SOILLESS MEDIA FOR SEED GERMINATION AND GROWTH OF TOMATO TRANSPLANTS, AND FOR THE ROOTING OF CERTAIN HERBACEOUS STEM CUTTINGS

by

Frederick Harding Ray

Thesis submitted to the Graduate Faculty
of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Horticulture

APPROVED:

W. P. Judkins, Chairman

P. L. Smeal

D. F. Amos

July, 1974
Blacksburg, Virginia

ACKNOWLEDGEMENTS

The author wishes to express appreciation to Dr. W. P. Judkins, who served as committee chairman and to Dr. P. L. Smeal and Dr. D. F. Amos as committee members whose guidance was essential in their respective fields. He wishes to thank Dr. M. E. Austin and for laying the groundwork.

Acknowledgement is due to Dr. C. Y. Kramer and staff for statistical analysis.

To his wife, , he expresses his appreciation for her unflagging determination and devotion.

TABLE OF CONTENTS

INTRODUCTION

The plant grower in metropolitan areas is experiencing increasing difficulty in securing good uniform topsoil at economic prices. When obtained, it may have several disadvantages. It could have toxic chemical residues. It may harbor weed seeds, insects or disease organisms which should be destroyed by sterilization. The nutrient content, pH, texture, and drainage characteristics may vary from source to source.

Soil may be modified with amendments such as peat moss, shredded bark, wood shavings, sawdust, rice hulls, calcined clays, sand, perlite, Weblite, vermiculite, and styrofoam. Plants grown side by side in the amended soils may not be uniform. Often this may be due to variation in the main ingredient of the mixture, topsoil, or the mixing procedure, which was not uniform from the outset.

Several media and mixtures of different media may be used for seed and vegetable propagation and for growing of bedding and potted plants. The following characteristics are required for good results:

1. The medium must be sufficiently firm and dense to hold the cuttings or seeds in place during rooting or germination.

2. Its volume must be fairly constant when either wet or dry; that is, excessive shrinking as a result of drying is undesirable.

3. It must have sufficient moisture retention so that watering does not have to be too frequent.

4. It must have sufficient porosity so the excess water drains away, permitting adequate aeration.

5. It must be free from weed seeds, nematodes and various noxious disease organisms.

6. It must not have an excessive salinity level.

7. It must be capable of being sterilized with steam without deleterious effects.

Artificial media, used for the rooting of cuttings, germination of seeds, or growing of plants should have these important advantages:

1. They are readily available, more uniform than soils, easily mixed, lighter than soils, and sterilization is usually unecessary, provided reasonable sanitary precautions are taken during mixing and handling.

2. They may be heat-pasturized or chemically fumigated without danger of phytotoxic residues as is sometimes produced in soil-organic material mixes.

3. They are chemically stable and may be stored indefinately.

4. The initial fertility of artificial media is low and the pH is constant; therefore, it is possible to have a known starting point for adding nutrients which will allow for nutrition control of a large variety of plants from seeding to selling.

5. In general, their cost compares favorably with good topsoil.

The organic and inorganic materials previously mentioned as amendments for topsoil modifications are used in the preparation of soilless media. These amendments are mixed in varying proportions to accommodate the plant species being grown or propagated.

The porosity of a medium which relates to its drainage is a primary factor to consider when designing a medium to grow the highest quality plants. The medium must have enough available moisture to endure neglect at the retail outlet and not become over saturated on the greenhouse bench. Drainage and aeration are essential in maintaining a proper balance between too much and too little moisture, especially when using an automatic versus a manual mist system,or poor watering practices. A medium that decomposes rapidly is easily compacted and may not maintain its pore space. Organic materials may shrink excessively and separate from their containers. Watering may be difficult because the water is not absorbed, but drains between the medium and the sides of its container.

Sand, gravel, perlite, calcined clays, cinders, styrofoam and Weblite have been incorporated in growing media to provide drainage and aeration. There are disadvantages to some of these materials. When irrigated, perlite floats to the surface of a peat-perlite mixture. Sand and gravel are very heavy and increase shipping and labor costs. Other materials such as calcined clays are unstable and break down with repeated usage. Weblite does not have these disadvantages. It is relatively lightweight, half the weight of river sand, and the particles retain more water on their surfaces than sand.

Weblite, a trade name for a heat-expanded Watauga shale, is manufactured in Roanoke, Virginia. The raw shale is crushed and screened in preparation for sintering. Shale and powdered solid fuel are blended together to form pellets and placed upon a continuously-moving, sintering machine grate. It is heated to 2200°F which causes the entrapped gases to create myriads of small pores in the shale particles accompanied by an increase in volume and a decrease in bulk density. This process produces a hard, vitreous, granular, inert, and durable substance. This lightweight aggragate is sterile, stable, and contains no impurities which are toxic to plants. Weblite has the following composition:

Total	Silica	as	SiO_2	58.33%
"	Aluminum	as	Al_2O_3	25.22%
"	Iron	as	Fe_2O_3	9.44%
"	Calcium	as	CaO	nil
"	Magnesium	as	MgO	2.75%
"	Sulfur	as	SO_3	nil
"	Sodium	as	Na_2O	0.08%
"	Potassium	as	K_2O	2.32%

Loss on ignition	1.50%
pH of 8x50 mesh Weblite	6.2 average
pH of 8x0 mesh Weblite	6.8 - 7.1 average

The components of the bedding-plant mixtures have also been used in the propagation of cuttings.

This research was undertaken to evaluate the effect of different media on: (1) seed germination, (2) bedding plant growth and (3) the propagation of herbaceous stem cuttings, and (4) to evaluate the physical properties of soilless media in relation to seed germination and tomato plant growth.

LITERATURE REVIEW

Between 1934 and 1939, English researchers at the John Innes Horticulture Institution developed a single soil in which a wide range of plants could successfully be grown. The John Innes Soil Mix is composed of composted sand, soil and peat moss. Baker (1957) lists several disadvantages inherent in the mixes. They are:

1. composted loam is not uniform;
2. composting requires extra time and space;
3. the term coarse sand is ambiguous; a
4. coarse sand gives the medium excess weight; and
5. steaming after the mix is prepared produces a toxic residue.

Baker (1957) also discusses the Einheitserde (standardized soil) medium developed by a German Researcher, Dr. A. Fruhstorfer. It is composed of subsoil clay and peat, and is not sterilized. This medium was not a uniform mixture because of the differences in the subsoil clays found throughout Germany.

The U. C. Mixes, developed by the University of California in 1957, were reproduceable. They are composed of fine sand and peat moss. These mixes range from 100% fine sand to 100% peat by volume. Standard nursery mixtures are equal parts by volume of sand, soil, and peat moss or bark.

Baker (1957) lists the following advantages for the U. C.

Mixes:

1. Toxic residues do not result from heat or chemical treatment;
2. Components are chemically uniform and readily available;
3. The mixes are readily leached, eliminating the salinity problem;
4. Composting is eliminated, thus lessening labor and storage requirements;
5. Shrinkage does not occur in storage; and
6. Local scarcities of leaf mold, animal manure, and turf are avoided.

Baumgartner (1957) reports sand is an excellent medium the first year, but becomes more difficult to wet after this period. Some sands present a concrete-like surface that repel water. Abernathie (1972) points out that one cubic foot of sand weighs 80 to 100 pounds, while the approximate weight of a cubic foot of vermiculite is only six pounds, and perlite only eight. An additional problem with the U. C. mixtures, reported by White (1966), is that the bedding-plant growers in the Northeast have been unable to find sources of fine, sharp quartz sand required for these mixtures. Furthermore, Chadwick (1949) states that cuttings rooted in fine bank sand had short, brittle roots, which were undesirable for potting due to excessive breakage.

DeWorth and Odom (1960) were among the first to develop a light-weight medium. They found that a mixture composed of 50% sphagnum peat moss and 50% horticultural-grade perlite produces higher quality greenhouse and nursery plants than any other media in use at that time. This medium was from 25 to 30% lighter than the John Innes and U.C. Mixes. The Cornell peat-lite mixes were developed by Boodley and Sheldrake (1963). These mixes were composed of equal parts peat and perlite of vermiculite. These components are readily available and are of known uniformity. In addition they contain few natural nutrients and do not require sterilization.

White (1966) analyzed the peat-lite mixes as follows:
Advantages:

1. Components are readily available in uniform conditions.
2. Components have chemical and physical conditions necessary for rapid plant growth.
3. Mixtures do not require steam sterilization.
4. Costs are competitive with other mixtures in many sections of the country.
5. Initial fertilization gives plants a fast start which can be maintained with liquid fertilization.
6. Mixtures can be reproduced batch after batch, year after year, which permits standardization and automation of production procedures.
7. They are lighter in weight for more economical

shipping costs.

Disadvantages:

1. Watering practices are different from mixes with soil. The peat-lite mixes require greater skill in judging when to water, especially during early stages of growth.
2. Plant injury may result from soluble salts. Probably this problem is closely related to the first in that the initial high rate of fertilizer incorporation into the mix requires an initial high watering frequency to prevent soluble salt injury.
3. Difficulties arise in thorough wetting of the peat moss.

Researchers have been looking for a lightweight, inert, inorganic medium to provide plant support, and supply aeration and drainage while still retaining moisture. Sand usually had been the basis for soilless media but it is not always available, nor is it light in weight. Mauldin (1944) reported on the use of anthracite coal ashes for the rooting of ornamental plants, while fly ash was used by Swartley (1947). A number of other mineral substances have been used to create light weight rooting and potting mixtures.

White (1966) indicates that vermiculite has the disadvantage of breaking apart with handling when wet. However, it has the ability to retain mineral nuttients and supplies some potassium and magnesium to the soil solution. Chadwick

(1949) states that vermiculite produces roots that are flexible, longer, thinner, and straighter than the roots produced in other media. Boodley and Sheldrake (1963) report that vermiculite has a relatively high cation-exchange capacity which results in good buffering characteristics and permits use of somewhat higher levels of fertility without plant damage. Abernathie's (1972) objection to vermiculite is that it is excellent for short-time use of one to two months, but when used for longer periods of time, the particles may compress, and all the desirable effects of drainage and aeration may be lost.

A variety of calcined clays of different origin or composition have been used as medium amendments. Coorts et al (1964) used arcillite and peat to grow geraniums and found that a buffer is needed for the medium. Wildon and O'Rourke (1964) experimented with arcillite and peat. Their results indicated that arcillite and peat produced greater growth and more rapid maturity than soil alone in several woody and ground cover plants grown in containers in the greenhouse.

Materials derived from volcanic rock have been used as media amendments. One such material, perlite, does not decay nor deteriorate except by physical breakage, and it is able to hold water on its irregular surfaces. According to Boodley and Sheldrake (1963), it contains appreciable amounts of sodium that can be extracted by growing plants. White (1966) describes perlite as a very light weight material that has a fairly large surface area but lacks interior surface for moisture storage. Flemer (1965) relates two disadvantages he found with perlite: (1) It was abrasive to the lungs of workers when it was being benched and moistened and, (2) it gave a fleshy and very brittle root system which fractured badly when the cuttings were removed and handled.

The University of Hawaii's potting mix is composed of volcanite and tree fern. Dr. Criley (1972) discussed volcanite cinders as a material to add weight to an otherwise very light mix. They are also used for their water-holding and aeration characteristics. Inose (1971) has experimented with pumice as a rooting medium and reports that the weight and cost is high, and water retention low. Scoria and sponge rock mixed with peat have been used as a potting medium.

Hydro-Tite Granite Meal, slate and Weblite are three processed minerals being used to grow potted plants. Hybro-Tite is crushed Georgian granite sold as a soil amendment for potted plants. It has a pH of 9.13 which is probably higher than most commonly-used amendments. Self (1972) has experimented with processed Birmingham slate as a rooting and growing medium. It has a pH of 8.5. The best rooting medium was a mixture of equal parts of fine and medium-grade shale. Self (1973) stated that the slate alone has low moisture retention, good aeration and a low soluble salt level.

Hall and Cannon (1963) indicated that a peat-Weblite combination produced the highest rooting percentages in *Rhododendron carolinianum* in most months. The peat-Weblite medium produced a majority of root balls in excess of 1½ inches in diameter. In contrast, in the peat-perlite medium most of the root balls produced were under ½ inch in diameter. They state that the larger peat-Weblite root balls indicate faster rooting and root growth and the possibility of earlier transplanting of these cuttings.

Weblite as a medium component has been used by the Plant Pathology and Physiology Department of Virginia Polytechnic Institute and State University,for seeding, and potting of seedlings and rooted cuttings. Spasoff (1973) has found a mixture of 45% Weblite, 45% vermiculite and 10% Sphagnum of Michigan peat moss to be the most suitable and least costly of the mixtures he tested. Weblite alone has been used as a propagation medium for seeds and cuttings. The Weblite corporation makes a commercial mix for golf greens composed of 45% Weblite, 45% soil and 10% Michigan peat moss, and a bedding mixture composed of one third each of Weblite, soil, and Michigan peat moss.

METHODS AND MATERIALS

SEED GERMINATION AND GROWTH OF TOMATO TRANSPLANTS

The effectiveness of 24 media in the germination and growth of Lycopersicon esculentum cv Better Boy to produce transplants of marketable size from seed were compared. The standard for comparison was the plants grown in a commercial preparation, Jiffy Mix. The mixtures were composed of varying amounts of Weblite, sand, peat moss, vermiculite, and Jiffy Mix. That fraction of Weblite and Petersburg sand retained on U.S. standard 2mm screen was used as the basis of the mixtures. Premier's German sphagnum peat moss, Zonelite's #3 vermiculite, and Jiffy Mix were the complements of the mixtures.

Each cubic yard of media was supplied with 448 g of pottassium nitrate, 896 g of 20% super phosphate, and 1.5 kg of dolomitic limestone. These were pulverized by a F4 Quaker City corn mill. Only proportional amounts of fertilizer and lime were added to the media containing Jiffy Mix depending on its percentage of the total mixture. The media were mixed by volume for five minutes in a Sears 2½ cubic foot, electric cement mixer. The pH of each medium was adjusted to a range of 5.6 to 6.4 by the addition of pulverized dolomitic limestone. The volume ratios are listed in Table I.

Ball's AC 6/8 cell-Paks were filled to their partitions with one of the 24 media and each medium was replicated four times. A set of the 24 media was randomly arranged in three A-8 Handi-Paks. Four replications were made using different random arrangements in each set.

The experiment was carried out in a glasshouse on raised wooden platforms with separation between the boards for drainage. The media were misted until field capacity was reached. Two tomato seeds per cell were sown one quarter of an inch deep. The mist system operated from 8 AM to 5 PM on a 10 second on, 15 minute off cycle. A 25°C day temperature was controlled by automatic ventilation and steam heat maintained a 20°C night temperature.

Germination was recorded from the first day until approximatly 95% had germinated. Once the seedlings had developed leaves, they were hand watered only when they appeared dry or wilted. The plants were harvested 42 days after sowing and their foliage condition was observed and recorded. Each plant was cut off at the soil line and placed in a paper bag, oven dried at 106°C and weighed in grams. Thirty-two days after germination each plant cell pak was treated with 20- 20- 20 soluble fertilizer through a 1:15 hozon attached to a water hose to correct symptoms of a nitrogen and phoshporous deficiency.

HERBACEOUS ROOTING STUDY

Six media were tested for their ability to promote root growth in <u>Chrysanthemum</u> <u>morifolium</u> cv Sunny Mandalay. The following media were used:

100% Sand
50% Sand- 50% peat moss
50% Perlite- 50% peat moss
100% Weblite
50% Weblite- 50% peat moss
100% Perlite

Weblite,(8x0 mesh), Premier's sphaghnum peat moss, and Zonalite's #3 perlite were used. Petersburg River sand was steam sterilized before use. The mixtures were combined by volume in a Sears and Roebuck 2½ cubic foot, electric cement mixer for five minutes.

Plastic A-8, Handi-Pak, trays were divided into three sections with fiberglass partitions. The six media were replicated three times and randomly placed in the 18 sections. These trays were misted to field capacity before the cuttings were stuck. Sunny Mandalay cuttings were trimmed to 10 cm before sticking. Neither rooting hormone nor bottom heat were implemented during the experiment. The cuttings were placed under intermittent mist for 10 seconds on and 15 minutes off from 8 AM until 5 PM. The trays were placed on a raised-wooden bench in a glass greenhouse. A 22°C day temperature was controlled by automatic ventilation, and steam heat maintained a 20°C night temperature.

Cuttings were evaluated by comparing root development and foliage conditions of the chrysanthemum cuttings after 18 days. A five point system was used: roots- (5) very heavily rooted, (4) heavily rooted, (3) average size root system, (2) at least one root and (1) callus only, no roots; foliage- (5) excellent dark-green color, no curling of leaf edges and a flush of new growth, (4) good color, (3) average color and condition, (2) fair color with turgid, slightly-curled leaves, and (1) poor color with chlorotic, wilted and curled leaves. The roots were washed with a misting nozzle before being evaluated.

Nine media were tested for their ability to promote root growth in <u>Dianthus</u> <u>caryophyllus</u> cv Caribe. The following media were used:

100% Sand
50% Sand 50% peat moss
100% Weblite
50% Weblite 50% peat moss
50% Weblite 50% vermiculite
100% Vermiculite
50% Vermiculite 50% perlite
100% Perlite
50% Perlite 50% peat moss

The media were prepared in the same manner as the previous rooting study. Zonalite's #3 vermiculite was used. Caribe stem cuttings, 10 cm long were stuck on March 30, 1973 and harvested April 25, 1973.

Cuttings were evaluated by comparing root development and conditions of foliage. The same five point system described above was used in evaluating the roots. The five point system used for the foliage was- (5) dark-green color, height increased at least 5 cm, (4) height increased at least

3 cm, (3) good foliage but no increase in height, (2) turgid, (1) wilted with brown leaves. Root balls were not washed with water due to the difficulty of particle removal.

PHYSICAL PROPERTIES OF SOILLESS MEDIA

The media identical to that of the tomato plant experiment were tested to determine their physical properties: bulk density, porosity, field capacity, permanent wilting point, and available moisture. This information was then compared with the results from the germination rates and the growth of the bedding plants.

The media were placed in #10 cans with six preforations on the lower sides of each can to allow drainage. Each can was filled to within one inch of the top with one of the 24 media. The 24 media were replicated four times and randomized. The media were saturated daily with a #400 water-spreader nozzle. The experiment was initiated on June 22, 1972. Core and fragment samples were taken on July 19 and August 21.

Fragment and undisturbed core samples were taken from the top inch of the media in each can. The sampler head of a double-cylinder, hammer-driven core sampler described by Blake (1965), was used to obtain undisturbed core samples. An aluminum core ring 2 inches in diameter and 1 inch in height was used in the sampling apparatus. The sampler head was pressed into each medium by hand. After shaping the sample, each core sample was placed in a numbered can and capped. The excess media removed from each sample was bagged as the fragment sample.

Core samples were trimmed and secured at their base by cotton bastiste held in place by a rubber band. Prior to each treatment each core was saturated with tap water and weighed to the nearest 0.1 grams. Undisturbed cores were desorbed at tensions of 0.06, 0.1 and 0.33 bars as described by Richards (1965). Core weights to the nearest 0.1 g were obtained after they had equilibrated at the various tensions. At the conclusion of the desorption determinations, cores were oven dried at 105°C and reweighed.

Fragment samples were air dried and passed through a 2mm sieve. Each fragment sample was placed in an aluminum ring 5 cm in diameter and 12 mm in height and leveled. Samples were water saturated, weighed to the nearest 0.1 g and desorbed at 15 bars as described by Richards (1965). After the sample had been desorbed they were weighted to the nearest 0.1 g, oven dried at 105°C, and reweighed.

The bulk density of each medium was determined by calculating oven-dry weight per core-ring volume as described by Blake (1965). Large (greater than 0.01 mm) and small (less than 0.01 mm) pores were determined by inference. The total porosity value was determined, according to Vomocil (1965), by adding the large and small pore space percentages.

The percentage of moisture at the various desorption levels was calculated by subtracting the oven-dry weight of the core samples from the weights at 0.06, 0.1 and 0.33 bars and dividing by the oven-dry weight, as described by Peters (1965). Permanent wilting point was determined by obtaining the difference between the 15 atmosphere weight and oven-dry weight which was divided by the weight of the oven dried medium (Peters, 1965). Plant available moisture was determined by subtracting the percent moisture at 15 bars from the 0.33 bar percentage (Peele and Beale , 1950).

RESULTS AND DISCUSSION

TOMATO SEED GERMINATION

The first day of germination there was significant difference of Lycopersicon esculentum cv Better Boy seed germination among the first 12 media listed in Table II. All but one of these media contain Weblite or vermiculite. On the second day of germination only the sand and vermiculite media had significantly lower germination rates than all the other media (Table III). By the fourth day there wes nearly 100% germination in all media.

An increase in available moisture does not necessarily increase germination percentage (Figure 1). The second best germinating medium, 100% Weblite, had a 30% higher germination rate than 100% sand, and yet there was a negligable difference (1.2 g) in their available moisture. The standard commercial germination media , vermiculite or Jiffy Mix, had slightly better than 50% germination, yet contained the highest available moisture.

The following constituents, when present in a medium, seemed to increase germination: Weblite, vermiculite, and combinations of vermiculite and peat moss. The coarser texture of the peat moss-vermiculite mixture in contrast to the Jiffy Mix allowed the medium to maintain a higher oxygen level. Oxygen is needed to support respiration of the germinating seeds.

Media such as Weblite that germinate seeds faster and have a higher germination percentage, but are not capable of nutrient retention, may be used repeatedly for mass germination and pricking out.

TOMATO SEEDLING RESULTS

No significant difference was found among the dry weights of tomato plants grown for 42 days in the first five media listed in Table IV. These media all contained vermiculite.

Figure 2 illustrates the results of the germination and dry plant weights. The media that have high germination rates and high dry weights are r, u, t, s and q (Fig.2). They all have Weblite and vermiculite in some proportion. Even though 100% vermiculite had a germination rate below 60%, by the fourth day all the seeds had germinated and these plants when harvested had the highest dry weights. Vermiculite is a good medium to germinate and grow tomato plants to transplant size. It has a high percentage of available moisture which reduces watering while germinating and growing. Shelf life is prolonged by the high percentage of available moisture.

Available moisture did not appreciably increase the dry weight of tomato plants (Fig. 3).

Stems of tomatoes grown in 100% vermiculite of 50% Weblite 50% vermiculite were observed to be stronger and more difficult to cut. The first true leaves of plants grown in media of at least 50% Weblite had a healthy, blue-green tinge.

In addition to the nutrients provided, vermiculite contains traces of magnesium and potassium , and Weblite contains traces of iron, magnesium and potassium may have been available after the initial nutrients were leached or utilized from the media. These nutrients presumably accounted for the better and healthier plants.

In Figure 4 the trend indicates as small pore space increases tomato plant dry weight increases.

There is no apparent relationship between the following physical properties: large pore space, total pore space, field capacity, permanent wilting point; and seed germination or tomato plant dry weight.

ROOTING OF CHRYSANTHEMUM

According to Duncan's Multiple Range Test, *Chrysanthemum morifolium* cv Sunny Mandalay stem cuttings which were rooted in Weblite had significantly larger root system than cuttings rooted in six other media. The rooting results from 100% sand, 50% Weblite 50% peat moss, and 50% sand 50% peat moss were not significantly different at the 5% level. The 50% perlite 50% peat moss, and 100% perlite media gave the poorest response. Cuttings rooted in 100% Weblite had long, fiberous, white roots uniformly distributed throughout the rootball. Cuttings rooted in 50% perlite 50% peat moss had short, fleshy, brownisn-white roots clustered around a small area at the base of the stem.

There were no significant differences in the foliage of duttings rooted in 100% Weblite, 50% perlite 50% peat moss or 100% sand at the termination of the study. Their foliage was in a dark-green, turgid condition; whereas the leaves of cuttings in sand-peat moss and perlite were light-green and plasmolized.

The variation in rooting response and foliage condition may be due to differences in available moisture and oxygen levels within the media. Weblite apparently provided a better balance between oxygen and water than did perlite-peat moss or perlite. The cells in the foliage plasmolized when the oxygen replaced the water that drained through the perlite. The roots were not able to absorb enough moisture from the medium and replace the water lost to evapo-transpiration. Weblite (50%) peat moss (50%) and 50% sand 50% peat moss mixtures retained considerable moisture to the extent of becoming partially water saturated. The lack of oxygen needed to support root respiration and maintain water absorption produced plasmolysis.

The larger root system produced in 100% Weblite indicates rapid root development. The more optimum rooting environment of Weblite appeared to produce a more desirable root system and foliage condition. Once the cuttings rooted they could have proliferated due to traces of iron, magnesium and potassium in the Weblite.

ROOTING OF CARNATION

The *Dianthus caryophyllus* cv Caribe stem cuttings rooted in 50% vermiculite 50% perlite, 100% vermiculite, or 50% vermiculite 50% Weblite (Table XIII) were significantly better than cuttings rooted in 100% Weblite, 100% perlite, 100% sand, 50% Weblite 50% peat moss, 50% perlite 50% peat moss or 50% sand 50% peat moss. The cuttings found in the first three media, mentioned above,had a more fiberous root system as exemplified by a larger more uniform root ball. Several cuttings inserted in 100% sand or 50% perlite 50% peat moss were hollowed and rotting at the base. Cuttings rooted in 100% perlite had brownish-white roots.

The foliage on stem cuttings rooted in 50% vermiculite 50% Weblite, 50% vermiculite 50% perlite,100% vermiculite, or 100% Weblite (Table XIII) were significantly better than cuttings rooted in 100% perlite, 100% sand, 50% peat moss 50% Weblite, 50% perlite 50% peat moss,or 50% sand 50% peat moss. Foliage of cuttings rooted in the first four media, mentioned above, were turgid and dark-green. Plasmolysis was more severe on foliage of cuttings rooted in 50% perlite 50% peat moss, and 50% sand 50% peat moss. An over abundance of water may have caused the plasmolysis of cuttings rooted in 50% perlite 50% peat moss and 50% sand 50% peat moss. Lack of moisture in 100% perlite may have killed some of the cells causing the brownish-white roots. Cuttings with the best roots and foliage may result from indirect chemical action of vermiculite.

SUMMARY AND CONCLUSIONS

Soilless media were tested to evaluate their effect on seed germination, bedding plant growth, and the propagation of herbaceous stem cuttings, and to evaluate the physical properties of soilless media in relation to seed germination and tomato plant growth.

Lycopersicon esculentum cv Better Boy were sown in 24 soilless media and grown to transplant size. These media, composed of various proportions and combinations of Weblite, vermiculite, Jiffy Mix, peat moss, and sand, were randomized in a complete block design. Duncan's Multiple Range was used to test the differences among means of percentage germination and the dry weight of tomato plants harvested 42 days after sowing.

The media identical to the bedding plant experiment were tested to determine their physical properties. The results of the seed germination and transplant study were compared to each media's bulk density, porosity, field capacity, permanent wilting point, and available moisture.

Chrysanthemum morifolium cv Sunny Mandalay was rooted in six media and *Dianthus caryophyllus* cv Caribe was rooted in nine media. The cuttings were misted automatically. No rooting hormone nor bottom heat was applied. Upon termination of the experiment, their root systems and foliage conditions were evaluated and tested according to Duncan's Multiple Range.

Tomato seeds sown in Weblite and Weblite mixtures of vermiculite and peat moss had a significantly higher germination rate than sand and sand mixtures. By the second day of germination these Weblite media had above 77% germination. Seeds germinated in 100% Weblite and 30% better germination than in 100% sand, yet they contain nearly the same available moisture (3.41% and 2.14%, respectively). By the end of the fourth day nearly 100% of the seeds had germinated.

Weblite is not capable of nutrient retention; therefore it is not economically feasible to use it solely for growing seedlings to transplant size. Media of this type should be used for mass germination and pricking out.

Vermiculite (100%) or Jiffy Mix (100%), both standard germinationg media, contained the highest available moisture (211.23 and 187.89%, respectively); yet they had only slightly better than 50% germination. Availability was not a determining factor in seed germination under automatic mist.

Tomato plant weights increased when grown in media containing at least 50% vermiculite, than in other media.Stems of tomato plants grown in 100% vermiculite or 50% Weblite 50% vermiculite were strong and difficult to cut. The first true leaves of plants grown in media of at least 50% Weblite had a healthy, blue-green tinge in contrast to foliage of the other plants. Their foliage lacked this blue-green color, but would still be considered healthy.

Tomato plant dry weights were increased by media containing a greater amount of small pore space, for example, 100% vermiculite contained 46.47% small pore space and had a tomato plant dry weight of .48 g while 50% sand 50% Jiffy Mix had only 24.51% small pore space and a tomato plant dry weight of .19 grams.

Tomato plant dry weights were decteased in media containing a greater bulk density, for example, 100% Jiffy Mix had a bulk density of 1.5 and a tomato plant dry weight of .35 g while 50% Weblite 50% peat moss had a bulk density of .60 and the tomato plant dry weight of .17 grams.

Stem cuttings of chrysanthemums rooted in 100% Weblite had significantly larger root system than cuttings rooted in 100% sand, 50% Weblite 50% peat moss, 50% sand 50% peat moss, 50% perlite 50% peat moss, or 100% perlite.

Carnation stem cuttings rooted in vermiculite, Weblite, or mixtures of vermiculite with Weblite or perlite had significantly larger root systems than cuttings rooted in 100% perlite, 100% sand, 50% Weblite 50% peat moss, 50% perlite 50% peat moss, or 50% sand 50% peat moss.

Good foliage conditions of stem cuttings of chrysanthemem and carnations were a direct expression of the cuttings ability to root. A poor foliage condition was observed in conjunction with a limited or non-existant root system.

The results of this study indicate several areas where experimentation is needed:

1. to establish the optimum misting cycle for each media;
2. to test the media on plant materials difficult to root, such as woody perenials, for a more absolute expression of rooting;
3. to determine the temperature ranges of each media two inches below the surface or at the base of the stem cutting to be rooted to determine if heat absorption by the media is a factor; and
4. to determine the shelf life for garden center use of tomato transplants grown in different media.

LITERATURE CITED

Abernathie, J. A. 1972. Soilless Mediums for Transplant Stock. Am. Nurseryman 136(8): 68-70.

Baker, K. F. (Editor). 1957. The U. C. System for Producing Healthy Container-Grown Plants. Univ. of Cal. Agr. Expt. Sta. Man. 23.

Baumgartner, L. L. 1957. A New Potting Soil Mix. Proc. Int. Plant Prop. Soc., 7:84.

Blake, G. R. 1965. Bulk density. In: C. A. Black (Editor). Methods of Soil Analysis, Part 1. Agronomy 9:379-390. Am. Soc. of Agron., Madison, Wis.

Boodley, J. W. and R. Sheldrake, Jr. 1963. Artifical Soils for Commercial Plant Growing. Cornell Ext. Bul. 1104.

Chadwick, L. C. 1949. The Effect of Certain Mediums and Watering Methods on the Rooting and Subsequent Growth of Ornamental Plants. Proc. Am. Soc. Hort. Sci. 53: 553-566.

Coorts, G. D., A. D. Leasure and J. B. Gartner. 1964. The Effect of Nitrogen and Potassium Nutrition on Geraniums Grown in Various Media. Proc. Am. Soc. Hort. Sci. 84:595-599.

Criley, R. A. 1972. Personal Communication. Univ. of Hawaii, Honolulu, Hawaii.

DeWorth, A. F. and R. F. Odom. 1960. A Standard Light-Weight Growing Medium for Horticulture Specialty Crops. Texas Agr. Expt. Sta. M. P. 420.

Flemer, W. III. (Moderator). 1965. Rooting Chemicals vs. Powder Use, etc., Rooting Media, Natural, Artificial Fiber, etc. Proc. Int. Plant Prop. Soc. 15:249-250.

Hall, T. and T. F. Cannon. 1965. Propagation of Rhododendron carolinianum by Stem Cuttings. Proc. Int. Plant Prop. Soc. 15:134-138.

Inose, K. 1971. Pumice as a Rooting Medium. Proc. Int. Plant Prop. Soc. 21:82.

Mauldin, M. P. 1944. Anthracite Coal Ashes for Rooting Cuttings of Ornamental Plants. Sci. 99:145.

Peele, T. C. and O. W. Beale. 1950. Relation of Moisture Equivalent of Field Capacity and Moisture Retained at 15 Atmospheres Pressure to the Wilting Percentage. Agron. Jour. 42:604-607.

Peters, D. B. 1965. Water Availability. In: C.A. Black (Editor). Methods of Soil Analysis, Part I. Agronomy 9:279-285. Am. Soc of Agron., Madison, Wis.

Richards, L. A. 1965. Physical Condition of Water in Soil. In: C. A. Black (Editor). Methods of Soil Analysis, Part I. Agronomy 9:128-151. Am. Soc. of Agron., Madison, Wis.

Self, R. L. and N. A. Driskell. 1972. Processed Slate as a Rooting and Growing Medium. Proc. of S. N. A. Res. Conf. 17:50.

Self, R. L. 1973. Personal Communication. Auburn Univ. Mobile, Ala.

Spasoff, L. C. 1972. Personal Communication. Va. Poly. Ins. and S. U. Blacksburg, Va.

Swartley, J. C. 1947. Fly Ash as a Propagation Medium. Am. Nurseryman 86 (12): 10-12.

Volmocil, J. A. 1965. Porosity. In: C. A. Black (Editor). Methods of Soil Analysis, Part I. Agronomy 9:299-314. Am. Soc. of Agron., Madison, Wis.

White, J. W. 1966. Growing Media, Watering and Fertilization. In: J. W. Mastalerz (Editor). Bedding Plants. Penn. State Man. pp. 42-52.

Wildon, C. E. and F. L. S. O'Rourke. 1964. The Effect of Arcillite in Media for Pot Plants. Mich. Agr. Expt. Sta. Res. Report 16.

APPENDIX

Table I. Alphabetical coding for the soilless media.

a	100% Sand
b	100% Peat moss[z]
c	100% Vermiculite
d	100% Weblite
e	100% Jiffy Mix
f	50% Sand 50% Jiffy Mix
g	80% Sand 20% Jiffy Mix
h	20% Sand 80% Jiffy Mix
i	50% Sand 50% vermiculite
j	80% Sand 20% vermiculite
k	20% Sand 80% vermiculite
l	50% Sand 50% peat moss
m	80% Sand 20% peat moss
n	20% Sand 80% peat moss
o	50% Weblite 50% Jiffy Mix
p	80% Weblite 20% Jiffy Mix
q	20% Weblite 80% Jiffy Mix
r	50% Weblite 50% vermiculite
s	80% Weblite 20% vermiculite
t	20% Weblite 80% vermiculite
u	30% Weblite 50% vermiculite 20% peat moss
v	45% Weblite 45% vermiculite 10% peat moss
w	50% Weblite 50% peat moss
x	50% Peat moss 50% vermiculite

[z]All peat moss is German sphagnum peat moss.

Table II. First day of tomato seed germination as affected by soilless media.

Code	Media	Mean Percentage	Statistical Significance
s	80% Weblite 20% vermiculite	27.08	a[z]
r	50% Weblite 50% vermiculite	27.08	a
t	20% Weblite 80% vermiculite	22.92	ab
q	20% Weblite 80% Jiffy Mix	22.92	ab
v	45% Weblite 45% vermiculite 10% peat moss	18.75	abc
d	100% Weblite	18.75	abc
p	80% Weblite 20% Jiffy Mix	16.67	abc
x	50% Peat moss 50% vermiculite	14.58	abc
u	30% Weblite 50% vermiculite 20% peat moss	10.42	abc
n	20% Sand 80% peat moss	10.42	abc
c	100% Vermiculite	10.42	abc
g	80% Sand 20% Jiffy Mix	8.33	abc
w	50% Weblite 50% peat moss	6.23	bc
o	50% Weblite 50% Jiffy Mix	6.25	bc
m	50% Sand 20% peat moss	6.25	bc
l	50% Sand 50% peat moss	6.25	bc
b	100% Peat moss	6.25	bc
j	80% Sand 20% Jiffy Mix	4.17	bc
f	50% Sand 50% Jiffy Mix	4.17	bc
e	100% Jiffy Mix	4.17	bc
i	50% Sand 50% vermiculite	2.08	c
a	100% Sand	2.08	c
k	20% Sand 80% vermiculite	0	c
h	20% Sand 80% Jiffy Mix	0	c

[z]Means not followed by the same letter are significantly different at the 5% level according to Ducan's Multiple Range Test.

Table III. Second day of tomato seed germination as affected by soilless media.

Code	Media	Mean Percentage	Statistical Significance
r	50% Weblite 50% vermiculite	83.33	a[z]
d	100% Weblite	83.33	a
o	50% Weblite 50% Jiffy Mix	81.25	ab
u	30% Weblite 50%vermiculite 20% peat moss	79.17	ab
s	80% Weblite 20% vermiculite	77.08	ab
q	20% Weblite 80% Jiffy Mix	77.08	ab
g	80% Sand 20% Jiffy Mix	77.08	ab
t	20% Weblite 80% vermiculite	70.83	abc
v	45% Weblite 45% vermiculite 10% peat moss	68.75	abc
m	80% Sand 20% peat moss	68.75	abc
w	50% Weblite 50% peat moss	66.67	abc
b	100% Peat moss	62.50	abc
n	20% Sand 80% peat moss	58.33	abc
f	50% Sand 50% Jiffy Mix	58.33	abc
c	100% Vermiculite	58.33	abc
x	50% Peat moss 50% vermiculite	56.25	abc
p	80% Weblite 20% Jiffy Mix	56.25	abc
a	100% Sand	54.17	abc
l	50% Sand 50% peat moss	50.00	abc
h	20% Sand 80% Jiffy Mix	50.00	abc
e	100% Jiffy Mix	50.00	abc
i	50% Sand 50% vermiculite	47.92	bc
j	80% Sand 20% vermiculite	41.67	c
k	20% Sand 80% vermiculite	39.58	c

[z]Means not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

Table IV. Tomato plant dry weight grown in soilless media.

Code	Media	Mean Weight (g)	Statistical Significance
c	100% Vermiculite	.48	a[z]
k	20% Sand 80% vermiculite	.47	a
t	20% Weblite 80% vermiculite	.46	ab
x	50% Peat moss 50% vermiculite	.41	abc
u	30% Weblite 50% vermiculite 20% peat moss	.38	abcd
e	100% Jiffy Mix	.35	bcde
q	20% Weblite 80% Jiffy Mix	.34	cdef
s	80% Weblite 20% vermiculite	.32	cdef
r	50% Weblite 50% vermiculite	.32	cdef
i	50% Sand 50% vermiculite	.28	defg
h	20% Sand 80% Jiffy Mix	.28	defg
v	45% Weblite 45% vermiculite 10% peat moss	.24	efgh
o	50% Weblite 50% Jiffy Mix	.23	fgh
p	80% Weblite 20% Jiffy Mix	.23	fgh
l	50% Sand 50% peat moss	.19	ghi
g	80% Sand 20% Jiffy Mix	.19	ghi
f	50% Sand 50% Jiffy Mix	.19	ghi
w	50% Weblite 50% peat moss	.17	ghi
j	80% Sand 20% vermiculite	.14	hij
m	80% Sand 20% peat moss	.14	hij
n	20% Sand 80% peat moss	.13	hij
b	100% Peat moss	.12	hij
d	100% Weblite	.08	ij
a	100% Sand	.05	j

[z]Means not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

Table V. Available moisture of soilless media.

Code	Media	Mean Percentage	Statistical Significance
c	100% Vermiculite	211.23	a[z]
e	100% Jiffy Mix	187.89	ab
x	50% Peat moss 50% vermiculite	185.03	b
b	100% Peat moss	179.23	b
q	20% Weblite 80% Jiffy Mix	54.48	c
u	30% Weblite 50% vermiculite 20% peatmoss	45.15	cd
t	20% Weblite 80% vermiculite	36.45	cde
k	20% Sand 80% vermiculite	31.28	cdef
r	50% Weblite 50% vermiculite	30.86	cdefg
h	20% Sand 80% Jiffy Mix	25.60	defg
v	45% Weblite 45% vermiculite 10% peat moss	23.06	defg
o	50% Weblite 50% Jiffy Mix	18.73	defg
n	20% Sand 80% peat moss	18.05	defg
i	50% Sand 50% vermiculite	13.63	efg
f	50% Sand 50% Jiffy Mix	12.79	efg
s	80% Weblite 20% vermiculite	11.65	efg
w	50% Weblite 50% peat moss	11.45	efg
p	80% Weblite 20% Jiffy Mix	10.23	efg
j	80% Sand 20% vermiculite	7.97	fg
l	50% Sand 50% peat moss	7.04	fg
g	80% Sand 20% Jiffy Mix	6.60	fg
m	80% Sand 20% peat moss	3.76	fg
d	100% Weblite	3.41	fg
a	100% Sand	2.14	g

[z]Means not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

Table VI. Small pore space of soilless media.

Code	Media	Mean Percentage	Statistical Significance
e	100% Jiffy Mix	46.74	a[z]
c	100% Vermiculite	46.47	a
x	50% Peat moss 50% vermiculite	40.69	b
q	20% Weblite 80% Jiffy Mix	36.40	c
b	100% Peat moss	35.40	c
h	20% Sand 80% Jiffy Mix	34.70	cd
t	20% Weblite 80% vermiculite	34.67	cd
y	30% Weblite 50% vermiculite 20% peat moss	34.42	cd
k	20% Sand 80% vermiculite	33.94	cd
r	50% Weblite 50% vermiculite	31.64	de
n	20% Sand 80% peat moss	30.68	e
v	45% Weblite 45% vermiculite 10% peat moss	28.05	fg
o	50% Weblite 50% Jiffy Mix	25.68	gh
f	50% Sand 50% Jiffy Mix	24.51	hi
w	50% Weblite 50% peat moss	23.08	hij
i	50% Sand 50% vermiculite	23.03	hij
s	80% Weblite 20% vermiculite	22.01	ijk
l	50% Sand 50% peat moss	20.34	jkl
p	80% Weblite 20% Jiffy Mix	19.90	kl
j	80% Sand 20% vermiculite	18.25	lm
g	80% Sand 20% Jiffy Mix	15.96	mn
d	100% Weblite	14.49	no
m	80% Sand 20% peat moss	12.58	o
a	100% Sand	8.99	p

[z]Means not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

Table VII. Large pore space of soilless media.

Code	Media	Mean Percentage	Statistical Significance
b	100% Peat moss	53.49	a
x	50% Peat moss 50% vermiculite	49.59	b
e	100% Jiffy Mix	48.23	bc
w	50% Weblite 50% peat moss	47.39	bc
n	20% Sand 80% peat moss	47.20	bc
o	50% Weblite 50% Jiffy Mix	46.28	bcd
q	20% Weblite 80% Jiffy Mix	45.95	cd
l	50% Sand 50% peat moss	45.79	cd
u	30% Weblite 50% vermiculite 20% peat moss	44.98	cde
c	100% Vermiculite	42.96	def
v	45% Weblite 45% vermiculite 10% peat moss	41.93	ef
f	50% Sand 50% Jiffy Mix	40.61	fg
h	20% Sand 80% Jiffy Mix	40.34	fgh
m	80% Sand 20% peat moss	38.12	ghi
p	80% Weblite 20% Jiffy Mix	37.26	hi
k	20% Sand 80% vermiculite	36.69	ij
t	20% Weblite 80% vermiculite	36.15	ij
r	50% Weblite 50% vermiculite	35.13	ijk
g	80% Sand 20% Jiffy Mix	35.05	ijk
a	100% Sand	33.72	jkl
i	50% Sand 50% vermiculite	33.40	jkl
s	80% Weblite 20% vermiculite	31.78	klm
j	80% Sand 20% vermiculite	31.38	lm
d	100% Weblite	28.62	m

[z]Means not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

Table VIII. Total pore space of soilless media.

Code	Media	Mean Percentage	Statistical Significance
e	100% Jiffy Mix	94.72	a[z]
x	50% Peat moss 50% vermiculite	90.53	b
c	100% Vermiculite	89.43	b
b	100% Peat moss	88.88	b
q	20% Weblite 80% Jiffy Mix	82.35	c
u	30% Weblite 50% vermiculite 20% peatmoss	79.40	cd
n	20% Sand 80% peat moss	78.00	de
h	20% Sand 80% Jiffy Mix	75.03	ef
o	50% Weblite 50% Jiffy Mix	71.96	fg
t	20% Weblite 80%vermiculite	70.82	gh
k	20% Sand 80% vermiculite	70.63	gh
w	50% Weblite 50%peat moss	70.47	gh
v	45% Weblite 45% vermiculite 10% peat moss	70.23	gh
r	50% Weblite 50% vermiculite	66.77	hi
l	50% Sand 50% peat moss	66.13	i
f	50% Sand 50% Jiffy mix	65.12	i
p	80% Weblite 20% Jiffy Mix	57.16	j
i	50% Sand 50% vermiculite	56.43	j
s	80% Weblite 20% vermiculite	53.79	jk
g	80% Sand 20% Jiffy Mix	51.00	k
m	80% Sand 20% peat moss	50.71	k
j	80% Sand 20% vermiculite	49.63	k
d	100% Weblite	43.11	l
a	100% Sand	42.84	l

[z]Means not followed by the same letter are significantly different at the 5% level Duncan's Multiple Range Test.

Table IX. Bulk density of soilless media.

Code	Media	Mean Value	Statistical Significance
a	100% Sand	1.44	a[z]
j	80% Sand 20% vermiculite	1.25	b
m	80% Sand 20% peat moss	1.23	b
g	80% Sand 20% Jiffy Mix	1.15	c
i	50% Sand 50% vermiculite	1.00	d
f	50% Sand 50% Jiffy Mix	.93	de
d	100% Weblite	.93	de
l	50% Sand 50% peat moss	.89	e
s	80% Weblite 20% vermiculite	.81	f
p	80% Weblite 20% Jiffy Mix	.80	f
k	20% Sand 80% vermiculite	.70	g
h	20% Sand 80% Jiffy Mix	.69	g
r	50% Weblite 50% vermiculite	.61	h
w	50% Weblite 50% peat moss	.60	hi
v	45% Weblite 45% vermiculite 10% peat moss	.60	hi
o	50% Weblite 50% Jiffy Mix	.58	hi
n	20% Sand 80% peat moss	.57	hi
t	20% Weblite 80% vermiculite	.52	i
u	30% Weblite 50% vermiculite 20% peat moss	.42	j
q	20% Weblite 80% Jiffy Mix	.40	j
e	100% Jiffy Mix	.15	k
c	100% Vermiculite	.15	k
x	50% Peat moss 50% vermiculite	.11	k
b	100% Peat moss	.07	k

[z]Means not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

Table X. Field capacity of soilless media (1/3 Bar).

Code	Media	Mean Percentage	Statistical Significance
b	100% Peat moss	313.96	a[z]
x	50% Peat moss 50% vermiculite	267.84	b
c	100% Vermiculite	252.66	bc
e	100% Jiffy Mix	239.56	c
q	20% Weblite 80% Jiffy Mix	69.11	d
u	30% Weblite 50% vermiculite 20% peat moss	62.88	d
t	20% Weblite 80% vermiculite	52.20	de
k	20% Sand 80% vermiculite	40.21	ef
r	50% Weblite 50% vermiculite	39.65	efg
h	20% Sand 80% Jiffy Mix	33.05	fgh
v	45% Weblite 45% vermiculite 10% peat moss	33.04	fgh
n	20% Sand 80% peat moss	30.38	fghi
o	50% Weblite 50% Jiffy Mix	29.28	fghi
w	50% Weblite 50% peat moss	22.73	fghij
f	50% Sand 50% Jiffy Mix	18.01	ghij
i	50% Sand 50% vermiculite	17.26	hij
s	80% Weblite 20% vermiculite	17.01	hij
p	80% Weblite 20% Jiffy Mix	15.56	hij
l	50% Sand 50% peat moss	12.69	hij
j	80% Sand 20% vermiculite	10.45	ij
g	80% Sand 20% Jiffy Mix	10.05	ij
d	100% Weblite	8.24	ij
m	80% Sand 20% peat moss	6.41	j
a	100% Sand	4.01	j

[z]Means not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

Table XI. Permanent wilting point of soilless media.

Code	Media	Mean Percentage	Statistical Significance
b	100% Peat moss	104.39	a[z]
x	50% Peat moss 50% vermiculite	82.81	b
e	100% Jiffy Mix	51.68	c
c	100% Vermiculite	41.44	d
u	30% Weblite 50% vermiculite 20% peat moss	17.79	e
t	20% Weblite 80% Jiffy Mix	15.75	ef
q	20% Weblite 80% Jiffy Mix	14.14	efg
n	20% Sand 80% peat moss	12.33	efgh
w	50% Weblite 50% peat moss	11.28	efghi
v	45% Weblite 45% vermiculite 10% peat moss	9.98	fghij
o	50% Weblite 50% Jiffy Mix	9.63	fghijk
r	50% Weblite 50% vermiculite	8.79	fghijk
k	20% Sand 80% vermiculite	8.58	fghijk
h	20% Sand 80% Jiffy Mix	7.45	ghijk
l	50% Sand 50% peat moss	5.65	hijk
s	80% Weblite 20% vermiculite	5.36	hijk
p	80% Weblite 20% Jiffy Mix	5.34	hijk
f	50% Sand 50% Jiffy Mix	5.23	hijk
d	100% Weblite	4.83	hijk
i	50% Sand 50% vermiculite	3.64	ijk
g	80% Sand 20% Jiffy Mix	3.45	jk
j	80% Sand 20% vermiculite	2.66	jk
m	80% Sand 20% peat moss	2.65	jk
a	100% Sand	1.88	k

[z]Means not followed by the same letter are significantly different at the 5% level accorging to Duncan's Multiple Range Test.

Table XII. Root response and foliage condition indices[z] of _Chrysanthemum morifolium_ cv. Sunny Mandalay in Propagation media.

Root Response			Foliage Condition		
Media	Mean Index	Statistical Significance	Media	Mean Index	Statistical Significance
Weblite	3.47	a[y]	Weblite	3.83	a[y]
Sand	2.87	b	Perlite-peat moss	3.70	a
Weblite-peat moss[x]	2.63	b	Sand	3.40	ab
Sand-peat moss	2.50	b	Weblite-peat moss	3.00	bc
Perlite-peat moss	2.03	c	Sand-peat moss	2.90	c
Perlite	1.57	d	Perlite	1.83	d

[z]Rooting Index: (1) no roots; (5) heavily rooted
Foliage Index: (1) light-green, wilted leaves; (5) dark-green, turgid leaves

[y]Means not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

[x]All combination media are made up of 50% of each component.

Table XIII. Root response and foliage condition indices[z] of *Dianthus caryophyllus* cv Caribe in propagation media.

Root Response			Foliage Condition		
Media	Mean Index	Statistical Significance	Media	Mean Index	Statistical Significance
Vermiculite-perlite[x]	3.33	a[y]	Vermiculite-Weblite	3.44	a[y]
Vermiculite	2.98	ab	Vermiculite-perlite	3.42	a
Vermiculite-Weblite	2.36	bc	Vermiculite	3.33	a
Weblite	2.11	cd	Weblite	3.29	a
Perlite	1.84	cde	Perlite	2.76	b
Sand	1.60	cdef	Sand	2.64	b
Peat moss-Weblite	1.42	def	Peat moss-Weblite	2.04	cc
Peat moss-perlite	1.27	ef	Peat moss-perlite	1.73	cd
Peat moss-sand	1.00	f	Peat moss-sand	1.44	d

[z]Rooting Index: (1) no roots; (5) heavily rooted
Foliage Index: (1) light-green, wilted leaves; (5) dark-green, turgid leaves

[y]Means not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

[x]All combination media are made up of 50% of each component.

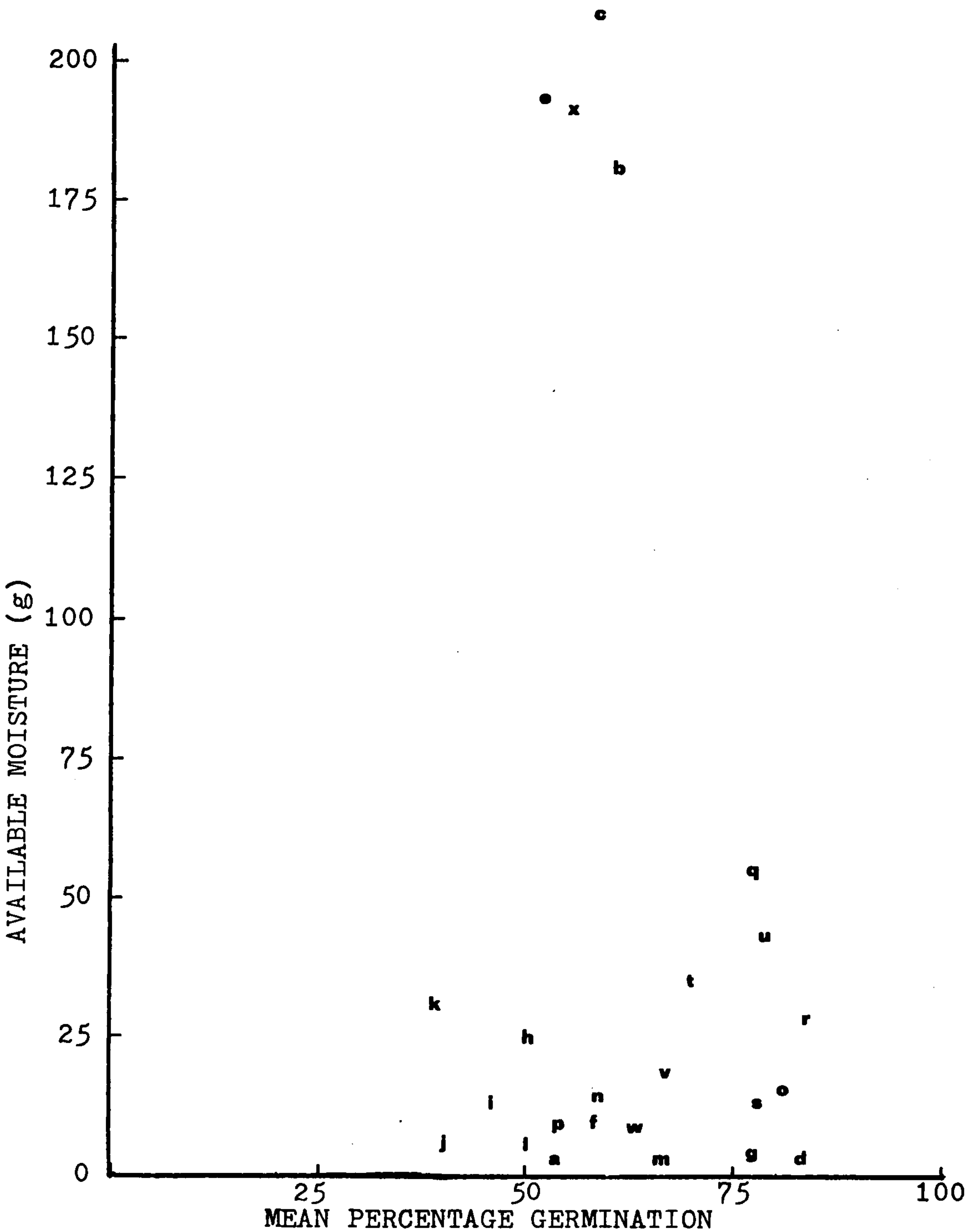

Figure 1. Available moisture in relation to tomato seed germination (second day) in soilless media.

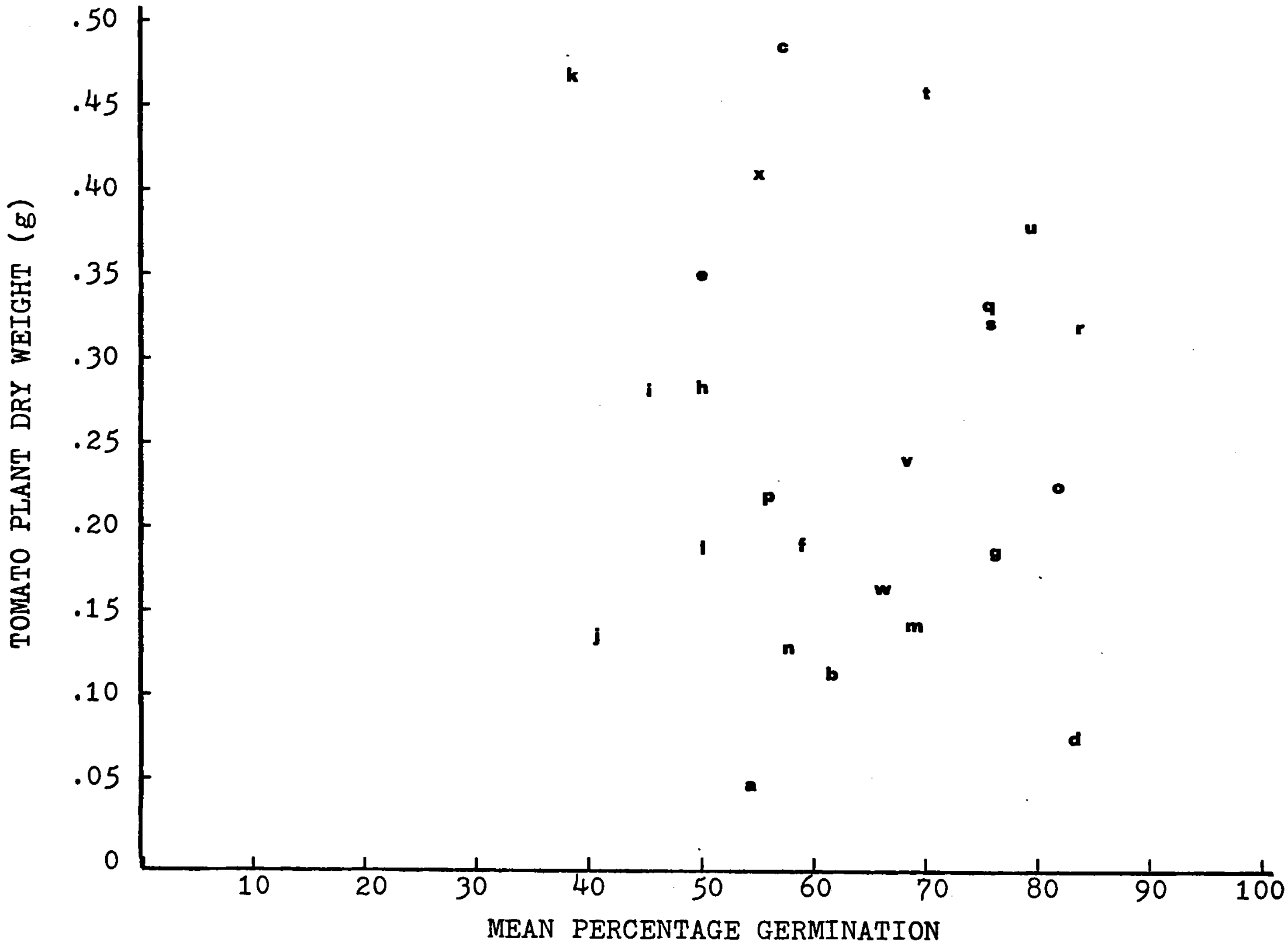

Figure 2. The dry weight of tomato plants in relation to second day seed germination in soilless media.

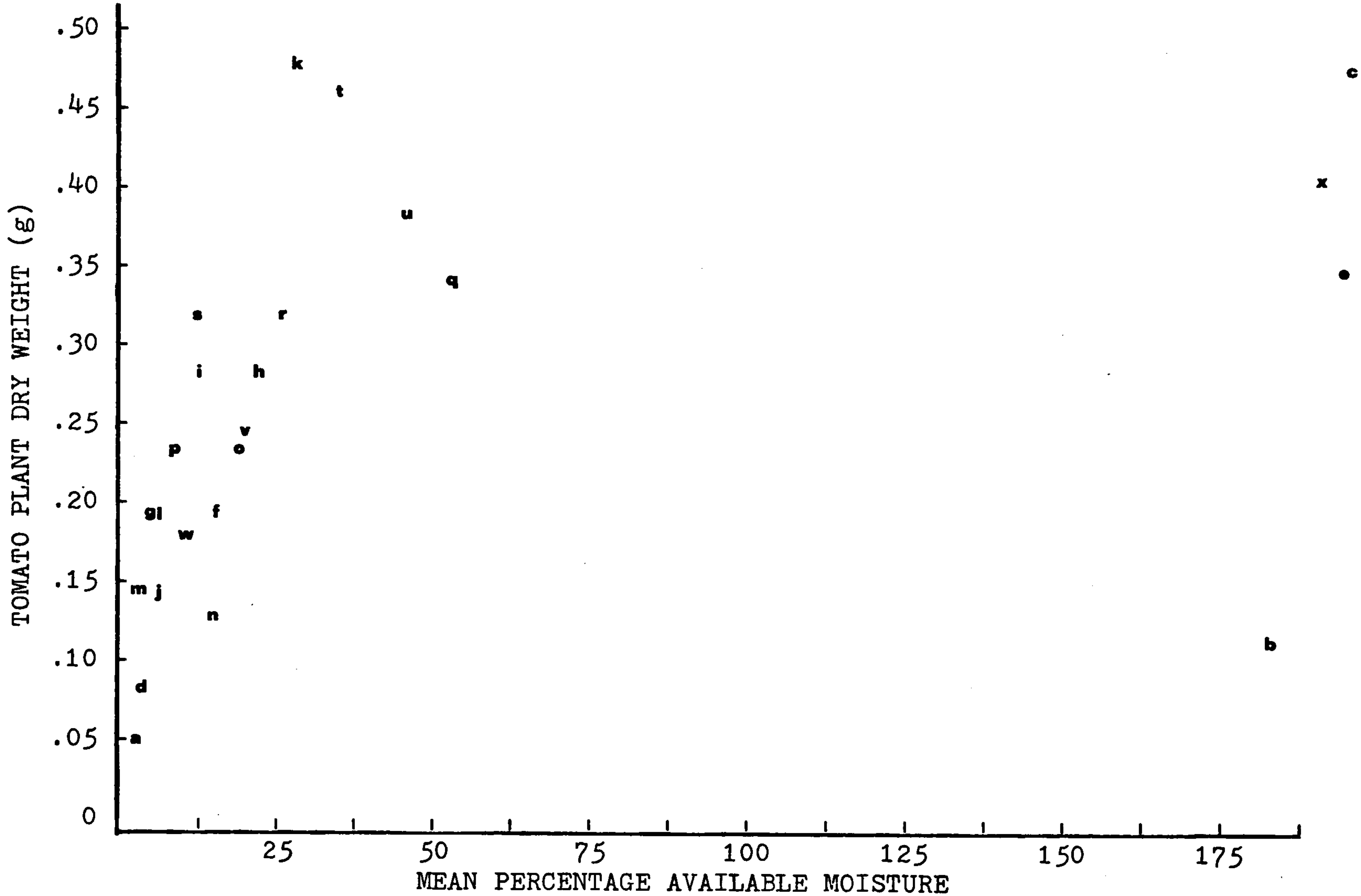

Figure 3. Dry weight of tomato plants grown in soilless media in relation to available moisture.

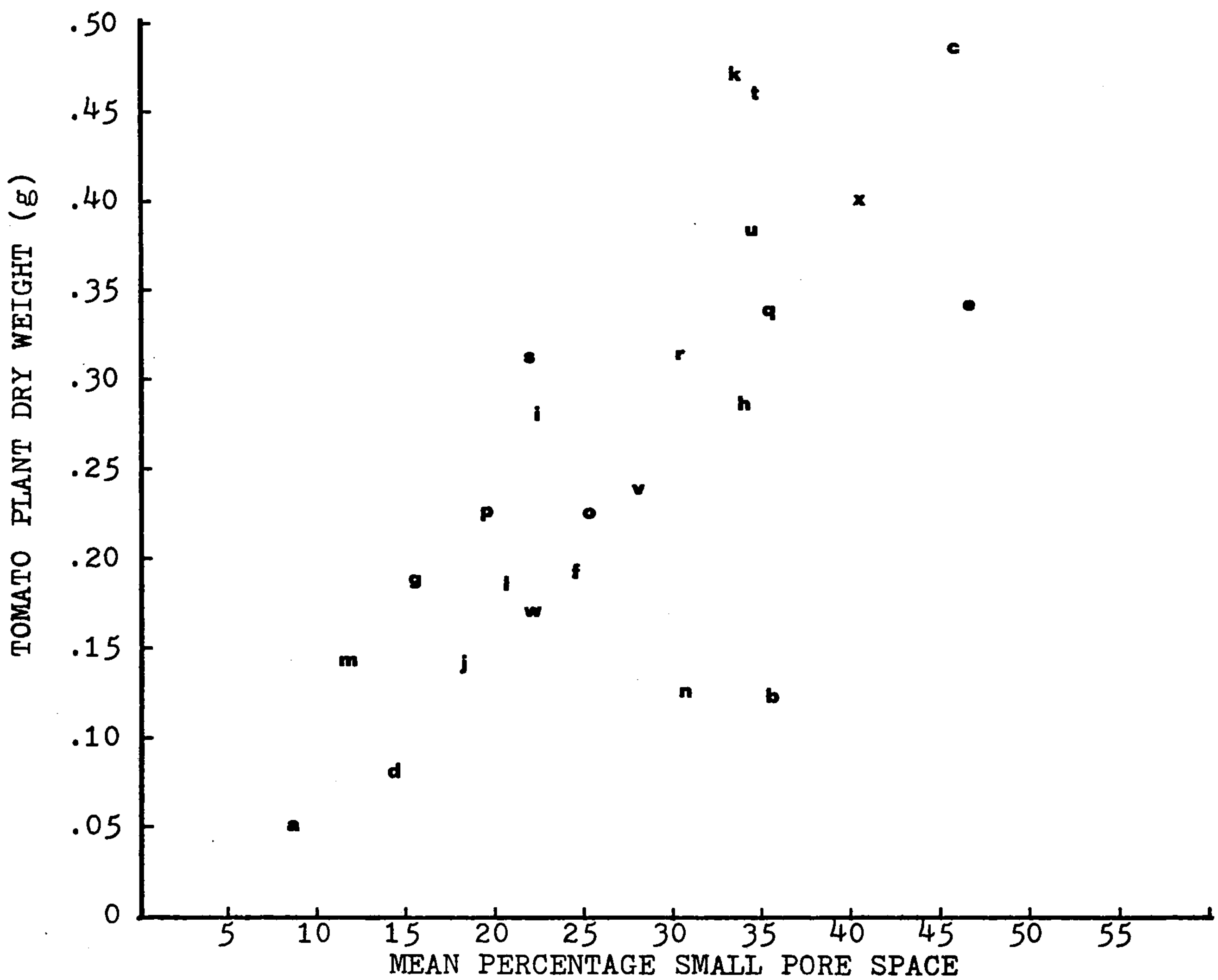

Figure 4. Dry weight of tomato plants grown in soilless media in relation to small pore space.

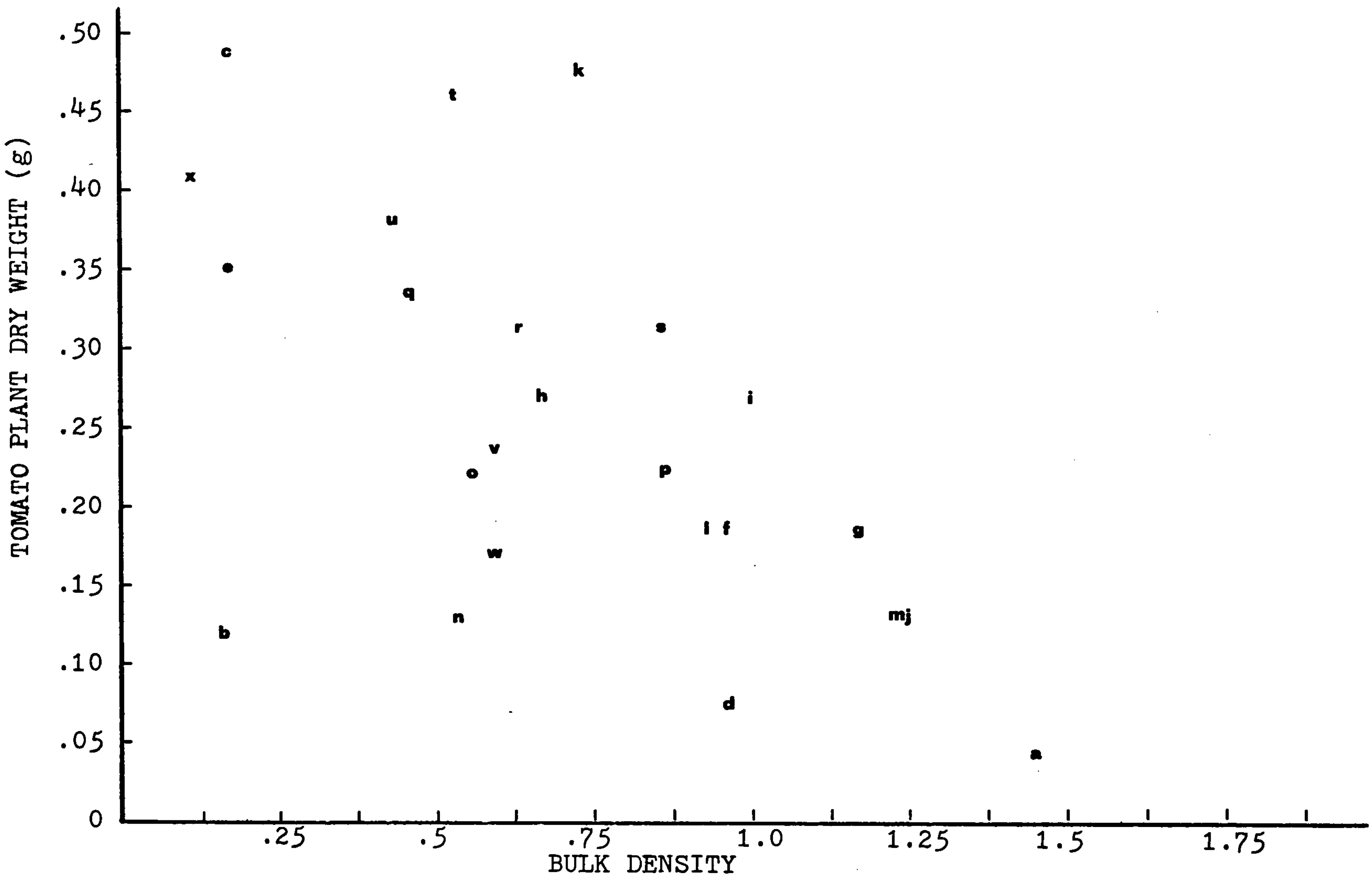

Figure 5. Dry weight of tomato plants grown in soilless media in relation to bulk density.

The vita has been removed from the scanned document

SOILLESS MEDIA FOR SEED GERMINATION AND GROWTH OF TOMATO TRANSPLANTS, AND FOR THE ROOTING OF CERTAIN HERBACEOUS STEM CUTTINGS

by

Frederick Harding Ray

(ABSTRACT)

Media containing Weblite were compared to various media for its effectiveness in germination, plant growth and rooting.

The 24 media were compared by determining the percentage germination and the dry weight, after 42 days, of Lycopersicon esculentum cv Better Boy, grown to transplant size. These media were composed of various proportions and combinations of Weblite, vermiculite, Jiffy Mix, peat moss and sand. The available moisture, porosity, field capacity and permanent wilting point of these 24 media were determined. This information was compared with the results from the germination and growth study of tomato plants. Weblite was a constituent of the seven best media for germination. Tomato plants grown in media containing vermiculite had the highest dry weights.

Chrysanthemum morifolium cv Sunny Mandalay stem cuttings were rooted in six media. These media were composed of various proportions and combinations of sand, peat moss, Weblite, and perlite. Their root system and foliage condition were evaluated 18 days later. Weblite was significantly better in rooting Chrysanthemums than the six other media.

Dianthus caroyphyllus cv Caribe stem cuttings were rooted in nine media. These media were composed of various proportions and combinations of sand, peat moss, Weblite, perlite, and vermiculite. Their roots, stem and foliage condition were evaluated 26 days later. The best root system developed in media with vermiculite as its main constituent.