20

March 1960

A Standard Light-weight Growing Medium for Horticultural Specialty Crops

TEXAS AGRICULTURAL EXPERIMENT STATION
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SUMMARY

Trials were conducted during 1957-59 with lightweight aggregates as soil amendments in potting mixtures for container-grown plants.

A mixture of one part each by volume of horticultural perlite and sphagnum peat moss consistently produced higher quality plants than any other mixture used.

The mixture recommended is 25 to 30 percent lighter in weight than potting soils in common use. This factor is important because of the transportation costs of container-grown plants.

The materials can be mixed readily into a uniform growing medium which will provide excellent aeration and drainage and retain sufficient nutrients for good plant growth.

Materials used in the mixture are available readily in uniform grade at reasonable cost and are relatively inert and chemically uniform.

There is no appreciable shrinkage or compaction of this medium in container production.

Labor requirements for high quality plant production are reduced.

Many kinds of plants can be produced in this medium.

This medium leaches readily and salinity problems are reduced.

Variations in plant growth from the use of animal manures and organic composts, and differences in decomposition of organic soil amendments, are reduced and more uniform results are possible.

Problems of scarcity of suitable soils, animal manures or other organic soil amendments are eliminated.

This mixture can be sterilized with chemicals or steam without producing toxic residues.

The fertility of the medium is low, furnishing a low starting level for fertility programs.

Various size aggregates of perlite in the mixtures did not result in significant differences in the quality of plants produced until extremely small aggregates were used.

THE COVER PICTURE

Poinsettias. Variety Indianapolis Red. Rooted cuttings planted 9/25/59, photographed 12/10/59. Grown in 1/2 peat moss, 1/2 perlite.

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A Standard Light-weight Growing Medium for Horticultural Specialty Crops

A. F. DeWerth and R. E. Odom*

TEXAS NURSERYMEN AND FLORISTS producing plants in containers are faced with increasing costs of production and transportation without a corresponding increase in returns for these crops. This problem suggested the use of light-weight aggregates and containers to reduce shipping weight. To be acceptable, crops produced in a light-weight medium should be of equal or better quality than plants produced in potting soils now in use by these growers.

Preliminary trials were conducted at College Station with three lightweight materials used as soil amendments—1/8 to 1/4-inch aggregate charcoal, expanded perlite and peat moss. These earlier trials led to the adoption of perlite and peat as the better, more uniform and most widely available materials.

Geologists use the term perlite to describe a siliceous volcanic rock which, when crushed and heated quickly to a temperature of approximately 1800° F., expands (like popcorn) to form non-combustible, light-weight aggregates with a closed cellular structure. It is white in color and can be manufactured to weigh 4 to 15 pounds per cubic foot. The average weight of processed horticultural perlite is about 8 pounds per cubic foot, or about one-twelfth that of sand.

Particles of ungraded perlite vary in size from very fine to the size of a small pea. The sizes are designated by the U. S. standard screen sizes—#8 (3/32"), #16 (3/64"), #30 (3/128"), #50 and #100.

Being a form of natural glass, perlite is not susceptible to decay. It is sterile, non-toxic and chemically inert. It is not a fertilizer. It has a pH of about 7.5. Water adheres easily to the surface depressions of perlite particles, and the sealed air cells or bubbles prevent the water from being retained by the perlite. This characteristic makes the water held by the perlite readily available for plant intake. When moistened with water, perlite can be mixed readily with peat moss or soil.

This material is now readily available in a horticultural grade, is chemically uniform, stable to steam and chemical fumigation, easily made into a uniform mixture, assures good aeration, has low fertility, is relatively inexpensive, has reasonably good water and nutrient retention, is light in weight and does not shrink or break down during mixing or storage.

Peat moss is the poorly decomposed remains from stems and leaves of several species of sphagnum mosses. The following morphological features are common in sphagnum peat mosses: they are light tan or yellow-brown in color when squeezed dry; have a porous, fibrous or spongy texture; are quite elastic when dry; light in weight; absorb water readily; and contain transparent hyaline cells which act as storage compartments when water is absorbed. This unique feature accounts for the large water-absorbing power of the mosses.

Sphagnum peat mosses have several important physical properties which distinguish them for this purpose. They possess a very low volume weight, 0.2 to 0.4 cubic centimer per gram; absorb 10 to 30 times their own weight in water; are 95 to 99 percent pure organic matter; and the structure of the original source plants is evident and is easily identifiable because of the fresh condition of decomposition.

The chemical properties of sphagnum peat mosses also are unique. They have a very acid reaction, pH 3.0 to 4.5; are practically undecomposed, only very slightly soluble in organic solvents; have a low nutrient content, 0.8 to 1.5 percent nitrogen, and only traces of phosphorus and potassium; and the carbon-to-nitrogen ratio and the cellulose content are very high. This means that sphagnum peat mosses will be decomposed easily by microorganisms when nutrients and water are applied. The nitrogen present will not be available readily since the organisms tie it up in the decomposition process.

Additional advantages of peat moss over other organic materials are freedom from weed seed, diseases and offensive odors. It is very light and easy to work with.

EXPERIMENTAL PROCEDURE

Description of the Project

A total of 3,000 plants per year were included in experiments conducted during 1957-59.

Pot plant crops were grown on raised benches in greenhouses cooled by the fan and wetpad method. Nursery stock was grown in containers on an asphalt-

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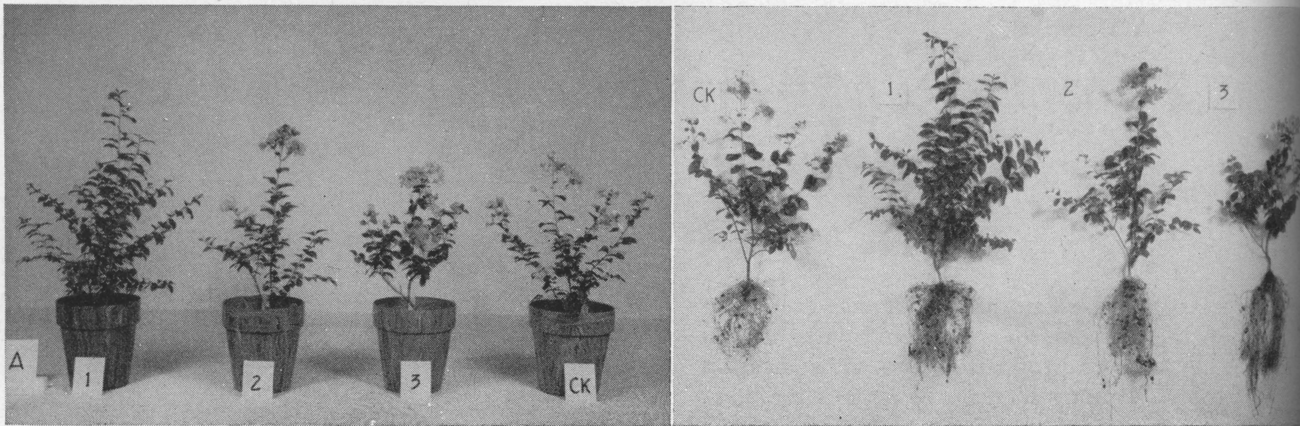


LAGERSTROEMIA INDICA

At left in various growing media in pots. At right, growing media washed off to show the root systems. At left —liners planted 5/1/58, pruned 6/15/58, photographed 8/1/58. No. 1, 1/2 peat moss, 1/2 perlite. No. 2, 1/3 peat moss, 1/3 Miller clay, 1/3 perlite. No. 3, 40 percent perlite, 60 percent Miller clay. Check (Ck), 1/2 peat moss, 1/2 Miller clay.

paved area outdoors and in a lath house producing 30 percent shade.

The experimental design was a 4 x 4 latin square replicated three times, and cultural practices were the same for each treatment.

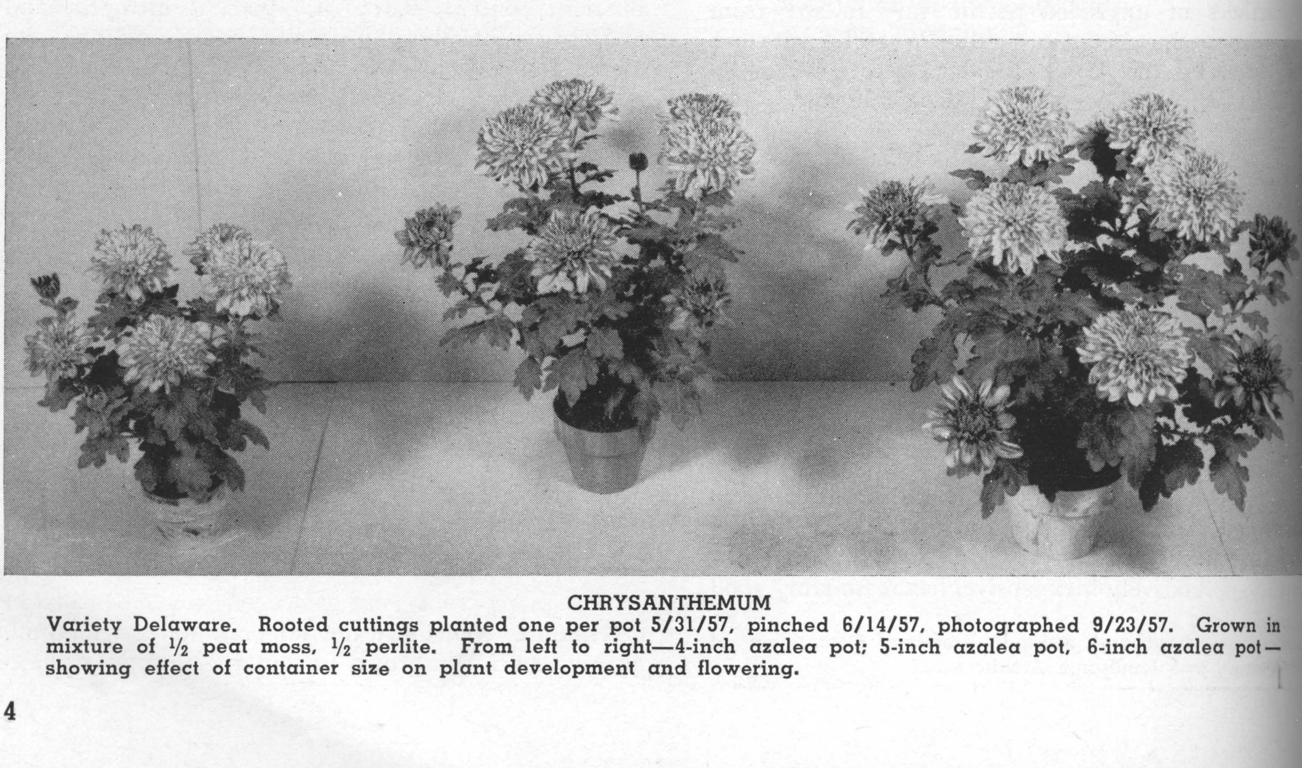
All plants used in the trials were propagated asexually by cuttings to avoid as much as possible the natural variation characteristics of most plants produced from seed.

The results obtained were based on the increase in fresh weight of plants during the growing season and on the increase in vertical growth, the number of breaks produced and the horizontal spread of the plants.

Preliminary trials were conducted during 1957 with crops of chrysanthemum and coleus grown in clay and plastic containers in the greenhouse. *Pittosporum tobira* Whitespot, *Ilex aquifolium* and *Ligustrum japonicum* were placed in 30 percent shade and in full sun on the asphalt slab, and were grown in metal Plantainers (a crimped No. 10 food can) and in plastic 6-inch pots. Twenty-five individuals were included in each treatment.

The trials were expanded in 1958 to include the following greenhouse crops: chrysanthemums, St. Paulias, geraniums, poinsettias, ornamental peppers, crotons, coleus and various tropical foliage plants. Nursery crops included *Ilex vomitoria, Lagerstroemia indica* rosea, *Tecomaria capensis, Callistemon lanceolatus, Plumbago capensis, Juniperus chinesis* Armstrong, *Berberis mentorensis, Berberis sargentiana, Deutzia gracilis, Ilex opaca* East Palatka, *Lonicera maxiomiczi* sachalinensis, *Lonicera syringatha* and *Pyracantha crenata* serrata-graberi.

Fifty individuals were included in each treatment.



CHRYSANTHEMUM

Variety Delaware. Rooted cuttings planted one per pot 5/31/57, pinched 6/14/57, photographed 9/23/57. Grown in mixture of 1/2 peat moss, 1/2 perlite. From left to right—4-inch azalea pot; 5-inch azalea pot, 6-inch azalea pot—showing effect of container size on plant development and flowering.

TABLE 1. COMPOSITION OF GROWING MEDIA, 1957 TRIALS, PARTS BY VOLUME

Number of mixture	Perlite	Sphagnum peat moss	Miller clay	1/8 to 1/4-inch charcoal
1	2	1	1	
2	1		1	
3	1	1	1	
4		2	2	1

Types and Sizes of Containers

Clay and plastic azalea pots in 3½, 4, 5 and 6-inch sizes were used for the greenhouse crops to determine the effect of these pots on plant development and a comparison of growth quality in containers of various sizes.

Nursery stock trials were grown in metal Plantainers, 6 and 7-inch standard plastic pots and 1-gallon plastic growing containers.

Description of Planting Stock

Well-rooted cuttings were used for all greenhouse crops and records were taken when individual crops were mature.

Well-rooted single lead liners planted in 2¼-inch pots, which were not pot bound, were used for nursery stock trials. All such trials were planted May 1, pruned to 6 inches in height on June 10 and sheared again to 6 inches in height on August 5.

Growing Mixtures

The growing mixtures used during 1957 are shown in Table 1. Mixtures used in 1958-59 are shown in Table 2.

Several graded sizes of expanded perlite were used in these trials to determine whether specially graded aggregate sizes would produce significant differences in plant growth. The horticultural perlite grade used was a mixture of number 6, 8, 16 and 30 aggregate sizes.

Three mixtures of fertilizer materials were used as basic ingredients and were incorporated with the potting mixtures at the time of potting.

For short-term greenhouse crops, the following ingredients were added to each cubic yard of all mixtures containing soil because of the alkaline reaction of the soil used:

2½ pounds treble superphosphate (45% P_2O_5)
3 pounds gypsum
5 pounds complete fertilizer (5-10-5)

For plots containing only peat moss and perlite, the following materials were used per cubic yard of mixture because of the highly acid reaction of the medium:

2½ pounds treble superphosphate (45% P_2O_5)
6 pounds finely ground dolomitic limestone
5 pounds complete fertilizer (5-10-5)

For longer-term nursery stock grown in mixtures containing soil, the following basic ingredients were used per cubic yard of mixture:

½ pound fritted potash (35% K_2O)
1 pound urea-formaldehyde nitrogen (38% N)
1 pound treble superphosphate (45% P_2O_5)
5 pounds gypsum

For nursery stock grown in mixtures containing only peat moss and perlite, the following basic ingredients were used per cubic yard of mixture:

½ pound fritted potash (35% K_2O)
1 pound urea-formaldehyde nitrogen (38% N)
1 pound treble superphosphate (45% P_2O_5)
6 pounds finely ground dolomitic limestone

All treatments were then placed on a regular feeding program in which a soluble complete fertilizer with a 1-2-1 ratio was applied at the rate of 1 ounce to 2 gallons of water. Chelated iron was added to the mixture every fifth application at the rate of 1 ounce to 25 gallons of water. The fertilizer was applied every 10 days.

Based on data obtained during 1957-58, these fertilizer practices were changed in 1959 as follows:

All crops were fertilized with a soluble complete fertilizer having a 1-2-1 ratio at the rate of 1 ounce to 5 gallons of water each time the crop was watered.

This practice was followed throughout the life of the crops. The plants were leached with plain water about every fifth watering to avoid any build-up of total soluble salts.

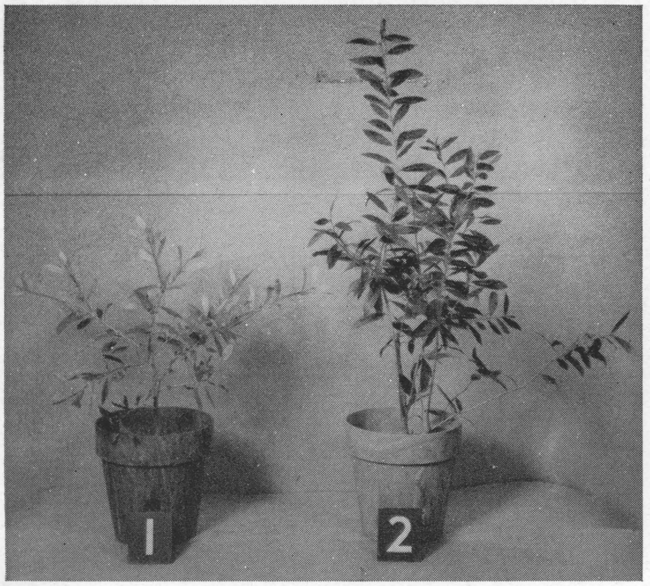
TABLE 2. COMPOSITION OF GROWING MEDIA, 1958-59 TRIALS, PARTS BY VOLUME

Number of mixture	Miller clay	Sphagnum peat moss	Horticultural perlite	No. 8 perlite	No. 6 perlite	No. 16 perlite
1		1	1			
2	1	1	1			
3	2		3			
4		1			1	
5	1	1			1	
6	2				3	
7		1		1		
8	1	1		1		
9	2			3		
10		1				1
11	1	1				1
12		2				3
Control	1	1				

ILEX VOMITORIA
Liners planted 4/1/59, pruned 6/15/59 and 8/1/59, photographed 2/1/60. No. 1 grown in 1/2 peat moss, 1/2 perlite. No. 2 grown in 1/3 peat moss, 1/3 perlite, 1/3 Miller clay. Note compact uniform root system on No. 1.

RESULTS

Statistical analysis of the data, based on an increase in fresh dry weight and on measurements of the increase in terminal growth, spread and number of breaks per plant at the time of maturity for greenhouse crops and at the end of 6-months and 1-year growing periods for nursery stock in containers, indicated that all plants grown in the mixtures containing peat moss and perlite were of higher quality and larger than those grown in all other mixtures.



CALLISTEMON LANCEOLATUS
Liners potted 5/1/58, pruned 6/10/58, photographed 8/1/58. No. 1 planted in 1/2 Miller clay, 1/2 peat moss. No. 2 planted in 1/2 perlite, 1/2 peat moss.

The 1957 trials showed a deficiency of magnesium in the synthetic mixtures, but this was corrected in later trials by increasing the amounts of dolomite in the basic mixtures. There was a greater gain in soluble salt accumulation in the mixtures containing soil, which in some cases reached the danger range. There was no evidence of soluble salt accumulation in the peat moss and perlite mixtures. The most favorable range of soil reaction for most crops grown (pH 6.5) was maintained consistently in the peat moss and perlite mixtures, while those containing soil tended to increase in alkalinity.

There were no significant differences in the rate of growth or quality among the various graded aggregates of perlite, but those having the higher percentage of the finer aggregates produced the least consistent results.

Plants grown in the peat moss and perlite mixtures produced a heavier and more abundant root system than those grown in the other media, and less root loss was experienced from overwatering and underwatering during the trials.

All plants grown in non-porous containers, especially those of plastic, produced a more uniform and denser root system than those grown in porous clay pots. All the plants in non-porous containers withstood periods of drouth and overwatering much better than those in porous containers and recovered from checks in growth resulting from extremes in moisture stress more rapidly.

Plants from these trials transplanted to outdoor areas in other soil types were established faster and better when grown in peat moss and perlite than when grown in the other mixtures.

The mixtures containing equal parts of peat moss and perlite did not shrink away from the sides of the containers, and showed little or no compaction due to routine growing practices. Both of these undesirable effects were noted with all other mixtures.

The general health, color and size of the plants in the peat moss and perlite mixture were superior to all other treatments throughout these trials.

Nursery stock produced under the lath shade was significantly better and larger than that grown in full sun or on the asphalt slab. This may be due principally to the high light intensity, high temperatures and low humidities which prevail in this area of Texas.

DISCUSSION

Potted plants make up approximately 75 percent of the total florist crop production in Texas.

The production of nursery stock in containers combines the care required for greenhouse-potted plants with most of the considerations required for growing nursery stock under field conditions. This method of producing nursery stock has expanded rapidly in Texas during recent years.

The production of nursery stock in containers has advantages over field production which far outweigh the disadvantages.

Many more plants can be grown on a given area in containers than in the field. When many plants can be concentrated in a small area, it is more economical to produce them.

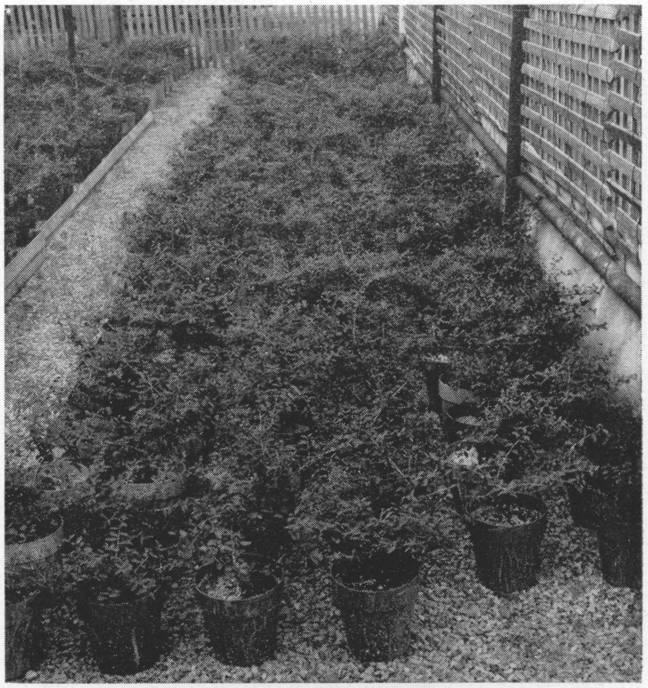
Container production of nursery stock provides the grower with better control of environmental factors, such as light, soil, fertilization and irrigation, than is possible in field production, and he can extend his selling season, reduce his harvesting and over-all production costs and produce a better crop in less time. The development of automation in his operations also is more feasible and practical.

The greatest single drawback to increased efficiency and improved quality for growers of both greenhouse-potted plants and container-grown nursery stock is the lack of standardization. This need for standardization is, perhaps, greater in growing media than in any other phase of operation.

Nearly all kinds of plants can be grown successfully in the same growing medium or in slight modifications of it.

The principal advantage of the use of a standardized growing medium is the exact control that the grower can maintain in the production of his crops. He can then supply nutrients in the exact amount when they are needed with the result that he can always expect a top quality crop.

Much work has been done with soil mixtures and composts for container-grown plants in various experiment stations in several areas of the country. In some instances, the results announced have been misleading because the recommended soil mixtures and fertilizing requirements were for a certain type of soil or sand and the same treatments applied to other soils and sands did not always produce equally satisfactory results.



ILEX VOMITORIA, DWARF
Liners planted 4/1/59 pruned 6/15/59 and 8/1/59, photographed 2/1/60. Grown in 7-inch plastic pots in a mixture of 1/2 peat moss, 1/2 perlite.

A standardized growing medium composed of materials available in the same consistency and in the same uniformity in all areas eliminates such variations.

Initial costs may be somewhat higher when a grower first changes to the use of a standardized mixture of peat moss and perlite in large quantities, Table 3.

When consideration is given to the cost of composting or building up soil, sterilizing it, handling it and in may cases purchasing it, the cost factor in most instances may be considerably less over a period of time. The assurance of consistently better crops with less labor in producing them makes the cost differential negligible.

TABLE 3. COMPARATIVE COST OF MATERIALS PER CUBIC YARD OF POTTING MIXTURES

Mixtures	Sphagnum peat moss	Horticultural perlite	Miller clay	Sand	Basic fertilizer	Mixing and sterilizing	Total cost
1 part peat 1 part perlite	13.5 cu. ft. $3.50	13.5 cu. ft. $5.50			20¢	21¢	$9.41
1 part peat 1 part sand	13.5 cu. ft. $3.50			13.5 cu. ft. $2.25	20¢	46¢	$6.61
1 part peat 1 part sand 1 part Miller clay	9 cu. ft. $2.35		9 cu. ft. $1.50	9 cu. ft. $1.50	20¢	61¢	$6.16
1 part peat 1 part Miller clay	13.5 cu. ft. $3.50		13.5 cu. ft. $2.25		20¢	46¢	$6.41
1 part peat 1 part Miller clay 1 part perlite	9 cu. ft. $2.35	9 cu. ft. $3.60	9 cu. ft. $1.50		20¢	61¢	$8.26

Many disease problems are reduced or eliminated when a standardized mixture is used, provided other good sanitation is maintained.

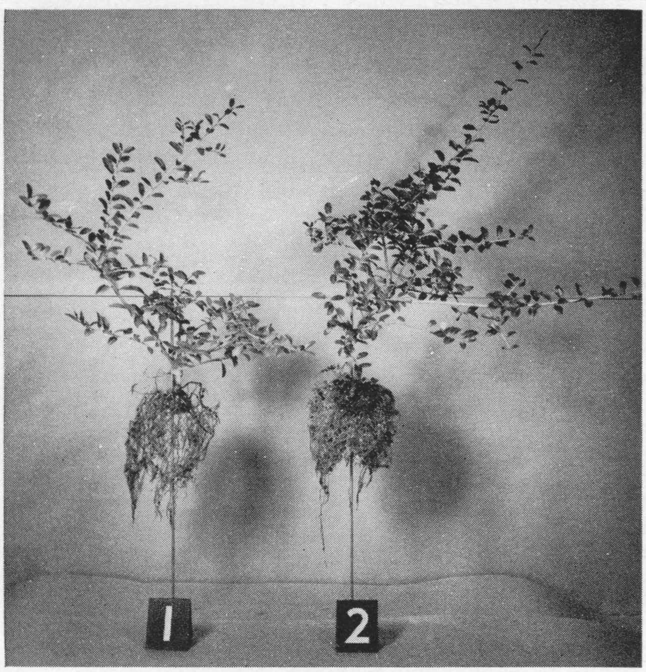
Evenness, reliability and a higher percentage of top-quality salable crops are the principal advantage of a standardized growing medium.

In many plant production areas of Texas today, it is almost a matter of necessity to adopt some standardized growing medium to produce consistently high quality, profitable crops because of the poor quality of the soil available, the salinity of the water which must be used and the difficulty involved in obtaining help with the skill necessary to produce high quality plants in containers, when variable soil composts are used.

The greatest essential need in any growing medium for containers is good drainage or aeration. This is much more vital than fertility. The addition of the necessary nutrients for good plant growth is easy, but adjusting the physical structure of variable soil mixtures for plants grown in containers to achieve suitable drainage or aeration often has proved exceedingly difficult.

In growing plants in containers, the goals are a good structural mass which will retain a good growing environment when the plants are transplanted, and a healthy root structure that will insure best results for the consumer.

The medium should maintain its original position in the containers and should not pull away from the sides as the moisture content decreases. When a growing mixture shrinks, it indicates a compaction which blocks the penetration of water and air through the mixture to the roots of the plants. When gaps are formed between the mixture and the container, much of the water merely runs through this crevice to the bottom of the container and is of no benefit to the plant.



ILEX VOMITORIA
Liners planted 4/1/59, pruned 6/15/59, photographed 8/1/59. No. 1 grown in 1/3 peat moss, 1/3 perlite, 1/3 Miller clay. No. 2 grown in 1/2 peat moss, 1/2 perlite. Note volume, density and number of roots produced on plant No. 2.

When such shrinkage and compaction occurs, greater losses after transplanting can be expected because it is difficult to maintain the same moisture stress in the medium around the plant and in the surrounding soil.

The physical ingredients in any standardized growing mixture must possess certain characteristics. In addition to providing good aeration and drainage and resisting shrinkage and compaction, they must be available readily in uniform grades and at a reasonable cost. Under Texas conditions, both perlite and sphagnum peat moss are available readily in uniform grades, and, when transportation costs of other suitable materials are considered, they are available at reasonable cost. When soil is used as a component of a growing medium, composting and hauling increase the basic costs. In general, the ease of handling and mixing peat moss and perlite reduces the usual soil handling costs considerably.

These materials also are reasonably uniform in soluble and potentially soluble chemical constituents.

Unlike various types of soil used in growing composts in which fertility levels often are high or in many cases unknown, peat moss and perlite are known to be low in fertility, which makes it simple and inexpensive for the grower to add fertilizers to bring a mixture of the two up to the desired fertility level for the crop he wishes to grow.

The light weight of these materials makes them highly desirable as ingredients for a standardized growing mixture for Texas growers since current marketing and shipping practices make it necessary to keep the weight of the plants handled as low as possible.

Since the peat moss used in this mixture is highly acid and most of the crops grown require only a slightly acid soil, some amendment must be used to reduce the acidity of the mixture. The best material for this purpose in finely ground limestone or dolomite. This provides the magnesium and calcium needed in this mixture as well as the neutralizing action obtained.

For crops requiring an acid soil or in areas where only alkaline water is available, calcium sulphate or gypsum, and magnesium sulphate can be added in the preparation of the basic growing mixture in place of the dolomitic limestone.

NURSERY AND GREENHOUSE APPLICATION

Properties of Growing Mixtures

The value of a standardized growing mixture has been developed adequately by these trials. The mixture of peat moss and perlite in equal proportions by volume uses materials which are easily identified, have uniform characteristics, are widely available, are easily handled mechanically and are free from toxicity even after steaming, and the mixture is extremely light in weight.

When properly prepared, it is easily leached and does not water-log readily because of improper watering practices.

The inherent fertility of this mixture is consistently the same, it always is very low, and is not highly retentive of nutrient materials that may be supplied in growing operations. Adequate amounts of nutrients must be supplied before and after the crop is planted. Not maintaining adequate fertility levels is a principal reason for failure with most standardized growing mixtures which do not contain soil.

Fertility Practices and Procedures

Both the peat moss and perlite must be wetted thoroughly before they are incorporated into a well-mixed uniform mass.

Several hundred species and varieties of nursery and greenhouse crops are now grown commercially in containers, and any discussion of the fertilizer requirements of these crops must be general in nature.

Much previous work on mineral nutrition of plants, however, has stressed the similarity of the response of most nursery and florist crops to certain fertility programs.

In the development of fertility programs for the commercial production of container-grown plants, careful consideration should be given to the characteristics of the fertilizing materials to be used, to the properties of the growing mixture, to the characteristics of the crop being grown and to the irrigation or watering practices to be followed.

All of these factors must be coordinated into a definite fertilization schedule regardless of the growing mixtures used, and the grower should maintain sufficient fertility levels to produce the optimum vegetative growth rate for the crop grown.

In trials with this standardized growing mixture, it has been assumed that the maintenance of high fertility levels are desirable and necessary.

There are 13 elements which plants normally derive from the soil to produce good plant growth. Six of these elements are required in relatively large quantities and the remaining seven usually are required in very small amounts.

While deficiencies and excesses of some of the elements required in small quantities sometimes occur in some areas, it is recommended in the management of this growing mixture that the grower not concern himself with the addition of these materials unless there is good reason to believe that a definite disorder due to the presence or absence of these materials actually exists. Such materials should not be applied until good advice in the diagnosing and treatment of the disorder has been obtained. Indiscriminate use of minor elements in a fertility program may create problems rather than solve them.

The development of a suitable fertility program for a standardized growing mixture will require some consideration of the quality of the water used for irrigation or watering practices.

In most cases, the water used for irrigation will contain enough calcium, magnesium and sulphate to meet the needs of the plants. However, a commercial grower should have an analysis made of the water he uses to determine the amounts of these three materials present, and to assist him in evaluating his other management practices which relate to the amounts and availability of the nutrients present in his growing medium, in the water supply and as they pertain to salinity problems in general.

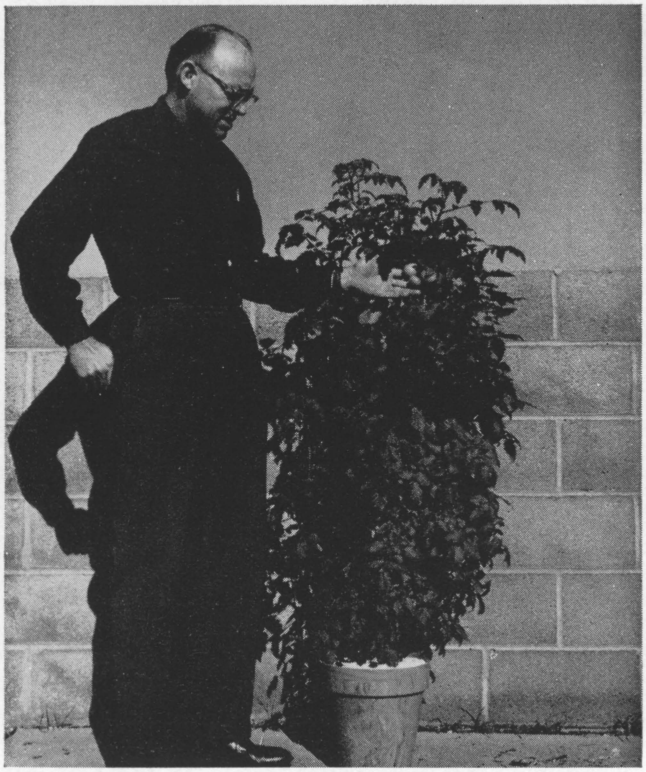
When the water used for growing operations contains 40 to 50 parts per million (ppm) of calcium, 15 to 20 ppm of magnesium and about 50 ppm of sulphate, the grower can be reasonably sure that these three materials are supplied adequately for good plant growth by his water supply.

When these three materials are not supplied in sufficient quantities by the water used, provision should be made to supply them in the fertility program.

The other three elements required in large amounts by plants are nitrogen, phosphorus and potassium.

When nitrogen is present in forms that are available readily to plants, it is subject to rapid leaching. This is especially true in this standardized mixture. Potassium also is subject to rapid leaching in this mixture. In standardized mixtures which use sand rather than perlite as a constituent, some sands are capable of supplying substantial quantities of potassium. This is not true of this mixture and potassium will have to be supplied frequently.

Phosphorus is precipitated and does not leach readily even in mixtures such as this. For this reason, phosphorus can be incorporated in the mixture at the time it is prepared, and can be added at intervals when necessary to maintain an adequate supply for optimum plant growth. When the grower starts with



TOMATO
Variety Waltham. Grown in a 10-inch pot of ½ peat moss, ½ perlite. Seedling planted 8/15/59, photographed 2/4/60. This plant produced 10 pounds of ripe tomatoes during this period.

a low fertility mixture such as this, the fertility must be built up before planting and then retained with liquid fertilizers, or the nutrient levels in the mixture will never catch up with the plant's needs and optimum quality cannot be produced.

A regularly scheduled fertility program should be developed for liquid and dry applications of fertilizers. In the production of some nursery crops, combinations of the two methods of application may be convenient and also may offer certain advantages.

TABLE 4. SOME SLOWLY SOLUBLE FERTILIZER MATERIALS AND RATES OF APPLICATION TO THE STANDARDIZED MIXTURE

Fertilizer		Pounds per cubic yard
Nitrogen		
Urea-formaldehyde	(38%N)	2.5
Blood meal	(13%N)	1
Fish meal	(11%N)	1
Hoof and horn meal	(13%N)	2
Castor pumice	(6%N)	2.5
Phosphorus		
Superphosphate	(20% P_2O_5)	3.5
Treble superphosphate	(45% P_2O_5)	1.5
Potassium		
Fritted potash		0.5
Magnesium and calcium		
Dolomitic limestone		6
Calcium and sulphate		
Gypsum		3

The application of fertilizers in liquid form is less costly and more convenient, rapid and sure for most commercial growers.

When a standardized growing mixture is used and liquid fertilization is followed, care should be taken to prevent the plants from showing signs of nutrient deficiency after they move from the grower to the retailer and into the hands of the consumer.

In this standardized mixture, essentially all the nitrogen and a considerable amount of the potassium reserves may be lost in the first few waterings they receive after they leave the hands of the grower.

For growers who use liquid feeding methods entirely, and especially those who follow the practice of feeding with every watering, it should be standard practice to add an insoluble source of nitrogen such as urea-formaldehyde at monthly intervals about 1 or 2 months before the plants are sold. This is especially true of container-grown nursery stock which moves less rapidly than florist crops through conventional marketing channels.

Liquid fertilization methods are recommended for large scale commercial operations. Smaller growers, or those who do not have equipment to apply nutrient materials in liquid form, should consider the use of fertilizer materials that do not leach readily. Some of the materials having these characteristics are listed in Table 4.

A complete fertilizer composed principally of the materials listed in Table 4 with an analysis of approximately 5-10-5 should be incorporated in the mixture at planting time to insure a substantial margin of safety and to supply the crop with enough of the needed elements to eliminate starvation symptoms. However, to provide some readily available nitrogen, about 20 percent of the total nitrogen in the mixture should be from soluble carriers.

In the development of an over-all fertilization program, careful consideration should be given to all of the following factors:

Properties of the growing mixture. This standardized mixture of coarse peat moss and perlite offers many advantages, but it has a low retentive capacity for most of the plant nutrients and adequate fertility must be provided before and after planting.

Characteristics of the fertilizers applied. In this medium, available forms of nitrogen and potassium will be leached out readily. Phosphorus will be retained almost in its entirety. While adequate calcium, magnesium and sulphate may be present in the water used to supply the needs of the crop, this should be determined previously, and if they are not available in sufficient quantities, they should be included in the fertility program.

Characteristics of the type or species of crop grown. While this factor must be considered in special cases, in general, it is desirable to provide suitable fertility levels to maintain optimum vegetative growth.

Method of watering and the amount and frequency of water applied. This factor also will influence the fertility requirements of the crop. The greater the amount of water used and the more often it is applied, the greater will be the loss of nutrients due to leaching.

The prime consideration of a successful fertility program is to place all fertilizer operations on a definite schedule.

In these trials, the practice of feeding with every watering gave excellent results when approximately 1 pound of a complete soluble fertilizer with a ratio of 1-2-1 was applied in each 100 gallons of water used, and the plants were watered every fifth application with clear water (no fertilizer added) to prevent the build-up of soluble salts.

When sufficient phosphorus, calcium and magnesium are added to the mixture at the time of potting, a mixture of 10 ounces of calcium nitrate and 4 ounces of potassium nitrate in 100 gallons of water can be used rather than the complete mixture.

Preparation of the Mixture

Be sure both the peat moss and perlite are wetted thoroughly prior to mixing. Incorporate 5 pounds of 20 percent superphosphate, 6 pounds of dolomitic limestone and 5 pounds of a complete 5-10-5 fertilizer compounded of slowly soluble materials with each cubic yard of this mixture. Mix the ingredients until it is certain that a uniform mixture is obtained. If the mixture is to be stored longer than 7 days, do not add the complete fertilizer until the mixture is to be used. The other ingredients can be added and this mixture stored for indefinite periods.

Pot plants in containers in accordance with established practices followed in production operations, but do not firm plants in as tightly as is the practice for growing mixtures containing soil.

Water plants in well with clear water so that the growing mixture is wetted thoroughly. Start the fertility program when the crop requires the second watering, then begin a scheduled liquid feeding program.

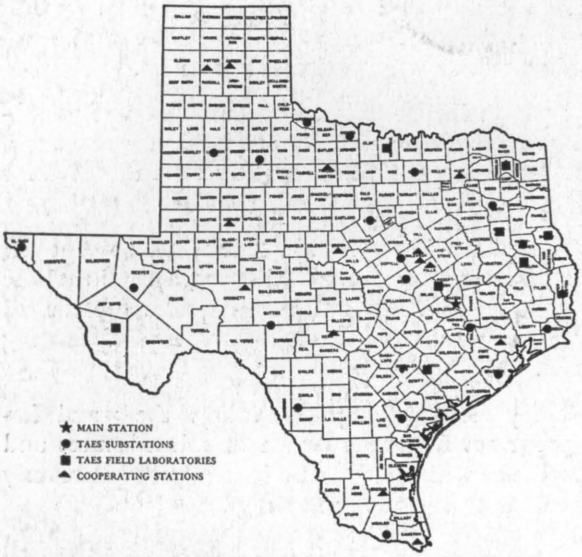
For dry feeding programs, follow the usual fertility programs for crops grown in soil mixtures and in accordance with the specific information previously outlined for this growing medium.

The optimum growth of many crops also depends on aeration in relation to the type of root system produced, the nutrient supply required in specific cases and other factors inherent in the type and size of container, in the medium and in the environment.

Additional trials are planned to investigate further some of these other factors with a much wider range of plant materials.

ACKNOWLEDGMENTS

Financial assistance from the Perlite Institute, New York, N. Y., supplies of perlite from the Texas Lightweight Products Company, Irving, Texas, charcoal from the Alamo Fuel Company, San Antonio, Texas, and assistance in the preliminary stages of these trials by Ernest R. Jensen are acknowledged.



Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

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The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of the parts of the A&M College of Texas.

ORGANIZATION

IN THE MAIN STATION, with headquarters at College Station, are 16 subject-matter departments, 2 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 21 substations and 9 field laboratories. In addition, there are 14 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

OPERATION

THE TEXAS STATION is conducting about 400 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

- Conservation and improvement of soil
- Conservation and use of water
- Grasses and legumes
- Grain crops
- Cotton and other fiber crops
- Vegetable crops
- Citrus and other subtropical fruits
- Fruits and nuts
- Oil seed crops
- Ornamental plants
- Brush and weeds
- Insects
- Beef cattle
- Dairy cattle
- Sheep and goats
- Swine
- Chickens and turkeys
- Animal diseases and parasites
- Fish and game
- Farm and ranch engineering
- Farm and ranch business
- Marketing agricultural products
- Rural home economics
- Rural agricultural economics
- Plant diseases

Two additional programs are maintenance and upkeep, and central services.

Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service

AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.

Today's Research Is Tomorrow's Progress