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Home Hydroponics

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Introduction

Hydroponics is often defined as "the cultivation of plants in water." Research has since determined that many different aggregates or media will support plant growth; therefore, the definition of hydroponics has been broadened to read "the cultivation of plants without soil."

Growers all over the world are using hydroponic techniques due to the lack of a large water supply or fertile farmland. Home gardeners have used hydroponics on a smaller scale to grow fresh vegetables year round and to grow plants in smaller spaces, such as an apartment or balcony. Greenhouses and nurseries grow their plants in a soilless, peat- or bark-based growing mix. The nutrients then are applied to the growing mix through the water supply. Therefore, this is also a type of hydroponics.

Soilless gardening offers many advantages to the home gardener. Since a sterile medium is used, there are no weeds to remove, and soil-borne pests and diseases are minimized, if not eliminated completely. Properly grown hydroponic plants also are healthier and more vigorous because all of the necessary growth elements are readily available. The plants can mature faster, yielding an earlier harvest of vegetable and flower crops. Hydroponic gardens use less space since the roots do not have to spread out in search of food and water. This small space requirement makes hydroponics ideal for home gardeners, and it makes better use of greenhouse space. The big advantage to hydroponics is the ability to automate the entire system with a timer. Automation reduces the actual time it takes to maintain plant growth requirements. Automation also provides flexibility to the gardener as one can be gone for long periods of time without having to worry about watering the plants.

Hydroponics offers many advantages for commercial agriculture. Cultivating plants without soil eliminates the need for vast farmland and allows crops to be produced in greenhouses or even in the desert sands. Hydroponic techniques also allow for precise water and nutrient application directly to the roots of each plant. Water is reused in these systems and less is lost through evaporation and run-off. Therefore, arid lands, such as deserts, can be transformed into productive lands using limited amounts of water. Growing plants hydroponically is not difficult if one understands the basic principles. As long as plant growth requirements are met, there are numerous hydroponic systems that can be used.

Plant Requirements

Growth Requirements

Whether a plant is grown in soil or a soilless medium, there are many factors affecting plant growth and productivity. All plants require nutrients, water, light, and air to grow. A plant grown in soil obtains nutrients and water from the soil, when available. With hydroponics, because water and nutrients are always available, the plant is never stressed. Sunlight and air are readily available in an outdoor hydroponic system. However, for an indoor system, one must provide an adequate light source and good air circulation. Metal halide lamps, sodium vapor lamps, gro-lights, or fluorescent lights used in conjunction with incandescent light bulbs provide adequate light. Plant roots must have oxygen available to keep them alive. Healthy roots (which are white in color) are responsible for the uptake of all nutrients for the plant. If the roots die, it is impossible for the plant to survive, even if the plant growth requirements are met. Air circulation around leaves is important since it mixes the air and allows the plant to

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draw out the carbon dioxide necessary to carry on photosynthesis. Air circulation also helps prevent fungal diseases caused by moist, stagnant conditions. Indoor units often have a small fan to circulate the surrounding air.

Nutrient Solution

The nutrient solution is the most important factor in the success or failure of a hydroponic system. Most fertilizers commonly available in garden centers do not contain all of the 13 elements necessary for plant growth because the growing media usually provides many of them. Hydroponic plants receive nutrients from a different source; so it is necessary to use a fertilizer formulated for hydroponic systems. Hydroponic fertilizers are available from many mail order companies and a few specialty garden centers. It is important to follow the dilution rate recommended on the label and to test the solution to be sure that the pH is between 5 and 6. Simple pH test kits and pH modifiers are available wherever fish supplies are sold.

Depending on the stage of plant development, some elements in the nutrient solution will be depleted more quickly than others. Because of this, it is important to change the nutrient solution every two weeks. The old solution can be used to water other houseplants or outdoor plants. Also, make sure that the nutrient solution is kept at the original volume. As water evaporates from the nutrient solution, the fertilizer becomes more concentrated and can burn plant roots. Add water only and not more fertilizer to raise the nutrient solution back to its original volume.

Types of Systems

Water Culture Systems

Water culture systems include the nutrient film technique, aeroponics, and the aeration method.

The nutrient film technique (Figure 1) uses a plastic trough or tube as the container through which a constant, thin film of nutrient solution flows. Plants are suspended through holes in the top of the trough. The trough is gently sloped so gravity pulls the solution back to the nutrient reservoir. There are many variations of this system, making it the most popular for the home gardener.

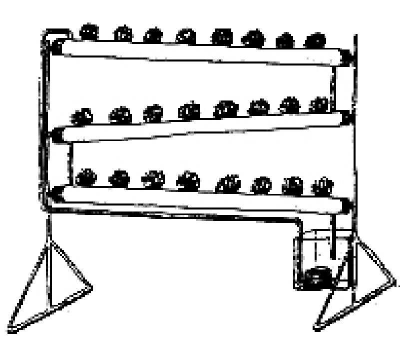

Figure 1. Nutrient Film Technique

Aeroponics (Figure 2) is the growing of plants in a container in which the roots are suspended in a nutrient mist rather than in a solution. The most popular container for aeroponics is an enclosed A-frame constructed of styrofoam boards. The plants are placed in holes along the sloped sides of the frame. The nutrient mist is delivered to the roots by a vaporizer or by special attachments available with drip irrigation kits. The mist clings to the roots. Any excess runs down the inside of the frame, is collected at the bottom, and is recycled back to the nutrient reservoir.

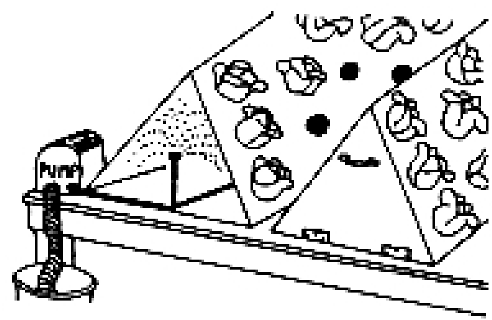

Figure 2. Aeroponics

The aeration method (Figure 3), one of the first systems to be developed, uses an aquarium air pump to bubble oxygen to the roots of plants immersed in the nutrient solution. Plants are suspended 1 inch above the solution by a 2-inch-deep mesh tray that is set into the container by placing the lip of the tray over the container's edge. A layer of inert material, such as gravel, clay pebbles, or vermiculite, is placed in the tray to provide stability for the plants while allowing the roots to grow down into the nutrient solution.

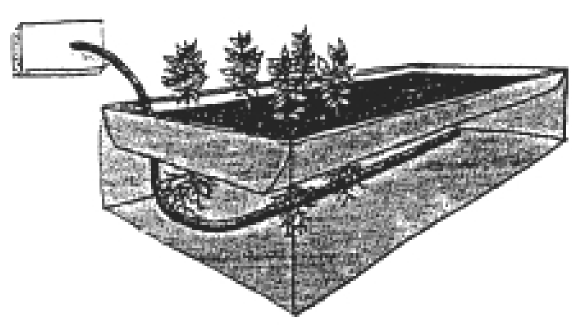

Figure 3. Aeration Method

Aggregate Systems

Aggregate systems use some form of inert material to support and surround plant roots. The most common materials used are rockwool, clay pebbles, gravel, perlite, vermiculite, sand, or foam chips. The media provides plant support, allows good oxygen penetration to the roots, yet retains a thin layer of nutrients and water around the roots. One of the most common systems using an aggregate media is the flood and drain method (Figure 4). A water-holding container, such as a plastic dish pan, is filled with the aggregate and plants. The container is flooded periodically with the nutrient solution. The solution is drained back into the nutrient reservoir by opening a valve at the bottom of the container. During each cycle, the roots should be submerged in the solution for no more than 20 to 30 minutes.

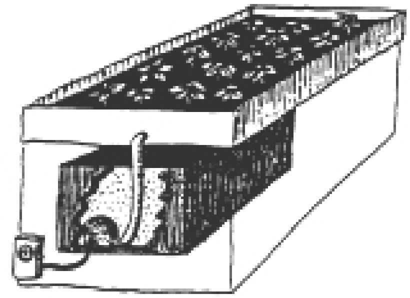

Figure 4. Flood and Drain Method

Another common aggregate system is the trickle feed method (Figure 5). The nutrient solution is continuously pumped from the reservoir through a 1/2-inch irrigation tube that branches into a number of 1/8-inch tubes. These smaller tubes deliver the solution to the containers. Any excess solution is collected at the base of each container and returned to the nutrient reservoir.

Nutrient Deficiencies

Symptoms	Deficiency
Entire plant is light green in color; lower leaves are yellow; growth is stunted	Nitrogen
Entire plant is bluish-green, often developing a red or purplish cast; lower leaves may be yellow, drying to a greenish-brown to black color; growth may be stunted	Phosphorous
Leaves have a papery appearance; dead areas along the edges of the leaves; growth is stunted	Potassium
Lower leaves turn yellow along the tips and margin and between the veins; the lower leaves wilt	Magnesium
Young stems and new leaves die	Calcium
Leaf tissue between the veins is lighter in color; yellowed; papery in appearance	Zinc
Leaf tissue appears yellow, while the veins remain green	Iron
Leaf edges appear dark green or blue; leaf edges curl upward; young leaves permanently wilt	Copper
Young leaves turn pale green, while the older leaves remain green; plant is stunted and spindly	Sulfur
Growth is stunted; lower leaves have a checkered pattern of yellow and green	Manganese
Leaves are stunted, pale green, and malformed	Molybdenum
Young leaves are scorched at tips and margins	Boron

Occasionally, the nutrients in a hydroponic system are used up faster than they can be replaced, and the plants will show a nutrient deficiency. A quick fix for most of the deficiencies is to spray the leaves with an all-purpose, foliar fertilizer, although this will not completely solve the problem. The best remedy is to change the nutrient solution every week instead of every two weeks. In some cases, it may be necessary to switch to a different type of hydroponic fertilizer, if the same deficiencies persist. There are several books on hydroponics that give other remedies for a nutrient deficiency problem.

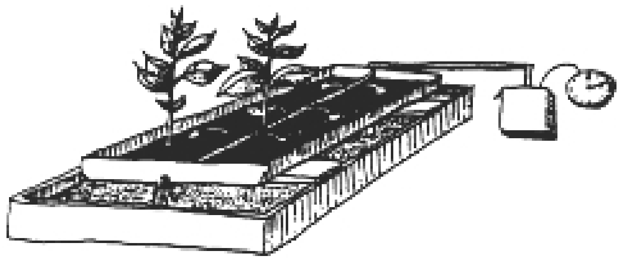

Figure 5 Trickle Feed Method

A modification of the trickle feed method is called tube culture (Figure 6). A 4- to 6-inch plastic tube or bag is filled with a lightweight aggregate. Holes are made on all sides of the container for the plants. The tube is hung vertically, and an irrigation tube is positioned at the top of the container. The nutrient solution seeps through the container and may or may not be recycled when it reaches the bottom.

Summary

Several developments in the past few years have made hydroponic gardening easier for the home gardener. Newer systems are simpler to set up and operate. An increase in suppliers of hydroponic products means equipment and special fertilizers are more easily obtained by the home gardener. The use of lightweight plastics in the newer systems makes hydroponics less expensive and a better investment than older systems that used heavy, concrete benches.

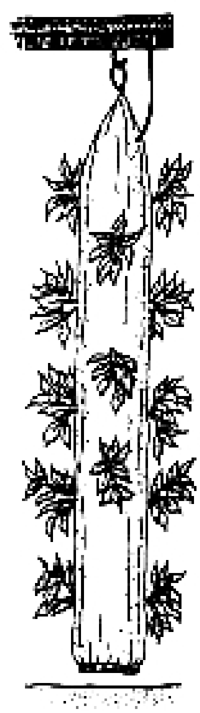

Figure 6 Tube Culture

Hydroponic systems are available in a variety of sizes and prices. Kits are available from many suppliers, and some hydroponic systems can be built easily at home from materials found at hardware stores and fish supply stores. Numerous hydroponic and soilless gardening books can be found in local libraries and bookstores. Information also is available through the Hydroponic Society of America, P.O. Box 6067, Concord, CA 94524, (415)682-4193.

Suggested Reading

Grow More Nutritious Vegetables Without Soil, James D. Taylor, Santa Anna, Calif.: Parkside Press Publishing Co., 1983.

Home Hydroponics...and how to do it!, Lem Jones, New York, N.Y.: Crown Publishers, Inc., 1977.

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