as individual culture jars. They should be half filled with cotton or paper to support the plant material. The medium should be poured into each culture bottle to the point where the support material is just above the solution.

When all bottles contain the medium and have the lids loosely screwed on, they are ready to be sterilized. This can be done by placing them in a pressure cooker and sterilizing them under pressure for 30 minutes or in an oven at 320 degrees F for 4 hours. After removing them from the sterilizer, place them in a clean area and allow the medium to cool. If the bottles will not be used for several days, wrap groups of culture bottles in foil before sterilizing and then sterilize the whole package. Then the bottles can be removed and cooled without removing the foil cover. Sterilized water, tweezers and razor blades, which will be needed later, can be prepared in the same manner.

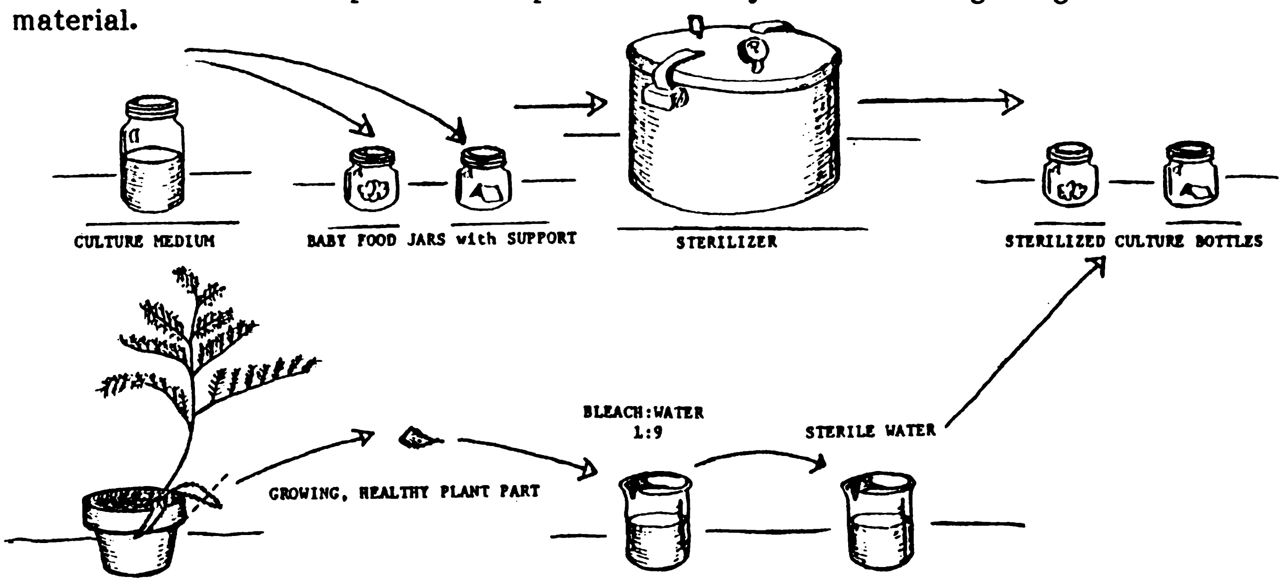
<u>Plant Disinfestation and Culture</u> Once the growing medium is sterilized and cooled, the plant material can be prepared for culture. Because plants usually harbor bacterial and fungal spores, they must be cleaned (disinfested) before placement on the sterile medium. Otherwise, bacteria and fungi may grow faster than the plants and dominate the culture.

medium. Otherwise, bacteria and fungi may grow faster than the plants and dominate the culture.

Various plant parts can be cultured, but small, actively growing portions usually result in the most vigorous plantlets. For example, ferns are most readily propagated by using only 1/2 inch of the tip of a rhizome. For other species, 1/2 to 1 inch of the shoot tip is sufficient. Remove leaves attached to the tip and discard. Place the plant part into a solution of 1 part commercial bleach to 9 parts water for 8 to 10 minutes. Be sure that all the plant tissue is submerged in the bleach solution. After this time period, rinse off excess bleach by dropping the plant part into sterile water. Remember, once the plant material has been in the bleach, it has been disinfested and should only be touched with sterile tweezers.

After the plant material has been rinsed, remove any bleach damaged tissue with a sterile razor blade. Then remove the cap of a culture bottle containing sterile medium, place the plant part onto the support material in the bottle making sure that it is not completely submerged in the medium, and recap quickly.

All transferring should be done as quickly as possible in a clean environment. Therefore scrub hands and counter tops with soap and water just before beginning to disinfest plant material.



Rubbing alcohol or a dilute bleach solution can be used to wipe down the working surface.

After all plants have been cultured, place them in a warm, well lit (no direct sunlight) environment to encourage growth.

If contamination of the medium has occurred, it should be obvious within 3 to 4 days. Remove and wash contaminated culture bottles as quickly as possible to prevent the spread to other uncontaminated cultures.

When plantlets have grown to a sufficient size, they can be transplanted into soil. Transplanting should be as gentle as possible because the plants are leaving a warm, humid environment for a cooler, drier one. After transplanting, the plants should be watered thoroughly and placed in a clear plastic bag for several days. The bag can be gradually removed to acclimate the plants to their new environment; start with one hour per day and gradually increase time out of the bag over a two week period until the plants are strong enough to dispense with the bag altogether.

SOILS AND FERTILIZERS

SOIL COMPOSITION

Soil is the result of parent materials (rock) having been acted upon by climate and vegetation, over a period of time. It is weathered rock fragments, with decaying remains of plants and animals (called organic matter). Soil also contains varying proportions of air, water, and micro-organisms. It furnishes mechanical support and "food" for growing plants.

A desirable surface soil in good condition for plant growth contains approximately 50% solid material and 50% open or pore space. The mineral component is usually made up of many different kinds and sizes of particles, ranging from those visible to the unaided eye to particles so small that they can only be seen with the aid of a very powerful (electron) microscope. This mineral material is about 45 to 48% of the total volume. Organic material makes up about 2 to 5% of the volume and may contain both plant and animal material in varying stages or degrees of decomposition. Under ideal or near ideal moisture conditions for growing plants, the soil openings or pore space contain about 25% air and 25% water based on total volume of soil.

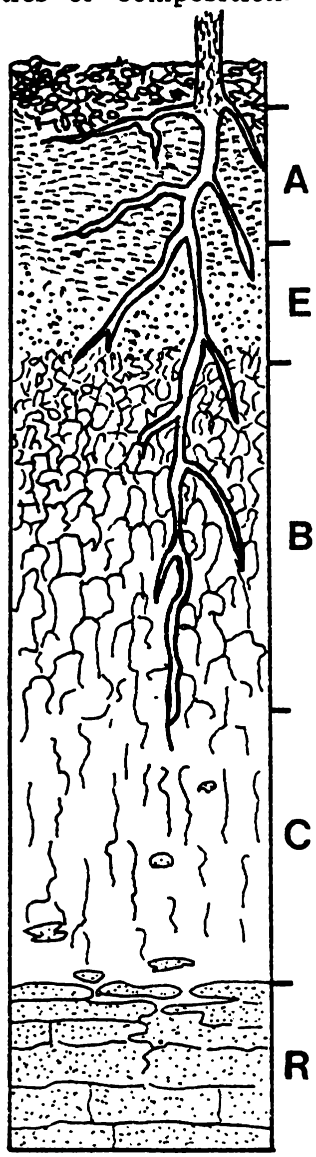
Although most Virginia soils developed under forest vegetation, climatic differences from south to north sides of Virginia and from sea level to the highest mountains (elevation 5,729 feet) vary considerably and have had rather marked effect on the soils that have formed.

The percentage of mineral matter and organic matter in a cubic foot of surface soil varies from one soil to another, and within the same soil, depending on kinds of crops grown, frequency of tillage, and wetness or drainage of the soil. Organic matter will usually be high in soils that have not been cultivated over long periods of time. Soils that are tilled frequently and have relatively small amounts of plant residues left on and worked into the soil are usually low in organic matter. Plowing and otherwise tilling the soil increases the amount of air in the soil, which increases the rate of organic matter decomposition. Soils with poor drainage or high water tables usually have higher organic matter content than those which are well drained, because the water excludes air from the soil mass.

Since either air or water fills pore spaces, the amount of air in a soil at a particular time depends on the amount of water present in the pore spaces. Immediately after a rain, there is more water and less air in the pore spaces. Conversely, in dry periods a soil contains more air and less water. Increasing organic matter content usually has the effect of increasing water holding capacity, but addition of large amounts of undecomposed organic material can reduce water capacity until the material has partially decomposed. Dark brown or black soils usually have high organic matter content.

SOIL HORIZONS OR LAYERS

Most soils have three distinct principal layers or horizons. Each layer can have two or more sub-horizons. The principal horizons (collectively called the soil profile) are A or surface soil, E or subsurface layer, B or subsoil, and C or parent material, Beneath the soil profile lies the rock, similar to that from which the soil developed, usually referred to as the R layer. Horizons usually differ in color, texture, consistence, and structure. In addition, there is usually considerable difference in chemical characteristics or composition.



The surface soil and subsurface layer are usually the coarsest layer. The surface soil contains more organic matter than the other soil layers. Organic matter gives a grayish, dark-brownish, or blackish color to the surface horizon, the color imparted depending largely upon the amount of organic matter present. Soils that are highest in organic matter usually have the darkest surface colors. This surface layer is usually more fertile and has the greatest concentration of plant roots of any horizon of the soil. Plants obtain much of their food and water from the surface soil.

The subsoil layer is usually finer and firmer than the surface soil. Organic matter content of the subsoil is usually much lower than that of the surface layer. Subsoil colors are strong and bright with shades of red, brown, and yellow being frequently observed. The subsoil supports the surface soil and may be considered the soil reservoir providing storage space for water and food for plants, aiding in regulating the temperature of the soil and the air supply for the roots of plants.

The bottom horizon or parent material is decomposed rock that has acquired some characteristics of the subsoil and retained some characteristics of the rock from which it weathered. It is not hard like rock but may show the form or structure of the original rocks or layering if it is in a water-laid deposit. The parent material influences soil texture, natural fertility, rate of decomposition and thus rate of soil formation, acidity, depth and, in some cases, topography (or lay of the land) on which the soil is formed.

PHYSICAL PROPERTIES OF THE SOIL

The physical properties of a soil are those characteristics which can be seen with the eye or felt between the thumb and fingers. They are the result of soil parent materials being acted upon by climatic factors (such as rainfall and temperature), and affected by relief (slope and direction or aspect) and vegetation (kind and amount, such as forest or grass) over a period of time. A change in any one of these influences usually results in a difference in the soil formed or developed. Important physical properties of a soil are color, texture, structure, drainage and depth.

Soil characteristics such as texture, structure, chemical composition, drainage, and depth, and surface features such as stoniness, slope, and erosion largely determine the suitability of a soil for use and its management needs. To a limited extent, the fertility of a soil determines what it may be used for, and to a larger extent the yields that may be expected. However, fertility level alone is not indicative of its productive capacity, since soil physical properties usually control the suitability of the soil as growth medium. Fertility is more easily changed than soil physical properties.

Color

When soil is examined, color is one of the first things noticed. In itself it is of minor importance, but it indicates or reflects soil conditions that are extremely important. In general, color is determined by: (1) organic matter content; (2) drainage conditions; and (3) degree of oxidation or extent of weathering.

Surface soil colors vary from almost white, through shades of browns and grays, to black. Light colors indicate low organic matter content and dark colors can indicate high content. Light or pale colors in the surface soil are frequently associated with relatively coarse texture and highly leached conditions, and occur in areas that have high annual temperature. Dark colors may result from high water table conditions (poor drainage), low annual temperatures, or other influences that induce high organic matter content and at the same time slow the oxidation (burning) of organic materials. Or they may result from colors imparted by the parent material. Shades of red or yellow, particularly where associated with relatively fine textures, usually indicate that subsoil material has been incorporated in the surface or plow layer.

Subsoil colors, in general, indicate air, water, and soil relationships and the degree of oxidation of certain minerals in the soil. Red and brown subsoil colors indicate that the soil allows relatively free movement of air and water. If these or other bright colors persist throughout the subsoil it is indicative of favorable aeration. Some soils that are mottled (have mixed colors) in the subsoil, especially where the colors are shades of red and brown, are also well aerated.

Soils with yellow-colored subsoils usually have some drainage impediment. Most soils that have mottling in the subsoil, especially where gray predominates, have too much water and too little air (oxygen) much of the time. The red to brown color of subsoils comes from iron coatings under well aerated conditions. In wet soils with low oxygen levels the iron coatings are chemically and biologically removed and the gray color of background soil minerals shows.

Texture

The relative amount of different size soil particles, or the fineness or coarseness of the mineral particles in the soil, is referred to as texture. Soil texture depends on the relative amounts of sand, silt, and clay. In each texture class, there is a range in the amount of sand, silt and clay that class contains.

The coarser mineral particles of the soil are called sand. These particles vary in size. Most sand particles can be seen without a magnifying glass. All feel rough when rubbed between the thumb and fingers.

Relatively fine soil particles that feel smooth and floury are called silt. When wet, silt feels smooth but is not slick or sticky. When dry, it is smooth and if pressed between the thumb and finger will retain imprint. Silt particles are so fine that they cannot usually be seen by the unaided eye and are best seen with a microscope.

Clays are the finest soil particles. Clay particles can be seen only with the aid of a very powerful (electron) microscope. They feel extremely smooth when dry, and become slick and sticky when wet. Clay will hold the form into which it is molded.

Loam is a textural class of soils that has moderate amounts of sand, silts and clay. Loam contains approximately 7-27% clay, 28-50% silt and approximately 50% sand.

Although there are about 20 kinds or classes of soil texture, most surface soils in Virginia fall into five general textural classes. Each class name indicates the size of the mineral particles that are dominant in the soil. Texture is determined in the field by rubbing or feeling moist to wet soil between the thumb and fingers. This is checked by laboratory or mechanical analysis or separation into clay, silt, and various size sand groups (called separates). Regardless of textural class, all soils in Virginia contain sand, silt, and clay, although the amount of a particular particle size may be small.

Principal Surface Soil Classes Found in Virginia

1. Loam - When rubbed between the thumb and fingers approximately equal influence of sand, silt, and clay is felt.

2. Sandy loam - Varies from very fine loam to very coarse. Feels quite sandy or rough, but contains some silt and a small amount of clay. The amount of silt and clay is sufficient to hold the soil together when moist.

3. Silt loam - Silt is the dominant size particle in silt loam, which feels quite smooth or floury when rubbed between the thumb and fingers.

4. Silty clay loam - Smooth to the touch when dry. When moist it becomes somewhat slick or sticky, or both. Noticeable amounts of both silt and clay are present in silty clay loam, but silt is a dominant part of the soil.

5. Clay loam - Clay dominates a clay loam, which is smooth when dry and slick and sticky when wet. Silt and sand are usually present in noticeable amounts in this texture of soil, but are overshadowed by clay.

Other textural designations of surface soils are sands, loamy sands, sandy clay loams, and clays. In each textural class there is a range in the amount of sand, silt, or clay that class may contain. Composition of each textural class does not allow for overlap from one class to another.

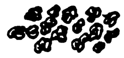
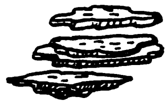
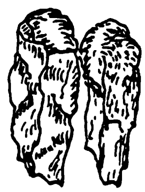
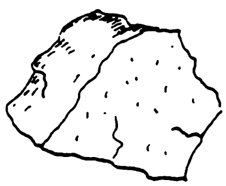
Texture of soil influences many different characteristics. A brief comparison between sandy and clay soils will highlight these points. Coarse-textured or sandy soils allow water to enter at a faster rate than fine-textured or clayed soils and to move more freely in the soil. In addition, the relatively low water capacity and the large amount of air present in sandy soils allows them to warm up faster than fine-textured soils. Sandy soils are also more easily tilled. They are best suited for the production of special crops such as vegetables, flue-cured tobacco, peanuts, and certain fruits.

Structure

Soil particles are grouped together in the formation processes to form structural pieces called peds or aggregates. In surface soil the structure will usually be granular unless it is disrupted. The soil aggregates will be rounded and vary in size from very small shot to large pea. If organic matter content is low and if the soil has been under continuous cultivation, the soil structure may be quite indistinct. If the soil is fine-textured with high organic content, it may have a blocky surface structure.

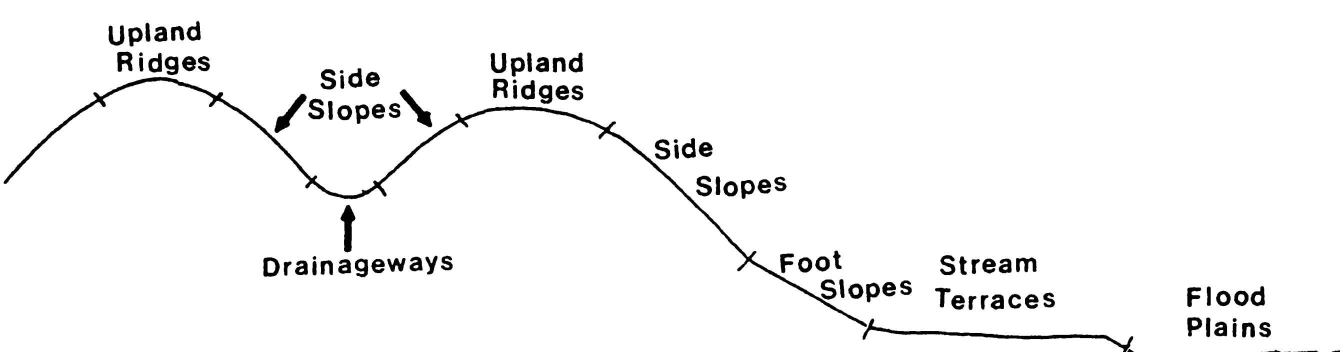
Structure of the soil is closely related to air and water movement within it. Good structure allows favorable movement of air and water, while poor or no structure slows down this movement. Water can enter a surface soil that has granular structure more rapidly than one that has little structure. Since plant roots move through the same channels in the soil as air and water, good structure allows extensive root development while poor structure discourages it. Water, air, and plant roots move more freely through subsoils that have blocky structure than those with platy or flaky horizontal structure. Good structure of the surface soil is promoted by an adequate supply of organic matter, and by working the soil when its moisture conditions are correct.

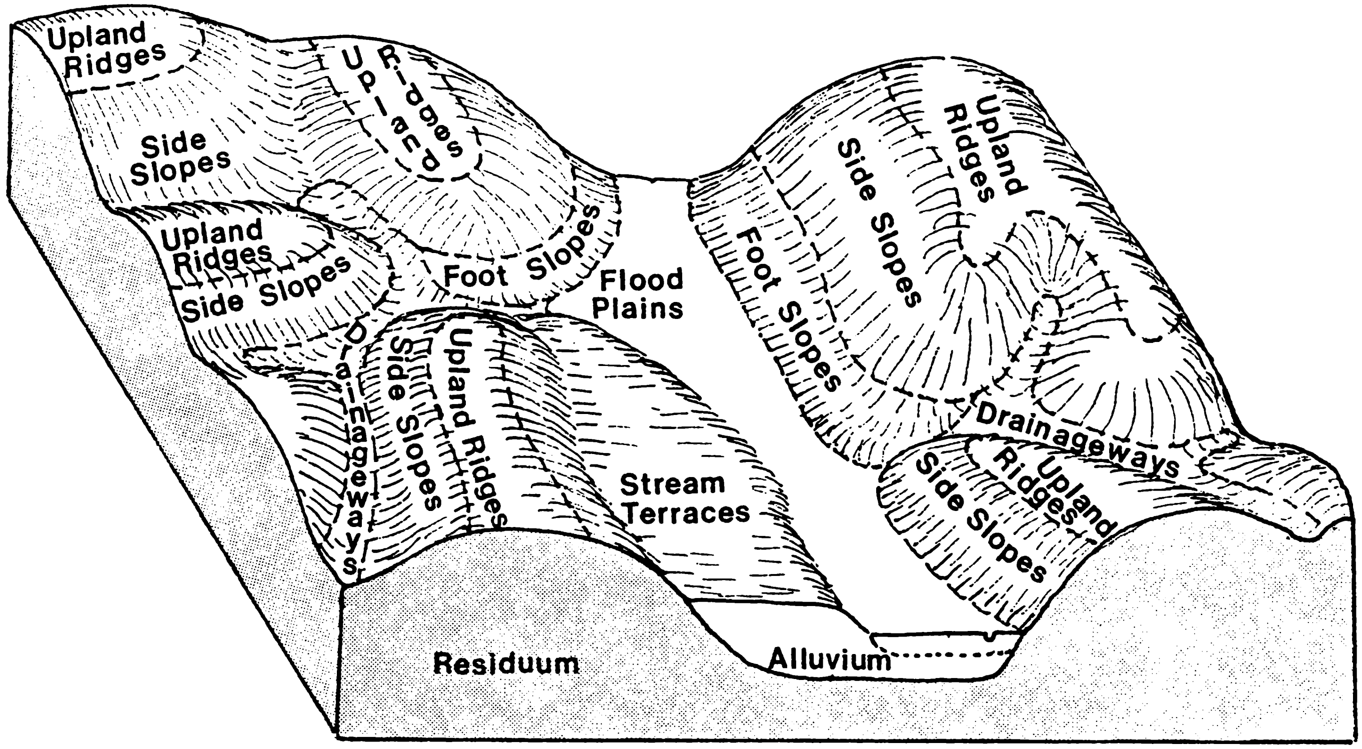
Growing plants also change the soil structure as they send their roots into the soil for mechanical support and to gather water and food. The roots of plants, as they grow, tend to enlarge the openings in the soil. When they die and decay, they leave channels for movement of air and water. In addition to the plants that we see, there are bacteria molds and other very small plants growing in the soil which can be seen only with the aid of a microscope. Even these plants enrich the soil as they die.

NAME	SHAPE	DESCRIPTION	WHERE COMMONLY FOUND IN SOILS
SINGLE GRAIN		Usually individual sand grains not held together by organic matter or clay	Sandy or loamy textures
GRANULAR		Porous granuals held together by organic matter and some clay	A horizons with some organic matter
PLATY		Aggregates that have a thin vertical dimension with respect to lateral dimensions	Compacted layers and sometimes E horizons
BLOCKY		Roughly equidimensional "peds" usually higher in clay than other structural aggregates	B horizons with clay
PRISMATIC		Structural aggregates that have a much greater vertical than lateral dimension	In some B horizons
MASSIVE		No definite structure or shape: usually hard	C horizons or compact transported materials

Drainage

Soil drainage is defined as rate and extent of water movement in the soil. Included is movement across the surface as well as downward through the soil. Slope or lack of slope is a very important factor in soil drainage. Other factors include texture, structure, and physical condition of surface and subsoil layers. Soil drainage is indicated by soil color. Clear, bright colors indicate well-drained conditions. Mixed, drab, and dominantly gray colors indicate imperfection in drainage. Low lying areas within the landscape receive run-off water, in addition to that which falls upon them. Frequently, the water from these areas must escape by lateral movement through the soil or by evaporation from the surface, as poor structure and other physical influences do not allow drainage through the soil.





Too much or too little water in the soil is equally undesirable. With too much water, most plants will suffocate. Where there is too little water, plants will wilt and eventually die. The most desirable soil moisture situation is one in which approximately one-half of the pore space of the surface soil is occupied by water.

Soil Depth

The effective depth of a soil for plant growth is the vertical distance into the soil from the surface to a layer that essentially stops the downward growth of plant roots. The barrier layer may be rock, sand, gravel, heavy clay, or a partially cemented layer.

Terms that are used to express effective depth of soil are:

VERY SHALLOW - soil is less than 10" to a layer that retards root development.

SHALLOW - soil is 10 to 20" to a layer that retards root development.

MODERATELY DEEP - soil is 20 to 36" to a layer that retards root development.

DEEP - soil is 36 to 60" to a layer that retards root development.

VERY DEEP - soil is 60" or more to a layer that retards root development.

Soils that are deep, well drained, and have desirable texture and structure are suitable for the production of most crops. Deep soils can hold much more plant food and water than shallow soils with similar textures. Depth of soil and its capacity for nutrients and water frequently determine the yield from a crop, particularly annual crops grown through the summer months.

Plants growing on shallow soils also have less mechanical support than those growing in deep soils. Trees growing in shallow soils are more frequently blown over by wind than those growing in deep soils.

Erosion

The principal reasons for soil erosion in Virginia are: insufficient vegetative cover, overexposure through the use of cultivated crops on soils not suited to cultivation, and use of improper equipment and methods in preparation and tillage of the soil. Soil erosion can be held to a minimum by using the soil to produce crops to which it is suited, using adequate fertilizer and lime to promote vigorous growth of plants, and using thorough soil preparation and proper tillage methods or mulch.

Soils that have lost part or all of their surface are usually harder to till and have lower productivity than those that have desirable thickness of surface soil. To compensate for surface soil loss, better fertilization, liming, and other management practices should be used. Increasing the organic matter content of an eroded soil often improves its tillage characteristics, as well as its water and nutrient capacity.

COMPONENTS OF SOIL

Soil Organic Matter

Organic matter in soil consists of the remains of plants and animals. When temperature and moisture conditions are favorable in the soil, earthworms, insects, bacteria, fungi, and other types of plants and animals use the organic matter as food, breaking it down into humus (the portion of organic matter that remains after most decomposition has taken place) and soil nutrients. Through this process, materials are made available for use as foods by growing plants.

The digested and decomposing organic material also helps develop good air-water relationships. In sandy soil, organic material occupies some of the space between the sand grains, thus binding these together and increasing water-holding capacity. In a fine textured or clay soil, organic material creates aggregates of the fine soil particles, allowing water to move more rapidly. This grouping of the soil particles into small pieces (aggregates or peds) causes it to feel mellow and makes it easy to work.

Organic matter content depends primarily on the kinds of plants that have been growing on a soil, the long term management practices, temperature and drainage. Soils that had native grass cover for long periods usually have relatively high organic matter content in the surface area. Those that had native forest cover usually have relatively low organic matter content. In either case, if the plants have grown on a soil that is poorly drained, the organic matter content is usually higher than where the same plant is grown on a well-drained soil--due to differences in available oxygen and other substances needed by the organisms that attack and decompose the organic material. Soils in a cool climate have more organic matter than those in a warm climate.

Water and Air in the Soil

All water in the soil ultimately comes from precipitation (rain, snow, hail, or sleet). As rain falls, some of it enters the soil through cracks, holes, and openings between the soil particles. As the water enters, it pushes the air out. If air is unavailable to plant roots for too long the plant suffocates.

Plants use some water, some is lost by evaporation, and some moves so deep into the soil that plant roots cannot reach it. If it rains very hard or for a long time, some of it is lost by run-off.

When organic matter decomposes in the soil, it gives off carbon dioxide. This carbon dioxide replaces some of the oxygen of the air in the soil. As a result, soil air contains less oxygen and more carbon dioxide than the air above the surface of the soil.

Carbon dioxide is dissolved by water in the soil to form a weak acid. This solution reacts with the minerals in the soil to form compounds that can be taken up and used as foods by the plants.

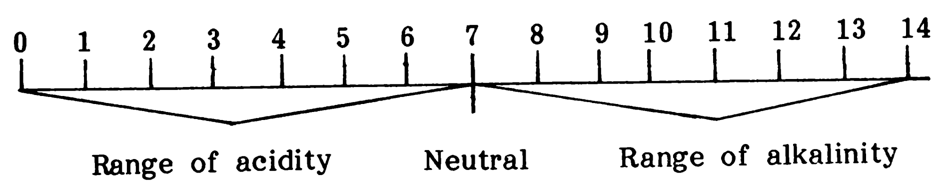
Plant Nutrients in the Soil

Plants need 17 elements for normal growth. Carbon, hydrogen and oxygen (which come from air and water) and nitrogen (which is in the soil) are the 4 elements that make up 95% of plant solids. Although the atmosphere is 78% nitrogen, it is unvailable for plant use. However, certain bacteria that live in nodules on the roots of legumes are able to fix nitrogen from the air into a form available to plants.

The other 13 essential elements are iron, calcium, phosphorus, potassium, copper, sulphur, magnesium, manganese, zinc, boron, chlorine, cobalt and molybdenum. These elements come from the soil. With the exception of calcium, magnesium, phosphorus, and potassium, there is usually enough of these elements in the soil for cultivation of crops.

SOIL pH

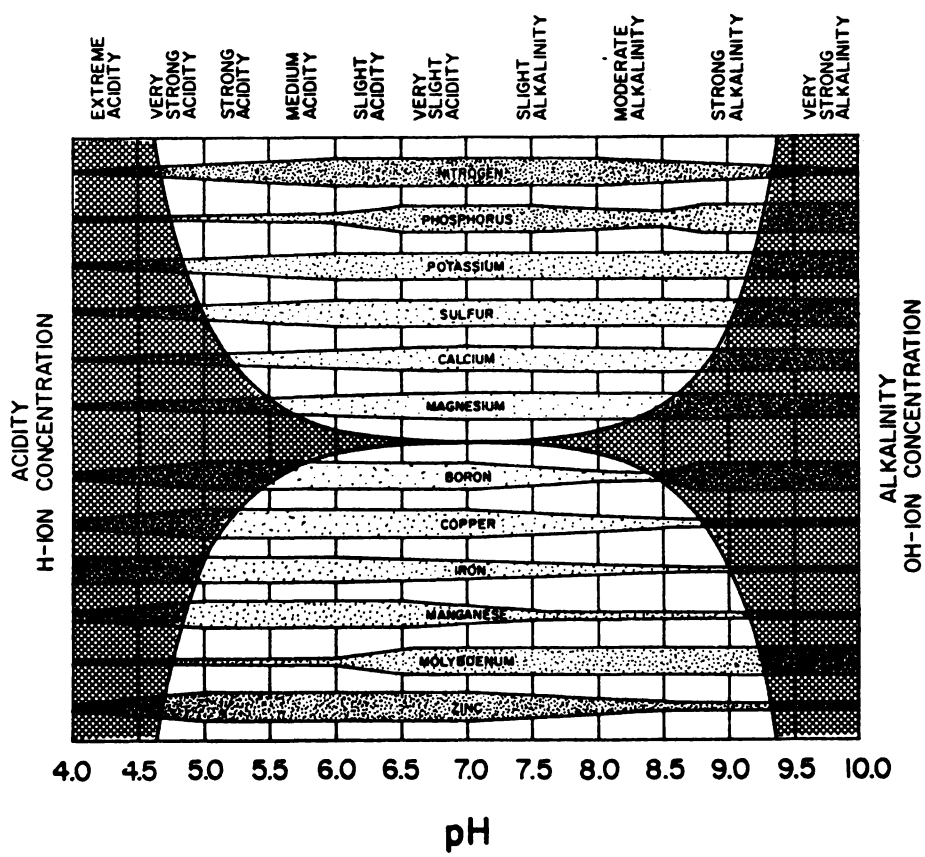
A pH is a reading taken from a scale that measures the hydrogen (acid forming) ion activity of soil or growth media. The reading expresses the degree of acidity or alkalinity in terms of pH values, very much like heat and cold are expressed in degrees Centigrade or Fahrenheit. The Centigrade temperature scale is centered around zero degrees or the freezing point of water, and thermometers are used to measure intensities of heat and cold above and below this point. The scale of measuring acidity or alkalinity contains 14 divisions known as pH units. It is centered around pH 7 which is neutral. Values below 7 constitute the acid range of the scale and values above 7 make up the alkaline range.



The measurement scale is not a linear scale but a logarithmic scale. That is, a soil with a pH of 8.5 is ten times more alkaline than a soil with a pH of 7.5, and a soil with a pH of 4.5 is ten times more acid than a soil with a pH of 5.5.

The pH condition of soil is one of a number of environmental conditions that affect the quality of plant growth. A near neutral or slightly acid soil is generally considered ideal for most plants. Some type of plant growth can occur anywhere in a 3.5 to 10.0 range. With some notable exceptions, a soil pH of from 6.0 to 7.0 requires no special cultural practices to improve plant growth.

The major impact that extremes in pH have on plant growth is related to the availability of plant nutrients and the soil concentration of the plant-toxic minerals. In highly acid soils, manganese can concentrate at toxic levels. Also at low pH values, calcium, phosphorous and magnesium become tied up and unavailable. At pH values of 7 and above, phosphorus, iron, copper, zinc, boron and manganese become less available.



By the application of certain materials to the soil, adjustments can be made in pH values. To make soils less acid apply a material that contains some form of lime. Ground agricultural limestone is the most frequently used. The finer the grind the more rapidly it becomes effective. Different soils will require a different amount of lime to adjust the reaction to the proper range. The texture of the soil, organic matter content, the crop to be grown and soil type are all factors to consider in adjusting pH. For example, soils low in organic matter require much less lime than soils high in organic matter to make the same pH change.

Wood ashes are often used as a soil amendment. They contain potash (potassium), phosphate, boron, and other elements. Wood ashes can be used to raise soil pH with twice as much ash applied as limestone for the same effect. Ashes should not come into contact with germinating seedlings or plant roots as they may cause root damage. Spread on a thin layer during the winter, and incorporate into the soil in the spring. Check pH yearly if you use wood ashes. Never use coal ashes or large amounts of wood ash (no more than 20 lbs. per 1000 square feet), as toxicity problems may occur.

If pH is too high, elemental sulfur or aluminum sulfate can be added to the soil to reduce alkalinity. Most ornamental plants require a slightly to strongly acid soil. These species develop iron chlorosis when grown in soils in the alkaline range. Iron chlorosis is often confused with nitrogen deficiency since the symptoms (a definite yellowing of the leaves) are similar. This problem can be corrected by applying chelated iron sulfate to the soil to reduce the alkalinity and add iron.

The term chelate comes from the Greek word for claw. Chelates are chemical claws that help hold metal ions, such as iron, in solution, so that the plant can absorb them. Different chemicals can act as chelates from relatively simple natural chelates like citrate, to more complex manufactured chemicals. When a chelate metal is added to the soil, the nutrient held by the chelate will remain available to the plant.

Most nutrients do not require the addition of a chelate to help absorption. Only a few of the metals, such as iron, benefit from the addition of chelates. The types of chelate used will depend on the nutrient needed and the soil pH.

FERTILIZERS

There are 17 elements essential to plant growth. Nitrogen, phosphorous and potassium are considered fertilizer macronutrients because plants require them in quantity for maximum growth. Calcium, magnesium, and sulfur are secondary macronutrients but usually are either present in sufficient quantities or are added coincidentally with other materials (i.e.lime). The others, called micronutrients, are just as important but are necessary in smaller amounts. If plants lack any of these elements, they exhibit signs of nutrient difficency. Some of these symptoms are given in the discussion of nutrients in the chapter on botany.

Fertilizer Analysis

The fertilizer analysis refers to how much of an element there is in a formulation based on percentage of weight. All fertilizers are labeled with three numbers. These three numbers give the percentage by weight of nitrogen (N), phosphate (P2O5), and potash (K2O). Often, to simplify matters, these numbers are said to represent nitrogen, phosphorus, and potassium, or N-P-K. We should remember that it is not N-P-K, but N-P2O5-K2O. For example, if we have a 100 pound bag of fertilizer labeled 10-10-10, there are 10 pounds of N, 10 pounds of P2O5, and 10 pounds of K2O. To convert the P205 to actual phosphorous multiply it by 0.43 and to convert K20 to actual potassium, multiply it by 0.83.

The other 70 pounds is filler. Filler is important so that we can evenly spread out the fertilizer and burn the plant with too much fertilizer. A 100 pound bag of fertilizer labeled 0-20-10 would have 0 pounds of N, 20 pounds of P2O5, 10 pounds of K2O, and 70 pounds of filler.

For many years there has been a model label law which many states have adopted for the classification of fertilizers. The law also establishes minimum levels of nutrients allowable and provides specific labeling requirements. To date, model label legislation has not met with total acceptance, so there are still differences from state to state as to what constitutes a fertilizer and the type of information on labels.

Even so, the information contained on fertilizer labels has been quite well standardized, and the consumer is protected by state laws requiring manufacturers to guarantee the claimed nutrients.

The law only requires that the manufacturer guarantee what is claimed on the label, so in some cases, a fertilizer will contain secondary nutrients or micronutrients not listed on the label because the manufacturer does not want to guarantee their exact amounts. The gardener-consumer can rest assured that nutrients listed on the label are actually contained in the fertilizer.

Some mention should be made of the initials or designations W.I.N. and W.S.N. on fertilizer labels. These stand for water insoluble nitrogen and water soluble nitrogen, respectively. The W.S.N. dissolves readily and is usually in very simple form such as ammoniacal nitrogen (ammonia) or nitrate nitrogen. Nitrogen which will not dissolve readily may exist in other forms in the fertilizer. These are usually organic forms of nitrogen (with the exception of urea) that must be broken down into simpler forms before it can be used. Water insoluble nitrogen (W.I.N.) is referred to as a slow release nitrogen source and delivers nitrogen at different rates according to the amount and kind of material in its composition.

The best analysis to use depends on many factors, such as what nutrients are needed, what the soil structure and chemistry is and the method of applying the fertilizer.

Complete vs Incomplete Fertilizers

A fertilizer is said to be complete when it contains nitrogen, phosphorus, and potassium. The manufactures of commercial fertilizers are required to state the amounts of nutrients on the container as a guaranteed analysis. Examples of commonly used fertilizers are 10-10-10, 16-16-16, 20-10-5. An incomplete fertilizer will be missing one of the major components. Examples of incomplete fertilizers are indicated on the following chart.

COMMON INCOMPLETE FERTILIZERS OR FARM-TYPE FERTILIZERS

	%Nitrogen	%Phosphorus	%Potassium
Ammonium nitrate	34	0	0
Ammonium sulfate	21	0	0
Mono-ammonium phosphate	11	48	0
Muriate of potash (potassium chloride)	0	0	60
Potassium sulfate	0	0	52
Super phosphate	0	20	0
Triple super phosphate	0	45	0
Urea	46	0	0
Ureaformaldehyde	38	0	0

The blending of incomplete fertilizers is used to make complete fertilizers. As an example, if 100 pounds of urea (46-0-0) were combined with 100 pounds of triple super phosphate (0-45-0), and 100 pounds of muriate of potash (0-0-60), a fertilizer grade of 15-15-20 would result.

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Example:      46 - 0 - 0 100 pounds of fertilizer
         plus 0 -45 - 0 100 pounds of fertilizer
         plus 0 - 0- 60 100 pounds of fertilizer
       equals  46 -45 -60 300 pounds of fertilizer
       or approximately:
              15 -15 -20 in 100 pounds of fertilizer
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This tells us that 100 pounds of urea fertilizer originally contains 46 pounds of nitrogen; triple super phosphate has 45 pounds of phosphorus; and muriate of potash has 60 pounds of potash.. When these three quantities are combined, each quantity is diluted by the other two by one-third, provided each bag has equal weight.

The fertilizer ratio indicates the proportion of nitrogen, phosphate, and potash contained in the fertilizer. The specific fertilizer ratio you will need depends on the soil nutrient level. For example, a 1-1-1- ratio (10-10-10, 15-15-15, 20-20-20) is widely used at the time of lawn establishment, but established lawns generally respond better to fertilizer ratios high in nitrogen. Two of the most common complete fertilizers used by homeowners are 10-10-10 and 5-10-10.

Special Purpose Fertilizers

When fertilizer shopping, you will find fertilizers packaged for certain uses or types of plants such as Camellia Food, Rhododendron and Azalea Food, or Rose Food. The camellia and rhododendron-azalea fertilizers belong to an old established group, the acid plant foods. Some of the compounds used in these fertilizers are chosen because they have an acid reaction, so they are especially beneficial to acid-loving plants where soil is naturally neutral or alkaline. The other fertilizers packaged for certain plants do not have as valid a background of research. Compare, for example, the fertilizer ratios of three different brands of rose foods.

A soil test should be performed before the purchase of any expensive special purpose fertilizers. It is not possible to make a blanket statement that one fertilizer is best for every area of the state. It is true that different plants use different nutrients at different rates. What is unknown is the reserve of nutrients already in the soil. This changes with every soil type and location.

Slow Release Fertilizers

Plants can take up fertilizers continuously, so it is beneficial to provide them with a balance of nutrients throughout their growth. Perhaps the most efficient way to achieve this is to apply a slow-release fertilizer, which is supposed to release nutrients at the same rate they are taken up by the plants. Slow-release fertilizers contain one or more essential elements. These elements are released or made available to the plant over an extended period.

Slow release fertilizers can be categorized by the way in which the fertilizer is released. The three major types of nutrient release are: (1) materials that dissolve slowly, (2) materials from which the nitrogen is released by microorganisms, and (3) granular materials with membranes made of resin or sulfur that control the rate of nutrient release from the granules into the soil.

Sulfur-coated urea is a slow release fertilizer with a covering of sulfur around each urea particle. Different thicknesses of sulfur control the rate of release of nitrogen which becomes more rapid as temperature increases. Watering does not affect its release rate. Sulfur-coated urea applied to the soil's surface releases more slowly than it does if it is incorporated into the soil. This material generally costs less than other slow release fertilizers and it supplies the essential element, sulfur.

When fertilizer products coated with several layers of resin contact water, the layers swell and increase the pore size in the resin so that the dissolved fertilizer can move into the soil. Release rate depends on the coating thickness, temperature, and water content of the soil. There is often a large release of fertilizer during the first two or three days after application. Release timing can be from 0 to 6 months depending on the coating.

Slow release fertilizers need not be applied as frequently as other fertilizers, and higher amounts can be applied without danger of burning. Plants may use the nitrogen in slow release fertilizers more efficiently than in other forms since it is continually being released at the proper rate over a longer period of time than conventional fertilizers. Slow release fertilizers are generally more expensive than other types. The real benefit, however, is the frequency of application, which is much lower than with conventional fertilizers.

Urea formaldehye and sulfur-coated urea have been used as turf fertilizer while resin coated fertlizers are predominantly used in container growing.

Caution should be used in applying slow release fertilizers around trees or shrubs as they may keep the plant in growth late in the summer. The late season growth may not harden off completely and excessive winter damage may occur.

The table below compares slow release fertilizers and conventional fertilizers.

COMPARISON OF SLOW RELEASE FERTILIZERS AND CONVENTIONAL FERTILIZERS

Slow Release Fertilizer

Advantages	Disadvantages
1. Fewer applications	1. Unit cost is high
2. Low burn potential	2. Availability limited
3. Release rates vary depending on fertilizer characteristics	3. Release rate governed by factors other than plant need
4. Comparatively slow release rate	

Conventional Fertilizer

Advantages	Disadvantages
1. Fast acting	1. Greater burn potential
2. Most are acid forming	2. Solidifies in the bag when wet
3. Low cost	3. N leaches readily

Manures or Sewage Sludge

Advantages	Disadvantages
1. Low burn potential	1. Salt could be a problem
2. Relatively slow release	2. Bulky, difficult to handle
3. Contains more than nitrogen	3. Odor
4. Conditions soil	4. Expensive per pound of actual nutrient
	5. Weed seeds a problem
	6. Heavy metals on foodcrops

Organic Fertilizers

The word "organic" applied to fertilizers simply means that the nutrients contained in the product are derived solely from the remains, or a by-product of a once-living organism. Urea is a synthetic organic fertilizer, an organic substance manufactured from inorganic materials. Cottonseed meal, blood meal, bone meal, hoof and horn meal, and all manures are examples of organic fertilizers. Most of these products packaged as fertilizers will have the fertilizer ratios stated on the package labels. Some organic materials, particularly composted manures and sludges are sold as "soil conditioners" and do not have a nutrient guarantee although small amounts of nutrients are present. Most are high in just one of the three major nutrients and low or zero in the other two, although you may find some fortified with nitrogen, phosphorus, or potash for a higher analysis. Many are low in all three. In general, organic fertilizers release nutrients over a fairly long period; the potential drawback is that they may not release enough of their principal nutrient at a time to give the plant what it needs for best growth. Because organic fertilizers depend on soil organisms to break them down to release nutrients, most of them are effective only when soil is moist and soil temperature is warm enough for the soil organisms to be active.

Cottonseed meal is a by-product of cotton manufacturing. As a fertilizer it is somewhat acid in reaction. Formulas vary slightly, but generally contain 7 percent nitrogen, 3 percent phosphorus, and 2 percent potash. Cottonseed meal is more readily available to plants in warm soils, but there is little danger of burn. For general garden use apply 2 to 5 pounds per 1000 square feet. Cottonseed meal is frequently used for fertilizing acid-loving plants such as azaleas, camellias, and rhododendrons.

Blood meal is dried, powdered blood collected from cattle slaughterhouses. It is a rich source of nitrogen, so rich, in fact, that it may do harm if used in excess. The gardener must be careful not to exceed the recommended amount suggested on the label. In addition to nitrogen, blood meal supplies certain of the essential trace elements, including iron.

Fish emulsion, a well-rounded fertilizer, is a partially decomposed blend of finely pulverized fish. No matter how little is used, the odor is intense, but it dissipates within a day or two. Fish emulsion is high in nitrogen and is a source of several trace elements. In the late spring, when garden plants have sprouted, an application of fish emulsion followed by a deep watering will boost the plant's early growth spurt. Contrary to popular belief, too strong a solution of fish emulsion can cause plants to "burn," particularly in containers.

Manure is a complete fertilizer, but low in the amounts of nutrients it can supply. Manures vary in nutrient content according to the animal source and what the animal has been eating, but a fertilizer ratio of 1-1-1 is typical. Manures are best used as soil conditioners instead of nutrient suppliers. Commonly available manures include horse, cow, pig, chicken, and sheep. The actual nutrient content varies widely: the highest concentration of nutrients is found when manures are fresh. As it is aged, leached, or composted, nutrient content is reduced.

Even though fresh manures have the highest amount of nutrients, most gardeners prefer to use composted forms of manure to ensure a lesser amount of salts, thereby reducing the chance of burning plants. Fresh manure should not be used where it will contact tender plant roots. Typical rates of manure applications vary from a moderate 70 pounds per 1000 square feet to as much as one ton per 1000 square feet.

Sewer sludge is a recycled product of municipal sewage treatment plants. Two forms are commonly available, activated and composted. Activated sludge has higher concentrations of nutrients (approximately 6-3-0) than composted sludge, and is usually sold in a dry, granular form for use as a general purpose, longlasting, nonburning fertilizer. Composted sludge is used primarily as a soil amendment and has a lower nutrient content (approximately 1-2-0). There is some question about the longterm effect of using sewage sludge products in the garden, particularly around edible crops. Heavy metals, such as cadmium are sometimes present in the sludge, and may build up in the soil. Possible negative effects vary, not only with the origin of the sludge, but also with the characteristics of the soil where it is used.

In the following table showing the approximate nutrient content of manures and suggested yearly rates of applicaton per 1000 square feet of garden area, rates given are for materials used singly; if combinations of two or more materials are used, the rate should be reduced accordingly.

Type of Manure or Fertilizer	Nitrogen %	Phosphorus %	Potassium %	Suggested Amounts of Material (pounds) per 1000 square feet of Garden Area
Chicken manure, dry	2.0 - 4.5	4.6 - 6.0	1.2 - 2.4	125
Steer manure, dry	1.0 - 2.5	0.9 - 1.6	2.4 - 3.6	450
Dairy manure, dry	0.6 - 2.1	0.7 - 1.1	2.4 - 3.6	600

Compared to synthetic fertilizer formulations, organic fertilizers contain relatively low concentrations of actual nutrients, but they perform other important functions which the synthetic formulations do not. Some of these functions: increasing organic content of the soil; improving physical structure of the soil; increasing bacterial and fungal activity, particularly the mycorrhiza fungus which alone makes other nutrients more available to plants.

Fertilizers Combined with Pesticides

The major reason for buying a fertilizer combined with a pesticide is convenience. It is very convenient to combine everything you need in one application, but it is also very expensive. The problem is that the timing for a fertilizer application often does not coincide with the appearance of a disease or an insect problem. Sometimes, in the case of a number of turfgrass diseases, a primary cause of disease infestation is a lack of proper fertilizer. A fertilizer-insecticide combination will do an adequate job of controlling a turf pest plus give the grass "a shot in the arm" and help it in its recovery.

Fertilizer Formulation

Fertilizers come in many shapes and sizes. The type or form the fertilizer comes in is called the formulation. Different formulations are made to facilitate types of situations in which fertilizer is needed. All formulations must give the amount of nutrients and sometimes it tells how quickly a nutrient is available. Some of the formulations available to the homeowner include: water soluble powders, slow release pellets, slow release collars or spikes, liquids, tablets, and granular solids.

Liquid fertilizers come in a variety of different formulations, including complete formulas and special types that offer just one or two nutrients. All are made to be diluted with water; some are concentrated liquids themselves, others are powder or pellets. Growers of container plants often use liquid fertilizers at half the recommended dilution twice as frequently as recommendations suggest so that the plants receive a more steady supply of nutrients.

Applying Fertilizer

Computing the amount of fertilizer needed for a given area is rather tricky at first, but after a few times the logic falls into place and becomes second nature. The following are some examples of fertilizer determinations for lawns and gardens.

Example 1. Determine the amount of ammonium sulfate a 5000 square foot lawn needs if the lawn requires 1 pound of nitrogen per 1000 square feet.
Lawn: 5000 square feet
Fertilizer: ammonium sulfate (21-0-0)
Rate: 1 pound of nitrogen per 1000 square feet
(1) Ammonium sulfate is 21 percent nitrogen (round to 20 percent)
(2) 20 percent is the same as 0.20 or 1/5th
(3) This means for every 5 pounds of fertilizer there is 1 pound of nitrogen so 5 pounds of fertilizer = 1 pound nitrogen
(4) We need 1 pound nitrogen every 1000 square feet
Since: 1 pound N = 5 pounds fertilizer
5 pounds fertilizer = 1 pound nitrogen per 1000 square feet.
(5) We are fertilizing 5000 square feet (5 x 1000 square feet) 5 x 5 pounds of fertilizer = 25 pounds fertilizer per 5000 square feet.

$$\text{Total Fertilizer Needed} = \frac{\text{N application rate (lb/1000 sq. ft.)}}{\text{N content of fertilizer as a decimal}} \times \frac{\text{lawn size sq. ft.}}{1000} = \frac{1}{0.20} \times \frac{5000}{1000} = \frac{5}{0.20} = 25 \text{ lb. Fertilizer}$$

Example 2. Determine how much 20-10-5 needs to be applied to get 2 pounds of phosphorus per thousand square feet in a garden that measures 20 x 10 feet.
Garden: 20 x 10 = 200 square feet
Fertilizer: 20-10-5 = 10 percent phosphorus
Rate: 2 pounds of phosphorus per 1000 square feet

$$\text{Total N Needed} = \frac{\text{2lb. Phosphorus}}{0.10} \times \frac{200}{1000} = \frac{2}{0.10} \times \frac{200}{1000} = 20 \times 0.20 = 4 \text{ lb. 20-10-5}$$

Recommendations for fertilizing vegetables are usually given in the following words: "Apply 3 to 4 pounds of 5-10-10 fertilizer per 100 square feet of garden space." All that is fine, as long as you are using a 5-10-10 formula. If the fertilizer you want to use has a different formula, say one with a higher nitrogen content as indicated by the first number in the formula, the rate of application should be reduced to avoid nitrogen burn. A high phosphorus fertilizer such as 6-18-6 is often recommended for vegetables as a starter food. In the following chart you see how the amount to be applied decreases as the percentage of nitrogen decreases the percentage of nitrogen is indicated by the first number in each series:

Formula	Pounds per per 100 square feet
5-10-10	3.5
6-18- 6	2.8
8-12- 4	2.0
12- 6- 6	1.4
16-16-16	1.0

Nitrogen fertilizers do not burn or damage plants if they are applied correctly. Fertilizers are salts, much like our familiar table salt except that they contain various plant nutrients. When a fertilizer (salt) is applied to a soil, nearby water begins to move very gradually towards the area where the fertilizer has been applied. Salts and the fertilizer begin to diffuse or move away from the place where they had been applied. This dilutes the fertilizer and distributes it through a much larger area. If tender plant roots are close to the placement of a fertilizer, water is drawn from these roots, as well as surrounding soil. The more salt or fertilizer applied, the more water is drawn from nearby roots. As water is drawn from the roots, plant cells begin to dehydrate and collapse and the plant roots burn or dehydrate to a point where they cannot recover. If soil moisture is limited, most of the water drawn towards the salt will come from plant roots and the damage will be severe.

Two rules should be kept in mind when applying a fertilizer during hot weather when soil moisture is limited: 1) do not over apply nitrogen fertilizers and 2) make sure adequate moisture is present after applying fertilizers high in salts. The following table is a chart of commonly used garden fertilizers high in salt content or burn potential. The last column is the practical measure of relative saltiness. A higher number indicates greater saltiness.

Material	Nutrient Level	Relative Saltiness Per Weight Of Nutrient
Ammonium nitrate	33 percent Nitrogen	1.49
Ammonium sulfate	21 percent Nitrogen	1.63
Potassium nitrate	14 percent Nitrogen	2.67
Natural Organic Fertilizer	5 percent Nitrogen	0.40
Urea formaldehyde	38 percent Nitrogen	0.13
Urea	45 percent Nitrogen	0.81
Superphosphate	20 percent Phosphorus	0.20
Potassium Chloride	60 percent Potash	0.87
Potassium Sulfate	50 percent Potash	0.43
Dolomite	30% Calcium, 20% Magnesium	--
Gypsum	33 percent Calcium	0.12
Epsom salts	16 percent Magnesium	1.38

Soluble salts will accumulate on top of the soil in a container and form a yellow to white crust. A ring of salt deposits may form around the pot at the soil line or around the drainage hole. Salts will also build up on the outside of clay pots.

Soluble salts build up when fertilizer is applied repeatedly without sufficient water to leach or wash the old fertilizer or salts through the soil. It also occurs when water evaporates from the soil and minerals or salts stay behind. As the salts in the soil become more and more concentrated, plants find it harder and harder to take up water. If salts build up to an extremely high level, water can be taken out of the root tips causing them to die.

Soluble salts problems commonly occur on plants in containers but are rarely a problem in the garden. The best way to prevent soluble salt injury is to stop the salts from building up. Water correctly. When water is applied, allow some water to drain through and then empty the drip plate. Water equal to one-tenth the volume of the pot should drain through each time you water. Do not allow the pot to sit in water. If you let the drained water be absorbed by the soil, the salts that were washed out are taken back into the soil. Salts can be reabsorbed through the drainage hole or directly through a clay pot.

Pot plants should be leached every 4 to 6 months. Leach a plant before fertilizing to avoid washing away all newly added fertilizer. Leaching is done by pouring a lot of water on the soil and letting it drain completely. The amount of water used for leaching should equal twice the volume of the pot. A 6 inch pot will hold 10 cups of water so 20 cups of water are used to leach a plant in a 6 inch pot. Keep the water running through the soil to wash the salts out. If a layer of salts has formed a crust on top of the soil, you should remove the salt crust before you begin to leach. Do not remove more than 1/4 inch of soil. It is best not to add more soil to the top of the pot. If the soluble salt level is extremely high or the pot has no drainage, repot the plant.

The level of salts that will cause injury varies with the type of plant and how it is being grown. A plant grown in the home may be injured by salts at concentration of 200 ppm. The same plant growing in a greenhouse where the light and drainage are good will grow with salts 10 times that level, or 2000 ppm. Some nurseries and plant shops leach plants to remove excess salts before the plant is sold. If you are not sure that has been done, leach a newly purchased plant the first time you water it.

Timing of Fertilizer Application

Soil type dictates the frequency of fertilizer application. Sandy soils require more frequent applications of nitrogen and other nutrients than clay type soils. Other factors affecting frequency of application include the crop being grown and what we want the crop to do, frequency, and amount of irrigation or water applied, and type of fertilizer applied and its release rate.

The crop influences timing and frequency of application since some crops are heavier feeders of some nutrients than others. Root crops require less nitrogen fertilization than leafy crops. Corn is a heavy feeder of nitrogen while most trees and shrubs are generally light feeders. Corn may require nitrogen fertilization every four weeks while most trees and shrubs perform nicely with one good, well-placed application every year. A general rule of thumb is that nitrogen is for leafy top growth; phosphorus is for root and fruit production; and potassium is for cold hardiness, disease resistance, and general durability.

Proper use of nutrients can control plant growth, rate, and character. Nitrogen is the most critical nutrient in this regard. If tomatoes are fertilized heavily with a nitrogen fertilizer into the summer, the plants may be all vine and no fruit. This is also the case with potatoes which will show excess vining and poor tuber formation. If slow release fertilizers or heavy amounts of manure are used on crops that form fruit or vegetables, it will keep the plant producing leaf or vine growth and fruit or vegetable development will occur very late in the season.

Remember that a nitrogen application will have its greatest effect for three to four weeks after application. If tomatoes are fertilized heavily on June 1, there may be no flower production until July 1 which will delay fruit ripening in late August. For this reason it is important to plant crops with similar fertilizer needs close together to avoid improper rates of application.

Late fertilization (after July 1) of trees and shrubs can cause new flushes of growth to occur on woody plants that are normally adjusting themselves for the coming winter. This may delay dormancy of woody plants and cause severe winter dieback in new growth.

The following suggestions about groups of garden plants are given as general guides. Gardeners should be aware that individual species within these groups vary considerably. After each group of plants, the need for the primary nutrients (nitrogen, phosphorus, and potassium) is indicated as high, medium or low.

Vegetables	High
Herbs	Medium to Low
Lawns	Medium to High
Fruits	Medium
Annual flowers	Medium
Perennial flowers	Medium to Low
Deciduous shrubs	Medium to Low
Evergreen shrubs	Low
Deciduous shade trees	Medium to Low
Evergreen shade trees	Low

Application Methods

There are different methods of applying fertilizer depending on the formulation and the crop needs.

Broadcasting A recommended rate of fertilizer is spread over the growing area and left to filter into the soil or incorporated into the soil with a rototiller or spade. Broadcasting is used over large garden areas or when time or labor is a limitation.

Banding Narrow bands of fertilizer are applied in furrows 2 to 3 inches from the garden seeds and 1 to 2 inches deeper than the seeds or plants that are to be planted. Careless placement of the fertilizer band too close to the seeds will burn the roots of the seedlings. The best technique is to stretch a string where the seed row is to be planted. With a corner of a hoe, dig a furrow 3 inches deep, 3 inches to one side of, and parallel with the string. Spread the fertilizer in the furrow and cover with soil. Repeat the banding operation on the other side of the string, then sow seeds underneath the string.

For plants widely spaced, such as tomatoes, fertilizers can be placed in bands 6 inches long for each plant or in a circle around the plant. Place the bands 4 inches from the plant base. If used in the hole itself, place the fertilizer at the bottom of the hole, work it into the soil, place a layer of soil about 2 inches deep over the fertilized soil and then put the plant in the hole.

Banding is one way to satisfy the need of many plants (especially tomatoes) for phosphorus as the first roots develop. When fertilizers are broadcast and worked into soil, much of the phosphorus is locked up by the soil and is not immediately available to the plant. By concentrating the phosphorus in the band, the plant is given what it needs even though much of the phosphorus stays locked up.

Starter Solutions Another way to satisfy the need for phosphorus when setting out transplants of tomatoes, eggplant, peppers or cabbage is through the use of a liquid fertilizer high in phosphorus as a starter solution. Follow directions on the label.

Side Dressing Dry fertilizer is applied as a sidedressing after plants are up and growing. Scatter fertilizer on both sides of the row 6 to 8 inches from the plants. Rake it into the soil and water thoroughly.

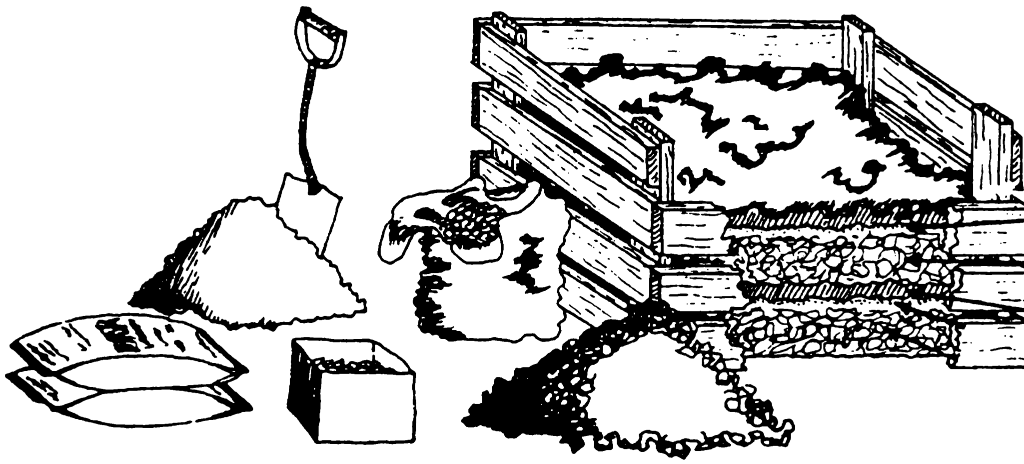
Foliar Feeding Used when insufficient fertilizer was used before planting; a quick growth response is wanted; micronutrients (such as iron or zinc) are locked into the soil; or when the soil is too cold for the plants to extract or use the fertilizer applied to the soil. Foliar applied nutrients are absorbed and used by the plant quite rapidly. Absorption begins within minutes after application and, with most nutrients, it is completed within 1 to 2 days. Foliar nutrition can be a supplement to soil nutrition at a critical time for the plant, but not a substitute. At transplanting time, an application of phosphorus spray will help in the establishment of the young plant in cold soils. For perennial plants, early spring growth is usually limited by cold soil, even when the air is warm. Under such conditions, soil microorganisms are not active enough to convert nutrients into forms available for roots to absorb; yet, if the nutrients were available, the plants could grow. A nutrient spray to the foliage will provide the needed nutrients immediately to the plants, allowing them to begin growth.

IMPROVING SOIL STRUCTURE

In special cases, coarse sand, vermiculite and perlite are added to heavy clays to help improve the soil texture or structure. However, these inert materials can be expensive and large quantities are needed to do any good. In some cases they can make the situation worse by causing clays to "set up" similar to concrete. Compost, manures and other organic amendments are usually more effective and economical for modifying the soil structure.

Organic matter is a great soil improver for both clay and sandy soils. Good sources of organic matter include manures, leaf mold, sawdust, and straw. These materials are decomposed in the soil by soil organisms. Various factors, such as moisture, temperature, and nitrogen availability determine the rate of decomposition through their effects on these organisms. Adequate water must be present, and warm temperatures will increase the rate at which the microbes work. The proper balance of carbon and nitrogen in the material is needed for rapid decomposition. The addition of nitrogen may be necessary if large amounts of undecomposed high-carbon substances such as dried leaves, straw, or sawdust are used. Fresh green wastes, such as grass clippings, are higher in nitrogen than dry material. Nitrogen is used by the microbes in the process of breaking down the organic matter and may cause a nitrogen diffficency in the plants by using up the available nitrogen, if it is not present in sufficient amounts.

BUILDING A COMPOST PILE



The use of compost is one way to get around the tying up of nitrogen during decomposition. Compost is usually made by the gardener from plant wastes. Correct composting is an art which can result in a valuable nutrient and humus source for any garden. The basis of the process is the microbial decomposition of mixed raw organic materials to humus, a dark, fluffy product resembling rich soil, which is then spread and incorporated into the garden soil.

Start your compost pile with a 3-inch layer of coarse plant material such as small twigs or chopped corn stalks. This will aid in aeration and drainage. On top of this, put a layer of plant and kitchen refuse - leaves, straw, weeds, waste from garden plants, husks, coffee grounds, crushed egg shells, canning wastes, etc. It is a good idea not to use meat wastes because they will attract digging animals. Next, add a layer of nitrogen-rich material. This can be fresh manure if available, fresh grass clippings (not too thick a layer, as they will mat) or fresh hay. If you don't have enough nitrogenous materials, there will not be enough nitrogen for the microorganisms to make proteins. Add more in the form of synthetic nitrogen fertilizer (1/2 cup 10-10-10 per 6" layer will do), blood meal (also 1/2 cup per 6" layer), or cottonseed meal (1 cup per 6" layer). The latter two are expensive if purchased in the typical five-pound bags available in garden centers, but cottonseed meal can be found at a very reasonable price if purchased in bulk at a farm supply store.

If a more alkaline compost is desired, add 1 pint of ground limestone per square yard of surface area. Liming will also help reduce odors and keep compost "sweet."

It was formerly recommended that a 1" layer of soil be added for each 6" layer of plant wastes to supply microorganisms for the composting process, but research has shown that this is not necessary under certain conditions. Enough soil is generally included on roots of plants and in manure to inoculate the compost pile. Compost "starters" are also unnecessary. If the wastes are free of soil for the most part, however, a sprinkling of soil or a starter at each layering may be beneficial.

Repeat the layers of plant material and nitrogenous material as many times as needed to use all the plant refuse you have available. If you are using a ready-made composter, follow the manufacturer's instructions. The top of the pile should be low in the center to cause water to move into the pile rather than to run off.

Water the pile as often as necessary to keep the contents moist, but not soaking wet. Within a few days, the pile should heat up significantly, to about 160 degrees F. This temperature will kill many weed seeds and harmful organisms, and is a necessary stage in composting. If the pile fails to heat (like grass clippings do when left in the sun in a black plastic bag), there is not enough nitrogen in the pile (or perhaps not enough moisture), and more should be added. The pile will also decrease in size after a few weeks if it is composting properly.

If you smell ammonia it may mean that the materials in the pile are too tightly packed or that the pile is too wet; i.e., there is not enough air. Turn the heap, adding some coarser material, and start over.

The pile should be forked over after about a month (two weeks if the material is shredded), putting the outside materials on the inside and vice versa to make sure everything gets broken down. Turn again 5-6 weeks later. The plant materials should decompose into good compost in about 4 or 5 months in warm weather, but may take longer under cool or dry conditions. Composting may be completed in 1 or 2 months if the materials are shredded, kept moist, and turned several times to provide good aeration.

When compost is finished it will be black and crumbly, like good soil, with a pleasant, earthy smell. Only a few leftover corncobs or stalks will remain undecayed. These can be sifted out and added to the next batch. For use in potting mixtures, a relatively fine sieve (1/4" hardware cloth) will take out the larger chunks. Otherwise, the compost can be spread in the garden as it is and dug or tilled under.

If you need only a small amount of compost, you can use a plastic trash bag to compost relatively fine material such as leaves, lawn clippings or chopped garden refuse. Make layers as in a compost pile, or mix all materials together. Add 2 quarts of water to dry material (one quart if it is quite moist or succulent). Tie the bag and turn it over every few weeks to aerate the material and distribute the moisture.

Another source of inexpensive soil improvement that should not be underestimated is the cover crop. Green manures, or cover crops, such as annual rye or ryegrass are planted in the garden in the fall for incorporation in the spring. For best results, seed should be sown a little before the first killing frost. In a fall garden, plant cover crops between the rows and in any cleared areas. Cover cropping provides additional organic matter, holds nutrients that might have been lost over the winter, and helps reduce erosion and loss of topsoil. Legume cover crops can increase the amount of nitrogen in the soil and reduce fertilizer needs. A deep-rooted cover crop allowed to grow for a season in problem soil can help break up a hardpan and greatly improve tilth. Incorporate green manures at least two weeks before planting vegetables. They should not be allowed to go to seed.

The regular addition of manures, compost, cover crops and other organic materials can raise the soil nutrient and physical level to a point at which the addition of synthetic fertilizers is greatly reduced. This highly desirable soil quality does not come about with a single or even several additions of organic material, but rather requires a serious soil-building program.

SOIL TESTING

The purpose of a soil test is to supply the homeowner with enough information to make a wise fertilizer purchase. A soil test from Virginia Polytechnic Institute And State University will provide information on soil textue, pH, salt content, lime content, and available phosphorus and potassium. The results of the soil test are mailed to the homeowner with recommendations as to what kind of fertilizer should be applied for economical growth of the desired crop. Soil tests should be performed if such tests have never been done before. A soil test need not be performed more often than every 3 to 4 years. The sample should be submitted in the fall prior to planting or tilling so that needed lime can be changing the pH over the winter. Fertilizers should be incorporated the next spring.

The accuracy of the soil test is a reflection of the sample taken. Be sure the sample is representative of the area to be treated. Sample the soil from 10 random areas of the garden to a depth of 6-12 inches. Avoid sampling unusual areas such as those near gravel roads, manure or compost spots, brush piles or under eves. Place the samples in a clean pail or container and mix the soil thoroughly transfer a pint of mixed soil to a container and transport it to the County Extension Office

TURF

TURF

prepared by
John R. Hall III, Extension Agronomist, Turf
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INTRODUCTION

Producing quality lawns in Virginia can be challenging. Geographically, Virginia is located in what is known as the transition zone. This means the climate is hostile to both cool-season grasses and warm-season grasses. However, with proper cultural practices, a good lawn can be established and maintained.

ESTABLISHING A NEW LAWN

Basic Requirements

Turf may be established from seed, or vegetatively from sprigs, plugs, or sod. The method depends on the type of grass desired, and on the environmental situation, on time limitations and financial considerations.These factors are discussed more in the section on Seed vs. Sod. The same basic requirements for lime, fertilizer, and seedbed preparation apply for both seeding and vegetative establishment. After the new lawn is established and growing well, begin a good comprehensive maintenance program to keep it healthy and attractive looking.

<u>Soil Test</u> The first step in establishing a new lawn is to have the soil tested. Test results will determine which basic nutrients are available in the soil, and will provide recommendations for lime and fertilizer. Forms and sample boxes, along with instructions for obtaining good samples, are available from your Extension Office. A separate sample should be taken for each different lawn area. For the average yard, this means one sample from the front and one from the back. Large yards with widely varied conditions may require more samples. There is no need to sample more areas than you are willing to treat individually.

<u>Pre-plant Weed Control</u> Observe the topsoil or lawn area to be planted and determine if there are weeds present that should be controlled prior to planting. Grassy weeds that are particularly troublesome in lawns of Kentucky bluegrass, perennial ryegrass or creeping red fescue lawns are: Johnsongrass, Quackgrass, Tall fescue, orchardgrass or bermudagrass. These weeds can be controlled prior to planting by properly applying herbicides.

Controlling troublesome perennial broadleaf weeds prior to establishment can be beneficial. For further detail about broadleaf weed control, request Virginia Tech Publication, "Lawn Weed Control" from your Cooperative Extension Office.

<u>Pre-Plant Installation of Irrigation and Drainage</u> If possible, irrigation systems and drainage tiles should be installed prior to topsoil application, to avoid contamination of topsoil with subsoil. Stockpiling of topsoil is advisable if considerable subsoil grading is necessary.

<u>Soil Preparation</u> Remove building debris and other trash from the lawn area during all stages of construction. Such material causes mowing hazards, encourages short root systems, and rotting woody material is often the host for "Fairy Ring" diseases. The subgrade should be sloped away from the house, and the area should be allowed to settle for two or three weeks before seeding or sodding. Several wetting and drying cycles will aid settling and help you to locate low spots in the lawn which should be filled. Topsoil depth should be a minimum of 6 to 8 inches.

The significant contributions of Larry Lilly, Arlington County Master Gardener, to the original publication of this material are gratefully acknowledged.

Lime Soils in most areas of Virginia are acid, and enough lime will be recommended by the soil test to raise the soil pH to 6.2. About 100 pounds of limestone per 1000 square feet raises the pH about one unit on loamy soils; sandy soils require less, and clay soils require more. The lime should be tilled into the soil to a depth of four to six inches.

Fertilizer In the absence of a soil test, apply the following nutrients per 1000 square feet prior to turf establishment, and incorporate into the soil to a depth of four to six inches:

1 1/4 to 2 1/2 lbs. of Actual Nitrogen (N)
3 1/2 to 5 lbs. of Phosphate (P_2O_5)
2 to 3 1/2 lbs. of Potash (K_2O)

Examples of complete fertilizers that furnish nutrients within acceptable ranges are:

50 lbs. of 5-10-5 per 1000 square feet
or
25 lbs. of 10-20-10 per 1000 square feet
or
25 lbs. of 5-20-10 per 1000 square feet

Materials which contain a single major nutrient such as 0-48-0, or 0-0-60 can also be used. There are many types of fertilizer available that can provide the proper amount of nutrients. It is often beneficial to incorporate about 2/3 of the recommended amount of fertilizer and apply 1/3 to the surface just prior to seeding. The surface applied portion should be raked into the top 3/4 inch of soil.

Establishment Methods

When to Establish Seed will germinate only under proper conditions. There are certain periods each year when temperature, moisture and day length are most favorable for establishing turfgrasses. Late summer seedings are preferred for cool-season species such as Kentucky bluegrass or tall fescue. Early spring seedings may also bring good results. In Northern Virginia and the area of Western Virginia at lower elevations, the best seeding dates are mid to late March for spring seeding, and the last week of August to mid-September for fall seeding. It may be possible to get good results as late as the middle of October for fall seeding. At higher elevations in Western Virginia the best seeding dates are April and early May in the spring and mid August to mid September in the fall. In Southside and Southeastern Virginia February 15 to March 30 are the best spring dates. In the fall, September 15 to October 15 is most suitable.

Sod of Kentucky bluegrass and tall fescue can be installed during most of the year except in mid-winter when the ground is frozen. When extreme heat and drought conditions exist in summer, sodding operations should be delayed. If done under drought conditions, the turf must be kept moist and cool. The soil should be watered enough to cool it prior to installation, and again thoroughly watered as the sod is laid. Improved strains of warm-season grasses such as zoysiagrass and bermudagrass, which are normally sprigged or plugged, should be established during May after the soil is warm. May and June planting will have the greatest chance of surviving the first winter. However, these grasses have been successfully planted as late as July. Late summer plantings are not recommended because there is not sufficient time for proper establishment before cold weather.

Seed vs. Sod A quality lawn containing the recommended mixtures of grass varieties and species can be established with either seed or sod. Both seed and sod of recommended varieties are available, and the soil preparation for the two methods does not differ.

Initially, seed is less expensive than sod. However, successful establishment is more risky with seed than with sod, and if reseeding of certain areas or even an entire lawn is necessary, the overall expense may be less with sod. Also, because of the time required for seed to germinate and become well rooted in the soil, the area is exposed to excessive erosion and sedimentation. Sodding practically eliminates such problems, a consideration which may be especially important on steep hills or banks.

Sodding provides an immediately pleasing turf that will successfully compete with viable weed seed already present in the soil. When using seed, an intensive weed control program may be necessary to reduce weed competition.

Whereas seed should be established only in the early fall or early spring, sod offers less time limitations in that it may be established in nearly any season.

Seeding and Mulching A well prepared seedbed is essential for the establishment of turfgrasses. The seedbed should be tilled to a depth of six inches if possible, and lime and fertilizer worked into the soil prior to seeding. Prepare a smooth, firm seedbed; then divide the seed and sow in two directions, perpendicular to each other. If low rates of seed are being sown, mixing sawdust or other suitable material with the seed aids in obtaining uniform coverage. Cover the seed by raking lightly and rolling. Avoid a smooth surface. A finished seedbed should have shallow uniform depressions (rows) about one half inch deep and one to two inches apart such as are made by a corrugated roller.

Mulch the area with straw or other suitable material so that approximately 50 to 75 percent of the soil surface is covered. This is normally accomplished by spreading 1 1/2 to 2 bales of straw per 1000 square feet. A light mulch does not need to be removed after establishment, however, a heavy mulch should be removed when the seedlings are about 2 inches tall. Avoid damaging the young seedlings during mulch removal.

Sodding Soil preparation should be similar to that described for seeding, but one must take care not to disturb the prepared soil to the extent that deep footprints or wheel tracks exist. These depressions restrict root development and give an uneven appearance to the installed sod. During hot summer days, the soil should be dampened just prior to laying the sod. This avoids placing the turf roots in contact with an excessively dry and hot soil.

Premium quality sod is easier to transport and install than inferior grades. Such sod is light, does not tear apart easily, and quickly generates a root system into the prepared soil. Before ordering or obtaining sod, be sure you are prepared to install it. Sod is perishable, and should not remain on the pallet or stack longer than 36 hours. The presence of mildew and distinct yellowing of the leaves is usually good evidence of reduced turf vigor.

To reduce the need for short pieces when installing sod, it is generally best to establish a straight line lengthwise through the lawn area. The sod can then be laid on either side of the line with the ends staggered as when laying bricks. A sharpened masonry trowel is very handy for cutting pieces, forcing the sod tight, and leveling small depressions. Immediately after the sod is laid, it should be rolled and kept very moist until it is well-rooted in the soil.

Plugging and Spraying The best quality zoysiagrass and bermudagrass must be vegetatively established, using either plugs or sprigs. Again, the soil should be prepared as described for seeding.Plugs of zoysiagrass are commonly available, and are one to two inches in diameter and one to two inches deep. The plugs should be fitted tighty into prepared holes and tamped firmly into place.Sprigs can be either broadcast over an area and covered lightly with soil by discing, or can be planted in rows on six to twelve inch centers. In either case, the sprig should promote rooting at the nodes. Sprigs can be purchased as sod and then shredded, or can often be purchased by the bushel. One bushel of sprigs is approximately equivalent to one square yard of sod.

Post-Planting Irrigation

New seedings and spriggings require intensive irrigation to insure successful establishment. Seedings require light, frequent watering to insure the seed and surface of the soil are constantly moist. Plan to keep the soil moist for 30 days following planting. During hot days this may necessitate 3 or 4 light waterings during the day to insure moisture for rapid and successful germination. If the soil dries out during the germination process, the seeding is likely to die. Areas sodded and plugged also require intensive irrigation. However, frequent light watering is not as helpful as daily, heavy irrigation to ensure the soil beneath the sod or plug is moist to a six inch depth.

RENOVATING AN OLD LAWN

A lawn of less than satisfactory appearance, but fair condition, may be renovated without having to completely rebuild it. Advantages of renovation include less expense and mess, since minimum tilling of the soil is required. The lawn will be able to take light traffic during the renovation period. If the lawn is extremely poor in quality, badly infested with weedy grasses, or if the soil has low fertility or the grade is very uneven, complete re-establishment may be a better choice. This section will outline the basic steps in renovating a lawn.

Basic Steps in Lawn Renovation

Determine Cause of Poor Quality Lawns usually require renovation because of one or more of the following reasons: poor fertilization practices; inadequate drainage; excessive traffic; poor selection of a grass variety; weed invasion; drought; insect or disease damage; or excessive shade.

Have Soil Tested The soil analysis will help to determine lime and fertilizer needs. Ideally, the soil should be tested early enough so that results will be back before the lawn renovation is started.

Remove Weeds and Undesirable Grasses If possible, plan a year ahead to bring broadleaf weeds under control; this way they will not compete with the new grass you are trying to establish. If you have not been able to plan this far ahead, apply broadleaf weed control thirty days prior to verticutting and seeding. If perennial weedy grasses are present, these should be controlled with a nonselective herbicide. Follow label directions closely.

Dethatch if Necessary Cut grooves in the soil so that seed can make good soil contact. Seed planted on top of the thatch layer is largely wasted since thatch is a buildup of old grass clippings and undecomposed organic matter grass debris. Due to the high cellulose content of grass, it is slow to decay and forms a semi waterproof mat between the soil and grass leaves If you have low spots in the lawn, they can be filled and leveled at this time with good topsoil.

Apply Lime and Fertilizer Consult soil analysis recommendations.

Sow the Seed Divide the seed and sow it in perpendicular directions. Then rake or drag it in lightly.

Apply Crabgrass Control This is necessary if seeding is done in the spring and the area has a history of crabgrass. The only material that will kill the crabgrass and allow the seed that you have planted to germinate is a preemergence herbicide, called Siduron. Follow label directions closely.

Water Consistently As outlined in the lawn establishment section, water lightly every day until the seed has germinated, and then water less frequently but more deeply to keep the soil moist until new grass is established.

Maintenance To keep newly renovated lawn healthy and attractive, begin a good comprehensive lawn maintenance program.

RECOMMENDED TURFGRASS VARIETIES FOR VIRGINIA

Cool and Warm Season Grasses

Turfgrass varieties fall into two basic categories: cool-season and warm-season grasses. Cool-season grasses, such as Kentucky bluegrass, tall fescue and perennial ryegrass, have a long growing season in most areas of Virginia and provide an attractive winter color. Warm-season grasses such as zoysiagrass and bermudagrass go dormant after the first hard frost, and stay brown through the winter months. Zoysiagrass greens up around mid-May in the Washington area. While the winter color of the warm-season grasses may make them less desirable, maintenance costs are somewhat reduced since water requirements are less and the shorter growing season requires less mowings per year.

The Virginia-Maryland labeling system has been developed to promote quality turfgrass seed. It simplifies the purchase of quality seed by circumventing the need to study the seed label. The consumer can simply look for the appropriate label.

The following recommendations are developed from research conducted in Virginia and Maryland. Turf and seed specialists from the University of Maryland, the United States Department of Agriculture and Virginia Tech concur in making these recommendations.

Kentucky Bluegrass Best suited to areas in and west of the Blue Ridge Mountains and north of Richmond; it provides lush, green, fine bladed lawns. However, in the transition zone it may require irrigation in the summer to keep it from going into summer dormancy. It does not perform well in shady conditions or on poor soil. Kentucky bluegrass is best suited to a well-drained soil and moderate to high levels of sunlight and management. It can be established from seed or sod.

Mixtures or blends of Kentucky bluegrass varieties are recommended in Virginia as it is thought they are more likely to provide good quality turf over a wide variety of management situations. There are two catagories of mixtures.

When seeding a mixture of Category I seed, individual varieties should make up no less than 10 percent nor more than 35 percent of the total mixture by weight. Bluegrass mixtures madeup of varieties from Category I may be 100 percent bluegrass or if mixed with Category II seed, as little as 65 percent bluegrass. Category II varieties include Kentucky bluegrass and other grass species that can be blended for use in special situations. They are to be mixed with Category I varieties at the rate of 10 to 35 percent. The exception is perennial ryegrass which is mixed at the rate of 10 to 15 percent, by weight, with bluegrass.

Category I - Recommended Kentucky bluegrass varieties (65 to 100%)

Adelphi, America, Aspen, Bristol, Cheri, Columbia,Eclipse, Enmundi, Georgetown, Glade, Majestic, Merit, Merion, Midnight, Parade, Plush, Ram I, Rugby, Sydsport, Victa

Category II - Special use varieties (10 to 35%)

Shade Tolerant:
Bristol, Columbia, Eclipse,Enmondi, Georgetown, Glade, Midnight, Sydsport,Touchdown and/or Pennlawn Creeping Red Fescue

Low Maintenance Tolerant:
Columbia, Emmundi,Escort, Georgetown, Holiday, Kenblue, Monopoly, Shasta, South Dakota Certified, Vantage, Victa, Wabash and/or Pennlawn Creeping Red Fescue (Pennlawn is not to exceed 20% by weight of the mixture.)

Where erosion is a concern or seedings are being made outside of recommended dates, the addition of certified perennial ryegrass to the Kentucky bluegrass mixture at one quarter pound per 1000 square feet is recommended.

Perennial ryegrasses for blending with bluegrass: (10 to 15%)
Birdie, Blaser, Citation, Dasher, Derby, Diplomat, Fiesta, Pennfine,Palmer, Ranger, Regal

Categories I and II Seeding Rates: 2 to 3 lbs per 1000 square feet.

<u>Tall Fescue</u> Tall fescue is a moderately coarse-textured turfgrass which is tolerant of a wide range of soil types and climatic extremes. It is best suited to areas where low to moderate management levels are provided, and can be established from seed or sod.

Tall fescue does not have the recuperative potential of Kentucky bluegrass, since it does not spread by rhizome action. Therefore, infrequent overseeding may be necessary in tall fescue lawns.

The new fine-bladed tall fescues such as Adventure, Apache, Arid, Falcon, Hounddog, Jaguar, Mustang, Olympic, and Rebel, have received much publicity and though they are finer bladed than Kentucky 31 they are not as fine as Kentucky bluegrass.

Of the varieties listed below, tall fescue may be planted without mixing or may be mixed with Kentucky bluegrass in a 90/10 ratio which should be seeded at rate of 4 to 6 pounds per 1000 square feet.

90-100% Certified Adventure, Apache, Arid, Falcon, Houndog, Jaguar, Kentucky 31, Mustang, Olympic or Rebel

0-10% Baron,Enmundi, Eclipse, Kenblue*, Ram I, South Dakota Certified* and Victa Kentucky bluegrass

*Not recommended for use with the fine-bladed tall fescues

Creeping Red, Hard and Chewing Fescues. These grasses are known collectively as the fine fescues. As a group of grasses, they exhibit shade, drought, low nitrogen and acid soil tolerance. They perform best in shady lawns in mixtures with shade tolerant Kentucky blue grasses as noted earlier. They are generally susceptible to Helminthosporium, leaf and crown rot diseases.

Perennial Ryegrasses In recent years there has been a tremendous increase in the use of the improved perennial ryegrasses. They produce medium textured lawns due to their blade width, and blend well with Kentucky bluegrass. Some strengths of the perennial ryegrasses are their quick germination and establishment rate, good traffic bearing characteristics, and early spring green up. However, they tend to be susceptible to disease in hot weather and exhibit poor heat tolerance. At present, perennial ryegrasses are not capable of providing the level of season-long quality we associate with a good Kentucky bluegrass mixture. They are best utilized in mixtures with Kentucky bluegrass as noted earlier.

Zoysiagrass Zoysiagrass is a warm-season grass of fine to medium texture that turns brown with the first hard frost in the fall, and greens up about mid-May. It does well in full sun, and is not suitable for shady areas. It can be established from sod, plugs, or sprigs; however, its rate of establishment from plugs or sprigs is extremely slow.

Meyer Zoysia (*Zoysia japonica* Steud.) has moderate density and medium blade width with good cold tolerance.

Emerald Zoysia (*Zoysia matrella* L. Merr.) has a higher density and a finer blade width than Meyer Zoysia. It has less cold tolerance than Meyer and should only be recommended in central and southern Virginia.

Planting Rate: 2" diameter plugs on 8 to 12" centers or sprigs broadcast at 5 to 7 bushels per 1000 square feet will require 2 to 3 growing seasons for 100% cover.

Planting Dates: May 1 to July 15

Bermudagrass Bermudagrass is a fine bladed warm season grass. It is not commonly used or recommended for home lawns in the Northern Piedmont and areas in and west of the Blue Ridge due to lack of winter hardiness. Bermudagrass can be established by sod, sprigs or plugs.

Purchasing Quality Seed

The purchase of lawn seed is a long term investment, and the seed you buy will influence your success in developing a beautiful lawn. It is not possible to evaluate the quality of seed by looking at it. Information that will help you make a wise choice is printed on seed packages.

There are differences in lawn seed, and it pays to compare. The price you pay for seed will represent only a small portion of the total cost of planting, fertilizing, mowing, etc. Don't let low cost be the only factor you use when selecting lawn seed. Choose those varieties that have been tested and have proven to be best suited for your area of Virginia.

Virginia has a seed label law that is basically a truth in labeling law. The seed contained in the package is not required to perform according to standards established by law; but, the label on the package must include an analysis of the seed it contains. This analysis enables the purchaser to determine the kind of seed contained in the package, to estimate how well it should perform, and to compare its cost effectiveness with other brands.

Analysis A sample seed label looks like this:

```
Kind: KY bluegrass            Variety: Merion
Pure Seed: 96%                Germination 85%
Inert Matter 3%               Date of Test 4/84
Other Crop Seed: 0.7%
Weed Seed 0.3%                Lot # - 1A
Noxious Weeds: 120 Annual Bluegrass per lb
John Doe Seed Co., Richmond, VA.
```

Germination - The percentage of viable (live) seed. The date of test should have been within the previous 12 months.

Pure Seed - The percentage (by weight) that is actually seed of the crop specified.

Inert Matter - The percentage (by weight) of chaff, dirt, trash, and anything that is not seed.

Weed Seeds - The percentage (by weight) of all weed seeds in the sample and the number of noxious weed seeds present. If possible, avoid seed lots with noxious weeds.

Other Crop Seeds - The percentage (by weight) of crop seed other than the crop specified. For example, in tall fescue, this includes orchardgrass and ryegrass. In Kentucky bluegrass it can include bentgrass, ryegrass, tall fescue or perennial ryegrass contaminants.

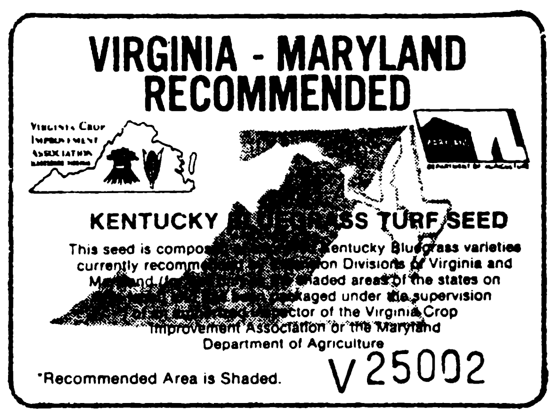
Cost Effectiveness When considering seed lots of similar quality, compare the amount of Pure Live Seed (PLS) in the package. The only thing you really want to pay for is seed that will grow. To determine the amount of PLS, look at the analysis on the label; multiply the germination percentage by the percentage of pure seed and then multiply by 100 to get the percentage.

```
Example: Germination =80%
         Purity      =90%
         0.80 x 0.90 =0.72
         0.72 x 100  =72% PLS
```

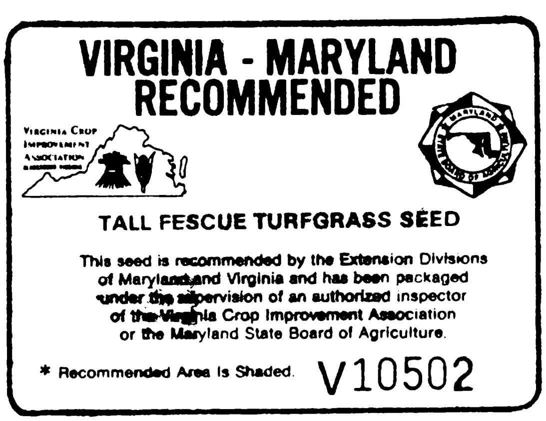
To obtain the cost per pound of PLS, divide the price per pound by the PLS. If the seed costs $2.25 per lb, then 0.72 into 2.25 = $3.12, the actual cost of Pure Live Seed.

Quality Certified seed is a guarantee from the seller that you will get the kind and variety of lawn seed named on the label. Buying certified seed is a good practice. If the seed is certified, a blue certification label will be attached to the seed package.

Also, the Virginia and Maryland Cooperative Extension Services have worked with the U.S. Department of Agriculture, seedsmen, and the Crop Improvement Association to develop a program that helps purchasers recognize quality lawn seed. In both states, special labels are placed on packages containing seed that meets very high standards of purity, germination, and freedom from weed and other crop seed. Seed in a package that carries one of these labels is certified and recommended for use in both states:



Label colored orange



Label colored green

Label colored yellow

Purchasing Quality Sod

There are several types of sod being grown in Virginia. The basic types are Kentucky bluegrass blends, Kentucky bluegrass-fine fescue mixtures, tall fescue-Kentucky bluegrass mixtures, Bermudagrass and zoysiagrass. Each of these types of sod is best suited to particular uses and geographic areas of Virginia. Some sod producers grow sod in the Virginia Crop Improvement Association (VCIA) certified sod program which means that the sod produced must meet established standards of quality.

VCIA sod is of high quality, meeting rigid standards requiring preplanting field inspections, prescribed varieties and mixtures, periodic production inspections, and a final preharvest inspection. This program provides the consumer with guaranteed standards of quality. Sod in the VCIA program which cannot quite meet program standards may be classified as VCIA "approved" sod and sold at a lower price than sod in the "certified" category which meets all VCIA standards. VCIA certified sod can be identified by its VCIA certified turf label.

High quality sod is also available outside the VCIA certified sod program but it is not graded by uniform standards.

Kentucky Bluegrass Blends Kentucky bluegrass blends contain two or more varieties of Kentucky bluegrass and no fine fescue. They are best suited for the north central Piedmont region and areas along and west of the Blue Ridge Moutains of Virginia. They will require moderate to full sunlight, periodic fertilization and irrigation and good soil drainage in order to provide quality turf. Kentucky bluegrass blends function well on lawns, athletic fields, recreational areas and in situations where year round erosion control is necessary.

Kentucky Bluegrass-Fine Fescue Mixtures These mixtures usually contain 80 to 90% Kentucky bluegrass and 10-20 % Creeping Red Fescue. The fine fescue component adds shade and drought tolerance to a sod mixture. It is a good all-purpose sod designed for use in the north central Piedmont and areas along and west of the Blue Ridge Mountains in Virginia. This sod will tolerate moderate shade and drought conditions. Kentucky bluegrass-fine fescue mixtures also function well on lawns, athletic fields, recreational areas and in situations where year round erosion control is necessary.

Tall Fescue-Kentucky Bluegrass Mixtures These mixtures generally contain from 80 to 95% fine bladed tall fescue and 5 to 20% Kentucky bluegrass. Tall fescue is a broader bladed grass than Kentucky bluegrass and therefore this sod has a coarser texture than Kentucky bluegrass sod. Tall fescue sod is drought tolerant and performs best in areas east of the Blue Ridge Mountains in Virginia. Tall fescue sod is adapted to a wide range of soil conditions and management programs. It is not well suited to areas of heavy traffic but performs well in lawns, recreational areas and in situations where year round erosion control is necessary.

Bermudagrass Bermudagrass is a warm season grass that goes dormant in the winter in Virginia. It is best suited for areas in the south central Piedmont and coastal plain regions east of the Blue Ridge mountains. It is very drought tolerant, requires full sunlight and grows most actively in the sumnmer months. It functions well on lawns, athletic fields, and other areas where excessive winter traffic is not anticipated. It can be established from sod, sprigs, or plugs.

Zoysiagrass Zoysiagrass is a warm season grass that goes dormant in the winter in Virginia. It is best suited for areas in the south central Piedmont and coastal plain regions east of the Blue Ridge Mountains. It is very drought tolerant and slightly more shade tolerant than bermudagrass. It functions well on lawns and recreational areas where excessive winter traffic is not anticipated. It can be established from sod, sprigs, or plugs.

LAWN MAINTENANCE

The wide variety of microclimates and variation of soil types in Virginia makes it difficult to formulate a general program for lawn maintenance. This section deals with the basic factors required for maintaining a lawn however the recommendations may need to be modified for your particular location. As mentioned earlier, the first thing to do in maintaining your lawn is to have the soil tested.

Factors to consider that are necessary every year for high turfgrass quality are genetic potential, mowing, fertilization, weed control, irrigation, and leaf raking. In addition to these, the following cultural practices may be necessary during some years: dethatching, pH adjustment, aeration, disease control, and insect control.

Yearly Maintenance

Genetic Potential The potential for a lawn to provide a quality surface is very dependendent upon the varieties of grass in the lawn. New, improved varieties are being released each year. Periodic infusion of improved varieties will increase the chances of producing a high quality lawn. The best maintenance program is not likely to produce a quality lawn if inferior turfgrasses dominate the stand.

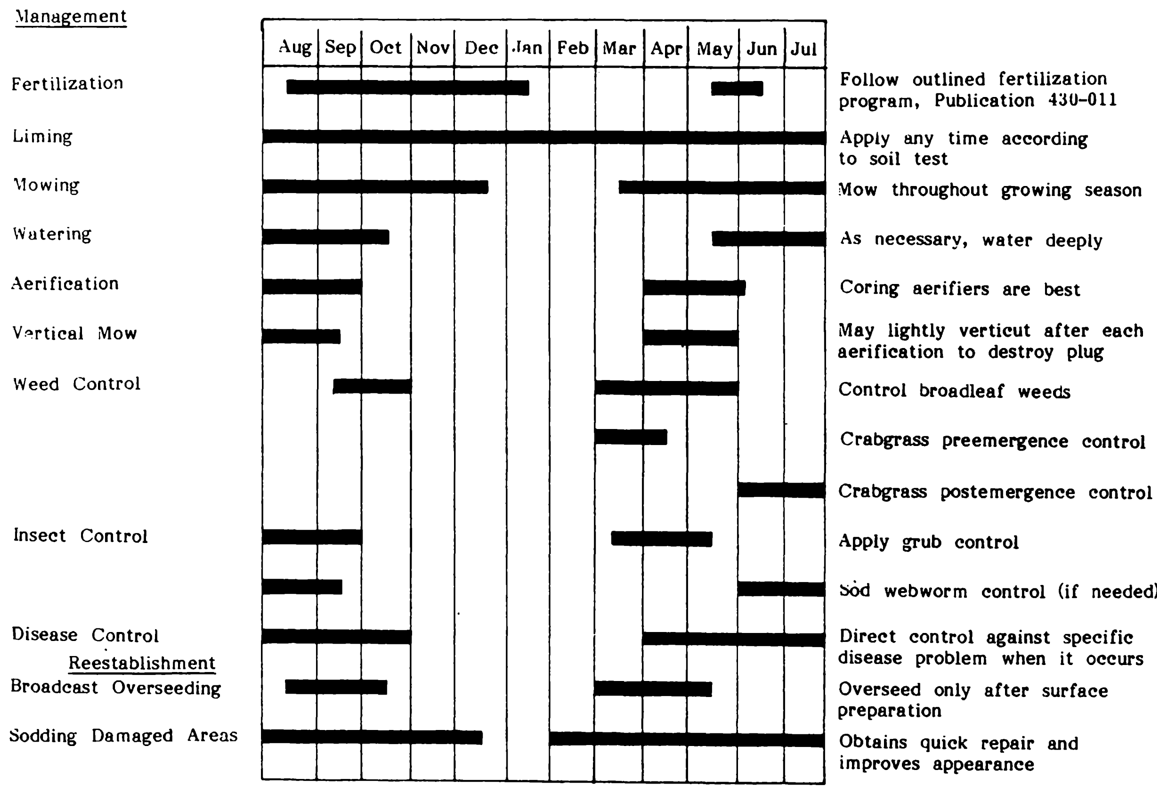
Mowing Mowing grass is one of the major time consuming practices in turfgrass management, and yet the total impact of mowing management is seldom considered. To appreciate the true impact of mowing on turfgrass, it is necessary to understand the physical, environmental, and physiological effects of mowing on the turfgrass community.

The most obvious physical effect of mowing is the decrease in leaf surface area of the grass plants. The leaves of the grass plant are the site of photosynthesis, and any decrease in leaf surface area proportionately decreases the plant's ability to produce carbohydrates which are essential for root, shoot, rhizome and stolon growth. If more than one-third of the grass vegetation is removed during mowing, root growth is temporarily slowed by the plant's inability to produce carbohydrates at the previous rate. Carbohydrates can be pulled out of reserve to enhance extensive root, rhizome and stolon development. However, carbohydrate reserves can be called on to support root, rhizome and stolon structures only a limited number of times while the grass plant is recuperating from the shock of a severe mowing. We need to think of mowing primarily as a carbohydrate-depleting management factor. Improper mowing habits can weaken the plant as the mowing season progresses, reducing its recuperative potential and predisposing it to insect, disease and drought susceptibility. It has been shown that severe defoliation of the grass plant creates extreme effects upon root growth. In cases where 50% of the existing Kentucky bluegrass foliage was removed in mowing, only 35% of the roots were producing growth 33 days after mowing.

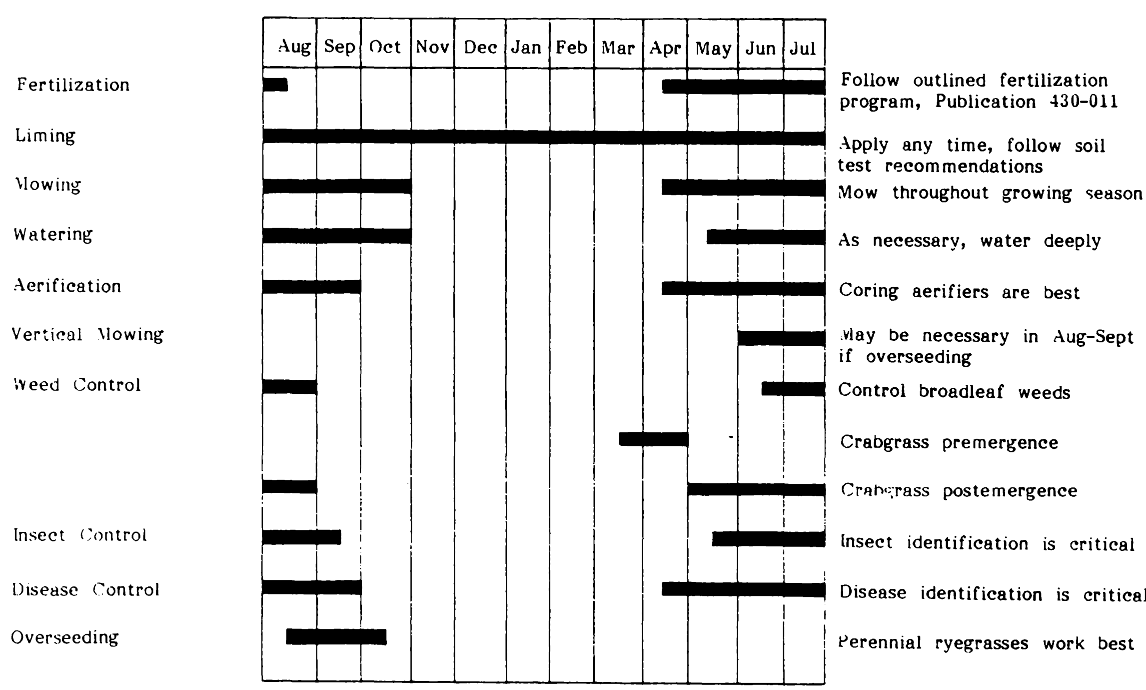
Wound hormones are produced every time grass is cut. These compounds and phenol oxidase enzymes are involved in wound healing. The production of compounds involved in healing mowing wounds occurs at the expense of food reserves. If you are cutting grass with

CALENDAR FOR LAWN MAINTENANCE

TURF CARE CALENDAR FOR COOL SEASON GRASSES



TURF CARE CALENDAR FOR WARM SEASON GRASSES



a dull mower, you are creating severe wounds that require more wound healing compounds and therefore more stored food reserves. So be sure to keep your mower blade sharp! Continuous use of dull mowers depletes the plant of stored reserves necessary for survival during the stress filled months of July and August. Eventually the plant's ability to heal the mowing wound is impaired by lack of food reserves, and the open wound becomes a site of fungal entry leading to serious disease problems. Every unit of plant energy that must be utilized to heal dull mower wounds is simply one less unit that will be available for healing during periods of stress.

Lowering the mowing height severely disrupts the environmental and competitive forces that exist in the turfgrass community. In a mixed community of turfgrass plants, some plants will become less competitive as the mowing height is lowered. In managing tall fescue-Kentucky bluegrass blends, it is essential to realize that lowering mowing heights to 1 inch or less is likely to decrease the amount of leaf area per unit of ground area, and thereby decrease the plant's capability to intercept and use sunlight. Lower mowing heights increase the number of plants per unit area for some grasses, but it is highly likely that the individual plants in the crowded community become weaker. Weaker plants require more intensive management to be able to withstand periods of stress. Low mowing heights in Kentucky bluegrass often lead to increased weed populations of Annual bluegrass and crabgrass. The following table shows recommended mowing heights for turfgrasses commonly used in Virginia:

Turfgrass	Mowing height (inches)
Kentucky bluegrass	1 1/2 to 2 1/2
Tall fescue	1 1/2 to 3
Creeping red fescue	2 to 3
Perennial ryegrass	1 1/2 to 2 1/2
Bermudagrass	1/2 to 1
Zoysiagrass	3/4 to 1

In late May and early June it is generally beneficial to raise the mowing height a little on cool-season grasses to help maximize the amount of food being produced by photosynthesis. Higher mowing heights will reduce stress levels on the turf and at the same time increase the likelihood of surviving drought, since root development potential is increased by the higher mowing height.

Frequency of mowing can have severe effects on turfgrass communities. Excessive mowing frequency reduces total shoot yield, rooting, rhizome production, and food reserves. Mowing frequency should be determined by seasonal growth demands, and should be often enough that no more than one third of the existing green foliage is removed with any one mowing.

In summary, mowing the lawn is the most frequent maintenance factor in the production of a good lawn. For good results, mow as high as reasonable for the desired appearance and use of the turf; use a sharp blade; and don't mow more often than necessary, but often enough so that plant height is being reduced by not more than one third each time.

Fertilization The time table for fertilizing cool season grasses is completely different from that of warm season grasses. Warm season grasses go dormant during the time when the cool season grasses make the most effective use of fertilizer for root growth and development.

Late fall fertilization is a concept that is essential in the maintenance of quality cool season grasses in Virginia. The advantages of late fall fertilization that have been observed in research and practical observation are increased density, increased root growth, decreased spring mowing, improved fall to spring color, decreased weed problems, increased drought tolerance, and decreased summer disease activity. The amounts of fertilizer to apply and the time periods when they should be applied are critical.

The ideal lawn fertilization program provides the nutrition that maximizes the chances of producing a quality lawn. Temperature and moisture vary greatly and affect turfgrass growth. Therefore, nutritional needs vary from month to month. Excessive stimulation of growth from nitrogen fertilizers can be more detrimental than no fertilization. The source of nitrogen in fertilizers influences nitrogen availability to the turfgrass plant. There are two types of nitrogen sources; quickly available and slowly available. Quickly available materials are water soluble and can be immediately utilized by the plant. Slowly available nitrogen sources release their nitrogen over extended periods of time and, therefore, can be applied less frequently and at higher rates than the quickly available nitrogen sources.

The numbers on the fertilizer bag (such as 10-10-10 or 46-0-0) tell you the percent of Nitrogen (N), phosphate (P_2O_5), and potash (K_2O) in the fertilizer. If your soil test indicates low or medium levels of phosphorous or potassium, complete fertilizers should be used. If high levels of phosphorous and potassium are present in the soil, then fertilizers supplying only nitrogen will be adequate.

Fertilizers can provide nitrogen to plants immediately or over an extended period of time. The amount that can be safely applied at one time depends upon the availability of the nitrogen. The portion of the nitrogen that is slowly available is listed on the fertilizer bag as Water Insouluble Nitrogen (WIN). For example, a 20-10-10 fertilizer with 5% WIN actually has 5/20 or 1/4 of the nitrogen in the slowly available form. A 50 lb. bag of this material would provide 10 lbs. of total Nitrogen (N) 2.5 lbs. of which would be slowly available (WIN).

A fertilizer label will provide the following information:

Guaranteed Analysis

Total Nitrogen	16%
5.6% Water Insoluble Nitrogen (WIN)	
Available Phosphoric Acid (P_2O_5)	4%
Soluble Potash (K_2O)	8%

To find the % nitrogen that is WIN, use the following calculation:

$$\frac{\%WIN}{\%\ Total\ Nitrogen} \times 100 - \%\ \text{of total nitrogen that is WIN or slowly-available}$$

Therefore:

$$\frac{5.6}{16} \times 100 = 35\%\ \text{of the total nitrogen is WIN or slowly-available.}$$

If no WIN is listed on the fertilizer label, assume it is all water soluble or quickly-available nitrogen, unless the fertilizer label indicates it contains sulfur coated urea. Sulfur coated urea fertilizers provide slowly available nitrogen, but the fertilizer label does not list it as WIN. If the fertilizer contains sulfur coated urea, include that portion as water insoluble nitrogen when determining the portion of the fertilizer that is slowly available.

Statements on a fertilizer bag such as "contains 50% organic fertilizer" do not mean the fertilizer is 50% slowly available. It is impossible to calculate the amount of WIN from this information.

If more detailed information is needed on nitrogen sources, ask your local Extension agent for Publication 430-170 entitled "Fertilizer Selection for the Lawn."

TABLE 1. Fertilization Program for Kentucky Bluegrass, Tall Fescue, Creeping Red Fescue, and Perennial Ryegrass Lawns

PROGRAM I - Fertilizers with Less than 50% Slowly Available Nitrogen (WIN)

Time of Application	Nitrogen per 1000 sq. ft. ----lbs----	Application Priority
September	1	2nd
October	1 to 1 1/2	1st
Nov 15 to Dec 15	1 to 1 1/2	3rd
May 15 to June 15	0 to 1/2	4th

Total Applied per Year = 3 to 4 1/2 POUNDS

PROGRAM II - Fertilizers with 50% or More Slowly Available Nitrogen (WIN)

Time of Application	Nitrogen per 1000 sq. ft. ----lbs----	Application Priority
August 15 to Sept. 15	1 1/2 to 2	1st
October 15 to Nov 15	1 1/2 to 2	2nd
May 15 to June 15	0 to 1 1/2	3rd

Total Applied per Year = 3 to 5 1/2 POUNDS

Important Comments about Programs I and II

1. Application Priority - The priority of each application is listed for those not wanting to make all applications. For instance, if you desire to make only one application following Program I, the best time is in October.

2. Sources of nitrogen recommended in Program I may cause significant leaf burn if applied when temperatures are high or there is moisture on the leaf blades. Water the lawn after fertilization to wash particles off the blades. This is particularly important when using ammonium nitrate or urea.

3. The November 15 to December 15 application in Program I should be made after the last mowing. It is important that the grass not go into the winter excessively long.

4. In heavily shaded areas with fine fescue turf, it may be beneficial to reduce fertilizer rates or omit applications until leaf collection is finished in the fall.

5. Use the higher amounts of nitrogen where soils are sandy, irrigation is used, clippings are collected, the growing season is extended, recuperative potential is needed, or high quality is desired.

6. In Program II, it may be beneficial to apply 1 lb. of soluble nitrogen per 1000 sq. ft. in mid-December to encourage root growth and stored food reserves.

TABLE 2. Fertilization Program for Bermudagrass and Zoysiagrass Lawns

PROGRAM III - Fertilizers with less than 50% Slowly-Available Nitrogen (WIN)

Time of Application	Nitrogen per 1000 sq. ft. ----lbs----	Application Priority
April	1 to 1.5	1st
May	1 to 1.5	2nd
July	1 to 1.5	3rd

Total Applied per Year = 3 to 4.5 POUNDS

PROGRAM IV - Fertilizers with 50% or More Slowly-Available Nitrogen (WIN)

Time of Application	Nitrogen per 1000 sq. ft. ----lbs----	Application Priority
April	1.5 to 2.5	1st
June 15 to July 15	1.5 to 2.5	2nd

Total Applied per Year = 3.0 to 5.0 POUNDS

Important Comments about Programs III AND IV

1. Application Priority - Priority of each application is listed for those not wanting to make all applications. For instance, if you desire to make only one application following Program III, the April application will be most beneficial.

2. Winter Hardiness - Improved winterhardiness on Bermudagrass will result from the application of 2 to 3 lbs. per 1000 sq. ft. of potassium from 0-0-60 (muriate of potash) or 0-0-54 (potassium sulfate) in late August or September. Water- in these potash applications to minimize leaf burn.

3. Rates and sources of nitrogen recommended in Program III may cause significant leaf burn if applied when temperatures are high or there is moisture on the leaf blades. Water the lawn after fertilization to wash particles off the blades.

4. Overseeded Bermudagrass lawns will require additional nitrogen applications after seeding in September, then again in December or January. Water soluble sources providing 1 lb. nitrogen per 1000 sq. ft. are recommended.

If more detailed information is needed on factors affecting fertilization, request Publication 430-011 entitled "Lawn Fertilizaiton in Virginia" from your local Cooperative Extension Office.

Weed Control Weed control can be minimized by good mowing and fertilization management since this makes grass more capable of competing with weeds. If chemical control should be necessary, care should be taken to apply chemicals at the time of year when they will be most effective, and not to exceed the recommended rates. Careless application of weed control chemicals can result in damage to the desirable grasses, as well as damage to other ornamental plantings.

There are two basic groups of weeds: broadleaf weeds, and weedy grasses. Broadleaf weeds consist of the familiar dandelions, chickweed, clover, ground ivy, wild onions, oxalis, plantain, anything which is not classed as a grass. Examples of weedy grasses are crabgrass, and goosegrass. Control for each of the two groups varies.

There are good selective herbicides available for broadleaf weed control. In general, broadleaf weeds respond best to weed killers when they are most actively growing and/or in the seedling stage. This is usually in late spring or early fall. When equally effective, fall applications are preferable because fewer ornamental and garden plants are in an active state of growth. Applications of high rates of weed killer during hot, dry conditions may brown desirable grasses. Pesticides recommended for control of specific broadleaf and grassy weeds, are contained in the Virginia Cooperative Extension Service Pest Management Guide for Turfgrass (Publication 456-013).

Control of perennial, weedy grass is more difficult, because selective herbicides that do not affect desirable grasses are not available. Therefore, spot spraying, physical removal, or total kill of existing lawns is often necessary. Detailed discussion of weed control methods in lawns is contained in Virginia Cooperative Extension Publication 427-045 entitled "Lawn Weed Control."

Irrigation Lawns can use an inch or more of water per week in hot, dry weather. If rainfall does not provide this much water, irrigation will be necessary to keep the lawn green through the summer months. The lawn should be watered when the soil begins to dry out, but before the grass actually wilts. At that stage, areas of the lawn will begin to change color, displaying a blue-green or smoky tinge. Also, loss of resilience can be observed; footprints will make a long lasting imprint instead of bouncing right back. Ideally, the lawn should be watered before these signs can be observed.

Cool season grasses usually go semidormant in the hottest part of the summer, returning to full vigor in cooler fall weather. If you want to keep the lawn green through the summer, regular deep watering will be necessary. If the lawn does go dormant (turns brown), let it stay that way until it naturally greens up again. Too many fluctuations between dormancy and active growth can weaken the lawn.

Light sprinkling of the surface is actually more harmful than not watering at all, since this encourages root development near the surface. This limited root system will require more frequent waterings and will necessitate keeping the surface wet, which is ideal for weeds and diseases. Watering should be an all or nothing type of commitment. If you water, do it consistently and deeply. If you don't intend to be consistent, it is better not to water at all, and to allow the grass to go dormant until natural conditions bring it back. Encouraging deep root growth by irrigating infrequently, but heavily, will maximize water use efficiency and turfgrass qality.

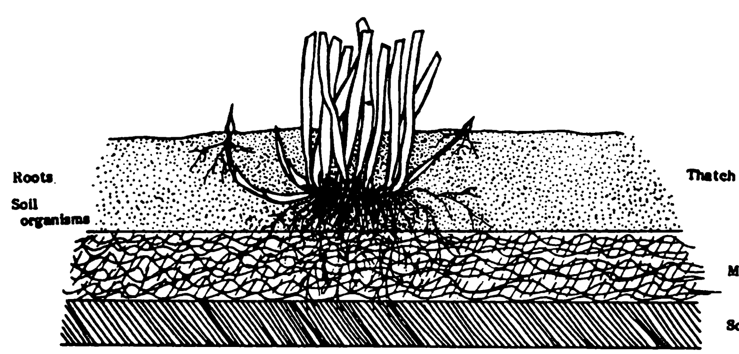
The best time to water a lawn is in the early morning. Evaporation is minimized and water use efficiency is better than during midday. Early evening or night watering is not encouraged because it leaves the blades and thatch wet going into the evening. This maximizes the potential for disease activity.

Dethatching In addition to regular maintenance factors already discussed, in some years, it may be necessary to remove thatch. Thatch is the tightly interwoven layer of living and dead stems, leaves and roots that exists between the green blades of grass and the soil surface. This layer of decomposing organic matter accumulates on the soil surface in an innocuous fashion. During the early stages of thatch development, when it measures less than 0.5 inch in thickness, it can actually be beneficial to the grass. Thin layers of thatch can increase wear tolerance of turf by providing better dissipation of compaction forces; reduce weed populations by not providing ample conditions for germination; reduce water evaporation by blocking sunlight and air exchange with the soil surface; and insulate crown tissue, protecting it from frost and traffice damage. Thatch problems are inevitable under intensive turfgrass management programs unless thatch reduction principles are built into the program.

The single cause of thatch buildup is the fact that the accumulation rate of dead organic matter on the soil surface is greater than the decomposition rate. There are many reasons for this imbalance between rate of accumulation and decomposition. Some of the factors involved include excessively high nitrogen levels, type of turfgrass, excessive irrigation, mowing management, chemical use, and soil type.

The effect of excessive thatch buildup upon turfgrass quality is subtle but deadly. This layer of undecomposed organic matter is capable of altering pest populations, moisture relations, nutrient utilization patterns, soil temperatures, and other climatic and biotic factors.

The moist microclimate created by the thatch layer favors fungal invasion and allows pathogenic microorganisms to live and sporulate. Probability of insect pathogens surviving the winter is increased by the insulating effect of thatch. Soil borne fungus and insect pathogens often escape control methods due to the inability of applied pesticides to penetrate the thatch layer. The thatch layer prevents adequate water infiltration, causing reduced root growth and increased potential for wilt damage. When thatch layers are kept moist, roots tend to develop in this zone and crown regions of the individual turfgrass plants tend to be elevated in the thatch. This elevation of the crown region away from the soil leads to increased exposure to temperature extremes and greater probability of stress damage. Interception of lime and fertilizer applications by thatch layers produces erratic fertilizer response. In some cases the microorganisms tie up the applied nitrogen, and it is not available to the turfgrass plants.



Above is an illustration of a block of turf with thatch, mat and soil layers in profile. Note that the crown of the grass plant is elevated into the thatch layer. The mat is the layer of decomposing thatch which is becoming integrated into the soil.

By now you should be convinced that excessive thatch buildup is bad for the lawn; the problem is what to do about it. There is no simple method of controlling thatch development. Preventive programs for thatch reduction should be built into the maintenance program. Curative programs involving the labor intensive process of dethatching may also be required at times.

Preventive thatch management involves modification of nutrition, cultivation, mowing and irrigation practices. The pH of the thatch layer appears to be more important to thatch decomposition than soil pH. Researchers have shown that light annual applications of lime (20 to 25 lbs. per 1000 sqare feet) may be beneficial in speeding the thatch decomposition rate. Moderate use of nitrogen with more frequent small applications appears to decrease thatch buildup. Aerification and topdressing of turfgrass speeds up thatch decomposition. Aerobic microorganisms involved in the thatch decomposition benefit from improved oxygen levels as much as the turfgrass. Topdressing serves to innoculate the thatch layer with microorganisms and improve moisture retention in the thatch layer, thus increasing microbial activity.

If the thatch layer in your lawn is more than one half inch thick, dethatching to remove excessive thatch will be beneficial. Timing of the dethatching operation is critical, and is best done during periods when the plants can recover from the treatment. Kentucky bluegrass and other cool season grass lawns should be dethatched in early fall or early spring. Spring verticutting can lead to excessive crabgrass invasion if improperly timed. Vertical mowers, or verticut machines, can be rented. These machines, rake the surface of the soil, and leave the thatch debris on top of the lawn. This material should then be raked up and removed. If overseeding is planned, it is good to do it in conjunction with the verticutting process, since the grooves cut in the soil will provide good soil contact for the new seed.

<u>pH Adjustment</u> Soils in Virginia are typically acid, and from time to time it may be necessary to add lime in order to keep the soil pH near 6.2. Soil test results will tell how much lime should be applied.

<u>Aeration</u> If soil is heavy or compacted, aeration may be necessary. Roots need oxygen as well as water and nutrients; compacted soil restricts the absorption of water, and also does not allow the soil to exchange and replenish oxygen from the atmosphere.

Aeration is best done by a machine which forces hollow metal tubes into the ground and brings up small cores of soil which are left laying on the surface. The soil should be moist, not too wet or too dry, when this is done. Simply punching holes with a spiked roller may improve water retention, but this practice also increases compaction in the soil.

Reinoculation of thatch layers with soil and microbes through the aeration process is beneficial in helping create an environment conducive to thatch decomposition.

<u>Disease Control</u> Proper management will greatly reduce a lawn's susceptibility to disease. Disease damage may be difficult to identify since many of the symptoms may also be caused by improper management or by environmental factors such as competition from tree roots. Nearly all lawn diseases are caused by fungus, and fungicides can be applied to prevent and control them. For specific disease control recommendations consult your local Extension Office and the Virginia Cooperative Extension Service Pest Management Guide for Turfgrass(Publication 456-013).

Insect Control There are naturally many different types of insects present in a lawn. Most of these are not harmful to the grass. Control for insects is not necessary unless the pest population builds up enough to cause visible damage to the lawn.

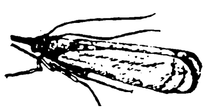
Close examination, on hands and knees, is the best way to identify insect pests in a damaged lawn. You may be able to see the insect in action. If you think you have an insect problem, your local Extension Office can help in identifying the pest and suggesting recommended control measures.

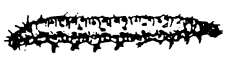
The most common above ground insect pests in Virginia lawns are chinch bugs and sod webworms; these feed on grass leaves and stems. Below ground, the most common pests are white grub larvae and weevil or billbug grubs; these feed on plant stems and roots.

CHINCH BUGS

Chinch bugs are small white and black insects that suck sap from grass, producing yellow and then brown patches. To test for chinch bugs, cut both ends off of a large tin can; push one end into the soil, fill the can with water, and chinch bugs will float to the surface if present.

SOD WEBWORMS



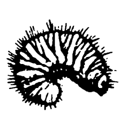


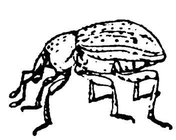
Sod webworms are the larval or caterpillar stage of several species of lepidoptera. Adults are commonly seen flying in jerky, short flights as you walk through the grass. Caterpillars do the damage, feeding on the grass blades at night. Sod webworms prefer well managed lawns. Damage appears as small brown areas in the grass.

WHITE GRUBS

White grubs are the larval or grub stage of several species of beetles and chafers. Typically cream colored with a brown head, and a dark area at the posterior end. White grubs feed on roots, causing brown areas in the lawn. Usually turf can be rolled back like a rug to reveal white grubs.

BILLBUGS & WEEVILS Larvae look much like white grubs, except that they are smaller and do not have legs. Larvae feed on roots, and adult beetles feed on grass blades and stems. Damage is similar to that caused by white grubs.





SUMMARY

Maintaining a healthy and attractive lawn requires a strong commitment to constant care. Timing for each phase of lawn management is important; it is not enough to throw down some fertilizer or weed control chemical whenever you feel like it. Good results, and good return on your investment of time and money, can be obtained only by doing things at the appropriate time. Basic guidelines have been set forth in this chapter. More information can be gained from other publications and books. As specific questions and problems arise, remember that your local Extension Office can provide answers and help.

SELECTION, USE AND CARE OF WOODY PLANTS

SELECTION, USE AND CARE OF WOODY PLANTS

INTRODUCTION

Woody ornamental plants are key components in a well designed, useful environment. This large group of plants falls into three groups: trees, shrubs, and vines. These can be defined as:

Trees: Woody plants that produce one main trunk and a more or less distinct and elevated head (height of 15 feet or more).

Shrubs: Woody plants that remain quite low and produce shoots or stems from the base and usually not a single trunk (height of 15 feet or less).

Vines: Climbing or crawling woody plants without self supporting upright stems.

This chapter will cover factors to consider in selecting plants based on desired uses of the plants, and environmental factors influencing plant growth; procedures for planting and care of woody plants; a listing of trees, shrubs, vines, and ground covers that are recommended for use in Virginia.

VINES IN THE LANDSCAPE

Vines are generally described as woody or semiwoody climbing or trailing plants. Like shrubs, trees, and ground covers, vines can be important to the interest of any garden landscape. Each species and variety of vine possesses distinctive characteristics which make it well adapted to certain locations in the landscape plan.

Selection

In selecting vines, as in selecting trees and shrubs, one must review carefully the needs of the area, and then select the most suitable plants. Vines can be useful in a variety of sites. Some vines are valued for the shade they provide when trained over an arbor. Others add interest to a planting when trained against the wall of a building, or when used to frame a doorway. Some vines can be used to relieve the monotony of a large expanse of wall, being trained in a definite pattern, or allowed to completely cover a wall with leafy green, while others dramatically change a plain fence. Vines can be useful to form a cascade of bloom on rough, steep banks while holding the soil in place.

Vines also offer diverse visual qualities and are valued for the rich texture of their foliage, their decorative habit of growth, the fragrance of their blooms or the beauty of their flowers. Some are valued for the graceful tracery of their simple stems or for the beauty of their leaf pattern. To the home gardener, vines offer a rich source of material with which to create interesting, exciting and beautiful plantings.

Vines are generally segregated into three general groups depending on how they climb:

> Some, like Boston ivy, climb by attaching small rootlike holdfasts to the wall as a means of support. Sometimes these are modified tendrils with small circular discs at the tips; others like English ivy, have small rootlets along the stem to firmly attach the vine to either brick or wood.

Vines such as clematis and grape, climb by attaching and winding tendrils or leaflike appendages, which act as tendrils, around the object on which they are growing.

The third group, including bittersweet and wisteria, climb by twining. It is interesting to note that all vines do not twine in the same direction. There is not a haphazard method of twining. The plants of each species invariably twine in one direction, start the winding of young vines around their support in the correct direction. As example, bittersweet twines by climbing from left to right. Hall's honeysuckle twines by climbing from right to left.

By knowing in advance how each vine climbs, the proper means of support can be provided for those selected.

Culture

Most vines will quickly revert to a tangled mass of foliage over the ground if they are not given the proper means of support and a reasonable amount of care and maintenance.

The best type of support for vines is the one that gives the required structural strength and stability, and at the same time is neat in appearance.

Like most other plants, vines do require some maintenance. Pruning is necessary for the removal of old wood. This may require several cuts to each stem so they can be untangled. It is often necessary to prune occasionally to keep the plant within bounds and to guide future growth. As with other plants, vines are pruned to produce better bloom.

Insect and disease control is important and spraying against insects can be done as a part of the general spraying program for the garden.

The area to be covered should be studied carefully to determine what type of vine should be used. The rate of growth is a critical consideration, since there are vines that exhibit rampant growth and can soon become a nuisance.

GROUND COVERS

In a broad, general sense, ground covers include any material that covers the ground surface so that it cannot be seen from above and so that rain does not strike directly upon it. With this definition, grass, various types of paving, shrubs and even trees could be called ground covers. However, here we are referring to ground covers as low (up to 18"), mat forming or trailing plants, other than grasses or other plants that tolerate walking or mowing.Most ground covers are not intended to be walked upon and will be severely damaged by pedestrian traffic.

When ground covers are carefully chosen and used with distinction and skill, they greatly enhance the beauty of the landscape composition. In addition to their aesthetic value, they fulfill a number of other important functions:

- Controlling erosion on slopes
- Obstructing traffic without impeding view
- Helping conserve soil moisture and, during periods of extreme heat, helping lower temperatures in the soil
- Simplifying maintenance: for example, if the area available for lawn is larger than necessary, maintenance can be reduced by introducing large areas of ground covers
- Filling narrow, odd shaped areas where mowing and edging might be a problem
- Being used in areas of dense shade where grass is difficult to grow
- Producing interesting ground patterns by their variation in height, texture, and color

In practice, the ground covers most frequently used are plants that are easily propagated,vigorous and hardy.

Selection

Selection of a ground cover will depend upon the area where it will be used. Is the area flat or sloping? Is it in sun, partially or deeply shaded? Soil conditions must be studied. Some ground covers prefer a moist soil, rich in organic matter while others will adapt to dry, sandy situations. Give consideration to color, texture, height and habit as well, since some ground covers tend to grow rampantly.

One problem that limits the use of ground covers is the cost of installation since large numbers of small, individual plants are required. In addition, a well prepared planting bed is essential to the establishment of ground covers and can be costly and time consuming.

Culture

Significant maintenance is necessary for the first one to three years or until the ground cover becomes established. They require cultivation to control weeds and other plant invaders; fertilization to encourage fast, vigorous growth to achieve good cover; irrigation in times of dryness; and disease and pest control. When these maintenance considerations are ignored, the progress toward achieving a good ground cover planting is disappointing.

Wherever paving, lawn or cultivated beds are not desirable, ground covers can be successfully used. Newly cut banks, and any slopes greater than 12 percent are best treated with ground cover plantings. Around buildings, ground covers are superior to paving or structural controls for reducing heat, glare, noise and dust.

See the recommended planting lists for ground covers to fit your landscape needs.

SELECTING TREES AND SHRUBS

Because there are so many woody plants available to us for use in landscaping, we must be careful to select plants that are appropriate for our needs. Selection should be based on several different factors.

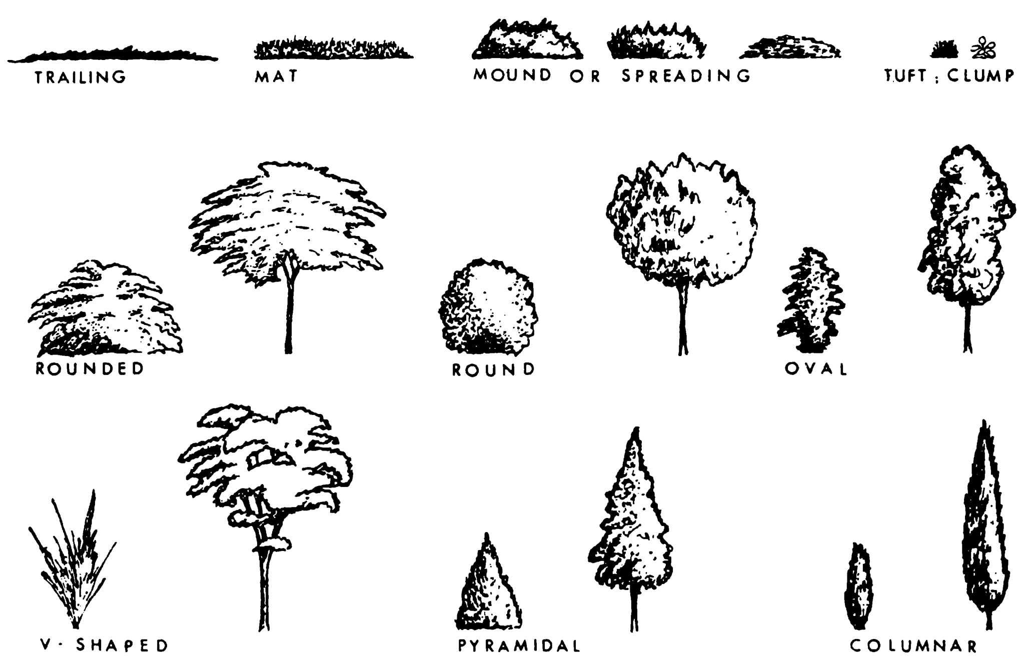
The intended purpose should influence selection of plants with appropriate shape, size and other physical characteristics. Trees are used for shade, ornamental, screening, windbreak, and sound reducing purposes. Shrubs are used for screens, barriers, windbreaks, ornamentals, ground covers, wildlife shelters. Both trees and shrubs can be selected to provide edible fruit or nuts.

Providing shade usually requires tall sturdy, long living species. The density of foliage, which determines the amount of shading is important. A tree such as a Norway maple will produce a very dense shade that prevents other plants from growing under it, while a honeylocust will produce a light partial shade which is not a hindrance to other plants growing below it. Deciduous trees should be used to shade the south windows of a home in the summer, thus allowing the sun to penetrate in the winter.

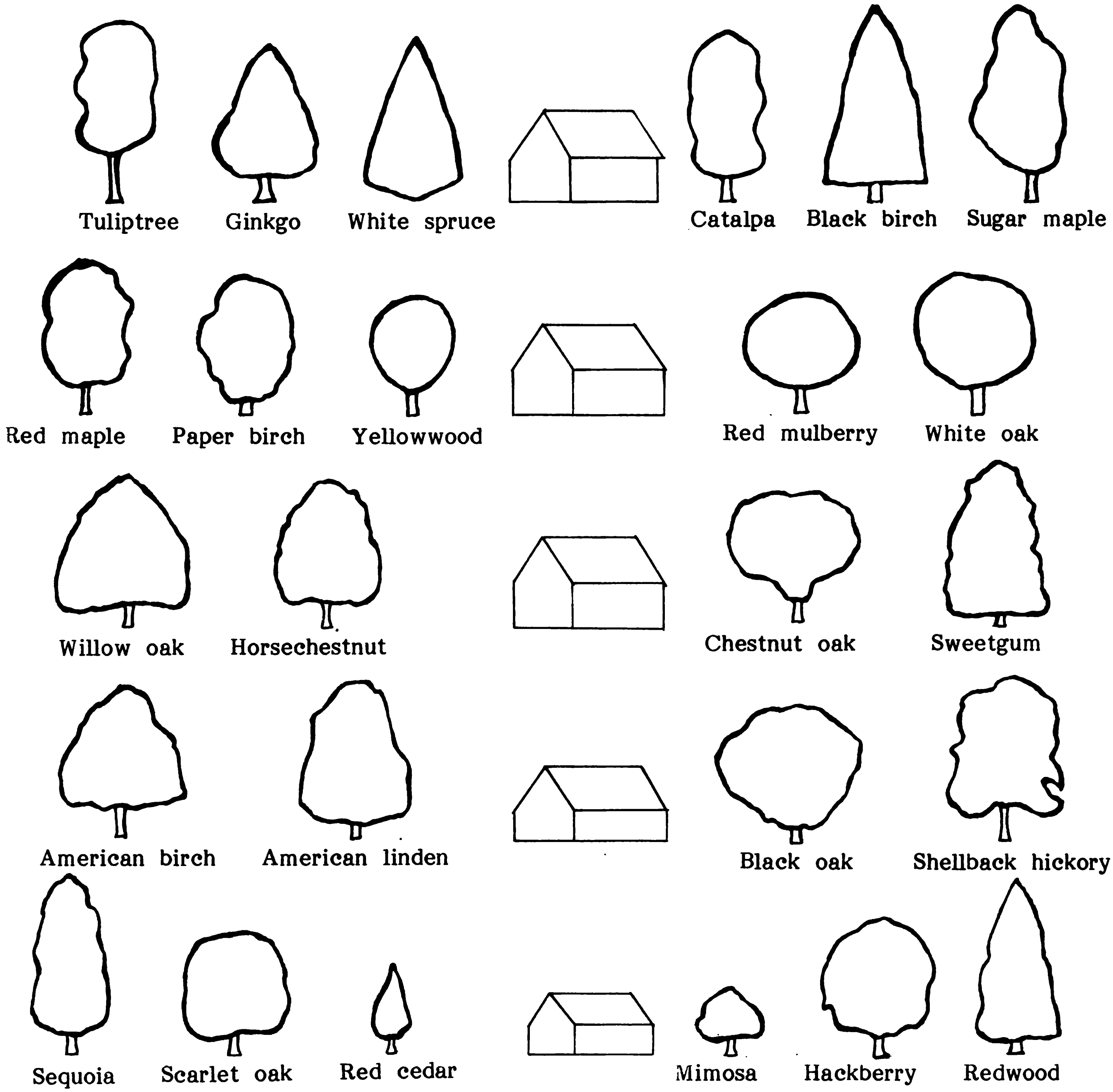
Screens usually require plants that produce a dense foliage. Windbreaks in addition must be able to survive rigorous climate conditions. Evergreen plants are usually chosen for screening. Barrier plantings usually require sturdy plants with a dense growth, and possibly thorns or spines.

Ornamental attributes are quite varied. Both trees and shrubs can be selected for flowers or colorful fruit, interesting foliage, fall color, interesting bark, winter colors of foliage or branches, or interesting shapes of the plants themselves.

MANNER OF GROWTH

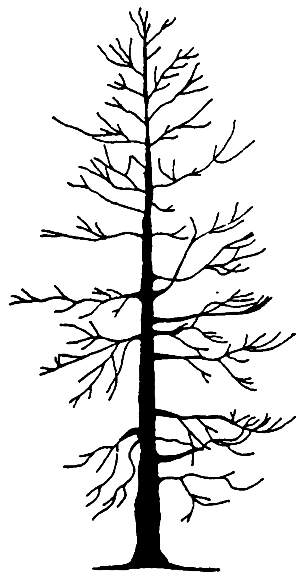


Size of mature shade trees in relation to the height of a 2-story house.

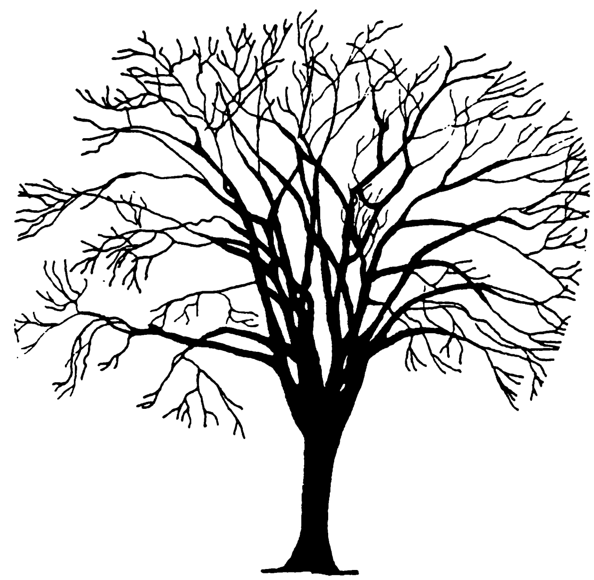


Consider the size of mature trees and shrubs and where they are to be used. Trees that grow tall; such as the American elm, White oak, Sycamore, and Tulip trees; are suitable for two story and larger buildings. They tend to dominate the low flat appearance of, or hide, one story buildings. For attractive and proper balance with one story buildings, trees that do not grow over about 35 feet are recommended. Shrubs that outgrow their spaces can hide windows, block walkways, or crowd out other plants. Shrubs can sometimes be kept small by pruning, but this requires a continuing maintenance. Careful consideration of mature sizes will reduce the need for pruning.

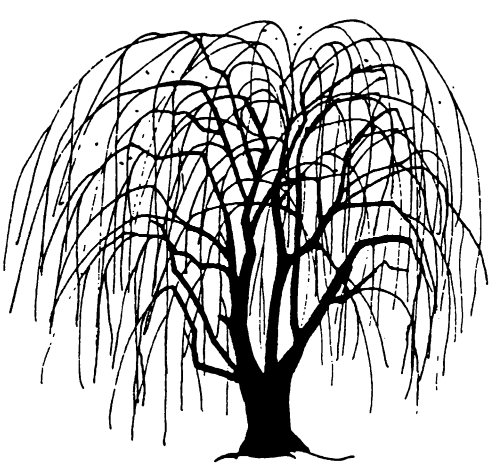
Shape is especially important in selecting trees for ornamental and shade purposes. Tall trees with long, spreading or weeping branches give abundant shade. Small trees and trees of other shapes, including the narrow, columnar Lombardy poplar, the pyramidal evergreens, the clump birch and the low growing Hawthorn, crabapple, and dogwood are useful for ornamental purposes but do not give abundant shade.



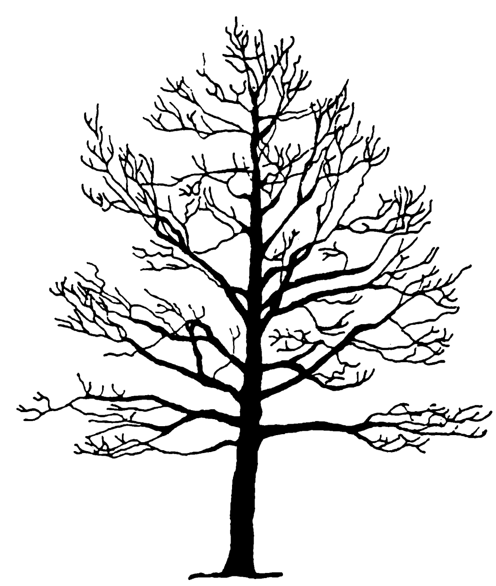
Trunk Single,
Branches Horizontal
White Pine



Trunk Dividing,
Branches Spreading
Elm

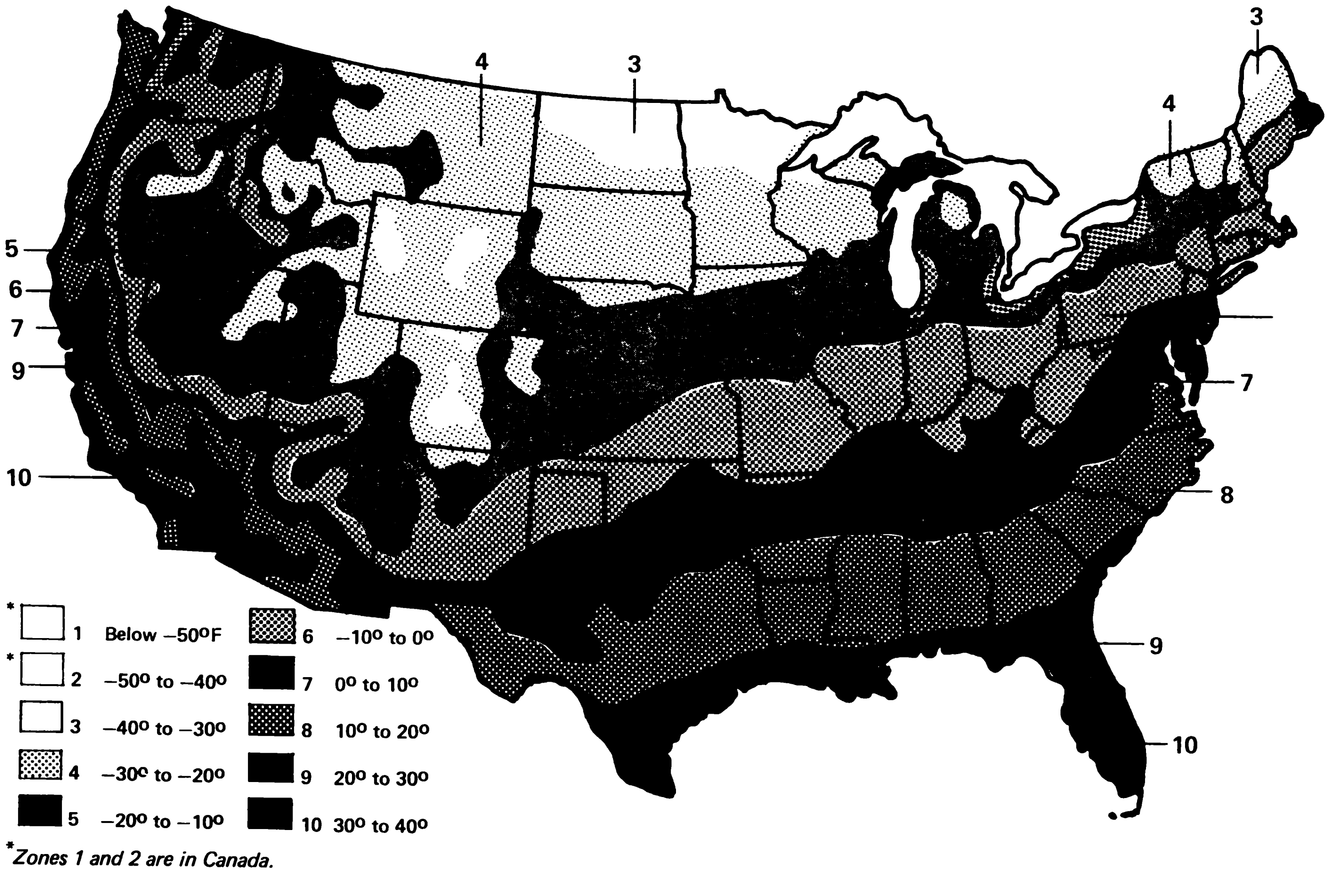


Branches Pendulant
Willow



Branches Ascending
White Oak

Environmental conditions should influence the selection of plants. Size of the planting area is important as is the site chacteristics such as sunny or shaded, wet or dry, exposed to winter winds or pollution. Plants selected should be tolerant of the existing conditions, and be hardy in the appropriate climate zone. The country is defined in a series of zones, based on the average minimum winter temperature.



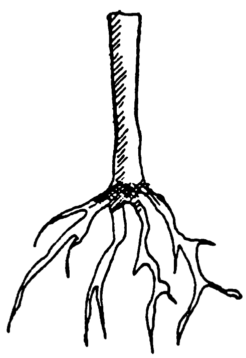
Finally, consider how much maintenance the plant will require and any possible disadvantages including susceptibility to attack by diseases and insect pests; soft or brittle wood that is easily damaged by wind and ice; fruits and seeds that are large, messy, smelly or otherwise obnoxious, and abundant shedding of twigs and small branches. Some examples of these conditions are killing of Lombardy poplar by Cytospora canker or by borers, breaking of Siberian elm branches by wind and ice, and the production of bad smelling fruit by the female ginkgo. The production of fruit by the mulberry, which as previously mentioned, attracts birds, can also be an undesirable characteristic. Since this fruit is soft and decomposes rapidly when ripe, it is messy on walks and attracts flies and other insects.

PURCHASING TREES AND SHRUBS

Once the selection process is completed, plants can be purchased. Transplants can be classified into three classes according to the way they are dug and/or shipped: bare rooted plants, balled and burlapped plants, and container grown plants.

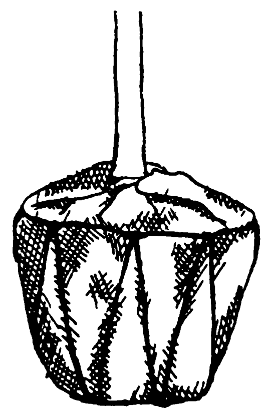
Bare Rooted Plants These have had the soil washed or shaken from their roots after digging. Nearly all are deciduous trees or shrubs which are dormant. Most mail order plants are of this class because plants in soil are too heavy to ship economically. A good many tap rooted plants, such as nut trees and some fruit and shade trees are handled this way because they are not amenable to balling and burlapping. Plants available in nurseries in early spring with roots wrapped in damp sphagnum and packaged in cardboard or plastic containers, are also bare-rooted plants. These need special attention because their roots are tightly bunched up in unnatural positions in order to force them into the package. Discard the sphagnum packing and be sure to spread the roots out to a natural position.

Plants in the bare root class are planted while they are dormant. Fall planting is well suited for these plants. Never let the roots dry out. This is perhaps the single most important source of failure with bare rooted plants. Keep roots in water or wrapped in plastic or wet paper until you are ready to place the plant in the hole. This class of plants may need extra pruning at planting time.

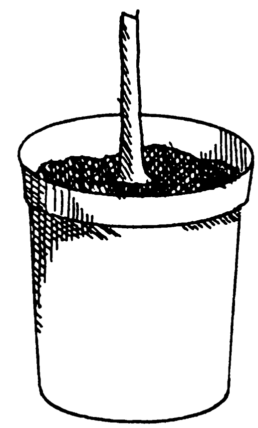


a. Bare root

b. Pre-packaged bare root



c. Balled and burlapped



d. Potted and container grown

Balled and Burlapped Plants These are likely to have been grown in nursery rows for some time and to have been root pruned so that the root system within the balls is compact and fibrous. Such plants re-establish themselves rapidly. This method is primarily used for plants that never lose their foliage and thus are not amenable to bare root treatment. Such plants are broadleaf evergreens like rhododendrons and azaleas, and conifers of all types. A number of deciduous trees and shrubs that have branching root systems which are easily contained in a soil ball are also sold as B & B plants.

Plants in this class are planted almost any time that the ground can be worked. Plants put out in summer will need special attention to keep them adequately watered.

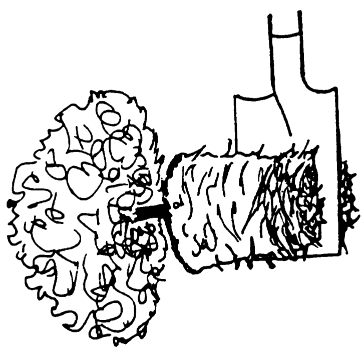
When selecting a balled and burlapped plant, be sure that the ball is sound and hasn't been broken. Avoid those plants that feel loose in the soil balls. Be sure that the soil ball does not dry out. These plants usually will need very little pruning at planting.

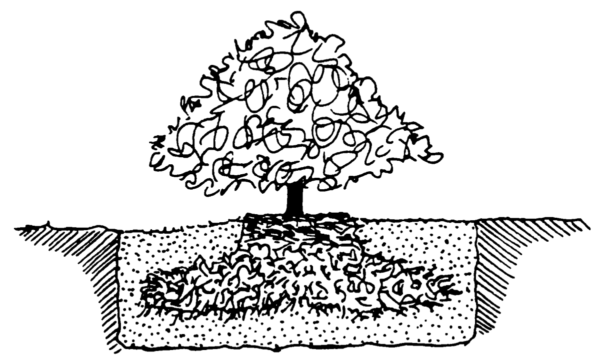
Container grown Plants These are usually grown in the container in which they are sold. They are increasing in popularity in the nursery trade. Because of their appearance, gardeners are often misled into thinking that all they have to do is plunk these plants into the ground and forget about them. Nothing could be further from the truth.

These plants can be planted whenever balled and burlapped plants are planted.

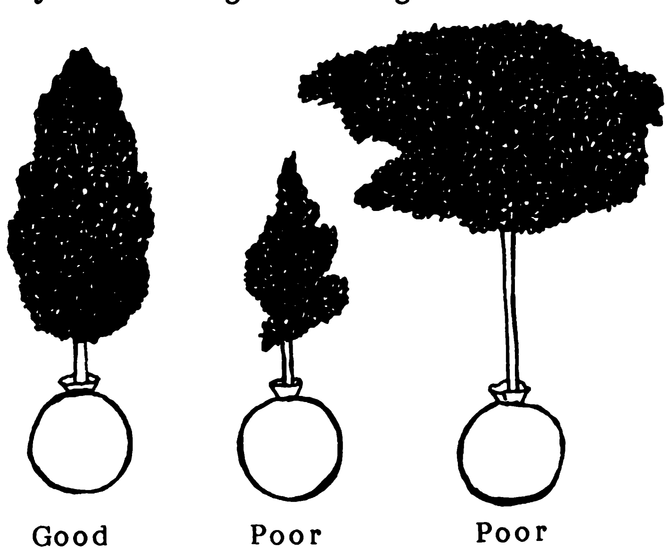
This class of plants may have what may be called a container habit. Their roots are contained in a limited space and coiled around one another in the container, and may fill it tightly. Some of the larger roots may have become coiled back around the trunk and begun a process called root strangulation, or girdling root.

The solution to container habit is to split the lower half of the root system and spread the roots horizontally. This practice will prune the roots, thus encouraging new laterals, prevent girdling roots and raise the lower roots closer to the soil surface.



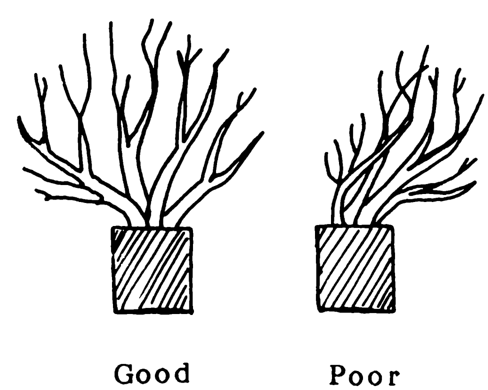


When selecting plants, look for a good natural shape, free from thin spots or broken limbs. Make sure the root ball is solid and the bark has no broken places. Avoid container grown plants where you can see roots circling on the surface or coming out of the drainage holes. Plants chosen should be free of any insects or diseases. Generally, the smaller sizes of a plant will cost less, and may establish faster. Don't buy plants so small they are in danger of being walked on or mowed over.

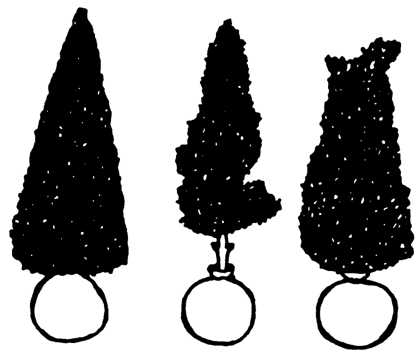


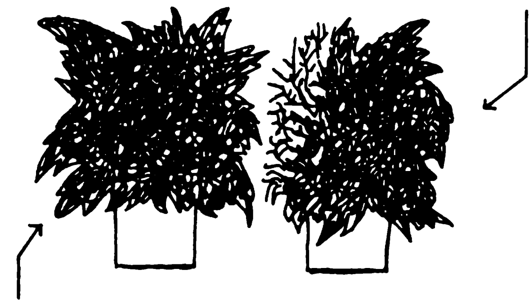
PROPORTION OF ROOTS TO TOP

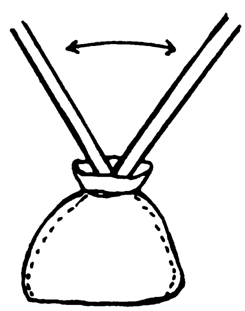
SHRUB SYMMETRY



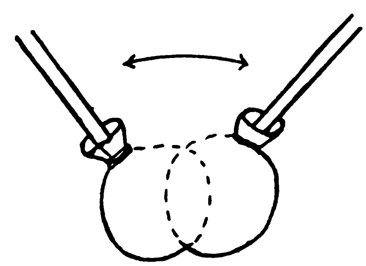
Evergreen Silhouettes



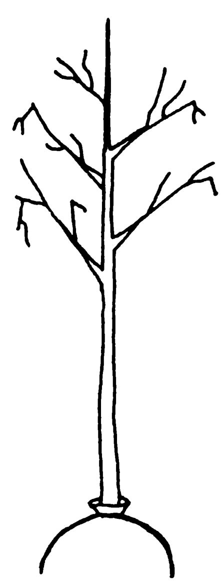




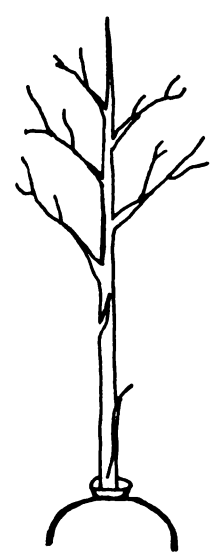
Loose root ball is unacceptable.



Root ball of acceptable B&B plant stays firm when rocked gently.



Broken twigs are acceptable.



Broken branches, gouged trunk are unacceptable.

PLANTING TREES AND SHRUBS

The proper installation of plants in the landscape involves much more than just digging holes and setting plants in them. The planter is responsible, as far as possible, for developing a satisfactory microclimate for optimum growth and development of the plant. A healthy and vigorous plant is required if the landscape is to achieve the desired effect. Healthy plants will need less maintenance in the years following establishment.

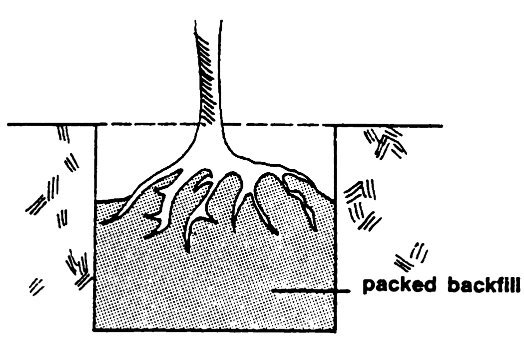
The planting hole is of real importance since this is the environment of the plant root system. Plantsmen make many suggestions about how large the planting hole should be, but generally if the hole is twelve inches wider in diameter and six inches deeper than the soil ball, the size will be adequate. For very large specimens, such as trees of four-inch caliper or more (the term caliper is derived from the use of a caliper to measure the trunk diameter) and large shrubs with a soil ball of three feet or more, the hole should be made up to twenty-four inches wider. The depth, six inches deeper than the soil ball, remains the same.

A traditional recommendation for preparing a planting hole for trees and shrubs has been to incorporate organic matter into the backfill soil before returning it to the hole around the plants. Recent research has cast doubt on the value of this practice. In fact, it appears that energy could be better spent digging a slightly larger hole than working organic matter into the soil.

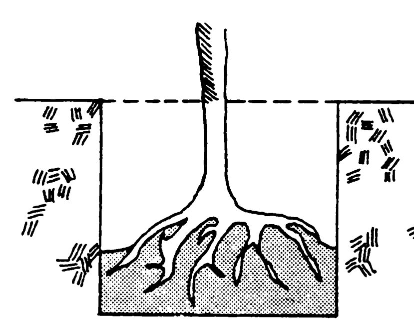
Apparently, the addition of organic matter into the backfill soil creates an interface between the amended soil and the undisturbed soil around the planting hole that is detrimental to root growth and water movement between the two soils. In tests conducted at the University of Georgia, examination of the root systems of plants in holes with amended soil revealed that the majority of the roots were confined to the original planting hole.

Add six to eight inches of backfill before placing the plant in the hole. Firm in place to reduce settling. This should bring the top of the soil ball to a level slightly higher than the surrounding soil. The finished planting depth after settling of the soil should be such that the plant is exactly the same depth after replanting as when growing in the nursery. Probably more plants are lost because they were planted too deep than for any other reason.

Proper planting depth

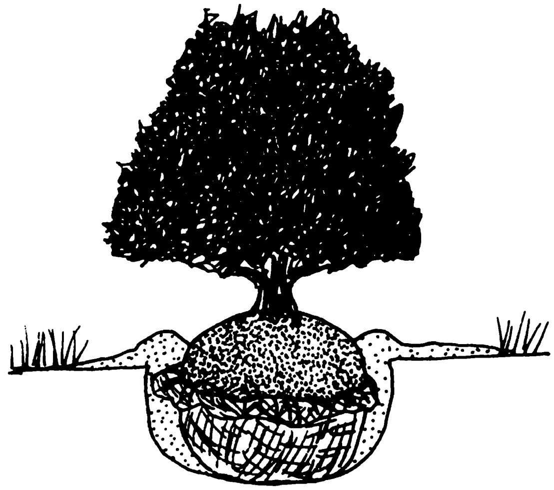


correct



incorrect

An acceptable amount of settling of the plant will occur with the use of six inches of backfill in the bottom of the planting hole. However, in certain sections of the country wet springs (the main planting season) are common. Then six inches of backfill in the bottom of the planting hole may result in excessive settling. A more practical approach if weather conditions of this type are prevalent is to excavate the hole no deeper than the depth of the soil ball. When planting a poorly drained site, set plant so that several inches of the root ball are above the soil level.

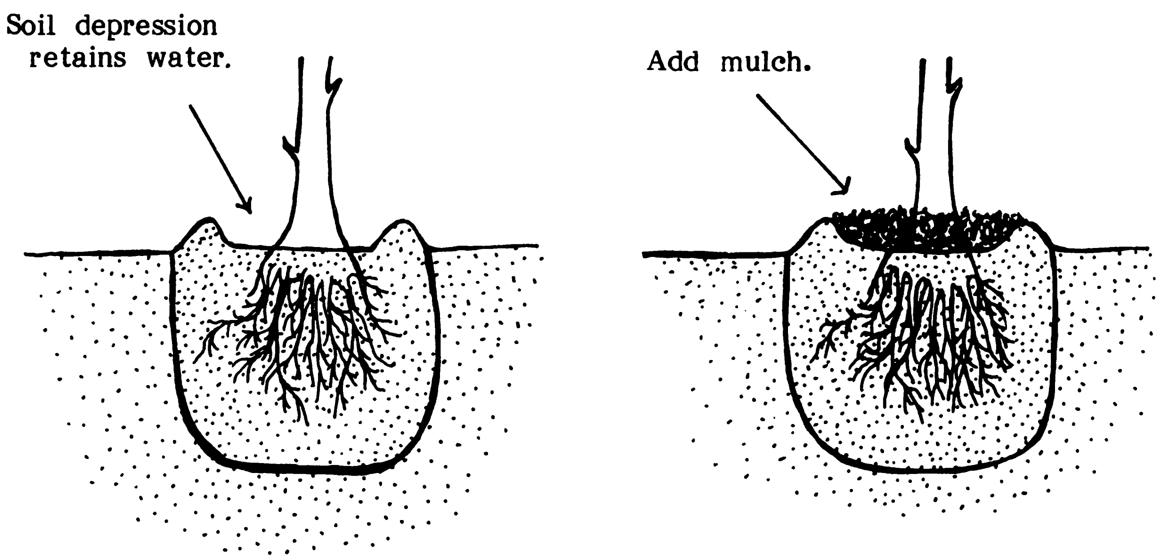


Once the six inches of backfill has been added, carefully place the plant in the hole. Balled and burlapped material (referred to as B & B) must be handled carefully. On most species if the soil ball is broken for any reason, many of the roots will be severed from the trunk and the plant will die. Always pick the plant up by the soil ball or container, never by the trunk or stem. The burlap should not be removed from the soil ball of B & B plants. Remove all plastic or metal containers before placing the plant in the hole. Small containers with tapered sides can be removed by turning the plant upside down and giving the top edge of the container a sharp rap. Catch the soil ball in the hands as it slips from the container. Do not break the soil ball apart. The larger sized containers, of five gallons or more, should be cut away with special cutters. If the plants have become overgrown in the container and the root mass is growing in a tight, compact circle around the soil ball, cut out the outer roots with a sharp knife in two or four places around the soil ball. Make the cut from the top to the bottom of the soil ball. Decomposable containers (papier mache) need not be removed from the soil ball.

Bare-root plants should have the packing material and all damaged or dead roots removed. If possible, before planting, the roots should be soaked in water for at least one hour but not longer than twenty-four hours. Do not allow roots to be exposed to sunlight or dry out before planting. It is best to keep bare roots covered with moist burlap or some reasonable substitute until planting time.

After the B & B plant or container grown plant has been placed in the hole, fill in around the plant with the backfill until the hole is two-thirds full. With the bare-root plant the soil should be worked gently in and around the roots while the plant is being supported. The most satisfactory way of firming the soil and removing air pockets is to fill the hole with water. If it is not practical to use this procedure, firm the soil by hand around the plant ball or roots. However, be sure not to use excessive force, since soil compaction should be avoided.

Before finishing the filling process, make certain the plant is straight and at the proper depth then complete the filling process with the backfill. If the specimen is an individual, construct a ring of earth two to three inches high at the edge of the outside diameter of the hole to form a water basin. Plants in beds probably will not require a water basin. Water the plant thoroughly as soon as the water basin is constructed. After the water has soaked away, fill the basin with a mulch material. Organic mulches such as pine needles, bark, and wood chips provide the best environment for future root development.



It should be noted that no fertilizer is added to the backfill mixture. Newly developing roots can be damaged by too much fertilizer. If it is apparent from knowledge of the soil condition that fertilizer is needed, add a water soluble material at the recommended rate during the final watering phase. Large areas should already have an established fertility level based on recommendations from soil test results before the planting of individual plants takes place. A fertility program should begin late in the fall of the first growing season.

TRANSPLANTING NATIVE TREES

Many homeowners who transplant native plants from the woods are often disappointed because the plants die. Nursery trees are root pruned a year or more before transplanting is to occur, which results in a compact root system. This allows more of the roots to be dug up when transplanting.

For success in transplanting native plants, it is important to understand the environment in which they are growing naturally. Duplicating this environment on the new planting site is the key to the plant's survival. Some environmental factors to consider include light, soil moisture, and soil acidity. Most of our native soils are slightly acid, so you may have to adjust the soil pH in the new location. This can be determined by having the soil tested at your local Extension Office well in advance of anticipated transplanting. Soil moisture can vary within the distance of a few feet. Plants growing naturally on a slope probably require good drainage, while those growing in bogs require wet conditions. Similarly, if the soil is sandy, the plant will transplant best into sandy soil. A plant growing on the edge of the woods generally requires more light than one in a deep thick forest. These environmental conditions must be similar at the new location.

The following planting conditions will increase the chance of survival:

> Root prune by dividing the circumference of the root area to be dug into six segments, and prune with a sharp spade every other segment two years prior to transplanting, and the remaining segments the year prior to transplanting. Since roots form at the cut edge, the root ball that is dug for transplanting must be larger than the pruning cut to get the maximum number of new roots.
>
> Transplant during the dormant season.
>
> Dig a hole no deeper and 6 to 12 inches wider than the root system. Refill with a mixture of enough existing and native soil of the plant to accommodate the root ball or bare-root system. Set the plants a few inches higher than when growing in the woods.
>
> Firm the soil and water thoroughly. The plant should now settle so it will still be a higher depth than it was before transplanting. Avoid planting too deep.
>
> Mulch with approximately 2 inches of decayed sawdust, leaf mold, or other available materials.
>
> Stake, using either the 2 or 3-stake method to insure a straight trunk and to prevent small plants from being stepped on.
>
> Do not use high nitrogen fertilizer at the time of planting.
>
> Adequate soil moisture is critical for several months after transplanting. Water only when necessary. Overwatering will result in sure death. To determine if the soil is dry, stick your finger 1 to 2 inches below soil surface. When necessary water slowly in order to soak the ground thoroughly.

CARE OF TREES AND SHRUBS

Pruning and Supporting Newly Installed Plants

An initial pruning may be needed immediately after planting. Container grown and B & B plants require only the removal of all broken and damaged branches. Bare-root stock may require more severe pruning since the root area has been markedly reduced during digging. For these plants, it may be helpful to reduce water loss by removing one-third of the leaf area. This pruning can be done by using the thinning process. Be sure not to ruin the natural growth habit of shrubs, and do not remove the central leader of trees.

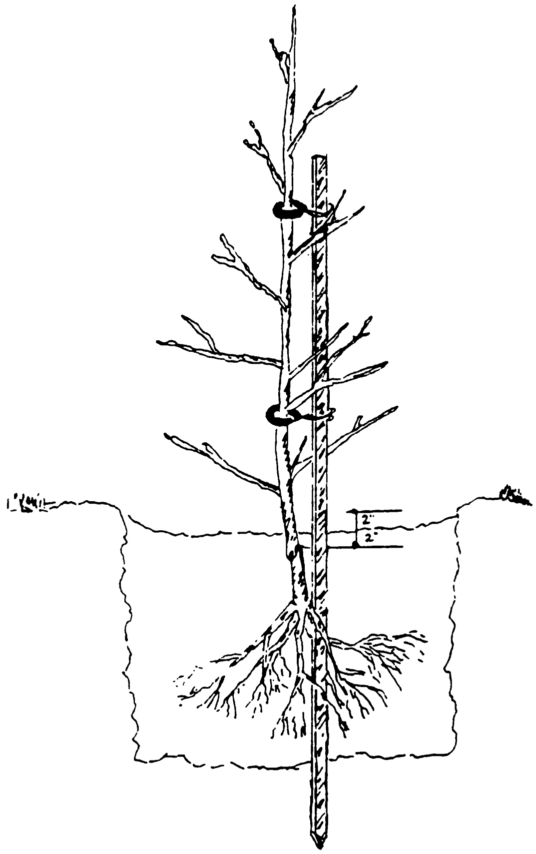
With all newly planted woody plants, it is usually more successful to avoid heavy pruning at planting if you can insure that the plants will be well-watered during their first year or two in the ground. Pruning reduces the leaf area; this reduces transpiration but also reduces the leaf surface area which produces photosynthates for root growth. Since the plant will not resume a normal growth rate until the original root system size is re-established, one is better off to avoid wilting by watering, than by canopy pruning. This also avoids a proliferation of suckers in the inner canopy.

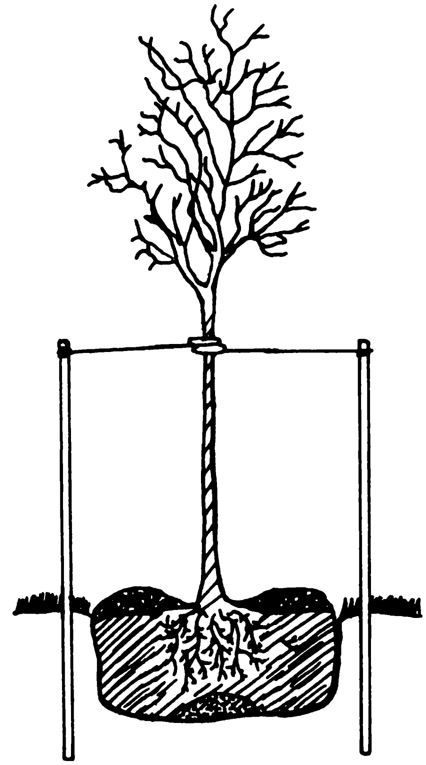
Most shrubs do not need to be supported after planting unless bare-root stock has been planted that is quite large, or very tall B & B specimens have been used. If so, use the same techniques for shrubs that will be described for trees.

A general rule of thumb is to provide support for all bare-root trees over eight feet in height. Smaller B & B or container grown trees usually do not need support. Trees that are quite large, six inches or more in diameter, should be supported. There are several methods for supporting smaller trees, any one of which is satisfactory. A single stake about three-fourths the height of the bare-root tree should be driven at a distance of two to four inches from the center of the planting hole, so that the stake will be on the southwest side of the tree trunk. This should be done before the tree is placed in the hole. Then plant the tree according to the procedures described in the previous paragraphs. After the planting is completed, fasten the tree to the stake with a wire or a suitable substitute formed in a loose loop. Before fixing both ends of the wire to the stake, slip a short length of rubber hose onto the wire. The part of the wire in contact with the trunk should be covered with the rubber hose to prevent injury to the bark as the tree moves in the wind. The advantage of this method of support is that the stake is close to the trunk and does not cause maintenance problems. In turf areas, stakes and guy wires outside the perimeter of the planting hole can be troublesome since they hinder mowing operations. Under no circumstances should this method of support be used on B & B or container grown stock, for it is usually not possible to locate a stake close to the trunks of such stock before planting, and if driven through the soil ball, the stake will cause damage to the soil ball and the roots.

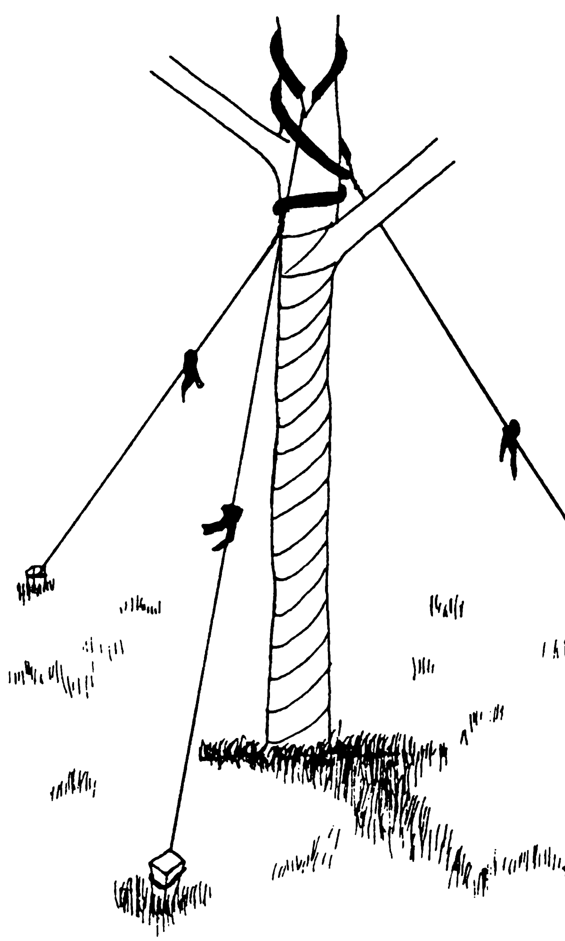
A more satisfactory method of supporting small trees is to use two parallel stakes driven solidly at least eighteen inches into the firm soil about a foot beyond the planting hole on opposites sides of the tree. The height of the stakes after being driven into the ground should be approximately two-thirds that of the tree. The tree is then supported by wires attached to both stakes and looped loosely around the trunk. A rubber hose length can be used to protect the tree trunk.

A third method, the one most commonly used, is to fasten three guy wires to stakes that have been fixed in firm soil around the edge of the planting hole at an equal distance from the hole and from each other. Stakes are generally used on smaller plants. They should be driven 18 to 30 inches into the ground at a 45° angle away from the tree trunk. It is absolutely essential that all three stakes be firmly fixed so that one or more of them will not pull out in high winds. The top of the stakes are notched to hold the wire. The wire is then fastened two-thirds of the way up the trunk by a loose rubber-hose covered loop. The other ends of all wires should be fastened equally tightly, without putting a strain on the trunk, to the stakes. The wires should be firm but loose enough to allow slight movement of the tree, a factor essential to its proper development.

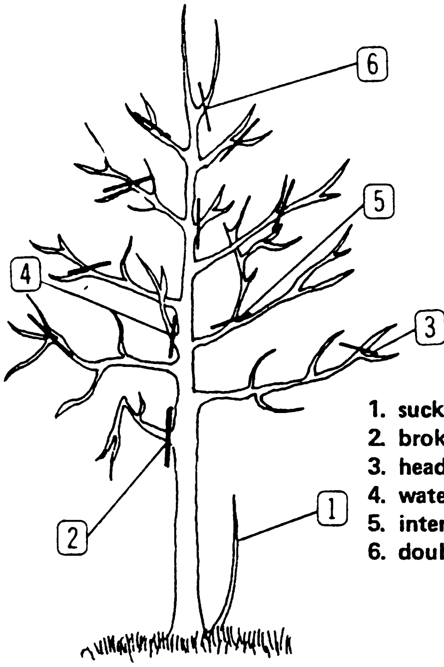




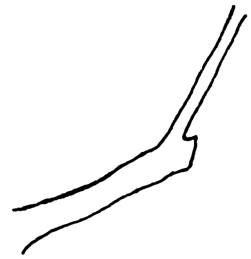
Guying trees greater than 3″ caliper



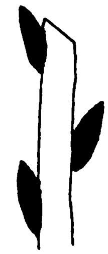
Pruning at planting time



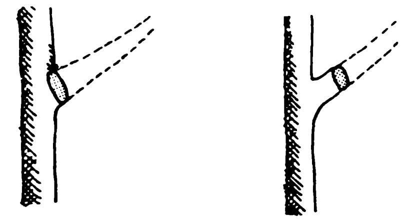
1. sucker
2. broken branch
3. heading back side branch
4. water sprout
5. interfering branch
6. double leader



head back to a side branch ....



or bud



leave no stubs

All support should be removed from the small trees within one year after planting. The tree should have become established in this period of time, and it has been reported that growth is actually reduced if the supports are left in place for longer periods of time.

Plants in your landscape will require periodic maintenance to produce the best effects. This includes fertilization, winterizing, mulching, watering, and pruning. Pruning is covered in another chapter.

Fertilizing Trees and Shrubs

Ornamental trees and shrubs planted in fertile well drained soil should not require annual fertilization. Trees and shrubs that are growing well don't require extra nutrients. If you have ornamentals that are not doing too well, fertilization may be helpful but only after the problem causing poor growth has been corrected.

Poorly growing plants will exhibit any or all of these symptoms:
- light green or yellow leaves
- leaves with dead spots
- leaves smaller than normal
- fewer leaves and/or flowers than normal
- short annual twig growth
- dying back of branches at the tips
- wilting of foliage

These symptoms of poor growth may be caused by inadequate soil aeration, moisture, or nutrients; by adverse climatic conditions; by wrong pH; by disease or by other conditions. You should attempt to determine the specific cause in each particular situation and apply corrective measures. Do not assume that an application of fertilizer will quickly remedy any problem which is encountered.

The cause of poor growth may or may not be evident. Ornamentals transplanted or disturbed by constructions within the past five or ten years may be in shock, their root systems having been disturbed. Pruning to balance the top growth with root growth at the time of the injury will help, followed by fertilization.

Good soil drainage to a depth of at least 2 feet is needed for ornamental trees and shrubs in the landscape planting. Plants on poorly drained soil may exhibit one or more symptoms of poor growth. If the site is low, install drainage tile to remove excess water before the plants are set out. The tile must have an outlet at a lower level so the water can move out freely. If the use of tile is impractical, or a suitable outlet for the water cannot be arranged, the grade may be elevated by using fill to provide better runoff and drainage conditions.

Most trees and shrubs tolerate a rather wide range of soil acidity. A range of pH 6.0 to 7.0 is suitable for most landscape plants. They usually will make satisfactory growth without special treatment to raise or lower the pH of the soil.

Plants such as andromeda, azalea, blueberry, camellia, laurel and rhododendron are exceptions to the above rule. They grow best on an acid soil with a pH of 5.0 to 5.5. On soils with a pH of 6.0 or higher, these acid loving plants may become quite yellow and grow poorly.

Soil pH can be lowered quite easily for these acid loving plants. You should first have the soil tested to determine the pH level. If the pH is too high, it can be lowered by using sulfur, iron sulfate, or aluminum sulfate.

Apply sulfur at the rate of 1 lb. and aluminum sulfate at the rate of 2 lbs. per 100 square feet to reduce a loam soil 1.0 pH value, and make it more acid. Use 1/2 as much on sandy soil and 1 1/2 times as much on clay soils. After several months, test the soil again to determine the effectiveness of treatment. You may need to repeat the application every year or two to maintain the desired pH level.

Severely cold or hot, dry weather may be injurious, especially to plants exposed to the wind or to those that are near the limits of their natural zone, such as southern magnolia and white birch. Small plants can be protected with burlap aprons, and mulching heavily in early winter will help conserve moisture. Consider another species more appropriate to the site.

Injury from insects, diseases or air pollution can devitalize a tree or shrub, resulting in premature death. Fertilization of such plants should be carried out with caution since over stimulated plants become weakened, predisposed to diseases, and attractive to pestiferous insects.

Small trees and shrubs that are weak should have between one-half and a full cup of 10-10-10 fertilzer spread evenly under their branches in late winter or early spring. Fertilization in summer may cause serious injury the following winter by stimulating late growth that will not harden off before frost.

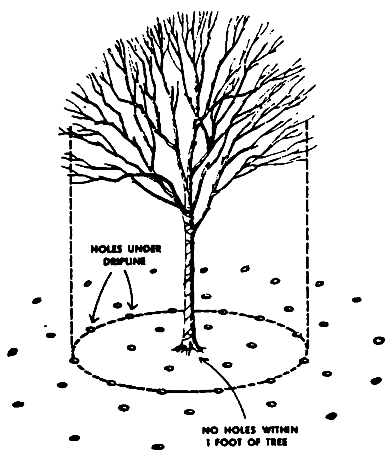
Large trees that need stimulation require a pretty good dose of nitrogen. Research indicates that complete fertilizers usually are not essential. To determine how much nitrogen is needed, measure the diameter of the tree at breast height. For each six inches of diameter, apply one pound actual nitrogen. (One pound actual nitrogen equals ten pounds of 10-10-10 or three pounds ammonium nitrate 33-0-0 or twenty pounds 5-10-10). Application should be made in December or January. Spread the fertilizer evenly under the branches. Soluble nitrates will move into the soil quite readily. This amount of nitrogen may injure turfgrasses, especially if the weather is dry. Do not fertilize trees unless they need it!

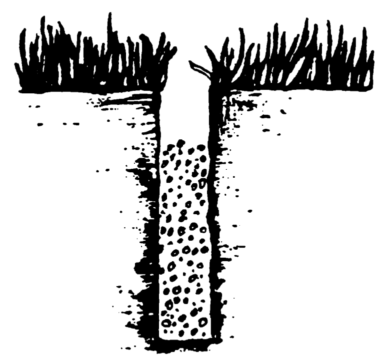
Mature trees which are making weak growth on poor soils may benefit from having fertilizer placed in holes around the tree. The holes should be about fifteen inches deep, one or two inches in diameter, and eighteen to twenty-four inches apart. They should be spaced uniformly over the area of greatest root concentration. Professional arboriculturists who have pneumatic equipment for making holes in the soil commonly use this method.

An easy way to mark off the area to ensure complete coverage is to make concentric circles with narrow bands of ground limestone. Make the first circle about twelve inches from the trunk and successive circles at eighteen to twenty-four inch intervals, to a point three to five feet beyond the end of the branches. Then punch holes at eighteen to twenty-four inch intervals along the circles taking care to avoid major roots. The holes can be made with a punch bar when the soil is moist after a period of rain or sprinkler irrigation. Commercial landscaping concerns make the holes with air hammers or special air blast equipment. However, some recent researchers have begun to cast doubt on the actual effectiveness of drilling holes as compared to simply placing the fertilizer on the surface of the soil.

Apply the fertilizer at the rate of three pounds of 5-10-5 formula for each inch of trunk diameter measured three feet above the ground. Mix fertilizer with equal parts of dry soil or sand and fill each hole to within six inches of the top. Water can be used to cause the fertilizer to move out into the soil around each hole. Fill the top portion of each hole with rich garden loam.

If part of the root zone is covered by the pavement of a walk or drive, it may be necessary to locate the holes closer together in the lawn covered portion of the root zone to apply the desired amount of fertilizer. Roots also tend to be more extensive in the cooler soils in the northern quadrant around the tree.





The fertilizer in the holes will become available quite slowly. Thick concentration of feeder roots usually develop near each point of application. The trees should show renewed vigor the year after application. Treatment should not have to be repeated for several years.

Depending on the reason a large tree is doing poorly, fertilization might be called for each year. However, a feeding program must be coupled with proper cultural practices. For example, neglecting necessary insect or disease control and failure to remove dead wood from a large shade tree will negate the positive effects of fertilization. Fertilizer is not a substitute for water during drought.

A moderate rate of growth and good green color is all that is desired of woody plants. Excessive vigor which is evident by lush green leaves and long shoot growth, is undesirable. Such plants are more susceptible to injury by cold in winter, are more likely to be broken during wind and sleet storms, and usually will have a shorter life than those making moderate growth.

Mulching Plants

For year round benefits of mulching, apply a two inch mulch of aged sawdust, fresh shredded bark or wood chips, or peat moss around shrubs, roses, and recently planted trees. This mulch will conserve moisture, and help suppress the growth of weeds and grass. A two inch layer should be used under the branches of shrubs and roses of all ages. A circle of mulch three or four feet in diameter should be maintained for several years around recently planted shade trees.

Sawdust or shredded bark from the inside of a large pile may go through anaerobic decomposition and become very acid, with a pH of about 3.0 and a pungent odor. Such material is toxic to plants.

In some cases, mice may tunnel in the mulch and cause damage by chewing the bark from the stems of shrubs. This is more likely to happen when coarse materials like straw, hay, or pine needles are used. The best control is to keep the mulch back about six inches from the stems, and trap or poison the mice. A circle of crushed stone or coarse sharp cinders about six inches wide around the stems may also be helpful.

Mulch should be maintained for at least three or four years around newly planted ornamental trees. It should extend at least three inches from the trunk, and be renewed as often as necessary to maintain a layer two inches thick. A circle of mulch will make it easier to mow around young trees with less possibility of damage to the bark. The layer of mulch should be renewed to a two inch depth, if necessary, after a killing frost in the fall.

Both organic and inorganic mulches can be useful in the home landscape. Some of the more readily available ones include:

<u>Sawdust</u> A 2" layer of sawdust provides good weed control. If applied around growing plants, add 1/2 pound of actual nitrogen per 10 cubic feet of sawdust to prevent nutrient deficiencies; fresh sawdust contains a great deal of carbon and very little nitrogen, and its breakdown requires that microorganisms take nitrogen from the soil. A very thin layer of sawdust (1/4") is useful in starting seeds because it helps keep moisture in; again, be sure nutrients are adequate. There is often a problem with crusting of fresh sawdust, with resulting impermeability to rainfall. Sawdust is best used for garden paths and around permanent plantings. Readily available from sawmills.

<u>Bark</u> A 2-3" layer of one of several types of bark provides good weed control. Bark is slow to decompose and will stay in place. Shredded bark decomposes more quickly than the "stone" types. Bark and wood chips are often available free or for a small charge from professional tree pruning services, or may be purchased in large bags at retail stores. These make a very attractive mulch, and are especially recommended for mulching around trees and shrubs. When used over black plastic around perennials, bark provides effective weed control for long periods of time. Be sure there are holes in the plastic to allow water penetration.

Hay or straw A 3-4" layer of hay provides good annual weed control. Some people use a one-foot compacted layer of straw, pulling back the layer for planting. This provides excellent weed control. These materials decompose quickly and must be replenished to keep weeds down. They stay in place and will improve the soil as they decay. Avoid hay which is full of weed seed and brambles. Fresh legume hay, such as alfalfa, supplies nitrogen as it quickly breaks down. Hay and straw are readily available in rural areas, but city dwellers may not be able to obtain hay. Straw, on the other hand, may be purchased at most garden centers, often commanding a high price. Both are recommended for vegetable and fruit plantings but not for ornamental plantings.

Pine needles Baled pine needles are also found in garden centers for use as mulch. They make an excellent mulch for acid-loving plants, but can release too much acid for many vegetable plants. Pine needles are best used around shrubs and trees, particularly acid-loving types. Readily available.

Grass clippings A 2" layer of grass clippings provides good weed control. Build up the layer gradually, using dry grass, to prevent formation of a solid mat. Clippings will decompose rapidly and provide an extra dose of nitrogen to growing plants, as well as making fine humus. Avoid crabgrass and grass full of seed heads. Also, do not use clippings from lawns which have been treated that season with herbicide or a fertilizer-herbicide combination ("weed and feed" types). Grass clippings may be used directly as mulch around vegetables or fruit plants, or they may be composted if added to the pile a little at a time. They are an excellent source of nitrogen to help increase microbial activity in the compost pile, especially for those gardeners without access to manures.

Leaves A 2-3" layer of leaves, after compaction, provides good weed control. Leaves will decompose fairly quickly, but are easily blown unless partially decomposed. Leaves are usually easy to obtain, attractive as a mulch, and will improve the soil once decomposed. Highly recommended as a mulch.

Peat moss A 2-3" layer of peat moss will give fair to good weed control. This material is slightly acid, and thus suitable for use with acid-loving plants. However, peat tends to form a crust if used in layers thick enough to hold weeds down, or it may be blown away. Peat is also a relatively expensive mulching material, probably more suitable for incorporation into the soil.

Compost A 2-3" layer of compost is a fair weed control. Most compost, however, provides a good site for weed seeds to grow. It, too, is probably better used by incorporating it into the soil, since it is an excellent soil amendment. A layer of compost may be used on overwintering beds of perennials, such as asparagus or berries to provide nutrients and help protect crowns.

Hulls and ground corncobs A 2-4" layer of these materials will provide fair weed control, but both have a tendency to be easily blown by the wind. Peanut hulls will stay in place somewhat better than corncobs. A heavier mulch, such as partially rotted hay or straw, may be used on top to hold the lighter materials down. Recommended if readily available in your area.

Gravel, stone, and sand A one inch layer of rock will provide fair weed control. Rocks, of course, do not decompose noticeably. They make a good mulch for permanent plantings, as around foundation plants and in alpine gardens, but are not recommended for acid-loving plants, since alkaline elements within the rocks may dissolve and leach into the soil. None of these mulches are effective in controlling erosion; soil will wash right out from under rocks, and sand will be swept away. Availability varies with area.

Black plastic One layer of black plastic provides excellent weed control. It is relatively slow to decompose, but will be somewhat broken down by sunlight and must be replaced every two years at least. Black plastic mulch will increase the soil temperature by about 8 degrees F. in the spring. It may cause soil temperatures to rise too much in mid-summer, though, "cooking" the roots of plants unless a good foliage cover or organic mulch prevents direct absorption of sunlight. Check periodically to see that soil remains moist beneath the plastic; cut holes in it if water doesn't seem to be getting through. Black plastic is easy to obtain, but is fairly expensive. A new type of black plastic has recently come onto the market which has a white, reflective side to prevent the overheating problems experienced with solid black plastic.

Clear plastic One layer of clear plastic will provide little weed control; in fact, it makes an excellent greenhouse environment for growing weeds. This material is most often used to raise the soil temperature early in the spring to prepare an area for planting. It will raise the soil temperature by 10 degrees or more. It is not recommended as a weed-controlling mulch. Clear plastic is readily available, and somewhat less expensive than black plastic.

Paper Using 2-4 layers of newspaper provides good weed control. It decomposes within a season and is readily available and cheap. Cover with an organic mulch, such as sawdust or hay, to hold paper in place. Excellent for use in pathways and around newly set strawberry plants. Lead in printers' ink has been a concern of some gardeners desiring to use newspaper; however, printers no longer use lead compounds in ink for black and white newsprint, though colored inks may contain lead.

Aluminum coated plastic and foil One layer of either of these materials provides excellent weed control. Decomposition is very slow. Soil temperatures are decreased by up to 10 degrees F. They provide additional reflection of light to help speed up fruiting of such vegetables as peppers and eggplant in not-so-sunny gardens. The reflective quality of aluminum foil has been shown in university tests to inhibit the colonization of plants by aphids. Expensive. Unattractive.

Watering Plants

Watering plants correctly is vital for developing and maintaining a landscape planting. Lack of water can cause a plant to wilt and ultimately dry up and die. Excessive water can cause root rot, in which case the plant wilts because it is oxygen starved and, consequently, is unable to take up moisture. As a rule, plants are capable of withstanding moderate drought more easily than too much moisture. For this reason, it is important to water thoroughly, yet allow the soil to become fairly dry between waterings.

Wilting is a condition brought about in plants when roots are unable to supply sufficient moisture to the stems and leaves. Wilting for short periods of time will not harm plants; over a prolonged period, however, it will cause permanent damage. Sometimes a plant will wilt on a hot day because moisture is evaporating from the leaves faster than the roots can supply it. If there is ample soil moisture, the plant will absorb water in the evening to firm up the stems and leaves.

In late summer or early fall it is not uncommon to experience a sustained period of wilting, particularly of broad leaved evergreens such as rhododendrons. Latest research establishes this condition as the cause of much leaf damage typically attributed to winter desiccation. When the leaves hang down and no rain is predicted, it is advisable to provide prolonged, deep watering to keep the leaves turgid. To wet the soil at least 6 inches deep requires 1 to 2 inches of surface water.

Container grown landscape plants may be susceptible to drought stress once they are transplanted to the landscape. Drought stress occurs because the well drained organic mix in which the plants are grown in the nursery is prone to rapid loss of moisture due to plant transpiration (loss of water from plant leaves) and evaporation from the soil surface. Even though moisture is available in the soil surrounding the organic mix, it does not move into the transplanted root ball rapidly enough to prevent moisture stress from developing. Research has shown that the available moisture in the container mix can be depleted in about two days in the absence of irrigation. For this reason, these plants are watered at least every other day while in the nursery. This routine should be followed after transplanting until the root system penetrates the surrounding soil back fill (approximately three to four weeks) where moisture is available for absorption by the plant.

Care must also be taken not to allow the transplant root ball to dry out because the organic mix is very difficult to rewet once it becomes dry. Water can be applied to a drought stressed plant where the root ball has become very dry and not successfully relieve the moisture stress because the medium does not readily absorb the applied water. In this case, water should be applied two or three times each day until the root ball has been rewet.

To maximize the effectiveness of watering practices:

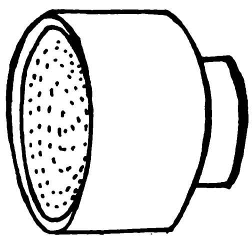
Know the condition of the soil. It is important to observe how quickly the soil dries out after a rain or watering. For example, a clay type soil will need less watering than a sandy one. Clay soil drains slowly, porous sandy soil quickly. The addition of organic matter to the soil will increase drainage in clay soil and moisture retention in sandy soil. When preparing a hole for planting, if the subsoil at the bottom of the hole is very hard and prevents water from draining quickly, it should be broken up with a shovel or a pick.

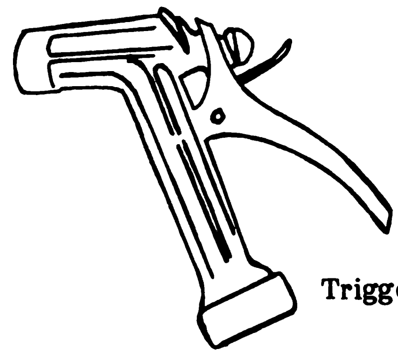
Learn the cultural requirements of plants being grown. Different plants have different water needs; azaleas require more moisture than cacti. The use of good reference books will provide the gardener with this information. It is particularly important to provide a relatively high soil moisture supply for evergreen plants during the fall before the ground freezes. The leaves of such plants continue to lose water during the winter, especially when the temperature is above 40°F. If the soil is dry, the plants may become desiccated, turn brown and die. Therefore, water your shrubs several times during the late fall, if the soil moisture supply is low.

Mulch plantings to reduce the frequency of watering during dry spells. Mulches help keep the soils cool and reduce water loss through evaporation.

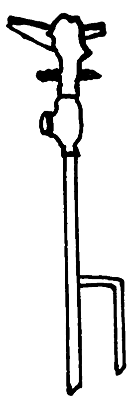
As with any job, to do it properly the gardener must have the right tools, namely: hose, water breakers, sprinklers, sprinkling can and utility pails.

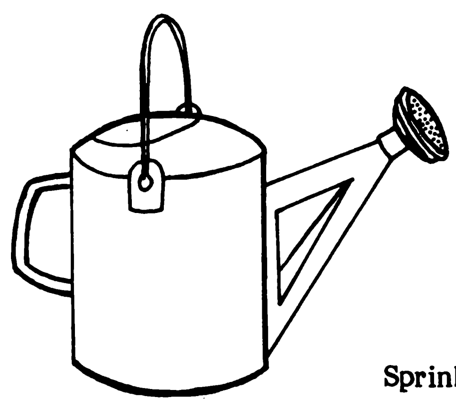
When acquiring a hose, make sure it will reach all plants in the garden so the end can be placed at the base of any plant. When watering individual plants with a hose, attach a water breaker to the end. It will concentrate a soft flow of water in a small area but will not wash away soil. Don't use a trigger type nozzle it will wash soil away from the roots.


Water breaker


Trigger-type nozzle

There are many types of good sprinklers on the market. One type is a spike sprinkler on a riser that can be adjusted from two feet to four feet. This sprinkles above shrubs and small trees, providing excellent water distribution. However, much water is lost to evaporation. Sprinklers should not be used on windy days, because water will be blown away from the desired location.


Spike sprinkler on riser


Sprinkling can

Sprinkling cans are appropriate for watering vegetable and flower seeds sown directly in the garden. A hose used for this purpose can cause seeds to be washed away. Until seedlings become well established, they should continue being watered with a sprinkling can. Utility pails are helpful when only one or two newly planted shrubs or small trees need water.

If the soil is dry when preparing a hole for a new plant, dig the hole and fill it with water the day before the plant goes into the ground. This allows the soil time to absorb water and does not create a muddy condition during the planting. Once a tree or shrub has been planted, the soil around the stem should be shaped to create a shallow depression the diameter of the root ball. Fill the depression with water. This permits water to go straight to the root zone rather than runoff the surface. Thorough soaking after planting eliminates air pockets around roots.

It is important when planting (particularly container grown material) to avoid covering the top of the root ball with more than one-half to one inch of fine soil. Otherwise water can be diverted sideways through the native soil and not soak down into the root ball where it is needed.

When there is an extended period without rain during the summer, new plants should be deeply watered once a week. By allowing the soil surface to dry out somewhat between waterings, major root development will be at greater depths where soil moisture is highest. Plants watered frequently but lightly will have roots close to the surface, making them more vulnerable to wilting. They will not become well established and will have little drought tolerance. This happens with automatic overhead sprinkler systems that are designed to go on for a short period of time each night and only moisten the surface. This practice also encourages many foliar diseases in midsummer.

During cool seasons less watering is necessary because evaporation from the leaves and soil is slow. Normally, abundant rainfall during spring and autumn diminishes the need for watering. During any dry autumn before the ground freezes, all garden plants should have a thorough watering to help prevent root damage to the plants from the cold temperatures of winter. Damage to roots from unusually cold temperatures around the roots shows up in the spring in the form of leaf drop because there are then not enough roots to support the foliage.

With well established groups of woody plants, watering should be done every ten days during prolonged dry spells. Since root systems of established plants are rather widespread and deep, it is vital that enough moisture be put down to reach them. A general rule of thumb is that one inch of water penetrates six inches of soil. If a sprinkler is set up to water a group of plants, a coffee can should be placed in range of the sprinkler. When one inch of water accumulates in the can, one inch of water has been distributed in the soil.

Plantings watered by surface flooding need some form of water retention to prevent runoff. Shallow trenches can be created between the rows of plants and flooded to a depth of one to two inches. This method works well on level ground where plants are grown in rows.

The best time to water is in the morning or evening when air temperatures are lower than at midday, thus reducing evaporation. In the evening do not wet foliage because this can encourage fungus or mildew, making plants unsightly and jeopardizing their health.

Winterizing Trees and Shrubs

It is often necessary to give a little extra attention to plants in the fall to help them over winter and start spring in peak condition. Understanding of certain principles and cultural practices will significantly reduce winter damage of ornamentals.

<u>Causes of winter damage</u> Types of winter damage can be divided into three categories: 1) desiccation, 2) freezing, and 3) breakage.

Desiccation, or drying out, is a significant cause of damage, particularly on evergreens. This occurs when water is leaving the plant faster than it is being taken into the plant. There are several environmental factors that can influence desiccation. The needles and leaves of evergreens transpire some moisture even during the winter months. During severely cold weather, the ground may freeze to a depth beyond the extent of the root system, thereby cutting off the supply of water. If the fall has been particularly dry, there may be insufficient ground moisture to supply the roots with adequate water. Water loss is greatest during periods of strong winds and during periods of sunny, mild weather. The heat of the sun can cause stomates on the lower sides of the leaves to open; thus, increasing transpiration. Small, shallow rooted plants are often injured when alternate freezing and thawing of the soil heaves the plants from firm contact with the soil and exposes the roots to desiccation of drying winds. Injury due to desiccation is commonly seen as discolored, burned evergreen needles or leaves. It is worst on the side facing the wind. It can be particularly serious if plants are near a white house where the sun's rays bounce off the side, causing extra damage.

Freezing injury can take several forms. New growth stimulated in early fall by late summer fertilization may not have had time to harden off sufficiently to survive sudden drops to below freezing temperatures. Ice crystals rupture cell walls. This damage will show up as dead branch tips and branches. A sharp temperature change between day and night may freeze the water within the trunk of a tree causing it to explode or split open in a symptom called frost cracking. If not severe, these cracks seem to close when warm weather arrives but the wood fibers within may not grow together. This is sometimes called southwest injury because it is commonly found on the southwest side of shade trees where the warm afternoon sun has served to create further extremes in the day and night temperatures.

The sun can also prematurely stimulate the opening of flowers or leaf buds in the spring which might be killed by freezing night temperatures. Bud injury due to the cold temperatures of winter also occurs in the dormant state on more tender trees and shrubs. Flowering shrubs may lose their flower buds although their leaf buds usually come through. Root injury may occur in containers and planters, or balled and burlapped (B & B) stock which has been left exposed during the winter. Lethal root temperatures can start at 23° F on some species.

Breakage of branches is usually related to snow and ice. Two causes of damage by snow and ice are weight and careless removal. High winds compound the damage done when ice is on the plant. Damage may take the form of misshapen plants or may actually result in broken branches and split trunks.

Avoiding Damage Much of the disappointment and frustration of winter damaged plants can be avoided by planning ahead:

Select Hardy Plants. Grow plant materials that are native or are known to be winter hardy in your area.

Select Appropriate Site. When planting broadleaf evergreens that are known to be easily injured, such as some varieties of rhododendrons, azaleas, camellias, daphne, and hollies, select a location on the north, northeast, or eastern side of a building or other barrier where they will be protected from prevailing winds and intense winter sun. These exposures will also delay spring growth, thus preventing injury to new growth of flowers from late spring frost.

Avoid Poorly Drained Soil. Avoid low spots that create frost pockets and sites that are likely to experience rapid fluctuations in temperature. Since heavy snow and ice can cause much damage to branches and trunks, it is important that plants be placed away from house eaves and other snow or ice collecting areas, where snow or ice is likely to fall or slide onto the plants.

Follow Recommended Cultural Practices. Following recommended cultural practices has been shown to be highly effective in reducing winter injury to ornamentals. Plants that are diseased or deficient in nutrients are more susceptible to winter injury than strong, healthy plants.

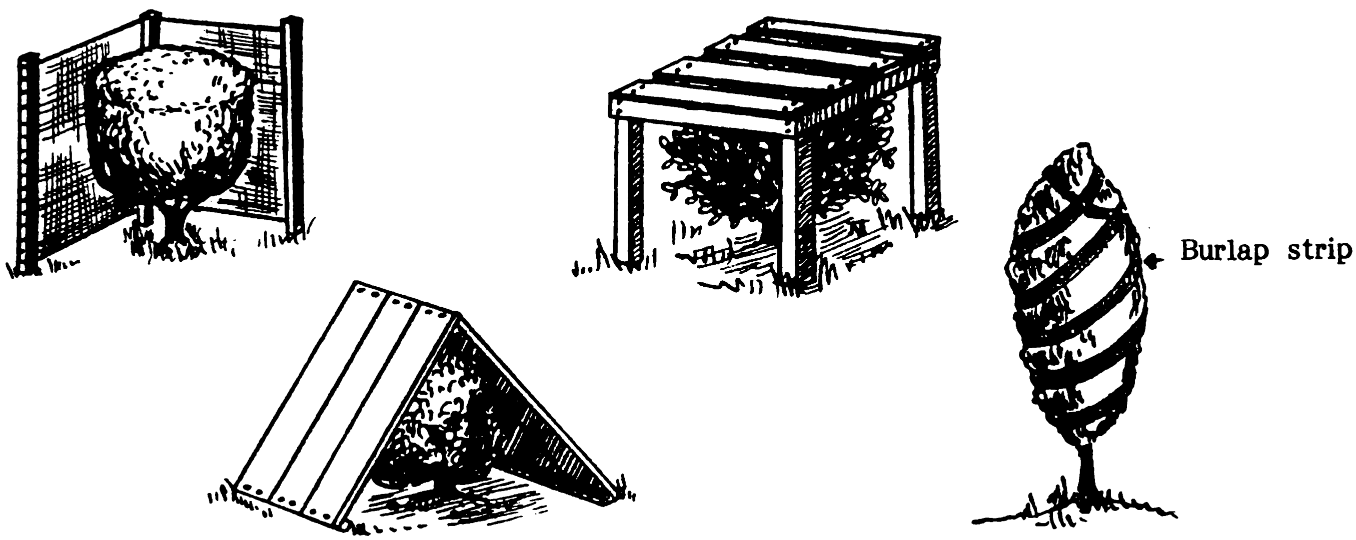
- Fall fertilization, after plants are dormant but before soil temperature drops below 45 degrees F may be of value in preventing winter damage. Avoid late summer or early fall fertilization while plants are still active as this stimulates late fall growth which is easily killed by the cold.

- Proper pruning at an appropriate time throughout the year is effective in reducing damage by ice and snow. Particularly important is the removal of any weak, narrow angled, V-shaped crotches. Avoid late summer pruning which stimulates new, tender growth and reduces the supply of nutrients available to the plant through the winter.

- Proper watering can be a critical factor in winterizing. If autumn rains have been insufficient, give your plants a deep soaking that will supply water to the entire root system before the ground freezes. This practice is especially important for broad and needled evergreens. Watering during January, February, and March, when there are warm days is also important. Mulching is an important control for erosion and loss of water. A two inch layer of mulch material such as tan bark, fir bark, pine needles, wood chips or sawdust will reduce water loss and help maintain uniform soil moisture around roots. Mulching also reduces alternate freezing and thawing of the soil which heaves some shallow rooted plants and can cause significant winter damage.

Protecting Against Damage Special precautions can be taken to protect plants during the winter. Antidesiccant compounds are sold in many garden centers and supply catalogs. However, research has shown that these compounds degrade rapidly and are relatively little value to homeowners.

Small evergreens can best be protected by using wind breaks made out of burlap, canvas, or similar materials. Wind breaks help reduce the force of the wind and also shade the plants. Windbreaks can be created by attaching materials to a frame around a plant. A complete wrapping of straw or burlap is sometimes used. Black plastic should be avoided as a material for wrapping plants. During the day it builds up heat inside and actually increases the extreme fluctuation between day and night temperatures and may speed up growth of buds in the spring, making them more susceptible to a late frost. Certainly these various boxes, shields and wrappings add nothing to the aesthetics of your winter landscape. If your ornamentals require annual protection measures to this extent, it would be wise to move them to a more protected location and replace them with hardier specimens.



Collecting snow should be removed with a broom. Always sweep upward with the broom to lift snow off. When the branches are frozen and brittle, avoid disturbing them. Wait until a warmer day.

Protection against an early frost can be given to a particularly valuable specimen by providing it with a fine, gentle, continuous spray of water. Satisfactory protection can be obtained in many cases, even when the temperature drops as low as 20 F. When the air temperature drops below freezing, the water sprayed onto the plant begins to form ice. During the process of freezing, water gives off heat and enough heat is absorbed by the plants to prevent them from freezing. As long as water is applied continuously, the plant remains above its freezing point. The application of water should begin when the temperature at plant level reaches 34° F. and must be constant throughout the period when the air temperature is below freezing and continued until all the ice has melted off the plant. A stationary or rotary sprinkler will give satisfactory results. Bark splitting, especially dangerous on newly planted trees, can be prevented by wrapping trunks with burlap strips or with commercial tree wrap.

<u>If Winter Injury Occurs</u> After a particularly severe winter, many plants may show substantial injury. Damage symptoms are discolored burned evergreen needles or leaves, dead branch tips and branches, heaved root systems and broken branches. At winter's end, remove only those branches that are broken or so brown that they are obviously dead. Do not remove branches when scraping the outer bark reveals a green layer underneath. Wait until midsummer before pruning because even the deadest looking plant may still be alive. The extent of winter damage can best be determined after new growth starts in the spring. At that time, prune all dead twigs or branches back to within one quarter of an inch above a live bud, or flush with the nearest live branch.

If discoloration on narrow-leaved evergreen needles is not too severe, they may regain their green color or new foliage may be produced on the undamaged stem. Broad-leaved evergreens showing leaf damage will usually produce new leaves, if branches and vegetative leaf buds have not been too severely injured. Damaged leaves may drop or be removed. Prune to remove badly damaged or broken branches to shape plant and to stimulate new growth.

Replant smaller plants with root systems partially heaved out of the ground as soon as the soil thaws. Unless the root system is small enough to be pushed easily with the fingers into the soft soil, dig the plant, retaining as much as possible of the root system within a soil ball and replant it. An application of fertilizer to the soil around winter damaged plants, accompanied by adequate watering, will usually induce new growth to compensate for winter injuries.

Special care should be given to plants injured by winter's cold. The dry months of June, July and August can be particularly damaging as the plants are weakened and less able to survive the stress of drought. Be sure to water adequately.

First Aid for Storm Damaged Trees

The treatment of storm damaged trees and fruit trees necessitates wise decisions and prompt action if the maximum in repair work is to be achieved. Repairs come in two stages: First Aid for immediate attention and Follow-up Work to be distributed over a period of several months to several years.

Decision factors - is the tree damaged beyond practical repair?

If over thirty to fifty percent of the main branches or trunk are severely split, broken, or mutilated, extensive repair efforts are questionable.

Desirability of species. Some less desirable species are: black locust, Siberian (Chinese) elm, box elder, mulberry, true poplars, silver leaf maple, arborvitae. More desirable trees are: oak species, most maples, pecans, sweet gum, pine species, magnolia, hollies, hackberry, beech.

Location. If too close to power lines, building or other structures, the tree may need to be removed.

Soundness. Extremely old, low vigor trees might not have recovery ability.

Special values. Rarity of species or variety, sentimental and/or historical value.

Purpose of the tree. Does it serve a true landscape purpose or value?

Workmanship factors

Remove only the branches necessary for immediate repairs. Too much removal of wood in one season can help create such problems as sunscald, weak branching habits and soft sucker growth.

Re-attach bark to the inner wood with galvanized nails if healing seems possible. Reshape torn tissue areas to a vertically elongated shape to encourage healing. Support split branches with adequate guys or braces. Avoid stubbing of branches; make branch removal cuts at side branches when possible. Try to maintain a state of balance for the entire tree top.

Observe safety precautions relative to falling branches, using ladders, contact with power lines, etc.

If work is done by someone else, know if adequate insurance is carried for personal injury and liability, and property damage.

Promptly remove all debris from the premises such as broken branches and prunings to help eliminate breeding grounds for insects and diseases.

Follow-up considerations

Check the progress of growth unions of re-attached bark areas.

Establish a tree fertilizer program. Most older trees need fertilizer to increase vigor and reduce susceptibility to breakage.

Gradually prune and reshape trees for balance and general appearance over a period of three to five years.

Control devitalizing conditions such as sucker sprouts, insect and disease damage.

Replacement trees, if necessary, should be carefully selected for durability, general adaptation, and size for the area.

Special Fruit Tree Treatment Broken limbs should be cut back to a fairly strong side branch. When cutting terminal growth to the side branch, make cut so it continues the line of direction of the side branch so the wound will heal quickly. Some split crotches may be drawn together with bolts.

If damage to fruit trees has destroyed over 50% of the bearing surface, it may be wise to remove the entire tree. Damage that exposes large areas of wood or where large pruning cuts are made have traditionally been treated with commerical wound dressing but current research indicates that this is not necessarily useful and may encourage disease.

Protecting and Repairing Trees During Construction

The location of a house on a lot should be carefully planned to utilize existing trees and avoid unnecessary and destructive grading. Trees of desirable species located where they may serve a useful purpose in the landscape should be protected during the construction process. Consult a person with training and experience in landscaping to help select those trees which should be saved, and those which should be removed.

Plan protective measures before construction starts. If this is not possible, start corrective practices as soon as damage is observed. The longer an injury is neglected, the greater will be the ultimate damage to the tree.

Trees may respond quite differently to various types of injury. Under some circumstances death may occur soon after the tree has received apparently minor damage. In other cases, trees may grow quite satisfactorily after being subjected to severe injury.
In most situations an effort should be made to save well located trees of young or middle age.

Protecting Trees During Construction. Trees which are not needed in the landscape planting should be eliminated before construction starts. This will provide more space for the soil from the basement, building supplies, and the movement of men and equipment involved in building the house.

Protect trees which are to be saved for future landscape use by placing tall conspicuous stakes at the ends of the branches on the sides where trucks or bulldozers will be operating. As added protection attach heavy fencing to the stakes.

General Corrective Practices Damage to trees during construction operations usually involves impairment of the water and nutrient supply system. This is true when either the roots or top of the tree is damaged. Therefore, three corrective procedures should be applied: 1) prune back and thin out the branches to reduce water requirement; 2) irrigate as needed to maintain an adequate moisture supply in the soil, and 3) apply fertilizer to help stimulate renewed growth.

Prune back the top in proportion to the severity of the damage to the tree. In cases of serious injury, cut back and thin out the branches quite drastically.

Bruised and Peeled Bark Damage to tree trunks caused by careless operation of trucks or other equipment should be treated to promote rapid healing. Trim back the bruised bark around the wound to sound tissue on each side, and cut to a point at the top and bottom. This will facilitate movement of moisture and nutrients around the damage area.

If the damaged area is less than 25% of the circumference of the trunk, the wound should gradually heal over and no permanent injury should result. If the damage involves more than 50% of the circumference, the tree may be seriously reduced in vigor. It may lose branches and be quite unsightly. However, the corrective procedures of top pruning, irrigation, and fertilization should be practiced until the tree recovers or it is evident that the tree will not recover satisfactorily and should be removed.

Broken branches Remove tree branches which have been broken from any cause. Damage near the end of a branch can be eliminated by cutting back to a strong lateral. Cut the entire branch off close to the trunk at the "collar" when the broken area is near the base.See the chapter on pruning for more details.

Root Damage by Trenches The digging of trenches for water or gas lines, or for foundations for buildings, walks, or drives may damage the root system of nearby trees. If such injury cannot be avoided, the top of the tree can be pruned back and thinned out to reduce the demand for water from the remaining roots.

Roots Covered By Pavement Roots which are covered by pavement may be deprived of air and moisture which are essential for growth. If the covered area involves only a portion along one side of the tree, satisfactory growth should continue. If the entire area around the tree is paved, the surface should be porous to allow water and air to penetrate, or if brick or flagstone is used, the joints should not be mortared. When the pavement is nonporous, an opening should be left around the trunk of the tree. This opening should be at least six feet in diameter for small trees. The opening should be larger around mature trees unless the roots extend beyond the pavement into uncovered soil. Roots of trees typically extend several feet beyond the spread of the branches.

Fertilization of Damaged Trees When the root system of a tree has been damaged during construction, a moderate application of fertilizer may be beneficial. Use two pounds of a 5-10-5 formula per tree for each inch of trunk diameter measured three feet above the ground.

The easiest and most practical method of application is to broadcast the fertilizer over the area of greatest concentration of feeder roots. These are located in a band around the tree starting about two feet from the trunk and extending out several feet beyond the ends of the branches. Scatter the fertilizer evenly over this area, and apply water liberally to wash it into the ground. Most of the feeder roots occur in the top foot of soil, with very few extending below two feet.

If the trees are large and making relatively weak growth, and if the root damage has been quite severe, greater benefit may be secured by placing the fertilizer in holes punched in the ground around the tree. Holes should be about fifteen inches deep, one or two inches in diameter, and eighteen to twenty-four inches apart. They should be spaced uniformly over the area of greatest root concentration.

Apply fertilizer at the rate of three pounds of 5-10-5 formula for each inch of trunk diameter measured three feet above the ground. Mix fertilizer with equal parts of dry soil or sand and fill each hole to within six inches of the top. Water may be used to cause the fertilizer to move out into the soil around each hole. Fill the top portion of each hole with rich garden loam.

Grading Around Trees A majority of the feeder roots of trees are located within a foot of the surface and typically extend several feet beyond the end of the branches. The topmost roots usually are covered with about four inches of soil. Topsoil should not be disturbed around landscape trees during the construction operation unless absolutely necessary to change the grade.

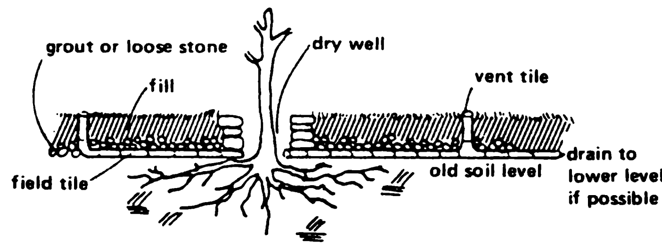
The removal of soil around ornamental trees may damage or destroy vital feeder roots. If damage is not too severe a layer of fertile loam may be applied over the exposed roots. The tree should recover and continue active growth.

In some situations the grade level around the house may need to be changed and involve the addition of soil around trees. If the ground level is raised six inches or more, the air supply to the roots will be reduced and the tree may decline in vigor or die. Beech, oak, dogwood, poplar, hickory, walnut, and most evergreen trees are particularly susceptible to injury of this type.

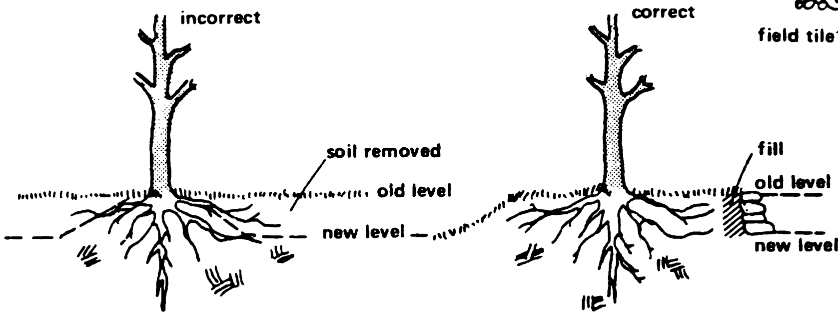
When the change in grade involves an increase of one foot or less, use crushed stone or gravel as the basic fill. Cover this with about six inches of a sandy soil, which should allow adequate aeration of the tree roots.

A tree well should be constructed if more than one foot of fill is to be applied. Pile coarse stones in a ring around the tree starting about three feet from the trunk, to a depth about eight inches below the final expected soil level. Slope the stone fill down to extend and terminate at a distance equal to about 3/4 the mature spread of the branches. Construct a facing stone wall to form a well around the tree. Apply about two or three inches of crushed stone or gravel on the coarse stones, and cover with earth to the desired grade level. This will allow air to reach the roots and should permit healthy growth even though several feet of soil is added around the trees.

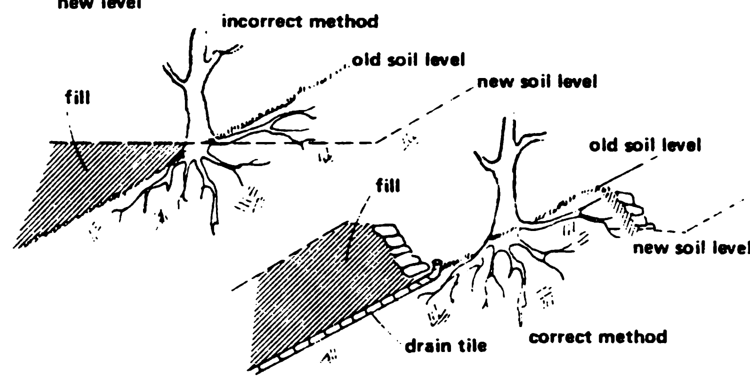
Proper tiling system for raising ground level around tree.



Lowering soil level.



Protecting tree from cut-and-fill damage.



Mower Wounds Can Kill Trees

Injury and infection started by lawnmower wounds can often be the most serious threat to tree health on golf courses, parks, and home lawns.

Most arborists and tree pathologists have been aware of the lawnmower problem for some time. Extensive research has been conducted on the importance of wounds in tree health care. This research has led to significant adjustments in pruning, cabling, bracing, injection, and cavity treatment.

Lawnmowers cause the most severe injury during periods when tree bark is most likely to slip, in early spring during leaf emergence and in early fall during leaf drop. If the bark slips, a large wound is produced from even minor injuries.

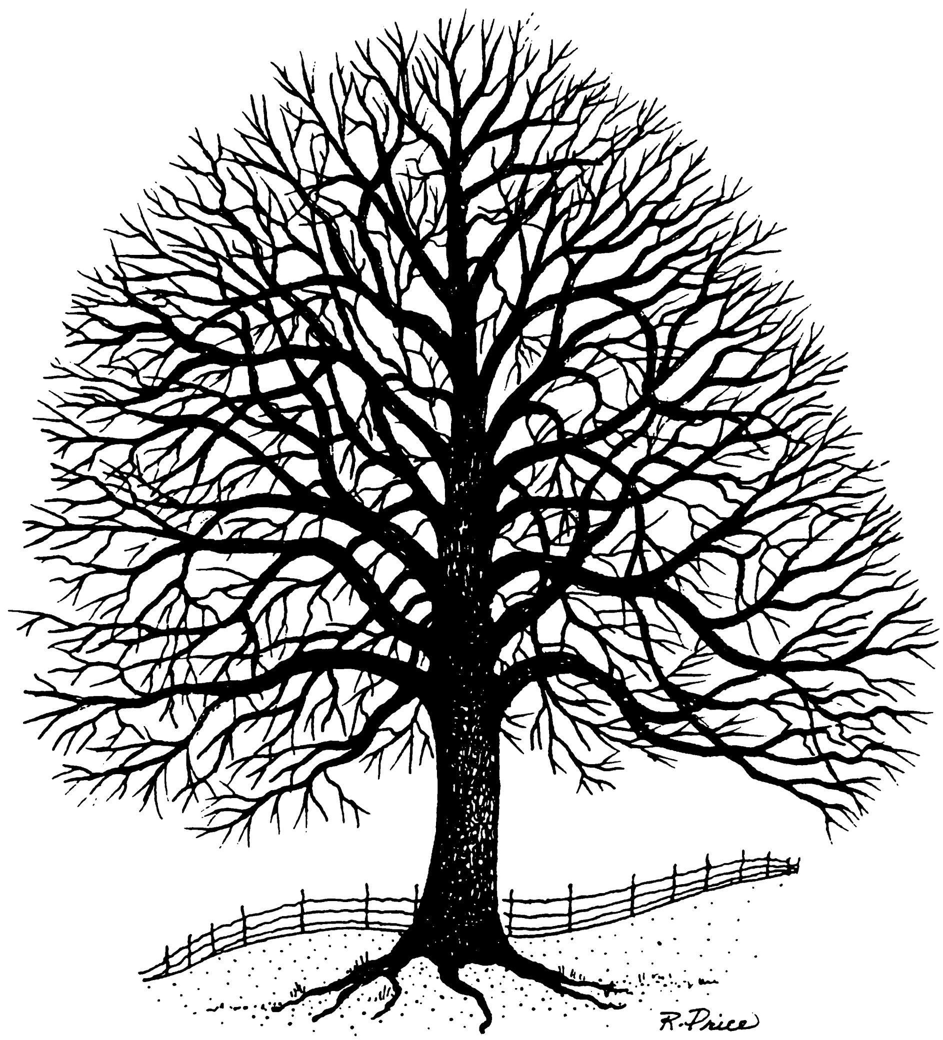
Most tree injuries occur when mower operators attempt to trim grass close to tree trunks with a push or riding mower. This can be prevented by removal of turf around trees or by hand trimming. However, care must be used to avoid harming the tree with one of the filament line weed trimming machines. They,too, can do a great deal of damage to the bark, particularly of young trees.

The site of injury is usually the root buttress, since it flares out from the trunk and gets in the path of the mower. However, injury is also common anywhere from the roots to several feet above the ground.

Although large wounds are most serious, repeated small wounds can also add up to trouble.

Wounds from lawnmowers are serious enough by themselves, but the wounded tree must also protect itself from pathogens that invade the wound. These microorganisms can often attack the injured bark and invade the adjacent healthy tissues, greatly enlarging the affected area. Sometimes, trees can be completely girdled from microbial attack following lawnmower wounds.

Decay fungi also become active on the wound surface and structural deterioration of the woody tissues beneath the wound will often occur. Many wounded trees which are not girdled may eventually break off at the stem or root collar due to internal decay.



TREES RESISTANT TO GYPSY MOTH

Species rarely fed upon:

ash	Fraxinus species
red cedar	Juniperus virginiana
dogwood	Cornus florida
honey locust	Gleditsia triacanthos
sycamore	Platanus occidentalis
tulip tree	Liriodendron tuplifera
white cedar	Thuja occidentalis
black walnut	Juglans nigra
black locust	Robinia pseudoacacia

Species fed upon when other foliage is gone:

hickory	Carya species
black gum	Nyssa sylvatica
hornbeam	Carpinus caroliniana
red maple	Acer rubrum
Norway maple	Acer platanoides
sassafras	Sassafrax albidum
beech	Fagus grandifolia

PLANTS TOLERANT OF CHILDREN AND ANIMALS

Most of these plants have thorns which may be objectionable. They all will discourage traffic.

barberry	Berberis species
hawthorn	Crataegus species
pyracantha	Pyracantha species
flowering quince	Chaenomeles species
trifoliate orange	Poncirus trifoliata
roses	Rosa species
red cedar	Juniperus virginiana
osmanthus	Osmanthus heterophyllus
yucca	Yucca species
holly (American, English, Chinese)	Ilex species
mahonia	Mahonia species

PLANTS TO ATTRACT WILDLIFE

Birds and other animals seek food, shelter, water, and safe areas for reproduction. The plants listed help meet these requirements.

Trees:

beech	Fagus species
oak	Quercus species
pine	Pinus species
red cedar	Juniperus virginiana
ash	Fraxinus species
birch	Betula species
cherry	Prunus species
dogwood	Cornus species
blackgum	Nyssa sylvatica
hickory	Carya species
holly	Ilex species
magnolia	Magnolia species
maple	Acer species
persimmon	Diospyros virginiana
tulip tree	Liriodendron tulipifera
service berry	Amelanchier species
sassafras	Sassafras albidum
crabapple	Malus species

Shrubs:

sumac	Rhus species
spice bush	Lindera benzoin
viburnum	Viburnum species
yew	Taxus species
elderberry	Sambucus species
rhododendron	Rhododendron species
hawthorn	Crataegus species
Russian olive	Elaeagnus angustifolius
Oregon grape	Mahonia species
pyracantha	Pyracantha species

Vines and other plants:

blackberry
raspberry
teaberry
partridge berry
sunflower
honeysuckle
Virginia creeper
bittersweet
pokeberry
blueberry

PLANTS TOLERANT OF DRY, POOR SOIL

Get the plants listed here off to a good start by preparing the soil they are to be planted in and by watering until they are established.

Trees:

graybirch	Betula populifolia
hackberry	Celtis occidentalis
junipers	Juniperus species
golden rain tree	Koelreuteria paniculata
osage orange	Maclura pomifera
Virginia pine	Pinus virginiana
chestnut oak	Quercus prinus
locust	Robinia pseudoacacia
sassafras	Sassafras albidum

Shrubs:

amur maple	Acer ginnala
Japanese barberry	Berberis thunbergii
quince	Chaenomeles species
smoketree	Cotinus coggygria
broom	Cytisus species
Russian olive	Elaeagnus angustifolia
witch hazel	Hamamelis virginiana
St. Johnswort	Hypericum species
privet	Ligustrum species
buckthorn	Rhamnus species
sumac	Rhus species
yucca	Yucca species

Groundcovers:

yarrow	Achillea species
crown vetch	Coronilla varia
Sweet William	Dianthus species
daylilies	Hemerocallis species
cinquefoil	Potentilla species
lavender cotton	Santolina chamaecyparissus
creeping phlox	Phlox subulata
St. Johnswort	Hypericum species

PLANTS TOLERANT OF SHADE

The degree of tolerance varies from plant to plant. Most will do better with some sun, especially those that flower.

Trees:

service berry	Amelanchier species
red bud	Cercis canadensis
dogwood	Cornus florida
hollies	Ilex species
arborvitae	Thuja occidentalis
hemlock	Tsuga species

Shrubs:

abelia	Abelia species
alders	Alnus species
chokeberry	Aronia species
aucuba	Aucuba japonica
barberry	Berberis species
Hinokia cypress	Chamaecyparis species
mountain laurel	Kalmia latifolia
leocothoe	Leucothoe fontanesiana
Oregon grape	Mahonia species
heavenly bamboo	Nandina domestica
pieris	Pieris species
rhododendron	Rhododendron species
yew	Taxus species
viburnum	Viburnum species

Ground covers:

spurge	Pachysandra terminalis
periwinkle	Vinca minor
bugle weed	Ajuga species
lily-of-the-valley	Convallaria majalis
ferns	several
daylilies	Hemerocallis species
plantain lily	Hosta species
Virginia bluebells	Mertensia virgnica
primrose	Primula species
stonecrop	Sedum species
violets	Viola species

PLANTS TOLERANT OF SALT

autumn olive	Elaeagnus angustifolia
honey locust	Gleditsia triacanthos
mulberry	Morus species
black locust	Robinia pseudoacacia
buffalo berry	Shepherdia argentea
tamarix	Tamarix gallica
white oak	Quercus alba
red oak	Quercus rubra
English oak	Quercus robur
white willow	Salix alba

PLANTS WITH COLORFUL AUTUMN FOLIAGE

SHRUBS:

Botanical Name	Common Name	Color Range	Height
Acer ginnala	Amur Maple	Scarlet	8'
Cornus alba 'sibirica'	Siberian Dogwood	Red	9'
Euonymus alatus	Winged Euonymus	Scarlet	7'
Rhus aromatica	Fragrant Sumac	Yellow-scarlet	4'
Rhus copallina	Shining Sumac	Scarlet	25'
Rhus glabra	Smooth Sumac	Bright red	25'
Rhus typhina	Staghorn Sumac	Red	30'
Rosa rugosa	Rugosa Rose	Red-yellow	6'
Vaccinium species	Blueberries	Scarlet	3-25'
Viburnum dentatum	Arrowwood	Glossy red	15'
Viburnum prunifolium	Black Haw	Shining red	15'
Virburnum lentago	Nannyberry	Purplish-red	30'
Nandina domestica	Nandina	Bright red to scarlet	6'

TREES:

Acer saccharum	Sugar Maple	Red-yellow	Tall
Acer rubrum	Red or Swamp Maple	Red	Tall
Acer tataricum	Tatarian Maple	Red to yellow	Medium
Chionanthus virginicus	Fringetree	Yellow	Medium
Cornus florida	Flowering Dogwood	Scarlet	Small
Cornus florida rubra	Red Flowering Dogwood	Red	Small
Cornus mas	Cornelian Cherry	Red	Small
Cornus kousa	Japanese Dogwood	Bronze to red	Small
Crataegus phaenopyrum	Washington Hawthorn	Scarlet/orange	Medium
Botanical Name	Common Name	Color Range	Height
Ginkgo biloba	Ginkgo	Yellow	Tall
Liquidambar styraciflua	Sweet Gum	Scarlet	Tall
Oxydendrum arboreum	Sourwood or Sorrel Tree	Scarlet	Medium
Pyrus calleryana 'Bradford'	Bradford Pear	Dark red	Medium
Quercus borealis	Red Oak	Red	Tall
Quercus coccinea	Scarlet Oak	Scarlet	Tall
Sassafras albidum	Sassafras	Orange/scarlet	Medium

PLANTS WITH ATTRACTIVE FRUIT

SHRUBS:

Botanical Name	Common Name	Color of Fruit	Season	Height
Aronia arbutifolia	Red Chokeberry	Red	F	8'
Aucuba japonica	Japanese Aucuba	Red	W	7-10'
Berberis thunbergii	Japanese Barberry	Red	F-W	5'
Callicarpa japonica	Japanese Beauty-berry	Purple	F	6'
Cotoneaster species	Cotoneaster	Red	F	1-15'
Elaeagnus multiflora	Cherry Elaeagnus	Red	Mid-S	9'
Euonymus alatus	Winged Euonymus	Scarlet	F	7'
Ilex cornuta	Chinese Holly	Red	F-W	10'
Ilex verticillata	Winterberry	Red	F-W	7'
Ligustrum lucidum	Evergreen privet	Blue-black	F-W	10'
Lonicera species	Bush Honeysuckle	Red	S-F	8-15'
Mahonia aquifolium	Oregon Holly Grape	Bluish-black	S	6'
Nandina domestica	Nandina	Red & white	F-W	6'
Pyracantha coccinea lalandei	Pyracantha or Firethorn	Orange	F-W	6-20'
Rhus glabra	Smooth Sumac	Scarlet	F-W	15-20'
Rhus typhina	Staghorn Sumac	Crimson	F-W	15'
Rosa species	Rose	Red	F	6'
Symphoricarpos albus	Snowberry	White	F	3'
Viburnum dilatatum	Linden Viburnum	Red	F	10'
Viburnum opulus	European Cranberry-bush Viburnum	Red	F-W	10'

TREES:

Botanical Name	Common Name	Color of Fruit	Season	Heigh
Acer ginnala	Amur Maple	Red	Sum	20'
Cornus florida	Flowering Dogwood	Red	F	25'
Crataegus species	Hawthorn	Red	F	15-30'
Ilex aquifolium	English Holly	Red	F-W	50'
Ilex cassine	Dahoon	Red	F-W	36'
Ilex opaca	American Holly	Red	F-W	45'
Ilex vomitoria	Yaupon Holly	Red	F-W	24'
Juniperus virginiana	Red Cedar	Bluish	F-W	75'
Liquidambar styraciflua	Sweet Gum	Brown	F	100'
Magnolia grandiflora	Southern Magnolia	Red	F	80'
Malus species	Crab Apple	Red to yellow	F	20-40'
Melia azedarach	Chinaberry	Yellow	F-W	40'
Oxydendrum arboreum	Sourwood or Sorrel Tree	Grayish	F-W	75'
Photinia serrulata	Chinese Photinia	Red	F-W	25'
Paulownia tomentosa	Royal Paulownia	Dark Brown	F	45'
Sorbus species	Mountain Ash	Red	F	30'
Evergreens with cones		Brown	F-W	75-100'

VINES:

Ampelopsis brevipedunculata	Porcelain Ampelopsis	Lilac-blue	F	25'
Celastrus scandens	American Bittersweet	Yellow-red	F-W	30'
Euonymus fortunei	Wintercreeper	Orange	F	30'

PROBLEM TREES

When selecting a tree to plant in your yard it is nice to know exactly what you are getting. Many homeowners plant a sapling, enjoy it for a few years, and then discover some serious disadvantages when the tree reaches an effective height.

Following is a list of trees which you should know something about before you plant them in your yard.

Acer negundo (Box Elder)
This tree has weak wood, is short-lived and is susceptible to box elder bugs.

Acer saccharinum (Silver Maple)
One of the worst trees available because of its brittle wood and tendency to become hollow and hazardous. Its shallow surface roots can ruin sidewalks and driveways, and prevent turfgrass growth underneath. Also susceptible to insects. Outlawed in some localities.

Ailanthus altissima (Tree of Heaven)
A weed tree that sprouts up everywhere and has a disagreeable odor. It is outlawed in some cities.

Albizia julibrissin (Mimosa)
Susceptible to Mimosa Wilt (root fungus) and has weak, fast growth.

Betula papyrifera (White Clump Birch)
Authorities say it isn't likely to do well where the mean July temperature is above 70 degrees F. Once weakened, the bronze birch borer will kill it. It is pretty but short-lived.

Betula pendula (European White Birch)
This birch is susceptible to insects and much environmental stress .

Catalpa spp.
All catalpas have messy flowers and seed pods.

Ginkgo biloba (Ginkgo)
Do not plant the female Ginkgo. It's fruits have a very offensive odor.

Juglans nigra (Black Walnut)
The tree roots produce a toxin that is harmful to certain other plants, and anthracnose will defoliate it during August and September. The wood is valuable though.

Laburnum anagyroides (Golden Chain Tree)
This tree is subject to much environmental stress .

Malus species (Crabapple)
Most varieties are defoliated by scab diseases every year. The fruits can be messy.

Melia azedarach (Chinaberry)
This tree has weak wood, seeds that are a pest and many suckers.

Morus species (Mulberry)
Mulberries have messy fruit.

Paulownia tomentosa (Empress Tree)
Its pretty flowers become thousands of seeds which sprout everywhere. Its wood has been bringing high prices lately.

Platanus occidentalis (Sycamore)
Leaves and seeds from this tree are messy; it has brittle wood and surface roots. Anthracnose, a late spring blight which occurs most years will attack it.

Populus species (Lombardy poplar, white or silver poplar, hybrid poplars, cottonwood)
These trees have brittle wood and surface root systems, but their main problem is that they are very susceptible to canker diseases which disfigure and usually kill them. Some also have messy flowers or send up suckers from their roots. The Lombardy poplar is very short-lived. Note that the Tulip Poplar (or Yellow Poplar or Tulip Tree) is not a poplar, but rather a liriodendron. While it does have brittle wood, it is a pretty good tree.

Prunus serotina (Black Cherry)
Has objectionable fruit; is susceptible to insects and attracts many birds.

Robinia pseudoacacia (Black Locust)
It is good for fence posts and firewood, but not for landscaping. It has brittle wood, is susceptible to cankers, and leaf miners render it unattractive by summer.

Salix species (Willows)
These trees have very brittle wood and are susceptible to canker diseases. Their roots will clog sewer and drain pipes. Some are attractive on large lots.

Sorbus species (Mountain Ash)
Does best in cool climates. Subject to damage from sawflies, borers, scale, and fire blight.

Ulmus americana (American Elm)
Until Dutch elm disease can be controlled, this long time favorite should not be planted.

Ulmus pumila (Siberian Elm)
Its brittle wood will result in severe damage in ice storms, and its seeds and suckering habit make it a pest. Also very short-lived. Note that the Chinese elm (Ulmus parvifolia) is often confused with the Siberian Elm, but is far superior.

Fruit trees (and fruit trees that only flower)
These are often subject to Japanese beetle infestation. Fruit trees require a genuine commitment; don't try to get into them halfway.

The following trees can be counted on to give you trouble if they are not planted correctly. Many of them are slightly out of their preferred habitat and will not tolerate much abuse.

Abies species (Fir)
Few nice ones exist because they need deep, fertile, well drained soils and a cool, moist climate.

Acer saccharum (Sugar Maple)
Sugar maples grow well enough to produce maple syrup only in western Virginia's mountains.

Picea abies (Norway Spruce)
Subject to environmental stress .

Picea pungens (Colorado Blue Spruce)
Virginia is not at all like Colorado. Most spruces lose their attractiveness in a few years.

Pinus palustris (Longleaf Pine)
They do not tolerate our area well; subject to much environmental stress.

Pinus strobus (White Pine)
This is a very large tree and won't tolerate overcrowding. It also dislikes disturbed soil and suffers from air pollution. Does not like extreme heat or poor drainage.

Pinus sylvestris (Scotch Pine)
The Scotch Pine is subject to environmental stress.

Tsuga canadensis (Hemlock)
Once established, hemlock does pretty well. It requires rich soil and shelter from wind and sun to get off to a good start.

A PLANT LIST FOR THE TIDEWATER AREA

The Tidewater Plant List includes over 150 species that do well in Southeast Virginia, where the minimum temperature rarely goes below 15 degrees F. Although not comprehensive, it is designed to give the user the broadest selection in each of the categories.

Key:

Ht/Wd	Height and width a mature plant can expect to attain.				
Trait	The most useful characteristic(s) of the plant as well as potential pest problems.				
	b	interesting bark	1	tent catepillars	
	fc	distinctive fall color	2	bagworms	
	fl-#	conspicuous flowers and month of bloom	3	webworms	
	fo	interesting foliage	4	mites	
	fr	showy fruit	5	borers	
	f-#	fragrant and month	6	leaf spot	
	h	heat tolerant	7	mildew	
	s	spines (arise from leaf edges)	8	decline (includes environmental stress)	
	t	thorns (arise from stems & trunks)	9	root rot	
Growth:	VF	Very Fast	Soil:		
Light:	S	full sun	D	Dry	
	sS	partial shade	M	Moist	
	s	shade	W	Wet	

LARGE DECIDUOUS TREES (40 ft. and higher)

Botanical name	Common Name	Ht/Wd	Trait	Growth	Light	Soil
Acer rubrum 'columnare'	Columnar Red Maple	50-80/30-40	fc	Fast	sS/S	M/W
Acer rubrum 'October Glory'	October Glory Red Maple	50-80/40-50	fc	Fast	sS/S	M/W
Acer saccharum	Sugar Maple	50-75/40	fc	Fast	sS/S	M
Acer saccharum 'columnare'	Columnar Sugar Maple	50-75/30	fc	Fast	sS/S	M
Celtis occidentalis	Common Hackberry	30-50/25-40	b	Fast	sS/S	M
Fagus grandifolia	American Beech	80-100/50-70	b	Slow	sS/S	D/M
Fagus sylvatica	European Beech	80-100/50-70	b/fo	Slow	S	D/M
Fraxinus pennsylvanica	Green Ash	60/40	h	Fast	S	D/W
Fraxinus pennsylvania 'Marshall's Seedless'	Green Ash 'Marshall's Seedless'	60/40		Fast	S	D/W
Ginkgo biloba	Ginkgo (male only)	80/40	fo/fc/h	Slow	S	D/M
Gleditsia triacanthus inermus 'Shademaster'	Shademaster thornless honey locust	40/35-40	fo/h 2,3,4	Fast	S	D/M
Liriodendron tulipifera	Tulip Poplar	60-100/30-40	fl-5/fc	Mod.	S	M
Metasequoia glyptostroboides	Dawn Redwood	100/40-50		VF	sS/S	M
Nyssa sylvatica	Sour Gum	70-100/40-60	fc	Mod.	S	D/W
Platanus occidentalis	American Sycamore	80-11/50-70	6	Fast	sS/S	M/W
Quercus coccinea	Scarlet Oak	70/40-50	fc	VF	sS/S	D/M
Quercus macrocarpa	Bur Oak	80/30-40		Slo/Mod	sS/S	M/W
Quercus michauxii	Chestnut Oak	80/30-40		Mod.	sS/S	D/M
Quercus phellos	Willow Oak	70/30-40		Fast	sS/S	D/W
Quercus robur fastigiata	Pyramidal English Oak	80/30	h/4	Slow	sS/S	D/M
Quercus velutina	Black Oak	100/30-40		Slo/Mod	sS/S	D/M
Pyrus calleryana 'Bradford'	Bradford Pear	50-60/15-20	fc/h fl-3/4	Mod	sS/S	M
Tilia cordata	Littleleaf Linden	30-50/30	h	Mod	sS/S	M
Tilia cordata 'Greenspire'	Greenspire Linden	30-50/30	h	Mod	sS/S	M
Ulmus parvifolia	Chinese Elm	60-75/40-50	b	Mod/Fast	sS/S	D/W
Zelkova serrata	Japanese Zelkova	80-90/80-90	h	Mod	sS/S	D/M
Zelkova serrata 'Village Green'	Village Green Zelkova	80/80		Mod	S	D/M

LARGE EVERGREEN TREES (40 feet and higher)

Botanical Name	Common Name	Ht/Wd	Trait	Growth	Light	Soil
Cedrus atlantica	Atlas Cedar	40-60/30-40	fo/2	Mod	sS/S	D/M
Cedrus atlantica 'glauca'	Blue Atlas Cedar	40-60/30-40	fo/2	Mod	sS/S	D/M
Cedrus deodara	Deodara Cedar	60-100/40-50	fo/2/8	Fast	sS/S	D/M
Cedrus libani	Cedar of Lebanon	75/50	fo/2	Mod	sS/S	D/M
Cupressocyparis leylandii	Leyland Cypress	40/8-10	2	VF	sS/S	M
Cupressus sempervirens	Italian Cypress	60/5-8	2	Fast	sS/S	M
Chamaecyparis obtusa 'gracillis'	Hinoki Falsecypress	100/20-30	fo/2	Mod	sS/S	M
Chamaecyparis pisifera	Sawara Falsecypress	100/20	2	Fast	sS/S	M
Chamaecyparis thyoides	Whitecedar	100/20	2	Fast	S	M/S
Cryptomeri japonica	Cryptomeria	100/25-30	fo	Slow	S	M
Cunninghamia lanceolata	China Fir	60/30	fo	Slow-Mod	sS/S	M
Magnolia grandiflora	Southern Magnolia	80-100/50-80	fl-6; f-5/6	Slow-Mod	sS/S	D/M
Magnolia virginiana	Sweet Bay Magnolia	60/20-40	fl-6; f-5/6	Mod	sS/S	M/W
Pinus elliottii	Slash Pine	75-100/30-40	5	Fast	sS/S	D/M
Pinus nigra	Austrian Pine	80-90/30-40	5	Fast	sS/S	D/M
Pinus palustris	Longleaf Pine	80-100/30-40	5	VF	sS/S	D/M
Pinus taeda	Loblolly Pine	75-100/30-40	5	Fast	sS/S	D/W
Pinus thunbergiana	Japanese Black Pine	45/15-25	fo; h 5; 8	Fast	S	D/M
Quercus laurifolia 'Darlingtonia'	Darlington Oak	50/40-50	h	Slow	S	M
Quercus virginiana	Live Oak	40-80/60-100	h	Slow	sS/S	D/M
Thuja occidentalis	Arborvitae	60/30	h;2;4	Mod	S	M/W

SMALL DECIDUOUS TREES (15-35 feet)

Botanical Name	Common Name	Ht/Wd	Trait	Growth	Light	Soil
Acer ginnala	Amur Maple	20/20	fc;f-5	Mod	sS/S	M
Acer palmatum	Japanese Maple	20/20	fo	S	sS	M
Amelanchier canadensis	June Berry	20-30/12-15	fl-4	VF	sS/S	M
Betula nigra	River Birch	20-40/16-20	b;fc	Fast	sS/S	M/W
Cercis chinensis	Chinese Redbud	15/10-15	fl-4;5	Mod	sS/S	M
Chionanthus virginicus	White Fringe Tree	10-30/8-20	fl-5;f-5	Slow	sS/S	M
Cornus florida	Flowering Dogwood	15-30/12-20	fc;fr;5;6 fl(white)-4	Mod	sS	M
Cornus florida rubra	Flowering Dogwood	15-30/12-20	fc;5;6 fl(pink)-4	Mod	sS	M
Cornus kousa	Japanese Dogwood	20/15-18	fc; 5; 6	Mod	sS/S	M
Cornus mas	Cornelian Cherry	20-25/15-18	b;fl-3;5	Mod	sS/S	M
Cotinus coggyria	Smoke Tree	15-20/15-20	fc;fl-6/7	Slow	S	D/M
Cotinus coggyria 'purpureus'	Purple Smoke Tree	15-20/15-20	fl-6/7;fo	Slow	S	D/M

Botanical Name	Common Name	Ht/Wd	Trait	Growth	Light	Soil
Crataegus phaenopyrum	Washington Hawthorn	25-30/20-25	fl-5;fr t; 6	Fast	sS/S	M
Deutzia scabra	Fuzzy Deutzia	15/10-12	fl-5	Mod	sS/S	M
Franklinia altamaha	Franklinia	20/30/15-20	fc; f-10 fl-10	Slow	S	M/W
Koelreuteria paniculata	Golden Rain Tree	20-30/25-35	fl-6;fr	Slow	sS/S	M
Lagerstroemia indica	Crape Myrtle	30/15-20	fl-7/8 h;7	Slow	S	M/W
Magnolia soulangeana	Saucer Magnolia	25/30	fl-3	Mod	sS/S	M/W
Magnolia stellata	Star Magnolia	15-20/15-20	fl-3	Slow	S	M/W
Malus floribunda	Flowering Crabapple	25/25	fl-4; 1; 3;5;6;7	Mod	S	D/M
Oxydendrum arboreum	Sourwood	20-40/10-15	fc;fr fl-6/7;3	Slow	s/S	D/M
Prunus cerasifera 'atroparpurea'	Purple-Leaf Plum	15-30/20-25	fl-3;fo 1;5;6	Mod-Fast	S	M
Prunus serrulata 'Kwanzan'	Kwanzan Cherry	15-25/15-30	fl-4/5 1;5	Mod	sS/S	M
Prunus subhirtella 'pendula'	Weeping Cherry	15-20/10-15	fl-4;1;3 5;6;7;8	VF	S	M
Salix discolor	Pussy Willow	12-25/8-15	fl-3	Fast	sS/S	M/W
Salix matsudana 'tortuosa'	Corkscrew Willow	40/20-30	fo	Fast	S	M/W
Stewartia ovata	Mountain Stewartia	15/8-10	fl-6/7	Slow	sS/S	M
Styrax japonicus	Japanese Snowbell	20-30/15-20	fl-5	Slow	sS/S	M

SMALL EVERGREEN TREES (15-35 feet)

Botanical Name	Common Name	Ht/Wd	Trait	Growth	Light	Soil
Eribotrya japonica	Loquat	20-25/20-25	fl-11;h	Mod	sS/S	M
Ilex aquifolium	English Holly	10-20/6-12	fl-4;fr;s	Slow	sS/S	M
Ilex cassine	Dahoon Holly	20-30/10-15	fr	Mod	sS/S	M
Ilex latifolia	Lusterleaf Holly	15/7-11	fr	Mod	sS	M
Ilex 'Nellie R. Stevens'	Nellie R. Stevens Holly	25/10-15	fr	Mod	sS/s	M
Ilex opaca	American Holly (M & F)	30/12-20	fr;s	Slow	sS/S	M
Ilex opaca 'East Palatka'	East Palatka Holly	40/15-20	fr	Mod	sS/S	M
Ilex opaca 'Fosteri'	Foster's American Holly	40/12-20	fr;s	Slow	sS/S	M
Ilex pernyi	Pernyi Holly	20/8-10	fr;s	Slow	sS/S	M
Ilex vomitoria	Yaupon Holly	20/5-10	fr	Slo-Mod	s/S	M
Illicium anisatum	Anisetree	15/8-10		Mod	sS/S	M
Juniperus communis 'hibernica'	Irish Juniper	25/1.5-2	h;2;8	Slow	S	M
Juniperus virginiana 'cannaertii'	Cannaert Juniper	15-20/6-10	h;2	Fast	S	M
Ligustrum japonicum	Wax Ligustrum	10-18/8-15	fl-6;h	Fast	s-S	M
Osmanthus fortunei	Fortune's Osmanthus	20/15	f-10;s	Mod	S	M
Osmanthus fragrans	Fragrant Tea Olive	20/15	fl-10/11; f-10/11	Mod	sS/S	M
Osmanthus heterophyllus	Holly Osmanthus	15-20/12-18	fo;s	Mod	sS/S	M

Botanical Name	Common Name	Ht/Wd	Trait	Growth	Light	Soil
Photinia fraseri	Fraser Photinia	20-30/15-20	fo;h	Mod	S	M
Podocarpus macrophylla	Yew Podocarpus	30/5-20	fo;h	Slow-Mod	s-S	M
Prunus caroliniana	Carolina Cherry-Laurel	20-30/15-20		VF	s-S	M
Quercus acuta	Japanese Evergreen Oak	20-40/8-16	fo	Mod	S	M
Thuja occidentalis	Pyramidal Arborvitae	25/30	h;2;4	Mod	sS-S	M/W
Platycladus orientalis	Oriental Arborvitae	18-25/10-12	h;2;4	Fast	sS/S	M
	DECIDUOUS SHRUBS(up to 15 feet)					
Rhododendron calendulaceum	Flame Azalea	8-15/5-8	fl-4;4;9	Mod	sS/S	M
Rhododendron nudiflorum	Pinxter Bloom	2-6/2-6	fl-4;4;9	Slow	sS/S	M
Berberis thunbergii	Japanese Barberry	4/4	fl-4;fo fc;fr;h;t	Mod	sS/S	M
Buddleia davidii	Butterfly Bush	8-12/6-8	fl+f-6-9	Fast	S	D/M
Calycanthus floridus	Carolina Allspice	6/5-8	fl-4;f-4	Mod	s-S	M
Chaenomeles japonica	Japanese Flowering Quince	6/6	fl-3;t;l	VF	s-S	M
Clethra alnifolia	Sweet Pepperbush	3-10/3-8	fl-7;f-7	Mod	sS-S	M/W
Deutzia gracilis	Slender Deutzia	2-3/3-4	fl-4	Slow-Mod	sS-S	D/M
Euonymus alatus	Winged Euonymus	8-10/8-10	fc	Mod	sS-S	M
Exorchorda racemosa	Pearl Bush	10-15/10-15	fl-4	Mod	sS-S	M
Forsythia intermedia	Forsythia	8-10/10-12	fl-3	Fast	S	D/M
Hamamelis mollis	Chinese Witchhazel	10-12/5-6	fc,fl-2 f-2	Mod	sS-S	M
Hamamelis vernalis	Vernal Witchhazel	4-6/6-8	fc;fl-2 f-2	Fast	sS-S	M
Hibiscus syriacus	Rose of Sharon	8-10/3-5	fl-6/7/8 h	Fast	S	M/W
Hydrangea macrophylla	Bigleaf Hydrangea	4/4	fl-6/7	Mod	sS	M
Hydrangea quercifolia	Oakleaf Hydrangea	6-7/6-8	fl-6	Mod	sS	M
Ilex verticillata	Winter Berry (M & F)	6-8/3-5	fr	Slow	sS-S	M/W
Jasminum nudiflorum	Winter Jasmine	2-4/3-5	fl-2	Fast	s-S	M
Potentilla fruticosa	Bush Cinquefoil	2-4/3-5	fl-5/6/7	Mod	sS-S	M
Punica granatum	Pomegranate	12-15/12	fl-6;h	Mod	S	M
Spiraea prunifolia	Bridalwreath Spirea	4-6/5-8	fl-3	Fast	s-S	M
Spiraea thunbergi	Thunberg Spirea	3-5/3-5	fl-3	Fast	sS-S	M
Syringa persica	Persian Lilac	6-8/7-9	fl-4;f-4 5;7	VF	sS-S	M
Viburnum carlesii	Koreanspice Viburnum	6-8/4-6	fl-4;f-4	Mod	sS-S	M
Viburnum opulus	European Cranberrybush Viburnum	12/12	fl-5	Fast	sS-S	M
Viburnum plicatum tomentosum	Doublefile Viburnum	6-8/4-6	fl-4	Mod	sS-S	M
Vitex angus-castus	Chaste Tree	9-10/10-12	fl-7	Fast	sS-S	D/M
Weigela florida	Crimson Weigela	6-8/6-8	fl-5	Fast	S	M

EVERGREEN SHRUBS (up to 15 feet)

Botanical Name	Common Name	Ht/Wd	Trait	Growth	Light	Soil
Abelia grandiflora	Glossy Abelia	5-7/4-6	fl-6/7/8/9	Fast	s-S	M
Aucuba japonica	Japanese Aucuba	4-8/2-4	fo	Fast	s-sS	M
Rhododendron obtusum	Kurume Azalea	3-6/3-6	fl-4;4;9	Mod	sS	M
Berberis julianae	Wintergreen Barberry	3-6/2-5	fl-4;h;t	Slow-Mod	sS-S	M
Buxus sempervirens	American Boxwood	8-12/8-12	fo;4;8;9	Slow-Mod	s-sS	M
Buxus microphylla 'japonica'	Japanese Boxwood	8-12/8-12	fo;4;8;9	Slow	s-S	M
Camellia japonica	Japanese Camellia	10-15/5-7	fl-3/4	Slow	sS	M
Camellia sasanqua	Sasanqua Camellia	10/5-7	fl-10/11	Slow	sS-S	M
Cotoneaster horizontalis	Rockspray Cotoneaster	2/6-7	fo	Slow	S	M
Daphne odora	Fragrant or Winter Daphne	3-4/3-4	fl-3;f-3 9	Slow-Mod	s-S	M
Fatsia japonica	Japanese Fatsia	8/8-10	fl-12;fo	Mod	S	M
Ilex cornuta 'Burfordii'	Burford Holly	10-12/6-8	fr;s	Mod	sS-S	M
Ilex crenata	Japanese Holly	3-6/3-6	4;8	Slow-Mod	s-S	M
Ilex vomitoria 'nana'	Dwarf Yaupon Holly	2-3/4-6		Slow	s-S	M
Juniperus chinensis 'pfitzeriana'	Pfitzer Juniper	3-6/8-12	fo;4;2	VF	S	D/M
Juniperus chinensis 'pfitzeriana compacta'	Dwarf Juniper	2/6	fo;h;2	VF	S	D/M
Juniperus procumbens 'nana'	Dwarf Japanese Garden Juniper	.5-1/4-8	fo;h;2	Slow	S	D/M
Juniperus horizontalis 'plumosa'	Andorra Juniper	1-2/4-6	fc;fo; h;2	Mod	S	D/M
Ligustrum vicaryi	Golden Vicary Privet	8-12/5-10	fo	Fast	sS-S	M
Mahonia aquifolium	Oregon Hollygrape	3-6/3-6	fl-4;fo	Mod	s-sS	M
Mahonia bealii	Leatherleaf Mahonia	12/3-4	fl-12/1; fo	Mod	s-sS	M
Nandina domestica	Nandina	3-7/2-5	fc;fr;h	Fast	sS-S	M
Pieris japonica	Japanese Andromeda	6-9/4-6	fl-3;9	Slow	s-sS	M
Pinus mugo	Mugo Pine	3-5/2-4	fo;5	Slow	S	M
Pittosporum tobira	Pittosporum	7-9/6-9	fl-5;h	Mod	S	M
Pyracantha coccinea	Pyracantha	6-10/6-10	fr;t;h;4	Fast	S	M
Raphiolepis indica	Indian Hawthorn	3-5/4-5	fl-5	Slow	s-S	M
Viburnum rhytidophyllum	Leatherleaf Viburnum	10/8-10	fo	Fast	s-sS	M
Yucca filamentosa	Yucca	4/2-3	fl;fo;s	M	sS-S	D

INDOOR PLANTS

INDOOR PLANTS

INTRODUCTION

This chapter is designed to familarize you with the basic aspects of tropical plant care rather then attempting to acquaint you with specific cultural requirements of the more than 250 commonly grown plants in the foliage industry. Bear in mind that in most cases, homes and offices are environments poorly suited to the needs of tropical plants. Thus the task of the house plant owner/enthusiast is to select plants that can best withstand indoor conditions of a specific location.

SELECTING AN INTERIOR PLANT

Select only those foliage plants which appear to be insect and disease free. Check the undersides of the foliage and the axils of leaves for signs of insects or disease. Select plants that look sturdy, clean, well potted, shapely, and well covered with leaves.

Choose plants with healthy foliage. Avoid plants which have yellow or chlorotic leaves, brown leaf margins, wilted or water soaked foliage, spots or blotches and spindly growth. In addition, avoid leaves with mechanical damage, and those which have been treated with "leaf shines" which add an unnatural polish to the leaves. Plants which have new flowers and leaf buds along with young growth are usually of superior quality.

Remember that it is easier to purchase a plant which requires the same environmental conditions your residence has to offer than to alter the environment of your home or office to suit your plants.

Transporting House Plants

When transporting plants, remember the two seasons of the year that can cause damage to the plants: the hot summer and the cold winter months. In the summer avoid placing the plant in a car and leaving the car shut up, because temperature will rise and destroy the plant in a short period of time. If you have to travel for any distance at all, the plant can be burned by the sun shining on it even though the air conditioner is on and it's comfortable in the car. Shade the plant from direct sun while it is in the car.

During winter months wrap plants thoroughly before leaving the store to carry them to your car. A short run from the store to the car in very low temperatures can kill or severely damage plants. Wrap plants thoroughly with newspaper or paper bags, and place in the front of the car and turn on the heater. The trunk of most cars is too cold to carry plants safely during the winter months.

On an extended trip you should make special arrangements to make sure that the plant will not be frozen or damaged by cold weather. Many foliage plants will be damaged considerably if the temperature drops much below 50 F, so maintain as warm a temperature as possible around these plants when transporting them from one location to another.

Acclimatization

Research done in Florida in the late 1970's revealed an interesting phenomenon. Tropical plants grown in full sun have leaves (so called sun leaves) which are structurally different from the leaves of plants grown in shade (shade leaves). Sun leaves have fewer chloroplasts and thus less chlorophyll. Their chloroplasts are located deep inside the leaves and the leaves are thick, small and large in number. Shade leaves have greater numbers of chloroplasts and thus more chlorophyll, are thin, large and few in number. When plants are grown in strong light they develop sun leaves which are photosynthetically very inefficient. If these same plants are placed in low light, they must either remake existing sun leaves or drop their sun leaves and grow a new set of shade leaves which are photosynthetically more efficient. To reduce the shock which occurs when a plant with sun leaves is placed in shade, gradually reduce the light levels it is exposed to. This process is called acclimatization. The homeowner should acclimatize plants when placing them outdoors in summer by gradually increasing light intensities and reverse the process before plants are brought indoors in the fall. For newly purchased plants, acclimatize them by initially locating them in a high light (southern exposure) area of your home and gradually moving them to their permanent darker location over a four to eight week period.

ENVIRONMENTAL FACTORS

Light, water, temperature, humidity, ventilation, fertilization, and soil are chief factors affecting plant growth, and any one of these factors in incorrect proportions will prevent proper plant growth indoors.

Light

Light is probably the most essential factor for houseplant growth. The growth of plants and the length of time they remain active depend on the amount of light they receive. Light is necessary for all plants because they use this energy source to photosynthesize. When examining light levels for tropicals, consider three aspects of light: (1) intensity, (2) duration, and (3) quality.

Light intensity influences the manufacture of plant food, stem length, leaf color, and flowering. A geranium grown in low light tends to be spindly and the leaves light green in color. A similar plant grown in very bright light would tend to be shorter, better branched, and have larger, dark green leaves. Houseplants can be classified according to their light needs, such as high, medium, and low light requirements. The intensity of light a plant receives indoors depends upon the nearness of the light source to the plant (light intensity decreases rapidly as you move away from the source of light). The direction the windows in your home face will affect the intensity of natural sun light that plants receive. Southern exposures have the most intense light, eastern and western exposures receive about 60% of the intensity of southern exposures, and northern exposures receive 20% of a southern exposure. A southern exposure is the warmest, eastern and western are less warm and a northern exposure is the coolest. Other factors which can influence the intensity of light penetrating a window are the presence of curtains, trees outside the window, weather, seasons of the year, shade from other buildings and the cleanliness of the window. Reflective (light colored) surfaces inside the home/office will increase the intensity of light available to plants. Dark surfaces will decrease light intensity.

Day-length or duration of light received by plants is also of some importance but generally only to those houseplants which are photosensitive. Poinsettia, kalanchoe, and Christmas cactus bud and flower only when day-length is short (11 hours of daylight or less). Most flowering houseplants are indifferent to day-length.

Low light intensity can be compensated by increasing the time (duration) the plant is exposed to light, as long as the plant is not sensitive to day-length in its flowering response. Increased hours of lighting allow the plant to make sufficient food to survive and/or grow. However, plants require some period of darkness to develop properly and thus should be illuminated for no more than sixteen hours. Excessive light is as harmful as too little light. When a plant gets too much direct light, the leaves become pale, sometimes sunburn, turn brown, and die. Therefore, during the summer months, protect plants from too much direct sunlight.

Additional lighting may be supplied by either incandescent or fluorescent lights. Incandescent lights produce a great deal of heat and are not very efficient users of electricity. If artificial lights are to be used as the only source of light for growing plants, the quality of light (wavelength) must be considered. For photosynthesis, plants require mostly blues and reds but for flowering, infrared light is also needed. Incandescent lights produce mostly red, and some infrared light, but are very low in blues. Fluorescent lights vary according to the phosphorus used by the manufacturer. Cool white lights produce mostly blue light and are low in red light. Foliage plants grow well under cool white fluorescent lights and these lights are cool enough to position quite close to plants. Blooming plants require extra infrared which can be supplied by incandescent lights, or special horticultural type fluorescent lights.

Water

Over and under watering account for a large percentage of tropical plant losses. The most common question home gardeners ask is, "How often should I water my plants?" There is not a good answer to this question. Some plants like drier conditions than others. Differences in soil or potting medium and environment influence water needs. Watering as soon as the soil crust dries, results in overwatering.

Houseplant roots are usually in the bottom 2/3 of the pot, so do not water until the bottom 2/3 starts to dry out slightly. You can't tell this by looking. You have to feel the soil. For a six-inch pot, stick your index finger about two inches into the soil (approximately to the second joint of your finger). If the soil feels damp, don't water. Keep repeating the test until the soil is barely moist at the two-inch depth. For smaller pots, one inch into the soil is the proper depth to measure.

Water the pot until water runs out of the bottom. This serves two purposes. First, it washes out all the excess salts (fertilizer residue). Second, it guarantees that the bottom 2/3 of the pot, which contains most of the roots, receives sufficient water. However, don't let the pot sit in the water that runs out. After a thorough watering, wait until the soil dries at the two-inch depth before watering again.

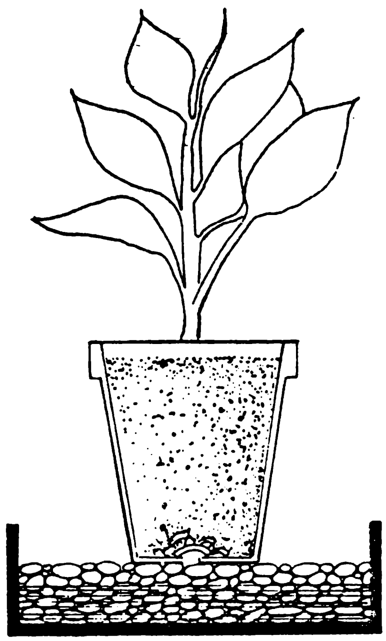
When you test for watering, pay attention to the soil. If your finger can't penetrate two inches deep, you either need a more porous soil mix, or the plant is becoming root-bound.

Temperature

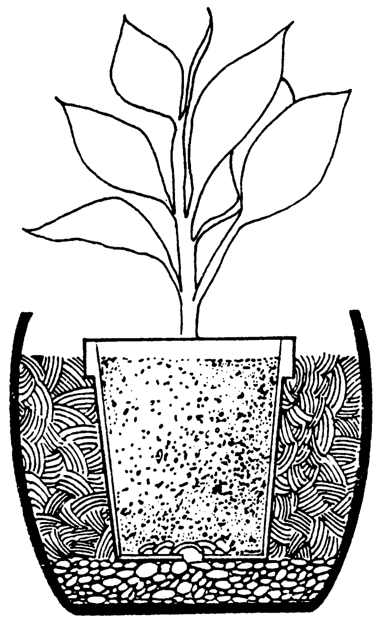
Most houseplants tolerate normal temperature fluctuations. In general, foliage houseplants grow best between 70 degrees and 80 degrees F. during the day and from 60 degrees to 68 degrees F. at night. Most flowering houseplants prefer the same daytime range but grow best at nighttime temperatures from 55 degrees to 60 degrees F. The lower night temperature induces physiological recovery from moisture loss, intensifies flower color, and prolongs flower life. Excessively low or high temperatures may cause plant failures, stop growth, or cause spindly appearance and foliage damage or drop. A cooler temperature at night is actually more desirable for plant growth than higher temperatures. A good rule of thumb is to keep the night temperature 10 to 15 degrees lower then the day temperature.

Humidity

Atmospheric humidity is expressed as a percentage of the moisture saturation of air. Two ways to provide increased humidity are by attaching a humidifier to the heating or ventilating system in the home or placing gravel trays (in which an even moisture level is maintained) under the flower pots or containers. This will increase the relative humidity in the vicinity of the containers. As the moisture around the pebbles evaporates, the relative humidity is raised.



A layer of gravel or pebbles increases the humidity level.



Another way of controlling moisture is to water sphagnum peat moss around the smaller pot

Another way to raise humidity is to group plants close together. You can also spray a fine mist on the foliage although it's of doubtful effectiveness for total humidity modification. Do this early in the day so that the plants will be dry by night. This lessens chance of disease since cool dampness at night provides an ideal environment for disease infection.

Ventilation

Houseplants, especially flowering varieties, are very sensitive to drafts or heat from registers. Forced air dries the plants rapidly, overtaxes their limited root systems, and may cause damage or plant loss. Houseplants are sensitive to natural or blended gas. Some plants refuse to flower, while others drop flower buds and foliage when exposed to gases. Blended gases are more toxic to houseplants than natural gases. Tomato plants are extremely sensitive to gas. They will turn yellow before the escaping gas is detected by household members and are sometimes used in greenhouses as indicator plants for excessive ethylene gas resulting from incomplete combustion in gas furnaces.

Fertilization

Houseplants, like most other plants, need fertilizers containing three major plant food elements: nitrogen (N), phosphoric acid (P), and potassium (K). They are available in many different combinations and under a multitude of brand names. Each brand should be analyzed on the label, indicating specifically how much water soluble elemental nitrogen, phosphate, or potash is available in every pound of the product. The majority of these fertilizers are about 20-20-20. The first figure indicates available nitrogen; the second, available phosphate; and the third, water soluble potassium. Commercial fertilizers used for houseplants are sold in granular, crystalline, liquid, or tablet forms. Each should be used according to instructions on the package label or even more dilute. Frequency of fertilizer application varies somewhat with the vigor of growth and age of each plant. Some need it every two weeks, while others will flower well for several months without needing any supplement. As a general rule, use a fertilizer recommended every two weeks from March to September. During the winter months no fertilizer need be added at all because reduced light and temperature result in reduced growth. Fertilizing at this time could be detrimental to some houseplants.

When applying fertilizer in a solution, make sure that some runs out of the bottom of the pot. This prevents root burn and the buildup of soluble salts or excess fertilizer and reduces the chance of burning the plant.

Soluable Salts

Reduced growth, brown leaf tips, dropping of lower leaves, small new growth, dead root tips, and wilting are all signs of high soluable salts. These salts will accumulate on top of the soil forming a yellow to white crust. A ring of salt deposits may be formed around the pot at the soil line or around the drainage hole. Salts will also build up on the outside of clay pots.

Soluble salts are minerals dissolved in water. Fertilizer dissoved in water becomes a soluble salt. When water evaporates from the soil the minerals or salts stay behind. As the salts in the soil become more and more concentrated, plants find it harder and harder to take up water. If salts build up to an extremely high level, water can be taken out of the root tips causing them to die.

High soluble salts damage the roots directly, and because the plant is weakened, it is more susceptible to attack from insects and diseases. One of the most common problems associated with high salt levels is root rot.

The best way to prevent soluble salt injury is to stop the salts from building up. Water correctly. When you water, allow some water to drain through and then empty the drip plate. Water equal to one-tenth the volume of the pot should drain through each time you water. DO NOT ALLOW THE POT TO SIT IN WATER. If you allow the drained water to be absorbed by the soil, the salts that were washed out are taken back into the soil. Salts can be reabsorbed through the drainage hole or directly through a clay pot.

Plants should be leached every 4 to 6 months. You should leach a plant before you fertilize so that you don't wash away all the fertilizer you just added. Leaching is done by pouring a lot of water on the soil and letting it drain completely. The amount of water used for leaching should equal twice the volume of the pot. A 6 inch pot will hold 10 cups of water so 20 cups of water are used to leach a plant in a 6 inch pot. Keep the water running through the soil to wash the salts out. If a layer of salts has formed a crust on top of the soil, you should remove the salt crust before you begin to leach. Do not remove more than 1/4 inch of soil. It is best not to add more soil to the top of the pot. If the soluble salt level is extremely high or the pot has no drainage, repot the plant.

The level of salts that will cause injury varies with the type of plant and how it is being grown. A plant grown in the home may be injured by salts at concentrations of 200 ppm. The same plant growing in a greenhouse where the light and drainage are good will grow with salts at 10 times that level, or 2,000 ppm. Some nurseries and plant shops leach plants to remove excess salts before the plant is sold. If you are not sure that has been done, leach a newly purchased plant the first time you water it.

MEDIA

The potting soil or media in which a plant grows must be of good quality. It should be porous for root aeration and drainage but also capable of water and nutrient retention. Most commercially prepared mixes are termed artificial which means they contain no soil. High quality artificial mixes generally contain slow release fertilizers which take care of a plant's nutritional requirements for several months. Commercial mixes are often misleading as to content and unsatisfactory. It is better to mix your own if possible.

Preparing Artificial Mixes

Artificial mixtures can be prepared with a minimum of difficulty. Most mixes contain a combination of organic matter, such as peat moss or ground pine bark, and an inorganic material like, washed sand, vermiculite or perlite. Materials commonly used for house plants are the peat-lite mixtures, consisting of peat moss and either vermiculite or perlite. Here are some comments concerning the ingredients for these mixes.

Peat Moss Readily available baled or bagged sphagnum peat moss is recommended. Such materials as Michigan peat, peat humus, and native peat are usually too decomposed to provide necessary structural and water-drainage characteristics. Most sphagnum peat moss is acid in reaction, with a pH ranging from 4.0 to 5.0 It usually has a very low fertility level. Do not shred sphagnum peat moss too finely.

Vermiculite This is a sterile, light-weight mica product. When mica is heated to approximately 1800 F., it expands its plate- like structure. Vermiculite will hold large quantities of air, water and nutrients needed for plant growth. Its pH is usually in the 6.5 to 7.2 range. Vermiculite is available in four particle sizes. For horticultural mixes, sizes two or three are generally used. If at all possible, the larger-sized particles should be used since they give much better soil aeration. Vermiculite is available under a variety of trade names.

Perlite This is a sterile material produced by heating volcanic rock to approximately 1800 F. resulting in a very light-weight, porous material that is white in color. Its principle value in soil mixtures is aeration. It does not hold water and nutrients as well as vermiculite. The pH is usually between 7.0 and 7.5. Perlite can cause fluoride burn on some foliage plants. Fluoride damage is usually seen on the tips of the leaves. The burn progresses from the tip up into the leaf. Fluoride burns can be prevented by adding 1 1/2 times the recommended amount of lime when mixing the soil.

A good artificial mix, containing no outside garden soil is as follows:

Formula

The following materials will make two bushels of mix:

- 1 bushel shredded peat moss
- 2 bushels perlite or vermiculite
- 1/2 cup finely ground agricultural lime
- 1/3 cup 20% superphosphate
- 1/2 cup 8-8-8 or similar analysis mixed fertilizer
- 1 level teaspoon chelated iron

Artificial mixtures are usually very low in trace or minor elements, therefore, it is important to use a fertilizer that contains these trace elements.

Soil Mixes for Specific Plants

Soils must have the most efficient composition or makeup for the type of plant or houseplant that is to be grown in them. According to generally accepted standards we can divide houseplant soils into four distinct groups according to the type of plant they are most suited to. Any soil containing garden loam should be pasteurized. This can be done easily at home. Spread the soil on a cookie tray and bake it at 180 degrees F. for 30 minutes. Do not heat it over 30 minutes.

Foliage Plants This soil should be moderately rich, have a good base of clay loam, and hold moisture and fertility adequately. It must be a crumbly, well textured soil. It is generally made up of one part of good garden loam, one part of clean sand or Perlite, and one-half to one part of either peatmoss, leafmold, or vermiculite. Mixing about 1 teaspoon of superphosphate with each quart of mixed potting soil is desirable and encourages good root growth after repotting. If the garden soil is alkaline, sphagnum peatmosses will have enough acid reaction to neutralize the mixture. This soil is used for all foliage houseplants and some flowering houseplants that do not prefer a rich soil. Compost or leafmold can replace a part of the peatmoss in the mixture.

Flowering Houseplants This soil is often referred to as humus soil because it contains about 50 percent humus rich materials or similar ingredients. It is important that the soil does not become so rich that it is soggy after it is watered. Two parts of sphagnum or one part sphagnum and one part vermiculite are added to one part garden loam and one part clean sand. Also add 1 teaspoon of super-phosphate per quart of soil mixture. This soil is used generally for African violets, gloxinias, begonias, calla lillies, and other tropical flowering plants.

Cacti and Succulents This soil does not need any humus material. It is composed of equal parts of sand, garden soil, and vermiculite or Perlite. It is preferred for cacti and other fleshy leaved, desert-type succulents.

Orchids Fir tree bark or Osmundun fiber is generally used in glazed or plastic pots. The container should be large enough so that new growth is one to two inches from the rim of container. Broken clay pieces can make up the lower inch in the container.

CONTAINERS

There are many types of containers from which to choose. A good container should be large enough to provide room for soil and roots, have sufficient head room for proper watering, provide bottom drainage and be attractive without competing with the plant it holds. Containers may be fabricated of ceramics, plastic, fiberglass, wood, aluminum, copper, brass, and many other materials.

Clay and Ceramic Containers Unglazed and glazed porous clay pots with drainage holes are widely used by commercial houseplant growers and are frequently left with the plant when it is purchased. Ornate containers are often nothing but an outer shell to cover the plain clay pot.

Clay pots absorb and lose moisture through their walls. Frequently the greatest accumulation of roots is next to the clay pot, because moisture and nutrients accumulate in the clay pores.

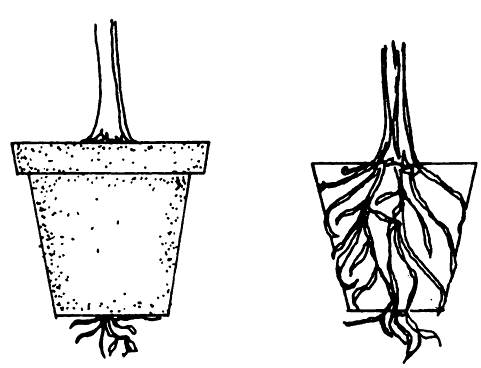
Although easily broken, clay pots provide excellent aeration for plant roots and are considered by some to be the healthest type of container for a plant.

Ceramic pots are usually glazed on the outside, sometimes also on the inside. They are frequently designed without drainage holes. This necessitates careful watering practices. Containers with no drainage are not good flower pots. Small novelty containers have little room for soil and roots and are largely ornamental. They should be avoided. It should be noted that putting potchips, clay pot shards or gravel in the bottom of a pot does not improve soil drainage; they only provide a small space beneath the soil where some excess water can drain inside the pot.

Plastic and Fiberglass Plastic and fiberglass containers are usually quite light and easy to handle. They have become popular in recent years because they are relatively inexpensive and quite attractive in shape and color. Plastic pots are easy to sterilize or clean for reuse, and because they are not porous as clay pots are, they need less frequent watering and tend to accumulate fewer salts.

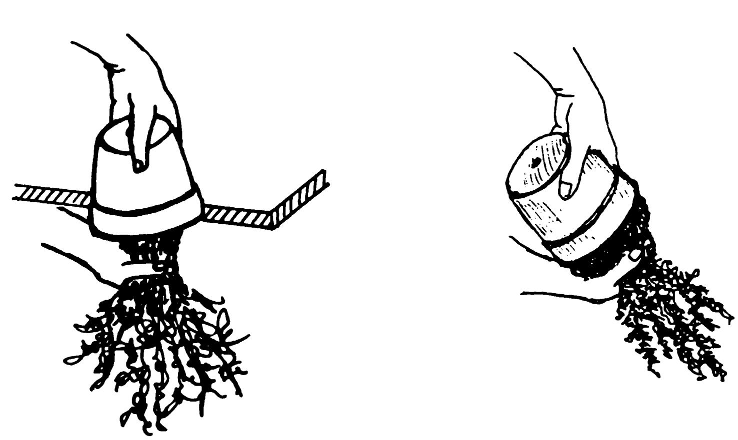
REPOTTING

Any actively growing houseplant needs repotting from time to time. This may occur very rarely with some slower growing plants, more frequently with others. Foliage plants require repotting when their roots have filled their pot and are growing out at the bottom of the pot.

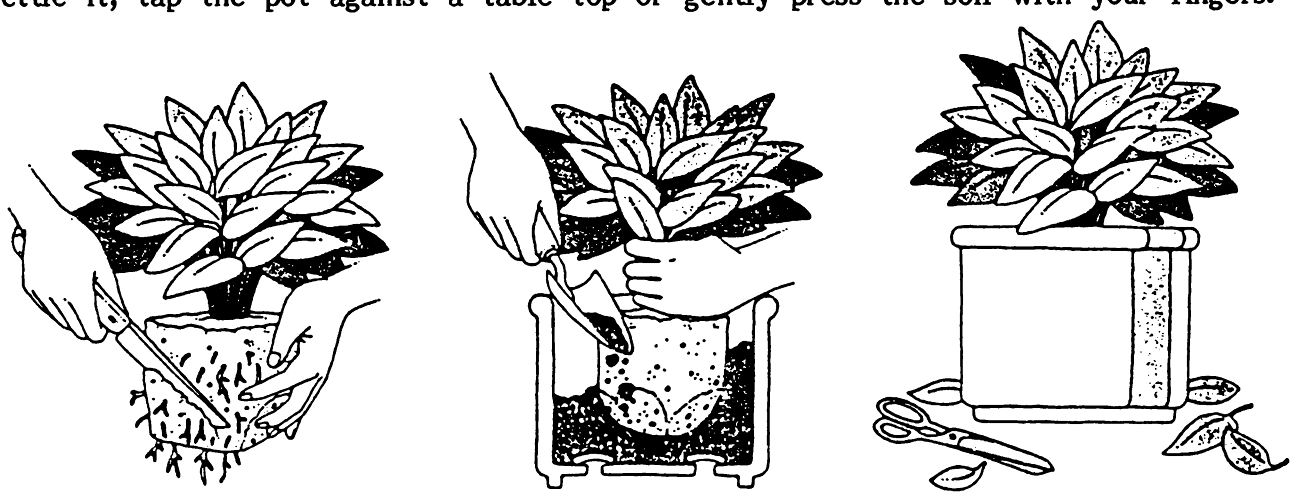


When repotting becomes necessary due to these indications by the plant, it should be done without delay. The pot selected for repotting should be no more than two inches larger in diameter than the pot the plant is currently growing in; should have at least one drainage hole; may be either clay, ceramic or plastic, and must be clean. Wash soluble salts from clay pots with water and a scrub brush and wash all pots in a solution of 1 part clorox to 9 parts water.

Potting media used should be coarse enough to allow good drainage yet have sufficient water retention capabilities. Most plants are removed easily from their pot, if the lip of the container is knocked upside down against any solid object. Hold your hand over the soil, straddling the plant between the fore and middle fingers while knocking it out of its present container.



Potting media should be moistened before you begin repotting. To repot, place drainage material in the bottom of the pot, if desired, and some new soil. If the plant has become root bound it will be necessary to cut and unwind any roots that circle the plant, otherwise the roots will never develop normally. If the old soil surface has accumulated salts, the top inch should be removed. Set the rootball in the middle of the new soil. Fill soil around the sides between the rootball and pot. Do not add soil above the original level on the rootball, unless the roots are exposed or it has been necessary to remove some of the surface soil. Do not pack the soil, to firm or settle it, tap the pot against a table top or gently press the soil with your fingers.



After watering and settling, the soil level should be sufficiently below the level of the pot to leave headroom. Headroom is the amount of space between the soil level and the top of the pot that allows for watering a plant. A properly potted plant has enough headroom to allow water to wash through the soil to throughly moisten it.

TRAINING AND GROOMING

This includes a number of minor care activities that distinguish the beginner from the more experienced houseplant grower. Pinching is one of them. Pinching is the removal of 1 inch or less of new stem and leaf growth. When it is necessary, pinch to just above the node. This leaves the plant attractive and stimulates new growth. It can be a one-time or continuous activity, depending on the need and the desires of the plant owner. If a plant should be kept compact, but well filled out, frequent pinching will achieve this. Pruning is a similar activity.

1. Leggy plant needs to grow bushier, keep more compact form.

2. Pinch out growing tip of tallest stem, removing it close to leaf joint.

3. New growth forms just below pinched-out tip, makes plant bushy.

Pruning includes removal of other than terminal shoot tips. Sometimes an entire branch or section of a plant should be removed for the sake of appearance. Disbudding is another related care activity. Certain flowerbuds are removed either to obtain larger blooms from a few choice buds or to eliminate flowering of a very young plant or recently rooted cutting that should not bear the physical drain of flowering early. Ivies and hoya, as well as philodendron and syngonium, are frequently grown in a formal pattern. This can be easily achieved by training them on trellises. It is important to keep plants clean and neat. It not only improves the appearance of plants but reduces the incidence of insects and disease problems. Remove all spent flowers, dying leaves, and dead branches. Keep leaves dust free by washing plants with warm water and mild soap (cover pot to prevent soap from entering the pot). If tips of leaves become brown and dry, trim them off neatly with sharp scissors. Removal of alkali deposits at the soil surface and replacement with clean soil does more for appearance than for the plant itself.

CARE OF SPECIAL POTTED PLANTS

Too little light, too high a temperature and improper watering are the usual causes of failure in caring for gift plants. These plants are grown in a greenhouse, where the night temperatures are usually cool, there is ample light and the air is moist. When these plants are brought into a dry home where the light is poor and the temperatures are maintained for human comfort without consideration for the plants, the results are frequently disappointing. Do not expect to hold over a gift plant from year to year. Enjoy them while they are attractive and in season and then discard.

Poinsettia Care The poinsettia requires bright light and should be kept away from drafts. A temperature between 65 and 70 degrees F. is ideal. Avoid temperatures below 60 degrees and above 75 degrees. Keep plants well watered but do not over-water. Some of the newer, long lasting varieties can be kept attractive all winter.

Gardeners frequently ask whether they can carry their poinsettias over to bloom again next year. It is questionable whether the results are worth the effort as the quality of home-grown plants seldom equals that of commercially grown plants. However, for those who wish to try, the following procedure can be followed.

After the bracts fade or fall, set the plants where they will receive indirect light and have temperature around 55 to 60 degrees. Water sparingly during this time, just enough to keep the stems from shriveling. Cut the plants back to within about five inches from the ground and re-pot in fresh soil. As soon as new growth begins, place in a well lighted window. After danger of frost, place the pot out of doors in a partially shaded spot. Pinch the new growth back to get a plant with several stems. Do not pinch after September 1. About Labor Day, or as soon as the nights are cool, bring the plant indoors. Continue to grow them in a sunny room with a night temperature of about 65 degrees.

The poinsettia blooms only during short days. To initiate blooms, exclude artificial light, either by covering with a light-proof box each evening or placing in an unlighted room or closet for a minimum of 12 hours of darkness. Plants require full light in the daytime, so be sure to return them to a sunny window. Start the short day treatment in about mid September to have blooms between December 1 and Christmas.

Azaleas Azaleas require direct sunlight to remain healthy. A night temperature of 60 degrees will prolong bloom. Keep the soil constantly moist. If the leaves should turn yellow, the soil is not acid enough. Use an acid fertilizer sold especially for azaleas. Do not use softened water. When repotting, use a mixture high in acid peat moss.

Azaleas can be planted, pot and all, in a shady spot in the garden during the summer months. Examine them frequently and keep them watered during dry periods. Greenhouse azaleas are not hardy, and need to be brought indoors before freezing weather.

Azaleas need a cool rest treatment before they are forced into bloom. Place the plants in a room with a temperature between 35-50 degrees F and filtered light. During this rest period, flower buds will develop. Then place in a well lighted warm (65° F) room around January 1 and the plant will bloom. Unless you have the proper growing conditions for the azalea, you should not attempt to carry the plants over.

Gardenia Gardenias grown indoors need special care. They demand an acid soil and should receive the same nutritional care as azaleas. The night temperature should be near 60 degrees and the humidity around the plant should be kept high. High temperature and low light intensity will result in flowerbud drop.

Amaryllis The secret of growing amaryllis is to keep the plants actively growing after they finish blooming. Keep the plants in full sun, with a night temperature above 60 degrees. As soon as danger of frost has passed, set the plants in the garden in a semishaded spot. In the fall, before danger of frostbring them in and store them in a cold dark place to rest. They will be ready to force again about January 1. Bring them into a warm light room and water moderately to begin new growth.

Christmas Cactus The Christmas cactus has become increasingly popular, with the development of several new varieties. At least three related species are sold in addition to a number of cultivars. All have similar cultural requirements.

The secret of good bloom seems to be one of temperature and photoperiod control. They will develop buds and bloom if given bright light, short days and night temperatures between 55 and 65 degrees F. Christmas cacti bloom best when somewhat pot bound. repotting is necessary only about once in 3 years. Full sunlight is beneficial in midwinter, but bright sun during summer months can make plants look pale and yellow. These plants grow naturally shaded by a canopy of leaves.

Christmas cacti require less water from October to March than they do when growth is active from April to September. A rest period is very important if plants are to bloom abundantly. Dormancy should be started about the middle of September and continued for 8 weeks. Care should be taken that soil never becomes water logged during the dark days of winter.

Cyclamen Cyclamen require full sunlight and a night temperature of between 50 and 60 degrees. They are heavy users of water and must be watered whenever the surface of the soil is dry. Flower buds will fail to develop if night temperature is too high or if light is poor.

Cyclamen can be carried over, but as with the poinsettia, homegrown plants are seldom equal to those grown by a commercial grower. Let the plants die down after they finish flowering. Repot the fleshy corm in June with the top of the corm above the soil line.

LIGHT REQUIREMENTS OF SELECTED HOUSE PLANTS

PLANT (BY COMMON NAME)	DIRECT SUN	BRIGHT LIGHT	AVG. LIGHT	LOW LIGHT
ALUMINUM PLANT		X	X	
ARECA PALM		X	X	X
ASPARAGUS				
Sprengeri	X	X		
Meyeri	X	X		
BOSTON FERN		X	X	
ALOE VERA		X	X	
BURRO'S TAIL	X	X		
CHINESE EVERGREEN		X	X	X
COLEUS	X	X		
CORN PLANT		X	X	
CROTON		X	X	
DUMB CANE	X	X	X	
DEVIL'S IVY	X	X	X	
FIDDLELEAF FIG		X	X	
FALSE ARALIA		X	X	
GERMAN IVY (GREEN)		X	X	
GERMAN IVY (VARIEGATED)		X	X	
GOLD DUST DRACENA		X	X	
GRAPE IVY		X	X	
HEARTLEAF PHILODENDRON		X	X	X
JADE PLANT	X	X		
JAPANESE ARALIA		X	X	
KANGAROO IVY		X	X	
MAIDENHAIR FERN			X	X
MOSES-IN-THE-CRADLE		X	X	
NORFOLK ISLAND PINE		X		
PARLOR PALM		X	X	X
PEPEROMIA		X	X	
PIGGYBACK		X	X	
PONYTAIL PALM	X	X		
RUBBER PLANT	X	X		
SCHEFFLERA	X	X	X	
SNAKE PLANT	X	X	X	X
SPIDER PLANT		X	X	
STRAWBERRY BEGONIA		X		
SWEDISH IVY	X	X	X	
TAHITIAN BRIDAL VEIL	X	X	X	
VELVET PLANT	X	X		
WANDERING JEWS	X	X	X	
WEEPING FIG		X		

TEMPERATURE REQUIREMENTS OF SELECTED HOUSE PLANTS

Cool Temperature plants are those that grow best at a 50 to 60 degrees F during the day and at 45 to 55 degrees F at night.

Azalea
Cacti and succulents *@
   (during winter rest
   periods only)
Camellia
Cast-iron plant *
Chrysanthemum
Citrus (grapefruit, lemon, orange)

Creeping fig
Daffodil, narcissus
Easter lily *
Euonymus japonica (spindle tree)
Ivy *

Hyacinth
Hydrangea
Japanese aralia
Jasmine
Jerusalem cherry
Miniature rose
Mock orange
Norfolk Island pine
Persian violet
Primrose
Tulip
Tree ivy
Wandering Jew
White Calla lily
Zephyr lily

Medium Temperature plants are those that grow best at 60 to 65 degrees F during the day and at 55 to 60 degrees F at night.

Amaryllis
Asparagus fern
Avacado
Baby,s tears
Begonia
Bird's nest fern

Bromeliads @
Bush violet
Cacti and succulents +@
Cast-iron plant +
Christmas cactus
Citrus +
Coleus
Crown of thorns @
Earth star @
Easter lily +
English ivy +

German ivy
Gold-dust tree
Hibiscus
Kangaroo vine @
Living stones @
Palms
Panda plant
Pepperomia
Piggyback plant
Pilea
Podocarpus
Purple passion plant @
Schefflera
Shamrock plant
Snake Plant @
Staghorn fern @
Strawberry begonia
Wax plant

High Temperature plants are those that grow best at 70 to 80 degrees F during the day and 65 to 70 degrees F at night.

African violets
Bromeliads
Cacti and succulents *@
Caladium
Calathea (peacock plant)
Chinese evergreen
Coconut palm
Copperleaf
Cordyline
Croton
Crown of thorns *
Dracena
Earth star *
False aralia
Ficus
Flame violet
Geranium
Golden Pothos
Hen and Chicks
Impatiens
Kangeroo vine *
Living stones *
Peace lily
Philodendron
Prayer Plant
Purple velvet plant *
Sensitive plant
Snake plant
Staghorn fern *
Swiss cheese plant
Veitch screw pine

@ Will also do well at high temperatures.
* Will also do well at medium temperatures.
+ Will also do well at cool temperatures.

PLANTS FOR SPECIFIC INDOOR GARDENING USES

Plants That Will Grow in Water

Scientific Name	Common Name
Aglaonema modestum	Chinese Evergreen
Crassula arborescens	Jade Plant
Dieffenbachia (all varieties)	Dumbcane
Hedera helix	English ivy
Hemigraphis colorata	Hemigraphis
Hoya carnosa	Wax plant
Monstera deliciosa	Cutleaf Philodendron
Pellionia pulchra	Satin Pellionia
Philodendron cordatum	Philodendrons (all
Philodendron micans	climbing types)
Piper nigrum	Black Pepper
Piper ornatum	Celebes Pepper
Scindapsus aureus	Devil's Ivy
Scindapsus pictus	Painted Devil's Ivy
Stephanotis floribunda	Stephanotis
Syngonium podophyllum	Arrowhead, Syngonian
Tradescantia (all varieties)	Wandering Jew

Plants That Will Withstand Most Adverse House Conditions and Abuse

Aglaonema modestum	Chinese Evergreen
Anthurium aemulum	Climbing Anthurium
Aspidistra elatior	Iron Plant
Chamaedorea elegans 'bellas'	Dwarf Parlor Palm
Cissus rhombifolia	Grape Ivy
Crassula arborescens	Jade Plant
Dieffenbachia amoena	Dumbcane
Dracaena fragrans	Massange Dracaena
Euphorbia mili	Crown of Thorns
Ficus elastica	Indian Rubber Tree
Ficus benjamina ,Exotica'	Java Fig
Hemigraphis colorata	Hemigraphis
Howeia belmoreana	Kentia Palm
Pandanus veitchii	Screw pine
Peperomia obtusifolia	Peperomia
Philodendron cordatum	Philodendron
Sansevieria trifasciata laurentii	Goldenstripe Sansevieria
Sansevieria zeylanica	Snakeplant
Scindapsus aureus	Devil's Ivy
Syngonium podophyllum	Arrowhead, Syngonium

Plants That Do Well Under Average Home Conditions

Acanthus montanus	Mountain Acanthus
Aechmea calyculata	Bromeliad
Aechmea orlandiana	Bromeliad
Asparagus sprengeri	Sprenger Asparagus
Araucaria heterophylla	Norfolk Island Pine
Begonia aconitifolia	Begonia
Begonia ulmifolia	Elm-leaved Begonia
Beloperone guttata	Shrimp plant
Caladium bicolor	Fancy-leaved Caladium
Cissus antarctica	Kangaroo Vine
Cissus rhombifolia	Grape Ivy
Cordyline australis	Grass Palm
Cyrptanthus acaulis	Earth Star
Cyrtomium falcatum	Holly Fern
Dieffenbachia x bausei	Dumbcane
Dieffenbachia picta	Dumbcane
Euphorbia milii	Crown of Thorns
Fatsia japonica	Japanese Fatsia
Fatshedera lizei	Botanical Wonder
Ficus benghalensis	Banyan Fig
Ficus eburnea	Ivory Fig
Ficus religiosa	Bo-tree Fig
Grevillea robusta	Silky Oak
Hedera helix (all varieties)	English Ivy
Pedilanthus tithymaloides	Slipper Flower or Red Bird Flower
Peperomia clusiaefolia	Peperomea
Peperomia crassifolia	Peperomea
Peperomia obtusifolia 'Variegated'	Variegated Peperomia
Peperomia sandersii	Watermelon Peperomia
Pereskia aculeata	Lemon Vine
Philodendron cordatum	Heartleaf Philodendron
Philodendron ,dubia'	Philodendron
Philodendron giganteum	Giant Philodendro
Philodendron imbe	Imbe philodendron
Philodendron x mandaianum	Philodendron
Philodendron panduraeforme	Panda Plant
Philodendron erubescens	Redleaf Philodendron
Philodendron selloum	Philodendron
Philodendron tripartitum	Trileaf Philodendron
Philodendron wendlandii	Philodendron
Pilea involucrata	Artillary Plant
Piper nigrum	Black Pepper
Piper ornatum	Celebes Pepper
Polyscias balfouriana	Balfour Aralia
Polyscias filicifolia	Fernleaf Aralia
Polyscias paniculata 'Variegata'	Jagged-leaf Aralia

Rhoeo spathacea	Moses in the cradle
Sansevieria trifaciata ,Hahni'	Hahn's Sansevieria
Sansevieria parva	Parva Sansevieria
Sansevieria subspicata	Rededge Sansevieria
Saxifraga sarmentosa	Strawberry geranium
Schismatoglottis picta	Painted Tongue
Scindapsus aureus	Devils Toy Pathos
Spathiphyllum 'Clevelandii'	Spathiphyllum
Syngonium podophylum 'Emerald Gem'	Variegated Arrowhead
Tradescantia (all varieties)	Wandering Jew

Plants Well Suited for Large Tubbed Decorative Specimens

Acanthus mollis	Artists Acanthus
Acanthus montanus	Mountain Acanthus
Alocasia cuprea	Giant Caladium
Alsophila australis	Australian Tree Fern
Codiaeum pictum	Croton
Dieffenbachia amoena	Spotted Dumbcane
Fatshedra lizei	Botanical Wonder
Fatsia japonica	Japan Fatsia
Ficus eburnea	Ivory Fig
Ficus elastica 'variegata'	Variegated India Rubber
Ficus lyrata	Fiddleleaf Fig
Monstera deliciosa	Cutleaf Philodendron
Pandanus veitchii	Screwpine
Philodendron elongatum	Philodendron
Philodendron giganteum	Giant Phildendron
Philodendron x mandaianum	Philodendron
Philodendron panduraeforme	Philodendron
Philodendron selloum	Philodendron
Philodendron wendlandii	Philodendron
Polyscias paniculata 'variegata'	Jagged-leaf Aralia
Schefflera digitata	Schefflera
Strelitzia reginae	Bird of Paradise

Low Creeping Plants for Ground Covers In Interior Planting Boxes

Episcia cupreata	Episcia
Ficus pumila	Creeping Fig
Ficus radicans	Climbing Fig
Fittonia verschafeltii	Silver Fittonia
Hedera helix	Hahn's Star English Ivy
Hemigraphis colorata	Hemigraphis
Pellionia daveauana	Pellionia
Pellionia pulchra	Pellionia

Philodendron cordatum	Heartleaf Philodendron
Pilea nummulariifolia	Creeping Artillery Plant
Saxifraga sarmentosa	Strawberry Begonia
Scindapsus aureus	Devil's Ivy
Tradescantia (all varieties)	Wandering Jew
Vinca major 'variegata'	Variegated Vinca

Plants That Withstand Dry, Warm Locations

Bromeliads -- all species and varieties
Cacti -- all species and varieties

Vines and Trailing Plants for
Totem Poles and Trained Plants

Anthurium almulum	Climbing Anthurium
Cissus antarctica	Kangaroo Vine
Cissus discolor	Begonia Cissus
Cissus rhombifolia	Grape Ivy
Clerodendrum Balfouri	Glorybower
Ficus pumila	Creeping Fig
Vanilla fragrans 'Marginata'	Vanilla

Plants Suitable For Hanging Baskets

Achimenes grandiflora	Bigpurple Achimenes
Aeschynanthus parasiticus	Lobecup Basketvine
Aeschynanthus parasiticus 'Black Pagoda'	Black Pagoda Basketvine
Aeschynanthus radicans	Lobbs Basketvine; Lipstick plant
Aeschynanthus pulcher	Scarlet Basketvine
Asarina erubescens	Creeping Gloxinia
Asparagus plumosus	Fern Asparagus
Asparagus sprengeri	Sprengeri Fern
Begonia 'Elsie M. Frey'	
Begonia x hiemalis	Winter Flowering Begonias
Callisia elegans	Striped Inch plant
Ceropegia woodii	String of Hearts; Rosary Vine
Chlorophytum bichetii	St. Bernard's Lily
Chlorophytum comosum 'Variegatum'	Green Lily
Chrysanthemum morifolium 'Anna'	Daisy Cascade
Chrysanthemum morifolium 'Jane Harte'	Daisy Cascade

Cissus quadrangula	Winged Treevine
Codonanthe crassifolia	Central American Bellflower
Coleus rehneltianus 'Trailing Queen'	Trailing Coleus
Columnea x banksii	Goldfish Vine
Columnea microphylla	Small-leaved Goldfish Vine
Commelina communis aurea-striata	Variegated Widows Tear
Cyanotis kewensis	Teddy Bear Plant
Cyanotis somaliensis	Pussy Ear
Cymbalaria muralis	Kenilworth Ivy
Davallia fejeensis plumosa	Rabbit's Foot Fern
Episcia cupreata 'Amazon'	Amazon Flame Violet
Episcia cupreata 'Chocolate Soldier'	Carpet Plant
Episcia cupreata	Ember Lace Episcia
Episcia cupreata 'Emerald Queen'	Emerald Queen Episcia
Episcia cupreata 'Silver Sheen'	Silver Sheen Episcia
Episcia dianthiflora	Lace Flower Vine
Episcia 'Moss Agate'	Panama Episcia
Erythrorhipsalis pilocarpa	Bristletufted twig cactus
Euphorbia mammillaris	Corncob Plant
Fittonia verschaffeltii	Mosaic Plant
Fittonia verschaffeltii	Silvernerve Fittonia
Fittonia verschaffeltii var. Pearcei	Snake Skin Plant
Fuchsia 'Jubilee'	Jubilee Fuchsia
Fuchsia 'Swingtime'	Swingtime Fuchsia
Fuchsia triphylla 'Gartenmeister Bohnstedt'	Honeysuckle Fuchsia
Hatiora salicornioides	Drunkard's Dream
Hedera helix 'Hahns Variegated'	Variegated Hahn's English Ivy
Hedera helix 'Ivalace'	Ivalace English Ivy
Hemigraphis colorata	Red Ivy
Hemigraphis Exotica	Waffle Plant
Hoya australis	Porcelain Flower
Hoya bella	Miniature Wax Plant
Hoya carnosa 'Compacta'	Compact Wax Plant
Hoya carnosa 'Exotica'	Exotic Wax Plant
Hoya carnosa 'Krinkle Curl	Hindu Rope Plant
Hoya carnosa 'Tri-color'	Variegated Wax Plant
Hoya imperialis	Honey Plant

Hoya keysi	Pubescent Wax Plant
Hoya longifolia shepherdii	Shepherd's Wax Plant
Hoya motoskei	Spotted Wax Plant
Hoya purpureo-fusca	Silver Pink Wax Plant
Hypocyrta nummularia	Miniature Pouch Flower
Hylocereus undatus	Nightblooming Cereus
Ipomoea batatas	Blackleaf Sweet Potato
Kalanchoe gastonis-bonnieri	Life Plant
Kalanchoe manginii	Mangin Kalanchoe
Kalanchoe pubescens	Jinglebells Kalanchoe
Kalanchoe uniflora	Miniature Kalanchoe
Mammillaria elongata	Lace Mammillaria
Nephrolepis exaltata bostoniensis	Boston Fern
Nephrolepis exaltata 'Rooseveltii'	Tall Featherfern
Pelargonium x frangrans	Scented Geranium
Pellonia daveauana	Trailing Watermelon Vine
Pellonia pulchra	Satin Pellonia
Peperomia acuminata	Mexico Pepperface
Peperomia cubensis	Cuban Pepperface
Peperomia glabella 'Variegata'	Variegated Waxprivet Peperomia
Peristrophe hyssopifolia 'Aurea-Variegata'	Marble-leaf
Philodendron micans	Velvet-leaf Vine
Philodendron oxycardium	Heart-leaf Philodendron
Pilea nummulariifolia	Creeping Charley
Platycerium alcicorne	Elkhorn Fern
Plectranthus coleoides 'Marginatus'	Candle Plant
Plectranthus oertendahli	Prostrate Coleus
Plectranthus purpuratus	Moth King
Plectranthus tomentosus	Succulent Coleus
Polypodium aureum	Hare's Foot Fern
Portulacaria afra 'Variegata'	Rainbow Bush
Rhipsalis capilliformis	Treechair Rhipsalis
Rhipsalis cassutha	Mistletoe Rhipsalis
Rhipsalis houlletiana	Snowdrop Cactus
Rhipsalis paradoxa	China Rhipsalis
Rhipsalis pentaptera	Fivewing Rhipsalis
Rhipsalis trigona	Triangle Rhipsalis
Ruellia makoyana	Monkey Plant
Schlumbergera bridgesii	Christmas Cactus
Schlumbergera gaertneri	Easter Cactus
Scindapsus aureus	Devil's Ivy
Sedum morganianum	Burro Tail
Senecio herreianus	Green Marblevine
Setcreasea purpurea	Purple Heart
Stapelia gigantea	Giant Toadplant
Stenotaphrum secundatum variegatum	Variegated St. Augustine Grass

Streptocarpus saxorum	False African Violet
Tradescantia albiflora 'Albovittata'	Giant White Inch
Tradescantia sillamontana	White Velvet; White Gossamer

Plants suitable for Tropical Terrariums

Aglaonema commutatum	Chinese evergreen
Begonia boweri	Miniature begonias
Chamaedorea elegans	Neanthe bella, parlor palm
Cissus antarctica 'Minima'	Dwarf kangaroo ivy
Coffea arabica	Arabian coffee plant
Cordyline terminalis minima 'Baby Ti'	Dwarf ti plant
Cryptanthus bivittatus minor	Dwarf rose-stripe earth star
Dizgygotheca elegantissima	False aralia
Dracaena sanderana	Belgian evergreen
Dracaena surculosa	Gold dust dracaena
Ficus	
diversifolia	Mistletoe fig
pumila 'Minima'	Dwarf creeping fig
Fittonia verschaffeltii	Mosaic plant
Maranta leuconeura kerchoveana	Prayer plant
Nephrolepis exaltata cvs.	Boston fern
Peperomia sandersii	Watermelon pepporonia
Pilea	
cadierei 'Minima'	Aluminum plant
depressa	Miniature pilea
microphylla	Artillary plant
nummulariifolia	Creeping Charlie
Pteris spp.	Brake or table ferns
Saintpaulia cvs.	Miniature African violets
Selaginella	Club moss, moss fern
kraussiana	Creeping club moss
emmeliana	Sweat plant
Sinningia pusilla (and other miniature cvs.)	Miniature gloxinias
Sngonium	Arrowhead vine, Nephthytis

Plants suitable for Desert Dish Gardens

Adromischus	Calico hearts, leopard spots
Aloe	Medicine Plant
Astrophytum myriostigma	Bishop's cap
Cephalocereus nobilis	Cylinder cactus
Cereus peruvianus 'Monstrosus'	Curiosity plant
Crassula	Jade plant
lycopodioides	Toy cypress, watch chain
rupestris	Rosary Vine
Echeveria	
Derenbergi	Painted lady
elegans	Mexican snowball
secunda var. glauca	Hen and chickens
Echinocactus Grusonii	Golden barrel cactus
Echinocereus pectinatus var. neomexicanus	Rainbow cactus
Echinocereus reichenbachii	Lace cactus
Echinocereus micromeris	Button cactus
Euphorbia lactea cristata	Crested euphorbia, frilled fan
Faucaria tigrina	Tiger jaws
Gasteria liliputana	Miniature gasteria, miniature ox tongue
Haworthia	Pearl plant, wart plant
fasciata	Zebra haworthia
margaritifera	Pearl plant
Lithops spp.	Living stones
Mammillaria	
bocasana	Powder puff cactus
elongata	Golden star cactus
fragilis	Thimble cactus
Opuntia	
erectoclada	Dominoes, pincushion cactus
microdasys	Bunny ears
vilis	Dwarf tree oputia
Portulacaria	
afra	Elephant bush
afra variegata	Rainbow bush
Rebutia	
kupperiana	Scarlet crown cactus
minuscula	Red crown cactus
Sedum	Stonecrop
acre	Golden carpet, gold moss
adolphi	Golden sedum
dasyphyllum	Golden glow
lineare	Carpet Sedum
morganianum	Burro's tail
multiceps	Miniature Joshua tree
pachyphyllum	Jelly beans
X rubrotinctum	Christmas cheer
Stahlii	Coral beads

HERBACEOUS PLANTS

HERBACEOUS PLANTS

INTRODUCTION

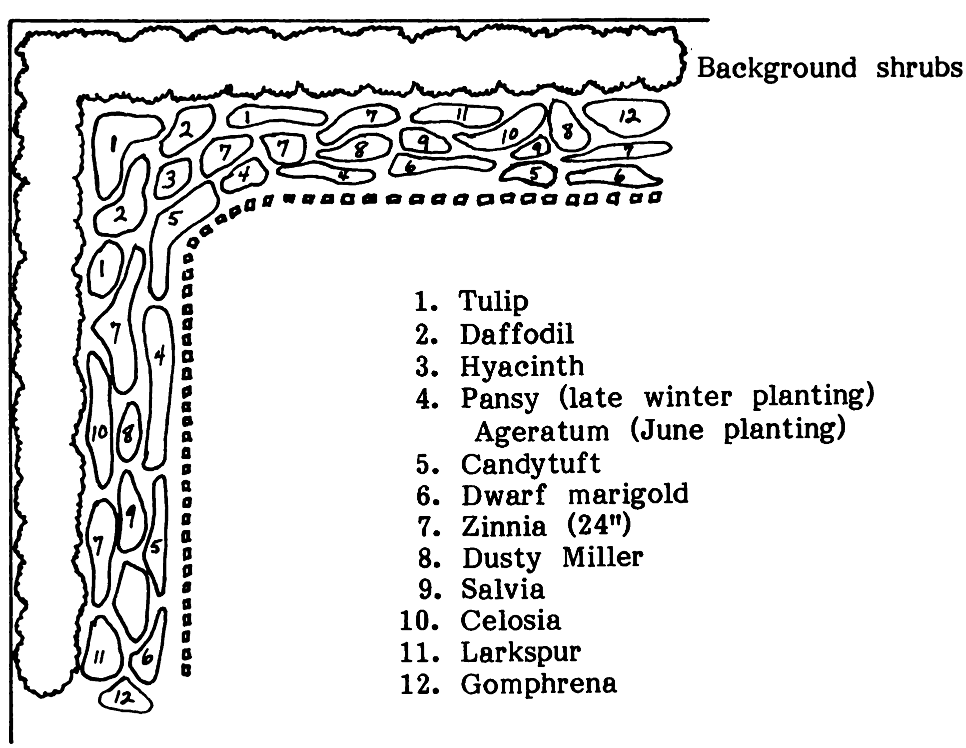
Flower gardening is the horticulturist's reward for hard work. Flowers and flower borders provide color against the predominant green of a landscape. They are the accent and contrast that make a landscape lively and interesting. Flowers also complement most of the features that conventional landscaping materials, such as trees and shrubs, establish. They can add depth and dimension, form and texture, and change heights and slopes, besides their most obvious asset which is color. Flowers can also be useful, providing culinary herbs for the table and cut flowers for arrangements.

PLANNING THE FLOWER BORDER

Much of the excitement of creating an herbaceous border lies in its great flexibility of design. In form, placement and selection of plants, the contemporary border follows few rigid rules and allows fullest expression of the gardener's taste.

The first step in planning the material for an all season, mixed perennial border, is to select key plants for line, mass, color, and dependability. Line is the silhouette or outline of a plant, mass is its shape or denseness and dependability refers to its ability to remain attractive with a minimun of problems. Garden books and catalogues can be very useful for reference.

The most attractive flower borders are those which are located in front of a suitable background such as a fence, shrubbery, or a building. In some cases tall flowers such as hollyhocks or sunflower may serve a dual purpose as flowers in the border and as background plants. Annual or perennial flowers of medium height may serve as background plants for a small border planting.



1. Tulip
2. Daffodil
3. Hyacinth
4. Pansy (late winter planting)
   Ageratum (June planting)
5. Candytuft
6. Dwarf marigold
7. Zinnia (24")
8. Dusty Miller
9. Salvia
10. Celosia
11. Larkspur
12. Gomphrena

A general rule, unless the garden is very spacious or formal, is to avoid a ruler-straight front edge. A gentle to boldly sweeping curve, easily laid out with a garden hose, is best even along a fence, and the border can taper as it recedes from the main viewing point if an effect of distance is desired. The deeper the curve the slower the eye moves and the greater will be the visual enjoyment. A border outlined with bricks or flat stones set flush with the soil is better than a steeply cut lawn edge which must be trimmed after mowing.

Even the advanced gardener finds it advantageous to plan a border to scale on graph paper. The hardest task, organizing the selection of plants, will be simplified if only two main mass forms are considered: drifts and clumps. Drifts are elongated groupings of a plant that flow through sections of the border. Clumps consist of circular groupings of a variety, or a single large plant such as a peony. The length of drifts and the diameter of clumps, as well as their heights, should be varied for best effect, and the dimensions should always be in proportion to the overall size of the border.

Establish plants in groups large enough to form masses of color or texture. As a rule, five or seven plants will create the desired effect. A large delphinium or peony will be of sufficient size to be attractive, but a random collection of different small to medium sized plants will present a disorganized, checker board appearance. Each group of flowers should have an irregular shape. These masses of color and texture should blend into a pleasing pattern of color harmony. Dwarf flowers may be used as a continous edging or border along the front of the bed.

Flower borders may be of any width, depending on the space available. In a small yard the bed may be only two or three feet wide. In a spacious location the border planting may have a width of six or eight feet. If the border is quite deep, a pathway of stepping stones may be helpful as a means of working among the flowers without compacting the soil.

Tall flowers should be selected for the back part of the bed, with medium height species in the middle, and dwarf varieties along the front as edging plants. This is very easily done because the height of all varieties is stated in the seed catalog from which you make selections. The plants along the front edge of the flower bed should be located back far enough to allow easy mowing of the lawn.

Plant height is best limited to two-thirds the width of the border, e.g., no plants taller than 4' in a border 6' wide. Height lines should be broken up too: letting some tall plants extend forward into the medium height groups, with a few recessed clumps or drifts leading the eye back into the border, gives a much more natural effect than a step profile. Try to vary heights but in general keep taller plants in the back and shorter ones toward the front.

The distance between plants in a flower border depends on the form of the individual plants, and the effect which is desired in the landscape. Allow adequate space between plants. Many gardeners crowd their plants too much.

As a rule, the tall spired type flowers such as hollyhock, gladiolus, and rocket snapdragons which are trained to a very few stems, should be spaced about one-fourth as far apart as their mature height. Tall bushy plants may be spaced about one-half as far apart as their mature height. Rounded bushy annuals and perennials should be spaced about as far apart as their mature height. Creeping, ground cover type plants may be spaced about twice as far apart as their mature height. In all cases, if a solid mass of plants is desired, the spacing may be reduced. If individual plants are to be conspicuous as specimens, and be allowed to produce large flowers, the distances should be increased.

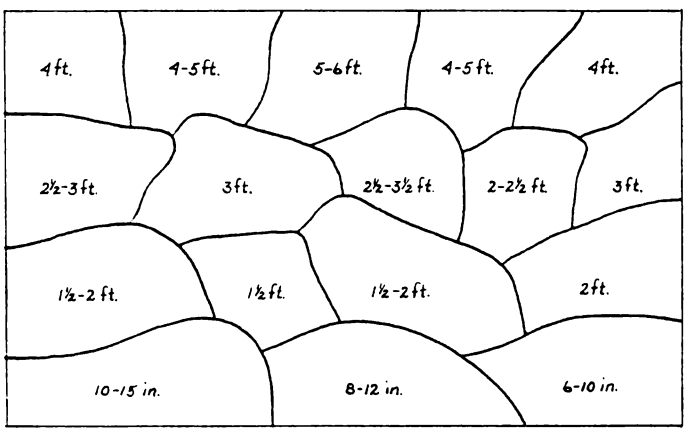
The enormous color range in perennials, plus their easy movability if disharmony occurs, give the gardener great latitude in choosing and combining colors. A border in tones of the same color can be effective, or several closely related colors may be used, or the border may be made wildly exuberant with a vast variety of hues in one or more seasons. Hues are modifications of color such as orangish red. The objective is a balanced composition in every season, with no section being at any time too heavily weighted with color, and the bloom so distributed that it always makes a pleasing pattern through the bed.

Many gardening books give excellent lists of compatible colors; these plus a garden notebook and camera are invaluable for planning and revising color schemes. For real floral artistry, it is perhaps more important to consider intensity which is the vividness of a color rather than hue. For example, light tones placed near dark ones, or contrasting palest tones with the most intense, can give new interest and life to the border. Also consider location and color. Near patios, white is especially good because it shows up well in the evening or dusk hours when patios are often in use. Some colors are suitable only as dramatic accents: deep pure red clashes with almost anything (unless softened by dark green foliage), yet properly used it confers strength and depth. White flowers and gray foliage are indispensable as separators of conflicting colors.

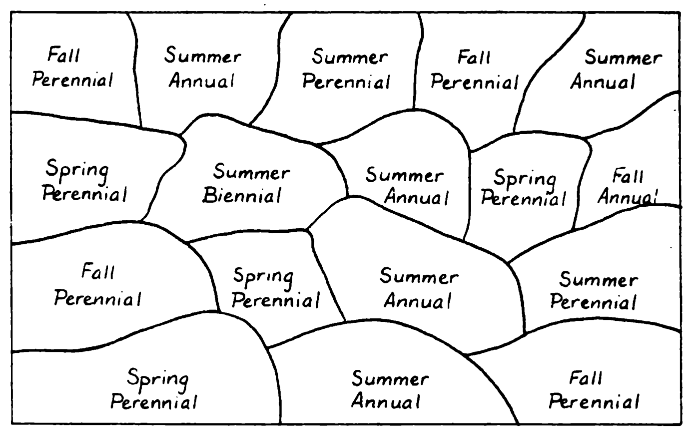
Red, orange, and yellow are warm colors. Blue, green, and violet are cool colors. The use of warm colors in the flower border of a small yard will give the illusion of little space. Conversely, the use of cool colors gives the impression of openesss and space. In general, the smaller the area, the fewer warm colors should be used.

As a gardener becomes adept at producing constant color harmony in the border, he becomes more aware of the roles played by plant forms and foliage. Good foliage is obviously vital in plants with short blooming periods. Consider how much of the plant foliage will be usable and whether it is a positive or negative attribute. Some plants practically disappear when their blooming season is over (i.e., oriental poppy and bleeding heart), but others stay presentable even when not in flower. Plants with distinctive forms, color, and foliage, airy and delicate, or strong and solid, are wonderfully useful for creating interest. Ornamental grasses, and even handsome foliaged vegetables like broccoli and asparagus can be used for effect.

The most logical way to choose plants is first by location, second by period of bloom, then by height and width, and finally,by color. Location takes into account the amount of sun or shade, water, etc. This information is not difficult to glean from books on perennials and catalogs.



Dividing a flower border into bold plant groupings according to height. Background: large groups of tall plants. Foreground: shallower, wide groupings of small plants.



Selection of garden groups as to season of flowering and whether annual, biennial, or perennial.

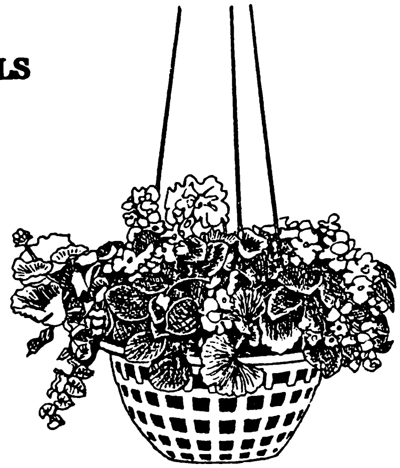
The only restrictions on any given plant will be environmental; a lack of ability to tolerate winter or summer temperature extremes, or special soil, moisture or light needs, and any limits the gardener must place on time available for maintenance.

Even in a small border, single plants of different varieties should not be used. This gives a jumbled look. Do not set in precise rows but in groups, as they might grow in nature. Allow enough space for each group to grow comfortably. Decide which flowers you like best, and let these be the basis of your planting. Place them in several spots, if you like, down the length of the border, but don't overdo any one plant.

The longer the border has flowers in bloom, the more you will enjoy it. Consider the months when each plant will be at its best. Do not confine yourself to material that blooms all at one time. Aim for a steady succession of color.

A last bit of advice, don't be afraid to be bold even if it results in some mistakes. Flowers are easy to move, change or take out altogether. There is no need to be conservative or confined. Flowers are fast growers and can be transplanted at almost anytime to help create the effect desired.

ANNUALS



Annual flowers live only one growing season during which time they grow, flower and produce seed, thereby completing their life cycle. Annuals must be set out or seeded every year since they don't persist. Some varieties will self sow or naturally reseed themselves. This may be undesirable in most flowers because the parents of this seed are unknown and hybrid characteristics will be lost. Plants will scatter everywhere instead of their designated spot. Examples are alyssum, petunia and impatiens. Some perennials, plants that live from year to year, are classed with annuals because they are not winter hardy and must be set out every year; begonias and snapdragons are examples. Annuals have many positive features. They are versatile, sturdy and relatively cheap. Plant breeders have produced many new and improved varieties. Annuals are easy to grow, produce instant color and most important, they bloom for most of the growing season.

There are a few disadvantages to annuals. They must be set out as plants or sowed from seed every year which involves some effort and expense. Old flower heads should be removed on a weekly basis to insure continuous bloom. If they are not removed, the plants will produce seed, complete their life cycle, and die. Many annuals begin to look disreputable by late summer and need to be cut back for regrowth or replaced by a second planting.

Annuals offer the gardener a chance to experiment with color, height, texture, and form. If a mistake is made, it's only for one growing season. Annuals are useful for filling in spaces until permanent plants are bought or grown, to extend perennial beds and fill in "holes" where an earlier perennial is gone or the next one has yet to bloom; to cover areas where spring bulbs have bloomed and died back; and, to fill planters, window boxes and hanging baskets.

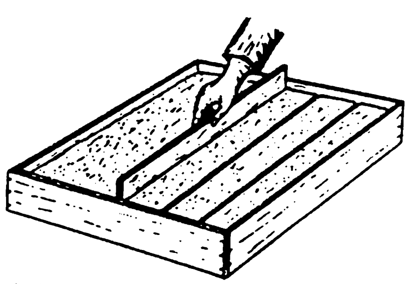
Culture and Maintenance of Annuals

Site Selection Consider aspects of the site that affect plant growth such as light, soil characteristics and topography. Different annuals perfom well in full sun, light shade, or heavy shade. The slope of site will affect temperature and drainage. Texture, drainage, fertility, pH. of the soil influence plant performance.

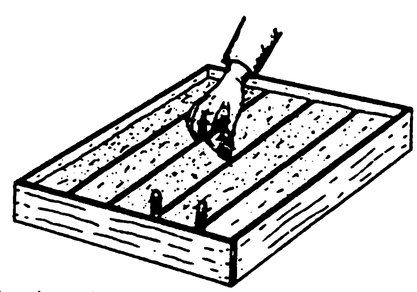
Site Preparation Preparation is best done in the fall. Proper preparation of soil will enhance success in growing annuals. First, have the soil tested and adjust the pH if needed. Check and adjust drainage. To do this dig a hole about 10 inches deep and fill with water. The next day, fill hole with water again and see how long it remains (should not exceed 8 hours). If drainage is poor, plan to plant in raised beds. The next step is to dig the bed. Add 4 to 6" organic matter to heavy clay to improve soil texture. Dig to a depth of 12 or 18 inches and leave "rough" in fall or early spring. Finally, in spring add fertilizer, spade again and rake surface smooth.

Seed Selection To get a good start toward raising vigorous plants, buy good viable seed packaged for the current year. Seed saved from previous years usually loses its vigor. It tends to germinate slowly and erratically and produces poor seedlings. Keep seed dry and cool until planted. If seed must be stored, place in an air tight container with powdered milk to absorb excess moisture and refrigerate. When buying seed, look for new varieties listed as hybrids. Plants from hybrid seed are more uniform in size and more vigorous than plants of open-pollinated varieties. They usually produce more flowers with better substance.

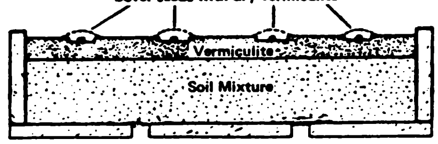
Starting Plants Indoors The best media for starting seeds is loose, well drained, fine textured, low in nutrients, and free of disease causing fungi, bacteria, and unwanted seeds. Many commercial products meet these requirements. Fill clean containers about two-thirds full with potting medium. Level the medium and moisten it evenly throughout. It should be damp but not soggy. Make a furrow one-fourth of an inch deep. Sow large seed directly in the bottom of the furrow. Before sowing small seed, fill the furrow with vermiculite; sow small seeds on the surface of the vermiculite. Seeds may be sown in flats following seed package directions or directly in individual peat pots or pellets, two seeds to the pot. After seed is sown, cover all furrows with a thin layer of vermiculite, then water with a fine mist. Place a sheet of plastic over seeded containers and set them in an area away from sunlight where the temperature is between 60 and 75 degrees F. Bottom heat is helpful. As soon as seeds have germinated, remove plastic sheeting and place seedlings in the light. If natural light is poor, fluorescent tubes can be used. Place seedlings close to the tubes. After plastic is removed from container, the new plants need watering and fertilizing, since most planting material contains little or no plant food. Use a mild fertilizer solution after plants have been watered. When seedlings develop two true leaves, thin plants in individual pots to one seedling per pot. Transplant those in flats to other flats, spacing 1 1/2 inches apart, or to individual pots.



Make shallow depressions in the medium to facilitate uniform seeding.



Sow the seeds thinly and evenly, then label each variety.

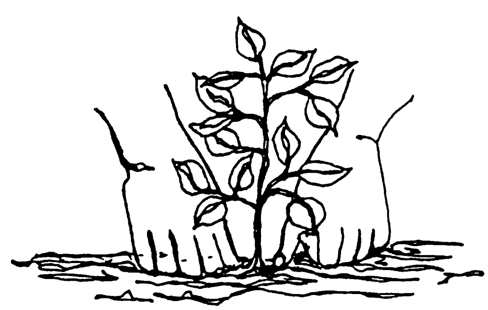


Cover seeds with dry vermiculite, then water carefully.

Planting Times Do not be in a rush to start seeds outdoors or to set out started plants. As a general rule, delay sowing seed of warm-weather annuals outdoors or setting out started plants until after the last frost. Most such seeds will not germinate well in soils below 60 degrees F. If soil is too cold when seed is sown, seeds will remain dormant until soil warms and may rot before it germinates. Some cold-loving annuals like larkspur or Shirley poppies should be sown in late fall or very early spring.

Sowing Seed Outdoors Annuals seeded in the garden frequently fail to germinate properly because the surface of the soil cakes and prevents entry of water. To avoid this, sow the seed in vermiculite filled furrows. Make furrows in soil about 1/2 inch deep. If the soil is dry, water the furrow, then fill it with fine vermiculite, sprinkle with water. Then make another shallow furrow in the vermiculite and sow the seed in this furrow. Sow at the rate recommended on the package. Cover the seed with a layer of vermiculite and using a nozzle adjusted for a fine mist, water the seeded area thoroughly. Keep seed bed well watered or cover with a mulch, such as newspaper to prevent excess evaporation of water. Remove mulch promptly, after germination starts so that young seedlings will receive adequate sunlight.

Setting Out Transplants By setting started plants in your garden you can have a display of flowers several weeks earlier than if you sow seeds of the plants. This is especially useful for annuals which germinate slowly or need several months to bloom such as verbena and scarlet sage. You can buy plants of these or other annuals or you can start your own. Buy only healthy plants free of pests and diseases. Before setting out transplants, harden them off by exposing them to outside conditions during the day which will provide more light and cooler temperatures than they received inside. After the last frostdate, annual plants may be set out. Dig a hole for each plant large enough to accept its root system comfortably. Lift out each plant from its flat with a block of soil surrounding its roots. Set the soil block in a planting hole and backfill it so the plant sets at the same level. Water each hole with a starter solution of fertilizer and water made from high phosphate fertilizer which is water soluable. Follow package directions.



If the plants are in fiber pots, remove the paper from the outside of the root mass and set the plant in a prepared planting hole. When setting out plants in peat pots, set the entire pot in the planting hole but remove the upper edges of the pot so that all of the peat pot is covered when soil is firmed around the transplant. If a lip of the peat pot is exposed above the soil level, it may produce a wick effect, pulling water away from the plant and into the air. After setting the plants, water them with a starter solution as described above. Provide protection against excessive sun, wind, or cold if needed while the plants are getting settled in their new locations. Inverted pots, newspaper tunnels, or cloaks can be used.

Thinning When most outdoor grown annuals develop the first pair of true leaves, they should be thinned to the recommended spacing. This recommended spacing allows the plants to have enough light, water, nutrients, and space for them to develop fully above and below the ground. If they have been seeded in vermiculite-filled furrows, the excess seedlings can be transplanted to another spot without injury. Zinnias are an exception to this rule of thinning. In many varieties of zinnias, flowers will appear with a large nearly naked corolla and few colorful petals. This phenomenum is sometimes referred to as Mexican hats. To avoid such plants in your garden, sow two or three seeds at each planned location. Wait until the plants bloom for the first time, then remove the plants with this undesirable characteristic. Thin the remaining plants to the recommended 8 to 12 inch spacing.

Another exception to the rule for thinning is sweet alyssum. This annual is particularly susceptible to damping-off. To insure a good stand of plants, sow the seed in hills and do not bother to thin the seedlings.

Watering Do not rely on summer rainfall to keep flower beds watered. Plan to irrigate them from the beginning. When you water, moisten the entire bed thoroughly, but do not water so heavily that the soil becomes soggy. After watering, allow the soil to dry moderately before watering again. A canvas soaker hose is excellent for watering beds. Water from the soaker hose seeps directly into the soil without waste and without splashing leaves and flowers. The slow-moving water does not disturb the soil or reduce its capacity to absorb water. Water wands and drip systems are also good. Sprinklers are not as effective as soaker hoses. Water from sprinklers wets the flowers and foliage making them susceptible to diseases. Structure of the soil may be destroyed by impact of water drops falling on its surface; the soil may puddle or crust, preventing free entry of water and air. The least effective method for watering is with a hand-held nozzle. Watering with a nozzle has all the objections of watering with a sprinkler. In addition, gardeners seldom are patient enough to do a thorough job of watering with a nozzle; not enough water is applied, and the water that is applied usually is poorly distributed over the bed.

Mulching Mulches help to keep the soil surface from crusting, aid in preventing growth of weeds, and organic mulches can add humus to the soil. Grass clippings make a good mulch for annuals, so long as you do not let them mat. Sheet plastics also may be spread over the soil surface to retard evaporation of water and to prevent growth of weeds. However, these materials are unsightly for use in the flower garden.

Weeding (Cultivating) After plants are set out or thinned, cultivate only to break crusts on the surface of the soil. When the plants begin to grow, stop cultivating and pull weeds by hand. As annual plants grow, feeder roots spread out between the plants; cultivation is likely to injure these roots. In addition, cultivation stirs the soil and uncovers other weed seeds that then germinate.

Deadheading (Removing Old Flowers) To maintain vigorous growth of plants, and assure neatness, remove spent flowers and seed pods. This step is particularly desirable if you are growing ageratum, calendula, cosmos, marigold, pansy, scabiosa, or zinnia.

Staking Tall growing annuals like larkspur, or tall varieties of marigold or cosmos need support to protect them from strong winds and rain. Tall plants are supported by stakes of wood, bamboo or reed large enough to hold the plants upright but not large enough to be conspicuous. Stakes should be about 6" shorter than the mature plant so that their presence will not interfere with the beauty of the bloom. Begin staking when plants are about one third their mature size. Place stakes close to the plant but take care not damage the root system. Secure the stems of the plants to stakes in several places with paper covered wire or other materials that will not cut into the stem. Plants with delicate stems (like cosmos) can be supported by a framework of stakes and strings in criss-crossing patterns.

Fertilizing When preparing beds for annuals, fertilizer should be added according to recommendations given by soil sample analysis, or derived from observation of plants that have grown on the site. Lime may also be needed if the soil test results indicate. Use dolomitic limestone rather than hydrated lime. Ideally, lime should be added in the fall so it will have time to change the pH. Fertilizer should be added in the spring so it will not leach out before plants can benefit from it.

Once annuals have germinated and begin to grow, additional fertilizers may be needed. This is especially true if organic mulches are added because microorganisms decomposing the mulch take up available nitrogen. Thus a fertilizer high in nitrogen should be used in these situations. A teaspoon of 10-6-4 per plant every two to three weeks is sufficient. Be sure to work the fertilizer in around the plants in such a way as to avoid direct contact between the stems and the fertilizer. Apply fertilizers to damp soil.

Controlling Insects and Diseases

Insect Pests Do not apply an insecticide unless it is necessary to prevent damage to flowers or shrubs. Most insect pests in the garden will not cause appreciable damage if their predators and parasites are protected by avoiding unnecessary applications of insecticides. However, if there is a pest that usually causes serious damage unless an insecticide is used, apply the insecticide as soon as the infestation appears and begins to increase.

Watch for such insect pests as spider mites, aphids, Japanese beetles and other beetles, lacebugs and thrips; these are some of the insects most likely to need promp treatment with insecticides. Do not treat for soil insects unless you find numbers of cutworms, white grubs, or wireworms when preparing the soil for planting.

When using a pesticide be certain that the pest and the flower or shrub are indicated on the label. Read and follow all directions for use, including precautions, shown on the label.

If pesticides are handled, applied, or disposed of improperly, they may be injurious to human beings, desirable animals and fish as well as plants, or flowers and beneficial insects. Use pesticides only when needed and handle them with care.

Diseases Since annuals only grow in the garden for one season, diseases are not as serious a problem as they are for perennials. Select varieties of plants that are resistant to disease, follow recommended practices for planting and maintaining annuals and you will avoid most disease problems. However, there are times when weather conditions are highly favorable and diseases will occur. If this happens, determine what disease is affecting your plants, then apply the appropriate pesticide according to label directions.

Damping-off causes seeds to rot and seedlings to collapse and die. The disease is carried in soil and may be present on planting containers and tools. Soil moisture and temperature necessary for germination of seeds also are ideal for development of damping-off. Once the disease appears in a seed flat, it may travel quickly through the flat and kill all seedlings planted there. This can be prevented. Before planting, treat the seed with a fungicide, sterilize the soil, and use sterile containers. Treat the seed by tearing off the corner of the seed packet and, through the hole in the packet, inserting about as much fungicide dust as you can pick up on the tip of the small blade of a penknife. Close the hole by folding over the corner of the packet, then shake the seed thoroughly to coat it with the fungicide dust.

Unless you use artificial soilless mixes, sterilize the soil in an oven. Fill a container or metal tray with moist not wet soil. Hold it at 180 degrees F for 30 minutes. Do not overheat.

To avoid introducing the damping-off organism on containers, use fiber seed flats or peat pots. These containers are sterile, inexpensive, and easily obtained from garden shops. Fiber flats are light and strong. They cost so little that they can be thrown away after one use. Peat pots can be set out in the garden along with the plants they contain; roots of the plants grow through the walls of the pots. Plants grown in peat pots suffer no setback when they are transplanted to the garden. Larkspur and poppy, which ordinarily do not tolerate transplanting, can be grown in peat pots satisfactorily. If you use wooden boxes or clay flower pots for soil containers, clean them well. Soak clay pots in water and scrub them well to remove all of the white fertilizer crust from the outside. Sterilize clay pots by swabbing them with a solution of 1 part chlorine bleach to 10 parts water. Allow containers to dry thoroughly before filling them with soil. If, despite your precautions, damping-off appears in your seedlings, it is best to discard the containers and soil and start again.

BIENNIALS

Biennials are plants that complete their life cycle in two years of growing seasons. During the first growing season they produce leaves, usually a rosette, then in the second growing season, preceded by a cold period, they produce blooms and die. For the flower gardener, biennials present the obvious disadvantage of producing only foliage the first year and no blooms. For this reason, new varieties have been developed that produce early bloom. "Foxy" is a variety of foxglove that will bloom the first year. Biennial seeds can be sown in midsummer to produce plants that develop in the fall, forcing the plant to bloom the next year. Popular biennials are stock and hollyhock. Cultural practices are basically the same as for annuals except the plants remain two years.

PERENNIALS

Perennials are plants that live year after year. Trees and shrubs are perennial. Most garden flowers are herbaceous perennials. This means the tops of the plants, the leaves, stems, and flowers die back to the ground, each fall with the first frost or freeze. Every spring, new plant tops arise from the roots, which persist through the winter. Any plant that lives through the winter is said to be hardy.

There are advantages to perennials, the most obvious being that they do not have to be set out, like annuals every year. Some perennials such as delphiniums have to be replaced every few years. Another advantage is that with careful planning a perennial flower bed will change colors, as one type of plant finishes and another variety begins to bloom. Also, since perennials have a limited blooming period of about 2 to 3 weeks, deadheading, or removal of old blooms, is not as frequently necessary to keep them blooming.However they do require pruning and maintenance to keep them attractive. Their relatively short bloom period is a disadvantage but by combining them with annuals a continous colorful show can be provided. Most require transplanting every 3 years.

Culture and Maintenance of Perennials

<u>Site Location</u> You need to consider many of the same aspects of site selection for perennials as you do for annuals; sunlight (full sun to heavy shade), slope of the site (affects temperature and drainage), soil type, and the role the plants selected will play in the garden. This is especially important with perennials, as they usually are left in the site selected for several years. In general, it is best to plant clumps of perennials rather than one plant. Large plantings may be made if space allows. An ideal location would provide a background such as a wall or hedge against which perennials will stand out while in bloom. In island beds, perennials can provide their own background if tall ones are put in the center, and low ones toward the edges.

<u>Soil Preparation</u> Preparing the soil is extremely important to perennials. Many annuals can grow and flower in poorly prepared soil, but few perennials survive more than one year if the soil is not properly prepared.

For new beds, begin preparing the soil in the fall before planting time. Have the soil tested first. The test results will indicate how much lime or an acidifier needs to be added during preparation and how much fertilizer needs to be added in the spring. Materials to adjust pH need time to work. Before preparing new beds, test the soil to see that it is well drained, yet has some water holding capacity. Test for drainage as described in the section on annuals. If drainage is inadequate, dig furrows along the sides of the bed and add soil from the furrows to the bed. This raises the level of the bed above the general level of the soil. Excess water can then seep from the bed into the furrows. Raised beds may wash during heavy rains. This can be prevented by surrounding the beds with wooden or masonry walls. Since raised beds dry out more quickly than flat beds (little moisture moves up into the bed from the soil below), be sure to water beds frequently during the summer. After forming the beds, spade the soil to a depth of 8 or 10 inches. Turn soil over completely,incorporating 2 to 4 inches of organic material. Remove debris and leave rough during the winter.

In the spring, just before planting, spade again. At this spading add recommended levels of fertilizers. Be sure to work any phosphorous deeply into the soil, where plant roots can get it. Rake the soil surface smooth. After raking, the soil is ready for seeding or planting.

Selecting Plants It is best to select plants with a purpose in mind such as edging plants, accents for evergreens, masses of color, rock garden specimens, etc. With specific purposes in mind, you can choose perennials by considering their characteristics and deciding which plants best meet your requirements.

For a good display from a limited number of plants in a limited amount of space, select named varieties. Observe the flowering times of perennials in your neighborhood. That way you will be able to choose plants that will flower together and plants that will be showy when little else is in bloom. The flowering time may vary as much as six weeks from year to year but plants of the same kind and their cultivars usually flower at the same time. To obtain details on particular plants or groups of plants you could consult plant societies, specialty books, nurserymen who specialize in herbaceous perennials, and local botanical gardens.

Plants of many perennials can be bought from local nurserymen. These plants usually are in bloom when they are offered for sale, which allows you to select the colors you want. Buy perennial plants that are compact and dark green. Plants held in warm shopping areas are seldom vigorous and generally have thin pale yellow stems and leaves. Avoid buying these plants. Buy named varieties of plants. Disease resistance, heat and cold resistance, growth habits and colors are known for these plants.

Many perennials do not grow true to type if sown from seed saved from old plants. If you plant seed, you have saved, many off types of color, flower form and plant habit are produced. Purchased seed, whether hybrid or strains, usually give uniform results. You can sow perennial seeds directly in the beds where the plants are to bloom or you can start early plants indoors or in a cold frame and set them out in beds after the weather warms.

Planting Times Generally, late summer or fall flowering perennials are planted in the spring while spring flowering perennials are planted in late summer or early fall. However, it is wise to check exact planting dates for specific perennials. Regardless of the time of planting, perennials should be allowed sufficient time to establish themselves before blooming or the onset of cold weather.

Planting Seed Outdoors Perennials seeded in the garden frequently fail to germinate properly because the surface of the soil cakes and prevents entry of water. To avoid this, sow the seed in vermiculite filled furrows. For planting directions follow directions in the section on annuals.

Setting Out Plants Whether you buy plants from a nursery, mail order source, or start your own indoors, set them out the same way. When the time comes to set plants out in the garden, remove them from flats by slicing downward in the soil between the plants. Lift out each plant with a block of soil surrounding its roots and set the soil block in a planting hole. If the plants are in fiber pots, remove the fiber from the outside of the root mass and set the plant in a prepared planting hole. When setting out plants in peat pots, remove the top edge of the pot to prevent it from drying out and limiting the root development of the plant. Thoroughly moisten the pot and its contents to help the roots develop properly. Drench the soil around the planting hole with a liquid fertilizer 16-12-10 or 20-20-20 mixed 1 tablespoon per gallon of water, to stimulate root growth. Set the moistened pot in the planting hole and press the soil up around the plant. Allow plenty of space between plants because perennials need room to develop. Perennials usually show up best when planted in clumps or groups of plants of the same variety.

Watering Since herbaceous perennials grow back from the roots every year, it is important to encourage healthy deep roots. Proper watering promotes good root development. Make sure when watering that all the roots are reached. Follow directions on watering in annual section.

Mulching Mulch gives an orderly look to the garden and cuts down on weeding. They are very useful for maintaining uniform moisture conditions in the garden. Soil temperatures are modified by mulches to various degrees. Organic mulches may add some nutrients and humus to the soil, improving its tilth and moisture-holding capacity. Most organic mulches should be applied after plants are well established and when there is good soil moisture. Inorganic mulches such as plastic films and paper are applied prior to planting. Black plastic and similar materials should be spread on land that has been completely prepared for planting and has a high moisture level. Bark, pine needles and shredded leaves are common organic mulches used in perennial beds. Gravel and black plastic are inorganic materials to use. All mulches require care to keep them attractive; litter is very noticeable. (See Woody plants chapter, pages 20-21 for details on mulching materials.)

Perennials should be mulched during the winter months to protect them from heaving from repeated freezing and thawing of the soil. However, you must be careful with winter mulching as it can do more harm than good. Be careful not to pile mulch heavily over the crowns as this would encourage rotting. Boughs of evergreens give ample protection but allow air circulation. Apply mulch around the plants only after the soil temperature has decreased after several killing frosts. If the winter mulch is applied too early, the warmth from the soil will cause new growth to start. Severe damage to the plant can result from new growth being frozen back. Remove winter mulch as soon as growth starts in the spring. If you don't, new growth will develop abnormally with long, gangly stems and insufficient chlorophyll.

Weeding Follow weeding directions in section on annuals. A few preemergent herbicides are now registered for use in perennial flowers.

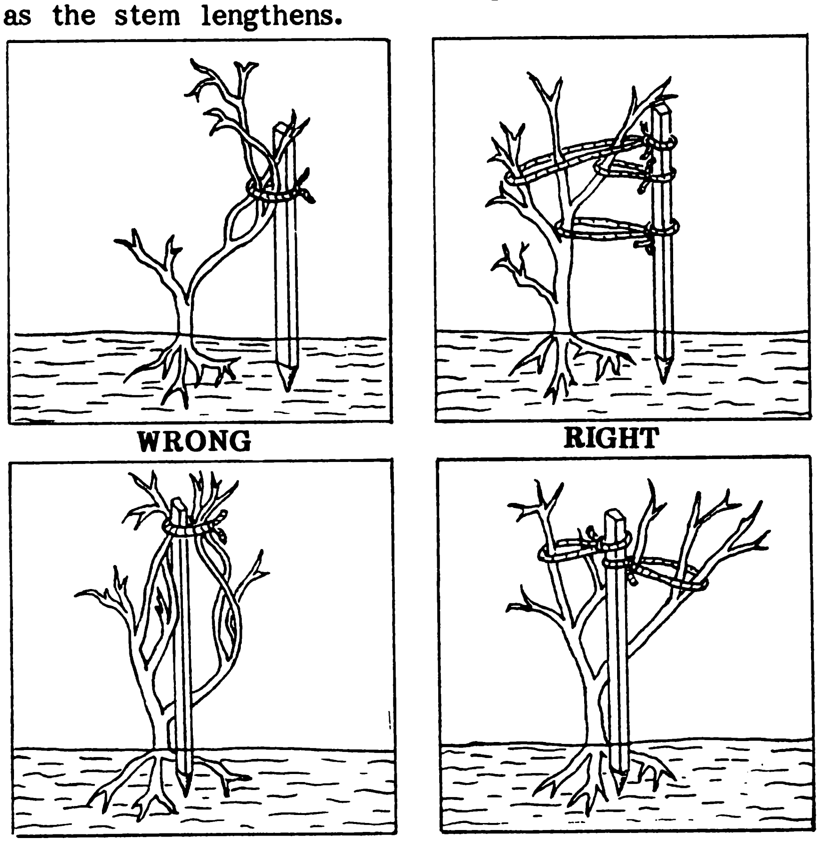
Fertilizing Regular fertilization is necessary. Perennial plantings can rob the soil of its natural fertility. However, do not fertilize perennials heavily. A light fertilization program gives a continuous supply of nutrients to produce healthy plants. Use 5-10-5 fertilizer. Place fertilizer in small rings around each plant in March. Repeat twice at six week intervals. This should be enough to carry plants through the summer. Apply another treatment of fertilizer to late blooming plants in late summer. Always water the bed after applying fertilizer. This will wash the fertilizer off the foliage and prevent burn. It will also make fertilizer available to the plants immediately.

Deadheading After perennials have bloomed, spent flowers should be removed. Cut flower stems down to a healthy leaf or to the ground if there are no more buds. This will keep the beds looking neat and will prevent plants from wasting energy setting seed. Delphiniums can be forced to reblossom if cut back severely after the first bloom.

Disbudding To gain large blooms from perennials as opposed to more numerous but smaller blooms, you should disbud. In disbudding, small side buds are removed, which allows the plant to concentrate its energy to produce one or a few large blooms. Peonies and chrysanthemums are examples of plants which are often disbudded.

Staking Most erect perennials are top heavy and all of the taller ones need staking. If plants fall over, the stem will function poorly where it has been bent. If the stem is cracked, rot organisms can penetrate the break. Stake plants when you set them out so that they will grow to cover the stakes. Once staked, tall perennials can better withstand hard, driving rain and wind.

Use stakes made of any material. Select stakes that will be 6 to 12 inches shorter than the height of the grown plant. Place stakes behind the plants and sink into the ground far enough to be firm. Loosely tie plants to the stakes, using paper covered wire, plastic or other soft material. Tie the plant by making a double loop of the wire with one loop around the plant and the other around the stake. Never loop the tie around both stake and plant. The plant will hang to one side and the wire may girdle the stem. Add ties as the stem lengthens.



The plants in the illustrations at left have been tied too tightly.
It is better to tie the principal branches loosely as shown in the illustrations on the right.

Fall Care In the fall, after the foliage of perennials has died down, remove dead leaves, stems and spent flowers. These materials often harbor insects and disease causing organisms. Apply winter mulch after the soil temperature has dropped.

Controlling Insects and Diseases

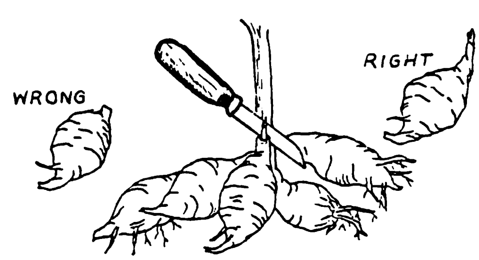
Although perennials in general are healthy plants, there are occasionally some problems. It is advisable to select resistant varieties. Plant perennials in conditions of light, wind, spacing, and soil textures which are suited to them. Remove spent flowers, dead leaves and other plant litter as these serve as a source of reinfestation. It is advisable to know the major insect and disease pests (if any) of each specific plant type grown so that you can correctly diagnose and treat each problem as it arises.

Asexual Propagation of Perennials

Division Most perennials left in the same place for more than 3 years are likely to be overgrown, overcrowded, with dead unsightly centers and in need of basic feeding and soil amendment. The center of the clump will grow poorly, if at all, and the flowers will be sparse. The clump will deplete the fertility of the soil in as the plant crowds itself. To divide mature clumps of perennials, select only vigorous side shoots from the outer part of the clump. Discard the center of the clump. Divide the plant into clumps of three to five shoots each. Be careful not to overdivide; too small a clump will not give much color the first year after replanting. Divide perennials when the plants are dormant, just before a new season of growth or in the fall so they can become established before the ground freezes.

Day lily

Iris



Dahlia

Stagger plant divisions so that the whole garden will not be done over at the same time; good rotation will give you a display of flowers each year. Do not put all the divisions back into the same space that contained the original plant. That would place too many plants in a given area. Give extra plants to friends, plant them elsewhere in your yard, or discard them.

Cuttings Many plants can be propagated from either tip or root cuttings. Generally, tip cuttings are easier to propagate than root cuttings.

Select second growth of dianthus, candytuft, and phlox for cuttings. Make tip cuttings 3 to 6 inches long. Treat the base of the cutting with a root stimulant. Leave all foliage on the cutting except the part that will be below the soil line. Insert one cutting each in peat pots.

Place peat pots of tip cuttings in a lightly shaded place. Cover with a sheet of clear plastic. Check regularly to make sure the cuttings do not dry out.

When cuttings do not pull easily out of the soil, they have begun to root. Make holes in the plastic sheet to increase the exposure of the cuttings to the air. This will harden the cuttings. Every few days make new holes, or enlarge the holes.

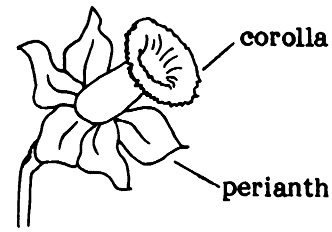
Make root cuttings of phlox, babysbreath, and oriental poppy. Dig the plants in late summer after they have bloomed. Select pencil size roots; cut them into 4 inch sections. Put each piece in a peat pot. Prepare a tray of peat pots as for seeds, except the soil mix should be 2 parts sand, 1 part soil, and 1 part peat moss. Water thoroughly. For more information see the chapter on plant propagation.

BULBS

This is a term loosely used to include corms, tubers, tuberous roots and rhizomes as well as true bulbs. This section of the chapter will refer to all of the above as bulbs. However, a true bulb is a complete or nearly complete miniature of a plant encased in fleshy modified leaves called scales which contain reserves of food. Corms are the base of a stem that becomes swollen and solid with nutrients. It has no fleshy scales. The tuber, which is an underground stem that stores food, differs from the true bulb or corm in that it has no covering of dry leaves and no basal plant from which the roots grow. Usually short, fat and rounded, it has a knobby surface with growth buds, or eyes, from which the shoots of the new plant emerge. Tuberous roots are the only ones from this group that are real roots; their food supply is kept in root tissue, not in stem or leaf tissue as in other bulbs. Rhizomes, which are sometimes called rootstocks are thickened stems that grow horizontally, weaving their way along or below the surface of the soil and at intervals sending stems above ground. Many vegetables are propagated from or produce edible organs of these types; e.g.; tuber, Irish potato; tuberous root, sweet potato; rhizome, Jerusalem artichoke; bulb, onion.

Bulbs are broadly grouped into spring flowering (January - May) and summer flowering (June - September). Spring bulbs provide early color before most annuals and perennials. One of the most popular spring bulbs is tulip. These are sold by type and variety. Tulips come in all colors except blue. Some of the most common types are:

Breeder - bronzed, not clear colors
Cottage - late blooming
Darwin - tallest wide flow
Lily flowered - petals recurve - bell-shape
Parrot - twisted ruffled petals
Double - 2 or more rows of petals

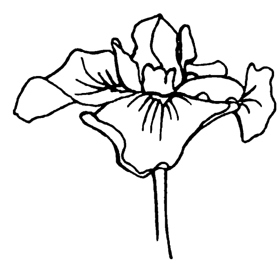


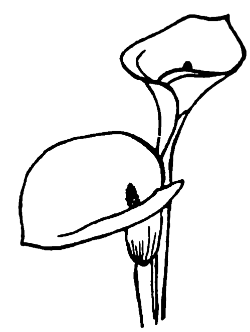
Narcissus, daffodils, jonquils are classed by length of corolla in relation to perianth segments. They come in the colors of white, yellow, red, peach, but not blue. Many have naturalized in places. Hyacinths produce a large single spike of many small fragrant flowers, and come in a complete color range. Crocus are usually grown for early bloom (in snow). There are no reds.

Selecting spring bulbs of quality is very important because the flower bud has already developed before the bulb is sold. Size is also important, look for plump, firm bulbs. Select on a basis of color, and size for intended purposes, for example small ones for naturalizing and large ones to stand out as speciman plants. Keep cool (60-65 degrees F.) until planting.

Summer flowering bulbs include:

amaryllis
tuberous begonia
caladium
day lily
dahlia
gladiolus
lily
spider lily





Most are hardy perennials and the roots overwinter successfully. However, the caladium, and some others may have to be dug and stored.

Culture and Maintenance of Bulbs

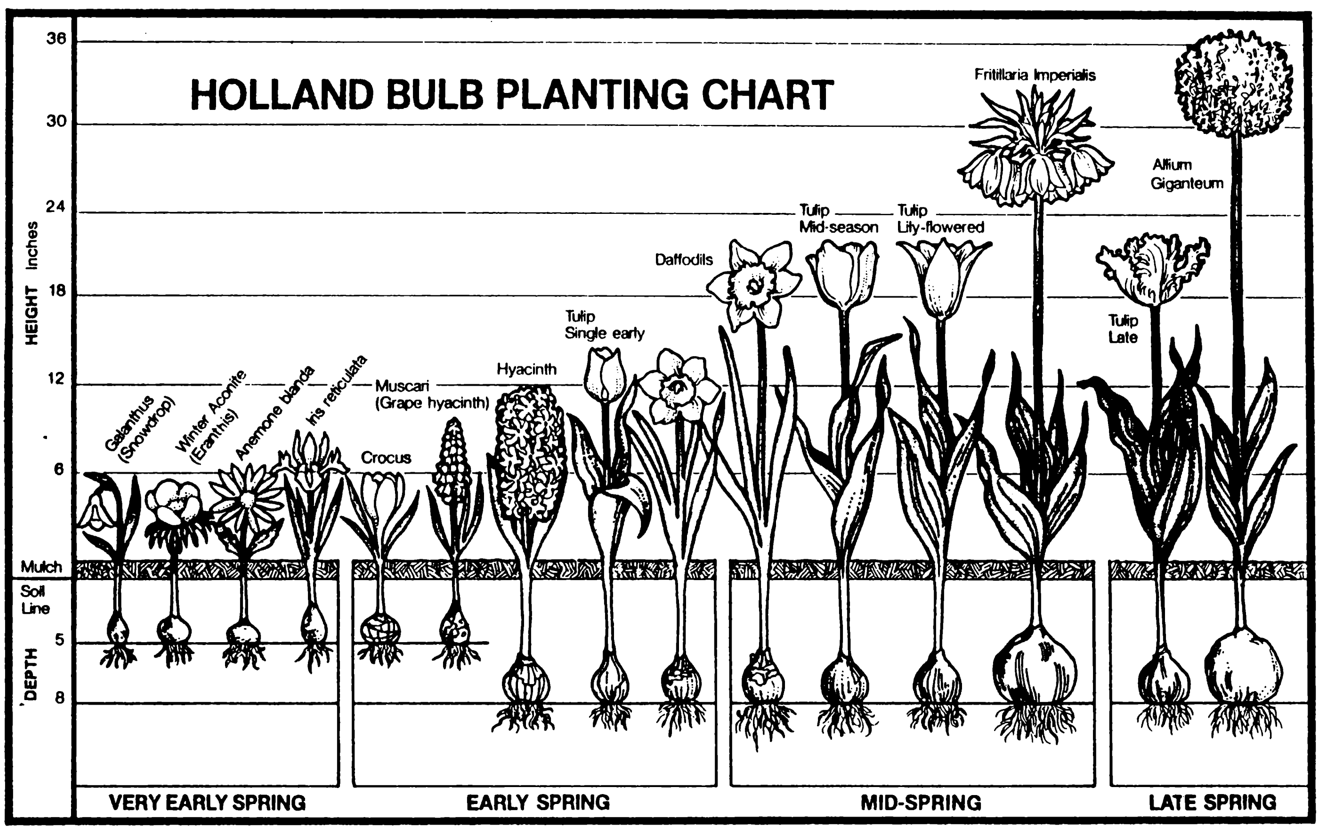
<u>Storage</u> If bulbs are bought before planting time, keep them in a cool, dry place. A temperature of 60 to 65 degrees F is cool enough to prevent bulbs from drying out until time for planting. Temperatures higher than 70 degrees F will damage the flower inside spring flowering bulbs. Rhizomes, tubers and tuberous roots are more easily desiccated than bulbs and corms and should be stored in peat, perlite or vermiculite.

<u>Site Selection</u> In selecting a site for planting, consider light, temperature, soil texture and function. Most bulbs need full sunshine. Select a planting site that will provide at least 5 to 6 hours of direct sunlight a day. Bulbs left in the ground year after year should have 8 to 10 hours of daily sunlight for good flowering. Bulbs planted in a southern exposure near a building or wall, will bloom earlier than bulbs planted in a northern exposure. Adequate drainage is an important consideration. Most bulbs and bulb-like plants will not tolerate poor drainage and rot easily if planted in wet

areas. Function must also be kept in mind. If bulbs are being used to naturalize an area, toss the bulbs out to create a scattered effect then plant them where they fall. Spanish squills will do beautifully, along with daffodils to achieve a natural effect.

Site Preparation Good drainage is the most important single factor for successful bulb growing. Bulb beds should be dug when the soil is fairly dry. Wet soil packs tightly and retards plant growth. Spade the soil 8 to 12 inches deep. As you dig, remove large stones and building trash, but turn under all leaves, grass, stems, roots, and anything else that will decay. Add fertilizer, and organic matter to the soil. Use 1 pound of 5-10-10 fertilizer for a 5 by 10 foot area, or a small handful for a cluster of bulbs. Place a 1 to 2 inch layer of organic matter over the bed. Thoroughly mix the fertilizer and organic matter with the soil. For individual planting holes, loosen the soil below the depth the bulb is to be planted. Add fertilizer and cover with a layer of soil (bulbs should not contact fertilizers directly). Set bulb upright in planting hole and cover with amended soil. Organic fertilizers in wet hot summers retard blooming and promote disease, especially among gladiolus not dormant then.

Time of Planting Hardy, spring flowering bulbs are planted in late summer or early fall. Hardy, fall flowering bulbs such as colchicum are planted in August. Tender, summer flowering bulbs are planted in the spring after the danger of frost. Lilies are best planted in late fall.



Produced by Netherlands Flower-bulb Institute

Depth of Planting It is best to check correct planting depth for each bulb with a successful local grower, or other good local source. Bulb catalog and reference book recommendations for planting may be either too shallow or too deep depending on soil condition. As a general rule of thumb, bulbs should be planted two and one half to three times the diameter of the bulb in depth. It is important not to plant bulbs too shallow as this will encourage frost heaving.

Watering Normal rainfall usually provides enough moisture for bulbs. But, during dry weather, water plants at weekly intervals soaking the ground thoroughly. Be especially careful not to neglect bulbs after blooming.

Mulching In the winter, mulch bulbs 2 to 4 inches deep with organic material such as straw, pine bark, hay or ground leaves. Do not use large leaves as they may mat too tightly on the ground. A winter mulch prevents alternate freezing and thawing, which damages bulbs and plant roots. Apply mulch after cold weather arrives. You may damage the bulbs if you mulch while the soil temperature is still high. Remove the mulch as soon as danger of severe freezing has passed in early spring. If you leave the mulch on the ground after new growth starts, the tops of the new shoots will be pale green or colorless, and new stems and foliage may be broken.

Fertilizing After plants bloom, fertilize them lightly with 5-10-10 fertilizer. Use no more than 1 pound for a 5 by 10 foot flower bed. Avoid high nitrogen fertilizer. Be sure to keep fertilizer off the leaves and away from roots; it will burn them. In addition to 5-10-10 fertilizer, you can use bonemeal as an extra source of phosphorus.

Staking Some tall, heavy flowered bulbs may require staking. If stems are allowed to fall over, they will be damaged and the flowers will not show to the best advantage. Stake plants when they are emerging but be careful not to damage the bulb with the stake. For flowers that face one direction, use the stake to orient the face to the front of the bed.

Deadheading When flowers fade, cut them off to prevent seed formation. Seeds take stored food from the bulbs.

Moving If leaving bulbs in place for bloom next year, do not cut the leaves after flowering until they start to wither. Green leaves produce food for plant growth next year. After leaves turn yellow, cut and destroy the stems and foliage of the plants. Dead foliage left on the ground may carry disease to new growth the next year. If you wish to move bulbs from one place to another or if a planting has become crowded and ceased blooming this must be done after the foliage has faded. Bulbs dug and moved before foliage fades are useless.

Digging and Storing Many summer flowering bulbs should be dug and stored as they are tender. This is done when the leaves on the plants turn yellow. Use a spading fork to lift the bulbs from the ground. Wash off any soil that clings to the bulbs, except for those that are stored in pots or with the soil around them. Spread the washed bulbs in a shaded place to dry. When dry, store them away from sunlight in a cool, dry basement, cellar, garage, or shed at 60 to 65 degrees F. Avoid temperatures below 50 or above 70 degrees F. Be sure that air circulates around stored bulbs. Never store bulbs more than two or three layers deep as they generate heat and cause decay. Leave the soil on achimenes, begonia, canna, caladium, dahlia, and ismene bulbs. Store these bulbs in clumps on a slightly moistened layer of peat moss or sawdust in a cool place. Rinse clean and separate them just before planting.

ANNUALS FOR SPECIAL USES

ANNUALS FOR BEDDING (Masses and Drifts)

Begonia semperflorens
Browallia
Celosia
Cineraria maritima
Coleus
Dahlia dwarf
Dianthus
Gerbera
Heliotrope
Hunnemannia
Impatiens (shade)
Lantana
Lobelia (shade)
Marigold
Nicotiana
Petunias
Phlox drummondi
Salvia splendens
Scabiosa
Torenia

ANNUALS FOR THE MIXED BORDER

Ageratum
Alyssum
Balsam
Bells of Ireland
Campanula
Marigold
Nicotiana
Petunia
Salvia farinacea and splendens
Wallflower
Centaureas
Cleome
Cosmos
Cynoglossum
Lantana
Larkspur
Snapdragon
Statice
Tahoka-daisy
Zinnia

ANNUALS FOR EDGING

Ageratum, dwarf
Alyssum
Begonia semperflorens
Dianthus
Daisy, Dahlborg
Lobelia
Marigold, dwarf
Myosotis
Nierembergia
Petunia
Phlox drummondi
Portulaca
Torenia
Verbena
Vinca

ANNUALS FOR GROUND COVERS

Creeping Zinnia
(Sanvitalia procumbens)
Myosotis
Nasturtium
Portulaca
Vinca
Sweet Alyssum
Thunbergia
Verbena

ANNUALS FOR FOLIAGE

Amaranthus
Basil
Castor Bean
Coleus
Dusty Miller
Kochia

ANNUALS FOR FRAGRANCE

Alyssum
Dianthus
Heliotrope
Mignonette
Nasturtiums
Nicotiana
Stock
Petunias
Phlox
Sweet peas

ANNUALS FOR FENCES AND TRELLISES

Canary Creeper
Cardinal Climber
Cobaea
Cypress Vine
Sweet Pea
Gourds
Morning Glory
Moonflower
Scarlet Runner
Thunbergia

ANNUALS FOR LOW BORDERS

Dwarf Celosia
Dwarf Bedding Dahlias
Kochia
French Marigolds
Nuggent Marigolds
Red & Gold Hybrids Marigolds
Hybrid Petunias
Lilliput Zinnias

ANNUALS FOR SCREEN PLANTS

Amaranthus
Tall Celosia
Cleome
Kochia (evergreen)
Tall Marigolds
Tithonia
Tall Zinnias

ANNUALS OF INTERMEDIATE HEIGHT

Asters
Calendulas
Cornflowers
Bedding Dahlias
Gaillardia pulchella
Gloriosa Daisy
Nicotiana
Salvia
Scabiosa
Cut-and-Come-Again-Zinnias

ANNUALS FOR WINDOW BOXES OR HANGING BASKETS, URNS OR TUBS

Alyssum
Begonia semperflorens
Coleus
Lantana
Lobelia
Nierembergia
Cascade Petunias
Thunbergia

ANNUALS FOR THE SEASIDE

Alyssum
Dusty Miller
Statice
Petunia

ANNUALS FOR THE ROCK GARDEN

Ageratum	Coleus
Alyssum	Pansy
Begonia semperflorens	Gazania
Dwarf Celosia	Lobelia
French Marigolds	Nugget Marigolds
Nasturtiums	Dwarf Petunias
Phlox	Portulaca
Torenia (Wishbone Flower)	Verbena
Dwarf Zinnias	

ANNUALS FOR CUT FLOWERS

Asters	Gomphrena
Bells of Ireland	Gypsophila
Carnation	Larkspur
Celosia	Marigold
Centaurea(Bachelor Buttons)	Nasturtium
Cosmos	Petunias
Cynoglossum	Verbena
Dahlia	Rudbeckia bicolor
Daisy, Tahoka	Salpiglossis
Gaillardia pulchella	Salvia
Gerbera	Scabiosa
Zinnia	Snapdragons
Statice	Tithonia

ANNUALS FOR SPECIAL ENVIRONMENTS

Annuals tolerant of cool weather Plant after danger of heavy frost is over in the spring, except sweet peas, which should be planted just as soon as the soil is workable. Some varieties can also be sown, with risk, late in fall, just before the ground freezes, so seed will not germinate until spring. In the warmer areas of Virginia, plant in fall.

Alyssum	Geranium
Aster	Gloriosa Daisy
	Helichrysum
Bells of Ireland	Larkspur
Calendula	Lobelia
Candytuft	Nigella
Chrysanthemum (annual)	Pansy
Clarkia	Phlox
Cleome	Poppy, Shirley & California
Cornflower	Salpiglossis (painted tongue)
Cosmos	Salvia farinacea
Cynoglossum	Scabiosa
Dianthus	Snapdragon
Didiscus (lace flower)	Statice
Dimorphotheca (African Daisy)	Stock
Gaillardia pulchella	Sweet Pea

TENDER ANNUALS Plant when all danger of frost is over in the spring.

Ageratum
Balsam
Begonia
Celosia
Coleus
Globe Amaranth
Gourds
Impatiens
Zinnia
Marigold
Morning Glory
Nasturtium
Nicotiana
Petunia
Salvia
Verbena
Vinca

HEAT RESISTANT ANNUALS

Celosia or Cockscomb
Cleome or Spider flower
Corn flower
Cosmos, especially ,Diablo' and ,Sunset'
Four o'clock
Gaillardia or Blanket Flower (annual)
Geranium
Globe Amaranth
Helichrysum or Strawflower
Larkspur
Lynthrium
Marigolds, especially the triploids and giant hybrids
Morning Glory
Nicotiana or Flowering Tobacco
Nierembergia or Cupflower
Petunia, especially multifloras
Phlox drummondii
Portulaca or Moss Rose
Salvia, red or blue
Scabiosa or Pincushion Flower
Shasta Daisy
Sunflower
Verbena
Zinnia, all kinds, especially the vigorous hybrids

EXTREMELY HEAT RESISTANT ANNUALS

Amaranthus, especially tricolor, Joseph's Coat
Four o'Clock
Morning Glory
Ornamental Pepper
Sunflower
Zinnias, various narrow-leaved drought resistant kinds such as 'Classic' and 'Mexican'

ANNUALS FOR PARTIAL SHADE

Alyssum	Lobelia
Balsam	Myosotis
Begonia	Nasturtiums
Browallia	Nicotiana
Calendula	Pansy
Coleus	Petunia
Cornflower	Snapdragon
Impatiens	Torenia
Aster	Wallflower

ANNUALS THAT TOLERATE HEAT, DROUGHT AND SANDY SOILS

Alyssum	Phlox
Cleome	Portulaca
Gaillardia	Salvia
Gloriosa Daisy	Sunflowers
Marigolds	Verbena
Petunias	Zinnias

ANNUALS BY COLOR AND HEIGHT

Variety	Color of Bloom	Height (Inches)
African Daisy	white, yellow, salmon	6-12
Ageratum	blue, white	4-24
Arnaranthas	red or red & green	48-96
Anterrhinum majus	red, orange, yellow white, purple	6-36
Arctotis	white, bluish eye	24
Aster (Callistepheus chinesis)	yellow, pink red, blue, white, lavender	18
Balsam (Impatiens balsamina)	rose, purple, white	12-18
Basil, red	grown for red-purple foliage	15
Browallia	blue, violet, white	24
Calendula	yellow, gold	12-24
California Poppy (Eschscholtzia californica)	red to yellow	12
Cabbage, flowering	red to white	8-14
Candytuft (Iberis)	pink,lilac,white	12-16
Chrysanthemum	yellow, purple, orange	36
Caster Beans	red inconspicuous flowers	72-96
Cineraria	violet, pink, blue, white	10-14
Clarkia	white, pink, red, pink & red	18
Cock's Comb (Celosia)	yellow to crimson	12-48
Cornflower (Centaurea cyanus)	pink, blue, white	36
Coleus	grown for variegated foliage	8-20

Cosmos	lilac, red, yellow, white	36-72
Dustymiller (Centaurea cineraria)	rose-purple	24
Forget-Me-Not (Myosotis)	blue, pink	12
Four O'Clock (Mirabilis)	pink, white, yellow	24
Gaillardia pulchella	yellow, orange, red	15-24
Gloriosa Daisy	yellow, orange, red	24-30
Gomphrena	white, pink, purple	15-30
Heliotrope	rose	10
Impatiens	red, pink, white, orange	8-24
Larkspur (Delphinium)	blue	18-36
Lobelia	blue, violet, white	4-18
Lupine	pink to purple	24-36
Marigold (Tagetes)	yellow, orange to red-brown	8-48
Mimulas		
Nemophila	blue	10
Nicotiana	red, white	24-48
Nigella	white, blue, violet	12-15
Pansy (Viola)	blue, purple, white, yellow	8-12
Periwinkle (Vinca rosea)	rose, white	18
Petunia	white to rose, purple	6-8
Phlox drummondii	white, rose, purple	6-18
Poppy (Papaver)	red, pink, blue, orange	varies
Portulaca	yellow, white, rose, orange	8
Salvia	blue, red	18-36
Scabiosa	purple, pink, white	36
Snapdragon (Antirrhinum)	blue, purple, yellow, orange, red	6-18
Statice or sea lavender (Limonium)	yellow, rose, violet, white	18-24
Strawflower (Helichrysum)	white, red, yellow	36
Sunflower (Helianthus)	yellow to red-brown	12-108
Sweet Alyssum (Alyssum maritimum)	white	3-10
Sweet Pea (Lathyrus)	orange, yellow, rose purple, white	48+(vine)
Verbena	white, pink, blue, red	18-24
Vinca	white, purple, red	6-18
Torenia	white, blue, violet	12
Zinnia	red, pink, yellow, orange	6-36

PERENNIALS FOR SPECIAL USE

PERENNIALS FOR BORDERS OF PONDS AND STREAMS (Well-drained soil)

Sunny Locations:
Cimicifuga racemosa (Cohosh Bugbane)*
Grasses (Ornamental Grasses)
Iris, in variety
Lythrum Salicaria (Spiked Loosestrife)*
Myosotis scorpioides semperflorens (Dwarf Perpetual Forget-me-not)
Tradescantia virginiana (Spiderwort)*
Trollius europaeus (Globeflower)
Semi-shady Locations:(* also do well)
Anemone hupenhensis or A.x hybrida (Japanese Anemone)
Eupatorium purpureum (Joe-pye-weed)
Iris cristata (Crested Iris)

PERENNIALS FOR BACKGROUND PLANTING

Althaea rosea (Hollyhock)
Aster novae-angliae (New England Aster)
Campanula pyramidalis (Chimney Bellflower)
Cimieifuga racemosa (Cohosh Bugbane)
Delphinium hubrids (Delphinium)
Helenium autumnale (Sneezeweed)
Helianthus Maximiliani (Maximilian Sunflower)
Hibiscus grandiflorus (Great Rosemallow)
Rudbeckia laciniata (Goldenglow) 'Hortensia'
Valeriana officinalis (Common Valerian)
Yucca filamentosa (Common Yucca)

PERENNIALS FOR EDGING

Achillea tomentosa (Woolly Yarrow)
Ajuga reptans (Carpet Bugle)
Aurinia saxatilis 'Compacta' (Dwarf Goldentuft)
Arabis caucasica (Wallcress)
Bellis perennis (English Daisy)
Aubrietia deltoidea (Purple Rockcress)
Campanula carpatica (Carpanthian Bellflower)
Cerastium tomentosum (Snow-in-summer)
Dianthus deltoides (Maiden Pink)
Dianthus plumarius (Grass Pink)
Iberis sempervirens (Edging Candytuft)
Papaver nudicaule (Iceland Poppy)
Phlox subulata (Moss Phlox)
Primula veris (Cowslip Primrose)
Sedum stoloniferum (Running Stonecrop)
Armeria sp. (Thrift)
Petrorhagia saxifraga (Tunic flower)
Veronica latifolia (Rock Speedwell)
Viola, in variety (Violet)

PERENNIALS FOR GROUND COVER, BANKS AND TERRACES

Sunny Locations:
Cerastium tomentosum (Snow-in-summer)
Ceratostigma plumbaginoides (Larpente Plumbago)
Coronilla varia (Crownvetch)
Iberis sempervirens (Edging candytuft)
Nepeta mussini (Mussini Mint)
Phlox subulata (Moss Phlox)
Sedum spurium (Running Stonecrop)
Thymus praecox subsp. artieus (Mother-of-thyme)
Veronica latifolia (Rock Speedwell)
Vinca minor (Periwinkle)
Shady Locations:
Aegopodium podograria (Goutweed)
Ajuga reptans (Bugle)
Asperula odoratum (Sweet Woodruff)
Convallaria majalis (Lily-of-the-valley)
Hedera helix (English Ivy)
Pachysandra terminalis (Japanese Pachysandra)
Sedum ternatum (Mountain Stonecrop)

PERENNIALS FOR BOLD OR SUB-TROPICAL EFFECTS

Aruncus dioicus (Spirea)
Acanthus mollis (Artist's Acanthus)
Dipsacus fullonum (Teasel)
Echinops ritro and exaltatus (Globe Thistles)
Elymus arenarius (Sea Lyme grass)
Helianthus salicifolius (Sunflower)
Heracleum laciniatum (Cow-parsnip)
Kniphofia uvaria (Torchlily, Red-hot-poker plant)
Onopordum acanthium (Scoth Thistle)
Yucca filamentosa (Yucca)

PERENNIALS FOR NATURALIZING

Asclepias tuberosa (Butterfly weed)
Aster (various)(Aster)
Cimicifuga racemosa (Cohosh Bugbane)
Convallaria majalis (Lily-of-the-valley)
Hepatica (Roundlobe Hepatica)
Lythrum Salicaria (Spiked loosestrife)
Lobelia cardinalis (Cardinal Flower)
Mertensia virginica (Virginia Bluebells)
Monarda didyma (Bee Balm)
Physostegia virginiana (False Dragonhead, Obedience)
Polemonium reptans (Creeping Polemonium)
Sanguinaria canadensis (Bloodroot)
Smilacina racemosa (Solomon's zig-zag, False spikenard)
Solidago canadensis (Canada Goldenrod)
Trillium grandiflorum (Trillium)

PERENNIALS FOR OLD-FASHIONED GARDENS

Aconitum, in variety (Monkshood)
Althaea rosea (Hollyhock)
Asters, old varieties
Campanula, in variety (Bellflower)
Delphinium x Belladonna (Delphinium)
Dianthus barbatus (Sweet William)
Dianthus plumarius (Grass or Garden Pink)
Dicentra spectabilis (Bleeding-heart)
Dictamnus alba (Dittany or Gas Plant)
Digitalis, in variety (Foxglove)
Hemerocallis lilio asphodelus (Lemon Lily)
Hesperis matronalis (Sweet Rocket)
Lilium candidum (Madonna Lily)
Lilium lancifolium (Tiger Lily)
Lunaria (Honesty)(Biennial)
Mertensia (Mertensia or Blue Bells)
Myosotis, in variety (Forget-me-not)
Paeonia officinalis types (Peony)
Primula veris (Primrose)
Viola odorata (Sweet Violet)

FRAGRANT PERENNIALS

Artemisia abrotanum (Southernwood)
Convallaria majalis (Lily-of-the-Valley)
Dianthus plumarius (Grass Pink)
Dictamnus albus (Dittany or Gas Plant)
Galium odoratum (Sweet woodruff)
Hesperis matronalis (Sweet Rocket)
Hosta plantaginea grandiflora (Funkia or Big Plantain Lily)
Heliotropium arborescens (Heliotrope)
Monarda didyma (Bee Balm)
Paeonia, in variety (Peony)
Phlox paniculata (Phlox)
Rosa species (Roses-Cabbage and Sweet Brier)
Valeriana officinalis (Common Valerian)
Viola cornuta (Tufted Pansy, Horned violet)
Viola odorata (Sweet Violet)
Thymus, in variety (Thyme)
Lavandula vera (True Lavender)

PERENNIALS HAVING ESPECIALLY LONG BLOOMING SEASONS

Anchusa azurea (Bugloss)
Campanula carpatica (Tussock Bellflower)
Delphinium, if cut back
Heuchera sanguinea (Coral Bells)
Iris, fall blooming varieties
Lathyrus latifolius (Perennial Pea)
Lysimachia (Gooseneck Loosestrife)
Border Phlox, if cut back
Scabiosa graminifolia (Pincushion Flower)
Viola tricolor (Johnny-jump-up)

PERENNIALS SUITABLE FOR CUT FLOWERS

Achillea millefolium (Yarrow)
Anemone japonica (Japanese Anemone)
Aster (various)(Aster)
Chrysanthemum coccineum (Painted Lady)
Delphinium hybrids (Delphinium)
Dianthus barbatus (Sweet William)
Dicentra (Bleeding Heart)
Gaillardia aristata (Blanket Flower)
Gypsophila paniculata 'Flore Pleno' (Babysbreath)
Heuchera sanguinea (Coral Bells)
Iris (various)(Iris)
Lysimachia (Gooseneck Loosestrife)
Mertensia virginica (Blue Bells)
Paeonia (various)(Peony)
Rudbeckia (various)(Cone Flower)
Salvia azurea grandiflora (Azure Sage)

PERENNIALS FOR SPECIAL ENVIRONMENTS

PERENNIALS FOR SHADE

Ajuga (Bugle)
Anemone japonica (Japanese Anemone)
Asperula (Woodruff)
Convallaria majalis (Lily-of-the-Valley)
Dicentra spectabilis (Bleeding-Heart)
Helleborus niger (Christmas rose)
Heuchera sanguinea (Coral Bells)
Hosta, in variety (Plantain Lily)
Mertensia virginica (Virginia Bluebells)
Phlox divaricata
Primula, in variety (Primrose)
Dodecathelon meadia (Shooting Star)
Trillium grandiflorum (Trillium)
Trillium (Trillium)
Trollius europeaus (Globeflower)

PERENNIALS FOR SEMI-SHADE

Anchusa azurea (Bugloss)
Aquilegia hybrids (Columbine)
Campanula rotundifolia (Harebell)
Chelone lyonii (Pink Turtlehead)
Cimieifuga racemosa (Cohosh Bugbane)
Digitalis purpurea (Foxglove)
Doronicum plantagineum (Leopard's bane)
Monarda didyma (Bee-balm)
Physostegia virginiana (False Dragonhead, Obedience)
Polemonium
Pulmonaria saccharata (Bethlehem Sage)
Pyrethrum (Chrysanthemum coccineum, Pink Daisy)
Saxifraga (Saxifrage)
Silene caroliniana (Wildpink)

PERENNIALS FOR WET SOILS

Asclepias incarnata (Swamp Milkweed)
Boltonia asteroides (White Boltonia)
*Caltha palustris (Marsh Marigold)
Eupatorium purpureum (Joe-pye-weed)
Hibiscus Moscheutos (Swamp Rose-Mallow)
*Iris Pseudacorus (Yellowflag)
Lobelia cardinalis (Cardinal Flower)
Lysimachia clethroides (Clethra Loosestrife, Gooseneck Loosestrife)
Lythrum Salicaria (Spiked Loosestrife)
Miscanthus sinensis (Eulalia, Ornamental Grass)
Monarda didyma (Bee-balm)
Myosotis scorpioides (True Forget-me-not)
Onoclea sensibilis (Sensitive Fern)
Osmunda cinnamomea (Cinnamon Fern)
*Osmunda regalis (Royal Fern)
Saxifraga pennsylvanica (Penn. or Swamp Saxifrage)

*May be grown in water.

PERENNIALS FOR POOR SOIL

Achillea millefolium (Milfoil or Yarrow)
Ajuga genevensis (Geneva Bugle)
Aurinia saxatilis (Goldentuft)
Cerastium tomentosum (Snow-in-summer)
Gypsophila paniculata (Baby's breath)
Helianthemum nummularium (Rock or Sun Rose)
Iberis sempervirens (Edging Candytuft)
Linaria vulgaris (Toadflax)
Phlox subulata (Moss Phlox)
Potentilla (Cinquefoil)
Sedum stoloniferum (Running Sedum)
Sempervivum (Roof Houseleek)
Verbascum Thapsus (Mullen)
Veronica rupestris (Creeping Speedwell)
Viola cucullata (Marsh Blue Violet)

PERENNIALS REQUIRING WELL-DRAINED SOIL

Arabis alpina (Alpine Rockcress)
Asclepias tuberosa (Butterflyweed)
Aubrietia deltoidea (Purple Rockcress)
Coreopsis grandiflora (Tickseed)
Dianthus barbatus (Sweet William)
Digitalis purpurea (Common Foxglove)
Echinops Ritro (Steel Globe Thistle)
Eryngium maritmum (Sea-holly)
Globularia trichosantha (Globe Daisy)
Helianthus maximiliani (Maximilian Sunflower)
Iris x germancia (Bearded Iris)
Liatris pycnostachya (Cattail Gayfeather)
Papaver nudicaule (Iceland Poppy)

PERENNIALS FOR DRY, SANDY SOIL

Achillea Ptarmica (Sneezewort)
Anthemis tinctoria (Golden marguerite)
Asclepias tuberosa (Butterflyweed)
Aster novae-angliae (New England Aster)
Coreopsis grandiflora (Tickseed)
Dianthus plumarius (Grass Pink)
Echinops Ritro (Steel Globe Thistle)
Euphorbia corollata (Flowering Spurge)
Helianthus, in variety (Sunflower)
Limonium latifolium (Statice)
Papaver nudicaule (Iceland Poppy)
Rudbeckla laciniata (Goldenglow)
Yucca filamentosa (Common Yucca)

BLOOM CALENDAR

SCIENTIFIC NAME	COMMON NAME	HEIGHT INCHES	COLOR
	PERENNIALS FOR LATE WINTER		
Heleborus niger	Christmas Rose	12	White
Iberis sempervirens	Edging Candytuft	12	White
Sanguinaria canadensis	Bloodroot	8	White
Galanthus nivalis	Common Snowdrop	6	White
Scilla siberica	Siberian Squill	6	Blue
Chionodoxa Luciliae	Glory-of-the-snow	4	Blue
Claytonia virginica	Spring beauty	4	Blue
Crocus vernus	Dutch Crocus	4	Various
Eranthis hyemalis	Winter Aconite	3	Yellow
	PERENNIALS FOR EARLY SPRING		
Cheiranthus cheirii	Common Wallflower	24	Yellow
Iberis gibraltarica	Gibraltar Candytuft	18	White
Aquilegia canadensis	American Columbine	18	Red-Yellow
Dodecatheon Meadia	Common Shootingstar	15	Lilac
Bergenia cardifolia	Heartleaf Saxifrage	12	Purple
Pulmonaria angustifolia	Cowslip Lungwort	12	Blue
Mitella diphylla	Coolwort	12	White
Arabis alpina	Alpine Rock-cress	12	White
Adonis amurensis	Amur Adonis	12	Yellow
Tulipa (early)	Tulip	12	Various
Narcissus (various)	Narcissus	12	Yellow
Leucojum vernum	Spring Snowflake	12	White
Dicentra Cucullaria	Dutchman's Breeches	10	White
Primula elatior	Oxlip Primula	9	Various
Primula veris	Cowslip	9	Yellow
Anemone Pulsatilla	Pasqueflower	9	Purple
Viola cornuta	Horned Violet	8	Various
Viola odorata	Sweet Violet	8	Violet
Muscari botryoides	Common Grape Hyacinth	8	Blue
Hyacinthus orientalis	Hyacinth	8	Various
Hepatica americana	Roundleaf Hepatica	6	Blue
Aubrietia deltoidea	Common Aubrietia	6	Purple
Trollius europaeus	Globe Flower	24	Yellow
	PERENNIALS FOR LATE SPRING		
Dicentra spectabilis	Bleedingheart	36	Pink
Iris germanica	Iris	18-36	Various
Thalictrum aquilegifolium	Columbine Meadowrue	36	Purple
Hemerocallis	Lemon Daylily	36	Yellow
Paeonia officinalis	Common Peony	30	Various
Aquilegia chrysantha	Golden Columbine	24	Yellow
Doronicum cordatum	Caucasian Leopardbane	24	Yellow
Euphorbia epithymoides	Cushion Spurge	24	Yellow

Chrysanthemum coccineum	Painted Lady	24	Various
Trollius europaeus	Common Globeflower	24	Yellow
Aurinia saxatilis	Goldentuft	18	Yellow
Tulipa Gesnerana	Darwin Tulip	18	Various
Gaillardia aristata	Common Peren. Gaillardia	15	Red-Orange
Brunnera macrophylla	Siberian Bugloss	12	Blue
Convallaria majalis	Lily-of-the-valley	12	White
Nepeta Mussinii	Mussini Mint	12	Blue
Phlox divaricata	Blue Phlox	12	Lavender
Galium odoratum	Sweet Woodruff	8	Yellow
Ajuga reptans	Carpet Bugle	6	Purple
Phlox subulata	Moss Phlox	6	Pink
Primula	Primrose	6	
Polemonium reptans	Creeping Polemonium	6	Blue
Ranunculus repens	Creeping Buttercup	6	Yellow
Silene quadrifida	Alpine Catchfly	6	White
Cerastium tomentosum	Snow-in-summer	6	White
Veronica prostrata	Rock Speedwell	4	Blue
Pulmonaria officinalis	Pulmonuria	6-12	Purple

PERENNIALS FOR EARLY SUMMER

Althea rosea	Hollyhock	72	Various
Astilbe ,Davidii'	David Astilbe	60	Rose
Delphinium hybrids	Larkspur	24-60	Various
Digitalis purpurea	Common Foxglove	48	Purple
Anchusa azurea	Italian Bugloss	36	Blue
Gypsophila Bristol Fairy	Babysbreath	36	White
Lupinus polyphyllus	Washington Lupinus	36	Various
Pentstemon barbatus Torreyi	Torrey Pentstemon	36	Scarlet
Papaver orientale	Oriental Poppy	36	Red-Pink
Lilium candidum	Madonna Lily	36	White
Aconitum Napellus	Aconite	24	Blue-White
Baptisia australis	Blue Wild-indigo	24	Blue
Campanula medium	Canterbury bells	24	Blue
Chrysanthemum maximum	Shasta Daisy	24	White
Platycodon grandiflorus	Balloonflower	24	Blue-Violet
Achillea Ptarmica	Sneezewort	24	White
Lilium pumilum	Coral Lily	23	Red
Achillea Millefolium	Common Yarrow	18	Rose
Dianthus barbatus	Sweet William	18	Various
Linum perenne	Perennial Flax	18	Blue
Oenothera fruticosa	Common Sundrops	18	Yellow
Dianthus plumarius	Grass Pink	12	Various
Lychnis viscaria	German catchfly	12	Purple
Papaver nudicaule	Iceland Poppy	12	Various
Thalictrum minus	Maidenhair meadowrue	12	Yellow
Veronica spicata	Spike Speedwell	12	Purple
Astilbe japonica	Japanese Astilbe	12	White
Dianthus deltoides	Maiden Pink	9	Pink
Campanula carpatica	Tussock Bellflower	8	Blue

PERENNIALS FOR MID SUMMER

Macleaya cordata	Pink Plum Poppy	72-96	Cream
Lilium tigrinum	Tiger Lily	24-60	Orange
Cimicifuga racemosa	Cohosh Bugbane	48	White
Hemerocallis Thunbergi	Japanese Daylily	48	Yellow
Lythrum Salicaria	Purple Loosestrife	48	Rose-Purple
Heliopsis helianthoides	Pitcher Heliopsis	36	Orange
Physostegia virginiana	Obedience	36	Pink
Monarda didyma	Oswego Beebalm	36	Scarlet
Echinops Ritro	Steel Globe Thistle	36	Blue
Phlox paniculata	Perennial Phlox	24	Various
Asclepias tuberosa	Butterflyweed	24	Orange
Lychnis chalcedonica	Maltese Cross	24	Scarlet
Lychnis x Haageana	Haage Campion	12	Orange-Scarlet
Heuchera sanguinea	Coralbells	18	Crimson
Veronica incana	Woolly Speedwell	12	Rosy-purple

PERENNIALS FOR LATE SUMMER AND EARLY FALL

Eupatorium purpureum	Joe-pye-weed	72	Purple
Campanula pyramidalis	Chimney Bellflower	72	Blue
Lilium Henryi	Henry Lily	60-72	Orange
Artemisia vulgaris	White Mugwort	48	White
Liatris pycnostachya	Cattail Gayfeather	48	Purple
Lilium speciosum	Speciosum Lily	24-48	Pink
Solidago canadensis	Canada Goldenrod	36	Yellow
Rudbeckia fulgida	Showy Coneflower	36	Golden,
Lilium superbum	American Turk's cap Lily	24-36	Orange-Red
Veronica longifolia subsessilis	Clump Speedwell	24-36	Blue-Purple
Aster spectabilis	Seaside Aster	24	Purple
Liatris spicata	Spike Gayfeather	24	Purple
Stokesia laevis	Stokesia	12-24	Lavender-White
Limonium latifolium	Bigleaf Sea-lavender	20	Lavender
Hosta plantaginea	White Plantainlily	12-18	White
Colchicum autumnale	Common Autumn Crocus	3-4	Purple
Aster tataricus	Tartarian Aster	60-72	Violet-Blue
Chrysanthemum serotinum	Giant Daisy	60	White
Aconitum carmichaelii	Violet Monkshood	48-60	Blue
Aster novibelgii	New York Aster	36-60	Blue
Salvia azurea grandiflora	Great Azure Sage	48	Blue
Aster novae-angliae	New England Aster	36-48	Various
Helenium autumnale	Common Sneezeweed	36-48	Yellow
Kniphofia Uvaria	Common Torchfly	36	Orange
Echinacea purpurea	Purple Coneflower	36	Purple-Rose
Anemone x hybrida	Japanese Anemone	24-36	Various
Chelone Lyonii	Pink Turtlehead	24-36	Pink
Aconitum Fischeri	Azure Monkshood	24-36	Blue
Salvia patens	Gentian Sage	12-24	Blue
Sedum spectabile	Showy Stonecrop	18	Crimson
Anemone hupehensis	Japanese Anemone	12	Rose

LANDSCAPE DESIGN

LANDSCAPE DESIGN

INTRODUCTION AND DEFINITION OF LANDSCAPE DESIGN

Landscape design can be defined as the art of organizing and enriching outdoor space through the placement of plants and structures in agreeable and useful relationship with the natural environment.

Merely planting trees and shrubs is not landscaping. Designing a landscape is an art. Landscaping means creating a plan to make the best use of the space available in the most attractive way. It means shaping the land to make the most of the site's natural features and advantages. It means building such necessary structures as fences, walls, and patios. Finally, it means selecting and growing the plants that best fit the design.

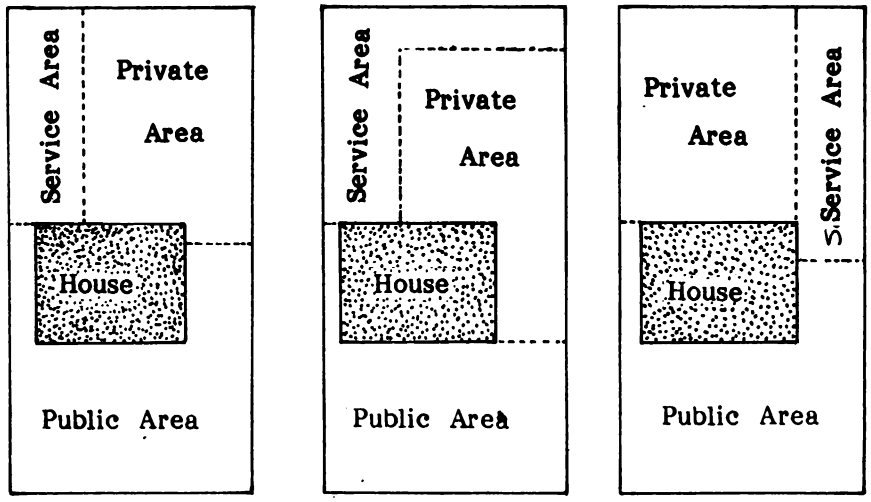
The smaller the house, grounds and budget, the greater the need for correct and complete planning, because every square foot of space and every dollar must produce maximum results. Plan for the best use of the site and minimum upkeep as well as pleasant appearance.

Plan for complete development. There is no need to develop all of the lot at once. However, there should be an overall plan so that when any work is done on the lot, it will be part of the general scheme. Carrying out the landscape plan is generally a matter of years for plantings need time to grow. Do not allow a spade of earth to be turned until a grading schedule has been prepared from a well studied plan for house and lot. To do otherwise is to sacrifice such things as valuable trees and soil.

ANALYSIS OF SITE AND FAMILY NEEDS

The fundamental principle of landscape design is that each development should be based upon a specific program and that this program should in turn be based upon: (1) The people who will use it, their cultural needs, individual desires, and economic abilities; (2) the climate; (3) the site, its immediate surroundings, topographic and ecological conditions, and all objects, natural and man-made now existing on the site or planned for the future; (4) the available materials and methods of fabrication.

The landscaper must study the habits of people, and what they do; understand their desires and needs and determine what space and materials are available and how they may be used to accommodate these goals. The first step in landscape design is to divide available space into use areas: the public area, the private area, and the service and work area. The public area is the section that passersby view. It is generally in front of the house and should present an attractive public view. The living or private area is for the family and may contain a patio, deck, or porch for outdoor sitting, entertaining, or dining. A play area may be incorporated depending on the family's interest and/or the presence and ages of children. A service or storage and work area should provide a place for garbage, oil tank, garden tools, etc. that is convenient for use but screened from the other areas. Also included in this area may be a cut flower bed or vegetable garden if desired.



FACTORS INFLUENCING LANDSCAPE DESIGN

The Lot and Its Characteristics

In laying out a design, preserve all the best natural resources on the site such as: trees (mature if not previously destroyed), brooks, ponds and rock outcroppings, good soil, turf and interesting variations in the terrain. These natural elements affect the ease of construction and landscape possibilities. A careful survey of the area should be made to determine whether site conditions will be a deterrent or can be incorporated into a design plan. Examples of problems are thin, overcrowded trees which should be removed. There might be microenvironmental problems on a site that require consideration. Examples are low places with cold air drainage or a spot with poor soil and water drainage.

Changes in elevation can add interest and variety to the home landscape. The character of the land, its hills, slope and trees should determine the basic landscape pattern. A hilly wooded lot lends itself to an informal or natural design, with large areas left in their natural state. In such a setting, large trees can be retained.

Although natural slope variations are an asset, avoid creating too many of them artificially. Excess grading of terraces or retaining walls should be avoided. If these features are necessary to facilitate construction or control water drainage, they should be designed to detract as little as possible from the natural terrain.

Neighborhood Sights and Sounds

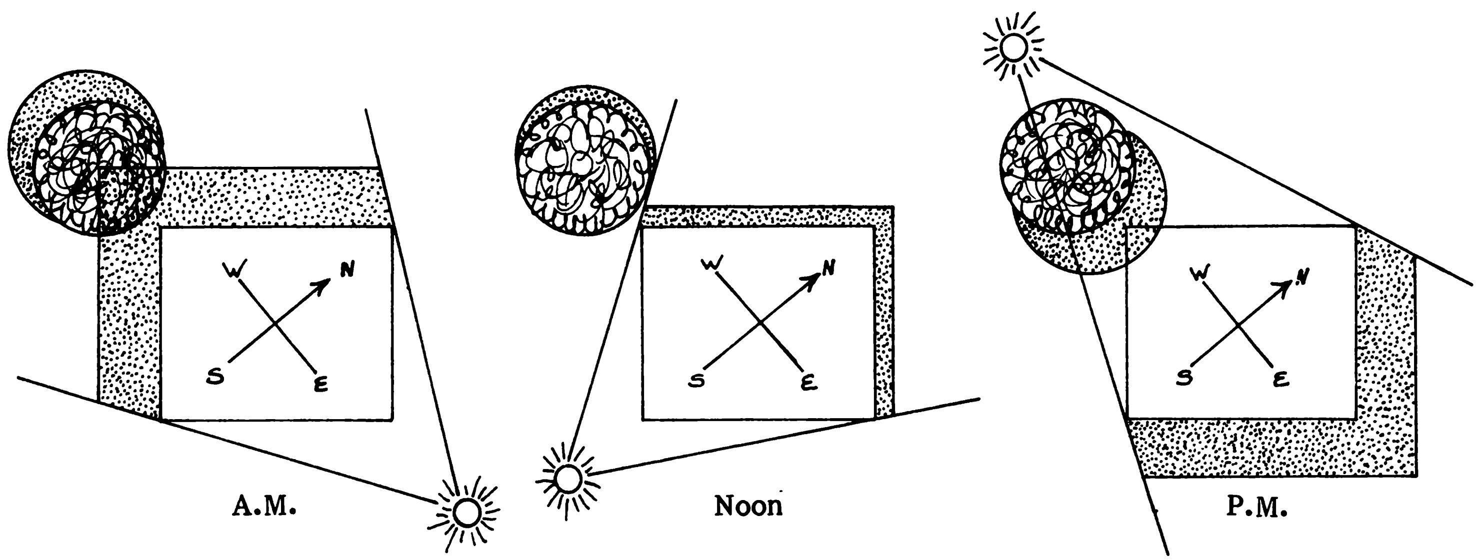
Keep good views open and screen out the undesirable. Often a shrub or two will provide all the screening that is necessary. Provide plantings to act as noise barriers. The principle rooms of the house should look out on the lawn or the garden. Design special areas to be viewed from favorite windows.

Climate

Climate includes sunlight, all forms of precipitation, wind, and temperature. All these affect the way a house should be placed on a lot, how the land is used and what is planted. In planning the grounds, don't fight the climate; capitalize on its advantages. In warm regions, enlarge the outdoor living area. In cold regions, plant so that the winter scene is enjoyed from the inside. Evergreens and hedges are picturesque when covered with snow. Since people respond differently to sun and shade, it is important to study the amount and location of each on the lot. Sun and shade patterns change with the seasons and vary each minute of the day. The sun is higher and shadows are shorter in the summer than in the winter.

Northern exposures receive the least light and therefore are the coolest. East and West receive more light; western exposures being warmer than eastern because they receive afternoon light. The southern orientation receives the most light and tends to be the warmest.

The principle rooms of a house should benefit from winter sun and summer breeze. This means that the house must be correctly oriented. A plan suited to one lot will not be correct for a lot facing a different direction. Sunlight and shade can be controlled by the location of buildings, fences, and trees. Figure out possible shade from trees and houses on neighbors' lots also.



Plan future shade from tree plantings with great care in order to keep sunny areas for garden, summer shade for house and terrace. Deciduous trees (those that shed their leaves) shade the house in summer and admit the sun in winter. Place trees off the corners rather than the sides of the house where they will accent the house and not block views and air circulation from windows. Remember that an over-planting of trees tends to shut out sun and air.

Family Activities

Use of the land should be a determining factor in landscape design. Analyze the activities of the family. For example, small children need open lawn for playing, gardeners need space for growing vegetables and flowers. Make allowances for future changes. Consider: outdoor living, playing, gardening, and household servicing. The family routine follows a general pattern, but varies with each family's way of living.

Family Growth

A sucessful landscape should be able to age and mature with a family. Don't plan a landscape whose use will remain static because it will not function as a family's needs change. A plan for a very young family calls for inexpensive plantings. There should be open areas in which children and pets can play. As a family reaches its middle years, more extensive and expensive plantings can be put in. The children's play area can serve other functions, the sand box can become a lily pool. As the children grow up they require less play area and less parental supervision; providing both a place and time for more sophisticated landscaping. With the approach of retirement years, the landscape should become one of low maintenance. Mature trees and shrubs will carry the landscape theme, high labor areas such as flower beds should be minimized. Ramps and walks may replace steps.

Cost Effective Maintenance

Decide on maintenance standards. For the person who enjoys puttering about the yard, landscape design may be elaborate. However, in general the simpler the site, the less there is to maintain. A low maintenance plan is the goal of most homeowners. This may be achieved to a large extent in the planning stage by careful attention to the nature of the site. Existing trees, elevations, and the use to be made of the area should be prime considerations.
Low maintenance may be achieved by adopting one or more of the following possibilities:

- Have little lawn area.
- Use ground covers or natural pinestraw, barkchips, and other mulches.
- Use paving in heavily traveled areas.
- Provide mowing strips of brick or concrete for flower beds and shrub borders.
- Use fences or walls instead of clipped formal hedges for screening.
- Design raised flower beds for easy access and to help control weeds.
- Install an underground irrigation system in areas of low rainfall.
- Have small flower beds. Use flowering trees and shrubs for color.
- Be selective in the choice of plant materials. Some plants require much less pruning, spraying and watering than others.
- Use native plant materials.
- Keep the design simple
- Use mulches for weed control when possible, but, if herbicides become necessary, use caution and follow directions.

DEFINITION OF AREAS AND DESIGN CONSIDERATIONS

Private or Outdoor Living Area

The private living area or outdoor living room has become an important part of the American home. No yard is too small to have a private sitting area where family and guests can gather. Where possible, there should be easy access from the house to the outdoor area. The ideal arrangement is to have the living room open onto a porch or terrace, and/or have the kitchen near the outdoor dining area. The outdoor living room can be simple. An open, grassy area enclosed by a wall or shrubs enables the homeowner and guests to sit outdoors in private, or a more elaborate outdoor living room can be developed by introducing a series of gardens or garden features.

The outdoor private area can serve the following functions:
- Outdoor entertaining
- Family relaxation
- Recreation
- Outdoor eating
- Aesthetic enjoyment

The following are guidelines to consider when planning the major private areas:

Privacy: The area should be enclosed from public view or nearby neighbors. Properly grouped shrub borders and trees will do this. For a small area, use a fence to save space. The private area should be screened from work areas, such as clothes lines, wood piles, garden sheds and other less pleasant views.

Livable touch: Furniture should be attractive, designed for outdoor use and appropriate for the size of the landscaping. Garden accessories should be kept to a minimum and be simple and unobtrusive.

Year-round interest: The outdoor living area should be planned so that selection of plant material is varied and there is interest throughout the year. This is especially true if the area is visible from the house. For winter interest, select shrubs and trees with colorful bark, evergreen foliage, or colorful fruit. The rest of the year use flowers, shrubs, and trees to create interest. Pools, stone steps, paving, walls, bird-feeding stands, and other architectural features will add interest to the garden. Architectural details do not change with the seasons, and they give interest and meaning to your garden throughout the year.

Climate control: Control of weather in the outdoor living area helps to extend the period of usefulness. Shade trees screen the area from the hot sun. Windbreaks cut down some of the wind in the fall. An awning or trellis type roof can protect against inclement weather. A garden pool or fountain can convey the effect of coolness during the hot summer season.

The terrace or sitting area: The center of activity for a living area is often a space arranged with garden or patio furniture. It may be a porch, deck or terrace next to the house, or the special section of the living area. This latter area might be under the shade of a large tree or in a shady corner. The sitting center may be either paved or in turf. Flagstone, brick, concrete blocks, or concrete with redwood dividers are materials commonly used for surfacing the outdoor terrace. The size of the paved terrace depends upon its expected use and the type and amount of furniture desired. An area 10' by 10' will accommodate four chairs and is about the minimum size for accommodating four people comfortably. Increase the size if space is desired for a picnic table, plus a pleasing grouping of four to eight chairs. This area may also include the grill or outdoor cooking area.

The play area: The play area can be a part of the outdoor living area or separate from it. For very young children, a small area enclosed by a fence near the kitchen or living area is desirable. A swing, sand box, or other equipment can be placed here. In yards with a good deal of open lawn space, there is room for croquet, badminton, or a portable wading pool. A large tree in the back yard may be ideal for a tree house. A paved driveway or parking area makes an ideal area for badminton, basketball, or shuffleboard for older children, as well as tricycling or roller skating for younger ones. Since ages of children in a family are always changing, it is necessary to make design adjustments to meet changing recreational needs.

Enclosed Front Yard as a Private Area: The area in front of the majority of homes has traditionally been left more or less open so the passing public can view the home. Plantings, such as hedges or a screen planting of trees and shrubs along the street in order to make the public area private, have been used to provide privacy for the front area. Privacy in the front yard may desirable when a picture window faces the street or when the front yard is used for outdoor sitting. Where space is limited, a tall attractive fence may provide privacy and be used as an attractive background for shrubs and smaller plants.

Service, Work, or Production Areas

Space often needs to be provided for permanent clothes lines, garbage cans, trash burners, air-conditioner units, tool storage, wood storage, vegetable garden, compost, cutting garden, propagating structures, small greenhouses, or kennel. Service facilities should not be visible from the outdoor living area or from the street. However, an exception might be an attractive greenhouse or tool storage building designed and constructed so that it blends well into the overall setting, with an interesting composition of plant material around it. Wood or wire fences, brick or masonry walls, or plant material alone or in combination are the materials most commonly used to hide or partially screen service areas.

In a small backyard, it may not always be feasible to completely enclose a permanent clothes line. Hiding with one or two large shrubs or using a vine-covered trellis will make the poles less noticable. Portable clothes lines are a solution if there is not enough space for permanent drying areas. When possible, the permanent or portable drying unit should be located near the laundry center so it will not be necessary to carry wet clothes far.

Public Area

This is the area, generally in the front facing the street, that the public sees. The landscape in this area should create the illusion of spaciousness. Keep the lawn open, keep shrubs to side and in foundation plantings. When selecting shrubs to frame the front door consider their texture, color, size and shape so they will enhance the total effect of welcoming guests. Tall trees in the backyard and medium sized ones on the sides and in front will help accomplish this effect. The house is to be the focal point of the view.

Driveways should be pleasing in appearance, useful, and safe. The landscaping of many homes is spoiled by poorly designed and maintained driveways. Some driveways tend to cut up the yard unnecessarily. Parking areas and turnabouts should be provided when practical. If possible, the driveway should be hardsurfaced because it is neater and requires less maintenance than unpaved driveways. Do not plant tall shrubery at a driveway entrance or allow vegetation to grow so tall that it obstructs the view of the highway in either direction.

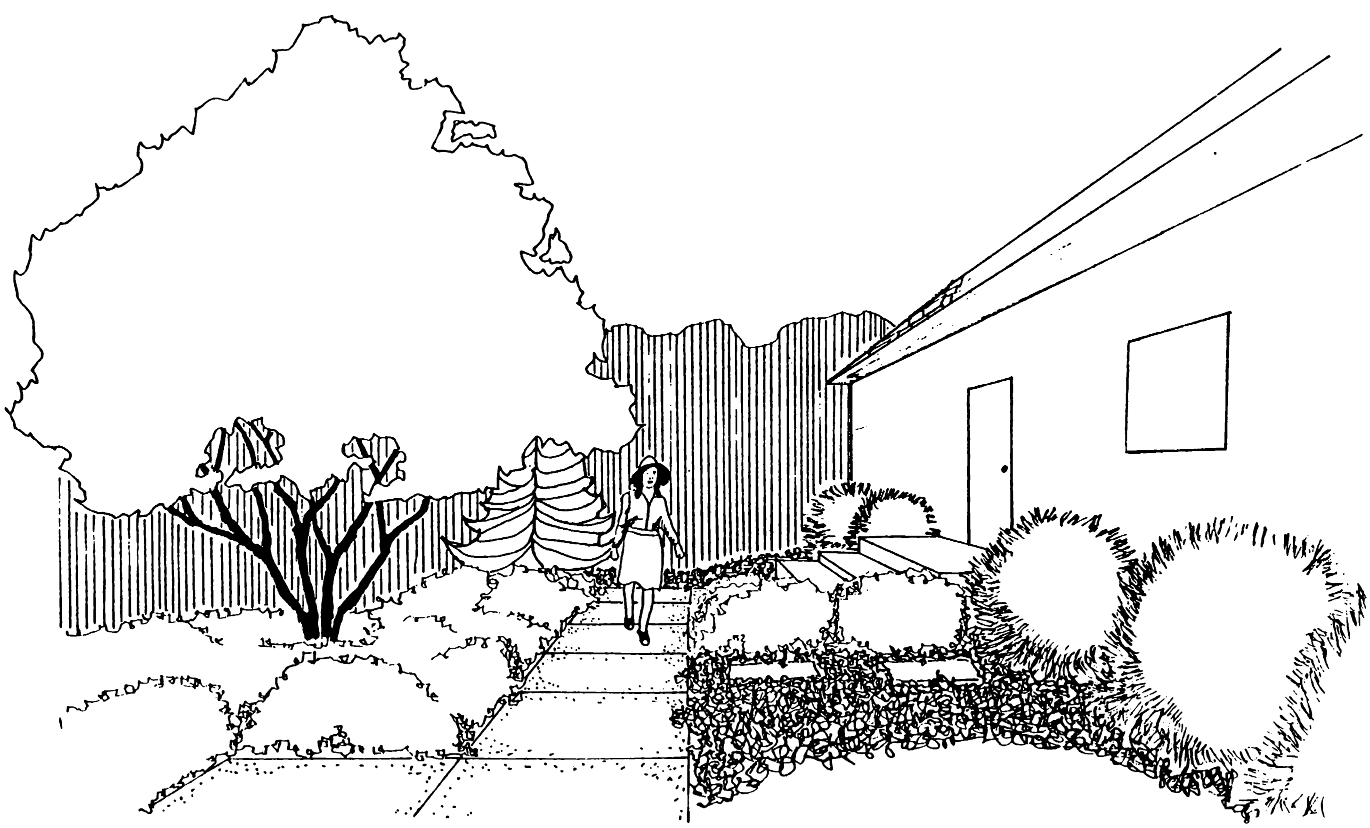
In planning the home grounds, give careful consideration to foot traffic patterns so there will be easy access from one area to another. This traffic may be serviced by walkways, terraces, or open stretches of lawn. In areas of heavy traffic, a paved surfacing material is best.

Design of the walk system to the front door will often depend on the location of the front door, where guests' cars will be parked, and the topography of the land. If guest parking is at the edge of the street, a straight walk is probably best if the grade is suitable. When the guest parking area is planned for the property, the walk might more logically lead from the guest parking area to the front door. Foot traffic can use the driveway.

Sometimes the topography of the land will make it desirable to have the entrance walk start at the edge of the property and curve to the front door to take advantage of a gradual grade. However, avoid curved walks that have no apparent reason for curving.

Generally, the walk to the front door parallels the house and joins the driveway. This design is sometimes used if the driveway entrance grade at the street is less steep than the area directly in front of the door. This type of design might eliminate the need for stairs. In running the walk parallel to the house, be sure sufficient space is left for plant material.

For a residence, make the front walk at least four feet wide. Build walks so they are safe. Avoid using materials that are rough or raised since it is possible to trip over or catch one's heel on such materials. Design steps so they will be safe, especially in wet or icy weather. Make the treads wider and the risers less tall than the treads and risers used indoors. Install handrails where needed.



ELEMENTS AND PRINCIPLES OF DESIGN

There are no hard and fast rules for landscaping since each design is a unique creation. Landscaping, as in all art forms, is based on certain elements and principles of design, which are discussed here.

Scale

Scale refers to the proportion between two sets of dimensions. Knowing the eventual or mature size of a plant is critical when locating it near a building. Plants that grow too large will overwhelm a building. Small plantings around a large building can be similarly inappropriate. It is essential, therefore, to know the final size of a particular plant before using it in a landscape. Both the mature height and spread of a plant should be considered.

Balance

Balance in landscaping refers to an aesthetically pleasing integration of elements. It is a sense of one part being of equal visual weight or mass to another. There are two types of balance, symmetrical and asymmetrical. Symmetrical balance is a formal balance. It has an axis with everything on one side being duplicated or mirrored on the other side. Asymmetrical balance is balance which is achieved by using different objects to achieve equilibrium. For example, if there is a very large object on one side of a seesaw, it can be counterbalanced by using many objects of a smaller size on the other side of the seesaw or one object of equal size. In each instance, balance is achieved. This applies to landscaping when there is a large existing tree or shrub. To achieve visual equilibrium, a grouping or cluster of smaller plants is used to counterbalance the large existing plant. Balance may also be achieved through the use of color and texture.

Symmetrical Balance

Asymmetrical Balance

Unity

A garden with too many ideas expressed in a limited area lacks unity. Too many showy plants or too many accessories on the lawn would claim more attention than the house itself. Using too many accent plants or plants with contrasting textures, form, or color violates the principles of unity. In order to achieve unity it is necessary to group or arrange different parts of the design to appear as a single unit. The design should be a pleasant picture from every angle.

Rhythm

Rhythm is a repetition of elements which directs the eye through the design. Rhythm results only when the elements appear in regular measures and in a definite direction. Rhythm can be expressed in color as well as form.

Simplicity

Every square foot of landscape does not have to have something in it. Such objects as bird baths and plastic yellow daisies are often overused in the landscape. There is an design concept expressed as "less is more." This statement is especially true regarding landscape design. Keep the landscape simple and it will look its best. Avoid cluttering the yard with unnecessary objects. This includes plant material, statuary, and miscellaneous objects. When too many extras are introduced the yard takes on a messy appearance. Use statuary or specimen plants with discretion. The simplist landscapes are often the most attractive. Remember, create spaces, don't fill them up.

Accent

Accent also referred to as; dominance, focalization, or climax is important in the total picture. Without accent a design may be dull, static, or uninteresting. Various parts, if skillfully organized, will lead the eye towards the focal point. This may be a garden accessory, plant specimen, plant composition, or water in some form. Emphasis may also be obtained through use of contrasting texture, color, or form, or by highlighting portions of a plant composition with garden lights.

Accent

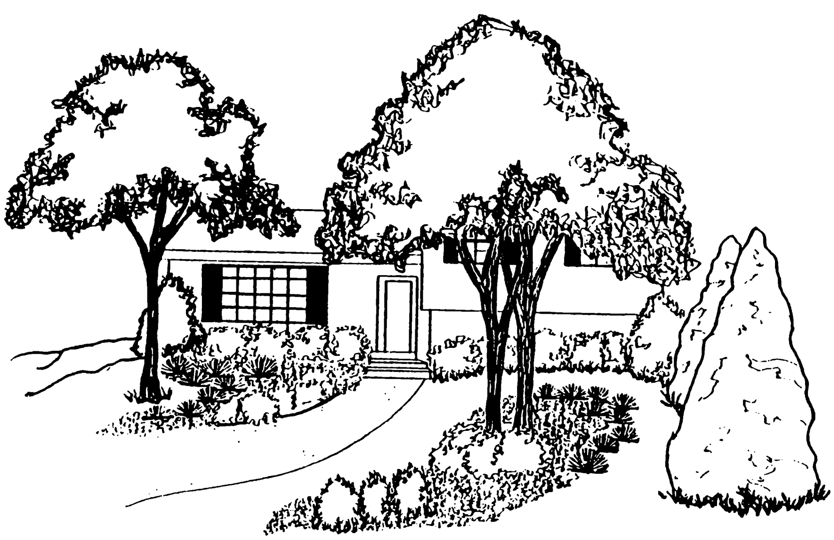
Repetition

Repetition

Do not confuse repetition in the landscape with monotony. A row of sheared hedges lined up in front and down the side of a home is not repetition; it is monotony. Repetition is something more subtle. For example, the use of curves in the landscape design. Curves may begin in bed lines in the front yard, continue in the side yard, and be picked up once more in the backyard. Alternatively, the repeated use of right angles on a grid design can successfully be used to achieve unity in the landscape. The right angles may begin in the front yard perhaps on the sidewalk, then be used in the bed lines which go around the property, and be picked up again in the backyard. By subtly repeating such design elements as bed lines in the yard, one can achieve a continuity or flow to the entire landscape.

Harmony

Harmony is achieved through a pleasing arrangement of parts.



Harmony

Lack of harmony

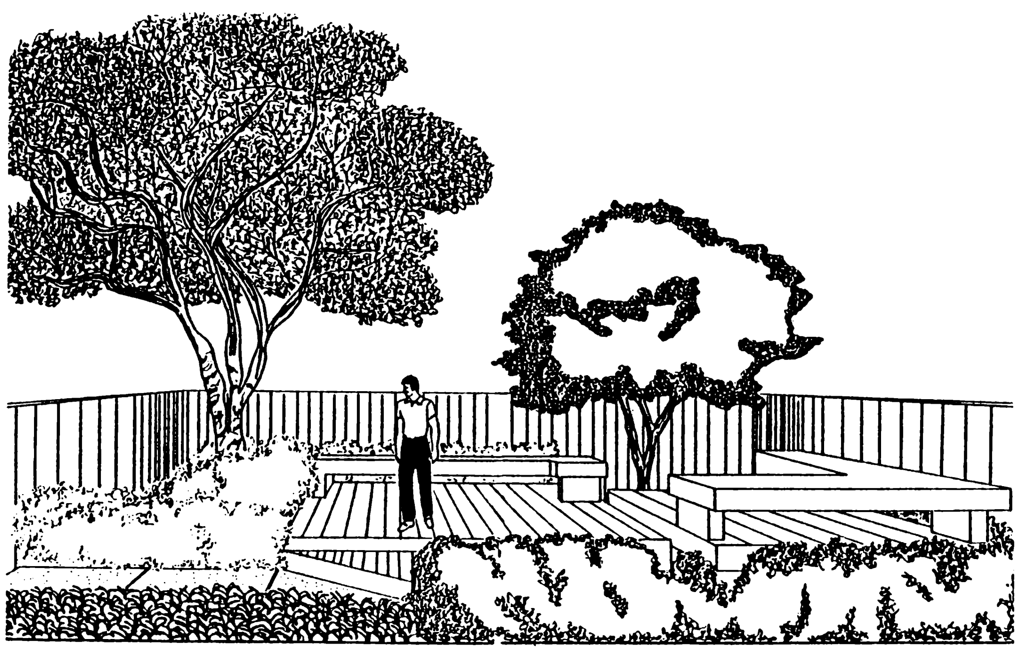
Space Dividers, Accents and Transitions

An easy method of combining plant and architectural characteristics is the consideration of space dividers, accents and transitions. These three elements are present in all successful landscape compositions.

Space Dividers define or give privacy to spaces, create the background for outdoor living activities, and create dominance. Space dividers can be made up of fences, walls, plants as hedges or plants as borders. Space dividers must have height, must be arranged in groups that border spaces (open lawn or patio area), and must contain the most visually uniform characteristics in the composition.

Transitions form the connecting link between the space dividers and accents, or between the house and the land. To harmonize these elements, the transitions msut be composed of characteristics that are found in both the space dividers and accents.

Accents, which should be in the minority of the composition, create interest by contrasting characteristics with the space dividers. Like sculpture, they may be displayed in two ways 1) hidden in niches within the space dividers, or 2) standing free within the room created by the space dividers. In any design, only one of the two methods should be employed or visual confusion may result.



Space dividers

Dominance and Contrast

In any composition, a majority of dominant or repeated characteristics are accented by a minority of contrasting characteristics.

For a garden in which a viewer spends little time, the magnitude of contrast between the dominant characteristics and accents is very strong. Gardens of this type include entrance courts, streetside foundation plantings, entrances to public buildings, or plantings seen from the highway. The magnitude of contrast refers to the degree of change between visual characteristics such as plant type, height, form, color and texture. Generally, the volume of dominant characteristics to contrasting features should be about 80-20 or 90-10 percent. Also, the accents must be concentrated in one area. Gardens of this type take on a bold, architectural effect as in many of the contemporary California gardens. The effect can be grasped and understood at a glance.

For a garden in which a great deal of time is spent, such as a viewing garden, a private garden off a study, or a dining garden, the magnitude of dominance to contrast should be about 70-30 percent. The contrast can be rhythmically placed instead of being concentrated in one area. This type of garden would be appropriate for relaxation and meditation. It often takes on a Japanese effect, which is conducive to contemplative study needed to grasp the essence of the garden.

In no case should the ratio of dominance to contrast drop to a 55-45 percent, for at this point dominance becomes lost and visual confusion results.

An example of a plant composition containing a strong contrast of space dividers, transitions, and accents is described as follows: space divider is formed by a grouping of hemlock, spruce, and white pine (all narrow-leaf evergreen trees); the accent by a massing of crepe myrtles (flowering deciduous tree), and the transition by a massing of firethorn (a broad-leaf evergreen shrub).

The contrast between the space dividers and the accents is created by:

1. tree types; evergreen and deciduous.
2. form; the evergreens are pyramidal as contrasted with the rounded crepe myrtle.
3. height; the evergreens grow to at least 40' as contrasted with the crepe myrtle growing to about 15'.

DRAWING A LANDSCAPE PLAN

The following section provides the information necessary to draw a landscape plan that embodies the elements of good design. These steps are for those who want the fun and satisfaction of preparing their own landscape plan. They are:

1. Preparing the map.
2. Deciding how the ground area is to be used.
3. Placing use areas on the map.
4. Developing the landscape plan.
5. Preparing a planting plan.

Completing these steps will enable you to develop a final plan that can be implemented over several years as time and money permit.

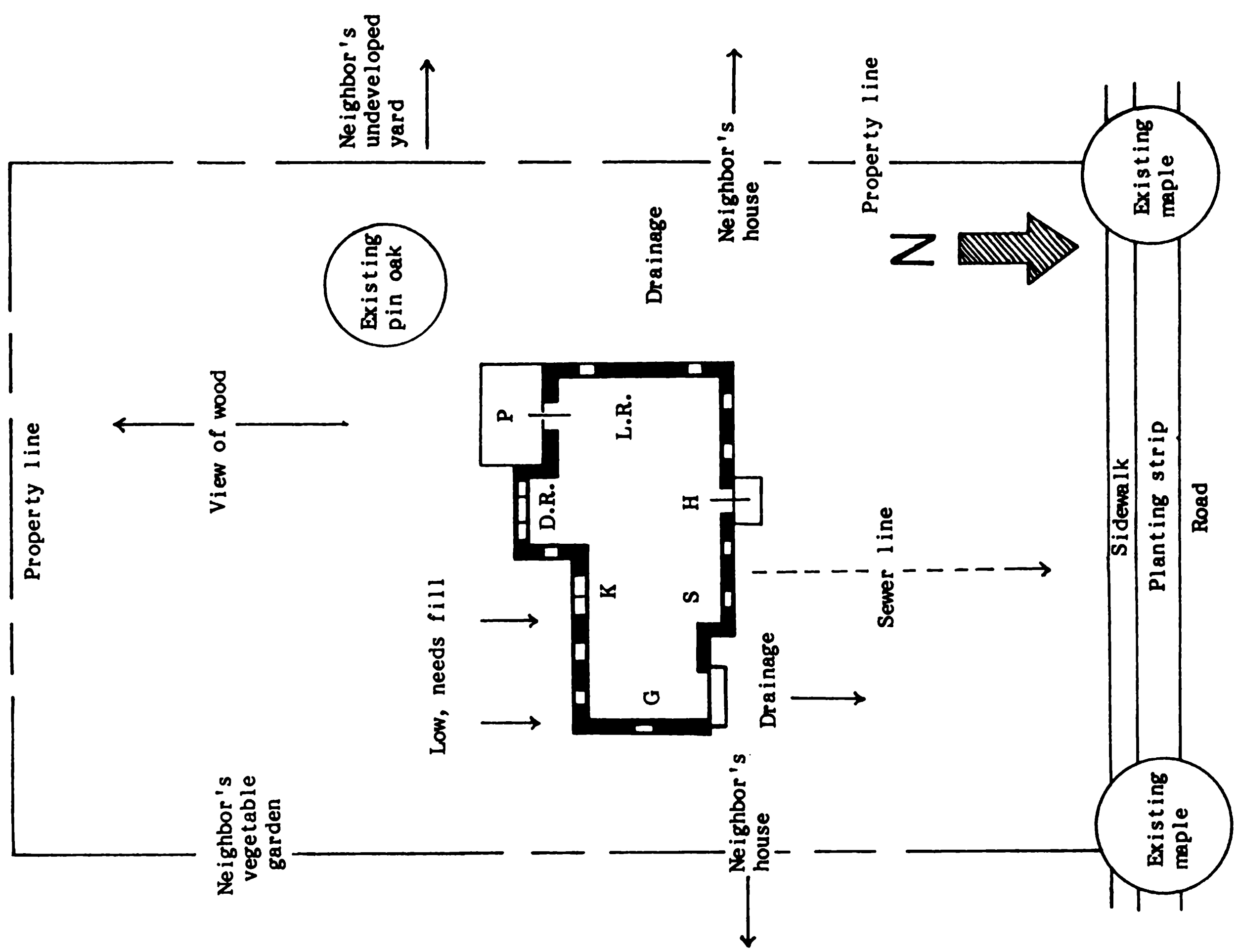
Step 1 - Preparing Baseline Map

Prepare a scale map of the home grounds. Use graph paper and let one square equal so many feet or draw to scale using a ruler or an engineer's scale.

Suggested Scale	Small Lot	Large Lot
Engineer	1" equals 10'	1" equals 20'
Ruler	1" equals 8'	1" equals 16'

The map should include the following:

* Property lines.
* Undesirable features of home grounds or adjoining property.
* North point
* Views - point arrows in direction of each good view.
* House, garage, other buildings.
* Doors, windows, porches, and location of rooms.
* Existing trees, rock outcroppings.
* Walks and driveways, if already constructed.
* Contour of the land, use an arrow to show direction of surface water flow.
* Scale used.
* Location of septic tank or sewer lines.



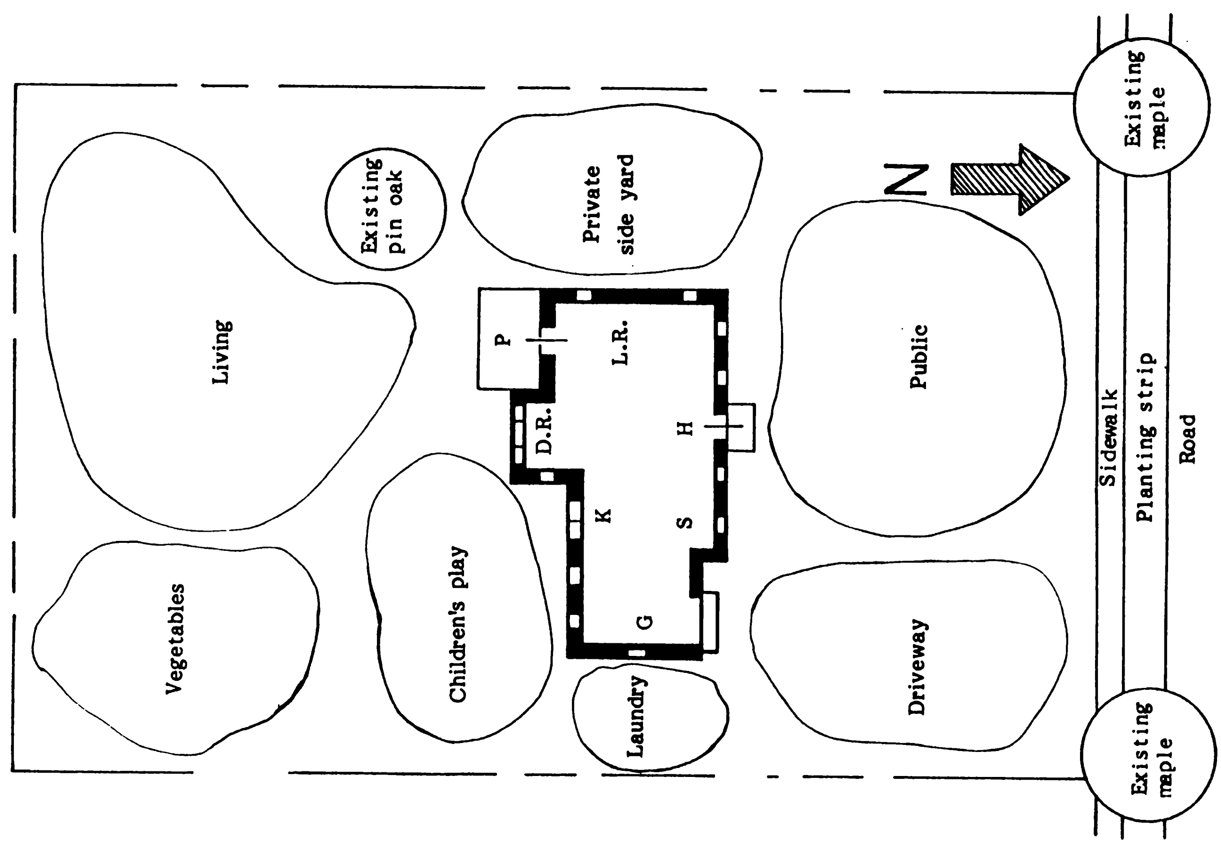
Step 2 - Deciding the Ground Area

Items listed below are most often included in the final development. Make a list that suits your individual needs.

* front lawn area or public area
* laundry area
* vegetable garden
* cooking and eating area
* garden pools
* walks
* flower beds
* outdoor living or private area
* children's play area
* small fruit
* driveway
  + guest parking
    + turnabouts
* garage
* List other items particular to your land area

Step 3 - Placing Use Areas on the Map

Place the use areas on the map. Fit them together with two considerations, traffic flow and use. How will people move from one area to another or from the house to an outside area? Will movement be comfortable? Will the outdoor area be functional in relation to the house? Will it make use of existing features such as views or changes in the terrain? Try different conbinations in relation to rooms of the house, surrounding areas, and potential views.



Step 4 - Develop the Landscape Plan

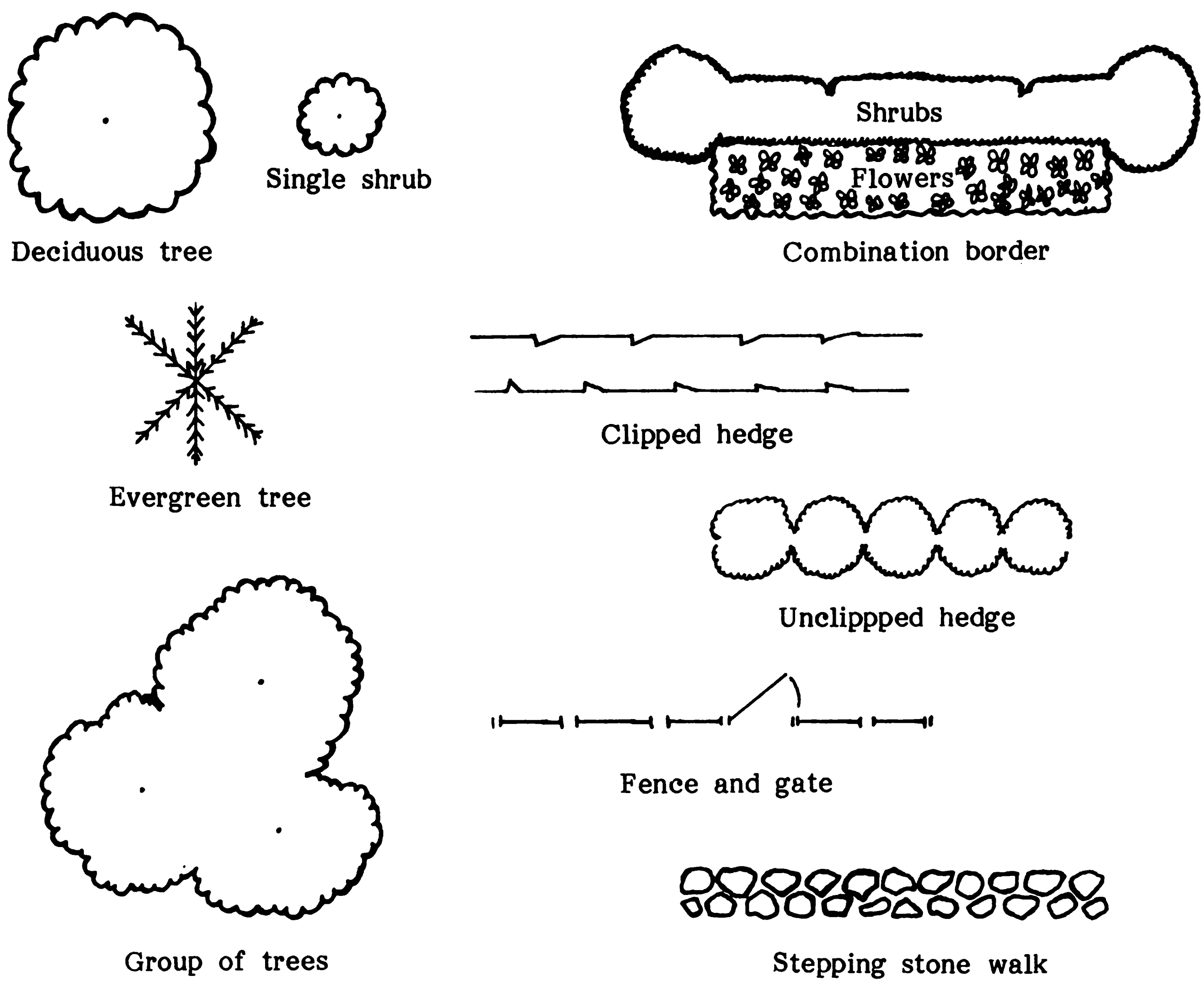
Design driveways, parking areas, and walks.

Indicate where plant masses are needed for (1) separating areas, (2) screening undesirable views, and (3) providing shade, windbreaks, beauty.

Do not attempt at this point to name the trees and shrubs, but think in terms of plant masses that will serve a purpose and help tie the various areas together into a unified plan considering design elements previously discussed.

In preparing the plan, use landscape symbols to indicate trees and shrub masses.

LANDSCAPE SYMBOLS



Draw symbols to scale to represent the actual amount of space that will be involved. For example, a white pine tree at maturity will have a spread of approximately 20'. Make the scale diameter of the symbol in this case 20'. Indicate on the map where paving, plants and structures will be.

In developing the plan, check to see if the proposed scheme is practical and if you can answer the following questions satisfactorily:

a. Is the driveway design pleasing, useful and safe?
   Have the following been provided for: safe entrance? turnabout? guest parking?
   Will guests use the front door?
   Is the coal bin or oil tank handy to the driveway but screened from public view?
   Will the proposed drive be too steep?

b. Are the walks convenient?

c. Will the view be attractive from:
   living room?
   picture window?
   porch?
   dining room?

d. Has a living area been provided, and is it screened from:
   neighbors?
   service area?
   buildings?

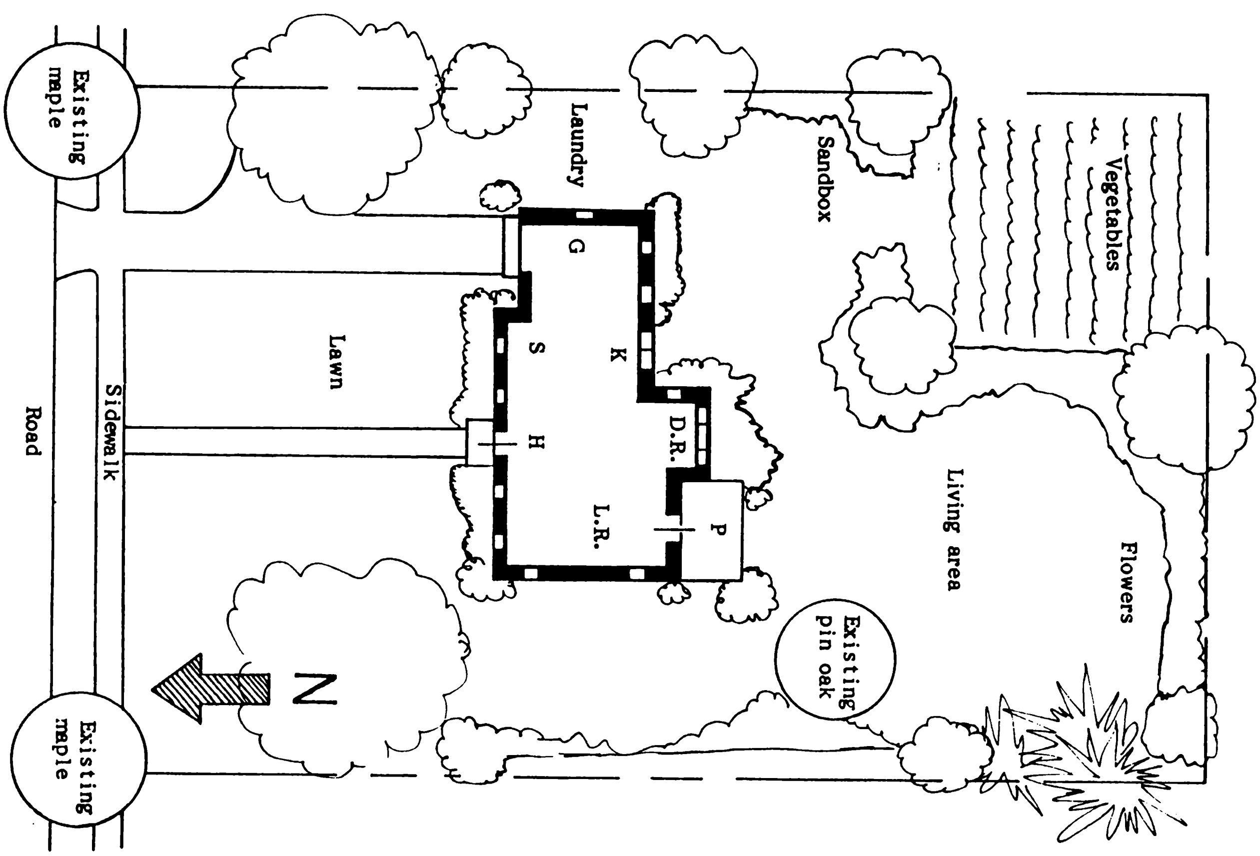
e. Is the clothes line close to the laundry?

f. Do all the parts fit together into a unified plan?

g. Has a good setting and background, and privacy been provided?

h. Are the house and major plants set back in case the highway department or local government decides to widen the road or street?

i. Will the proposed location of the septic tank and drainage fields interfere with planting needed shade trees?



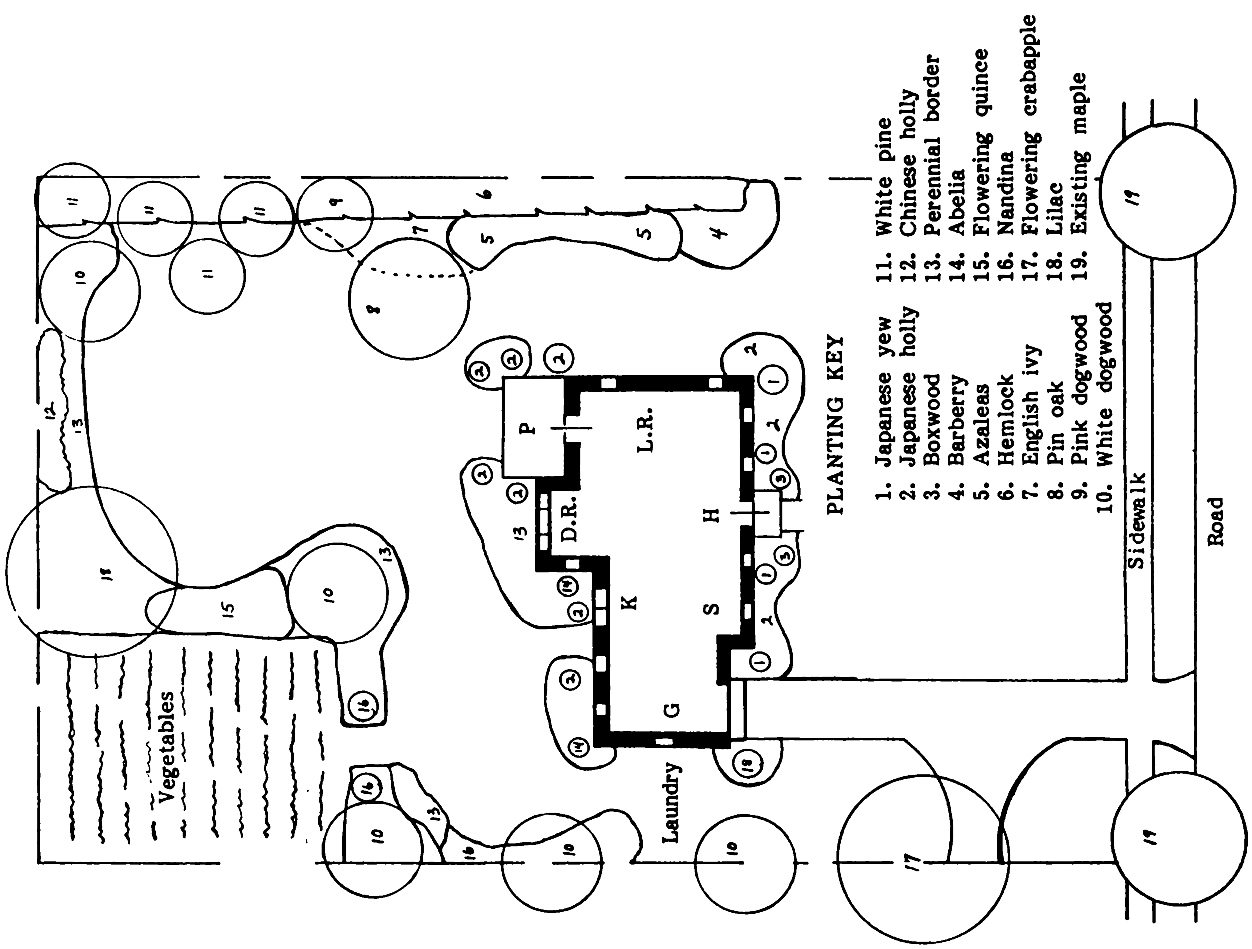
Step 5 - General and Specific Planting Plan

First, for each tree or shrub mass on the plan, make a set of specifications. These specifications should include:

Height - low, medium, tall
Form - spreading, upright, arching, or globe
Purpose - shade, background, hedge, screen, accent, or mass
Seasonal Interest - fruit, flowers, foliage
Type - evergreen, broadleaf evergreen, deciduous
Maintenance - subject to insects or plant diseases
Cultural Needs - shade, sunlight, moisture requirements

Then, select a plant or group of plants to meet the specifications. Consult garden books and nursery catalogs, visit a local nursery. Become familiar with plant material and discuss your plan with nurserymen.

On the map developed in step 4, designate specific plantings.



SELECTION OF PLANT MATERIALS

Well chosen plantings are necessary to achieve desired landscape effect. The homeowner has a choice of hundreds of varieties of trees, shrubs, vines, and perennials from which to select. Do remember, plants are not merely ornamental accessories. They make up masses and define space in the yard and, consequently, the silhouettes which produce the garden design. Therefore, when selecting plants consider both their cultural needs and aesthetic value.

Cultural Considerations in Selecting Plants

Hardiness - this is the plant's ability to withstand winter and summer climatic changes; also, its longevity or permanence. Usually a fast growing plant has a short life span and will consequently need replacing after a few years.

Soil and moisture conditions - these are important parts of the plant's environment. Some respond unfavorably when a change occurs in this environment; for example, some plants can tolerate extreme dry or wet conditions while others cannot.

Degree of sun or shade - this depends on where the plant is to be located in the garden Some plants just cannot take the sun while others require full sun for best display.

Maintenance - When selecting plant materials, consider the more practical aspect of maintenance. Try to choose trees and shrubs that tend to be disease and insect resistant.

Aesthetic value - this includes texture, color or foliage, flower, fruit, and bark. Select colors related to the house exterior, especially if the plant is used close to the house. Interest and effect can be created by using plants with strongly contrasting textures.

Aesthetic Considerations in Selecting Plants

Plant Size The size which a plant attains at maturity must be considered when selections are made for the landscape plan. A common mistake is the selection of plants which soon become too large for their location. The drastic pruning which then becomes necessary adds to the cost of maintenance and may reduce the grace and beauty of the specimen. Overgrown plants which are left unpruned will alter the balance and accent of the design, and may partially hide the house which they are supposed to complement.

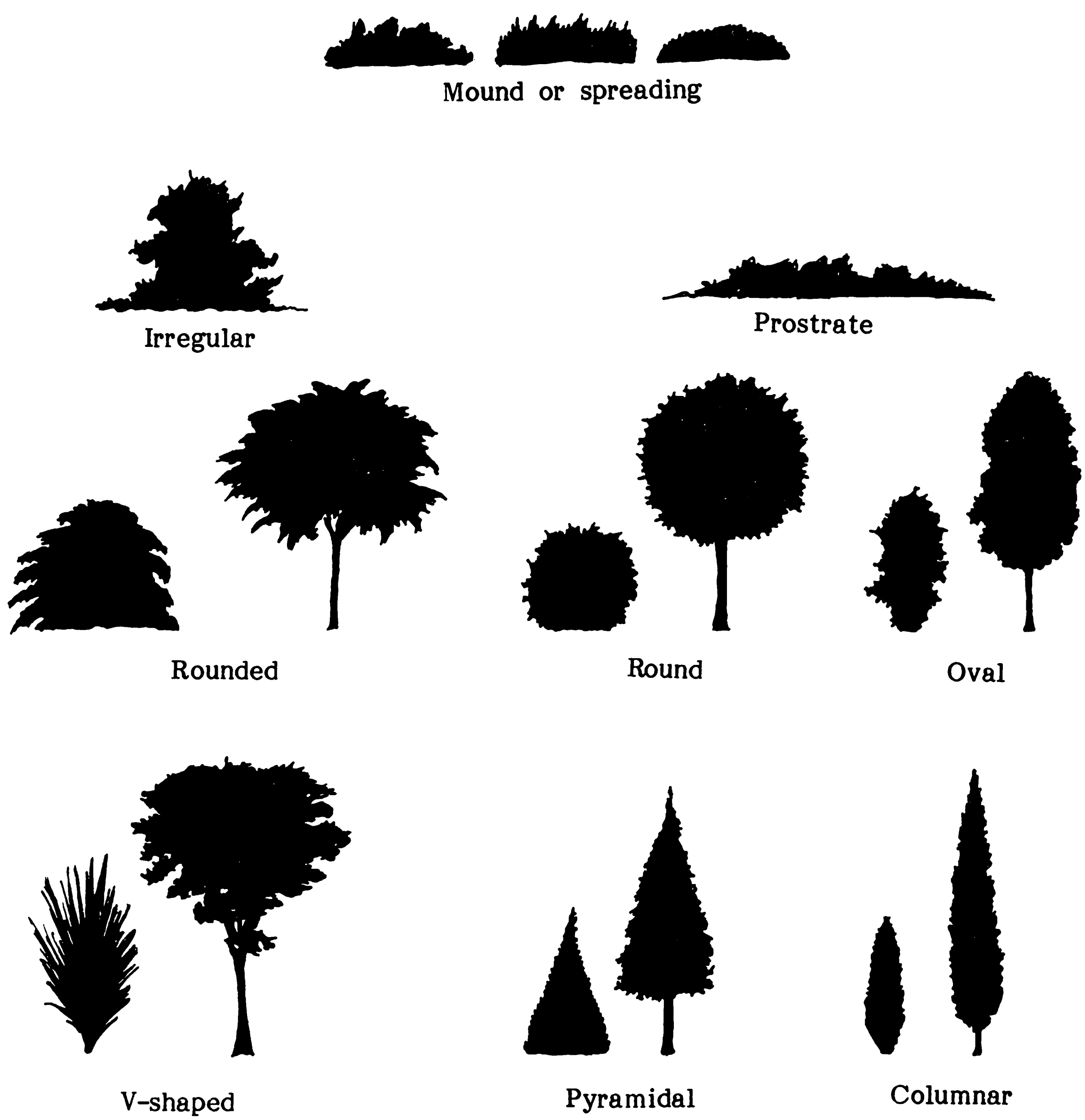
The landscape picture is constantly changing because the plants which give it form and substance are continually growing. This fact presents a challenge to the landscape architect which is not found in most other artistic media. Great care must be exercised in selecting plants which will immediately create the desired composition, and yet retain an appropriate size over a long period of years.

Plant Form The trees and shrubs used in landscaping develop many distinct forms. The more common forms are (1) prostrate or spreading, (2) round or oval, (3) vase, (4) pyramidal, and (5) columnar. The form of mature shrubs and trees usually is more open and spreading than that of a young plant. For example, the head of a young oak tree may be pyramidal in shape, during middle age the head is an irregular oval, and during old age a large, massive oak may have a spreading vase form.

Ground covers such as turf, low spreading shrubs, creeping plants, and prostrate vines are essential materials in landscaping. The principle use of turf is for the lawn area. Other ground cover plants are commonly used (1) on banks which are too rough or steep to mow, or (2) under trees where grass will not grow satisfactorily.

Shrubs are woody plants which grow to a height of 12 to 15 feet. They may have one or several stems with foliage extending nearly to the ground. The following are examples of the more common forms of shrubs: (1) Low spreading: Juniper species. (2) Round or Upright: a large majority of shrubs fall into this general form (3) Vase: Vanhoutte Spirae. (4) Pyramidal: Arborvitae species. (5) Columnar: Juniper species.

PLANT FORMS



Trees are woody plants which typically grow more than 15 feet tall and commonly have only one main stem or trunk. The head or leafy portion of the tree develops a typical form such as the following examples. (1) Round or Oval: most common trees such as maple, oak and pine. (2) Vase: Elm. (3) Pendulous or Weeping: Willow, Cherry and Jasmine. (4) Pyramidal: Spruce, Fir and hemlock. (5) columnar: Lombardy Poplar.

Trees are long lived and relatively inexpensive in initial cost and maintenance compared to lawns, flower beds and many other features of the design. In the past many builders have committed costly errors by destroying trees in establishing new residential subdivisions. Most real estate developers now appreciate the value of trees and attempt to save them when land is graded prior to the construction of houses. Regardless of our affection for trees we must recognize they do not live forever. Old and improperly located trees should be removed and new more suitable specimens should be planted.

Plant Texture The texture of plant materials is dependent on the size and disposition of the foliage. Plants with large leaves which are widely spaced have coarse texture. A plant with small closely spaced leaves has fine texture. Extremes in texture which prevent harmony in the composition should be avoided. On the other hand, some variation in texture is needed to give variety. Texture can be influenced on a seasonal basis depending on whether the plant is deciduous or evergreen.

Plant Color Green is the basic color of most plant materials in the landscape picture. Desirable variety may be secured by using plants with lighter or darker foliage tones. Accent may be introduced by the selection of flowering shrubs or those which produce colorful persistent fruit. Care should be exercised in the use of particularly showy plants such as Hydrangeas and Blue Spruce. Such plants may so dominate the landscape as to destroy the balance and unity of the composition.

For specifics on plant selection see the chapters on Turf; Annuals and Perennials; Trees, Shrubs and Groundcovers.

TREE FRUITS IN THE HOME GARDEN

SMALL FRUITS IN THE HOME GARDEN

Continued

TREE FRUITS IN THE HOME GARDEN

INTRODUCTION

Success with a home fruit planting depends upon how well it is planned and how well the plans are carried out. No longer can trees be planted and good quality fruit harvested with little or no effort. Relatively less care is required in the culture of sour cherries and pears than any of the other tree fruits, but even these cannot be expected to be good quality fruit, year after year, if left unattended. Proper attention must be given to insect and disease control, pruning, fertilization, soil management, and other necessary practices.

PLANNING THE HOME FRUIT PLANTING

It is desirable to locate your fruit planting as close to your home as possible. Where space is limited, fruit trees may be set in almost any location suitable for ornamental plants. Consider the mature size of the tree when designing the planting.
Dwarf fruit trees lend themselves admirably to ornamental plantings. They come into bearing earlier than standard-size trees, occupy less space, and can be more easily pruned and sprayed with equipment normally available to the average homeowner. Most nurseries now carry dwarf and semidwarf apple trees of several varieties. Dwarf pear, peach, and cherry trees of a few varieties are offered for sale by some nurseries. Certainly, in any planting where space is at a premium, dwarf trees should be considered.

Size of Planting

Space, site, size of family, and available time determine size of the planting. Cover the range of fruits insofar as family preference, adaptability, and space permit. Never attempt to plant more than you can care for properly. It is better to have a small home orchard well attended than a large one neglected. The information in Table 1 should help you determine the size of your planting.

Tree Spacing

How far apart must the trees be set? This is an important factor, and to a large extent it influences selection of site and varieties. Table 1 shows the minimum desirable distances between fruit trees in Virginia. They can be set farther apart if space allows, but, for best results, should not be set closer than the minimums indicated. To maintain a bearing surface low enough for necessary pest control, trees should not be crowded.

Table 1 — Space Requirement, Yield, Bearing Age, and Life Expectancy of Tree Fruits

Fruit	Minimum Distance between Plants	Approximate Yield per Plant	Bearing Age	Life Expectancy
	feet	bushels	years	years
Apple—standard	30	8	6-10	35-45
Apple—semidwarf	20	4	4-6	20-25
Apple—dwarf	12	1	2-3	15-20
Pear—standard	25	3	5-8	35-45
Pear—dwarf	12	½	3-4	15-20
Peach	20	4	3-4	15-20
Plum	20	2	4-5	15-20
Quince	15	1	5-6	30-40
Cherry—sour	20	60 qt.	4-5	15-20
Cherry-sweet	25	75 qt.	5-7	20-30

Site Selection

Importance of selecting the best site possible for fruit planting cannot be overemphasized. Good air drainage is essential. Cold air, like water, flows downhill. For this reason, fruit buds on plants set in a low spot are likely to be killed. Frost pockets, low wet spots, and locations exposed to strong prevailing winds must be avoided.

A deep, well-drained soil of good fertility should be selected. A fertile, sandy loam or sandy clay loam is suitable for most tree fruits. Adequate drainage of moisture is the most important soil characteristic. Poor soils may easily be improved by proper fertilization and cultural practices. Improving a soil with poor internal drainage is difficult and expensive. A fertile soil is desirable: a deep, well-drained soil is vital.

Variety Selection

Give special attention to the selection of varieties for the home garden. They must be adapted to your soil and climatic conditions. If possible without sacrificing too much yield or quality, select varieties with the fewest insect and disease problems.

Table 2 lists some varieties of tree fruits suitable for planting in Virginia. The varieties are listed in the order of ripening, and the list includes only those varieties of proven merit under Virginia conditions.

Several varieties of the same kind of fruit maturing at different times may be planted to prolong the season. The value of certain varieties for special uses such as freezing, canning, and preserving should be considered. Some varieties may be purchased in season from commercial growers more economically than you can grow them yourself.

Cross pollination is necessary for satisfactory fruit set in many tree fruits. Varieties that are cross-fruitful and that have overlapping bloom dates should be selected. To be certain of adequate cross pollination, plant at least three varieties of apples. Don't confine your selections to Summer Rambo, Winesap, and Stayman. These varieties will not cross pollinate. Golden Delicious is used by many commercial growers as a pollinizer for other varieties of apples in their orchards.

Table 2 — Some Suggested Varieties for the Home Fruit Garden * (Listed in Order of Ripening)

APPLES
- Lodi c
- Jerseymac c,d
- Paulared c,d
- Summer Rambo c,d
- Grimes Golden c,d
- **Jonathan (red strain) c,d
- Golden Delicious c,d
- **Delicious (red strain) c,d
- **Winesap c,d
- **Stayman (red strain) c,d
- **Rome Beauty (red strain) c,d

CHERRIES (sour)
- Montmorency c,f

**CHERRIES (sweet)
- Napoleon (Royal Anne) c,d
- Vernon c,d
- Ulster c,d
- Hedelfingen c,d
- Windsor c,d
- Hudson c,d

PEARS
- Moonglow c,d
- Magness c,d
- Maxine c,d
- Seckel c,d
- Orient c
- Kieffer c

PLUMS (Japanese)
- Early Golden c,d
- Methley c,d
- Shiro c,d

PLUMS (European and Prunes)
- Mohawk c,d
- Richards Early Italian Prune c,d
- Iroquois c,d
- Stanley c,d
- Shropshire (Damson) c
- Oneida c,d

NECTARINES
- Pocahontas d
- Cherokee d
- Cavalier d
- Redgold d

PEACHES
- Earlired c,d
- Sunhaven c,d,f
- Redhaven c,d,f
- Triogem c,d,f
- Washington c,d,f
- Glohaven c,d,f
- **Sunhigh c,d,f
- Cresthaven c,d,f
- Georgia Belle (white) c,d
- White Hale (white) c,d
- Redskin c,d,f
- Tyler c,d,f

**QUINCE
- Orange c

* Principal uses: c—cooking; d—dessert; f—freezing.

** In Eastern Virginia where mildew, blight, brown rot, bacteriosis, fruit cracking, and poor color can be serious due to climatic conditions, these varieties are difficult to grow.

At least two of the recommended pear, plum, and sweet cherry varieties should be planted. Inasmuch as Japanese- and European-type plums are not generally effective as pollinizers for each other, two varieties of the same type should be planted. Windsor is a good pollinating sweet cherry variety. Sour cherries cannot be used to pollinate sweet cherries because they do not overlap in bloom.

All of the sour cherry, peach, and nectarine varieties listed are sufficiently self-fruitful to set satisfactory crops with their own pollen.

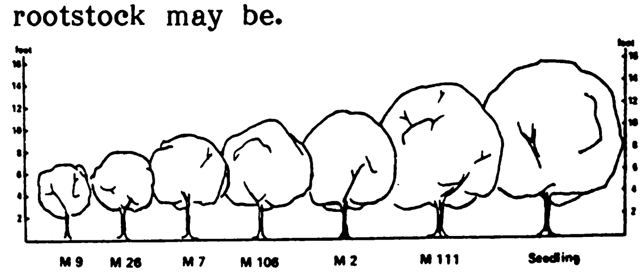
Apricots are not recommended for planting in Virginia. The buds of currently available varieties respond to the first warm days of early spring and are usually killed by frost or low temperature common to most areas. Unless protection can be provided, a crop can be expected no more frequently than once every 4 or 5 years.

Apple Rootstocks

Apples, like other tree fruits, do not "come true" from seed. If you plant a seed from a 'Red Delicious' apples; the fruit would likely be small, unattractive, and of poor quality. Therefore, apple trees are propagated vegetatively by either budding or grafting of the desired cultivar on a rootstock. The rootstock and scion variety maintain their respective genetic identy but are joined at the graft union and function as a unit. The purpose of this article is to introduce the subject of apple rootstocks-that part of the tree which is largely underground and therefore tends to go unnoticed.

Traditionally, apple trees have been propagated on seedling rootstocks-those which originate from apple seeds. More recently, increasing use is being made of vegetatively propagated or clonal rootstocks which have inherent advantages over the seedlings. Three major considerations in rootstock selection are:

Size control Probably the most widely accepted reason for the use of clonal rootstocks is tree size control. By proper selection of rootstock we can determine mature tree size. For example, the same variety of apple will produce a 16-18 foot tree on a Malling Merton (MM)111 down to a dwarf tree of 7-8 feet on a Malling (M)9. Intermediate sizes can be attained by other rootstocks such as M 26 and M 7. Unfortunately, many apple trees offered to homeowners are labelled as dwarf trees but the buyer has no idea of how dwarfing the rootstock may be.



Precocity The earliness at which a tree produces fruit is also directly affected by the rootstock. Trees on seedling rootstocks usually do not begin fruiting until they are 7-10 years old. Trees on M 9 will often produce crops in 2-3 years. Other rootstocks are intermediate in this regard. Usually, the more dwarfing the rootstock, the earlier the tree will bear fruit.

Stability A major consideration in selecting apple rootstocks is the degree of anchorage provided. For example, trees on M 9 are very small but because of brittle roots, must be provided some type of support. This can consist of a post, a trellis, or other means of holding the tree upright. The semi-dwarf M 7 may require support for the first few years but is often grown without support. The more vigorous MM 111 does not require support and is thus like seedlings.

The subject of apple rootstocks is not only quite complex but is changing rapidly. As more is learned about existing rootstocks and new ones are developed and tested, even greater control over growth and productivity should become available.

Buying Trees

Obtain the best nursery stock available. Buy only from reputable nurserymen who guarantee their plants to be true to name, of high quality, and packed and shipped correctly. Beware of basement bargains. High prices do not necessarily mean high quality, but good, well-grown nursery stock is not cheap.

One-year-old trees are usually preferred. A common mistake made by many homeowners is to select oversized or ready-to-bear nursery trees. Experience has shown that younger trees bear almost as soon, are easier to keep alive, and develop into more healthy, vigorous trees than do the oversized stock. The older trees cost nurserymen more to grow and are sold for higher prices, but are usually worth less.

For peaches, nectarines, and apricots, a 4' tree, 1/2" in diameter, is considered the ideal size for planting. Vigorous, 4 to 7', 1-year-old whips about 3/4" in diameter are preferred for apples. Pears, quince, plums, cherries, and apples may be planted as 1- or 2-year-old trees. Either will be satisfactory as long as the trees have attained sufficient size and have good root systems.

When purchasing apple trees on dwarfing rootstock, be sure to specify the rootstock desired. Three are currently suggested for planting in Virginia. EM-IX is very dwarfing, has a rather weak root system, and must have mechanical support. Trees on EM-VII and MM-106 attain a size about two-thirds that of the same variety on seedling rootstock.

SETTING THE ORCHARD

Time of Planting

Virginia climatic conditions are such that good results can be obtained regardless of whether the trees are planted in fall or early spring. Planting about a month after the first killing frost in the fall or about a month before the last killing frost in the spring is generally recommended. The important thing to remember is that trees should be dormant and that the soil should have proper moisture content to be in good working condition.

Soil Preparation

Preparation of the soil where fruit trees are to be planted should be as thorough as preparation of the soil for a vegetable garden. If the places selected for trees are in a lawn, it is best to spade the soil deeply over an area of several square feet where each tree is to stand. Where the trees are to be set, dig the holes wide enough to prevent the need for crowding or bending the roots.

Handling Nursery Stock

Roots of nursery stock should never be allowed to freeze or dry out. When your order arrives, unpack the bundles immediately and inspect the trees. The roots and packing material should be moist. Check to see if the bark is withered. Withered bark indicates the trees have been allowed to dry out in storage or in transit.

If trees cannot be planted immediately, they may be held dormant in the original packing in refrigerated storage for a week or two. If refrigerated storage is not available, trees should be taken out of the bundle and heeled-in carefully in a trench of moist soil in a shaded location.

Planting the Trees

Tree roots must be kept moist at all times. Keeping roots in a container of water for several days until the tree is planted is an excellent idea.

Prune the roots of young trees only where necessary to remove broken and damaged ones or to head back some that are excessively long. Should a tree be so badly scarred or damaged that there is doubt of its survival, it is wise to discard it.

Dig the hole a little deeper and wider than necessary to accommodate the roots, leaving the soil loose in the bottom of the hole. Set the tree at approximately the same depth it grew in the nursery. Never set it so deep that the union of the scion and rootstock is below ground level when the hole is filled.

Then begin filling the hole with pulverized topsoil, shaking the tree gently to filter the soil among the roots. Tamp firmly and thoroughly with the foot or a well-padded stick. The addition of water when the hole is about three-fourths full will aid in packing the soil around the roots and increase chances for the tree's survival. After the water has completely soaked in, finish filling the hole, leaving the soil loose on top.

ORCHARD MANAGEMENT

Cultural Practices

Young fruit trees should be mulched or cultivated until they begin to bear. Weeds must be eliminated so they will not compete for available moisture and fertilizer. Cultivation must be shallow to avoid injury to roots near the surface. The cultivated or mulched area should extend a little beyond the spread of the branches.

The use of mulch in the home fruit garden pays in many ways. It keeps down weeds, adds humus to the soil, conserves moisture, and keeps the soil cool during hot months.

Many materials may be used, including grass clippings, hay, straw, pine needles, peat moss, sawdust, and shavings. Where sawdust is used, a layer 2" deep may be sufficient; for more bulky materials, at least 5 or 6" should be applied.

Temporary nitrogen deficiency may occur when mulch material low in nitrogen begins to decay. This can be overcome by the addition of nitrogen fertilizer. Usually about 1/4 lb. of ammonium nitrate or 1/2 lb. of nitrate of soda to each 100 sq. ft. of mulched area will be enough.

The use of black polyethylene plastic as a mulch has given good results. Holes may be punched in the plastic to allow for moisture penetration. Although it does not decay and add humus to the soil, neither does it cause a temporary nitrogen shortage.

When trees are planted in rows, the area between the rows may be allowed to grow in sod or used for interplanting with low-growing vegetables or strawberries. There is no objection to this practice in the home orchard, provided ample plant nutrients and moisture are available for proper development of the fruit trees. Under sod culture, frequent close mowing during the growing season is desirable. This reduces competition for necessary moisture and plant nutrients, and also aids in disease and insect control.

Fruit trees, especially those on dwarfing rootstock, are becoming prominent in home landscape designs. They respond to the same general care and are no more difficult to handle under average lawn conditions than are ornamental trees and shrubs normally used.

Under lawn culture, fruit trees can be given more attention than is usually convenient under other systems of culture. Equipment and materials for watering, pruning, spraying, and other cultural practices are essentially the same as those required for ornamental plantings.

It is good practice to apply a mulch or cultivate lightly for the first year or two, or until the tree has become firmly established. Lawn grass, if kept closely clipped, may then be allowed to grow around the base of the tree.

Chemicals for weed control should be used with extreme caution in the home garden. Careless use can result in severe injury to fruit trees and nearby ornamental plantings. See your Extension Agent for latest recommendations.

Fertilization

As a rule, no fertilizer is recommended or needed at the time of planting. After the young tree becomes established and growth begins, apply 1/4 to 1/2 lb. of a 16 or 20% nitrate fertilizer in a circle around the tree, about 8 to 10" from the trunk.
Usually fruit trees show no increased growth or fruitfulness from the use of any nutrient element except nitrogen. Other elements are used by the tree; however, only in special cases are they deficient in the soil. Deficiencies are more likely to occur on light, sandy soils.

Because there are many soil types and varying levels of natural fertility, it is difficult to make one fertilizer recommendation which will apply equally well in all areas of Virginia. A rule of thumb practiced in many commercial apple and peach orchards is to apply about 1/4 lb. of a 20% nitrogen fertilizer, or its equivalent, for each year of the tree's age. If nitrate of soda is used (containing 16% nitrogen), about one-fourth more would be needed. Only about two-thirds as much ammonium nitrate (33%) would be necessary.

Where a good mulch is applied regularly, the use of chemical fertilizer to supplement natural fertility of the soil is usually unnecessary. Overfertilization with either organic or inorganic materials should be avoided. Excessive vegetative growth will result, usually accompanied by delayed fruiting and possible winter injury.

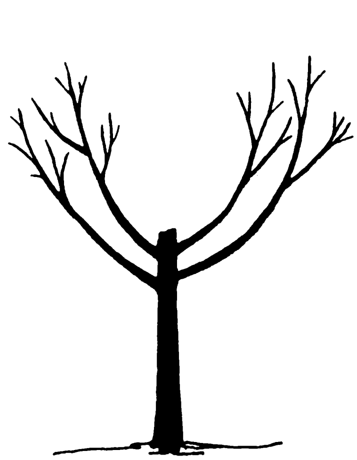
Where poor growth results from the use of nitrogen only, other elements may be needed. Contact your local Extension Agent for fertilizer recommendations which will apply specifically to your locality.

Fertilizer may be applied either after the leaves have fallen or in early spring about 3 or 4 weeks before active growth begins. On light, sandy soils, it is best to delay application until early spring. The usual method of application is to scatter fertilizer evenly under the tree, starting about 2' from the trunk and extending to just beyond the tips of the branches.

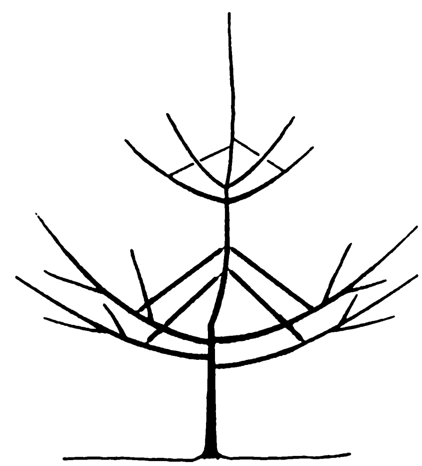
Terminal growth and general vigor of the individual tree should be observed closely. Where growth the past year was short, increase the amount of fertilizer slightly. If growth was excessive, reduce the amount or withhold it entirely. Remember that both pear and quince are highly susceptible to fire blight and excessive growth will make this disease more prevalent.

Mature, bearing peach, nectarine, and sweet cherry trees should produce an average of 10 to 15" of new growth annually. From vigorous, young, nonbearing trees, about twice that amount can be expected.

In general, 8 to 10" of terminal growth is considered adequate for mature, bearing apple, pear, quince, plum, and sour cherry trees. About twice that amount is sufficient for young, nonbearing trees.



Vase



Modified leader

Pruning

The general purpose of pruning fruit trees is to regulate growth, increase yields, improve fruit size and quality, and reduce production costs. Pruning is necessary to shape the trees for convenience of culture and for repair of damage.

The suggestions for pruning fruit trees are concerned with training to produce a strong framework and maximum yield of high quality fruit. For information on training to special forms to suit a particular need in the garden, contact your local Extension Agent.

Most pruning is done during the dormant season, preferably just before active growth begins in the spring. At this time, pruning wounds heal faster, flower buds can be easily recognized, and injury from low winter temperature is avoided. Summer pruning may be done to help train young trees to the desired shape, remove watersprouts and other undesirable growth, and maintain smaller tree size. It should be remembered, however, that all pruning has a dwarfing effect. For maximum yield of high quality fruit, prune only as necessary to establish a tree with a strong framework capable of supporting heavy crops annually without damage and to maintain a tree sufficiently open to allow penetration of sunlight, air, and spray material for good fruit development and pest control.

Although pruning procedures vary according to the type, age, and variety, all newly planted fruit trees should be pruned in the spring before growth starts. This is necessary to bring the top into balance with the root system, some of which may have been lost in transplanting, and to stimulate lateral bud development from which to select good scaffold limbs.

For a discussion of the proper pruning techniques to use on different fruit trees see the chapter on pruning.

Thinning

Quite frequently, peach and apple trees set more fruit than they can mature to a desirable size. By thinning (removing excess fruit), this difficulty can be overcome. Thinning not only allows for an increase in size of the remaining fruit on the tree, but also improves fruit color and quality, reduces limb breakage, and promotes general tree vigor. Thinning induces regular annual bearing in certain apple varieties, such as Golden Delicious, Yellow Transparent, and York Imperial, which otherwise have a tendency to bear heavy crops every other year. Perhaps one of the greatest benefits from thinning fruits is that it permits more thorough spraying or dusting for effective disease and insect control.

Peach thinning is a standard practice in commercial orchards. Experimental results indicate that the sooner peach trees are thinned after bloom, the earlier the ripening and the larger the fruits at harvest. It is doubtful that final size of the fruits of any variety will be greatly increased by thinning if it is delayed much after the pits begin to harden.

It is generally recommended that peaches be spaced 6 to 8" apart. When thinning by hand, grasp the stem or branch firmly between your thumb and forefinger and pull the fruit off with a quick motion of the second and third fingers.

Many growers use the pole method of thinning peaches. A 4 or 5' section of bamboo or other light wood is used. A piece of 3/4" garden or spray hose about 15" long is forced tightly onto the end of the pole, leaving some 8 to 10" of the hose extending beyond the end of the pole. A snug fit is necessary so the hose will remain in place while being used.

Many modifications of this tool are used. One of the most common is a 30" section of plastic pipe, 1" in diameter.

Remove peaches by striking the limbs about 18" from their tips with the flexible part of the hose, using sharp, firm blows. This dislodges any loosely attached fruits. With a little practice, you should be able to remove individual fruits by this method.

Apples should be thinned as soon as possible after the fruit has set. If full benefits are to be obtained, thinning should be completed within 20 to 25 days after full bloom.

In hand-thinning apples, use the same general technique used in hand-thinning peaches. A distance of 6 to 10" between fruits is recommended. With varieties of Delicious apples, where greater size of individual fruits is important, the greater spacing is preferred. The center apple of a cluster is usually the largest and the best apple to leave.

Thinning plums is usually limited to the large Japanese varieties. The primary concern here is to facilitate insect and disease control. Plums are usually thinned by hand to about 4" apart.

Rodent Control

Mice may cause serious damage to the home fruit planting. They chew off the bark at ground level or below and often completely girdle a tree, causing it to die. Most of this damage takes place during winter. Keep mulch pulled away from the base of the tree, and examine it frequently for the presence of mice. In many home and commercial plantings, mice are controlled by placing poison bait in their runways. These poisons and complete directions on how to use them may be obtained from many spray material dealers. Mice may also be controlled by trapping. This can be successful where only a few trees are involved.

Rabbits are responsible for the loss of thousands of young fruit trees each year. Perhaps the most satisfactory method of preventing rabbit damage is the use of a mechanical guard. Galvanized screen or hardware cloth with a 1/4" mesh is frequently used. A roll 36" wide may be cut lengthwise, forming two 18" strips. By cutting these strips into pieces 14" long, guards 14 by 18" are obtained. Roll or bend the strip around the trunk of the tree so that the long side is up and down the trunk and the edges overlap. Twist a small wire loosely about the center to prevent the strip from unrolling. Push the lower edges well into the ground. This metal guard will last indefinitely and can be left in place all year.

Tar paper, building paper, sheets of magazines, and aluminum foil can also be used in a similar manner, but must be removed in the early spring to prevent damage to the tree. Perforated plastic guards are also available. Like the metal guards, these can be left in place year round.

Other methods of rabbit control have been successful. Ordinary whitewash has given good results in some instances. A repellent wash recommended by the USDA, containing equal parts of fish oil, concentrated lime sulfur, and water, is used by some commercial growers. Also, rabbit repellents under various trade names are available. All these materials may be applied with a paint brush to the trunk of the tree from the ground up into the scaffold limbs.

Tree Fruit Spraying

For significant insect or disease problems it may be necessary to follow a spray program. Information on the use of chemicals for such a program is available from the Extension office.

To be successful with your spray program, spray at the proper time and do it thoroughly. Leave no portion of the tree unsprayed. To make the job easier and to ensure adequate coverage, thin out excessive growth and remove all dead and weak wood. Cut old trees back to 20' or less, if possible. Train younger trees so they reach a height of no more than 18'.

Semidwarf and dwarf trees should be considered when making your planting. Their smaller size makes the task of spraying much easier. Early maturing varieties are less likely to be seriously affected by insects and diseases because of the shorter growing season. This factor should not be overlooked in the selection of varieties.

Sanitation

Adopt good orchard sanitation practices. The destruction of harboring places for insects and diseases plays a large part in the control program. Conditions which encourage mice should be eliminated.

These are some practices to include in your orchard sanitation program:

1. Collect and burn debris.
2. Remove and destroy all dropped fruit.
3. Rake and burn apple and cherry leaves.
4. Scrape loose bark from trunks, crotches, and main limbs of apple trees.
5. Prune out and destroy all dead or diseased limbs, branches, and twigs.

APPLE VARIETIES OF YESTERYEAR

Arkansas Black Twig, Baldwin, Fall Cheese, Miliam, Roxbury Russet - you won't find these apple varieties in the modern supermarket. Yet, in the opinion of the apple connoisseur the dessert quality of these and other old time apple varieties is superior to that of most of those in popular demand today.

Many of the old varieties lost favor with the commercial grower because of low productivity, lack of attractiveness, susceptibility to the ravages of insects and diseases, and poor shipping quality. For the home gardener, however these faults are overshadowed by the delightful flavor, rich aroma, and culinary characteristics found in few of the more recently introduced apple varieties.

There is increasing interest in the growing of old fruit varieties, by both individuals, historical organizations, and public supported institutions. Some commercial nurseries now propagate one or more of the better known varieties, and there are a few that specialize in antique fruit varieties of all types. North American Fruit Explorers (10 south 055 madison St., Hinsdale, Ill. 60521), a nonprofit association of fruit gardening enthusiasts, actively promotes the culture of old fruit varieties. It is a valuable source of information for anyone interested in locationg a source of bud wood, characterists of varieties, and successful cultural practices.

Among the old time apple favorites available from private and commercial sources are some that have occupied a prominent place in Virginia history. Perhaps the most widely known is the Albemarle Pippin. Although seldom found in the orchards of Virginia, it is of some importance in western states under the name Yellow Newtown. Still found in some of the old orchards on both the eastern and western slopes of the Blue Ridge are such varieties as: Arkansas Black Twig, Baldwin, Ben Davis, Esopus Spitzenburg, Fallawater, Gano, Golder Russet, Gravenstein, Grimes Golder, Horse Apple, King David, Lady Apple, Limber Twig, Lowery, Maiden Blush, Milam, Mother Apple, Northern Spy, Roxbury Russet, Smokehouse, Virginia Beauty, Winter Banana, and Wolf River. Many of the less well known but equally good varieties, such as Bellflower, Father Abrahm, Fall Cheese, and Winter Cheese, may be found in private collections and at renovated historical sites.

Whether from a sense of nostalgia, a desire to preserve some of our history, or pride in having an antique to display, many of the old apple varieties have been saved from extention. Some have already been around for centuries; hopefully they can survive a few more. They are too good to lose.

SMALL FRUITS IN THE HOME GARDEN

INTRODUCTION

The small fruits offer definite advantages for home culture. They require a minimum of space for the amount of fruit produced, and bear one or two years after planting. Also, pest control is typically easier than with most tree fruits.

Success with a small fruit planting will depend upon the attention given to all phases of production—variety selection, soil management, fertilization, pruning, and pest control. Plant only what you can care for properly. It is better to have a small planting well attended than a large one neglected.

PLANNING THE SMALL FRUIT GARDEN

Locate your small fruit planting as close to your home as possible. Space in or near the vegetable garden is usually preferred. Where space is a limiting factor, small fruits may be used in place of ornamental plants of comparable size. Strawberries may be used as a border for a flower bed. Grapes and raspberries may be planted parallel to the garden on a trellis or a fence along a property line. Blueberries may be planted to form a dense hedge or used in a foundation planting around the home. Select a site that is free from frost pockets, low wet spots, and exposure to strong prevailing winds. Small fruits thrive best in a fertile, sandy loam soil high in organic matter, but they will give good returns on the average garden soil under adequate fertilization and good cultural practices.

Overcrowding frequently results in weak plants and low yields. It also makes insect and disease control more difficult. For best results, small fruit plants should be set no closer than the minimums indicated in Table 1.

Special attention should be given to the selection of varieties. They must be adapted to your soil and climatic conditions. If possible without sacrificing too much yield or quality, select varieties with the least insect and disease problems. Table 2 lists some varieties of small fruits suggested for planting in the home garden. They are listed in the order of ripening, and include only those adapted for growing under Virginia conditions.

Table 1. Space Requirement, Yield, Bearing Age, and Life Expectancy of Small Fruits.

Fruit	Minimum Distance		Average Annual Yield per Plant	Bearing Age	Life Expectancy
	Between Rows	Between Plants			
	feet	*feet*	*quarts*	*years*	*years*
Blueberry	6	4	4	3	20-30
Blackberry (erect)	8	3	1½	1	5-12
Blackberry (trailing)	8	6	1½	1	5-12
Raspberry (red)	8	3	1½	1	5-12
Raspbery (black)	8	4	1½	1	5-12
Raspberry (purple)	8	3	1½	1	5-12
Grape (Amer.) (Fr. Amer.)	10	8	15 lb.	3	20-30
Grape (muscadine)	10	10	25 lb.	3	20-30
Strawberry (regular)	3	1	½	1	3
Strawberry (everbearer)	3	1	½	⅓	2
Currant	8	4	5	3	10-20
Gooseberry	8	4	5	3	10-20

Table 2. Some Suggested Varieties for the Home Small Fruit Planting. (Listed in Order of Ripening)

BLUEBERRIES
- [1] Earliblue
- [1] Ivanhoe
- Blueray
- Bluecrop
- Jersey
- [2] Berkeley
- Herbert
- Coville

BLACKBERRIES (erect)
- Darrow
- Black Satin (thornless)
- Dirksen (thornless)

BLACKBERRIES (trailing)
- Lucretia
- [1] Boysenberry
- Lavaca

RASPBERRIES (red)
- Sunrise
- Latham
- Pocahontas
- Cherokee (everbearing)
- Heritage (everbearing)

[2] RASPBERRIES (black)
- New Logan
- Bristol
- Cumberland

[2] RASPBERRIES (purple)
- Sodus

[2] CURRANTS
- Wilder
- Red Lake

[2] GOOSEBERRIES
- Pixwell
- Red Jacket

STRAWBERRIES (regular)
- Earlidawn
- Earlibelle
- Earliglow
- Catskill
- Pocahontas
- Surecrop
- Atlas
- Redchief
- Guardian
- Marlate

[2] STRAWBERRIES (everbearing)
- Superfection (Gem, Brilliant)
- Streamliner
- Ozark Beauty

GRAPES (American Bunch)
- Price
- Seneca
- Himrod
- Fredonia
- Monticello
- Delaware
- [2] Concord
- Century I
- Steuben

GRAPES (French-American Hybrids)
- Aurora (Seibel 5279)
- Cascade (Seibel 13053)
- DeChaunac (Seibel 9549)
- Chancellor (Seibel 7053)

GRAPES (Vinifera)
- Pinot Chardonnay
- White Reisling

[1] GRAPES (Muscadine)
- Hunt
- Scuppernong
- * Carlos
- * Magnolia
- Thomas
- * Dearing
- Topsail

Obtain the best nursery stock available. Buy only from reputable nurserymen who guarantee their plants to be true to name, of high quality, and packed and shipped correctly. Beware of basement bargains. High prices do not necessarily mean high quality, but good, well grown plants are not cheap.

Place your order early—as soon as you decide what you want. Specify variety, size, and grade of plants desired, and time of shipment preferred. It is best to have the plants arrive at the time you are ready to set them out.

When your order arrives, unpack the bundles and inspect the plants. The roots should be moist and have a bright, fresh appearance. Shrivelled roots indicate that the plants have been allowed to freeze or dry-out in storage or transit. Such plants seldom survive. Plant roots must be kept moist and free from freezing temperatures at all times.

If the plants cannot be set immediately, they should be kept either in cold storage or heeled-in. Wrap them in polyethylene film, or other material that will prevent their drying out, and store them at a temperature just above freezing. Strawberry plants, in small quantities, may be held in the home refrigerator for a few days. If refrigerated storage is not available, remove the plants from the bundle, and heel them in carefully in a trench of moist soil in a shaded location. Pack the soil firmly around the roots to eliminate all air pockets and to prevent the roots from drying out.

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[1] Recommended for Eastern Virginia only.

[2] Not recommended for Eastern Virginia.

* Perfect flowered. Other varieties are pistillate and require pollinizers.

ESTABLISHING THE PLANTING

There is probably nothing that causes more disappointment and failure in small fruit plantings than the lack of careful preparation and attention to detail at the time the plantings are established. Prepare the soil properly, set the plants carefully, and generally create conditions favorable for new growth. Detailed suggestions for the establishment of each of the small fruits are included in this publication. These suggestions should be followed closely for best results.

MAINTAINING THE PLANTING

Once the planting has been established, future success will depend upon the care that it is given. If the planting is to be productive and long lived, it must be properly fertilized. Competition from weeds or other plants must be avoided. Insects and diseases must be controlled, and the plants must be properly pruned. Study the maintenance suggestions for each of the small fruit crops, and plan to care for the planting properly. To do otherwise will probably result in disappointment and wasted effort.

STRAWBERRIES

Strawberries are the most widely cultivated small fruit in America. They are the favorite of many for pies, jams, jellies, preserves, and for eating fresh. Inasmuch as strawberries are adaptable to a greater range of soil and climatic conditions than any other fruit, they are well suited to the home garden and may be grown successfully in every section of Virginia.

Variety Selection

Strawberry varieties vary greatly in their adaptability to soil and climatic conditions. The varieties suggested for planting in Virginia are of proven merit and have been selected on the basis of vigor and productivity of the plant and quality of the fruit. Virus-free plants of each variety are available.

Earlidawn is a very early variety that has blossoms which are somewhat tolerant to cold. The fruit is large, bright red, and medium firm. It is a good dessert variety and it freezes well.

Earlibelle, a variety adapted to the growing conditions of Eastern Virginia, produces heavy crops of brightly colored, large, firm berries even in crowded plant beds.

Earliglow is a new variety noted for its superior dessert quality and disease resistance. The medium-large berries are very attractive with a glossy, deep red color. It is one of the best for eating fresh, as a frozen product, and in jams and jellies. The plants are very vigorous and productive.

Catskill is a large, irregularly shaped strawberry. The fruit is red, mildly subacid, and has good dessert quality. It is above average as a freezing variety.

Pocahontas is a vigorous grower. The fruit is large with an attractive, bright red skin and flesh. It is slightly subacid, and of good dessert quality. It is also fine for freezing.

Surecrop is mildly subacid and good for desserts. The deep red berries are large and irregularly shaped. The plant is large, vigorous, and tolerant to droughty conditions. Atlas, from North Carolina, has performed well in Virginia. It has a large firm berry with a slight wedge shape. The color is medium red and the quality very high. The plants are large, vigorous, moderate in runner production, and quite tolerant to most strawberry diseases.

Redchief is an extremely productive, high quality dessert berry. It is medium to large in size, of uniform deep red color, with a firm glossy surface. Redchief is very resistant to red stele.

Guardian a midseason commercial variety, is also a favorite of the home gardener. The large, deep red berries are firm, uniform in size and attractive. It has good dessert quality and freezes well. The plants are vigorous, productive, and resistant to many common strawberry diseases.

Marlate, ripening a week or more after the normal late varieties, is popular with both home gardeners and commercial growers who wish to extend the berry season. Seldom damaged by late frost, it is usually a productive and dependable variety. The fruit is large and attractive with good flavor and dessert quality. It also makes a nice frozen product.

Everbearing Strawberries are not as good as the regular varieties, either in quality or yield. Because of consistently low yields, they are not recommended for planting in Eastern Virginia.

Superfection is currently the leading variety. The fruit is irregular in shape and of medium size and firmness. It is an acid berry of fair dessert quality.

Streamliner fruits are larger than those of Superfection and more symmetrical. Although soft, they are a little less acid and have a more pleasing flavor. Streamliner's productivity in Virginia has been disappointing.

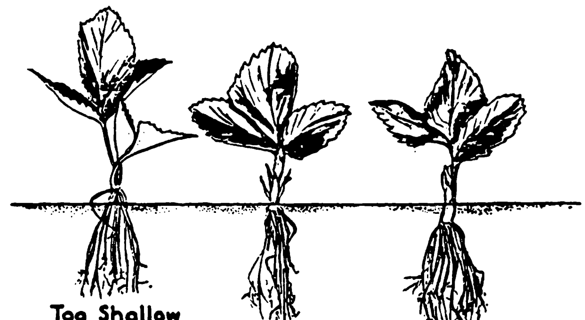
Ozark Beauty is an everbearing variety that shows considerable promise. The plant is vigorous and produces good quality fruit. The berries are red, wedge shaped, firm, and only slightly acid. It is a good variety for eating fresh and for freezing.

Establishing the Planting

Site and Soil Strawberries bloom very early in the spring, and the blossoms are easily killed by frost. In areas where late frosts are a hazard, try to select a site for your planting that is slightly higher than the surrounding areas. Although strawberries grow best in a fertile, sandy loam soil with a pH of 5.7 to 6.5, (Soil test information may be obtained through your Extension Agent) they may be successfully grown in any good garden soil that is well drained and well supplied with organic matter. Soil for strawberries should be thoroughly prepared for planting. It should be loose and free of lumps.

Do not set strawberries in land that has recently been in sod. A clean-cultivated crop planted on the site for a year or two will leave the soil better prepared for strawberries and will assist in controlling weeds and white grubs which are so troublesome in strawberry plantings. Where grubs and ants are a problem, chemical control may be necessary.

Planting Virus-free 1-year-old plants should be set out early in the spring, about 3 or 4 weeks before the average date of the last frost. Spacing of the plants will depend on the training system used, but they should not be crowded. They should be placed no less than 12" apart in rows 3 to 3 1/2' apart. Set each plant so that the base of the bud is at the soil level. Spread the roots out and firm the soil carefully about them to prevent air pockets which allow them to dry out.



Maintaining the Planting

Soil Management Cultivation for weed control in strawberries should begin soon after planting and continue at approximately 2-week intervals throughout the first growing season. Cultivation must be shallow to prevent root injury. Hoe as often as necessary to remove grass and weeds growing between the plants.

Chemicals for weed control may be used if so desired. Use only those materials recommended for strawberries, and follow directions on the labels. Contact your Extension Agent for the latest recommendations.

Most home garden strawberry plantings are mulched. Any organic material free of weed seeds makes good mulch. Hay, straw, and pine needles are most frequently used. Mulch should be applied 2 to 4" deep over and around the plants after the first freezing weather in the fall. This protects them from heaving and freezing injury during the winter. After the danger of frost is over in the spring, about half of the mulch should be raked off the plants into the area between the rows. Mulch left around the plants will help keep the berries clean, conserve moisture, and check weed growth.
Black plastic is frequently used as a mulch for strawberries. It is effective in inhibiting weed growth and preventing the evaporation of moisture from the soil surface. Mulching with strips of kraft paper treated with a fungicide for control of holds and other diseases has been satisfactory. It is as effective as the plastic mulch and is less expensive. Also, the paper breaks down after several months of use and is incorporated into the soil.

Fertilization Fertilization has seldom proved beneficial to strawberries on good soils well supplied with organic matter. Where a soil analysis indicates the need, about 1 lb. per 100' of row of a complete fertilizer, such as 10-10-10 or 10-6-4, should be cultivated into the soil before you begin to plant. The fertilizer used in the fall application should be the same analysis at the same rate and should be broadcast over the row in late August or early September. The limited root systems will not benefit from fertilizer placed in the row middles. Brush the material off the plants to avoid foliage injury.

Do not apply fertilizer in the spring to picking beds of strawberries growing in heavy land because there is danger of excess vegetative growth which results in reduced yield, increased rot, later ripening, and poorer quality fruit. In light, sandy soils, where nitrogen leaches out rapidly, a spring application is usually beneficial. Apply a quickly soluble nitrogen fertilizer, such as nitrate of soda, at the rate of 1/2 to 3/4 lb. per 100' of row before new growth begins.

Training There are three basic training systems used in strawberry production. Many modifications of these systems are found. Under the matted-row system, used by most home gardeners, runner plants are allowed to set freely in all directions. The mother plants should be set 24" apart in the row. Keeping the width of the plant bed narrow results in a better grade of fruit which is easier to pick.

In the hill system, plants are spaced 12" apart in the row. All runners are removed as soon as they appear, and the plants are encouraged to stool-out in large crowns. This system is desired by many because the planting is easier to cultivate and harvest and produces larger and better berries. More plants are required, however, and the initial cost of the planting is greater.

Plants in the spaced-row system are set 18 to 24" apart in the row. The runner plants are set in place by hand until the desired stand is obtained. They are usually spaced 6 to 12" apart. All the late-formed runners are removed as they appear.

Blossom Removal During the first season, all flower stems on the plants should be removed as soon as they appear. This strengthens the plants and allows for earlier and more vigorous runner production. The early-formed runner plants bear the best fruit the following year.

Renovation If your strawberry planting is in a vigorous condition, it may be retained for fruiting the second year. It is seldom advisable to fruit a planting more than 2 years. The berries are smaller and the plants tend to "run out."

Soon after harvest, remove the mulch, and clip the tops of the plants to within 1" above the crowns with a scythe or mower. If insects and foliage diseases are prevalent, move the leaves and mulch material out of the planting, and burn them. Apply a quickly soluble nitrogen fertilizer, such as nitrate of soda, at the rate of 1/2 to 3/4 lb. per 100' of row to encourage vigorous top growth. Any good garden fertilizer supplying an equivalent amount of nitrogen may be used if desired.

Some plant thinning may be needed, particularly in the matted-row system. Thin the plants to 6 to 8" apart after new foliage appears. Keep the planting clean-cultivated throughout the summer, irrigating when necessary during the dry season to keep the plants growing vigorously. Fertilize again in the fall as recommended for the first year, and renew the mulch after freezing weather begins.

Pest Control Birds are one of the biggest pests in the home garden strawberry planting, and it may be necessary to cover the plants with tobacco cloth or plastic netting to keep the crop from being eaten before the berries are ripe enough to harvest. Aluminum pie tins, suspended by a string or wire above the plants in such manner that they twist and turn in the breeze, have been successful in keeping birds away.

Culture of Everbearing Varities

The everbearing varieties of strawberries are less vigorous and generally less productive than the regular varieties. Irrigation is necessary for them because the late summer and early fall crop ripens during a period when soil moisture is usually quite low.

Soil preparation and fertilizer requirements before planting are the same as for regular varieties. Best yields are obtained from the everbearing varieties if they are set in early spring in the hill system about 1' apart, cultivated for the first 10 days to 2 weeks, and then mulched to a depth of 1 to 1 1/2¼' with sawdust.

Unless the sawdust is mixed with the soil, there is little danger of the development of a nitrogen deficiency. Should this occur, however, it can be quickly overcome through the application of 1/2 ob. of nitrate of soda to each 100 sq. ft. of mulched area.

Remove all runners as soon as they appear, to encourage the plants to stool-out in large crowns. Blossom clusters must be removed until the plants have become firmly established and are growing vigorously—usually about the first of July. Berries will begin to ripen about a month later and will continue until frost, if weed growth is kept down and adequate moisture is supplied. Fruit the plants for the spring and fall crops the second year, then destroy the planting.

Strawberry Growing in Pyramids and Barrels

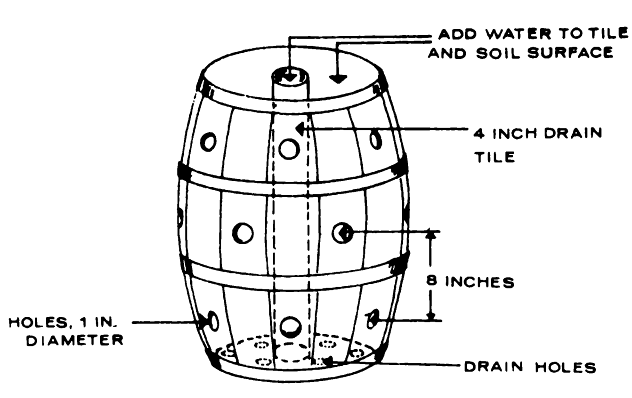
In a home garden where space is extremely limited or where the gardener wishes to use the strawberry planting as a novelty or decorative feature, the strawberry pyramid or the strawberry barrel can be useful and interesting. Pyramids may be square or round. Each step of the pyramid should have a flat surface not less than 6 to 8 inches in width. The frames for a square pyramid can be constructed out of 6-inch wide boards of a durable wood such as redwood.

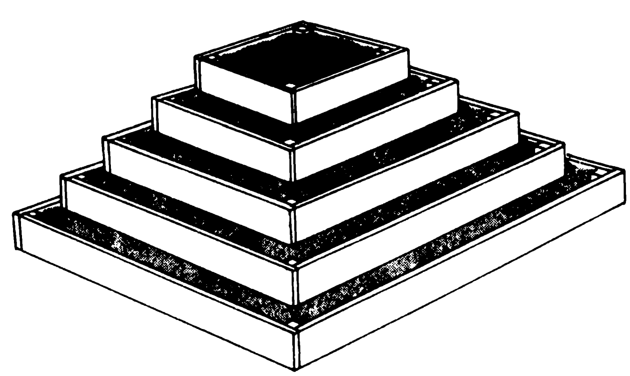
A suggested soil mixture for the pyramid is as follows:

6 parts top soil
2 parts peat
2 parts sand
1/4 lb. 5-10-10 (or similar general purpose fertilizer)
per 1,000 lbs. of soil mixture.

In preparing a strawberry barrel, 1-inch diameter holes are made in the sides of the barrel at approximately 8-inch spacings. As the barrel is filled with successive layers of soil, strawberry plants are carefully inserted through the holes so that the roots are held firmly in contact with the soil.

Barrel planter.





List of material necessary for a 72 inch wide, 5 level, square sided pyramid where each ascending level is 12 inches less in width.

4 boards 6 feet long and 6 inches wide
4 boards 5 feet long and 6 inches wide
4 boards 4 feet long and 6 inches wide
4 boards 3 feet long and 6 inches wide
10 feet of 2" x 2" for corners
1 pound of 6 penny galvanized nails

Though the strawberry barrel may be a successful novely, yields of fruit will be smaller than those in pyramid culture - and much more attention to planting, watering and winter protection will be required.

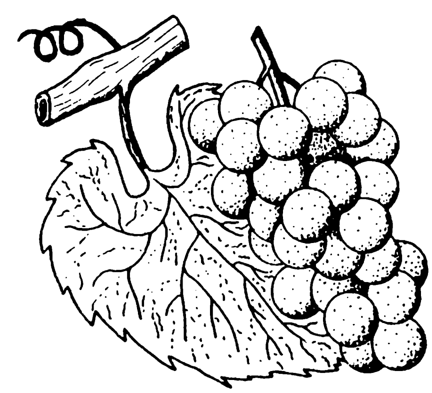
Damage to the strawberry plants growing under normal cultural conditions can be expected if they are not protected from extreme cold during the winter. Owing to the fact that plants growing in a pyramid or barrel are elevated above the normal ground level and therefore are highly exposed, additional winter damage can be expected to the crowns and fruit buds. Consequently, care must be taken to provide adequate winter protection (mulch). However, even with careful mulching, some plant injury can be expected during severe winters.

Harvesting

In the home garden, strawberries should be allowed to get an overall red color and become fully ripe before harvesting. It is at this stage that the sugar content is higher and the flavor is best. It will be necessary to pick every day during the peak of the season.

Harvest the berries carefully by the stems to prevent bruising. Pick all that are ripe, inasmuch as they will not keep until the next harvest. Ripe strawberries may be held for a day or two in a refrigerator.

GRAPES



Grapes of some type can be grown almost anywhere in Virginia. Careful selection of cultivated varieties compatible with local soil and climatic conditions has led to successful production in home gardens and commercial vineyards in many sections of the Old Dominion.

Variety Selection

American Bunch Grapes   Home fruit gardens in Virginia may include a number of varieties of bunch grapes ripening in succession over a long season.

Price, a 1972 introduction from VPI&SU, is a medium-sized blue black grape of good quality that ripens 4 weeks before Concord. It is less subject to black rot, mildew, and skin cracking than many other varieties. The vine is of average vigor and productivity.

Seneca, an early yellow grape, is noted for its good flavor and tender pulp. It holds well on the vine and will keep in cold storage for about 2 months after harvest. Vine vigor and productivity are only moderate, and this variety is quite susceptible to black rot and mildew.

Himrod, a new golden yellow grape, has good flavor and is almost seedless. Hardy, vigorous, and productive, it has been superior to its sister seedling, Interlaken, in all areas of Virginia where both have been grown.

Fredonia is the most popular early blue grape. It ripens about 10 days before Concord. The berries and bunches are large and attractive. Although the flavor is not as good as Concord, it appears to be better adapted to the warm climate of eastern and southern Virginia.

Monticello, another VPI&SU introduction, is a medium-size, blue black, slip-skin grape ripening 10 days before Concord. Although of only average vigor, it is very productive and must be cluster-thinned to prevent overbearing. It is high in sugars and very good as a table grape as well as for jams and jellies.

Delaware is a high-quality red grape ripening about 1 week before Concord. Quite susceptible to downy mildew, this variety produces clusters and berries that are rather small and vines that grow slowly. Delaware has an unusually good balance of sweetness and acidity. It yields fine quality white wines and is much used in blands for American champagnes.

Concord is by far the most widely planted blue grape. The good quality fruit ripens unevenly some seasons in warm climates. The vines are vigorous and productive.

Century I, a VPI&SU introduction of the nonslipskin type, ripens with Concord. Its crisp, meaty flesh has a flavor distinctly of the vinifera type, sweet and fruity. The clusters are large, usually well filled with large, ovate, reddish-black berries. It must be close-pruned and cluster-thinned to prevent overbearing which causes winter injury to the wood. Subject to black rot and powdery mildew, it requires disease control measures typical of vinifera grapes grown under eastern climatic conditions.
Steuben is a blue black variety ripening about 1 week after Concord. The berries are medium in size with a sweet, spicy flavor. They keep well in storage. The vines are hardy, vigorous, and productive.

<u>French-American Hybrids</u> Of the many varieties available, the following French-American hybrids have been sufficiently tested to be recommended for planting anywhere in Virginia where American bunch varieties can be grown.

Aurora (Seibel 5279) is an early pinkish-white grape with fine flavor. This variety can be used to produce a white table wine of excellent quality. The vine is vigorous and productive and has been amply hardy in winter cold in northern grape growing areas and in Virginia.

Cascade (Seibel 13053) is an early blue grape that is hardy and productive. It produces a superior rose wine and blends well with heavy-bodied dark-red wines. The vine generally crops regularly, but is severely damaged by birds in some seasons.

DeChaunac (Seibel 9549) has become an established commercial variety in Ontario, Canada, and most grape growing areas of the Eastern United States. The vine is below average in vigor, but is winter hardy, productive, and has very few disease problems. It ripens in early midseason. The wine is well colored red and of consistently high quality.

Chancellor (Seibel 7053), ripening with Concord in most areas of Virginia, is hardy, vigorous and very productive. It is a dark blue grape, making a red wine of very high quality.

<u>Vinifera</u> Few varieties of Vitis vinifera for table use have performed well in Virginia. They lack winter hardiness, are very susceptible to fungus diseases endemic to this area, and are totally lacking in resistance to the grape root louse (Phylloxera). Vinifera

culture in Virginia requires planting only vines grafted on resistant rootstocks, a rigorous spray program, and protection in areas subject to frequent low and fluctuating winter temperatures.

In northern grape growing areas, and in plantings in Virginia, there is limited production of some vinifera varieties for wine. Of these, Pinot Chardonnay and Johannisberg (White) Riesling have been the most successful.

Pinot Chardonnay, considered by many to be superior to all other varieties for dry white wine, is only moderate in hardiness, vigor, and productivity. It is a medium-size white grape in a compact cluster ripening 3 to 5 days ahead of Concord.

White Riesling is perhaps best for most Virginia conditions. The vine is vigorous, productive, and moderately winter hardy. It is a white grape, ripens about 1 week after Concord, and makes an excellent dry white wine under good growing conditions.

Muscadine Grapes In areas where it is adapted, the muscadine grape is a favorite for home plantings. It is highly desired for juice, jam, and jelly. Some varieties are cultivated for the exceptional quality of the wine. It cannot be successfully grown where temperatures fall below 10 degrees, however, which limits its production in Virginia to the southeastern portion of the state.

Most varieties have imperfect flowers and require pollination from either male or perfect—flowered varieties. Of those suggested for planting in Virginia, Carlos, Magnolia, and Dearing are perfect-flowered and will supply adequate pollination for the other varieties.

Hunt is an all-purpose black variety. The large, attractive berries ripen evenly and early—mid-September in eastern Virginia. It is excellent for wine, unfermented juice, jelly, jam, and for eating fresh.

Scuppernong, a name commonly applied to all bronze-skinned muscadine grapes, is the oldest and best known variety. Berry clusters are usually small and shatter badly, but the grape quality is good, and it has a very distinctive flavor.

Carlos, a 1970 introduction from North Carolina, is a perfect-flowered bronze variety, ripening with Scuppernong, and similar to it in size and flavor. It makes excellent white wine, is relatively cold hardy, disease resistant, and productive. It is recommended for both commercial and home garden planting.

Magnolia is a self-fertile white variety of large size and very high quality. The vine is vigorous and very productive.

Thomas, another old standard variety, has reddish black, medium to small, high quality berries which are very sweet. It is an excellent variety for unfermented juice.

Dearing, a light-skinned, perfect-flowered variety, has very sweet, medium-sized berries.

Topsail, the sweetest variety of all, is preferred by many because of the high sugar content. The berries are medium to large, greenish-bronze in color, and have a smooth skin. They ripen in early October in Virginia.

Establishing the Planting

Site and Soil Grapes should be planted where they have benefit of the sun for most of the day. They are deep-rooted plants, frequently penetrating to a depth of 6 to 8' under good soil conditions. They grow best on fertile sandy-loam soils high in organic matter. Deep sands or heavy clays may be used, however, if provisions are made for adequate fertilization, moisture, and soil drainage. Grapes are tolerant to a wide range of soil acidity, but prefer a pH of 6.0 to 7.0 .

Planting Grape vines are usually set in early spring about 3 or 4 weeks before the average date of the last frost. Vigorous 1-year-old plants are usually preferred. Allow plenty of room between plants—at least 8' for the American bunch varieties and 10' or more for the vigorous-growing muscadine type. Trim the roots to about 6" in length in order to encourage formation of feeder roots near the trunk. Where the vines are to be set, dig the holes large enough so that the roots may be spread without crowding, and the plants may be set at about the same depth they grew in the nursery. Prune to a single cane, and head it back to two buds.

Maintaining the Planting

Soil Management Mulching is the preferred soil management practice in the home grape planting. Almost any organic material may be used. Cover the area with mulch to a depth of 4 to 6". Black plastic is a satisfactory mulch material. However, it does not add to the humus content of the soil upon deterioration.

Although grapes are deep-rooted plants, they do not thrive in competition with weeds and grass. If mulch material is unavailable, some cultivation should be done. It should be shallow and only as necessary to eliminate undesired vegetation.

Fertilization Like all fruit plants, grapes require a large amount of nitrogen. Except in the sandy soils, this element may be the only one needed in the fertilization program. In the home garden, 1/4 teacup or about 2 oz. of nitrate of soda per vine should be applied after growth begins in the spring. Spread the fertilizer in a circle around the plant and 10 to 12" from the trunk. Repeat the application about 6 weeks later. Just before growth begins in the spring of the second year, apply 4 oz. in a 4' circle around each vine and about 1' from the trunk. Increase the amount to 8 oz. the third year. A mixed fertilizer, such as 10-10-10, applied at the above rates may be substituted where phosphorus and potassium are needed.

Fertilizer applications to mature bearing vines should be based on the growth and vigor of the plant. If the average cane growth is only 3' or less, additional nitrogen may be needed. Where proper pruning is practiced and competition from weeds and grass is kept to a minimum, however, it is doubtful that you will need to go beyond the amount recommended for a 3-year-old vine.

Training and Pruning Much attention is given to the training and pruning of grapes. To be most productive, they must be trained to a definite system and pruned rather severely. There are several training systems used. The two most common are the vertical trellis and the overhead arbor. Both of these are satisfactory in the home planting if it is kept well-pruned. For detailed discussion see the chapter on pruning.

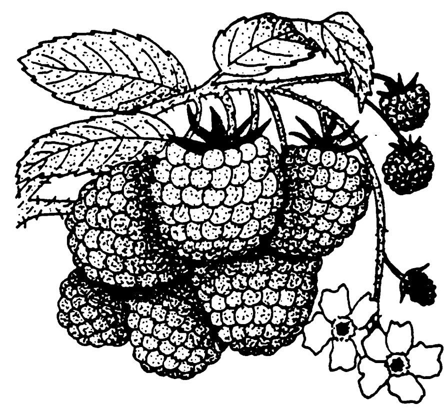
Harvesting

For best quality, bunch grapes should be fully ripe when harvested. They will not improve in sugar content or flavor after being removed from the vine. Most varieties should be used immediately because they do not keep well after ripening. Cut the clusters off with a knive or shears to avoid bruising the fruit and damaging the vine.

Muscadine grapes grow either singly or in loose clusters. Some varieties may be shaken off easily when ripe; others have to be handpicked. The grapes should be used soon after harvesting inasmuch as their storage life is relatively short.

BRAMBLES

The bramble fruits, which include the red, black, and purple raspberries, and the erect and trailing blackberries, may be successfully grown in most home gardens throughout Virginia. Both raspberries and blackberries will usually yield a moderate crop of fruit the second year after planting and a full crop the third season. With good management, it is possible for growers to extend the productive life of well-located plantings beyond the 6- to 8-year average.



Variety Selection

Of the many varieties of blackberries and raspberries available, few have proven satisfactory for growing under Virginia conditions. Only top-quality 1-year-old plants of the best varieties should be planted.Obtain virus-free plants when possible.

Blackberries   Three erect-type blackberries are suggested for planting in Virginia. All are relatively new, productive, vigorous, and winter-hardy.

Black Satin, entirely thornless, is very productive and hardy. The fruit is large, firm, jet black when fully ripe, and has a delicious flavor. Peak quality is attained 2 to 3 days after the berry turns black.

Darrow, ripening about the first week of August in the Charlottesville area, is a large berry, almost an inch long and 3/4" wide. It is glossy black, mildly subacid, and of good quality.

Dirksen, another thornless blackberry, is also very productive and hardy. Slightly smaller than Black Satin, it is equally as good when fully ripe.

Trailing blackberries thrive best in the warmer growing areas of southern and eastern Virginia.

The Lucretia dewberry, best of the trailing blackberries, is relatively winter-hardy, vigorous, and productive. The fruits are very large, often 1 1/2" long. It is a sweet berry with a good flavor.

The Boysenberry is easily winterkilled and should be planted only in areas of mild winters. The plants are extremely vigorous and productive. The berries are large and flavorful when fully ripe. Thornless boysenberries, with the same fruit characteristics as the regular boysenberries, are also available.

Lavaca, a seedling of the Boysenberry, is superior to its parent in production, size, and resistance to cold and disease. The fruit is also firmer, less acid, and of slightly better quality.

Raspberries Chances for success with raspberry plantings are better if the plantings are located in the cooler mountain sections of the state. Red raspberries have generally been more successful in the warmer areas than have the other types.

Sunrise, a good quality, early, red raspberry, is firm and fine textured. It is very tolerant to anthracnose, leaf spot, and cane blight, and has the ability to withstand low temperatures.

Latham is the standard red raspberry grown in the eastern United States. Plants of this variety are vigorous and productive and appear to be somewhat tolerant to viral diseases. The berries are above average in size, and are firm and attractive. The flavor is somewhat tart, but the quality is good. This variety ripens 1 1/2 to 2 weeks after Sunrise.

Pocahontas, a recent introduction from VPI&SU, has a large, firm, medium-red berry with a tart flavor. It is winter-hardy and productive.

Cherokee, another VPI&SU introduction, is an everbearer especially adapted to the Piedmont area of Virginia. The good-quality berries are large and firm. It is winter-hardy and very productive.

Heritage, an everbearing red variety, is recommended for planting. This variety may be annually pruned by simply mowing all tops in late winter. Use of this pruning technique will yield one crop in August of each year.

Black raspberries are very susceptible to viral diseases and are readily infected when grown near red varieties carrying the virus. Plants of red and black raspberries should be separated by at least 700'.

New Logan yields heavy crops of large, glossy-black fruit of good quality. The plants hold up well during drought and are relatively tolerant to mosaic and other raspberry diseases.

Bristol is a hardy, vigorous-growing, and highly productive variety. The good quality, glossy black berries are large, firm, and attractive. They may be difficult to pick unless fully ripe.

Cumberland, ripening about the same time as Bristol and 1 week later than New Logan, has long been the favored variety because of its attractive, large, firm berries and fine flavor. The plants are vigorous and productive.

The purple raspberry is a hybrid of the red and black types. The fruits have a purple color and are usually larger than the parent varieties. They are more tart than either the reds or blacks and are best used in jams, jellies, and pies. They are excellent for quick freezing. The plants are hardy, vigorous, and very productive. Brandy-wine is the best purple raspberry available. It ripens later than most red or black varieties. The fruit is large and firm, and quite tart, but of good quality.

Establishing the Planting

Site and Soil The brambles grow best on deep, sandy-loam soils, well supplied with organic matter. They may be grown in almost any good garden soil, provided it is well drained to a depth of at least 3' and has a high moisture-holding capacity. Although the pH of the soil is not critical, a range of 5.8 to 6.5 is considered optimum . Select a site where tomatoes, potatoes, or eggplants have not been grown. These crops often carry verticillium wilt which lives in the soil for many years. Inasmuch as brambles, particularly black raspberries, are very susceptible to this disease, plantings on such sites are usually unsuccessful.

Planting The bramble fruits should be planted early in the spring—about 4 weeks before the average date of the last frost. Work the soil as for garden vegetables, particularly where the plants are to be set. When planting in rows, allow at least 8' between rows to facilitate cultivation. Erect-growing blackberries and red and purple raspberries may be set as close as 3' in the row. Black raspberries should be not less than 4', and the trailing blackberries should be not less than 6'.

Set the plants at about the same depth they grew in the nursery. The crown should be at least 2" below the soil line. Spread out the roots and firm the soil carefully around them. Do not allow the roots to dry out.

Most bramble fruits come with a portion of the old cane attached. This serves as a handle in setting the plants. Soon after new growth begins, the handle should be cut off at the surface of the ground and burned. This is a safeguard against possible anthracnose infection.

Maintaining the Planting

Soil Management Brambles grow best where there is a large amount of humus in the soil. This is most easily maintained under a permanent mulch. Mulch should be applied soon after setting the plants, maintained throughout the life of the planting, and replenished annually or as needed.

Any good organic material is satisfactory. Two inches of sawdust should be sufficient. At least 5 or 6" of the more bulky materials should be applied. Where straw, sawdust, or other material low in nitrogen is used, it may be necessary to add sufficient nitrogenous fertilizer to prevent a temporary deficiency as the mulch begins to decay. Usually about 1/2 lb. of nitrate of soda or the equivalent for each 100 sq. ft. of mulched area will be enough. Black plastic serves as a good mulch to preserve moisture and keep down weeds, but it does not add to the humus content of the soil.

If mulch material is unavailable, or if cultivation seems necessary, make the cultivations very shallow to avoid disturbing the roots, and repeat as often as necessary to control weeds until the beginning of harvest.

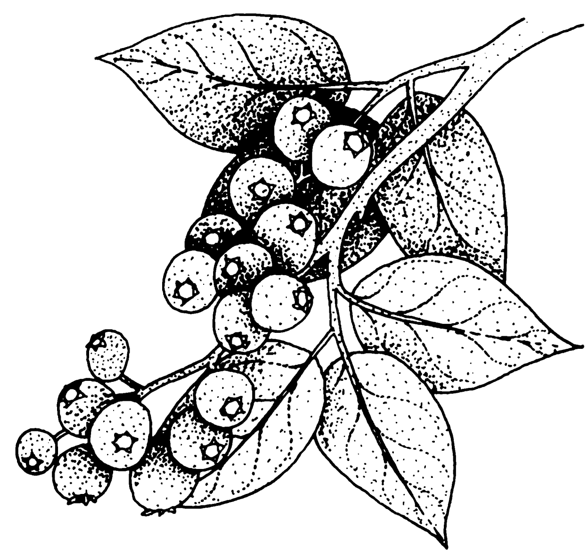
Fertilization On fertile soils, or where a good mulch is maintained, it is usually unnecessary to make an application of fertilizer in the bramble planting. If growth is poor, the addition of 1/2 to 1 lb. of nitrate of soda to each 100' of row when growth begins in the spring will be beneficial. On light, sandy soils, where phosphorus and potassium may be low, an equal amount of 10-10-10 or similar fertilizer should be used instead. Do not overfertilize, however, because it may result in too much vegetative growth with a loss of yield and quality of the fruit or in injury to the roots of the plant.

Training and Pruning Refer to the chapter on pruning.

Harvesting

Raspberries and blackberries are highly perishable. They should be harvested as soon as ripe, handled very carefully, and either placed in cold storage or used without delay. It may be necessary to harvest daily to prevent loss of fruit and the spread of molds and other diseases in the planting.

BLUEBERRIES



Many home gardeners have been successful with blueberry plantings in Virginia. Although they may be grown in any area where native blueberries, azaleas, mountain laurel, or rhododendrons do well, they have a better flavor when grown where nights are cool during the ripening season. They are very exacting in soil and moisture requirements, but require little protection from insect and disease pests.

Variety Selection

To provide for adequate cross pollination and to increase chances for a good crop of fruit, two or more varieties of blueberries should be planted. The following varieties suggested for planting in home gardens in Virginia ripen over a 6- to 8-week period, beginning in early June and continuing through July. All are vigorous and productive under good growing conditions and produce berries of large size and good quality.

Earliblue has a large, light blue berry. It is firm, resistant to cracking, and of good dessert quality. Lacking hardiness, it is not recommended for planting in western Virginia.

Ivanhoe, less hardy than most varieties, is one of the best in dessert quality. The berry is large, light blue, and firm.

Blueray, very hardy and productive, is recommended for planting throughout Virginia. The fruit is large, medium light blue, flavorful, and resistant to cracking.

Bluecrop, although lacking in vigor, is very hardy and drought resistant. The fruits are large, light blue, firm, and resistant to cracking. Their dessert quality is good.

Jersey, one of the leading commercial varieties, is also a favorite in the home garden. The plants are vigorous and hardy, producing heavy crops of large, light-blue berries of good quality.

Berkeley has a very large, light blue berry. It is exceptionally firm and resistant to cracking. Though only medium in dessert quality, it is well liked for its large size, firmness, and productivity.

Herbert is a variety with superior dessert quality. The berry is very large, medium blue, moderately firm, and resistant to cracking.

Coville is of good dessert quality, but quite tart until fully ripe. It is a very large berry, deep blue, firm, and resistant to cracking. The fruit hangs well in clusters even after it is ripe.

Establishing th Planting

Site and Soil Blueberries should be planted where they have full sunlight most of the day, and far enough from the roots of trees to avoid competition for moisture and nutrients. They are shallow-rooted plants and must either be irrigated, heavily mulched, or planted in a soil with a high water table. Adequate drainage must be provided, however, because they cannot tolerate wet feet.

They grow best in porous, moist, sandy soils high in organic matter with a pH range of 4.0 to 5.2. Have a soil test made (See footnote, page x). If it is not acid enough for blueberries, work such materials as peat moss, oak leaves, pine needles, or sulfur into the area where the plants are to be set. This should be done 6 months to a year before planting. To acidify sandy soils, sulfur is recommended at the rate of 3/4 lb. per 100 sq. ft. for each full point the soil tests above pH 4.5. On the heavier soils use 1-1/2 to 2 lb. Once the proper acidity is established, it can be maintained through the annual use of an acid fertilizer, such as ammonium sulfate or cottonseed meal.

Planting Vigorous 2-year-old plants about 15" high are recommended for planting. Set in early spring, about 3 or 4 weeks before the average date of the last frost. Blueberries are usually planted every 4' in rows 6' apart.

Give the roots plenty of room. Where the plants are to be set, dig the holes wider and deeper than necessary to accommodate the root systems. If not previously done, incorporate plenty of organic matter—well rotted sawdust, peat moss, or woods mold—into the soil in and around the hole. Trim off diseased and damaged portions of the top and roots, and set the plants just a little deeper than they grew in the nursery. Spread the roots out, and carefully firm the soil mixture over them. Water thoroughly after planting.

Maintaining the Planting

Soil Management Mulching is the preferred soil management practice in the blueberry planting. The entire area around and between the plants should be mulched. Nearly any organic material is satisfactory—leaves, straw, hay, peat moss, crushed corncobs, or sawdust. It should be applied to a depth of 5 or 6". Many growers use a combination mulch, a layer of leaves on the bottom with 2 or 3" of sawdust on top. Renewed annually, this heavy mulch retains moisture, keeps the soil cool, and adds needed organic matter.

Fertilization No fertilizer should be applied at planting time, and usually none is needed during the first growing season. On weak soils, however, the application of 2 oz. (1/4 teacup) of ammonium sulfate around each plant about the first of June will be beneficial.

Ammonium sulfate, at the rate of 2 oz., should be spread in a circle around each plant about 6 to 8" from its base just before the buds begin to swell the second spring. Increase the amount each succeeding spring by 1 oz. until each mature bush is receiving a total of 8 oz. (1 teacup) annually. Cottonseed meal has proven to be an excellent fertilizer for blueberries and is used by many home gardeners. It supplies the needed nutrients and helps maintain an acid soil. Use it at the rate of 1/2 lb. per plant. The rate should be doubled when the plants come into bearing.
Where sawdust is used as a mulch, it will be necessary to apply additional nitrogen to prevent a deficiency as the sawdust decays. Usually about 3/4 lb. of ammonium sulfate for each bushel of sawdust will be sufficient.

Pruning Refer to chapter on pruning.

Pest Control Birds are by far the greatest pest in the blueberry planting. Covering the bushes with wire cages, fish or plastic netting, or tobacco cloth, is perhaps the best method of control. Aluminum pie tins have been used successfully. They are suspended by a string or wire above the bushes in such a manner that they twist and turn in the breeze and keep the birds away.

Harvesting

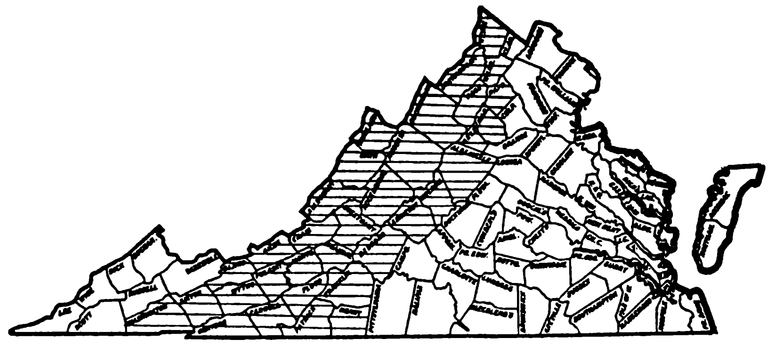
Some varieties of blueberry will bear the second year after planting. Full production is reached in about 6 years with a yield of 4 to 6 qt. per plant, depending on vigor and the amount of pruning.

Blueberries hang on the bushes well and are not as perishable as blackberries or raspberries. Picking is usually necessary only once every 5 to 7 days. Blueberries will keep for several weeks in cold storage.

CURRANTS AND GOOSEBERRIES

Currants and gooseberries are hardy and easy to grow in the home garden, but inasmuch as they are alternate hosts to the white pine blister rust disease, their planting is restricted in many areas of Virginia. At present, 33 counties are on the protected list .

In these counties, a permit must be obtained from the Commissioner of Agriculture and Commerce in Richmond before planting either currants or gooseberries. No permit will be issued for a planting "within 1,500' of sizeable plantings of ornamental or commercial white pine stands." There are no restrictions outside the protected areas except that "European black currant plants may not be moved intrastate to any destination in Virginia."



Before planting either of these fruits, contact your Extension Agent or the State Entomologist, Virginia Department of Agriculture and Consumer Services in Richmond, for regulations governing the production and shipment of currants and gooseberries in your area.

Variety Selection

Currants and gooseberries are used mainly in making jellies, jams, preserves, and pies. Red varieties of gooseberry are sweet when fully ripe and may be eaten fresh.

Wilder is one of the best currant varieties. It has large, dark red, subacid berries that hang in large, compact clusters which are easy to pick. The bush is upright-growing, large, and vigorous. Red Lake, ripening just after Wilder, has large, firm, light-red berries. The clusters are large and hang on long after the berries are ripe. The bush is upright-growing, vigorous, productive, and very hardy. Although European varieties of gooseberry are larger, the American varieties are more productive, hardier, and considered to be of better quality.

Pixwell is a nearly thornless variety of gooseberry that produces heavy crops of good quality fruit. The berries are pink when fully ripe and hang on slender stems almost an inch below the branches where they may be easily picked. The bushes are very hardy and thrive in almost any soil type.

Red Jacket is a vigorous-growing bush; large, sturdy, and nearly thornless. It is very productive, with large berries that are dull red when ripe.

Establishing the Planting

Site and Soil Currants and gooseberries need a cool, moist, shady location. They are very resistant to low temperatures, but do not thrive where the summers are hot and dry. Gooseberries are somewhat more tolerant to heat than are currants. Where only a few plants are grown for home use, the north side of a building may be selected to protect them from the summer heat.

Select a site with good air and soil moisture drainage. Currants and gooseberries bloom very early in the spring and need to be protected against frost. They are shallow-rooted plants which require a moist soil, but cannot long tolerate wet feet. They grow best in a deep fertile loam with a pH range of 6.0 to 8.0 . Although the heavier soils, such as silt or clay loams, are more suitable, the plants may be grown in lighter soils well supplied with organic matter if moisture is added during periods of drought.

Planting Vigorous 1-year-old plants are preferred. Planting in rows 8' apart with the plants spaced 4' within the row is the usual practice. Prepare the soil for planting as you would for a garden crop, and set the plants slightly deeper than they grew in the nursery. This causes new shoots to arise from below the soil level, forming bushes rather than single stems. Pack the soil firmly about the roots and cut the tops back to a height of 8 to 10".

Maintaining the Planting

Soil Management Mulching is the preferred soil management practice for currants and gooseberries. Any good organic material is satisfactory. Spread the mulch in a 3' circle around each bush, pulling it back each winter to eliminate a nesting place for mice which like to feed on the young shoots. Black plastic may be used if desired.

Fertilization Currants and gooseberries usually respond to fertilization even when planted in fertile soils. An annual fall or late winter application of either barnyard or poultry manure is an effective way of supplying their nutritional needs. Spread it about 1" deep in a 3' circle around each plant. In the absence of manure, 1 teacup or about 8 oz. of nitrate of soda per plant should be applied just before the buds break in the spring. On sandy soil, a complete fertilizer, such as 10-10-10 or 10-6-4, at the rate of 1-1/2 to 2 cups per plant may be needed.

Pruning Currants and gooseberries typically form bushes with many branches arising near the ground level. Pruning may be done any time during the dormant period and consists primarily of thinning-out excess stems. Except for the removal of weak, broken, or prostrate stems, very little pruning is done until the plants are 4 years old. The mature bush should have three or four stems each of 1-, 2-, and 3-year-old wood. The actual number should be determined by the vigor of the bush. Heading back is done only to reduce the height of extra long 1-year-old shoots.

Remove all wood over 3 years old. Cut off the damaged and low prostrate stems, retaining only the most vigorous of the 2- and 3-year-old shoots, and remove the rest. Head back young shoots that are too long .

Harvesting

Currants and gooseberries begin bearing when about 3 years old and have a productive life of 10 to 20 years. Under good cultural practices in the home garden, currants should yield 5 to 10 qt. per bush annually, and gooseberries even more. Unlike most fruits, currants and gooseberries may be left on the bush for several weeks after they are ready for use. Gooseberries may be left 4 to 6 weeks, and some varieties of currants even longer. They should be handled carefully to avoid bruising the fruit. Inasmuch as gooseberries sunscald very quickly, they should be placed in the shade soon after being picked.

VEGETABLE GARDENING

PLANNING AND LOCATING THE GARDEN

PLANNING GUIDELINES

When planning your garden, it is important to ask a few basic questions:

Who will be doing the work? Will the garden be a group project with family members or friends who will work willingly through the season to a fall harvest, or will you be handling the hoe alone - in between camping and swimming? Remember, a small weed-free garden will produce more than a large weedy mess.

What do you and your family like to eat? Although the pictures in the garden catalog look delicious, there is no value in taking up gardening space with vegetables that no one eats. Make a list of your family's favorite vegetables, ranked in order of preference. This will make a useful guide in deciding how much to plant of each. Successive plantings of certain crops, such as beans, will give you a longer harvest period and increase your yield. List recommended varieties and planting dates.

How do you plan to use the produce from your garden? If you plan to can, freeze, dry or store part of the produce, this will be a factor not only in planning the size of your garden but also in selecting the varieties you grow. Some varieties have much better keeping quality than others. Care should be used in choosing the seeds, making sure the varieties you select are adapted to your area and intended use.

How much space is available? That is, how much area can be converted into usable garden space, not simply how much empty ground is available.

SOME ADDITIONAL PLANNING HINTS

* Plan your garden on paper first. Draw a map showing arrangement and spacing of crops. If you wish to keep the garden growing all season, you may need a spring, summer, and fall garden plan. (See Publication 426-335, Intensive Gardening Methods.)

* Plan your garden and order seeds by January or February. Some plants may be started indoors as early as mid-February.

* In your plan, place tall and trellised crops on the north side of the garden so they won't shade the shorter vegetables.

* Group plants by length of growing period. Plant spring crops together so that later crops can be planted in these areas when the early crops mature. Consider length of harvest as well as time to maturity. Place perennial crops to the side of the garden where they will not be disturbed by annual tillage.

LOCATING THE GARDEN

* Vegetables grow best in a level area with loose, well-drained soil, and at least six hours of sun (8-10 hours is ideal).

* Use contour rows or terraces on sloped or hillside sites to avoid erosion. South-facing slopes are warmer and less subject to damaging frosts.

* Avoid placing the garden in low spots, at the base of a hill, or at the foot of a slope bordered by a solid fence. Such areas are slow to warm up in the spring and frost settles in these places since cold air naturally drains into low areas. If there is a creek nearby, the water table may be very high or the area subject to flooding.

* Avoid windy locations; if you must plant in a windy spot, build or grow a windbreak.

* Locate near a good and easily accessible supply of water if possible.

* Choose a spot near your home so it is convenient to work in the garden when you have a few minutes.

* Avoid planting near trees and shrubs; they compete for nutrients and water, and may cause excessive shading.

* Sites too near building may result in plants not receiving enough sunlight. Observe shading patterns through the growing season if possible before starting the garden. If you have a shaded area you wish to use anyway, plant it in shade tolerant crops. Increase effective light if needed by providing reflective surfaces around plants.

* Try not to plant related vegetables in exactly the same location in the garden more often than once in three years. Rotation prevents the buildup of insects and disease. Use old plans as guides for rotating crops.

* Avoid locations near busy roads. Airborne lead from automobile exhaust can contaminate vegetables, especially leafy types. If you must plant in a lead-prone area, try planting a hedge to trap lead in the air.

* Avoid locating the garden on a site where buildings with lead paint have stood; soil lead may be present in toxic amounts. If you are unsure about your chosen location, have the soil tested for lead content, or have tissue analyses done on some leafy vegetables.

SOIL PREPARATION

The ideal vegetable garden soil is deep, friable, well drained, and has a high organic matter content. Proper soil preparation provides the basis for good seed germination and subsequent growth of garden crops. The careful use of various soil amendments can improve your garden soil and provide you with the best possible starting ground for your crops.

SOIL TESTING

Check soil fertility and pH by having your soil analyzed at least once every three years. Soil pH measures the degree of acidity or alkalinity of the soil. Vegetables vary to some extent in their requirements, but most garden crops will do well with a soil pH of 6.2-6.8. This is a little below neutral or slightly acid (sour). If soil pH is too high or low, poor crop growth will result, largely due to the effects of pH on the availability of nutrients to plants. A soil test will also give you a relative idea of the nutrient level in your soil.

Soil test kits are available for checking your soil at home. Soil samples may also be sent to your local extension service for testing. The extension service will mail results back to you with recommendations for correcting any deficiencies or other problems that may exist. Private companies also do soil testing; these give detailed reports and recommendations in many cases, but may be expensive ($30 is not unusual). For best results, always follow carefully the instructions given for taking the soil test.

Once you know where your soil stands in terms of the basic nutrients and pH, make adjustments by adding required fertilizers and lime (or acidifiers). In new garden spots remove sod with a spade and use it to patch your lawn or put it in a compost pile to decay. Plow, spade, or rotary till the soil. Work only when the soil moisture conditions are right. To test, pick up a handful of soil and squeeze it. If it stays in a mud-ball it is too wet. If it crumbles freely it should be about right. Too-dry soil is powdery and clumpy and may be difficult to work. Take samples at the surface and at a 2-3" depth in several locations in your garden plot. If the soil sticks to a shovel, or if when spading the turned surface is shiny and smooth, it is still too wet. Working soils when excessively wet can destroy the soil structure, which may take years to rebuild. Plowing with a tractor when the soil is wet is especially damaging, causing the formation of a compaction layer that will inhibit root growth. Soils with adequate humus levels generally allow more leeway because of their improved structural qualities.

Just prior to planting, break up large clods of soil and rake the bed level. Small-seeded vegetables germinate best in smooth, fine-surfaced soil. But do not pulverize the seedbed soil. This destroys the structure and promotes crusting and erosion problems.

EQUIPMENT

The type of equipment used to prepare your garden will depend on the size of your garden, your physical ability, time and budget. Options include hand digging with a spade or shovel, tilling with a power rotary tiller, using a small garden tractor, or a full sized farm tractor.

TILLING THE SOIL

It was once assumed that gardens should be turned yearly with a moldboard plow, mostly for weed and other pest control. While garden plowing is still a common practice, turning the soil completely over has been found in some cases to be detrimental, causing soil compaction, upsetting balances of microorganisms, and often causing layers of coarse organic material to be buried below the influence of insects and microbes which would otherwise cause breakdown of the material. Chisel plowing, which does not have this disruptive effect, is one alternative, but it is limited to sandy or loamy soils and many farmers who work gardens do not have chisel plows. In addition, gardeners in less-than-rural areas have trouble finding a farmer who will come to plow and disk the garden for a reasonable price (or at all). Roto-tilling most home gardens is sufficient, as long as plant debris accumulation is not out of hand. Rotary tilling mixes the upper layers of soil rather than completely turning the soil over, and the effects produced are generally desirable. One possible harmful effect of rototilling only is the formation of a compaction layer just beyond the reach of the tines. This also occurs when a moldboard plow is used to the same depth every year, but at a somewhat deeper level. Use of deep-rooted cover crops (see below) or double digging can do much to prevent or alleviate this problem when it exists. Small gardens can be designed using raised beds which may be worked entirely by hand if the area is small enough.

Gardeners often wonder whether to have plowing or tilling done in the spring or fall. Working of the soil in fall has several advantages over the traditional spring plowing. It allows for earlier spring planting, since the basic soil preparation is already done when spring arrives. The turning under of large amounts of organic matter is likely to result in better decomposition when done in the fall, since autumn temperatures are higher than those of early spring, and there is more time for the process to take place. Insects, disease organisms and perennial weeds may be reduced by killing or inactivating them through burial or exposure to harsh winter weather. The physical condition of heavy clay soils may be improved by the alternate freezing and thawing, which breaks up tightly aggregated particles. Also, snow is trapped between the hills of roughly plowed soil, so more moisture is retained than on flat, bare ground. Incorporation of limestone or rock fertilizers in the fall gives them time to become integrated into the soil and influence spring plant growth.

Fall plowing alone is not recommended for hillside or steep garden plots, since soil is left exposed all winter, subject to erosion when spring rains come. If a winter cover crop is grown to improve soil and prevent erosion, the ground will have to be tilled in the fall to prepare the soil for seed, and again in spring to turn under the green manure. Spring plowing is better for sandy soils and those where shallow tilling is practiced. Generally, most gardens must be disked or rotary tilled in the spring to smooth the soil for planting.

SOIL AMENDMENTS

Any addition to the soil which improves its physical or chemical condition is considered a soil amendment. Many types of amendments are available to the home gardener.

Amendments to Change pH and Nutrient Levels

Lime, sulfur, and gypsum are common amendments used to change soil pH. The correct soil pH is essential for optimum plant growth. Dolomitic limestone adds calcium and magnesium as it increases pH. Gypsum adds calcium and some sulfur. Sulfur itself may acidify alkaline soil. The amount to add depends on the current and desired pH, one good reason to have your soil checked periodically.

Wood ashes are often used as a soil amendment. They contain potash (potassium), phosphate, boron, and other elements. Wood ashes can be used to raise soil pH with twice as much ash applied as limestone for the same effect. Ashes should not come into contact with germinating seedlings or plant roots as they may cause root burn. Spread in a thin layer over the winter, and incorporate into the soil; check pH yearly if you use wood ashes. Never use coal ashes or large amounts of wood ash (no more than 20 lbs. per 1000 square feet), as toxicity problems may occur.

Other amendments are added specifically to improve soil nutrient levels. Greensand and granite meal are sources of potassium. Granite meal is finely ground granite rock which releases its potassium slowly. Greensand is relatively low in potassium which is readily dissolved. Neither should be considered a sole nutrient source. Both materials may be hard to find in some areas. Other nutritional amendments that can be purchased for garden use include cottonseed meal, kelp meal, leather meal, and worm castings, as well as an array of synthetic fertilizers. The organic amendments are particularly useful where a trace element deficiency exists, while synthetic fertilizers are generally more available, less expensive, and have quicker results.

Amendments to Improve Soil Qualities

In special cases, coarse sand, vermiculite and perlite are sometimes added to heavy clays to help improve the soil texture (the ratio of sand:silt:clay) or structure. However, these inert materials can be expensive and large quantities are needed to do any good. Compost, manures and other amendments usually serve the purpose more economically and just as well.

Organic matter is a great soil improver for both clay and sandy soils. Good sources of organic matter include manures, leaf mold, sawdust, straw, and others. These materials are decomposed in the soil by soil organisms. Various factors, such as moisture, temperature, and nitrogen availability determine the rate of decomposition through their effects on these organisms. Adequate water must be present, and warm temperatures will increase the rate at which the microbes work. The proper balance of carbon and nitrogen in the material is needed to insure adequate nutrient availability both to growing plants and decomposing organisms. Adding nitrogen may be necessary if large amounts of undecomposed leaves, straw, sawdust or other high-carbon substances are used. Nitrogen is used by the decayers to make proteins for their own bodies, and if it is not present in sufficient amounts, the microbes have no qualms about stealing the plants' share. Generally, fresh green wastes, such as grass clippings, are higher in nitrogen than dry material.

The use of compost is one way to get around the decomposition problem. Compost is usually made by the gardener from plant and/or animal wastes. Correct composting is an art which can result in a valuable nutrient and humus source for any garden. The basis of the process is the microbial decomposition of mixed raw organic materials to a dark, fluffy product resembling rich soil, which is then spread and incorporated into the garden soil.

Animal manures are commonly used directly as a garden soil amendment. The value of manure in terms of the nutrients it contains varies. Fresh horse, sheep, rabbit, and poultry manures are quite high in nitrogen and may even burn plants if applied directly to a growing garden. They are best applied in the fall and tilled under. Manure usually has fewer total nutrients than synthetic fertilizers in terms of N, P, & K, but is a valuable soil builder. Unfortunately, manures may be a source of weed seeds; if this is a problem, composting in a hot pile may help. In urban areas manure may be hard to come by, but country dwellers usually find it plentiful.

Another source of inexpensive soil improvement that should not be underestimated is the cover crop. (See chart) Green manures, or cover crops, such as annual rye, ryegrass, and oats are planted in the garden in the fall for incorporation in the spring. For best results, seed should be sown a month before the first killing frost. In a fall garden, plant cover crops between the rows and in any cleared areas. Cover cropping provides additional organic matter, holds nutrients that might have been lost over the winter, and helps reduce erosion and loss of topsoil. Legume cover crops can increase the amount of nitrogen in the soil and reduce fertilizer needs. A deep-rooted cover crop allowed to grow for a season in problem soil can help break up a hardpan and greatly improve tilth. Incorporate green manures at least two weeks before planting vegetables; they should not be allowed to go to seed.

The addition of manures, compost, cover crops and other organic materials .bd regularly can raise the soil nutrient and physical level to a point at which the addition of synthetic fertilizers is no longer needed, or at least greatly reduced. This comes about not only through the intrinsic fertilizing value of the amendment, but also through the increased action of microorganisms on soil and humus particles; humic acid (and other acids) helps to release previously locked-up nutrients naturally present in the soil, and the extra surface area provided by humus serves as a reserve, holding nutrient elements until they are needed by plants. This highly desirable soil quality does not come about with a single or even several addition(s) of organic material, but rather requires a serious soil-building program. Information is widely available in books and magazine articles on this subject.

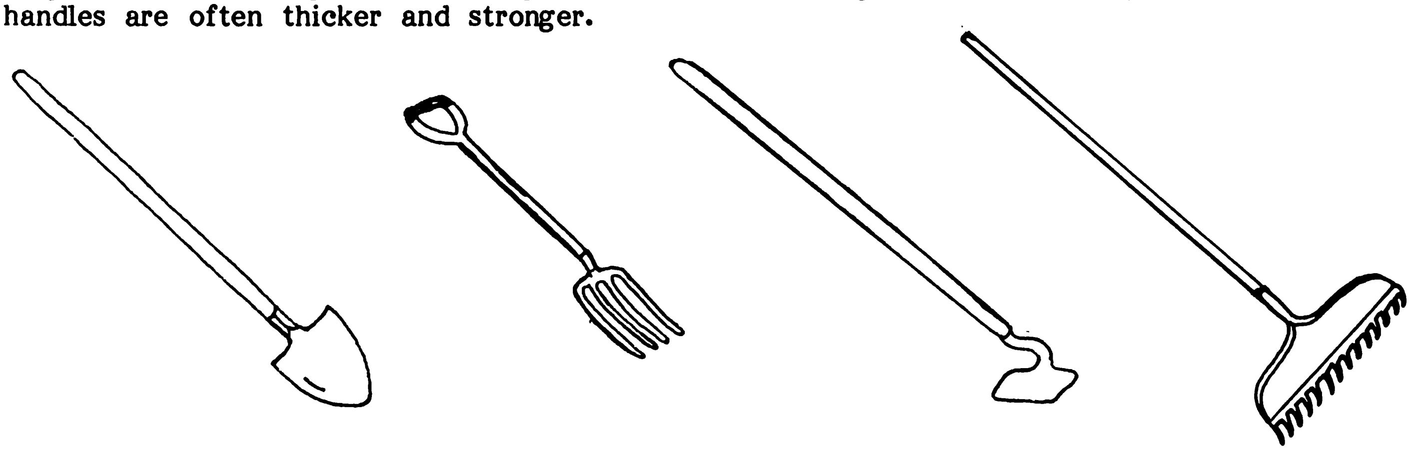
Remember, your soil is alive and constantly changing. By keeping it fertile and rich, many of your gardening problems may be diminished. Soil is the base for plant growth, and much attention should be paid to getting and keeping it in the best condition.

SELECTING GARDENING EQUIPMENT

Garden catalogs and stores are full of gardening tools, many highly specialized; some are very useful, others are nice but not necessary, and some are gimmicks. The gardening equipment you need depends on the size of your garden, your age and strength, and whether you want to get the job done in a hurry or prefer to take your time. The minimum equipment needed by most gardeners includes: a shovel or spade, a hoe, a rake, and a trowel. A wide selection of styles is available in each of these tools, and the choice is really one of personal preference and price range. You can get the best value for the price range you choose by knowing each tool's uses and particular qualities to look for when comparison shopping.

CULTIVATING - HAND TOOLS

A garden shovel with a pointed blade is lighter and smaller than most other shovels and is well suited for use in the garden. Shovels are earth movers with dish-shaped blades mounted to the handle at an angle. A spade has a flat blade and is designed for cutting rather than lifting or moving soil. Spades are excellent for shaping straight sided trenches and for edging beds. For general purpose digging, lifting and moving, a long handled shovel is ideal. Both shovels and spades come with long or short handles in standard or D-shaped styles. Choice of handle style will depend on personal preference; long handles offer greater leverage and are less tiring to use in many cases. Short handles are often thicker and stronger.

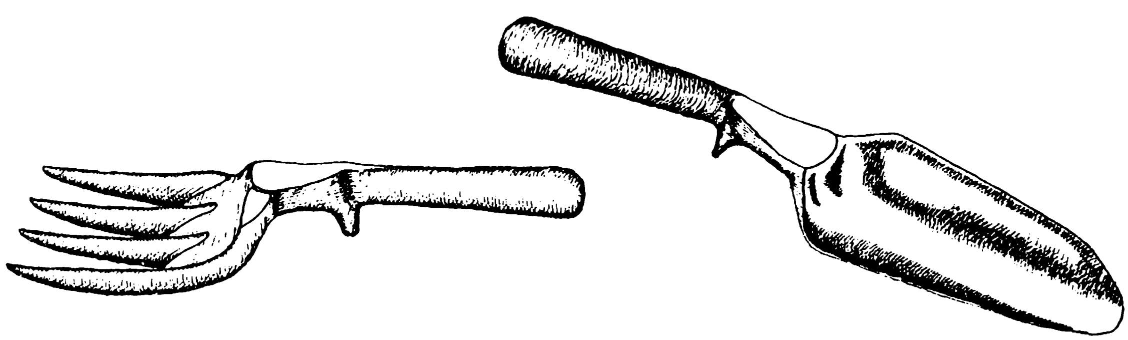


A spading fork is another useful digging tool. It is ideal for breaking and turning heavy soils and for loosening subsoil layers when doubledigging a bed. Turning coarse compost, spreading mulches, and digging root crops are other jobs for which a digging or spading fork is suited.

A hoe is essential in any garden for preparing the seed bed, removing weeds, and breaking up encrusted soil. Several different hoe styles are available. The pointed hoe with a heart-shaped blade is lightweight and useful for opening seed furrows and cultivating between plants. The hula or action hoe is a type of scuffle hoe which is very lightweight and maneuverable. Pushing and pulling it just under the soil surface eliminates newly emerging weeds and breaks up any crust on the soil surface. This type of hoe is most easily used on soil which is not compacted, since the blade is relatively thin and lacks the clod-breaking capabilities of a heavier hoe; it is also less effective in cases where weeds have gotten a good start. Other types of scuffle hoes are somewhat more sturdy, and are used with a pushing motion rather than pushing and pulling. Probably the most commonly used hoe is the square-bladed hoe, which lends itself well to many garden tasks.

A sturdy rake is useful in clearing the garden of rocks and debris. It is also helpful in spreading mulches and smoothing seedbeds. The size of the rake right for you depends on your size and strength and the uses you intend to put it to. As the number of tines increases, the rake weight also increases; avoid choosing a rake so heavy it will tire you after a short period of use. The length of the rake handle is important too; the tip of the handle should come up to your ear when standing upright. A handle that is too short will make your work harder, causing excess bending and back strain.

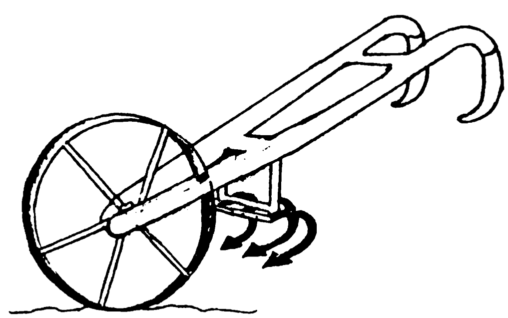
Especially in the spring, a trowel will be in constant use for those many digging jobs that need not be done with full-sized tools. The trowel is perfect for transplanting seedlings and bulbs or digging shallow-rooted weeds. Small hand cultivators, often sold in sets with trowels, are good for weeding in small areas and between closely spaced plants. Another useful small digging tool is appropriately named a digger (a.k.a. weeder, cultivator, asparagus knife). This tool is available from most hardware or discount stores for a few dollars. It is indispensable for digging up weeds with long taproots, such as dandelions or Queen Anne's lace, or for prying out Johnson grass rhizomes. It consists of a long (10"-14") solid metal rod with a two-pronged blade at one end and a handle at the other. This tool is practically indestructible and well worth the small investment of its price.



Some other tools that may have a place in the garden tool shed include the pickaxe, mattock and wheel cultivator. Pickaxes are used to break up extremely hard packed or stony soil. Mattocks are for the same purpose, but are equipped with a cutting blade for areas where larger roots need to be removed. A mattock may also be used to chop up debris for composting. A wheel cultivator has a number of attachments for soil preparation and weed control and may prove a good investment for those with larger gardens.

The power rotary tiller is probably the power tool most commonly purchased by gardeners. Whether or not a gardener needs a rototiller depends on the size of the garden, the gardener's capabilities, and the intended uses of the tiller. Tiller selection may be based on the nature of the work to be done, the quality of the machine and ease of repair, as well as personal preference. The tiller's engine powers rotating blades, or tines, which can make garden soil loose and fluffy, ready for planting. It can also chop up plant debris and mix it into the soil. Incorporating organic matter and manures into the garden is easily accomplished with a tiller, reducing the tendency to procrastinate this most necessary chore. The ability of the tiller to do these jobs effectively is a function of its weight, strength, design, type of tines, and type of soil. A heavy, powerful tiller is most effective on stony clay soils, while in a small garden or one with light soil, a smaller tiller is more appropriate. Very light-weight tillers, known as "soil blenders," are designed mainly for raised bed gardening; however, they are not widely available and generally must be mail-ordered.

Both front- and rear-mounted tine rototillers are available. Rear-tined tillers are generally better able to self-propel on all but the rockiest soils. They travel straight and can produce a footprint-free seedbed. Rear-tined tillers often have a number of attachments available for a variety of uses, such as hilling potatoes, making raised beds, even plowing snow! The price of a rear-tined rototiller is considerably higher in most cases than that of the front-tined type; consideration should be given to the payback time necessary for such a large investment.



If gardening is simply a hobby, or if the garden is small, a front-tined tiller may be suitable. Front-tined tillers are usually lighter in weight, but may require more strength to guide them through the soil. Operating this type of tiller is comparable to handling a large floor polisher such as those used in schools and hospitals - mainly, leverage is required for control, but new gardeners are sometimes scared away from these tillers because of the initial experience of having a tiller "run away" with them. The front-tined tiller may not make as straight a pass as the heavier rear-tined type, but it is much easier to turn. Due to this increased maneuverability, the front tined tiller is easier to use in small gardens and in corner areas.

The purchase of a tiller is a major investment as garden tools go. Features to look for include heavy cast iron, steel plate and tubing, heavy bearings, strong welds used in construction, and easily operable controls. Ask to look at the operator's manual and try to determine how simply a tune-up can be performed; you may save yourself a great deal of trouble and money if you can replace plugs and points yourself, particularly if you have no pick-up truck on which to load the tiller. Also consider the locations of service centers and parts dealers. Careful attention to your needs, abilities, and price range is important. Talk to people who have the types of tillers you are interested in. If possible, borrow or rent various types of machines and send for information before you buy.

If you are considering the purchase of a used rototiller, plan to do so well ahead of time so that you will not be rushed into a purchase. If you do not know much about such equipment it might be helpful to have a mechanically minded friend look over the machines you are considering. Above all, test each tiller for ease of starting and operation. An engine that smokes or runs roughly may require a lot of work. Tines should operate smoothly and freely. Check the welds in the handles to see that they are strong; re-welding may mean that the handles have broken at some time, a common problem in older tillers. Look at the dipstick if there is one; low oil or very sludgy oil may mean that the tiller has been maintained poorly. The oil and other fluids may also be checked by opening the drain plugs. Look for excessive dirt around the engine or in the air filter. This may also mean bad maintenance habits. Ask the owner for an operator's manual and ask where the machine has been serviced in the past. A good tiller is a long-term investment, so plan carefully before you buy.

OTHER POWER TOOLS

There are few other power tools needed in the vegetable garden. Cordless tools come with various cultivating attachments. Most are rechargeable and can make garden chores more pleasurable; these tools are especially useful to those with physical disabilities which limit strength.

A garden shredder is nice to have for a large garden with a lot of plant wastes. There are hand operated shredders which are slow but useful if wastes become available in small quantities and are not too coarse. Gasoline shredders are quite expensive, and may be disappointing to the gardener who wants to chip branches and other large materials. They are best used for shredding leaves, small branches, and other plant wastes (though sunflower stalks would probably be too much for one). A chipper, on the other hand, will chip large branches and other coarse material, but the cost of $1000 or more makes the chipper uneconomical for the home gardener.

CARTS/WHEELBARROWS

A wheelbarrow or cart is very handy to have in and around the garden area. It should be easy to handle when full, with good maneuverability. Durable construction is well worth paying for to ensure a long, useful life. Be sure to choose the size appropriate for your physical abilities and garden needs. A wheelbarrow generally requires more strength and control than do most garden carts, but many of the small carts generally available are made of relatively flimsy metal and, though inexpensive, are not particularly long-lasting or suitable for heavy items such as rocks. Again, consider your needs. If you plan to haul only light straw, leaves, sawdust, and such materials, then one of the small carts may be suitable. For heavier jobs, you may need a wheelbarrow; or investigate some of the newer garden carts, especially those with bicycle-size tires, which make easy work of hauling. They are made of heavy plywood and metal, but are well-balanced and easy to maneuver. These carts do, however, involve a sizeable investment (up to several hundred dollars) and a large storage space. Therefore, only serious gardeners or those with other uses for such a cart find these carts economical. One alternative is to build your own from one of several plans available from gardening magazines or private companies.

WATERING EQUIPMENT

Watering is one garden job that most gardeners must do at least occasionally. An adequate water supply may make a big difference in garden yields. Purchase of watering equipment depends upon available facilities, water supply, climate, and garden practices. If there is no outdoor spigot near the garden, the expense of having one installed may be greater than the benefits gained except in very drought-prone areas or in the case of a gardener who is fully dependent on the season's produce. Where rainfall is adequate except for a few periods in the summer, it is wise to keep watering equipment simple - a rain barrel or a garden hose with a fan-type sprinkler will suffice. A water breaker for small seedlings is a nice extra. But in areas where there are extended periods of hot weather without precipitation, the local water supply is likely to be short. Overhead sprinklers are wasteful of water, so in this case, a drip irrigation system may be in order. Drip irrigation puts water right at the roots and doesn't wet plant leaves, helping to control disease. Timers are available that allow automatic watering with drip and some other systems. However, this type of system is relatively expensive and may be considered a nuisance by some gardeners because of maintenance and placement requirements. Determine whether cultural practices such as mulching, close plant spacing, shading, or wide bed planting will meet most of your extra water needs. Then purchase watering gadgets accordingly.

SOIL TESTING EQUIPMENT

Soil test kits can be purchased in various sizes and levels of sophistication. These are handy but not always necessary; soil testing does not have to be done more frequently than once a year for most gardening purposes. If inexpensive garden soil tests are offered through the Extension Service or private labs, it is often preferable to have them do the tests, as results are likely to be more accurate. Some gardeners like to monitor the soil quality frequently, though, making a soil test kit a worthwhile purchase. An electronic pH tester is on the market for those who like gadgets.

SEEDING AND PLANTING TOOLS

Depending on the size of your garden and your physical abilities, you may want to consider a row seeder. Seeders with wheels make easy work of sowing long rows of corn or beans or other vegetables. Seeders are available which make a furrow, drop the seeds properly spaced, and close up the furrow behind the seed, all in one pass. They do not perform quite as well on small-seeded crops, and it is not really worth the effort of setting up a seeder for small areas. A hand-held seeder is probably a better choice for this type of work. Broadcast seeders are available for sowing seeds such as rye or wheat for a cover crop, but are generally not necessary for the average home gardener, since broadcasting is easily done by hand once the proper technique is learned. Finally, fluid sowing kits are sold for sowing pre-sprouted seeds in a gel that prevents drying. Fluid sowing devices may be made at home, however, at low cost.

ENVIRONMENTAL MONITORING EQUIPMENT

Serious gardeners often invest in various types of equipment that allows them to monitor the microclimate around the garden or indoors. A rain gauge is an inexpensive device that helps the gardener determine if enough rain has fallen for garden plants. A maximum-minimum thermometer is a costly, but often useful, device to measure nightly lows and daytime highs within an area; these are especially valuable in a greenhouse. Soil thermometers measure soil temperature and the internal temperature of a compost pile. Light and watering meters can be purchased for indoor plant monitoring.

TRELLISES/CAGES

Trellises and cages for vining plants save space and keep fruits off the ground, reducing the amount of stooping required for harvest and damage to plants. Look for heavy-duty materials and sturdy design that will stand up to rain, wind, and drying. Wire should be of a heavy gauge and wood should be treated with non-phytotoxic (i.e., not toxic to plants) materials. Metal parts should be rustproof or at least rust-resistant. If you build your own you will probably save a considerable amount of money and get better quality for the price.

COMPOSTING EQUIPMENT

If you wish to make compost regularly, it will be helpful to have compost bins in some form. You can construct two bins out of planks or concrete blocks. Make the bins about 4 feet high, 4 feet wide, and as long as desired, and open at one end for easy access. Leave spaces between blocks or planks for aeration. Plant refuse may be accumulated in one bin while the composting process is taking place in the other. A third bin may be desirable for near-finished or finished compost storage.

A simple, portable compost bin can be made with three or four sturdy, used pallets, which are simply stood on their ends in a square or open square and lashed or otherwise held together. This type of bin can be disassembled for easy turning and emptying and then reassembled around the new pile. A chicken wire cage supported by three or four wooden stakes will also work satisfactorily, but is somewhat less sturdy.

There are also ready-made and kit composters available, including slat-sided cylinders into which refuse is added from above and compost removed at ground level. Rotating barrels for easy turning are also available; gardeners who have physical handicaps may find either of these types easier to deal with than the standard compost bin.

Whichever type of compost maker you use, it's a good idea to make use of the nutrients which will leach out from under. This is easily done by locating the composter in the garden (which also reduces your hauling time) or under a large fruit tree. Or, make some provision to catch the run-off from the pile and use it as a liquid fertilizer.

HARVESTING EQUIPMENT

Harvesting equipment varies depending on the size and type of garden, whether or not food is to be stored, and the way in which it is to be processed. Baskets are useful to most any gardener. They may be purchased at garden or farm supply stores or sometimes may be scrounged from local grocery stores or fruit stands. Berry baskets for small fruits, baskets with handles for carrying vegetables, and peck or bushel baskets for storage are all useful. Fruit pickers are nice and easy to use for tall fruit trees. A sharp knife for cutting vegetables off plants is handy and helps prevent plant damage.

Food processing equipment includes canners, blanchers, dehydrators, and sealers for frozen food packages. There is even a (very expensive) home vacuum-packer available now. A food mill is inexpensive and very useful for making sauces and juices; a blender or food processor is also useful to the gardener with extra food. More specialized tools include corn cutters which remove kernels from the cob, bean Frenchers and shellers, cherry pitters, strawberry cappers, apple corers and peelers, jelly strainers and thermometers, and many more. For canning, a large kettle or pot is indispensable for preparing food prior to canning. A jar lifter will prevent burned fingers; a funnel for transferring food to jars reduces messiness. As always, choices depend on individual needs.

PURCHASING AND MAINTENANCE

When you purchase tools, buy for quality rather than quantity. Your tools will be in frequent use throughout the garden season. Cheap tools tend to break or dull easily and may end up making a job unnecessarily difficult and frustrating. Quality tools will last and tend to increase in value with time if well-kept. Tools should be lightweight for easy handling, but heavy enough to do the job properly. Metal parts should be of steel, which will stay sharp, keep its shape, and outlast an alloy. Individual tools differ on fine points. Consumers' magazines and gardening publications frequently have articles showing the novice what to look for in tools and list alternatives to local hardware stores, which often carry a single line of tools. Several excellent books featuring garden tools have been published and may be available at the library.

Keeping a tool clean and sharp will increase its usefulness and lengthen its life. Learn the techniques of sharpening each tool and practice them frequently. Professional gardeners often carry sharpening stones or files while working and sharpen after every hour or so of use. Clean your tools after each use. One effective method is to sink a small but deep box (with a removable cover to keep rain out) into the ground near your tool shed. Fill the box with sand and add used motor oil. At the end of the gardening day, remove clinging dirt from tools by plunging them into the oily sand several times. This will keep the tools cleaned and oiled, and will help prevent rusting.

The last and perhaps most important step in tool care is to put tools in their proper places. Tools left in the garden will rust and break and can be a safety hazard. Some gardeners paint handles with a bright color to make their tools easy to spot. And, if each tool has its own place in the storage area, it is simple to determine if tools are missing before closing up.

Before winter sets in, sharpen tools, then coat metal parts lightly with oil and rub wooden handles with linseed oil. Drain power tools of gasoline and obtain filters, mufflers, and tune-up parts so that a fall or late-winter tuning can get the machine ready for early spring jobs. Have maintenance done, if needed, over winter, when demand is lowest and you can afford to let the repairer take his or her time.

In fall, any trellises or cages that have been outdoors should be cleaned and stored inside if possible. Traps and other pest control devices should also be stored if the pest season is over. Cold frames and other season extenders should be protected from damage by ice and snow or high winds, and once their job is done should be repaired if necessary and put away if possible. Tools with wheels like cultivators, seeders, and carts should be oiled and stored.

Thoughtfully selected and cared for, your tools will give many years of service. This extra help in the garden will pay for itself in time.

SEED FOR THE GARDEN

Choosing and purchasing vegetable seeds is one of the most enjoyable gardening pasttimes. Thumbing through colorful catalogs and dreaming of the season's harvest is one way to make winter seem a little warmer. Seed purchased from a dependable seed company will provide a good start toward realizing that vision of bounty. Keep notes about the seeds you purchase - their germination qualities, vigor of plants, tendencies toward insects and disease, etc. From this information you can determine whether one seed company is not meeting your needs, or whether the varieties you have chosen are unsuitable for your area or gardening style. For example, if powdery mildew is a big problem on squash family plants in your area, the next year you may want to look for mildew-resistant varieties.

SAVING SEED

Saving your own vegetable seed is another pleasurable activity. It offers a sense of self-sufficiency and saves money. You can maintain a variety that is not available commercially, which helps to perpetuate a broad genetic base of plant materials. Breeders often search for old-time varieties when attempting to improve commercial plants, since the heirloom vegetables (as they are sometimes called) often have inbred disease- and pest-resistance or cold-hardiness. Participation in a seed-saver's exchange can be a rewarding experience. Extra seeds that you have may be traded for unusual types that are not available through other sources.

There are certain considerations that should be kept in mind when saving seed, however. Hybrid varieties will not likely grow to be the same as the parent plants; therefore, only open-pollinated varieties should be used for home seed production. Some seed dealers have responded to the increasing interest in seed-saving by clearly marking open-pollinated varieties in their catalogs. Another consideration in saving seed is the possibility of carrying seed-borne diseases into the next year's crop. Many commercially grown seeds are grown in dry areas unsuitable to fungal, viral and bacterial diseases which may be present in your region. Take care to control diseases which can be carried in seed. Another weather-related factor is the speed of drying of seeds, which can be adversely affected by frequent rains and/or humidity. And finally, if you've ever saved squash seed during a season in which you had more than one type of squash planted, you have probably seen the wierd results that may be obtained from cross-pollination! Saving seeds from cross-pollinated crops is not generally recommended for the novice because of problems with selection, requirements for hand pollination and isolation, biennial habits, and genetic variability.

Some common self-pollinated annual plants from which seed may be saved include lettuce, beans and peas, herbs, and tomatoes.

Saving beans and peas: Allow seed pods to turn brown on the plant. Harvest pods, dry for 1-2 weeks, shell, and then store in a cool (below 50 % F.), dry environment in a paper bag.

Saving lettuce seed: Cut off seed stalks when fluffy in appearance, just before all the seeds are completely dried. Seeds will fall off the stalk and be lost if allowed to mature on the plant. Dry the harvested seed stalk further, shake seeds off, and then store in a cool, dry environment in an envelope or small glass jar.

Saving herb seeds: Herbs vary in the way their seeds are produced. In general, allow herb seeds to dry on the plants until they are almost completely dry. Some seed heads, such as dill, will shatter and drop their seeds as soon as they are dry. Watch the early-ripening seeds; if they tend to fall off, harvest the other seed heads before they get to that point, leaving several inches of stem attached. Hang several stems upside down, covered with a paper bag to catch falling seed, in a warm, dry place until the drying is complete. Remove seeds from the seed heads and store in envelopes or small glass jars. Some herb seeds - dill, celery, anise, cumin, and others - are used themselves for flavoring and are ready to use once dry.

Saving tomato seeds: Pick fruit from desirable plants when ripe. Cut fruit and squeeze out pulp into a container. Add a little water, then let ferment 2-4 days at room temperature, stirring occasionally. When seeds settle out, pour off pulp and spread seeds thinly to dry thoroughly. Store in an envelope or glass jar in a cool dry place.

For all kinds of saved seeds, be sure to mark the storage containers clearly with permanent (preferably waterproof) ink, indicating the variety and date saved. Seeds will remain viable for some time if properly stored. To test for germination, sprout seeds between moist paper towels; if germination is low, either discard the seed or plant enough extra to give the desirable number of plants.

Viability of vegetable seeds (Average # Years Seeds May be Saved)

Vegetable	Years	Vegetable	Years
Asparagus	3	Leek	1
Bean	3	Lettuce	5
Beet	4	Muskmelon	5
Broccoli	5	Mustard	4
Brussels sprouts	5	Okra	2
Cabbage	5	Onion	1
Carrot	3	Parsley	2
Cauliflower	5	Parsnip	1
Celery	5	Pea	3
Chinese cabbage	5	Pepper	4
Collard	5	Pumpkin	4
Corn salad	5	Radish	5
Cress, water	5	Rutabaga	5
Cucumber	5	Spinach	5
Eggplant	5	Squash	5
Endive	5	Sweet corn	1
Kale	5	Tomato	4
Kohlrabi	5	Turnip	5
Watermelon	5		

DEPTH FOR PLANTING VEGETABLE SEEDS

The depth to cover seeds when you plant them depends on a number of factors such as the size of the seed, the type of soil you have, and the season of the year.

As a general rule, vegetable and flower seeds should be covered about 4-5 times their lateral diameter or width (not their length). There are exceptions, however; read the packet directions. Some seeds require light for germination and should not be covered at all. These instructions apply to seeds planted both inside and out.

Starting Seeds Indoors

To start seeds indoors, first be sure you have enough light. More homegrown seedlings are probably lost to this one factor than to any other. Vegetable seedlings grown under low-light conditions will most likely be leggy and weak, and many will fall over under their own weight after they are 3-4" tall. If you do not have a sunny room or back porch with a southern exposure, you will probably need supplemental lights. A simple fluorescent shop light with one warm white and one cool white bulb (or with gro-lights) will suffice.

It is probably easiest to use a soilless or peat-lite mix to start seedlings, since garden soil contains disease organisms which can be highly destructive to small plants. soil can be sterilized in the oven by baking it at 200 % F. until the internal soil temperature is 180 % F. It should be held at that temperature for 30 minutes. This is a smelly process, but it works. Garden soil that is high in clay should be conditioned ith compost or perlite to prevent excess moisture and/or shrinkage. You can mix your own peat-like mix if you prefer - 50% vermiculite or perlite and 50% fine sphagnum peat is excellent for starting seeds. Fertilizer at half the normal strength may be added to the mixture. Mix all together well.

Many types of containers can be used to start seeds. Flats or other large containers may be planted in rows and the seedlings grown until they have one or two sets of true leaves, at which point they are transplanted into other containers for growing to the size to transplant outdoors. Or, seedlings may be started in pots, old cans, cut-off milk cartons, margerine tubs, egg cartons, or other throwaways. The "pop-out" trays found at garden centers are easy to use and re-usable. Peat pots are nice, especially for large seeds and herbs. Sow one or two large seeds, or 10-12 small herb seeds, directly in each peat pot. Thin the former to one seedling per pot, but allow all the herb seeds to grow together. They hold each other up and grow much better than if sown singly. When transplant time comes, they are strong enough to take some dividing if desired. Peat pots may be planted directly in the garden; remove one side and do not allow the edges of the pot to stick out above the soil, since they will act as a wick and moisture will evaporate from this exposed surface.

Regardless of the type of container chosen, fill it 3/4 full with seed-starting mixture and sow the seeds. Cover to the specified depth and water the mix. If your home is dry, it may help to cover the containers with plastic wrap to maintain a steadier moisture level. Seeds and seedlings are extremely sensitive to drying out. They should not be kept soaking wet, however, since this condition is conducive to "damping-off," a fungus disease deadly to seedlings. Damping-off can be prevented or diminished by sprinkling milled sphagnum moss, which contains a natural fungicide, on top of the soil.

Another option is to use peat pellets or cubes, which are pre-formed and require no additional soil mix. The pellets or cubes are soaked until thoroughly wet, then seeds are planted in the holes provided. The whole pellet or cube may then be planted without disturbing the roots. The only disadvantage to this method is the expense.

STARTING SEED OUTDOORS

Many seeds may be sown directly in the garden. See the chart entitled "Plant Production Production Data Chart" for types of seed best planted this way. If your garden soil is quite sandy, or is mellow with a high content of organic matter, the seeds may be planted deeper. Young seedlings can emerge quite easily from a sandy or organic soil. If your garden soil is heavy with a high silt and/or clay content, however, the seeds should be covered only 2-3 times their diameter. In such soils it may be helpful to apply a band of sand, fine compost, or vermiculite 4 inches wide and 1/4 inch thick along the row after your seeds are planted. This will help retain soil moisture and reduce crusting, making it easier for seedlings to push through the soil surface.

Soil temperature has an effect on the speed of seed germination. In the spring, soil is often cold and seeds of some plants will rot before they have a chance to sprout. See the "Plant Production Data Chart" for optimum soil temperatures.

Crop	Days to Emergence From Seeding	Optimum Germination Soil Temp. Range	No. of Weeks to Grow Transplants
Beans	5-10	65°-85°	*
Beets	7-10	50°-85°	*
Broccoli	3-10	50°-85°	5-7
Cabbage	4-10	50°-85°	5-7
Carrots	12-18	50°-85°	*
Cauliflower	4-10	50°-85°	5-7
Celery	9-21	50°-65°	10-12
Chard, Swiss	7-10	65°-85°	*
Corn, Sweet	5- 8	65°-85°	*
Cucumber	6-10	65°-85°	4 (peat pots)
Eggplant	6-10	65°-85°	6-9
Lettuce	6-8	50°-65°	3-5
Melons	6-8	65°-85°	3-4 (peat pots)
Okra	7-10	65°-85°	*
Onion	7-10	65°-85°	8
Parsley	15-21	50°-85°	8
Peas	6-10	50°-65°	*
Pepper	9-14	65°-85°	6-8
Potatoes, Sweet	(slips)	65°-85°	5-6
Radish	3-6	50°-65°	*
Spinach	7-12	50°-65°	*
Squashes	4-6	65°-85°	3-4 (peat pots)
Tomatoes	6-12	65°-85°	5-7
Turnip	4-8	50°-65°	*

*transplants not recommended

Plant Production Data Chart

When you plant your fall garden in midsummer, the soil will be warmer and drier. Therefore, cover the seeds 6-8 times their diameter. You may need to water them each day with a sprinkler or a sprinkling can to promote germination. Moisture can also be retained with a shallow mulch or by covering the row with a board until the seeds are up. Shading the area may be helpful to keep the soil cooler for seed germination, especially when planting cool-weather crops in summer. Seed which requires a lower germination temperature (see Plant Production Data Chart) may benefit from being kept in the refrigerator for two weeks before planting, or from pre-sprouting indoors. Pre- sprouting is a useful technique for planting in cold soils, as well. However, seed must be handled very carefully once sprouted to prevent damaging the new root tissue.

Row Planting

A string stretched between stakes will provide a guide for nice straight rows, if desired. Use a hoe handle, a special furrow hoe, or a grub hoe to make a furrow of the appropriate depth for the seed being planted. Sow seed thinly; it may help to mix very small seed with coarse sand to distribute the seeds more evenly. Draw the soil over the seed, removing stones and large clods. Firming soil over seeds improves uptake of soil moisture, hastening germination. Water the seeds in to improve soil/seed contact. When plants have grown to about 4-6" tall, thin according to seed packet instructions to provide adequate room for growth.

Broadcast Planting

Many crops may be sown in wide rows or beds instead of in long, single rows. Crops such as spinach, beans, peas, beets, lettuce and carrots are especially suited to this type of culture. Seed should be sown evenly over the area, then raked in with a rake or three-pronged hand cultivator. Firm the soil over the seeds, then thin young plants to allow room for growth.

Hill Planting

Larger vegetables such as melons, squash, corn and cucumbers may be planted in hills. The soil is mounded to a foot or so in diameter, at the recommended spacing. Plant 4-6 seeds per hill, firming the soil well. Thin the seedlings to 3-5 plants per hill.

TRANSPLANTS FOR THE GARDEN

Most gardeners use transplants in their gardens at some time or another to give long-season plants a chance to grow to maturity under their preferred weather conditions, or just to lengthen the harvest season. Cool-season crops such as head lettuces, broccoli, celery, and others would not have a chance to reach their prime harvest stage in most places in Virginia in spring if not given those extra weeks indoors to get a head start. Tomatoes would certainly have a short harvest period in all but southeastern Virginia if started from seed in the ground, and peppers and eggplants might not produce at all if not grown from transplants.

Due to the amount of time, attention and need for controlled growing conditions, many gardeners prefer to purchase plants for their gardens. However, for a larger choice in varieties and the control of plant production from seed to harvest, others choose to start their own. Instructions for starting transplants from seed may be found in Publication 426-316, Seeds for the Garden.

ANNUAL PLANTS

Transplants of annual vegetables and flowers should be stocky, healthy, free from disease, and have good roots. They should not be too small or too mature (tomatoes will transplant all right with fruits already on them, but many other plants will drop flowers or fruit after transplanting). Be sure plants have been hardened-off so that they will easily adapt to environmental change, but they should not be so hardened that they are woody and yellow. Successful transplanting is achieved by interrupting plant growth as little as possible. This is one of the advantages of using peat pots or peat pellets, which do not have to be removed when transplanting.

Have the garden soil prepared before transplanting. All additives which require time to break down, such as manures, limestone, rock fertilizers, and green manures, should be incorporated at least several weeks before planting. Quick-acting (hydrated) lime and fertilizers and well-decayed compost may be added just before planting.

Transplant on a shady day, in late afternoon, or in early evening to prevent wilting. It helps to water the plants several hours before transplanting; if you are using bare-root plants, such as sweet potato slips or plants from an old-time farm supply store, soak the roots thoroughly an hour or two before setting them out in the garden. They should not have been allowed to dry out completely at any time. Handle plants carefully. Avoid disturbing the roots or bruising the stems.

Dig a hole large enough to hold the roots of the plants. Set the plants slightly deeper than previously planted and at recommended intervals. Tomatoes are an exception to the rule of how deep to plant; they will develop roots all along the stems, and you can plant deep enough to leave only two or three sets of leaves exposed. Press soil firmly around the roots of transplants. Pour about a cup of starter solution in the hole around the plant. Use a solution of about half the strength recommended for that type of plant during the normal growing season. Fish emulsion or dilute manure tea may also be used.

For a few days after transplanting, protect the plants from wind and sun by placing a piece of newspaper or cardboard on their south sides, or by covering with jugs, baskets, or flower pots. Water the plants once or twice during the next week if there is insufficient rain.

PERENNIAL PLANTS

When buying small fruit plants and perennial crowns such as asparagus, order early or buy from reliable local outlets. Discount department stores often allow plants to dry up, so watch for this, especially if you are buying bargain sale plants. Select varieties that will do well in your growing conditions. For perennial plants it will pay to do some research to find out what the major disease and insect pests are and buy resistant varieties. Dormant bareroot plants and one- or two-year-old crowns are preferred. Look for roots that are full, slightly moist, and have color. Roots that are dry brown or soggy black are indicative of poor storage and will probably not give good results. Check crowns for signs of viable buds. Inspect plants for signs of insects or disease. If you receive plants by mail which are not satisfactory, do not hesitate to write to the dealer.

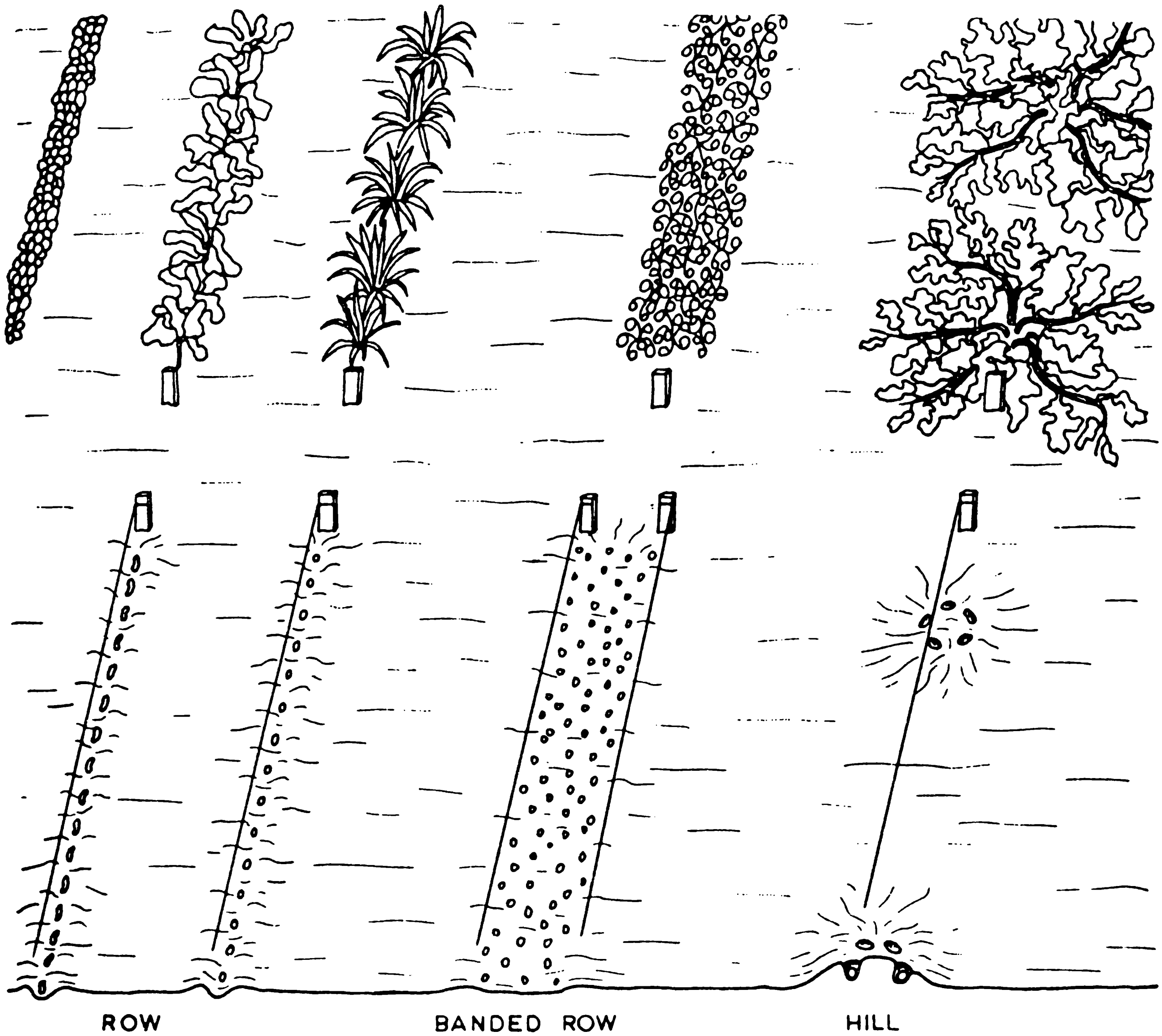
Once you have the plants, do not allow the roots to shrivel and dry out. Keep the roots moist (but not soaking wet) by misting occasionally, and do not allow them to freeze or be exposed to high temperatures. If it is necessary to keep the crowns for more than a few days, place in cold storage (not freezing) or else heel in a trench of moist soil in a shaded location. Pack soil firmly against roots to eliminate any air pockets.

Transplant crowns according to directions, digging holes large enough to give the roots plenty of room to spread. Remove any roots which are discolored or dried out. Perennial plants appreciate a dose of compost mixed into the bottom of the hole. See the Extension publications for individual plants for more details.

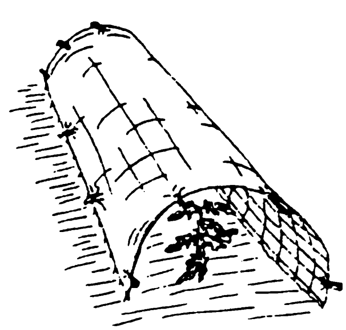
Once transplanted, shade the plants if necessary and water when needed. This extra care at the beginning of their growth will result in more productive, healthier plants.

Transplant Production Data (Ease of Transplanting)

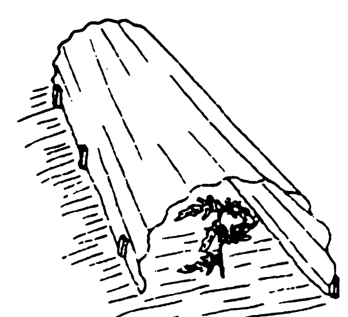
Easily Survive Transplanting	Require Care in the Operation		Not Successfully Transplanted by Usual Methods
Broccoli	Beets	Beans	
Cabbage	Carrots (young)		Corn
Cauliflower	Celery	Cucumbers	
Eggplant	Chard	Peas	
Lettuce	Melon	Okra	
Chinese cabbage		Squash	
Sweet potato slips			
Onion (tends to bolt)			
Tomatoes			
Pepper			



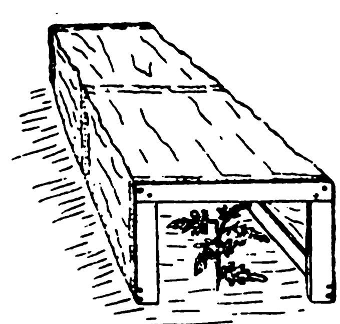
Tunnel Row Covers



Bend wire frame over plants and secure in soil. Drape clear plastic over wire and fasten with clothespins. Fold plastic back on hot days.



Bend fiberglass panel over the row and secure it with stakes.



Build a wood frame and cover it with clear plastic.

Adequate soil moisture is essential for good crop growth. A healthy plant is composed of 75-90% water, which is used for the plant's vital functions, including photosynthesis, support (rigidity), and transportation of nutrients and sugars to various parts of the plant. During the first two weeks of growth, plants are becoming established and must have water to build their root systems.

While growing, vegetable crops need about an inch of water per week in the form of rainwater, irrigation water, or both, from April to September. Keep a rain gauge near your garden or check with the local weather bureau for rainfall amounts, then supplement rainfall with irrigation water if needed. There are ways, however, to reduce the amount of water you have to add. (See below.)

During dry periods, one thorough watering each week of one to two inches of moisture (65 to 130 gallons per 100 square feet) is usually enough for most soils. The soil should be wetted to a depth of 5-6 inches each time you water and not watered again until the top few inches begin to dry out. An average garden soil will store about 2-4 inches of water per foot of depth.

REDUCING WATER DEMANDS

All of this water, however, may not be available to plants, particularly if the soil is a heavy clay. Clay particles hold soil moisture tightly; if, for example, there are 4-1/2 inches of water per foot of this type of soil, there may be as little as 1-1/2 inches available for plants. A relatively high level of humus in the soil, brought about by the addition and breakdown of organic matter, can improve this proportion to some extent. By causing clay particles to aggregate (stick together), humus also adds air spaces to tight clays, allowing moisture to drain to lower levels as a reserve, instead of puddling and running off the top of the soil.

The moisture-holding capacity of sandy soils is also improved by additions of organic matter. Though most soil water in sandy soil is available, it drains so quickly that plants are unable to reach water after even a few days following a rain. Humus in sandy soil gives the water something to cling to until it is needed by plants.

Addition of organic matter, then, is the first step in improving the moisture conditions in your garden.

Mulching is a cultural practice which can significantly decrease the amount of water that must be added to the soil. A 6-8" organic mulch can reduce water needs by as much as 1/2 by smothering weeds (which take up and transpire moisture) and by reducing evaporation of moisture directly from the soil. Organic mulches themselves hold some water and increase the humidity level around the plant. Black plastic mulch also conserves moisture but may increase soil temperatures dramatically during the summer (to the detriment of some plants and the benefit of others) if not covered by other mulch materials or foliage.

Shading and the use of windbreaks are other moisture-conserving techniques. Plants that wilt in very sunny areas can benefit from partial shade during the afternoon in summer. Small plants, in particular, should be protected. Air moving across a plant carries away the moisture on the leaf surfaces, causing more water to be needed by the plant. In very windy areas the roots often cannot keep up with leaf demands, and plants wilt. Temporary or permanent windbreaks can help tremendously.

During those times when cultural practices simply aren't enough, when rainfall is sparse and the sun is hot, watering can benefit your garden with higher yields, or may save the garden altogether in severe drought years.

Irrigation practices, when properly used, can benefit the garden in many ways:

1. Aids in seed emergence.
2. Reduces soil crusting.
3. Improves germination and plant stand.
4. Reduces wilting and checking of growth in transplants.
5. Increases fruit size of tomatoes, cucumber, and melons.
6. Prevents premature ripening of peas, beans, and sweet corn.
7. Maintains uniform growth.
8. Improves the quality and yields of most crops.

IRRIGATION METHODS

The home gardener has several options for applying water to plants - a watering sprinkler can, a garden hose with a fan nozzle or spray attachment, portable lawn sprinklers, a perforated plastic soaker hose, drip or trickle irrigation, or a semi-automatic drip system. Quality equipment will last for a number of years when properly cared for. When making a decision as to which type of watering equipment you will use there are a number of things to consider.

Purchase of watering equipment depends upon available water facilities, water supply, climate, and garden practices. If there is no outdoor spigot near the garden, the expense of having one installed may be greater than the benefits gained except in very drought-prone areas or in the case of a gardener who is fully dependent on the season's produce. Where rainfall is adequate except for a few periods in the summer, it is wise to keep watering equipment simple - a rain barrel or a garden hose with a fan-type sprinkler will suffice. A water breaker for small seedlings is a nice extra. But in areas where there are extended periods of hot weather without precipitation, the local water supply is likely to be short. Overhead sprinklers are wasteful of water, so, in this case, a drip irrigation system may be in order. Drip irrigation puts water right at the roots and doesn't wet plant leaves, helping to control disease. Timers are available that allow automatic watering with drip and some other systems.

Several types of drip or trickle equipment are available. The soaker hose is probably the least expensive and easiest to use. It is a fibrous hose that allows water to seep out all along its length at a slow rate. There are also hoses with holes in them that do basically the same thing; water drips out the holes. With the latter type, a flow regulator usually has to be included with the system so that the water can reach the end of the hose, yet not be sprayed out at full force. A special double-wall type of irrigation hose has also been developed which helps to maintain a more even flow. Finally, there is the emitter type system best used for small raised bed or container gardens, in which short tubes, or emitters, come off of a main water supply hose; emitters put water right at the roots of the desired plants. This is generally the most expensive form of irrigation and the most complex to set up, but it has the advantage that the weeds in the area are not watered, and evaporation from the soil is minimized. This type of system is best used in combination with a coarse mulch or black plastic. Drip systems generally have some problems with clogging from soil particles and/or mineral salts from water taken from springs or wells. New designs take into consideration the clogging problem; some include filters and self-flushing emitters. It is wise to make a complete investigation and comparison before purchasing a drip irrigation system.

Some basic techniques and principles for watering

1. Adjust the flow or rate of water application to about 1/2 inch per hour. Much faster than this will cause run-off, unless your soil has exceptionally good drainage. To determine the rate for a sprinkler, place small tin cans at various places within the sprinkler's reach, and check the level of water in the cans at 15 minute intervals.

2. When using the oscillating type of lawn sprinklers: (a) place the sprinkler on a platform higher than the crop to prevent water from being diverted by plant leaves; (b) try to keep the watering pattern even by frequently moving the sprinkler and overlapping about 1/2 of each pattern.

3. Do not sprinkle foliage in the evening. Wet foliage overnight can encourage diseases. Morning watering is preferred.

4. Perforated plastic hoses or soaker hoses should be placed, with holes down (if there are holes), along one side of the crop row, or underneath mulch. The water is allowed to soak or seep into the soil slowly.

5. It is best to add enough water to soak the soil to a depth of 5-6 inches. It takes approximately 2/3 gallon of water for each square foot or about 65-130 gallons for 100 square feet of garden area. This varies with the nature of your soil. Frequent, light waterings will only encourage shallow rooting which will cause plants to suffer more quickly during drought periods, especially if mulches are not used. On the other hand, too much water, especially in poorly drained soils, can be as damaging to plant growth as too little water.

6. By knowing the critical watering periods for selected vegetables or vegetable types, you can reduce the amount of supplemental water you add. This can be important, especially where water supplies are limited. In general water is most needed: during the first few weeks of development; immediately after transplant; during development of storage organs to be eaten.

Specifically, the critical watering periods for selected vegetables are:

Asparagus	Spear production, fern development
Broccoli, Cabbage, Cauliflower	Head development
Beans, peas	Pod filling
Carrot	Seed emergence, root development
Corn	Silking, tasseling, ear development
Cucumber	Flowering, fruit development
Eggplant, Tomato	Flowering, fruiting
Lettuce	Head development; moisture should be constant
Melons	Flowering, fruit development

7. In areas prone to repeated drought, look for drought-resistant varieties when buying seed or plants.

8. If water supplies are short in your area and you wish to use grey water, or water from household uses, on your vegetable garden, a few rules should be observed:

Do not use black water, any water run through the toilet, because of the possibility of contamination from fecal organisms.

It is preferable not to use kitchen waste water that contains grease or harsh cleaners, ammonia, bleach, softeners, or non-biodegradable detergents

If using water from the bathtub or washing machine, use only mild, biodegradable soaps. Omit softeners and bleaches. Allow the wash and rinse water to mix, if possible, to dilute the soap content. Never use a borax-containing product (such as washing soda) in water to be used on a garden because of the danger of applying plant-toxic levels of boron.

Apply greywater to the soil, not to plant leaves.

FERTILIZING YOUR GARDEN

The amount of fertilizer to apply to a garden depends on the natural fertility of the soil, the amount of organic matter present, the type of fertilizer used, and the crop being grown. The best way to determine fertilizer needs is to have the soil tested. Soil testing is available through your local Extension agent, through private labs, and with soil test kits which can be purchased from garden shops and catalogs. Vegetables fall into three main categories according to their fertilizer requirements heavy feeders, medium feeders, and light feeders. You may find it advantageous to group crops in your garden according to their fertilizer requirements to make application easier. For a complete discussion of fertilizers, refer to the Soil section of this handbook.

WEED CONTROL IN THE GARDEN

The old saying, "One year's weed - seven years' seed," contains more truth than myth, as most gardeners soon learn. Weeds, or native plants if you prefer, are remarkably adapted to conditions in the area where they grow - usually much more so than the "imported" cultured vegetables we prize so highly for food. Many weeds which would otherwise not be growing in a lawn or natural area appear to spring up as if by magic when the soil is cultivated. Weed seeds may remain viable for those seven (or more) years when conditions are not right for their growth. Then, brought to the surface by tilling, and uninhibited by sod or shade or other factors, they germinate and become the pests that take water, nutrients, sunlight and space from our vegetable plants. So we destroy them.

BENEFICIAL WEEDS

Native plants are not all bad. Some, such as the Venice mallow (or flower-of-an-hour), morningglory, and even thistles, have flowers that rival those we intentionally plant in flower beds. In fact, seeds of some "weeds" are sold by seed companies as flowering plants.

Other native plants are edible, providing nutritious variety to the regular diet: dandelions, purslane, chickweed, cress, mustards, and lambsquarters all offer greens; blackberries produce sweet fruits; Jerusalem artichokes (Sunchokes) are nothing but the tubers of the native sunflower; and, of course, there is always wild asparagus to stalk. Before you attempt to eat wild plants, be sure that you have them properly identified. Taking a course from a person knowledgeable about wild edibles is probably the best way to learn, since books often do not make fine distinctions between edible and non-edible wild plants.

Weeds are often a habitat for various insects, some of which are beneficial to the garden. They provide shelter, pollen and nectar for such insects as bees and predators of garden pests, such as preying mantids.

Wild plants also have other virtues. Parts of some plants are used in natural dyes and other home-made products. Weeds can be a good source of nitrogenous materials for the compost pile if pulled before flowering. Many have long roots which bring elements from the subsoil into their above-ground tissues; when the weeds are pulled or tilled and allowed to decay in the garden, these elements are made available to other plants. Finally, the presence of some native plants can indicate certain soil problems - deficiencies, pH changes, soil compaction, etc. - if the gardener knows how to read them. A small number of books are available with detailed information on this subject.

CONTROL METHODS

Despite all this goodness, though, most gardeners don't tolerate weeds in their vegetable plots. Perhaps it is an overreaction to the first garden he or she allowed to go completely to weeds ("I think there's a cucumber in here somewhere") or perhaps it's the unruly appearance of weeds, but most gardeners try to keep weeds out of the garden as much as possible. This may be a sensible approach. If one doesn't have time to ruthlessly destroy morningglory vines after enjoying the first few flowers - before they go to seed - the garden will soon become one glorious display of morningglories and little else.

Cultivation

There are several ways to rid the garden of most of the problem plants. Since mature weeds extract large quantities of moisture and nutrients from the soil, it is more beneficial (and easier) to remove the weeds when they are young and tender. Hand-pulling and digging are okay for small gardens and raised beds. Those with larger spaces usually prefer at least a hoe. There are manual-powered rotary cultivators that do a good job on long rows and pathways as long as the soil is not too wet or dry and the weeds are small. In large gardens, a rotary tiller of appropriate size makes the work easy and fast, but it is not the most pleasant chore to get behind a smoky, noisy engine on a hot August day. The manual and powered rotary cultivators are usually unable to turn under weeds very close to vegetable plants without damaging the vegetables. Hand-pulling or hoeing with a light touch are best for removing weeds near vegetable plants. Deep cultivation with any instrument is likely to damage roots or stems of your crop plants.

Turning under of weeds, especially before they flower, provides organic matter to the soil. Hand-pulled weeds (except for rhizomatous grasses) may be laid on top of the soil to dry out and will eventually have the same effect. However, if rain is predicted in your area within a day or two, it's best to put the weeds in a basket as you go along and add them to the compost pile; rain will wash soil around the roots and some weeds will survive. If weeds have started to go to seed, leaving them in the garden is not a good idea. Composting may not destroy weed seeds if the pile doesn't heat up enough after the weeds are added. Grasses that spread by rhizomes or stolons also present a problem if not completely dried up. In these cases, despite their potential value as organic material, it's probably better to let the trash men take the weeds, or burn them and spread the ashes in the garden (if local ordinances permit). Reducing weed growth around the garden by mowing or other means will also help prevent the spread of weeds and seeds to the garden area.

Cultivation is best done when the soil is somewhat moist, but not wet. Working wet soil will change the structure, especially of heavy soils. When it is too dry, weeds are difficult to pull and hoeing is also harder. A day or two after a rain or irrigation is probably the best time to cultivate. And if you have a choice, remember that the work will be much more pleasant in the cool temperatures of early morning or evening. On hot summer afternoons, you are likely to fatigue more easily, get a sunburn, or suffer from sun poisoning, sunstroke or worse. Wear protective clothing if you must work when it's hot, and stop frequently for rest and refreshment.

Mulching

But what if you don't have the time or the desire to do all that weeding? Mulching may be the answer if you have a reliable and constant source of mulching materials. (See VPI & SU Publication 426-326, Mulches for the Home Garden, for detailed information on various mulches.) Thick layers of organic mulch will not allow most annual weeds to poke through, and those that do are usually easily pulled. Weeds with runners, though, often are not so easily controlled, and black plastic may be a better choice where these prevail. For paths, newspaper, old carpeting, or other such materials, covered with sawdust, will provide excellent weed suppression. However, sawdust is not recommended for use right around plants because of its tendency to crust and because bacteria take nitrogen from the soil (and thus from vegetables) to break sawdust down.

Close Spacing

Once vegetable plants are established, if they have been planted close enough to each other they will shade the soil and prevent the growth of many weed seedlings. This is the effect achieved by a well-planned raised bed, in which plants are spaced so that the foliage of adjacent plants touches (forming a "closed canopy") at a mature growth stage.

Other Practices

Some gardeners are experimenting with various types of no-till gardening to reduce weed problems (as well as prevent erosion and moisture loss). The standard farm no-till practice of sowing a fall cover crop and then killing it with a herbicide, and planting vegetables in the dead sod (after a recommended waiting period) is one method. However, there are no herbicides recommended for use in established home vegetable gardens to kill emerged weeds at the present time. Use of weed-killers normally recommended for lawns or other areas is not advised, and until a safe herbicide is available for growing weeds, this type of no-till practice is unsafe for growing vegetables in the home garden. One alternative is the use of a living sod, mowed regularly, which has many of the benefits of no-till and does not necessitate the use of herbicides. This practice works best with raised beds, so that only the paths need to be mowed.

The use of cover crops over several seasons or years in a particularly weedy section can also reduce weed problems. However, this method requires leaving that part uncultivated, reducing your gardening space. Cover crops must also be mown or harvested regularly, which can be time-consuming and/or difficult if you lack appropriate tools. Investigate crop rotations thoroughly before using them to control weeds. All of the above techniques are still in the experimental stage for home gardeners. Try them in small sections of your garden to determine how effective they may be for your garden.

Herbicides

As mentioned before, herbicides may be used in and around the home garden, but it can be a risky business. They should always be used according to label instructions and only for crops listed on the label. The wrong herbicide can destroy your garden's productivity for years. Various products containing glyphosate may be used before vegetables are planted but not after they have emerged. Again, check with your Extension agent for recommendations. Even when used properly, drift from herbicide sprays used on the lawn or in areas surrounding the garden can cause damage to vegetable plants, so take care to spray on windless days and erect barriers to protect plants if necessary. (Drift from pre-emergence herbicides does not damage growing plants, but may prevent seeds from germinating.) Be aware that treatment with a herbicide for one type of weed may result in the area being colonized by other weeds which are tolerant to the chemical. Finally, never use an herbicide in the same sprayer you use for insect and disease control - keep a separate one for plant-killers only.

VEGETABLE PLANTING GUIDE AND RECOMMENDED PLANTING DATES

PLANTING MAP/GUIDE/DATES

The Planting Area Map which follows can be used to determine the average date of last frost in your area. The actual dates will vary due to local conditions and yearly temperature fluctuations. The average date of last killing frost in the spring can be used to adapt the Recommended Planting Dates Chart to your particular area. Specific instructions accompany this chart.

This chart can be used to tell the approximate earliest and latest date for a spring planting of each crop and the average length of harvest for each crop. This is particularly important in making maximum use of your garden space by following one crop with another one as soon as the first harvest is complete.

The Vegetable Planting Guide can be used to determine the approximate proper amount of a crop to plant to get the desired yield, the amount of seeds or transplants required to plant that amount of a crop, and the proper spacing between plants in a row.

In intensive, raised-bed gardens use the in-row figures between all plants; i.e., use equidistant spacing between plants. Sow seeds to a depth 3-5 times the diameter of the seed. For mid-summer plantings, sow up to twice this depth.

PLANTING AREAS MAP

PIEDMONT AREA

average last killing frost in spring
4/20 - 4/30

average first killing frost in fall
10/19 - 10/29

TIDEWATER AREA

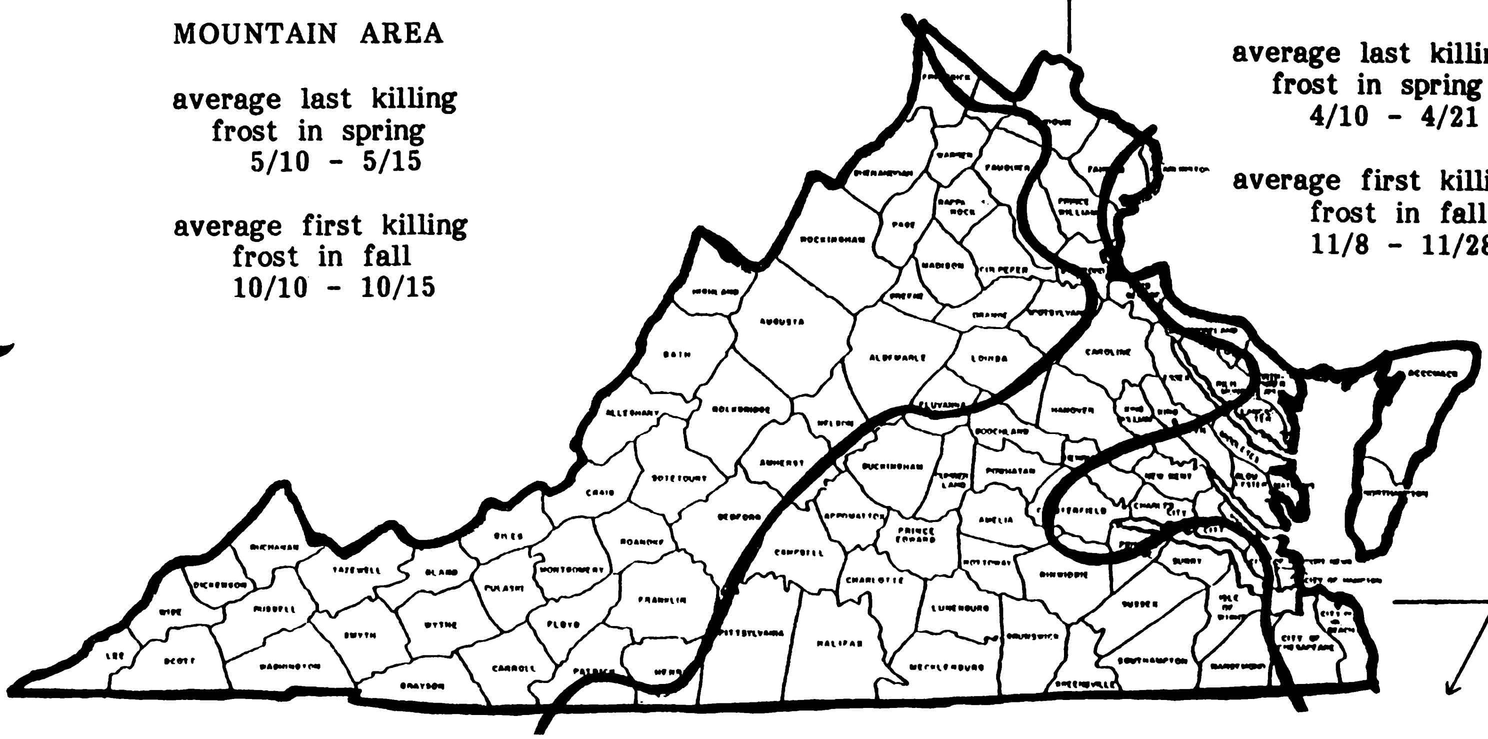
average last killing frost in spring
4/10 - 4/21

average first killing frost in fall
11/8 - 11/28

MOUNTAIN AREA

average last killing frost in spring
5/10 - 5/15

average first killing frost in fall
10/10 - 10/15



average number of frost free days

165 days

average number of frost free days

230 days

average number of frost free days

182 days

FALL VEGETABLE PLANTING CHART

To use this chart, write in the date of your average first fall frost on the line above the 00 column. From there, fill in the dates before that frost, to the left of the 00 column, each 10 days prior to the last. For example, if your average first frost date is October 25, write October 25 on the line above 00. Then write October 15 above the column marked 10 to the left of the 00 column, October 5 in the next column to the left, etc. To the right of the 00 column, write November 4, November 14, November 24, etc. To plan for a spring garden, use the planning calendar in VPI & SU Publication 426-332.

XXXXX = Planting period   ***** = Plant and harvest   ++++++ = Harvest period

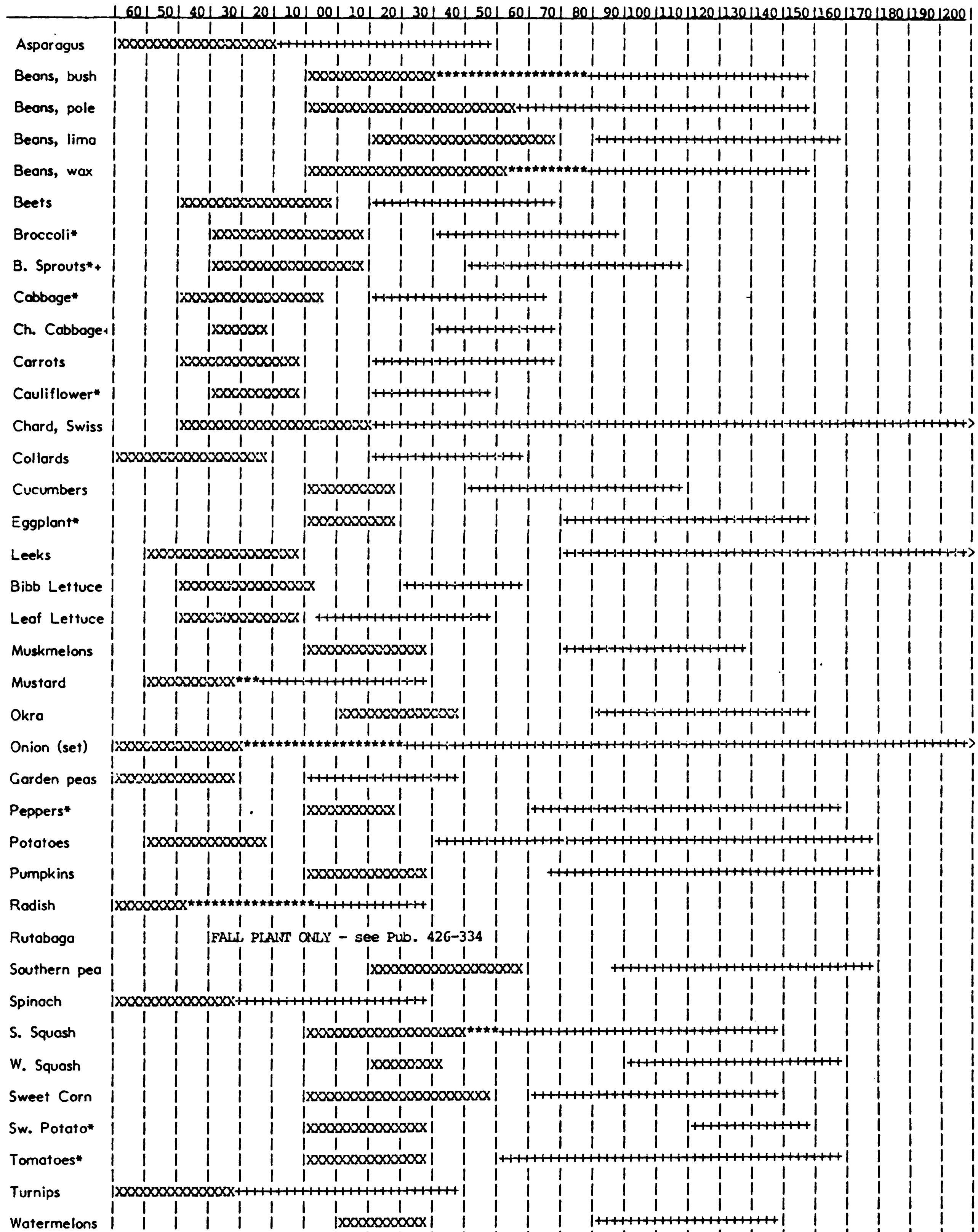
Columns: |160|150|140|130|120|110|100| 90| 80| 70| 60| 50| 40| 30| 20| 10| 00| 10| 20| 30| 40| 50| 60| 70| 80| 90|100|

Vegetable	XXXXX Planting period (days before 00)	***** Plant and harvest	++++++ Harvest period
Beans, bush	130–100		70 before – 00
Beans, wax	130–100		70 before – 00
Beets	110–80		60 before – 00
Broccoli	120–110		50 before – 10 after
B.Sprouts	130–110		50 before – 100 after >
Cabbage	120–100		50 before – 10 after
Ch. Cabbage	110–100		40 before – 20 after
Carrots	100–80		40 before – 100 after >
Cauliflower	90–80		20 before – 20 after
Chard, Swiss	100–80		30 before – 40 after
Collards	100–90		20 before – 40 after
Cucumbers	100–80		50 before – 10 before
Endive	80		00 – 40 after
Kale	90–70		30 before – 100 after >
Kohlrabi	70–40		00 – 50 after
Leeks	150–110		20 before – 100 after >
Bibb Lettuce	70–50		10 before – 20 after
Leaf Lettuce	70–50		30 before – 20 after
Mustard	60–40		20 before – 40 after
Onion seed*	60–30		HARVEST NEXT SPRING
Garden peas+	80		20 before – 20 after
Potatoes*	90		00 – 100 after >
Radish	60–40	30	20 before – 20 after
Rutabaga*	80–70		00 – 100 after >
Spinach	80–50		40 before – 40 after
Turnips	80–70	50	40 before – 100 after >

* Tidewater and Piedmont only   + Mountains only

RECOMMENDED PLANTING DATES

Instructions: To use this chart, write in the date of your average last spring frost on the line above the 00 column. From there, fill in the dates before that frost, to the left of the 00 column, each 10 days prior to the last. For example, if your average last frost date is April 15, write April 15 on the line above 00. Then write April 5 above the column marked 10 to the left of the 00 column, March 26 in the next column to the left, etc. To the right of the 00 column, write April 25, May 5, May 15, etc. Also make note of the approximate first frost date in the fall so you will know dates of end of harvest for tender crops. This will vary for different areas of Virginia. To plan for a fall garden, use the fall planning calendar in VPI & SU Publication 426-334.



KEY: * Transplants + Use special two-season varieties only
XXXXX = Planting period ***** = Plant and harvest ++++++ = Harvest period

VEGETABLE PLANTING GUIDE

Crop	Planting Distances in feet or inches		Approximate yield per 10 feet of row	Approximate no. of row feet to plant per person	Transplants or seed required per 10 feet of row	
	In rows	Between rows			No. of plants	Amount of seed
Asparagus	18"	48-60"	3-4 lbs.	15-20'	7-8 crowns	
Beans, bush	1-2"	24-30"	3-5 lbs.	20-50'		1 oz.
Beans, pole	4-12"	36-48"	6-10 lbs.	10-30'		1 oz.
Beans, lima	3-4"	24-36"	3-5 lbs.	20-30'		1 oz.
Beans, wax	2"	24-36"	3-5 lbs.	20-50'		1/8 oz.
Beets	2-3"	12-24"	8-10 lbs.	10'		1/8 oz.
Broccoli	15-24"	24-36"	4-6 lbs.	10-20'	5-8 or	1/10 oz.
Brussels sprouts	18-24"	30-36"	3-4 lbs.	10'	5-7 or	1/10 oz.
Cabbage	15-18"	30-36"	10-25 lbs.	10-15'	5-8 or	1/10 oz.
Chinese cabbage	12-24"	18-30"	20-30 lbs.	10-15'	8-12 or	1/5 oz.
Carrots	1-2"	15-30"	7-10 lbs.	10-20'		1/5 oz.
Cauliflower	14-24"	24-36"	8-10 lbs.	10-15'	5-8 or	1/10 oz.
Chard, Swiss	6-12"	18-30"	8-12 lbs.	5-10'		1/5 oz.
Collards	18-24"	24-36"	8-15 lbs.	10-15'	5-7 or	1/10 oz.
Cucumbers	12-18"	48-72"	8-10 lbs.	15-20'		1/10 oz.
Eggplant	18-24"	30-42"	10-12 lbs.	3-6'	5-7 or	1/40 oz.
Endive	9-12"	18-30"	3-6 lbs.	5-10'	5-10 or	1/40 oz.
Kale	10-18"	18-36"	4-8 lbs.	10-15'	6-10 or	1/10 oz.
Kohlrabi	4-6"	12-36"	4-8 lbs.	5-10'		1/10 oz.
Leeks	3-6"	12-30"	10-20 lbs.	3-6'		1/10 oz.
Lettuce (Bibb)	6-10"	14-24"	4-8 lbs.	15-20'		1/40 oz.
Lettuce (leaf)	4-6"	12-18"	5-10 lbs.	10-15'		1/40 oz.
Muskmelons	24-36"	60-90"	15-25 lbs.	8-12'	3-5	1/8 oz.
Mustard	3-4"	18-30"	3-6 lbs.	5-10'		1/10 oz.
Okra	12-18"	36-48"	5-10 lbs.	5-10'	7-10 or	1/5 oz.
Onions (sets)	2-4"	12-24"	7-10 lbs.	15-25'	30-60	1 lb.
Peas (English)	1-3"	12-30"	2-6 lbs.	40-60'		1/2 oz.
Peppers	18-24"	30-36"	5-18 lbs.	5-10'	5-7	NA
Potatoes, Irish	10-21"	24-36"	10-20 lbs.	75-100'		1 lb.
Pumpkins	4-7'	6-8'	10-20 lbs.	10'		1/20 oz.
Rutabaga	3-6"	15-30"	8-12 lbs.	5-10'		1/8 oz.
Southern peas	2-4"	24-30"	5-18 lbs.	25-30'		1 oz.
Sweet corn	9-12	24-36"	7-10 lbs.	40-60'		1/2 oz.
Spinach	3-6"	15-30"	4-6 lbs.	30-40'		1/8 oz.
Squash, summer	24-36"	36-60"	20-80 lbs.	5-10'		1/10 oz.
Squash, winter	3-7'	3-10'	10-80 lbs.	10'		1/10 oz.
Sweet potatoes	12-18"	36-48"	8-12 lbs.	75-100'	7-10	NA
Tomatoes	18-36"	36"	15-45 lbs.	10-15'	3-7	NA
Turnips	2-3"	12-24"	8-12 lbs.	10'		1/8 oz.
Watermelons	6-8'	7-10'	8-40 lbs.	10-15'	1-2	1/2 oz.

VEGETABLES RECOMMENDED FOR VIRGINIA

VEGETABLE VARIETY	*REMARKS*	*RESISTANT TO THE FOLLOWING*
ASPARAGUS		
Mary Washington (2-3 years)**	will produce for many years	rust
Beacon F (2-3 years)		fusarium crown rot
BEANS, BUSH		
Contender (50)		mosaic, mildew
Dwarf Horticultural (65)	"October" shell beans.	mosaic
Gator Green (55)		NY 15 and common mosaic
Slenderette (55)	canning	mosaic
Kentucky Wonder 125 (60)	bush, with pole bean flavor	mosaic, mildew
BEANS, LIMA		
Thaxter (70)		downy mildew
Jackson Wonder (65)		heat and drought
Fordhook 242 (75)		
BEET		
Ruby Queen (65)		
Detroit Dark Red (60)		
BROCCOLI		
Premium Crop (80)	for early crop	heat
Bonanza (95)	for fall crop	cold
Green Goliath (80)	bears over long period	
BRUSSELS SPROUTS		
Jade Cross (110)		
CABBAGE		
Stonehead (75)		yellows
Round Up (90)		yellows
Little Rock (96)		bacterial spot
Guardian (80)		black rot
Two Season (85)	Chinese cabbage	
CARROTS		
*Gold King (72)	nearly coreless	
Danvers (72)		
Imperator (78)		
CAULIFLOWER		
Snow Crown (80)	early spring or fall	
Self blanche (95)	wrapper leaves protect head; not for fall in western Va. due to late maturity	

VEGETABLE VARIETY	*REMARKS*	*RESISTANT TO THE FOLLOWING*
CORN, SWEET		
Sundance (65)		
Reward (63)		
Pennfresh (85)	early crop only	
Seneca Scout (85)	more stalks with 2 large ears	
Early Sunglow (64)		
Silver Queen (90)		
Golden Queen (95)		
CUCUMBER		
Dasher II (60)	slicing	anthracnose, leaf spot, mosaic, mildew, scab
Gemini (60)	slicing	same as Dasher II
*Bush Whopper (68)	slicing	anthracnose, leaf spot, mildew
Sweet Slice (65)	slicing	mosaic, downy mildew
Liberty (56)	pickling	anthracnose, leaf spot, mosaic, scab, mildews
EGGPLANT		
Mission Bell (95)	oval shape	
Black Knight (110)		
Black Beauty (120)		
KALE		
Vates Dwarf Blue (55) Curled		
LETTUCE		
Salad Bowl (50)	leaf	
Great Lakes (80)	head, heat tolerant	
Mission (Trial) (80)		
Dark Green Boston (70)	loose heading, heat tolerant	
Parris Island Cos (75)		
Buttercrunch (65)	Bibb-type	
MUSKMELON		
Ambrosia (82)	best flavor	powdery and downy mildew
Super Star (86)	tolerates powdery mildew & fruit spot	fusarium wilt
*Short n Sweet (85)		
Venus (90)	honeydew, green flesh, slipstem	fusarium wilt

VEGETABLE VARIETY	REMARKS	RESISTANT TO THE FOLLOWING
MUSTARD		
Tendergreen F1 (40)		
Southern Giant Curled (45)		
OKRA		
Annie Oakley (50)	spineless	
Clemson Spineless (56)		
ONION		
White Portugal (100)	white	
Silverskin (100)	white	
Ebenezer (110)	brown	
Mustang (110)	brown; stores well after curing	
Yellow Danvers (110)	same as Mustang	
PEAS		
Alaska (56)		fusarium wilt
*Novella (62)	easy to pick; fewer leaves; edible tendrils	
Greater Progress (62)		
Sugar Snap (70)	edible pod; needs support	fusarium wilt
Wando (68)	tolerates heat	
Green Arrow (70)	tolerant of downy mildew and fusarium wilt	
PEAS, SOUTHERN		
Queen Anne (56)		
Purple Hull Crowder (60-70)		
PEPPER		
Lady Bell (110)	sweet	drought, mosaic
Keystone		
Hungarian Wax (100)	hot	
Red Cayenne (110)	hot	
POTATO, IRISH		
Pungo (eastern Va) (100)		
Superior (eastern Va) (100)		
Pontiac (100)	red	
Kennebec (western Va) (112)	mosaic, late blight	
POTATO, SWEET		
Centennial (120)	also western Va. on S or SE slopes	
Jewel (120)		
Baker (120)		

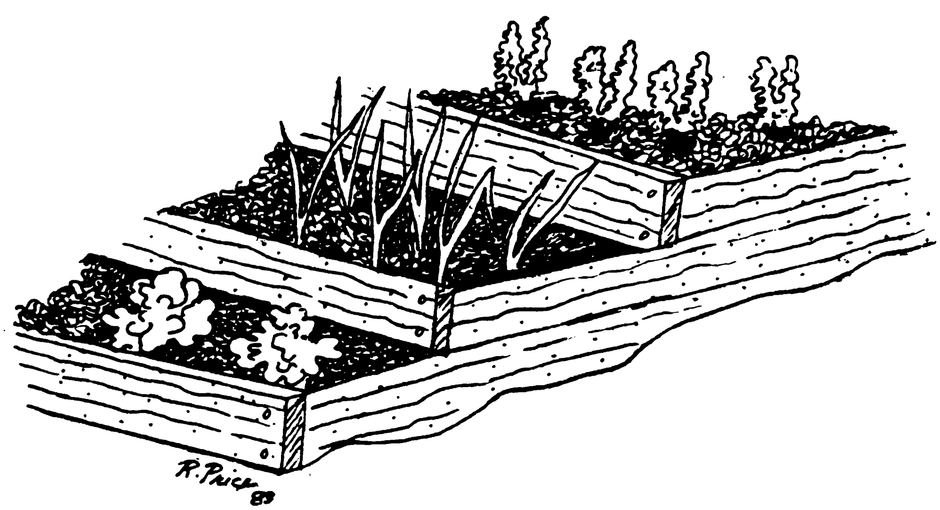
*These varieties specifically bred for minimum space requirements, as for urban or high density plantings. Your extension agent can advise you of sources of supply for new varieties.

VEGETABLE VARIETY	REMARKS	RESISTANT TO THE FOLLOWING
PUMPKIN		
Funny Face (100)	10-inch pumpkins	
*Spirit (105)	bush type	
Howden (110)	large, uniform	drought
Spookie (110)	small, uniform	drought
Sugar (110)	pie type, small	
RADISH		
Cherry Belle (24)	round, red	
Stop Lite (24)	round, red	
Icicle (30)	long, white	
SPINACH		
Melody (50)	tolerates heat	
SQUASH, SUMMER		
Butterbar (50)	yellow	
Goldbar (50)	yellow	
Goldrush (50)	yellow zucchini	
Aristocrat Zucchini (50)	green	
SQUASH, WINTER		
*TableAce (80)	acorn	
Table Queen (85)	acorn	
*Gold Nugget (85)	yellow	
*Butterbush (96)	butternut	
Waltham Butternut (96)	white	squash borer
Buttercup (100)		
SWISS CHARD		
Rhubard (50)		
Lucullus (45-55)		
TOMATO		
Quick Pick (60)	excellent flavor	fusarium wilt
Pik Red (70)	concentrated set, good canning	verticillium, fusarium wilt
Floramerica (78)		same as Pik Red
Better Boy VFN (105)		same as Pik Red
Sweet 100 (65)	Cherry tomato	
TURNIP		
Tokoyo Cross (40)		
Purple Top White Globe (55)	use for fall crop only	
All Top F1 (45)	for greens only	
WATERMELON		
Petite Sweet (80)	8 pounds	anthracnose and fusarium wilt
*Sugar Bush (75)	10 pounds	
Royal Charleston (90)	20-25 pounds	same as above
Crimson Sweet (90)	25 pounds	same as above
Top Yield (86)		anthracnose, fusarium wilt, and hollow heart

The purpose of an intensively grown garden is to harvest the most produce possible from a given space. More traditional gardens consist of long, single rows of vegetables spaced widely apart. Much of the garden area is taken by the space between the rows. An intensive garden reduces wasted space to a minimum. The practice of intensive gardening is not just for those with limited garden space; rather, an intensive garden concentrates your work efforts to create an ideal plant environment, giving better yields with less actual labor.

Though its benefits are many, the intensive garden may not be for everyone. Some people enjoy the sight of long, straight rows in their gardens. Others prefer machine cultivation to hand weeding; though there is often less weeding to do in intensive plantings (because of fewer pathways and closely spaced plants), what weeding has to be done is usually done by hand or with hand tools. Still other gardeners like to get their gardens planted in a very short period of time and have harvests come in all at once. The intensive ideal is to have something growing in every part of the garden at all times during the growing season.

A good intensive garden requires early, thorough planning to make the best use of time and space in the garden. The interrelationships of plants must be considered before planting, including nutrient needs, shade tolerance, above- and below-ground growth patterns, and preferred growing season. Using the techniques described below, anyone can develop a high-yielding intensive garden.



THE RAISED BED

The raised bed or growing bed is the basic unit of an intensive garden. A system of beds allows the gardener to concentrate soil preparation in smaller areas, resulting in more effective use of soil amendments and creating an ideal environment for vegetable growth.

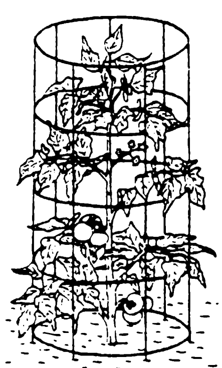
Beds are generally 3'-4' wide and as long as desired. The gardener works from either side of the bed, reducing the incidence of compaction caused by walking on the soil.

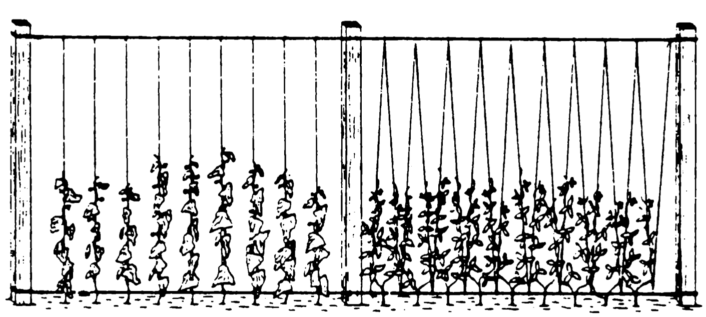
Soil preparation is the key to successful intensive gardening. To grow so close together, plants must have adequate nutrients and water. Providing extra synthetic fertilizers and irrigation will help, but there is no substitute for deep, fertile soil high in organic matter. Humus-rich soil will hold extra nutrients, and existing elements that are locked up in the soil are released by the actions of earthworms, microorganisms and acids present in a life-filled soil, making them more available for plant use.

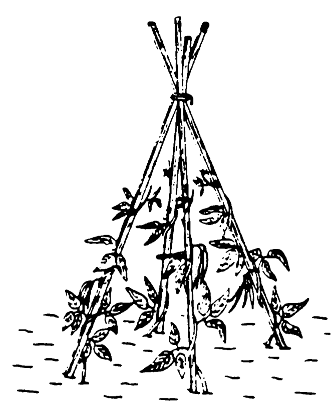
If your soil is not deep, double-dig the beds for best results. Remove the top twelve inches of soil from the bed. Insert a spade or spading fork into the next 10"-12" of soil and wiggle the handle back and forth to break up compacted layers. Do this every 6"-8" in the bed. Mix the top soil with a generous amount of compost or manure, and return the mixture to the bed. It should be somewhat fluffy and may be raised a bit. To create a true raised bed, take topsoil from the neighboring pathways and mix it in as well.

This is a lot of work! Try it in one or two beds for some of your most valuable plants; if you like the results you can proceed to other beds as you have time. One nice thing about raised bed gardening is that it breaks your work up into units. Instead of gazing desperately at a garden full of weeds, thinking you'll never have time to clean it up, you can look at each bed and say, "I can do that in half an hour today!" Other chores are accomplished with the same ease.

By their nature, raised beds are a form of wide-bed gardening, a technique by which seeds and transplants are planted in wide bands of several rows or broadcast in a wide strip. In general, the goal is to space plants at equal distances from each other on all sides, such that leaves will touch at maturity. This saves space, and the close plantings reduce moisture loss from surrounding soil.







VERTICAL GARDENING

The use of trellises, nets, strings, cages or poles to support the growing plant constitutes vertical gardening. This technique is especially suited, but not limited, to gardeners with a small garden space. Vining and sprawling plants, such as cucumbers, tomatoes, melons and pole beans are obvious candidates for this type of gardening. Some plants entwine themselves onto the support, while others may need to be tied. Remember that a vertical planting will cast a shadow, so beware of shading sun-loving crops - or take advantage of the shade by planting shade-tolerant crops near the vertical ones. Plants grown vertically take up much less space on the ground, and though the yield per plant may be (but is not always!) less, the yield per square foot of garden space is much greater. Because the vertically growing plants are more exposed, they dry out faster and may need to be watered more frequently. This fast drying is also an advantage to those plants susceptible to fungus diseases. A higher rate of fertilization may be needed, and soil should be deep and well-drained to allow roots to extend vertically rather than compete with others at a shallow level. Several examples of vertical gardening structures are shown.

INTERPLANTING

Growing two or more types of vegetables in the same place at the same time is known as interplanting. Proper planning is essential to obtain higher production and increased quality of the crops planted. This technique has been practiced for thousands of years, but is just now gaining widespread support in this country. To successfully plan an interplanted garden the following factors must be taken into account for each plant: the length of the plant's growth period, its growth pattern (tall, short, below or above ground), possible negative effects on other plants (such as the allelopathic effects of sunflowers and Jerusalem artichokes on nearby plants), preferred season, and light, nutrient and moisture requirements. Interplanting can be accomplished by alternating rows within a bed (plant a row of peppers next to a row of onions), by mixing plants within a row, or by distributing various species throughout the bed. For the beginner, alternating rows may be the easiest to manage at first.

Long season (slow maturing) and short season (quick maturing) plants like carrots and radishes, respectively, can be planted at the same time. The radishes are harvested before they begin to crowd the carrots. An example of combining growth patterns is planting smaller plants close to larger plants, (radishes at the base of beans or broccoli). Shade tolerant species like lettuce, spinach, and celery may be planted in the shadow of taller crops. Heavy feeders, such as cabbage family crops, should be mixed with less gluttonous plants. Root, leaf, and soil-building crops (legumes) may be mixed to take advantage of available nutrients.

Interplanting can help keep insect and disease problems under control. Pests are usually fairly crop-specific; that is, they prefer vegetables of one type or family. Mixing families of plants helps to break up large expanses of the pest-preferred crop, helping to contain early pest damage within a small area, thus giving the gardener a little more time to deal with the problem. One disadvantage is that when it does come time to spray for pests, it's harder to be sure that all plants are protected.

SPACING

Individual plants are more closely spaced in a raised bed or interplanted garden. An equidistant spacing pattern calls for plants to be the same distance from each other within the bed; that is, plant so that the center of one plant is the same distance from plants on all sides of it. In beds of more than two rows this means that the rows should be staggered so that the plants in every other row are between the plants in the adjacent rows (see illustration). The distance recommended for plants within the row on a seed packet is the distance from the center of one plant to the center of the next. This results in a more efficient use of space and leaves less area to weed and mulch. The close spacing tends to create a nearly solid leaf canopy, acting as a "living mulch," decreasing water loss, and keeping weed problems down. However, plants should not be crowded to the point at which disease problems arise or competition causes stunting.

SUCCESSION AND RELAY PLANTING

Succession planting is an excellent way to make the most of a intensive garden. To obtain a succession of crops, plant something new in the spots vacated by spent plants - corn after peas is a type of succession.

Relaying is another common practice, consisting of overlapping blocks of one vegetable grown over a period of time - a new block is planted before the old one is removed. For instance, sweet corn may be planted at two-week intervals for a continuous harvest. This requires some care, though; crops planted very early are likely to get a slower start because of low temperatures. In the case of corn, it can be disastrous to have two varieties pollinating at the same time, as the quality of the kernels may be affected. Give early planted corn extra time to get started, for best results. Another way to achieve the same result is to plant at once various varieties of the same vegetable; for example, you can plant an early-, a mid-, and a late-season corn at the same time have a lengthy harvest.

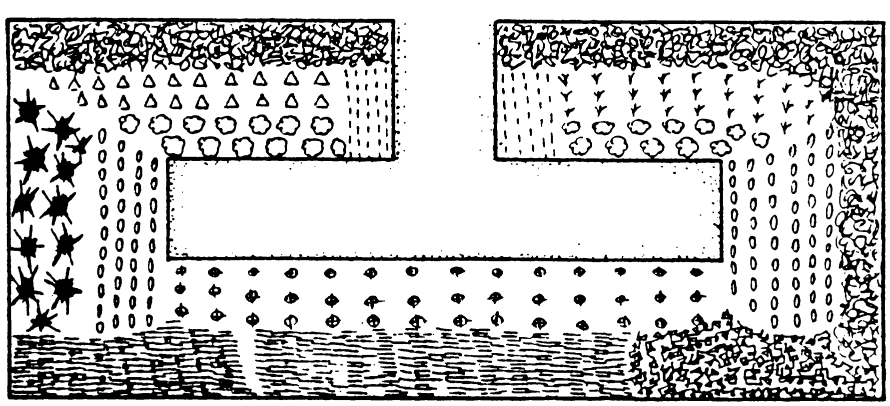
Planting a spring, summer, and fall garden is another form of succession planting. Cool season crops (broccoli, lettuce, peas) are followed by warm season crops (beans, tomatoes, peppers), and, where possible, these may be followed by more cool-season plants, or even a winter cover crop.

Starting seeds indoors for transplanting is an important aspect of this type of gardening. To get the most from your garden plot, a new crop should be ready to take the place of the crop being removed. Several weeks may be gained by having 6" transplants ready to go into the vacated area. Don't forget to recondition the soil for the new plants.

PLANNING AN INTENSIVE GARDEN

Begin planning your garden early. In January or February when the cold days of winter seem never-ending, pull out your last-year's garden records and dig into your new seed catalogs. As with any garden you must decide what crops you want to grow based on your own likes and dislikes, as well as how much of each you will need. Hopefully, you will have an account of which cultivars were most successful or tasted best. Use the charts below, and your own experience, to determine which crops are likely combinations.

Good gardening practices such as watering, fertilizing, crop rotation, composting, and sanitation are especially important in an intensive garden. An intensive garden does require more detailed planning, but the time saved in working the garden and the increased yields make it well worthwhile. Use your imagination and have fun!



Intensive Spacing Guide

(Note: to determine spacing for interplanting, add the inches for the two crops to be planted together, and divide the sum by 2. For example, if radishes are planted next to beans, add 2" + 4" = 6", then divide 6" 2" = 3". The radishes should be planted 3" from the beans.)

Plant	Inches	Plant	Inches
Asparagus	15-18	Lettuce, head	10-12
Beans, lima	4- 6	Lettuce, leaf	4- 6
Beans, pole	6-12	Melons	18-24
Beans, bush	4- 6	Mustard	6- 9
Beets	2- 4	Okra	12-18
Broccoli	12-18	Onion	2- 4
Brussels Sprouts	15-18	Peas	2- 4
Cabbage	15-18	Peppers	12-15
Cabbage, Chinese	10-12	Potatoes	10-12
Carrots	2- 3	Pumpkins	24-36
Cauliflower	15-18	Radishes	2- 3
Cucumber	12-18	Rutabaga	4- 6
Chard, Swiss	6- 9	Southern pea	3- 4
Collards	12-15	Spinach	4- 6
Endive	15-18	Squash, summer	18-24
Eggplant	18-24	Squash, winter	24-36
Kale	15-18	Sweet corn	15-18
Kohlrabi	6- 9	Tomatoes	18-24
Leeks	3- 6	Turnip	4- 6

Plants Grouped According to Nutrient Needs

Heavy Feeders	Light Feeders	Soil Builders
Asparagus	Carrot	Alfalfa
Beet	Garlic	Beans
Broccoli*	Leek	broad
Brussels sprouts*	Mustard greens	lima
Cabbage*	Onion	snap
Cantaloupe*	Parsnip	Clover
Cauliflower	Pepper	Peas
Celery	Potato	Peanut
Collard	Rutabaga	Soybeans
Corn	Shallot	
Cucumber*	Sweet potato	
Eggplant*	Swiss chard	
Endive	Turnip	
Kale		
Kohlrabi		
Lettuce		
Okra		
Parsley		
Pumpkin*		
Radish		
Rhubarb		
Spinach		
Squash		
summer*		
winter*		
Strawberry		
Sunflower		
Tomato*		
Watermelon*		

*Fertilize at least twice

ECONOMIC VALUE OF CROPS

It is difficult to evaluate the economic value of crops grown in the vegetable garden due to the different lengths of time they require for maturity and harvest, the availability of varieties and vegetables types not generally found in the marketplace, and the lack of comparison values for vegetables that are not acceptable by commercial standards (cracked tomatoes, crooked cucumbers, etc.), but which are perfectly useable by the home gardener. Nevertheless, several studies have attempted to determine which crops bring the most value per square foot of garden space, partly to aid small-space gardeners in making decisions about what to plant. Of course, if no one in the family likes beets, there is no point in growing them just because they are economically valuable, but this list may help you determine which vegetables to plant and which to buy. Perennial crops are not on the list below because each of the studies was on a one-season basis. But asparagus, rhubarb, horseradish and other perennial crops do also have considerable economic worth. Fruit trees and shrubs, too, are valuable producers, especially considering the long term.

Top 15 Vegetables in Economic Value

Tomatoes	Beets
Green bunching onions	Carrots
Leaf lettuce	Cucumbers
Turnip (greens + roots)	Peppers
Summer squash	Broccoli
Edible podded peas	Head lettuce
Onion storage bulbs	Swiss chard
Beans (pole, bush)	

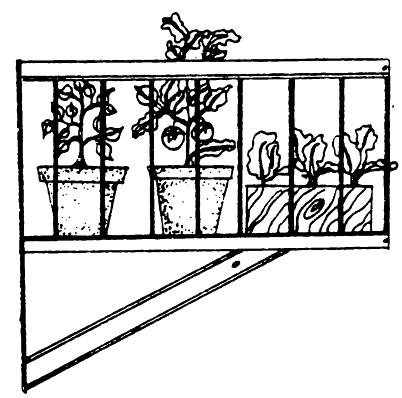
Values based on pounds produced per square foot, retail value per pound at harvest time, and length of time in the garden

Low-Value Crops (not recommended for small spaces)

Corn	Winter squash
Melons	Pumpkins

Miniature varieties or trellising may increase value per square foot.

CONTAINER GARDENING



If you don't have any space for a vegetable garden, or if your present site is too small, consider raising fresh, nutritious, homegrown vegetables in containers. A window sill, patio, balcony or doorstep can provide sufficient space for a productive container garden. Problems with soil-borne diseases, nematodes, or poor soil can also be overcome by switching to container gardening.

Grow vegetables that take up little space (such as carrots, radishes and lettuce), or crops that bear fruits over a period of time (such as tomatoes and peppers) for best use of space and containers. Dwarf or miniature varieties often mature and bear fruit earlier, but most do not produce as well overall as standard varieties. With increasing interest in container gardening, plant breeders and seed companies are working on vegetables specifically bred for container culture. These varieties are not necessarily miniature or dwarf and may produce as well as standard types if properly cared for.

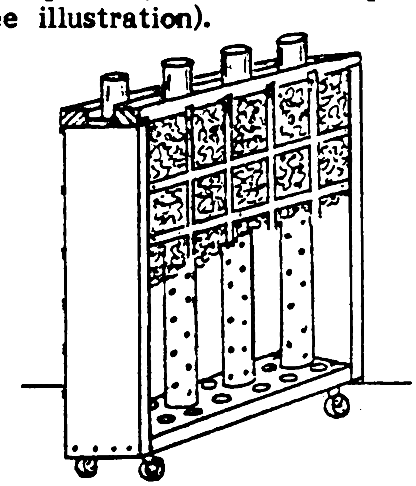
The amount of sunlight that your container garden spot receives may determine what crops can be grown. Generally, root crops and leaf crops can tolerate partial shade, but vegetables grown for their fruits generally need at least five hours of full, direct sunlight each day, and perform better with 8-10 hours. Available light can be increased somewhat by providing reflective materials around the plants (aluminum foil, white-painted surfaces, marble chips, etc.).

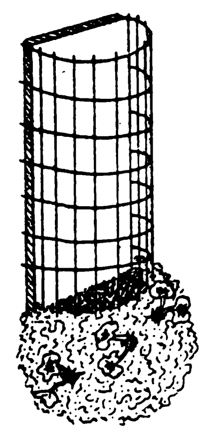
Container gardening lends itself to attractive plantscaping. A dull patio area can be brightened by the addition of baskets of cascading tomatoes or a colorful herb mix. Planter boxes with trellises can be used to create a cool shady place on an apartment balcony. Container gardening presents opportunities for many innovative ideas.

CONTAINERS

There are many possible containers - of clay, wood, plastic, metal or other materials. Containers for vegetable plants must (1) be big enough to support your plants when they are fully grown, (2) hold soil without spilling, (3) have adequate drainage, and (4) never have held products that would be toxic to plants or people. Consider using barrels, flower pots, cut-off milk and bleach jugs, recycled styrofoam coolers, window boxes, baskets lined with plastic (with drainage holes punched in it), even pieces of drainage pipes or cinder blocks. If you are building a planting box out of wood, you will find redwood and cedar to be the most rot-resistant (but bear in mind that cedar trees are much more plentiful than are redwoods). Wood for use around plants should never be treated with creosote or pentachlorophenol ("Penta") wood preservatives. These may be toxic to plants and harmful to people as well. If you have to use a wood preservative to keep wood from rotting, use a copper napthenate product, or ask for salt-treated lumber.

Some gardeners have built vertical planters out of wood lattice work lined with black plastic and then filled with a lightweight medium, or out of welded wire shaped onto cylinders lined with sphagnum moss and then filled with soil mix. Depending on the size of your vertical planter, 2" diameter perforated plastic pipes may be needed inside to aid watering (see illustration).





Whatever type of container you use, be sure that there are holes in the bottom for drainage so that the plant roots do not stand in water. Most plants need containers at least 6-8 inches deep for adequate rooting.

As long as the container meets the basic requirements described above it can be used. The imaginative use of discarded items or construction of attractive patio planters is a very enjoyable aspect of container gardening. For ease of care, dollies or platforms with wheels or casters can be used to move the containers from place to place. This is especially useful for apartment or balcony gardening so that plants can be moved to get maximum use of the available space and sunlight, and to avoid destruction from particularly nasty weather.

MEDIA

A fairly lightweight potting mix is needed for container vegetable gardening. Soil straight from the garden usually cannot be used in a container because it may be too heavy, unless your garden has sandy loam or sandy soil. Clay soil consists of extremely small (microscopic) particles. In a container, the bad qualities of clay are exaggerated

- it holds too much moisture when wet, resulting in too little air for the roots, and it pulls away from the sides of the pot when dry. The container medium must be porous in order to support plants, because roots require both air and water. Packaged potting soil available at local garden centers is relatively lightweight and may make a good container medium. Soilless mixes such as the peat-lite mix are generally too light for container vegetable gardening, not offering enough support to plant roots. If the container is also lightweight, a strong wind can blow plants over, resulting in major damage. Also, the soilless mixes are sterile and contain few nutrients, so even though you add the major fertilizers, no trace elements are available for good plant growth. Add soil or compost if you wish to use a sterile mix. For a large container garden the expense of prepackaged or soilless mixes may be quite high. Try mixing your own with one part peat moss, one part garden loam, and one part clean coarse (builder's) sand, and a slow release fertilizer (14-14-14) according to container size. Lime may also be needed to bring the pH to around 6.5. In any case, a soil test is helpful in determining nutrient and pH needs, just as in a larger garden.

PLANTING

Plant your container crops at the same time you would if you were planting your regular garden. Fill a clean container to within one-half inch of the top with the slightly damp soil mixture. Peat moss in the mix will absorb water and mix much more readily if soaked with warm water before putting the mix in the container. Sow the seeds or set transplants according to the instructions on the seed package. Put a label with the name, variety, and date of planting on or in each container. After planting, gently soak the soil with water, being careful not to wash out or displace seeds. Thin seedlings to obtain proper spacing when the plants have two or three leaves. If cages, stakes, or other supports are needed, provide them when the plants are very small to avoid root damage later.

WATERING

Pay particular attention to watering container plants. Because the volumes of soil are relatively small, containers can dry out very quickly, especially on a concrete patio in full sun. Daily or even twice daily watering may be necessary. Apply water until it runs out the drainage holes. (On an upstairs balcony this may mean neighbor problems, so make provisions for drainage of water. Large trays filled with coarse marble chips work nicely.) However, the soil should never be soggy or have water standing on top of it. When the weather is cool, container plants may be subject to root rots if maintained too wet. Clay pots and other porous containers allow additional evaporation from the sides of the pots and watering must be done more often. Small pots also tend to dry out more quickly than larger ones. If the soil appears to be getting excessively dry (plants wilting every day is one sign), group the containers together so that the foliage creates a canopy to help shade the soil and keep it cooler. On a hot patio, you might consider putting the containers on pallets or other structures that will allow air movement beneath the pots and prevent direct contact with the cement. Check your containers at least once a day and twice on hot, dry or windy days. Feel the soil to determine whether or not it is damp. Mulching and windbreaks can help reduce water requirements for containers. If you are away a lot, consider an automatic drip emitter irrigation system (see VPI & SU Publication 426-332, Watering, for more information.)

FERTILIZING

If you use a soil mix with fertilizer added, then your plants will have enough nutrients for 8-10 weeks. If plants are grown longer than this, then add a water-soluble fertilizer at the recommended rate. Repeat every 2-3 weeks. An occasional dose of fish emulsion or compost will add trace elements to the soil. Do not add more than the recommended rate of any fertilizer, since this may cause fertilizer burn and the death of your plants. Container plants do not have the buffer of large volumes of soil and humus to protect them from over-fertilizing or over-liming. Just because a little is good for the plants does not guarantee that a lot will be better.

GENERAL CARE

Vegetables grown in containers can be attacked by the various types of insects and diseases that are common to any vegetable garden. Plants should be periodically inspected for the presence of foliage-feeding and fruit-feeding insects as well as the occurrence of diseases. Protect plants from very high heat caused by light reflection from pavement. Move them to a cooler spot or shade them during the hottest part of the day. Plants should be moved to a more sheltered location during severe rain, hail, or wind storms, and for protection from fall frosts.

INDOOR CONTAINER GARDENING WITH VEGETABLES

If you want to have fresh vegetables over the winter, or if you don't have an outdoor space in which you can place containers, it is worth trying some indoor container gardening. Of course you cannot have a full garden in the house, but a bright, sunny window can be the site for growing fresh food all year. Some small-fruited tomatoes and peppers, several types of lettuce, radishes, and many herbs are among the plants you can include in your indoor garden.

Follow the directions given above for preparing your pots and for watering, fertilizing, etc. However, note that plants will dry out less quickly indoors and will also grow more slowly, needing less fertilizer. To make watering easier it is wise to set the pots in large trays with an inch or two of decorative stones in them. Not only will this prevent your having to move the plants in order to water them (which may discourage you from watering when you should), but it will also provide humidity, which is a major requirement, especially during winter when your house is warm and dry.

As mentioned before, a sunny window, preferably south-facing, is almost a must for indoor vegetable growing. Fruiting vegetables such as tomatoes and peppers will also need supplemental light, such as a combination warm white/cool white fluorescent fixture, during winter months. Insufficient light will result in tall, spindly plants and failure to flower and set fruit.

Herbs are a first choice for many indoor gardeners. Many are less demanding than vegetable plants, and cooks find it pleasant to be able to snip off a few sprigs of fresh parsley or chop some chives from the windowsill herb garden. Chives grow like small onions with leaves about six inches tall. These plants prefer cool conditions with good light, but will grow quite well on a windowsill in the kitchen. One or two pots of chives will provide leaves for seasoning salads and soups. Plant seeds or small bulbs in a six-inch pot. The plants should be about one inch apart over the entire surface area. It will require about twelve weeks from the time seeds are planted until leaves can be cut. For variety, try garlic or Chinese chives, which grow in a similar fashion, but have a mild garlic flavor.

Parsley seeds can be planted directly into six-inch pots, or young healthy plants can be transplanted from the garden. One vigorous plant per pot is enough. Standard parsley develops attractive, green, curly leaves about six or eight inches tall. Italian, or single-leaved, parsley has a slightly stronger flavor and is a favorite for pasta dishes. Leaves can be clipped about 10-12 weeks after planting the seeds.

Cilantro, or the leaves of the young coriander plant, can be grown in your windowsill garden. Cilantro is used in Oriental and Mexican dishes, but it is not available in most grocery stores and must be used fresh. Grow cilantro as you would parsley. Thyme and other herbs will also grow well indoors if given the right conditions.

The small-fruited varieties of tomatoes such as Tiny Tim, Small Fry and the paste tomato, Roma, may be raised quite satisfactorily in the home. They will challenge your gardening ability, and supply fruits which can be eaten whole, cooked, or served with salad. The Tiny Tim tomato grows to a height of about 12-15." Small Fry, which is about three feet tall, and Roma will need more space and should be located on an enclosed porch or in a sun room. Several varieties have been developed for hanging baskets, too, which may be worth experimenting with.

Some of the small-fruited peppers may be grown as house plants. Like tomatoes, they prefer warm, bright conditions in order to grow well for you. Fruits will be ready to harvest from peppers and tomatoes about ten weeks after planting. Whiteflies and aphids may present a problem on indoor tomato and pepper plants. Keep a close watch for these pests so that they do not get a good start in your planting. Yellow sticky traps, either purchased or homemade (from boards painted with Rustoleum no. 659 and smeared with a light coating of grease), are effective in trapping whiteflies. Insecticidal soap or other pesticide .bd approved for vegetable plants can be used to control whiteflies or aphids. Fortunately, you will be less likely to experience problems with such outdoor pests as tomato hornworms, corn earworm (in peppers), and late blight than you would if your plants were ouside.

For a quick-growing crop, try radishes. These must be grown very rapidly if they are to be crisp and succulent. Scatter radish seeds on moist soil in a six- or eight-inch pot. Cover with 1/4 inch of soil and place a piece of glass or plastic wrap over the pot to conserve moisture until the seeds germinate. Carrots are slower, but can be grown in the same way; use the small-rooted varieties, such as Little Finger, for best results indoors.

Experiment with various types of lettuce. Leaf lettuce and the miniature Tom Thumb butterhead are some to try. Space them according to package directions. Keep lettuce moist and in a very sunny spot.

If your light is limited, an old standby for fresh taste and high food value is sprouted seeds. Almost any seeds can be sprouted - corn, barley, alfalfa, lentils, soybeans, rye, peas, radish, mung beans, sunflowers, etc. Use only special seeds for sprouting available from health food or grocery stores to avoid the possibility of getting seeds treated with poison. Use any wide-mouthed container such as a Mason or mayonnaise jar. Soak the seeds overnight, drain, and place in the container. Cover with a double cheesecloth layer held with rubber bands, or a sprouting lid. Set the container in a consistently warm spot and rinse and drain seeds three times daily. In 3-5 days, sprouts will be 1" to 3" long and ready for harvesting. See Publication 426-419, Sprouting Seeds for Food, for other suggestions.

INFORMATION FOR GROWING VEGETABLES IN CONTAINERS

Vegetable*	Light Requirements**	Minimum Container Size	Distance (") Between Plants in Containers	Days from Seed to Harvest	Comments
Beans, bush	FS	2 gal.	2-3	45-60	Several plantings, 2-week intervals
Beets	FS/PS	1/2 gal.	2-3	50-60	Thin plants when 6-8" tall
Carrots	FS/PS	1 qt.	2-3	65-80	Several plantings, 2-week intervals
Cabbage	FS/PS	5 gal.	12-18	65-120	Requires fertile soil
Chard, Swiss	FS/PS	1/2 gal.	4-6	30-40	Harvest leaves
Cucumbers	FS	5 gal.	14-18	70-80	Require hot weather, vining types need support
Eggplant	FS	5 gal.	1 plant per container	75-100	Requires fertile soil
Kale	FS/PS	5 gal.	10-15	55-65	Harvest leaves
Lettuce, leaf	PS	1/2 gal.	4-6	30-35	Harvest leaves
Mustard greens	PS	1/2 gal.	4-5	35-40	Several plantings, 2-week intervals
Onions, green	FS/PS	1/2 gal.	2-3	70-100	Requires lots of moisture
Peppers, Bell	FS	2 gal.	1 plant per container	110-120	Require hot weather
Squash, summer	FS	5 gal.	1 plant per container	50-60	Plant only bush type
Tomatoes	FS	5 gal.	1 plant per container	55-100	Stake and prune or cage
Tomatoes, cherry	FS	1 gal.	1 plant per container	55-100	Helps to stake & prune
Turnips	FS/PS	3 gal.	2-3	30-60	Harvest leaves and roots

*Consult seed catalogs for varieties adapted to container culture.

** FS = Full sun FS/PS = Full sun; tolerates partial shade PS = Partial shade

PLANTING FOR A FALL HARVEST

By planning and planting a fall vegetable garden it is possible to have fresh vegetables up to and even past the first frosts. At the time when retail vegetable prices are on the rise, you can be reaping large and varied harvests from your still-productive garden site.

Many varieties of vegetables can be planted in mid- to late summer for fall harvests. Succession plantings of warm season crops (such as corn and beans) can be harvested up until the first killing frost. Cool season crops (such as kale, turnips, mustard, broccoli, cabbage, etc.) grow well during the cool fall days and withstand light frosts. Timely planting is the key to a successful fall garden.

To determine the time to plant a particular vegetable for the latest harvest in your area, you need to know the average date of the first killing frost (see map below) and the number of days to maturity for the variety you are growing. Choose earliest maturing varieties for late plantings. The formula below for determining the number of days to count back from the first frost will help determine when to start your fall garden.

Number of days from seeding or transplanting outdoors to harvest
+ Number of days from seed to transplant if you grow your own
+ Average harvest period
+ Fall Factor(about two weeks)
+ Frost Tender Factor (if applicable)

= Days to count back from first frost date

The Frost Tender Factor is added only for those crops that are sensitive to frost (corn, beans, cucumbers, tomatoes, squash), as these must mature two weeks before frost in order to produce a reasonable harvest. The Fall Factor takes into account the slower growth that results from cooler weather and shorter days in the fall, and amounts to about two weeks. This time can be reduced from 2-5 days by presprouting seeds. Almost any crop that isn't grown for transplants can benefit from presprouting. Sprout seeds indoors, allowing them to reach a length of up to an inch. Sprouted seeds may be planted deeper than normal to help prevent drying out, and they should be watered well until they break the soil surface. Care should be taken not to break off the sprouts when planting them.

When planting fall crops, prepare the soil by restoring the nutrients removed by spring and summer crops. A light layer of compost or aged manure, or a small application of complete chemical fertilizer will boost soil nutrients in preparation for another crop.

Dry soil may make working the soil difficult and inhibit seed germination during the midsummer period. Plant your fall vegetables when the soil is moist after a rain, or water the area thoroughly the day before you plant. Seeds may be planted in a shallow trench to conserve moisture. Cover the seeds about twice as deeply as you do in the spring. An old-time trick for germinating seeds in mid-summer is to plant the seeds, water them in well, and then place a board over the row until the sprouts just reach the soil surface; at that time remove the board. Plastic will also work, but must be completely anchored so that the soil does not dry out underneath or the plastic blow away. Plastic, especially black plastic, may cause the soil to get too hot. An organic mulch on top will help keep soil cool. Mulching between rows can also help keep the soil cooler and decrease soil drying. In severe hot weather a light, open type of mulch, such as loose straw or pine boughs may be placed over the seeded row. This must be removed as soon as the seedlings are up so that the seedlings receive full sun. Starting transplants in a shaded coldframe or in a cool indoor area is another possibility.

Once the young plants are established, a heavier mulch may be used to hold moisture and control weeds. Irrigate when necessary so the young plants have sufficient moisture. Fall plantings often have fewer insect problems, as they avoid the peak insect activity period of midsummer. However, some insects, such as cabbageworm and corn earworm, may be even worse late in the year than in summer; vigilance is still required! Avoid some pests and diseases by planting crops of different families than were originally in that section of your garden.

Some of the best quality vegetables are produced during the warm days and cool nights of the fall season. These environmental conditions add sugar to sweet corn and crispness to carrots. Parsnips and Jerusalem artichokes are examples of crops that are very much improved by a touch of frost.

The fall garden gives you a chance to try again any spring failures you might have encountered. Some crops, in fact, grow well only in the fall in certain areas - cauliflower and long-season Chinese cabbage are two examples of crops which do not produce well in Virginia's mountain areas in spring because they cannot reach maturity before the cool weather ends.

Protection of vegetable plants during cold periods may extend your season even further. See Publication 426-381, Extending the Gardening Season, for ideas. Though in the hot days of summer the last thing you want to think about is planting more crops to take care of, look ahead to the fall garden, which offers its own satisfaction through its prolonged harvest of fresh vegetables, savings in food costs, and the knowledge that you're making full use of your gardening space and season.

CARE OF FALL CROPS

The beginning of fall garden care comes when the weather and the radio station announce the first arrival of frost. Your main concern then should be to harvest all ripe, tender crops. Tomatoes, summer squash, melons, eggplant, cucumbers, peppers and okra are some of the crops that cannot withstand frost and should be picked immediately. Store the vegetables in a place where they can be held until needed for eating or processing. If the frost warning is mild (predicting no lower than a 30 % F. low) you can try covering tender plants in your garden that still hold an abundance of immature fruit. Baskets, burlap, or canvas sacks, boxes, blankets, or buckets help protect them from the frost. Warm days after the frost will still mature some of the fruit as long as the plants have this nightly frost protection. Much will depend on your garden's microclimate. If your spot is low and unsheltered, it is likely to be a frost pocket. Gardens sheltered from winds and on the upper side of a slop are less susceptible to early frost damage.

When using a cold frame to extend your harvest season, be sure to close the top on frosty nights to protect the plants from the cold. When the sun comes out the next morning and the air warms, you can open the cold frame again; leave it closed if daytime temperatures are low.

Cool-season crops such as cabbage, cauliflower, broccoli, spinach, and Brussels sprouts can withstand some cold. In fact, their flavor may be enhanced after a frost. They cannot stay in the garden all winter, but do not need to be picked immediately when frost comes. Kale, spinach, evergreen bunching onions, lettuce, parsley, parsnips, carrots and salsify are some crops that may survive all winter in the garden. Mulch these overwintering vegetables with 8" of mulch to prevent heaving of the soil. Most of these vegetables can be dug or picked as needed throughout the winter or in early spring.

Now is the time to prepare perennial vegetables for winter, too. Most will benefit from a topdressing of manure or compost and a layer of mulch which reduces damage from freezing and thawing. Dead leaf stalks of perennial vegetables such as asparagus and rhubarb should be cut to the ground after their tops are killed by frost (though some people prefer to leave asparagus stalks until late winter to hold snow over the bed). Don't forget strawberry beds. Remove weeds that you let grow when you were too busy last summer. You can transplant some of the runner plants if you carefully dig a good-sized ball of soil with the roots. Mulch the bed well with a light material. Old raspberry canes can be cut back at this time or late in the winter.

When your tender crops have been harvested and overwintering crops cared for, pull up all stakes and trellises in the garden except those stakes that are clearly marking the sites of overwintering plants. Clean stakes and trellises of remnants of plant materials and soil. Hose them down and allow to dry. Tie stakes in bundles and stack them so that they won't get lost over the winter. If possible, roll up trellises and tie them securely. Store these items inside your attic, barn, or shed in an area where they are out of the way, and where rodents and other animals cannot get to them to use as winter nests.

PREPARING SOIL FOR WINTER

Now you are ready to prepare your soil for winter. Pull up all dead and unproductive plants and place this residue on top of the soil to be tilled under, or in the compost heap. Remove any diseased or insect-infested plant material from your garden that may shelter overwintering stages of disease and insect pests. If you leave this plant material in your garden, you are leaving an inoculum of diseases and insects which will begin to reproduce the next spring and add to your pest problems.

The best thing to do is to remove infested plant material from the garden or burn it. Burning will kill any diseases or insects that may be in the plant wastes. Spread the ashes on your garden to get the benefit of mineral nutrients. Check burning laws in your area before you burn anything, though; you may need a permit. If you live near a wooded area, burning may be too risky. In this case, haul the diseased material away.

Clean-up also gives you the chance to add your compost to the garden. Compost contains highly nutritious, decomposed plant material and beneficial organisms, and is an excellent soil-builder. By spreading compost and other wastes on the soil and plowing them in, you are adding nutrients back into the soil for next year's crop. The beneficial insects and microorganisms in the compost will help integrate the compost into your soil, and the added humus will improve soil structure.

Don't overlook other excellent sources of organic material available during the fall. Leaves are abundant, and neighbors will usually be glad to give their leaves to you. but some on the garden now and store some for next year's mulch. Leaves will mat if put on in too thick a layer, and will not decompose quickly. You can help leaves break down more easily by running a lawn mower back and forth over the pile. Put the shredded leaves directly onto the garden or compost them. Sawdust and wood chips are easy to obtain this season from sawmills. Many farms and stables want to get rid of manure piles before winter sets in.

If you wait until spring to add organic material to your garden, it may not have time to decompose and add its valuable nutrients to the soil by the time you are ready to plant and you may have to delay planting to a later date. Hot, or very fresh, manure can also burn young seedlings. By adding these materials in the fall, you give them plenty of time to decompose and blend into your soil before planting time. If you don't have enough organic material for the entire garden, try to cover those areas that you want especially rich for next summer's crop.

If the weather stays dry enough before the ground freezes, you can plow or rototill in the fall. Turning under vegetation in the fall allows earlier planting in the spring and is especially good for heavy soils, since they are exposed to the freezing and thawing that takes place during the winter. This helps to improve the soil structure. If you have a rainy fall, or if your garden is steep and subject to erosion, you may decide you'd rather plant a cover crop for winter garden protection. A cover crop decreases erosion of the soil during the winter, adds organic material when it is incorporated in the spring, improves soil tilth and porosity, and adds valuable nutrients. Winter cover crops can be planted as early as August 1 but should not be planted any later than November 1. They should make some growth before hard frost kills them. Where you have fall crops growing, you can sow cover crop seed between rows a month or less before expected harvest. This way the cover crop gets a good start but will not interfere with vegetable plant growth. Some cover crops suitable for winter use are in the following table. Mixtures of legumes and non-legumes are effective as well.

Prepare the soil for cover crop seed by tilling under plant wastes from the summer. Ask at the seed store what the best type of cover crop for your area is and at what rate (pounds per 100 square feet) to plant it. Broadcast the seed, preferably before a rain, and rake it evenly into the soil. Spring planting may be delayed somewhat by the practice of cover cropping, since time must be allowed for the green manure to break down. If you have crops that need to be planted very early, you may prefer to leave a section of the garden bare or with a stubble mulch.

When time or weather conditions prohibit either tilling or cover cropping, you may wish to let your garden lie under a mulch of compost, plant wastes, or leaves all winter to be plowed or tilled under in the spring. However, if you want to plant early the next spring, a mulch of heavy materials such as whole leaves may keep the soil cold long enough to delay planting. In this case, chop them fine enough that they will break down over the winter. The addition of fertilizer high in nitrogen will also help break down organic matter more quickly.

Type	Legume/ Non-Legume	Amount to Sow per 100 sq. ft. (oz.)	When to Sow	When to Turn Under	Effects	Notes
Alfalfa	L	1/2	Spring Late summer	Fall Spring	Fixes 150-250 lbs. N/ac./yr.; deep roots break up hard soil, trace elements to surface.	Loam, fairly fertile soil; needs warm temps. for germination. Lime if pH is low. Hardy. In mountains sow by Aug. 10. Drought-tolerant. Inoculate.
Barley	N	4	Fall Spring	Spring Fall	Adds organic matter; improves soil aggregation	Prefers medium-rich, loam soil. Lime if pH is low. Not as hardy as rye. Tolerates drought.
Buckwheat	N	2-1/2	Spring Summer	Summer Fall	Mellows soil; rich in potassium.	Must leave part of garden in cover crop during season. Grows quickly. Not hardy.
Crimson clover	L	1/3	Spring Fall	Fall Spring	Fixes 100-150 lbs. N/ac./yr.	Not reliably hardy. Sow before mid-Sept. in Piedmont and mountains. Not drought-tolerant. Lime if pH is low. White clover somewhat hardier.
Fava beans	L	Plant 8" apart	Early spring Late summer	Early summer Fall	Some types fix 70-100lbs N/acre in as little as 6 wks. Use small-seeded rather than large-seed table types.	Will grow on many soil types. Medium drought tolerance. Likes cool growing weather. Good for mountain areas. If planted in early spring can grow late vegetables. Inoculate with same bacteria as for hairy vetch.
Oats	N	4	Spring Fall	Summer Spring	Adds organic matter; improves soil aggregation.	Needs adequate manganese. Not hardy; tolerates low pH.
Rye, winter	N	3-1/2	Fall	Spring	Adds organic matter; improves soil aggregation	Very hardy. Can plant till late October.
Vetch, hairy	L	2-1/2	Early fall	Spring	Fixes 80-100 lbs. N/acre/year	Inoculate; slow to establish. Fairly hardy. Till under before it seeds; can become a weed.
Wheat, winter	N	4	Fall	Spring	Add organic matter; improves soil aggregation.	Same as barley.

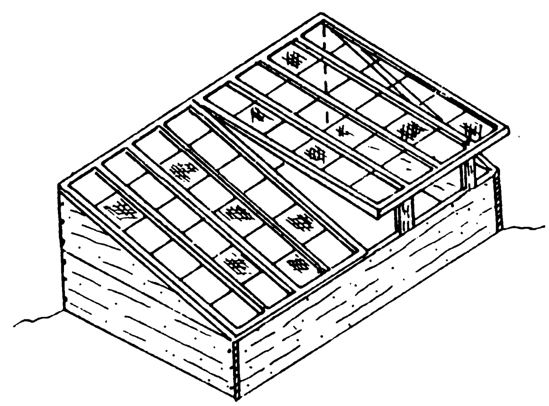
CARE OF GARDEN EQUIPMENT

Clean-up of tools and equipment is another important practice related to the garden which should not be ignored in the fall. Proper clean-up of tools now will leave them in top shape and ready to use when spring comes. Clean, oil and mend all hand tools. Repaint handles or identification marks that have faded over the summer. Sharpen all blades and remove any rust. Power tools should be cleaned of all plant material and dirt. Replace worn spark plugs, oil all necessary parts and sharpen blades. Store all tools in their proper place indoors, never outdoors where they will rust over the winter.

Unless you are lucky enough to live in a warm area where your cold frame will protect vegetables all winter, you will need to clean up the frame when all vegetables have been harvested. Remove all remaining plant material and spread it on the cold frame soil. Spade the plant refuse and any other organic material into the soil in the cold frame as thoroughly as possible. Do not leave the top on the cold frame over the winter, as the cold air or the weight of snow may crack or break the glass. Remove the top, wash it thoroughly, and store it on its side in a protected indoor area where it will not get broken.

Successful gardening doesn't stop when frost comes, but continues throughout the fall and early winter months. When following good garden care practices during this time, your garden will be ready for the growth of healthy vegetables next spring.

SEASON EXTENDERS



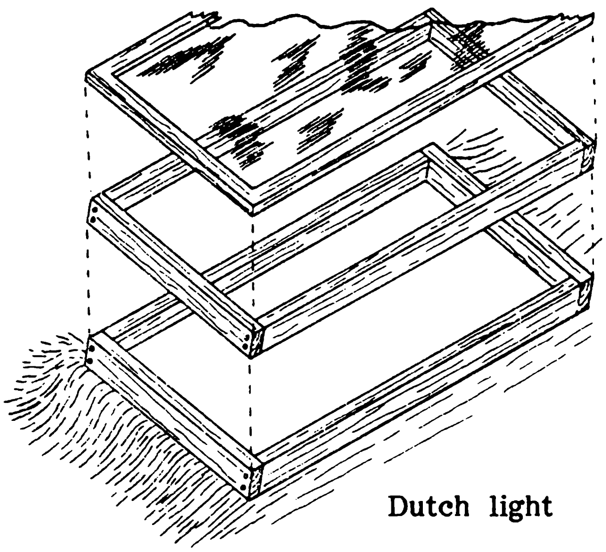
To get the most out of a garden, you can extend the growing season by sheltering plants from cold weather both in early spring and during the fall. Very ambitious gardeners can harvest greens and other cool-weather crops all winter by providing the right conditions. There are many ways to lengthen the growing season, and your choice depends on the amount of time and money you want to invest.

COLD FRAMES AND HOT BEDS

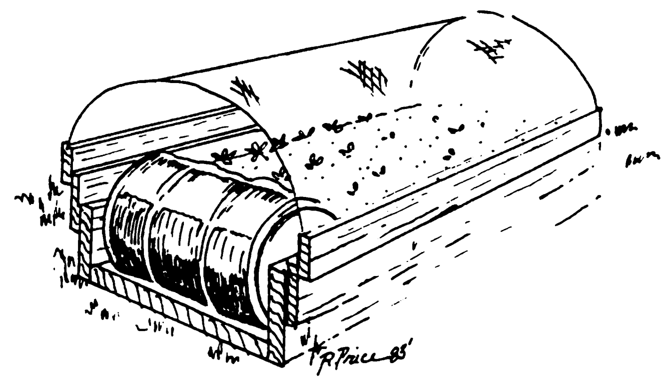
Cold frames, sun boxes, and hot beds are relatively inexpensive, simple structures for providing a favorable environment for growing cool-weather crops in the very early spring, the fall, and even into the winter months. Some are more elaborate and require a large investment, but are reasonable for those who are serious about having fresh vegetables during the winter.

Cold frames and sun boxes have no outside energy requirements, relying on the sun for their source of heat. Hot beds are heated by soil heating cables, steam-carrying pipes, or fresh, strawy manure buried beneath the rooting zones of the plants. Heat is collected by all these frames when the sun's rays penetrate through the sash (made of clear plastic, glass, or fiberglass. The ideal location for a coldframe is a south-facing or southeastern exposure with a slight slope to insure good drainage and maximum solar absorption.

A sheltered spot with a wall or hedge to the north will provide protection against winter winds. Sinking the frame into the ground somewhat will also provide protection, using the earth for insulation. To simplify use of the frame consider a walkway to the front, adequate space behind the frame to remove the sash, and perhaps weights to make raising and lowering of glass sashes easier. Some gardeners make their cold frames lightweight enough to be moved from one section of the garden to another. Another possibility is the Dutch light, which is a large, but portable greenhouse-like structure which is moved around the garden. (See illustration.)



Dutch light



Solar pod

New designs in cold frames include passive solar energy storage. For example, barrels painted black and filled with water absorb heat during the day and release it at night. The solar pod, shown above, is one design which provides for this type of heat storage. Other new cold frames are built with a very high back and a steep glass slope and insulated very well; these may also include movable insulation that is folded up during the day and down at night or during extremely cold weather to cover growing plants.

In early spring a coldframe is useful for hardening off seedlings which were started indoors or in a greenhouse. This hardening off period is important, as seedlings can suffer serious setbacks if they are moved directly from the warmth and protection of the house to the garden. The cold frame provides a transition period for gradual adjustment to the outdoor weather. It is also possible to start cool-weather crops in the cold frame and either transplant them to the garden or grow them to maturity in the frame.

Spring and summer uses of the coldframe center around plant propagation. Young seedlings of hardy and half-hardy annuals can be started in a frame many weeks before they can be started in the open. The soil in a portion of the bed can be replaced with sand or peat moss or other medium suitable for rooting cuttings and for starting sweet potato slips.

Fall is also a good time for sowing some cool-weather crops in frames. If provided with adequate moisture and fertilization, most cool-season crops will continue to grow through early winter in the protected environment of the cold frame. Depending on the harshness of the winter and whether or not additional heating is used, your frame may continue to provide you with fresh greens, herbs, and root crops throughout the cold winter months.

Growing frames can be built from a variety of materials, with wood and cinder blocks being the most common. If you use wood, choose wood that will resist decay, such as a good grade of cypress, or use pressure-treated wood. Never use creosote-treated wood or wood treated with pentachlorophenol, since these substances are harmful to growing plants. Wood frames are not difficult to build. Kits may also be purchased and easily assembled; some kits even contain automatic ventilation equipment.

There is no standard sized cold frame. The dimensions of your frame will depend on your situation, amount of available space, desired crops, size of available window sash, and permanency of the structure should all be considered. Do not make the structure too wide for weeding and harvesting; 4 to 5 feet is about as wide as is convenient to reach across. The sash of the frame should be sloped to the south to allow maximum exposure to the sun's rays.

Insulation may be necessary when a sudden cold snap is expected. A simple method is to throw burlap sacks filled with leaves over the sash on the frame at night to protect against freezing. Or, bales of straw or hay may be stacked against the frame.

Ventilation is most critical in the late winter, early spring, and early fall on clear, sunny days when temperatures rise above 45 degrees. The sash should be raised partially to prevent the buildup of extreme temperatures inside the frame. Lower or replace the sash each day early enough to conserve some heat for the evening.

In summer extreme heat and intensive sunlight can damage plants. This can be avoided by shading with lath sashes or old bamboo window blinds. Watering should be done early in the day so that plants dry before dark to help reduce disease problems.

You may convert your cold frame to a hotbed. For a manure-heated bed: 1) dig out to 2' deep (deeper to add gravel for increased drainage); 2) add an 18" layer of strawy horse manure; 3) .us cover with 6" of good soil. For an electric heated bed: 1) dig out area 8" or 9" deep; 2) lay down thermostatically controlled electric cable in 6-8" long loops, evenly spacing cable but never crossing itself; 3) cover with 2" of sand or soil; 4) lay out hardware cloth to protect cable; 5) cover with 4-6" of good soil.

CLOCHES

The cloche (pronounced klōsh) was originally a bell-shaped glass jar set over delicate plants to protect them from the elements. The definition has expanded, however, to include many types of portable structures which shelter plants from drying winds and cold air.

The idea is to provide a greenhouse-like atmosphere for seeds and small plants in order to get an early start on the season, or to extend the fall garden as long as possible. Cloches are set out over individual plants or are made into tunnels for whole rows. They trap solar radiation and moisture evaporating from the soil and plants. The hotkap and the ubiquitous cut-off plastic jug are simple forms. More elaborate ones are fiberglas tunnels, special plastic cloches or row covers with slits in them to allow for some aeration, and panes of glass connected by specially designed hinges to form a tent. There are a variety of forms on the market now, some of which work and some which don't, and some are easily constructed from materials around the home.

Cloches are generally lightweight, portable and reusable. It is preferable to have a design which can be closed completely at night to prevent frost damage and opened or completely removed during the day for good air circulation. Cloches should be anchored or heavy enough that they don't blow away.

GREENHOUSES

There is an almost overwhelming selection of greenhouses on the market, and plans for building even more types are available. If you intend to purchase or build a greenhouse, it is wise to investigate the alternatives thoroughly, preferably visiting as many operating home greenhouses as possible. List your needs and wants ahead of time and determine the uses you will put your greenhouse to. Then compare on that basis. Many companies will send free specifications and descriptions of the greenhouses they offer; look in gardening magazines for their ads.

The conservation minded person may find an attached solar greenhouse desirable. The initial cost is generally higher for a solar greenhouse than for the simpler free-standing, uninsulated types, but for maximum use with lower heating bills, one can insulate north and side walls, provide liberal glass area for winter sun-catching, and make use of some type of solar radiation storage. When attached to a house, these greenhouses can be used for supplementary household heating, but there is a trade-off between heating the home and growing plants (especially heat-loving ones) in the greenhouse. Some researchers have concluded that a good compromise is to forget winter tomatoes and grow cool-weather crops during the winter in a solar attached greenhouse. Virginia Tech now has a publication, obtainable from your Extension Agent, entitled Attached Solar Greenhouses, Publication No. 324-919.

SHADING

It is not always easy to start seeds or young plants for fall crops in the heat and dry conditions of August in Virginia. One simple way to provide shade in otherwise exposed conditions is to build a portable shade frame for placing over rows after seeds are sown or transplants are set out. This can be the same type of frame as used for starting early seeds, but using lath strips or an old bamboo shade instead of plastic.

CULTURE NOTES GUIDE

Individual plant sheets have been developed to provide an easy to use guide, a summary of a wide range of information concerning the culture, nutritional value, harvest, and storage of specific food crops. They are not intended to be comprehensive references, and you may need to consult other materials to obtain very detailed information. In most cases, though, the plant sheets should provide you with enough know-how to get a crop through from seed to harvest.

The following key will help to explain the various terms on each food crop fact sheet.

ENVIRONMENTAL PREFERENCES

LIGHT: sunny (requires direct light at least six hours per day; prefers 8-10 hours/day)
tolerates partial shade (will do well with fewer than 8 hours of sunshine per day, but probably needs at least 5 hours/day)
prefers shade (more than six hours of direct sunlight may be harmful; prefers filtered light, probably needs at least 3-4 hours of light per day)

SOIL: well-drained (water does not stand or remain puddled for more than 24 hours after a hard rain)
deep (at least 8-12" of topsoil or loose subsoil; no shallow hardpan)
loam (soil composed roughly of equal portions of clay and sand, with a reasonable amount of humus; good garden soils)

FERTILITY: results of soil tests can be used to indicate the basic fertility level of soils. Soil testing does not indicate nitrogen levels due to variability.

	lbs./acre P2O5	lbs./acre K2O
low	0-25 lbs.	0-90 lbs.
medium	6-85 lbs.	9-212 lbs.
high	86+ lbs.	213+ lbs.

acidity or alkalinity of the soil. 7.0 is neutral, below 7.0 is acid, above 7.0 is alkaline

TEMPERATURE: Approximate ranges of daily mean temperature preferred for optimum growth

MOISTURE: Amount of rainfall or supplemental watering needed for optimum growth; more for sandy soils, less for clay

average (roughly one inch of water per week)

moist (roughly 1-2" water per week; soil should be well-drained)

CULTURE

PLANTING: specific information needed to get plants started, such as when to seed, whether to start plants indoors, best transplant time, etc.

SPACING: optimum distances between plants and rows .

HARDINESS: very hardy perennial (can withstand winter extremes in most parts of Virginia with only slight protection) .

hardy perennial (can withstand winters with protection in colder areas)

hardy annual (can withstand frosts in spring and fall; may need protection from heavy frosts or freezing)

half-hardy annual (can withstand light frosts, but not heavy frosts or freezing)

tender annual (frost will seriously damage plant tissue)

very tender annual (frost will destroy plant tissues; needs warm weather for growth)

FERTILIZER NEEDS: low, medium, or heavy feeder (refers to relative levels of nutrient uptake from the soil. This information can be used to group similar types of plants, so that fertilizers may be applied to sections of the garden according to plant needs).

CULTURAL PRACTICES: Gives general growing information. Includes proven methods for increasing production and/or decreasing pest problems. Unique growing suggestions may be included.

COMMON PROBLEMS

This section gives a general list of the most common diseases, insects and cultural problems of the crop in the state of Virginia. Identify the cause of the problem, review non-chemical and preventative control information, then refer to current Pest Management Guides or contact your extension agent for specific chemical control information.

HARVESTING AND STORAGE

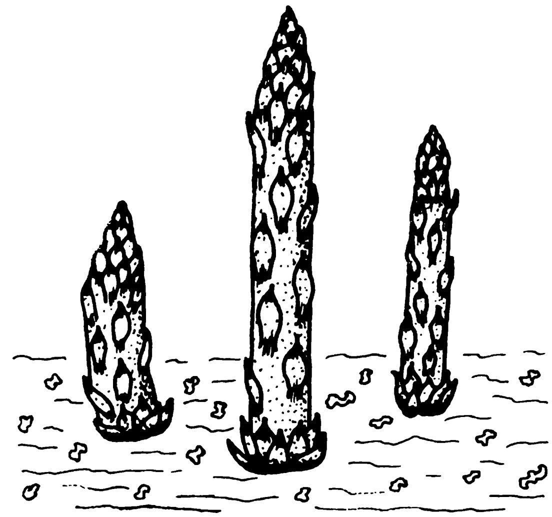
APPROXIMATE YIELDS: (These figures vary according to the variety, local environ mental conditions, planting designs, and cultural practices.)

AMOUNT TO RAISE PER PERSON: (These figures are average ranges. Specific amounts will vary depending on projected usage, whether fresh or processed, and according to personal preferences.)

STORAGE: (Optimum storage conditions; gives temperature ranges and % RH - percent relative humidity.)

PRESERVATION: (Suggestions for preserving the crop over an extended period. See Extension publications on food preservation for specific methods.)

ASPARAGUS



ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained, deep sandy loam
FERTILITY: medium-rich
pH: 6.0 - 6.7
TEMPERATURE: cool (60F-65F)
MOISTURE: average; a "flush" of spears often follows a soaking rain

CULTURE

PLANTING: one-year crowns, early spring
SPACING: 18" x 4-5'; or in wide beds of three rows with plants 18" apart in all directions
HARDINESS: Hardy perennial, should be mulched in autumn
FERTILIZER NEEDS: medium-heavy feeder, high P and K and organic matter at planting; annual nitrogen in late winter or very early spring; may sidedress after harvest; benefits from yearly topdressing of compost

CULTURAL PRACTICES

Asparagus is a perennial vegetable which will live from 12-15 years or longer. It is one of the most valuable of the early vegetables and is well adapted to freezer storage. During the harvest period (traditionally spring, but see below for summer harvest instructions), the spears develop daily from underground crowns. Asparagus does well where winters are cool and the soil occasionally freezes at least a few inches deep; it is considered very hardy.

Start asparagus either from seed or from one- to two-year-old crowns. For fastest results, crowns purchased from a respectable nursery are recommended (there is risk of disease from less reputable dealers' asparagus). Starting plants from seed requires an extra year before harvest. Seed may be started in peat pots; they are slow to germinate, so be patient. Seedlings may be transplanted in June. Crowns are usually shipped and set out in March or April.

Choose a site with good drainage and full sun. The tall ferns of asparagus may shade other plants, so plan accordingly. Prepare the bed as early as possible and enrich it with additions of manure, compost, bone or blood meal, leaf mold, or wood ashes, or a combination of several of these. In heavy soils, double-digging is recommended. To double-dig, remove the top foot of soil from the planting area. Then, with a spading fork or spade, break up the subsoil by pushing the tool into the next 10-12" of soil and rocking it back and forth. Do this every 6" or so. Double-digging is ideal for the trench method of planting asparagus since a 12" deep trench is usually dug anyway. The extra work of breaking up the subsoil will be well worth the effort, especially in heavy soil. The trench is dug 12-18" wide, with 4-5' between trenches. The same method may be used in wide-bed plantings, with plants staggered in three rows. Mix the topsoil that has been removed with organic matter and spread about two inches of the mixture in the bottom of the trench or bed. Set the plants 15-18" apart, mounding the soil slightly under each plant so that the crown is slightly above the roots.

Crowns should be of a grayish-brown color, plump and healthy-looking. Remove any rotted roots before planting. Spread the roots out over the mound of soil and cover the crown with 2-3" of soil. Firm well. As the plants grow, continue to pull soil over the crowns (about 2" every two weeks) until the trench is filled. Water if rainfall is inadequate.

Asparagus shoots or spears should not be harvested the first season after crowns are set. Harvest lightly for 3-4 weeks the second year. The fleshy root system needs to develop and store food reserves to produce growth during subsequent seasons. Plants harvested too heavily too soon often become weak and spindly and the crowns may never recover. An extra year is added to the above schedule for asparagus started from seed; i.e., do not harvest at all the first TWO seasons, and harvest lightly the third. When the asparagus plants are in their fourth season, they may be harvested for eight to ten weeks per year.

Weed the bed each spring before the first shoots come up, to avoid accidentally breaking off spears. During the production period, it is best to pull rather than hoe weeds if possible.

Harvest spears daily during the 8-10 week harvest period. The 6-8" spears are best, and should be snapped off just below the soil surface. If the asparagus is allowed to get much taller, the bases of the spears will be tough and will have to be cut; cutting too deeply can injure the crown buds which produce the next spears. Blanched asparagus is a gourmet item; to blanch (whiten) the spears, mound soil around them or otherwise exclude light from them so that chlorophyll is not formed in the stalks.

When harvest is over (after 8-10 weeks), allow the spears to grow. Asparagus has an attractive, fern-like foliage that makes a nice garden border. Some gardeners prefer to support the growing foliage with stakes and strings to keep them tidy. In high-wind areas, it is a good idea to plant the rows parallel to the prevailing winds so that the plants support each other to some extent.

There are several ways to extend the harvest period of your asparagus planting. One method is to plant at different depths (3", 4-6", 6-8", 8-10"). The shallow plantings will come up first and can be harvested while the deeper plantings are just forming. This method will result in a slightly longer harvest, but may result in some plants being less vigorous than others.

Another way to extend the harvest for a few weeks is to remove mulch from half of the asparagus bed. Leave the mulch on the other half. The exposed soil will warm up more quickly, and the crowns will sprout earlier. This process may be speeded up even further using black plastic, but be careful not to encourage growth too early, as heavy frost can make spears inedible. Remove mulch from the second bed when spears begin to appear.

A third technique for extending asparagus harvest has been the subject of university research and is highly recommended for home gardeners who have plenty of space. Plant double the amount of asparagus needed for your household. Harvest half of the plants as you normally would in spring and early summer, then allow the foliage to grow for the rest of the season. During the early harvest period, allow the ferns to grow in the other half of the asparagus planting. Then, cut the ferns in the second half in late July. This causes the crowns to send up new spears, which can be harvested till late in the season. If rainfall is short in summer, it will help to water this bed for good spear production. A light mulch will help keep the soil surface from becoming too hard for the shoots to break through easily. If using this method, harvest the spring bed only in spring and the fall bed only in fall! Otherwise, you risk weakening the crowns.

In all asparagus plantings, cut the foliage down to 2" stubs after frost when the foliage yellows, before the red berries fall off. A 4-6" mulch of compost, manure, leaves or other material added at this time will help control weeds and add organic matter and nutrients.

COMMON PROBLEMS

DISEASES: rust (use resistant varieties)
INSECTS: asparagus beetles, cutworms
CULTURAL: weak, spindly plants and/or too few spears from too early or too heavy a harvest; crown rot or poor production from inadequately prepared, heavy soil

HARVESTING AND STORAGE

DAYS TO MATURITY: 2-3 years
HARVEST: third year spears; snap off just under soil surface when 6-8" tall, before tips begin to separate; use or refrigerate immediately
APPROXIMATE YIELDS: (per 10 foot row) 3-4 pounds/year
AMOUNT TO RAISE PER PERSON: 6 lbs.
STORAGE: process or refrigerate immediately in plastic bag
PRESERVATION: can or freeze

BEANS

ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained
FERTILITY: medium-rich
pH: 5.8-7.0
TEMPERATURE: warm (65F - 80F)
except fava beans - cool (60F - 70F)
MOISTURE: average

CULTURE

PLANTING: seed after danger of frost is past. Inoculating seeds with nitrogen-fixing bacteria may increase yields on land newly planted in beans.
SPACING: bush snap 2" x 24-30"
bush limas 4" x 18-30"
pole beans 4-8" x 24-36"
HARDINESS: tender annual, except fava - semi-hardy annual
FERTILIZER NEEDS: Beans are medium feeders. Since beans are legumes they will fix nitrogen once a good root system is established; inoculation will speed the process. Excess nitrogen will delay flowering, so sidedress only after heavy bloom and set of

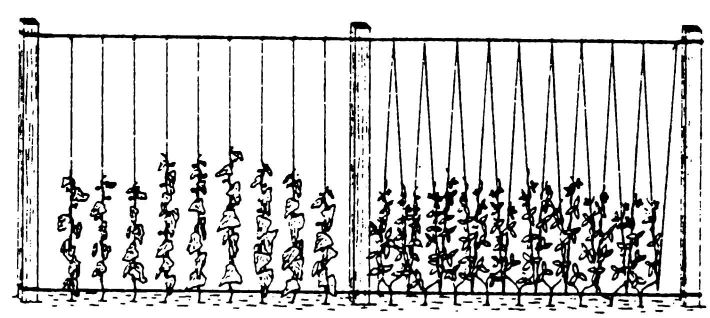
pods, using 1-1/2 oz. or 3 T. of 10-10-10 per 10 feet of row.

CULTURAL PRACTICES

Snap beans grown for the pod are the most common. Some beans like limas, soybeans, and dried beans are grown primarily for the seed itself and not the pod. The bush snap bean is the most popular because of its early maturity and because trellising is not required. Varieties include standard green, yellow wax, and purple-podded types, giving the gardener a larger choice than is generally available in supermarkets. Though wax beans are yellow and waxy in appearance, their flavor is only subtly different from that of regular green snap beans. The purple pod beans are different in appearance while growing, but the pods turn green when cooked. Flat-podded green snap beans are somewhat different in flavor and texture than the round-podded ones, and are preferred by many gardeners. These are available in both bush and pole types.

First plantings of bush beans should be made after danger of frost is past in the spring and soil is warmed, since seed planted in cold soils germinate slowly and are susceptible to rotting. Also, seedling growth may be slow in cool temperatures. Plant several crops of bush beans 2-3 weeks apart, until August 1 for a continuous harvest. Snap beans should be kept picked to keep plants producing heavily.

Half-runner beans have a growth habit between that of bush and pole beans, producing beans usually used as snap beans. Though they have runners about 3 feet long, half-runners are generally grown like bush beans. Trellising, however, may increase production of these already heavy yielders.



Pole type beans come in many varieties, generally bearing over a longer period than bush types. They require trellising, and for that reason generally yield more in the same amount of space. Pole beans are natural climbers but will not interweave themselves through horizontal wires. A teepee tripod support can be made with three wooden poles or large branches that are lashed together at the top. 5-6 seeds are planted in a circle 6-8 inches from each pole. Many types of homemade trellises work well as long as they provide the needed support. Trellises should be 6-8' tall and sturdy enough to withstand strong winds and rain. See illustrations for examples of bean trellises. Interplanting pole beans with corn is often recommended, but practices vary. Beans should be planted late enough to allow some growth and development of the corn first.

Scarlet runner beans are a type of pole bean which is quite ornamental as well as productive and delicious. The vines grow rapidly, producing beautiful red flowers and beans, which may be harvested as snap beans when young and as green shell beans later. Beans are ready to pick in 75-85 days and several pounds are produced per plant. The value of scarlet runner beans is mainly ornamental, though - the lush 6-15 foot vines can be used to cover arbors, trellises or fences. An added feature is that the flowers are attractive to hummingbirds. According to some catalogs, the scarlet runner bean grows best in cooler weather than standard beans prefer; in some very hot areas the vines may not keep producing all summer, as they will in cooler regions. Keeping maturing beans picked off will prolong the life of the vines.

Lima beans are available in bush or pole types. Bush limas mature about 10-15 days earlier than pole limas. Pole type limas have better yields and produce longer than the bush forms. Soil temperature must be 65 % for 5 days in order for the beans to germinate well. Because the large seeds store considerable amounts of carbohydrates, limas are quite susceptible to soil fungi and bacteria, which find these foods as nutritious as we do. So, the sooner the seedling can start using the stored food, the better. Pregermination or starting indoors helps if care is taken not to damage the shoots when planting and if soil remains moist for several days; seed treated with anti-fungal agents also have improved germination rates. Soil should be kept moist (but not soaking wet) until the seedlings come through the ground; do not allow a crust to form on the soil, since the seedlings will have trouble pushing through. Prevent crusting and conserve moisture by spreading 1/4" sand, sawdust, or a light mulch over the seeded row. A cold, wet spell can cause lima flowers to drop, as can excessively hot and dry periods, reducing yields. Baby limas or butter beans are less susceptible to blossom drop problems.

Southern peas are not actually beans or peas, but are used in the same ways. There are three commonly grown types - blackeye pea, cream pea, and crowder pea. They are available in both pole and bush forms. Southern peas may be harvested in the green shell or in the dried pea stage.

The yard-long or asparagus bean is related to blackeyed peas and has similar flavor, but the entire pod may be eaten. On trellised vines, pods may be produced which are 1-1/2 to 2 feet long (yard-long is stretching it a bit). Asparagus beans need warm temperatures and a long growing season to do well. Look for the seeds in novelty, gourmet, Oriental, or children's sections of seed catalogs.

Soybeans are increasing in popularity because of their high nutritional value and their versatility. Catalogs often list them as edible soybeans; all soybeans are actually edible, but those in garden catalogs have been bred to do well under ordinary garden conditions, requiring a shorter season and not growing as tall as the field types. There is also a difference in flavor and texture, as there is between sweet and field corn. Soybeans are less sensitive to frost and may have fewer problems with Mexican bean beetles than standard beans. Soybeans are quite delicious when harvested as green shell beans, but may also be allowed to dry on the vine. The pods of soybeans are quite difficult to open; cook for a few minutes to soften the pod before removing the beans.

Beans used primarily as dried beans are many and varied. Many can be used green, but dry well for easy storage. In the small garden, growing dry beans is somewhat impractical, since the amount of space required to raise a large enough quantity for storage is great. Many types of dry beans may be purchased in supermarkets at a very low cost, so it may be more worthwhile to grow higher-value crops in the limited space. However, if you have a very large garden area and a desire to sit on the front porch rocking away and shelling beans in the fall, they are worth a try. Some varieties available to gardeners are either rare or completely unavailable in the supermarket.

The horticultural, or October bean is very widely grown in parts of the state, called a "Virginia delicacy" by one Extension Specialist. The colorful pods and beans of the October bean make it an attractive addition to the garden and kitchen. The seeds of pinto beans look similar to those of the horticultural beans, but are smaller. They are widely used as brown beans and as refried beans in Mexican dishes. Black beans or black turtle beans make an unusual, delicious black-colored soup. They are easy to grow if given plenty of air movement to prevent disease problems to which they are susceptible. Kidney beans are the popular chili and baking bean, available in deep red or white types. Navy pea and Great Northern beans are used in soups and as baked beans. Cranberry and yellow-eyed beans are heirloom varieties again gaining favor among gardeners.

Mung beans, native to India, have enjoyed a rise in popularity because of their use as sprouts in Oriental dishes and salads, and gardeners now find seeds available for home production. Mung beans require 90 days of warm weather for good yield in the garden. Garbanzos, or chickpeas, produce plants which do not look like other bean plants. Garbanzos are actually neither true beans nor peas, but are leguminous. The fine-textured foliage is an attractive addition to the garden. Plant many seeds; the meaty seeds, like limas, tend to rot if they don't germinate and grow rapidly. Also, each pod contains only one or two seeds. The nutty-flavored beans of unusual texture are good roasted, in salads, and in soups. Garbanzos also require a warm climate and long (100 day) growing season.

Fava beans, or broad beans, are quite hardy. In cool climates they are often substituted for limas. Favas are sown early in spring, and are the exception to the rule, as they do not grow well in warm weather; in fact, if sown in April, they may be ready as green shell beans in late June or early July. It should be noted that some people of Mediterranean origin have a genetic trait which causes a strong allergic reaction to fava beans. People of this descent should sample the beans in small quantities at first.

COMMON PROBLEMS

DISEASES: mosaic (use resistant varieties); anthracnose; bacterial blight (use disease-free western-grown seed); seed rot (do not plant in cold moist soils); root and stem rots
INSECTS: Mexican bean beetles and larvae, corn earworm, mites
CULTURAL: Large plants with few beans (excess nitrogen); blossom drop (excessive heat, dry winds)

HARVESTING AND STORAGE

DAYS TO MATURITY:	snap beans	50-60 days
	pole limas	85-110 days
	bush limas	65-75 days
	pole beans	60-110 days

HARVEST: Snap beans - full size pods, small beans or larger beans as long as pods are still tender; pods break easily with a "snap" when ready; seed should not cause pods to bulge.

Lima/Dry beans - Seeds will be full sized and pods will be bright green. End of pod will be spongy. For dry beans (of all types) pods should remain on bush until dry and brown.
APPROXIMATE YIELDS: (per 10 foot row) Snap beans 3-5 lbs. Lima beans 4-6 lbs.
AMOUNT TO RAISE PER PERSON: snap beans - 8 lbs.; limas 5-10 lbs.
PRESERVATION: drying, freezing, and canning.

BROCCOLI

ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained, high organic matter
FERTILITY: rich
pH: 6.0 - 7.0
TEMPERATURE: cool (60F-65F)
MOISTURE: keep moist, not waterlogged

CULTURE

PLANTING: start seeds indoors for early spring transplants. Seed in beds or flats for fall transplants.
SPACING: 15-24" x 24-36"
HARDINESS: hardy annual
FERTILIZER NEEDS: heavy feeder, use starter fertilizer when transplanting, sidedress three weeks later and as needed (1 1/2 oz. 33-0-0 per 10 ft. row).

CULTURAL PRACTICES

There are two types of broccoli - heading and sprouting. Most garden broccoli is of the heading type which is closely related to cauliflower and forms a large central head. When this is removed, side branches will form throughout the summer. Sprouting or Italian broccoli forms many florets or small heads but these do not produce a solid head.

Broccoli Raab or Turnip broccoli is not a true broccoli but, in fact, a type of turnip cultivated for its flower head. Can be sown in spring to raise as an annual or can be sown in fall to raise as a biennial. Harvest leaves in fall and flower shoots in spring before they open. Cook and eat like asparagus. Most turnips grown for their greens can also be treated this way.

To raise broccoli, buy transplants locally or produce your own and set out April 10 to 30 or August 1 to August 15. Transplants for a fall setting can be produced along with cabbage and cauliflower transplants, taking about four weeks from seeding to setting into the garden. Set plants 18 inches apart in rows 30 inches apart. Sprouting and perennial broccolies are sown directly into the garden in spring. Follow packet directions.
Broccoli has a relatively shallow, fibrous rooting system. Cultivate carefully or, even better, mulch.
The heads of broccoli are really flower buds. These must be harvested before the flowers

open or show yellow. Mature heads measure three to six inches across. Lateral heads that develop later are smaller.

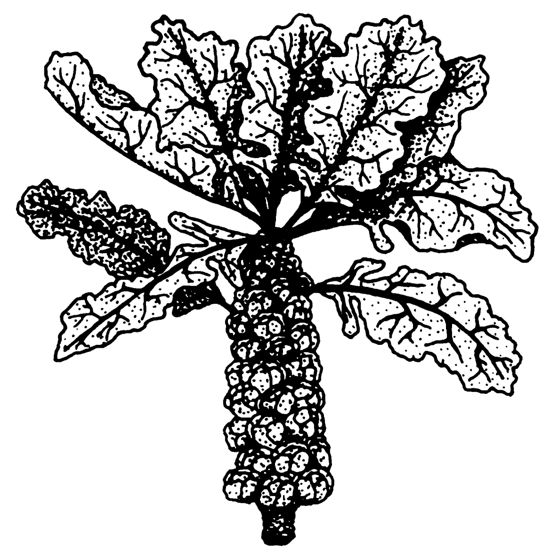
COMMON PROBLEMS

DISEASES: clubroot, yellows or fusarium wilt, blackleg and blackrot
INSECTS: cabbage root fly maggots, cutworms, cabbage worms, cabbage looper worms, flea beetles, aphids
CULTURAL: poor heading (buttoning), and early flowers (interrupted growth due to chilling, extremely early planting, or drying out; or high temperatures).

HARVESTING AND STORAGE

DAYS TO MATURITY: 60-100
HARVEST: large terminal bud cluster before flowers open, then small side bud clusters as they develop over following weeks. Harvest with 6-8 inches of stalk. Harvest sprouting and other types according to packet instructions.
APPROXIMATE YIELDS: (per 10 ft. row) 6-10 bunches or about 4-6 lbs.
AMOUNT TO RAISE PER PERSON: 8 lbs.
STORAGE: very cold (32F), moist (95% RH) conditions, 10-14 days
PRESERVATION: freeze

BRUSSELS SPROUTS



ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained loam, high organic matter
FERTILITY: rich
pH: 5.5 - 6.5
TEMPERATURE: cool (60F-65F)
MOISTURE: keep moist, not waterlogged

CULTURE

PLANTING: sow seeds early to mid-summer
SPACING: 12-18" x 24-30"
HARDINESS: hardy biennial
FERTILIZER NEEDS: heavy feeder, sidedress 1 tablespoon ammonium nitrate per 20 ft. of row 2-4 weeks after planting or when plants are 12" high.

CULTURAL PRACTICES

Brussels sprouts are grown for harvest in the fall because cool weather during maturity is essential for good flavor and quality. Brussels sprouts are tall (sometimes 2-3') erect biennials that are grown as annuals. The sprouts develop in the leaf axils and mature along the stalk. The lowest sprouts mature first and should be harvested when firm, 1 1/2 - 2" in diameter. Lowest leaves may be removed to permit sprouts to mature. New varieties are being developed for improved production. One new variety has a large cabbage-like head on the top which may be harvested anytime. Another has large leaves on the upper part of the plant which fold down over the sprouts to form a protective cover, making this variety even more cold-hardy than the usual varieties.

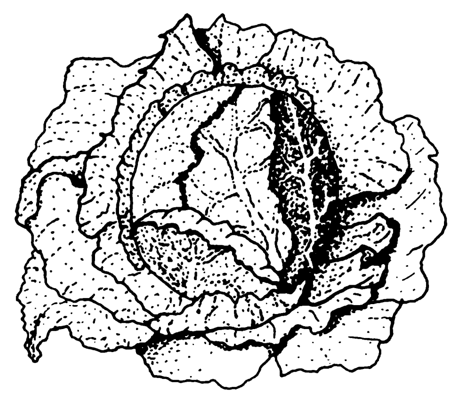
COMMON PROBLEMS

DISEASES: clubroot, yellows or fusarium wilt, backleg and black rot
INSECTS: cabbage root fly maggots, cutworms, cabbage worm, cabbage looper worms, flea beetles, aphids
CULTURAL: sprouts have loose tufts of leaves instead of firm heads (sprouts developed during hot weather, crop failures can also be due to water stress)

HARVESTING AND STORAGE

DAYS TO MATURITY: 80-100 days from seed
HARVEST: when sprouts are hard, compact and deep green about 1-1 1/2" diameter, after frosty weather for best flavor. Twist or snap off the stalk. The lowest sprouts mature first.
APPROXIMATE YIELDS: (per 10 ft. row) 4-6 lbs.
AMOUNT TO RAISE PER PERSON: 5 plants
STORAGE: cold (32F), moist (95% RH) conditions, 3-5 weeks
PRESERVATION: freeze

CABBAGE



ENVIRONMENTAL PREFERANCES

LIGHT: sunny
SOIL: well-drained
FERTILITY: rich
pH: 5.5-6.5
TEMPERATURE: cool (60F-65F)
MOISTURE: keep moist, not waterlogged

CULTURE

PLANTING: start seeds indoors for early spring transplants. Seed in beds or flats for fall transplants.
SPACING: 15-18" x 30-36"
HARDINESS: hardy biennial
FERTILIZER NEEDS: medium feeder, use starter fertilizer when transplanting, sidedress three weeks later (1 1/2 oz. 33-0-0 per 10 feet of row) .

CULTURAL PRACTICES

Cabbage grows from March to December. It will withstand temperatures as low as 15 % to 20F. Buy locally grown transplants or produce your own. Start them in growing structures four to six weeks before the first date when plants can be set out or sow a few seeds in the cold-frame or garden every month in order to have cabbage plants thereafter. It takes about three weeks to get plants ready from seeding to set during the summer months. Plant only the earliest varieties after July 1. It is best not to plant cabbage family crops in the same spot year after year, since diseases and insect pests will build up. Rotate crops within your garden.

Plant spacing affects head size. Close space (12 inches apart in the row) produces small heads. Average spacing is 15 to 18 inches apart in rows 30 inches apart. Varieties for sauerkraut are spaced wider. For a small family not interested in sauerkraut production, the dwarf varieties may be ideal. The heads are about the right size for a generous bowl of cole slaw, and the fast maturity makes these varieties excellent for succession planting. Cabbage is harvested when it reaches adequate size, depending on variety and growing conditions. Firm heads are preferred, especially for storage. Heads can be left on the plant in the garden for about two weeks in the summer, three to four weeks in the fall.

COMMON PROBLEMS

DISEASES: clubroot, yellows or fusarium wilt, blackleg or black rot
INSECTS: cabbage root fly maggots, cutworms, imported cabbage worms, cabbage looper worms, flea beetles, aphids
CULTURAL: head cracking or splitting (excessive water uptake and growth near maturity, root prune with spade or trowel or twist stalk to break some roots and reduce water uptake)

HARVESTING AND STORAGE

DAYS TO MATURITY: 70-100
HARVEST: when heads become firm, size will vary with variety, fertility, and spacing. If unable to harvest at maturity, bend over to break part of the roots to reduce head splitting.
APPROXIMATE YIELDS: (per 10 ft. row) 10-18 lbs.
AMOUNT TO RAISE PER PERSON: 15 lbs.
STORAGE: very cold (32F), moist (95% RH) conditions, 4-5 months
PRESERVATION: can as sauerkraut

CAULIFLOWER

ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained, high organic matter
FERTILITY: rich
pH: 6.0 - 7.0
TEMPERATURE: cool (60F-65F)
MOISTURE: keep moist, not waterlogged

CULTURE

PLANTING: Plant after danger of frost is past. Start seeds indoors for early spring transplanting. Seed in beds or flats for fall transplanting.
SPACING: 15-24" x 24-36"
HARDINESS: hardy annual
FERTILIZER NEEDS: heavy feeder, use starter fertilizer when transplanting, sidedress hree weeks later and as needed (1 1/2 oz. 33-0-0 per 10 ft of row).

CULTURAL PRACTICES

Spring seedlings should be transplanted after danger of frost is past. Fall cauliflower should be sown in late June to July. Many gardeners experience buttoning of cauliflower heads in the spring. This is a failure of the cauliflower head to gain in size after it reaches about an inch or less in diameter. It is usually due to transplant stress or heat stress during the head formation period. Some cauliflower varieties require too long a growing season for fall production in colder areas of VA. Use short-season types or season extenders in these areas. (See publication 426-381).

Cauliflower should be blanched when the curd flower head is about 2-3". Three to four large outer leaves are pulled up over the curd and fastened with a rubber band, or are broken over the top of the cauliflower and tucked in on the other side of the curd. Normal blanching time is 4-8 days and may take longer in the fall. Self-blanching types which have leaves that grow up over the head may eliminate the need for this practice.

If weather is warm during the blanching period, tie the leaves loosely to allow air circulation. Harvest while the curd is still firm. If it gets too mature, it will become grainy or "ricey."

COMMON PROBLEMS

DISEASES: club root, yellows or fusarium wilt, blackleg and black rot.
INSECTS: cabbage root fly maggots, cut worms, cabbage worms, cabbage looper worms, flea beetles, aphids
CULTURAL: poor heading (interrupted growth due to chilling from extremely early planting, or drying out, or high temperatures)

HARVESTING AND STORAGE

DAYS TO MATURITY: 55-120 days from transplanting
HARVEST: Cut before flower sections begin to separate. The curd should be compact, firm, white and fairly smooth. Leave a ruff of leaves surrounding head when harvested to prolong keeping quality.
APPROXIMATE YIELDS: (per 10 ft of row) 8-12 lbs.
AMOUNT TO RAISE PER PERSON: 8 lbs.
STORAGE: very cold (32F), moist (95% RH) conditions, 2-4 weeks
PRESERVATION: freeze,pickle

CORN

ENVIRONMENTAL PREFERENCES

LIGHT: sunny
HARDINESS: tender annual
SOIL: deep, well-drained loam
FERTILITY: rich
pH: 6.0-7.0
TEMPERATURES: warm (60F-75F)
MOISTURE: average

CULTURE

PLANTING: seed after danger of frost is past; extra sweet varieties should be planted when soil temperatures reach 65F
SPACING: 9-12" x 24-36" minimum of three rows side by side (preferably four rows) to insure good pollination
FERTILIZER NEEDS: heavy feeder; sidedress when plants are 12-18 inches high with 3 T. 10-10-10 per 10 feet of row

CULTURAL PRACTICES

Sweet corn varieties differ significantly in time to maturity and in quality; yellow, white, bi-color, standard and extra-sweet varieties are available. Most varieties planted are hybrids which have been bred for greater vigor and higher yields. A continuous harvest can be planned for by planting early-, mid-, and late-season varieties, or by making successive plantings of the same variety every two weeks or when the last planting has 3-4 leaves (corn sown in early spring will take longer because of cool temperatures). Use only the earliest varieties for July plantings to assure a good fall crop. Fall maturing sweet corn will almost always be the highest quality, since cool nights in September increase sugar content.

Pollination is a very important consideration in planting sweet corn. Because corn is wind-pollinated, block plantings of at least 3-4 short rows will be pollinated more successfully than one or two long rows. Good pollination is essential for full kernel development.

Most of the various types of corn will cross-pollinate readily. To maintain the desirable characteristics and high quality, extra-sweet and standard sweet corn should be isolated from each other. A distance of 400 yards or planting so that maturity dates are one month apart is necessary to insure this isolation. Sweet corn plantings must be isolated from field corn and popcorn or ornamental corn as well. White and yellow types will also cross-pollinate, but the results are not as drastic.

The newly developed extra- or super-sweet types convert sugar into starch more slowly than standard varieties. They are not necessarily sweeter than just-picked old favorites (though some cultivars are), but they will retain their sweetness after harvest longer than usual. Super-sweet varieties may be less creamy than standard varieties due to genetic differences. This characteristic decreases the quality of frozen or canned super-sweet corn, though newer cultivars of extra- sweets show improvement.

Early-maturing varieties tend to be relatively small plants (called coon corn by old-timers because the ears are easy for raccoons to reach). These should be planted in rows 30" apart with plants 8-9" apart. For medium to large plant varieties use a 36" row spacing with plants 12" apart in the row. Be sure to plant a block of rows for good pollination and full ears.

Some gardeners are interested in growing "baby corn" such as that found in salad bars and gourmet sections of the grocery store. Baby corn is immature corn, and many varieties are suitable, but "Candystick," with its 1/4" diameter cob at maturity, is a good one to try, especially since its dwarf habit means that it takes up less space in the garden. Harvesting at the right time is tricky; silks will have been produced, but ears are not filled out. Experimentation is the best way to determine when to harvest baby corn.

It is not necessary to remove suckers or side shoots that form on sweet corn. With adequate fertility these suckers may increase yield, and removing them has been shown in some cases to actually decrease yield.

Mulching is a useful practice in corn growing because adequate moisture is required from pollination to harvest to guarantee that ears are well-filled. Since main crops of corn usually ripen during Virginia's drier periods, it is especially critical to maintain soil water supplies; mulching reduces the need for supplemental watering and keeps the moisture content of the soil fairly constant. Most organic mulches are suitable; newspaper held down with a heavier material on top is an excellent moisture conserver in corn.

Normally, sweet corn is ready for harvest about 20 days after the first silks appear. Pick corn that is to be stored for a day or two in the cool temperatures of early morning to prevent the ears from building up an excess of field heat, which causes a more rapid conversion of sugars to starch. Of course the best time to pick is just before eating the corn; country cooks say to have the pot of water coming to a boil as you are picking the corn, husking it on the way from the garden to the house! This is an exaggeration, but with standard varieties, sugar conversion is rather rapid. Field heat can be removed from ears picked when temperatures are high by plunging the ears in cold water or putting them on ice for a short time. Then store in the refrigerator until ready to use. Extra-sweet varieties will also benefit from this treatment, but they are not as finicky.

COMMON PROBLEMS

DISEASES: Stewart's wilt (bacterial disease spread by flea beetle); smut (especially on white varieties) - remove infected part; stunt (transmitted by leafhoppers)
INSECTS: corn earworm, European corn borer, flea beetles, Japanese beetles (eat silks), corn sap beetles (damage kernels after husk is loosened)
OTHER: birds eating seed, raccoons eating mature ears of corn, gardener's impatience (picking too soon)

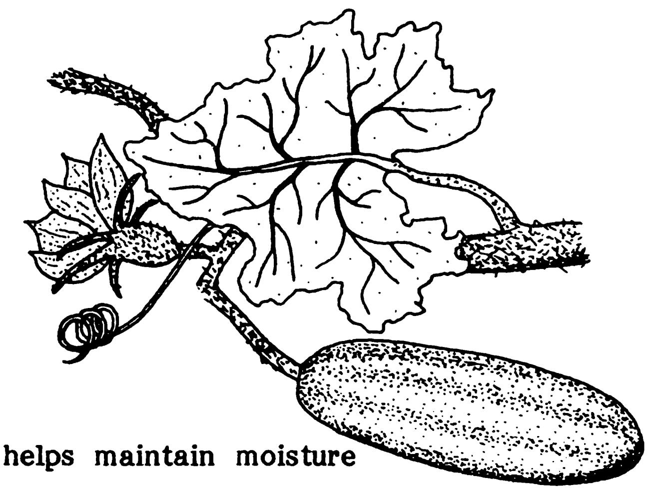
CULTURAL

Poor kernel development - failure to fill out to the tip; caused by dry weather during silking states, planting too close, poor fertility (especially potassium deficiency), too few rows in block resulting in poor pollination. Lodging (falling over) from too much nitrogen.

HARVESTING AND STORAGE

DAYS TO MATURITY: 63-100
HARVEST: When husk is still green, silks dry brown, kernels full size and yellow or white color to the tip of the ear; at milky stage (use thumbnail to puncture a kernel - if liquid is clear the corn is immature, if milky it's ready, and if no sap, you're too late). Cover unharvested ears checked by this method with paper bag to prevent insect or bird damage. Experienced gardeners can feel the outside of the husk and tell when the cob has filled out. Corn matures 17-24 days after first silk strands appear, more quickly in hot weather, slower in cool weather.
APPROXIMATE YIELDS: (per 10' row) 5-10 lbs. or roughly 10-20 ears
AMOUNT TO RAISE PER PERSON: 20-30 pounds or about 40-60 ears
STORAGE: refrigerate immediately to prevent sugars from turning to starch; cold (32F), moist (95% RH) conditions; will keep 4-8 days, but standard varieties will become starchy after a few days
PRESERVATION: frozen on cob or off; canned

CUCUMBERS



ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained; moderate-high organic matter
FERTILITY: rich
pH: 5.5-7.0
TEMPERATURE: hot (65-80 %F.)
MOISTURE: keep moist, not water-logged; mulch helps maintain moisture

CULTURE

PLANTING: Seed after danger of frost has passed and soil has warmed, or use plants sown indoors in peat pots 3-4 weeks prior to planting time.
SPACING: 12-18" x 48-72" in rows, 24-36" x 48-72" in hills (2-3 plants per hill); closer if trellised (see text)
HARDINESS: very tender annual
FERTILIZER NEEDS: heavy feeder; side-dress one week after blossoming begins and again 3 weeks later (1-1/2 oz. 33-0-0 per 10 feet of row)

CULTURAL PRACTICES:

Varieties include both the slicer or fresh salad type and the pickle type (which can also be used fresh), and dwarf-vined or bush varieties.

New varieties of cucumber are being released which are advertised as all-female, or gynoecious types. On a normal cucumber plant the first 10-20 flowers are male, and for every female flower (which will produce the fruit) 10-20 male flowers are produced. This indicated to plant breeders that production could be increased greatly if many more female flowers were produced. Some of the new varieties produce plants which have only female flowers, while others have a greater proportion of female to male flowers. These plants tend to bear fruit earlier, with a more concentrated set and better yields overall.

Parthenocarpic cucumbers are all female and are seedless because the fruit is produced without being pollinated. If this type of cuke is planted near others, pollination will occur and seeds will form. This type is usually grown in greenhouses.

Burpless cucumbers are long and slender with a tender skin. Through plant breeding the bitterness associated with the 'burp' has been removed. Other causes of bitterness in cucumbers include temperature variation of more than twenty degrees and storage of cucumbers near other ripening vegetables.

Most varieties of cucumber vines spread from row to row. Training on a trellis or fence along the edge of the garden will correct this and also lift the fruit off the soil. If trellised, plant four to five seeds per foot in rows spaced 30 inches apart. Untrellised rows may need to be spaced four to six feet apart. When plants are four to five inches high thin so they are nine to twelve inches apart. It may be better to plant a second crop around July 1, which will have fewer disease problems, than to try to continue harvesting an early planting until frost.

There are many excellent bus varieties of cucmber now available. Most of these produce well for the limited amount of space and may be a desirable alternative in a small garden if trellising is not possible.

In order for the flower to develop into a fruit, pollen must be carried by bees from male flowers - on the same plant or on different plants - to the female flower, the one with the tiny swollen pickle. (Gynoecious cucumber flowers are pollinated by male flowers from other plants, the seeds of which are usually included in the seed packet.) Poor cucumber set is common during rainy weather when bees are inactive. If pesticides are necessary, use them after sundown to avoid harming the bee population.

Plants respond to mulching with soil warming black plastic in the spring for earlier harvest. Organic materials are useful in the summer to return moisture and keep the fruit clean in non-trellised plantings.

Working in the vines when leaves are wet may help spread diseases. Wait until after morning dew or rain evaporates. Trellising gets leaves up off the ground so that they dry off faster. Also, if the vines are trellised, the gardener is less likely to step on the vines and there is no need to move the vines for weeding or other purposes, reducing the risk of damage. If vines are not trellised, avoid destroying blossoms or kinking vines by gently rolling the vines away rather than lifting them when searching for harvestable fruit.

There has been a significant increase in disease resistance in cucumber varieties in recent years. Try to select resistant varieties when possible.

<u>COMMON PROBLEMS</u>

DISEASES: Bacterial wilt (spread by cucumber beetles), mosaic, leaf spot, anthracnose, scab, powdery and downy mildews

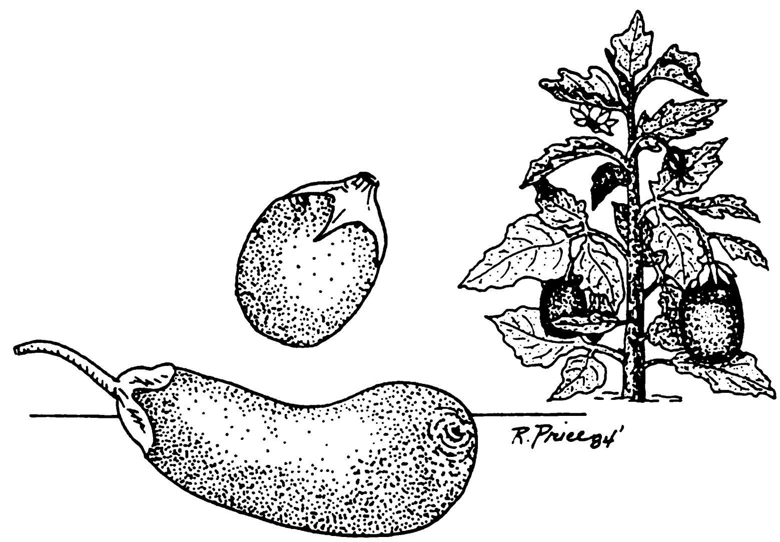
INSECTS: cucumber beetles, aphids, flea beetles, pickleworms

CULTURAL: mis-shapen cucumbers (low fertility or poor pollination), failure to set fruit (too few bees for adequate pollination, no pollinating plants for gynoecious hybrids, changes in temperature)

HARVESTING AND STORAGE

DAYS TO MATURITY: 50-70
HARVEST: From when cucumbers are about two inches long up to any size before they begin to turn yellow, about 15 days. Remove by turning cucumbers parallel to the vine and giving a quick snap. This prevents vine damage and results in a clean break.
APPROXIMATE YIELDS: (per 10 foot row) 8-10 pounds
AMOUNT TO RAISE PER PERSON: 10-15 lbs.
STORAGE: medium cool (45-50 %F.) and moist (95% RH) conditions
PRESERVATION: pickled

EGGPLANT



ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained, high organic matter
FERTILITY: rich
pH: 6.0-7.0
TEMPERATURE: warm (70F-85F)
MOISTURE: average

CULTURE

PLANTING: Transplant after danger of frost, when soil is thoroughly warm.
SPACING: 18-24" x 30"-36"
HARDINESS: very tender annual
FERTILIZER NEEDS: heavy feeder (3 Tablespoons of ammonium nitrate 33-0-0 per 10 feet of row)

CULTURAL PRACTICES

The standard eggplant produces egg shaped glossy purple black fruit 6-9" long. The long, slender Japanese eggplant has a thinner skin and more delicate flavor. Both standard and miniature eggplants can be grown successfully in containers; but, standards yield a better crop. White, ornamental varieties are available and edible yet are poor eating quality.

Warm to hot weather throughout the season is necessary for good production. Seeds germinate quickly at 70F-90F; and, plants should be grown for 8-9 weeks before setting them out. Cold temperatures will stop plant and root growth reducing plant vigor and yields. Using hot caps or cloches protects plants from cold conditions.

Though eggplants do well in hot weather, they must have well drained soil and do not thrive in very humid areas. When plants are about 6" high, nip back the growing tip to encourage branching. Pick fruits when immature - about 2/3 maximum size. Mature fruit should not be left on the plant as this will reduce overall productivity.

Because of the eggplant's susceptibility to verticillum wilt, rotate plantings with other crops on the same garden soil.

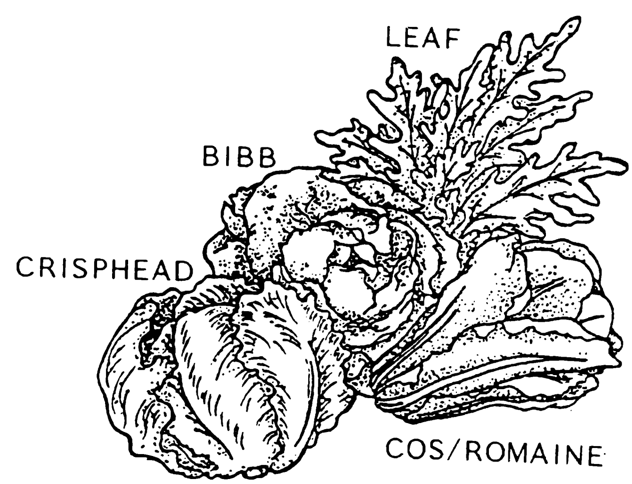
COMMON PROBLEMS

DISEASES: Verticillum wilt
INSECTS: flea beetles, aphids, lace bugs, Colorado potato beetle, red spider mites

HARVESTING AND STORAGE

DAYS TO MATURITY: 100-150 days from seed; 70-85 days from transplants
HARVEST: Fruit should be large, shiny, and a uniformly deep purple color When the side of the fruit is pressed slightly with thumbnail and an indentation remains, the fruit is ripe. Long, slender Japanese eggplant may be ready to harvest from finger or hotdog size. If fruit is a dull color and has brown seeds, it is too ripe and should be discarded.
APPROXIMATE YIELDS: (per 10 feet of row) 20 pounds
AMOUNT TO RAISE PER PERSON: 12 lbs.
STORAGE: cool (45-50 %F) moist (90% RH) conditions; 1 week
PRESERVATION: freeze, pickle

LETTUCE



ENVIRONMENTAL PREFERENCES

LIGHT: sunny, tolerates shade; prefers shade in summer
SOIL: well-drained, loose loam
FERTILITY: rich
pH: 6.0 - 7.0
TEMPERATURE: cool (60F-70F)
MOISTURE: moist, but not waterlogged; frequent, light waterings

CULTURE

PLANTING: seed leaf or butterhead types as soon as soil can be worked in the spring, or in late summer. Crisphead and Cos types may be transplanted in early spring or fall.
SPACING: leaf, Cos or butterhead, 4-10" x 12-24;" crisphead, 12-15" x 18-30"
HARDINESS: hardy annual
FERTILIZER NEEDS: medium-heavy feeder, use starter solution on transplants, sidedress if nutrient deficiencies are noted

CULTURAL PRACTICES

Lettuce, a cool-season vegetable crop, is one of the easiest to grow. Lettuce withstands light frost; however, sunlight and high summer temperatures usually cause seedstalk formation (bolting) and bitter flavors. Slow-bolting or heat-resistant varieties are available and are recommended for extending the lettuce-growing season. There are several types of lettuce commonly grown in gardens:

Crisphead, also known as iceberg, is the lettuce most widely available as a fresh market type. It has a tightly compacted head with crisp, light green leaves. Many gardeners find this type difficult to grow because it requires a long season and some of the most advertised varieties are not heat-resistant and tend to go to seed as soon as temperatures go up. Select a slow-bolting variety and start seed indoors in late winter or late summer for best results. Transplant in early spring or fall to take advantage of cool weather and mulch well to keep soil temperatures from fluctuating and to hold moisture in. An organic mulch is more suitable than black plastic after soil warms up. Mulching also keeps soil off the leaves, reducing chances of disease from soil-borne organisms.

Butterhead, or Bibb, lettuce, is a loose-heading type with dark green leaves that are somewhat thicker than those of iceberg lettuce. Butterheads develop a light yellow, buttery appearance and are very attractive in salads. A miniature variety of butterhead, "Tom Thumb," is very easy to grow, requiring a short growing time; one head of this lettuce is about right for one or two servings, so this is one lettuce to plant in succession, about two weeks apart. It may be started indoors for an even longer season. Bibb lettuce will develop bitterness readily if temperatures get too high.

Romaine, or Cos, is less commonly grown by gardeners, but is a very nutritious lettuce that deserves more attention. It, too, is relatively easy to grow, forming upright heads with rather wavy, attractive leaves.

Most gardeners who grow lettuce raise the leaf type, either with green or reddish leaves. This type is fast-growing, long-lasting lettuce used for salads, sandwiches, and in the popular wilted lettuce recipe. Leaf lettuce basically needs only to be planted and harvested.

Sow leaf varieties in rows, 10-20 seeds per foot, in rows 8-12" apart. Thin individual plants 4-8" apart, depending on variety. Leaf lettuce also grows very successfully in a wide bed arrangement; seedlings are thinned to 4-8" on all sides. Cos and head types should be sown or transplanted 12-18" apart. If in rows, allow 30" between rows.

Cultivate carefully as lettuce is shallow-rooted. Use frequent, light waterings to encourage rapid growth, but do not overwater, as this may cause disease of roots or leaves. Overhead watering should always be done in the morning to give plants time to dry off. As mentioned above, mulches are helpful in maintaining soil moisture and keeping leaves off the ground.

Lettuce planted in very early spring should be given full sun so that the soil will warm enough for rapid growth. For long-season lettuces, plant so that crops such as sweet corn, staked tomatoes, pole beans or deciduous trees will shade the lettuce during the hottest part of the day when temperatures are over 70 degrees. Inter-planting, i.e., planting between rows or within the row of later-maturing crops like tomatoes, broccoli, and Brussels sprouts, is a space-saving practice. Some lettuces, like "Tom Thumb" and leaf lettuces, are attractive in flower borders.

Lettuce is best planted in succession, or using different varieties that mature at different times. Thirty heads of iceberg lettuce harvested at once can present a major storage problem! Leaf and Bibb lettuces do well in hotbeds or greenhouses during the winter and in cold frames in spring and late fall.

COMMON PROBLEMS

DISEASES: stem, leaf and root rots
INSECTS: aphids, root aphids
CULTURAL: tip burn (irregular moisture, or lack of calcium; bolting, bitterness due to high temperature or lack of moisture; leaf rots due to soil and/or water on leaves

HARVESTING AND STORAGE

DAYS TO MATURITY: 40 - 80 days, depending on type
HARVEST: Leaf lettuce can be used as soon as plants are five to six inches tall. Use the older, outer leaves which contain high levels of calcium first. You may wish to harvest every other one of the largest plants to accomplish thinning.

Bibb lettuce is matured when the leaves begin to cup inward to form a loose head. The heads will never become compact. Cos or Romaine is ready to use when the leaves have elongated and overlapped to form a fairly tight head about four inches wide at the base and 6-8" tall. Crisphead is matured when leaves overlap to form a head similar to those available in groceries; heads will be compact and firm.

Crisphead lettuce will keep about two weeks in the refrigerator. Leaf and Bibb will store as long as four weeks if the leaves are dry when bagged. If lettuce is to be stored, harvest when dry, remove out leaves but do not wash, place in a plastic bag and store in the crisper drawer.
APPROXIMATE YIELDS: (per 10 foot row): 5 - 10 pounds
AMOUNT TO RAISE PER PERSON: 5-10 pounds
STORAGE: Cool (32 % F.), moist (95% RH) conditions; 2-3 weeks
PRESERVATION: cool, moist refrigeration; canning and freezing not recommended

MELONS

ENVIRONMENTAL PREFERENCE

LIGHT: sunny
SOIL: well-drained, moderate organic matter, sandy
FERTILITY: medium
pH: 6.0 - 7.5
TEMPERATURES: hot (70-85 % F.)
MOISTURE: average

CULTURE

PLANTING: seed after all danger of frost is past and when soil warms, or begin transplants in peat pots three to four weeks before this time.
SPACING: muskmelon hills 24-36" x 60- 90"; watermelon hills 6-8' apart
HARDINESS: very tender annual
FERTILIZER NEEDS: heavy feeder, use a starter solution for transplants, sidedressing with nitrogen may lower yield or quality or both. Late maturing varieties, however, may need some sidedressing at fruit set.

CULTURAL PRACTISES

Muskmelons and watermelons are warm season crops requiring a long growing season of 80 to 100 days from seed to fruit. Most present varieties are not well suited to small gardens because of the space requirement. But newer bush varieties are being developed for use in small gardens.

Melons can be produced from transplants or planted directly. Those grown from transplants can be harvested as much as two weeks earlier than melons grown directly from seed, since the gardener must wait until danger of frost is past to plant. Plant or transplant muskmelons in rows five feet apart with hills spaced every 2-3 feet, two or three plants per hill. Watermelon hills should be 6-8 feet apart, and rows 7-10' apart if a path is desired between rows. Seed should be sown 1/2" to one inch deep after danger of frost has passed and soil is warmed.

Muskmelons and watermelons are well suited for growing on black plastic mulch. The black plastic absorbs heat readily, allowing the soil to warm more quickly. It tends to keep the soil moisture level from fluctuating greatly. In addition, the mulch is very effective in controlling weeds, decreasing the labor necessary to care for your melons.

Male and female flowers are separated on the same plant. Bees must carry pollen from flower to flower to insure good fruit. Use insecticides late in the evening to prevent killing bees.

Melon plants can be trained in rows for easier harvesting. Growing on a trellis allows for closer spacing (rows three feet apart), but each trellised melon must be supported by a sling made of a material which dries quickly (to prevent rot). Old nylon stockings, cheesecloth, and other net-like materials make good fruit slings. Very large watermelons probably should not be trellised at all, since the weight of the fruit, even if supported, would likely damage the vine.

COMMON PROBLEMS

DISEASES: bacterial wilt (spread by cucumber beetles), fusarium wilt, leaf spot, powdery and downy mildews, alternaria blight.
INSECTS: cucumber beetles, squash vine borer, pickleworms, squash bug
CULTURAL: poor flavor and lack of sweetness due to poor fertility (low potassium, magnesium or boron), cool temperatures, wet weather, poorly adapted variety, loss of leaves from disease, picking melons unripe, or poor pollination (caused by wet, cool weather, lack of bee pollinators, planting too close, resulting in excessive vegetative growth). A heavy rain when melons are ripening may cause some of the fruit to split open. Fruit in contact with soil may develop rotten spots or be damaged by insects

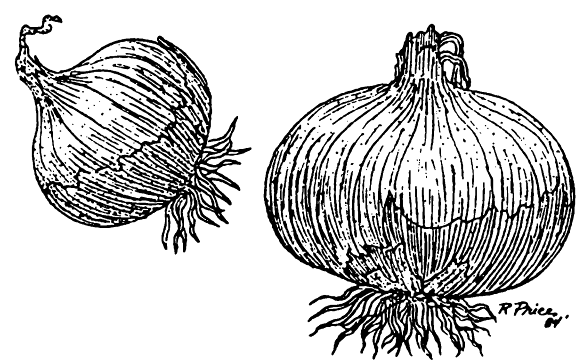
on the bottom. Place a board or a couple inches of light mulching material, such as sawdust or straw, beneath each fruit when it is nearly full-sized.

HARVESTING AND STORAGE

DAYS TO MATURITY: 70 - 130
HARVEST: Muskmelons are harvested at full-slip; i.e., when the stem separates easily at the point of attachment. Honeydew, Crenshaw, and Casaba melons are cut off after they turn completely yellow. These melons will rot if left on the ground for too long. For watermelons, become familiar with the variety being grown to determine the best stage for harvesting. The best indicator is a yellowish color on the underside where the melon touches the ground. A dead tendril or curl near the point where the fruit is attached to the vine is used by some as an indicator that the fruit is ready for harvest. You may also thump the fruit, listening for the dull sound of ripe fruit, rather than a more metallic sound; however, this technique takes some practice, and if you have just a few fruit, it is probably to wise include all of the above when making your decision.
APPROXIMATE YIELDS: (per 10 foot row) 8 - 40 pounds; more if trellised
AMOUNT TO RAISE PER PERSON: 10-15 lbs.
STORAGE: medium-cool (40-50 % F.), moist (80-85% RH) conditions;
PRESERVATION: cool, moist storage; may freeze muskmelons

ONIONS

ENVIRONMENTAL PREFERENCES



LIGHT: sunny, (green onions tolerate partial shade)
SOIL: well-drained loam
FERTILITY: medium-rich
pH: 5.5-7.0
TEMPERATURE: cool (45F-60F) during development; medium hot (60F-75F) during bulbing and curing.
MOISTURE: moist, but not waterlogged

CULTURE

PLANTING: Use sets, seeds, or transplants in spring for bulbs and for green or bunching onions. Seeds may be started indoors eight weeks before setting out; use sets in the fall for perennial or multiplier types of onions.
SPACING: standard 1-6" x 12-24"; wide row 4" x 4" in rows up to 2 feet apart. Plant close, then thin using thinnings as green onions.
HARDINESS: Bulb onions - hardy biennial; Green or bunching - hardy biennial; Egyptian or Perennial Tree and multiplier - hardy perennials
FERTILIZER NEEDS: Heavy feeder, apply 4-5 lbs. 10-10-10/100 sq. ft. before planting, use starter solution for transplants, and sidedress one to two weeks after bulb enlargement begins (3 Tablespoons 33-0-0 per 10 feet of row).

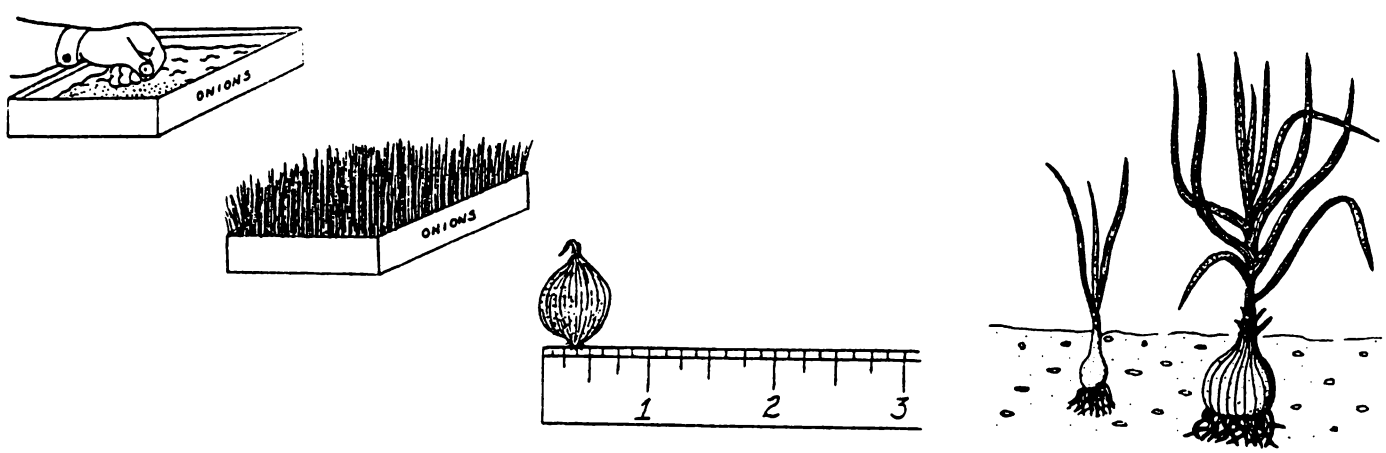
CULTURAL PRACTICES

Onions are often grouped according to taste. The two main types of onions are strong flavored (American) and mild (often called European). Each has three distinct colors - yellow, white, and red. In general, the American onion produces bulbs of smaller size, denser texture, stronger flavor, and better keeping quality. The Globe varieties tend to keep longer in storage.

Onion varieties also have different requirements as to the number of hours of daylight required to make a bulb. If the seed catalog lists the onion as "long day", it sets bulbs when it receives 15-16 hours of daylight and is used to produce onions in Nothern summers. "Short day" varieties set bulbs with about 12 hours of daylight and are used in the deep South for winter production.

For green or bunching onions, use sets, seeds, or transplants in spring; or, use Egyptian (Perennial Tree) and the Yellow Multiplier (Potato Onion) sets in the fall.

For bulb production, plant sets in early spring. Set one to two inches apart and one to two inches deep in the row. Thin to four inches apart and eat the thinned plants as green onions. Avoid sets more than an inch in diameter because they are likely to produce seed stalks. Too early planting and exposure to cold temperatures also causes seed stalk development. Some people have best bulb production using seedlings or transplants rather than sets. Egyptian Tree or Multiplier onions should be set in late October or early November. Plant four inches apart in rows one to two feet apart. Distance between rows is determined by available space and cultivating equipment.



Bulbs compete poorly with weeds due to shallow root systems. Shallow cultivation is necessary; do not hill up soil on onions as this can encourage stem rot. Insure ample moisture especially after bulbs begin enlarging.

Onions should be harvested when about two-thirds of the tops have fallen over. Careful handling to avoid bruising helps control storage rots. Onions may be pulled and left in the field for several days to dry then cured in a well ventillated attic or porch for one to two weeks out of direct sun. Tops may be left on or cut off; but, leave at least one inch of the top when storing. Thorough curing will increase storage life.

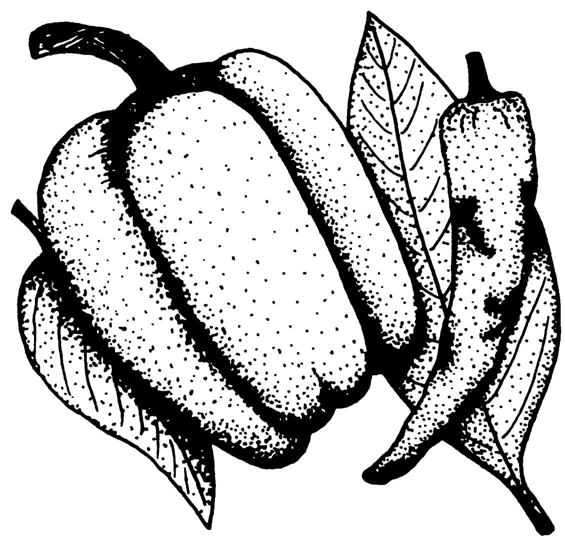
COMMON PROBLEMS

DISEASES: neck or stem rot, bulb rot
INSECTS: thrips, onion root maggots
CULTURAL: bulb rot from bruising, insufficient drying; split or double bulb from dry soil during bulb formation; very small bulb from too late planting or too dry soil.

HARVESTING AND STORAGE

DAYS TO MATURITY: 100-120 (Mature bulbs)
HARVEST: Harvest green onions when tops are 6 inches tall; bulbs after 2/3 or more of the tops have fallen over. Do not wait more than 1-2 weeks after this occurs. Allow for thorough drying before storage.
APPROXIMATE YIELDS: 10-15 lbs.
(per 10 feet of row)
AMOUNT TO RAISE PER PERSON: 10-15 lbs.
STORAGE: cool (32F),
dry (65-70% RH) conditions; 6-7 months
PRESERVATION: Onions may be stored dry or pickled and canned. Freeze well if chopped and covered with water. For fresh storage, maintain good air circulation. One effective storage method is to place onion in discarded hose, tie a knot and add other onion. When hose if filled, suspend from rafters in storage area.

PEPPERS



ENVIRONMENTAL PREFERENCES

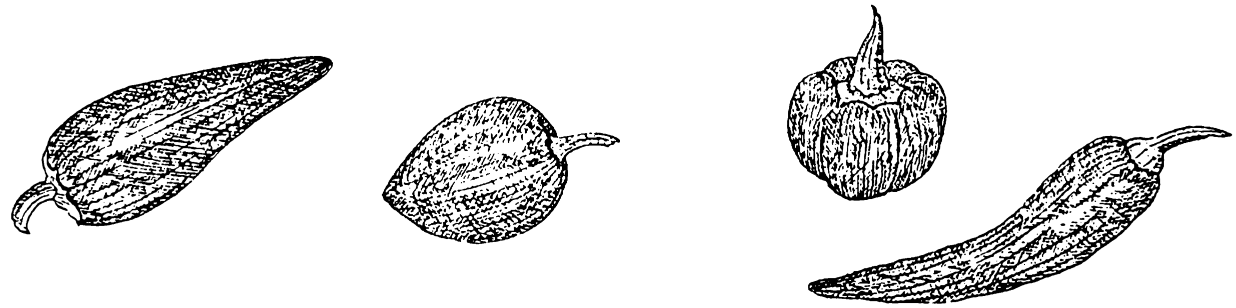
LIGHT: sunny
SOILS: well-drained, loose,
moderate organic matter
FERTILITY: medium-rich
pH: 5.5-6.5
TEMPERATURE: warm (70F-75F);
days 75F, nights 62F
MOISTURE: average

CULTURE

PLANTING: Set out transplants after the soil has thoroughly warmed in the spring, start seed indoors 6-8 weeks prior to this date.
SPACING: 18-24" x 30-36"
FERTILIZER NEEDS: Light-medium feeder, use starter solution for transplants , sidedress cautiously after first fruit sets (3 Tablespoons 33-0-0 per 10 feet of row), too much may cause excessive vegetative growth.

CULTURAL PRACTICES

Although types of peppers belong in one of six groups, most are classified according to their degree of hot or mild flavor. The mild peppers include Bell, Banana, Pimiento and Sweet Cherry while the hot peppers include the Cayenne, Celestial, Large Cherry, and Tabasco.



Bell peppers, measuring 3" wide by 4" long, usually have 3-4 lobes and a blocky appearance. They are commonally harvested when green yet turn red or yellow when fully ripe. About 200 varieties are available. Banana peppers are long and tapering and harvested when yellow, orange or red. Another sweet pepper, Pimiento peppers have conical, 2-3" wide by 4" long, thick walled fruit. Most Pimientos are used when red and fully ripe. Cherry peppers vary in size and flavor. Usually they are harvested orange to deep red.

Slim, pointed, slightly twisted fruits characterize the hot Cayenne pepper group. These can be harvested either when green or red and include varieties such as Anaheim, Cayenne, Serrano and Jalapeno. Celestial peppers are cone shaped, 3/4"to 2" long, and very hot. They vary in color from yellow to red to purple making them an attractive plant to grow. Slender, 1" to 3", pointed Tabasco peppers taste extremely hot and include such varieties as Chili Piquin and Small Red Chili.

Peppers generally have a long growing season and suffer slow growth during cool periods. Therefore, after the soil has thoroughly warmed in the spring, set out 6-8 week old transplants to get a head start toward harvest. Practice good cultivation and provide adequate moisture. Mulching can help to conserve water and reduce weeds.

Hot peppers are usually allowed to fully ripen and change colors (except for Jalapenos) and have smaller, longer, thinner and more tapering fruits. Yields are smaller for hot peppers.

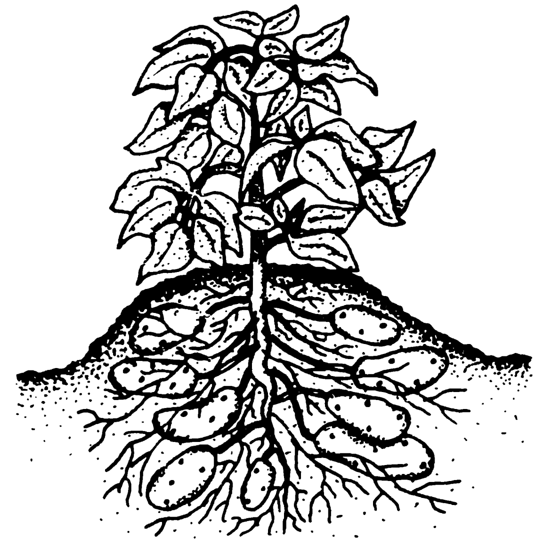
COMMON PROBLEMS

DISEASES: tobacco mosaic virus, bacterial spot, anthracnose
INSECTS: aphids, flea beetles, cutworms, European corn borer
CULTURAL: blossom end rot (moisture irregularities or calcium deficiency), blossom drop (when night temperatures go above 75F, or when a full crop of fruit set is excessive

HARVESTING AND STORAGE

DAYS TO MATURITY: 100-120 from seed, 70-85 from transplants
HARVEST: Harvest sweet peppers when they reach full size, while still in the green or yellow state. When allowed to mature on the plant most varieties turn red and sweeter and increase in vitamin A and C content. Cut instead of pulling to avoid breaking branches. Hot peppers are alllowed to ripen and change colors on the plant. Entire plants may be pulled and hung just before full frosts.
APPROXIMATE YIELDS: (per 10 feet of row) 2-8 lbs.
AMOUNT TO RAISE PER PERSON: 3-10 lbs.
STORAGE: medium cool conditions (45F-50F), moist (95% RH); 2-3 weeks
PRESERVATION: freeze, pickles and relishes, dried spices

POTATOES



ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained, moderate organic matter
FERTILITY: medium-rich
pH: 4.8-6.5
TEMPERATURE: cool (55F-65F)
MOISTURE: uniform moisture
(especially while tubers are developing)

CULTURE

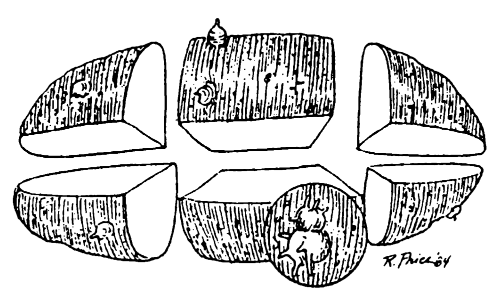
PLANTING: 1 1/2 - 2 oz. seed pieces with at least one good eye are in early spring; will resist light frost.
SPACING: 10-12" x 24-36"
FERTILIZER NEEDS: Medium-heavy feeder, add high phoshorus fertilizer (1 Tablespoon 10-20-10 per 10 feet of row) before planting, sidedress about 6 weeks after planting when tubers begin forming (5 Tablespoons 33-0-0 per 10 feet of row).

CULTURAL PRACTICES

Both white-skinned and red-skinned potatoes can be grown as an early crop for new potatoes and as a late crop for storage. Choose an early maturing variety and a mediumto-late maturing variety. Plant potatoes early from March 15 to April 20, depending on your location. Hard frosts and freezes may set back growth. Potatoes prefer cool springs and moisture throughout the growing season. Crops can be successfully planted as late as June for fall harvest and storage but yield may be reduced.

Avoid a garden site in a turned-under lawn as grub worms may damage developing tubers unless soil insecticides are used.

A soil pH of 6.0 to 6.5 is most desirable; however, scab disease will be less when the pH is between 5.0 to 5.2. In addition to the base application of fertilizer, add about one-fourth pound of 10-20-10 for each 75 foot row. Work this into the furrowand mix with the soil before planting.



Purchase certified seed stock that has been inspected for diseases that lower yields. Saving your own seed potatoes is generally not worth while because viruses and diseases often show up the next year. Seed potatoes should be firm and unsprouted. Wilted and sprouted potatoes usually have lost vigor from being too warm in storage.

Seed pieces for planting should be cut to about 1 1/2 to 2 ounces or int 1 1/2 inch cubes. Potatoes about six ounces in size will cut into four pieces nicely. Each seed piece should have at least one good bud or eye. Plant potatoes in furrows cut-side down, three to five inches deep. Later crops should be planted five to six inches deep.

Pull a ridge of soil over each row when planting. Drag a board or hoe across the ridges just before the sprouts break through to eliminate weeds. Later cultivation should be shallow and far enough from the rows to make certain that no roots are damaged

When the tops have grown too large to allow cultivation, a finishing cultivation, sometimes called laying by or hilling up is given. Laying by throws soil over the potatoes to prevent exposure of the potatoes to sun which can cause greening or scalding. Green portions on potatoes taste bitter and contain an alkaloid. Cut off and discard green areas before using.

The release of the new true seed potatoes is an interesting development. The major advantage of growing potatoes from seed is the decreased chance of disease. For the home garden, growing from seed pieces is generally less time consuming and will give better yields. With time, true seed potatoes may be bred for higher yields; but, at the present good quality stock potatoes yield the best crop.

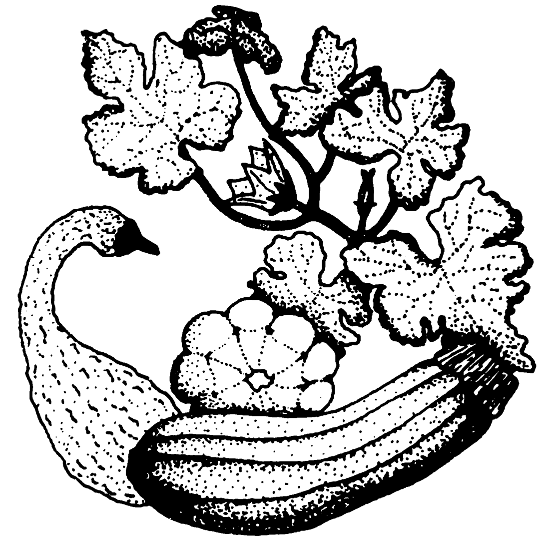
COMMON PROBLEMS

DISEASES: early blight, scab, late blight, tuber rots, virus complex, fusarium, verticillium and bacterial wilts.
INSECTS: Colorado potato beetles, flea beetles, leafhoppers
CULTURAL: green skin (sun exposure), hollow heart (alternate wet and dry conditions), Black Walnut wilt (too close to a Black Walnut tree).

HARVESTING AND STORAGE

DAYS TO MATURITY: 100-120
HARVEST: Dig early potatoes when tubers are large enough to eat. Harvest potatoes for storage two weeks after the vines die down or just after the first light frost nips the vines, before heavy freezing. Avoid skinning tubers when digging and avoid long exposure to light.
APPROXIMATE YIELDS: (per 10 foot row) 6-15 lbs.
AMOUNT TO RAISE PER PERSON: 75-100 lbs. (plant about 15 lbs. of "seed" potatoes person)
STORAGE: medium-cool (40F-50F), moist (90% RH) conditions; 6-8 months. Sprouting is a problem at higher temperatures.
PRESERVATION: usually stored in medium cool, moist conditions.

SQUASH



ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained
FERTILITY: medium-rich
pH: 6.0-7.5
TEMPERATURE: warm (65-75 %F)
MOISTURE: average

CULTURE

PLANTING: Seed after danger of frost is past and soil has warmed.
SPACING: hills (2-3 plants/hill) 3-4 ft. x 4-6 ft.; single plants 2-3 ft. x 3-5 ft.
HARDINESS: very tender annual
FERTILIZER NEEDS: Heavy feeder, sidedress one week after blossoming begins (3 Tablespoons 33-0-0 per 10 feet of row); repeat three weeks later.

CULTURAL PRACTICES

Summer squash grows on nonvining bushes. There are many varieties having different fruit shapes and colors. The three main types include the yellow straight neck or crooked neck; the white, saucer shaped, scallop or patty pan; and the oblong, green, grey or gold zucchini.

Soil containing plenty of well-rotted compost or manure is ideal, although good crops may be grown in average soils which have been adequately fertilized.

For extra early fruit, plant seeds in peat pots in greenhouses or hotbeds and transplant about three weeks later after danger of frost. Older plants that have hardened off and stopped growth will not transplant well and should be discarded. Squashes are warm season plants and do not do well until the soil and air temperatures are above 60 %F.

Seed or transplants can be planted through black plastic. Cover seed with one inch of soil.

Squash plants have male and female flowers on the same plant; but, they are separated. Pollen must be transferred from the male flowers to the female by bees. Use insecticides late in the evening to prevent killing bees.

COMMON PROBLEMS

DISEASES: powdery and downy mildews, blossom blight, bacterial wilt
INSECTS: cucumber beetles, squash vine borers, pickle worm
CULTURAL: blossom end rot (irregular moisture or calcium deficiency) flower drop (may occur normally when female flowers form before male flowers or during periods of heavy fruit set)

HARVESTING AND STORAGE

DAYS TO MATURITY: 50-65
HARVEST: Harvest when immature—only about 6-8" long and 1 1/2- 2" in diameter for elongated types, 3-4" in diameter for patty-pan types, and 4-7" long for yellow crooknecks. If the rind is too hard to be marked by the thumbnail, it is too old. Remove old fruit to allow new fruit to develop. Check plants daily once they begin to bear.
APPROXIMATE YIELDS: 20-80 lbs. (per 10 feet of row)
AMOUNT TO RAISE PER PERSON: 10-25 lbs.
STORAGE: cool (32-50 %F), moist (90% RH) conditions; 5-14 days
PRESERVATION: Usually in cool, moist storage, may can as pickles or relishes or freeze (quality may be poor on frozen squash).

TOMATOES

ENVIRONMENTAL PREFERENCES

LIGHT: sunny
SOIL: well-drained, loam
FERTILITY: medium-rich
TEMPERATURE: warm (70F - 80F)
MOISTURE: moist, but not waterlogged

CULTURE

PLANTING: transplant after all danger of frost is past and when the soil has warmed
SPACING: 18-36" x 36"
HARDINESS: tender annual
FERTILIZER NEEDS: heavy feeder; used starter solution for transplants, sidedress one or two weeks before first tomato ripens (1-1/2 oz. 33-0-0 per 10 feet of row); sidedress gain two weeks after first ripe tomato with a balanced fertilizer such as 5-10-5; repeat one month later.

CULTURAL PRACTICES

Tomatoes are valuable garden plants in that they require relatively little space for a large production. Each tomato plant, properly cared for, yields 10 to 15 pounds or more of fruit.

Choose varieties with disease resistance bred in for best results. Fusarium and verticillum wilt are common diseases that can destroy a whole tomato crop; treating either disease is difficult. Many varieties are resistant to these two diseases - look for "VF" after the cultivar name, indicating resistance to the wilts. "VFN" means the plants are resistant to verticillum, fusarium and nematodes; "VFNT" adds tobacco mosaic to the list.

The varieties of tomato plants available may seem overwhelming to a new gardener; ask gardening friends for the names of their favorites. This will give you a good idea of what does well in Virginia. Several major types of tomatoes exist that can be chosen according to need:

(a) Midget, patio, or dwarf tomato varieties have very compact vines best grown in hanging baskets or other containers. The tomatoes produced may be, but are not necessarily, the cherry type (1" diameter or less). Some produce larger fruit. These plants are usually short-lived, producing their crop quickly and for a short period.

(b) Cherry tomatoes have small, cherry-sized (or a little larger) fruits often used in salads. Plants of cherry tomatoes range from dwarf ("Tiny Tim") to seven-footers ("Sweet 100"). One standard cherry tomato plant is usually sufficient for a family, since they generally produce abundantly.

(c) Compact or determinate tomato plants may include cultivars of the above two categories. Determinate refers to the plant habit of growing to a certain size, setting fruit, and then declining. Most of the early ripening tomato varieties are determinate and will not produce tomatoes throughout a Virginia summer.

(d) Indeterminate tomato plants are the opposite of the determinate types. The vines continue to grow until frost or disease kills them. These are the standard, all-summer tomatoes that most people like to grow. They require support of some kind for best results, since otherwise the fruit would be in contact with the soil and thus susceptible to rot.

(e) Beefsteak type tomatoes are large-fruited types, producing a tomato slice that easily covers a sandwich, the whole fruit weighing as much as two pounds or more. These are usually late to ripen, so plant some standard-sized or early tomatoes for longest harvest.

(f) Paste tomatoes have small pear-shaped fruits with very meaty interiors and few seeds. They are less juicy than standard tomatoes and are without a central core. Paste tomatoes are a favorite for canning since they don't have to be cut up and since they are so meaty.

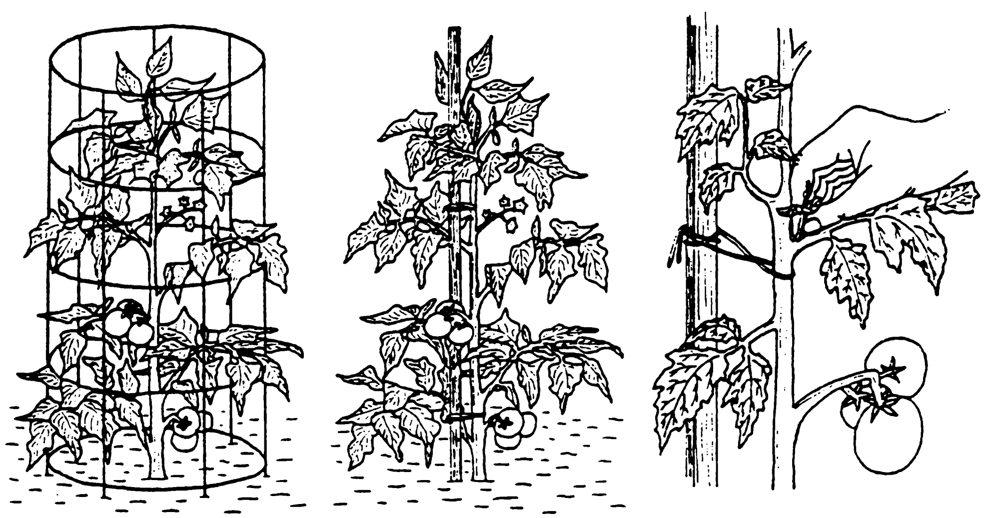
(g) Some tomatoes are orange, yellow, pink, or striped, and usually the only way to get these is by growing your own.

(h) Winter storage tomatoes are a relatively new item for gardeners. The plants are set out later in the season than most tomatoes and fruit are harvested partially ripe. If properly stored, they will stay fresh for twelve weeks or more. While the flavor does not equal that of summer vine-ripened tomatoes, many people prefer them to grocery store tomatoes in winter.

Tomato plants may be started indoors from seed or transplants may be purchased. If you are starting your own plants, use a light soil mix and give the plants plently of light. Tall, spindly transplants are usually caused by low light levels in the home. Unless you have a sunny, south-facing window, supplemental light will probably be necessary. The seed are sown six to eight weeks before the last frost date in your area. A few weeks before transplanting time, harden-off indoor-grown plants by exposing them to an increasing number of hours outdoors each day. Bring plants in if there is danger of frost. A few varieties of tomato (the sub-arctics) are bred to grow well in low spring temperatures; however, these are rarely available in the usual markets and ordinarily must be grown from seed.

When you are ready to put home-grown or purchased plants into the ground, select stocky transplants about six to ten inches tall. Set tomato transplants in the ground covering the stems so that only two or three sets of true leaves are exposed. Horizontal planting of tomato plants is an effective way to make plants stronger, especially leggy ones. Roots will form along the buried portion of the stem, giving better growth and less chance of plant injury from a too-weak stem. Do not remove the containers if they are peat or paper pots, but open or tear off one side to allow roots to get a good start. If non-biodegradable containers are used, knock the plants out of the pots before transplanting, and loosen the roots somewhat. Press the soil firmly around the transplant so that a slight depression is formed for holding water. Pour approximately one pint of starter solution (2 Tbsp. 5-10-10 or 5-10-5 fertilizer per gallon of water, or dilute fish emulsion) around each plant to wash the soil around the roots.

If plants are to be staked or trellised, space them 24" apart in rows three feet apart. Though it requires more initial work, staking makes caring for tomatoes easier than for sprawling tomato plants. Since they are off the ground, fruit rots are reduced, spraying is easier and may be required less, and harvesting is much less work. Use wooden stakes six feet long and 1-1/2 or 2 inches wide. Drive them one foot into the soil about four to six inches from the plant soon after transplanting. Attach heavy twine or strips of cloth to the stakes every ten inches. As the plants grow, pull the stems toward the stakes and tie loosely.



Prune staked tomatoes to either one or two main stems. At the junction of each leaf and the first main stem a new shoot will develop. If plants are trained to two stems, choose one of these shoots - normally at the first or second leaf-stem junction - for the second main stem. Remove all other shoots, called suckers, weekly to keep the plant to these two main stems. Pinch shoots off with your fingers. Tomato plants may also be set along a fence or trellis and tied and pruned in a manner similar to that used with stakes.

Growing tomatoes in wire cages is a method gaining in popularity among gardeners because of its simplicity. Cage-growing allows the tomato plant to grow in its natural manner, but keeps the fruit and leaves off the ground, offering the advantages of staking as well. Using wire cages requires a large initial expenditure and a large storage area, but many gardeners feel that the freedom from pruning and staking is worth it. The cages, if heavy duty, will last many years. Be sure to get fencing with at least 6" spacing between wires so that you can get your hand inside to harvest the tomatoes. If tomato plants in wire cages are pruned at all, once is enough; prune to three or four main stems. Wire-cage tomatoes develop a heavy foliage cover, reducing sunscald on fruits and giving more leeway when bottom leaves become blighted and have to be removed (many staked plants are nearly naked by late summer). Caged plants are less prone to the spread of disease from plant handling, since they do not have open wounds and must be handled less frequently than staked plants. However, it helps to space the plants somewhat further apart (three feet is good) to allow good air circulation between plants; humidity is higher because of the foliage density, and diseases such as late blight spread rapidly in humid situations. If well-nourished and cared for, however, caged tomatoes can produce exceptional harvests and make up for the extra space with high production. This type of culture is especially suited to the indeterminate varieties.

COMMON PROBLEMS

DISEASES: early blight, septoria leafspot, verticillum and fusarium wilts, late blight, tobacco mosaic virus, bacterial spot
INSECTS: flea beetle, hornworm, stink bugs, Colorado potato beetle, fruitworm, aphids, mites, whiteflies, cutworms
OTHER PESTS: nematodes
CULTURAL: blossom-end rot (irregular soil moisture or calcium deficiency); poor color, yellow spots or large whitish-grey spots (sunscald from lack of foliage cover); leaf roll (physiological condition often found in pruned tomatoes); fruit cracking (irregular soil moisture); black walnut wilt (caused by roots of tomato plants coming in contact with roots of black walnut tree)

HARVESTING AND STORAGE

DAYS TO MATURITY: 55-105
HARVEST: Harvest fully vine ripened but still firm (most varieties are dark red). Picked tomatoes should be placed in shade. Light is not necessary for ripening immature tomatoes. Some green tomatoes may be picked before the first killing frost and stored in a cool (55F), moist (90% RH) place. When desired, ripen fruits at 70F.
APPROXIMATE YIELDS: (per 10 feet of row) 15-45 lbs.
AMOUNT TO RAISE PER PERSON: 20-25 pounds for fresh used; 25-40 pounds for canning
STORAGE: green tomatoes - medium cool (50F-70F), moist (90% RH) conditions; 1-3 weeks. Ripe tomatoes - cool (45F-50F), moist (90% RH) conditions; 4-7 days.

PRESERVATION: Can or freeze as sauces or in chunks (whole or quartered), peeled