cellent tool for research to produce information in standard and specific detail. Such findings could be applied directly to practical growing since duplication of soil mix properties is entirely feasable.

The final consideration is that of fertilizing the growing plants. Experience to date indicates that nitrogen is the element most rapidly lost. Potassium is next and phosphate is least rapidly reduced. Fertilizer formulae which seem best suited to the system generally follow a nitrogen, phosphate, potash ratio of about 3—1—2. Both liquid and dry materials are currently being used. A detailed discussion of this phase seems unwarranted here as the variations due to conditions of growing and materials in use are too numerous. Frequent, light feeding is desirable.

This is not the only system of soil mix preparation and handling which can be used to produce quality plants and such is not meant to be inferred. However, it is one of the few systems which offers simplicity and reliability. It is the result of careful consideration of basic scientific principles coupled with practical trial in the field. The take home lesson is not the example formulation, but, rather, the principles upon which it is based. Finally, it offers features which lend it to use in assembly line type production.

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MODERATOR MATKIN: Our roundtable this morning is to encompass, in addition to this discussion about West Coast production, other parts of the country. You will find that much of the fundamental information that we enjoy in learning how to grow comes from our universities. The universities are doing basic things that we, as growers, are unable to do.

We have with us a gentleman from Ohio State University, Mr. Phillip Barker, who will discuss the research that they are doing on container production at that institution.

Mr. Barker presented his paper entitled "The Production of Nursery Stock in Containers." (Applause)

THE PRODUCTION OF NURSERY STOCK IN CONTAINERS

PHILIP A. BARKER
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The production of nursery stock in metal containers was begun at Ohio State University in 1953. The project was expanded in 1954 to include a total of 1500 plans of 17 different species and varieties. During the winter of 1954-55 protection tests were conducted with these plants and those that survived, with 3000 additional plants, were included in the 1955 study. Since its beginning the project has been primarily one of determining the adaptability of various ornamental plants to production in containers under Ohio climatic conditions. It is proposed that these plants will be used further in a marketing study to determine customer acceptance of container nursery stock.

CONTAINERS USED

The nursery stock was canned in either green painted "Plantainers" or "Nursericans" or asphalt coated salvaged frozen food cans. These containers have a total volume respectively of .76, 1.43, and 3.80 gallons. The Nursericans has been the least satisfactory since it rusted out near the soil line, frequently before the end of the first growing season. Also no advantage has been seen for the removable bottom of the Nurserican, so styled for easy removal of the plant and soil ball. Rusting eliminates the advantage of this feature soon after the plants are placed in the containers. The Plantainer, with its corrugated sides, has been very durable even through the second growing season. With the sides tapered inward towards the bottom, the plant and soil ball can be readily knocked out of either the Plantainer or the Nurserican.

The frozen food cans or "egg cans," collected localy, punched with 4 to 6 side drainage holes, were dipped in RC-1 asphalt, a commercial nomenclature for rapid cure asphalt cutback. This asphalt dried sufficiently to permit canning within one week after the cans had been dipped. So treated, these containers have resisted rusting and have been in service for three years and still show no detrimental effects. Because of the straight sides, it is necessary to cut the sides of this container to free the soil ball when planting..

SOIL MIXTURE AND CANNING PROCEDURES

The plants have generally been canned in a "standard" soil mixture which is based on the results of a series of tests. This consists of equal parts by volume of silt loam soil, bank sand, and German peat moss. It is conceivable that the soil mixture might be varied to some extent depending upon the plant type, soil weight limit, or soil drainage. Tests were made in 1954 in which pea gravel was placed ½ inch deep in the bottom of the container over which was placed the plant and the standard soil mixture or a "special" soil mixture consisting of equal parts by volume of hadite, silt loam soil, bank sand, and German peat. This special soil mixture was also used without the pea gravel. With none of these soil variations was there any indication of significantly improved soil drainage or plant development compared with the standard soil mixture. In 1955 all the plants were canned with the standard soil mixture. In all cases the soil was steam sterilized after which it, together with the sand, and the water saturated peat was passed through a Royer shredder. This provided fast and effecient mixing.

Canning was done manually from a bench. At the time of canning, slight to severe root pruning was done depending upon the compactness and size of the root system. With 7 to 8 foot 1 year-old whips of Moraine Locust, it was necessary to prune off as much as two-thirds of the root system in order to get them in the 3.80 gallon food containers. Top pruning ranged from none on the Moraine Locust to cutting back one-year old plants of *Forsythia intermedia spectabilis* to an average height of 6.3 inches.

GROWING AREAS

Before setting the container nursery stock in the growing areas, the ground base was treated with a soil sterilant for the prevention of weeds. Vapam 4-S, a soil sterilant solution of sodium N-methyl dithiocarbamate,

applied to the soil surface at 1 quart per 100 sq. ft. and watered in thoroughly has provided good weed control for at least one growing season.

Following application of the Vapam 4-S, the area was divided into 4 plots, (1) a soil check plot, (2) soil covered with 8 inches of wood shavings, (3) soil covered with 3 inches of sand, and (4) soil covered with 1½ inches of pea size crushed limestone. An equal number of each plant type was placed in each plot, arranged in beds 10 feet wide but split by an 18 inch work isle through the center. Walks, 42 inches wide, were provided between the plant beds.

The spacing of the plants in the growing beds is a controversial subject. Plants in the tests at Ohio State University were spaced initially so that optimum sunlight and air circulation might be equally available to every plant throughout the growing season. In this manner all the soil balls, regardless of the location of the plants in the bed or the surface type plots on which they were located, tended to dry out fairly evenly. But shifting and relocation of some of the plant types was necessary as the season advanced due to the ultimate growth of some of the plant types.

Where located on either the sand or wood shavings surface type plots, the plants developed heavy root systems outside the drainage holes. These roots were a hinderance when relocating the plants and certainly are unsightly when selling the plant. Growth measurements indicated no better plant development on these two surface type plots as elsewhere. Consequently the disadvantages of roots growing out the drainage holes seem to far surpass any possible advantage.

Drainage of excess water away from the plants was poorest in the soil surface area. Another disadvantage of setting the plants directly onto soil seems to be that of soil clods collecting on the bottom of the containers, and also the clogging of the drainage holes. The former condition results in uneven setting of the container, either when displaying the plant in the sales area, transporting it, or when shifting to another location. From these tests it appeared that, from the standpoint of best growing conditions, including drainage and general area neatness, crushed limestone was the best.

WATERING AND FERTILIZING

All the plants were hand watered with the use of a watering hose equipped with a wand type aerator so that splashing could be reduced, except for one small growing area which was generally watered with a revolving sprinkler. Plant development appeared to be slightly poorer in the area that had been watered with the sprinkler. Also it was particularly difficult to determine just when enough water had been applied. With hand watering, the exact amount of water could be applied daily by filling the container to the top. This would generally be enough water to provide for some leaching action to carry away the excess salts that accumulated from the frequent fertilizer applications.

The hand watering system, with a Hozon attached, was also useful for fertilizing the plants. Through the Hozon was siphoned a soluble fertilizer concentrate which, when mixed with the water in the hose, could be applied to the plants at any predetermined rate. During the 1955 growing season, four applications of 20-20-20 soluble fertilizer were

made followed by a fifth application contained only nitrogen and potassium. The sixth and final application contained only soluble nitrogen. Fertilizer was applied at 3 to 4 week intervals. This fertilizer program differed somewhat from that used in 1954 when soluble forms of nitrogen was applied every two weeks, potassium every two or three weeks and phosphorus three to five times during the growing season. Soil tests were made previous to each application to assess the nutrient requirements.

PRUNING AND GROWTH MEASUREMENTS

During 1954 all the plants were pruned by frequently pinching out the shoot tips with the result that very compact plans were obtained. In 1955 a series of moderate pinchings were made on the more vigorously growing plant types and one or two prunings on the trees and larger shrubs primarily for the purpose of shaping.

In the table below is listed some of the plant types grown and the growth measurements for each. It is of interest to note that the sweetgums, canned in the spring of 1954, grew less that year than in 1953 and in 1955 they grew nearly as much as during the previous three years combined.

PLANT TYPE	GROWTH IN HEIGHT (INCHES)						
	Up to and including 1954	During 1955	Percentage gain in 1955	Percentage of total growth in: '52	'53	'54	'55
Liquidambar styraciflue	33.0	28.5	86.2	13.2	23.6	16.2	47.0
Forsythia intermedia spectabilis	6.3*	15.6	245 4				
Ilex crenata rotundifolia	9.1	7.7	85.5				
Red Leaf Peach	54.6*	24.7	45.3				
Malus purpurea, Eley	41.7	37.3	90.1				
Gleditsia triacanthos inermis, Moraine	99.1	4.7	5.7				

* Plant tops were pruned back when planted to the heighth indicated.

** Growth of these trees was greatest in branch spread.

WINTER PROTECTION TESTS

One of the important factors in the production of nursery stock in containers in Ohio is the determination of the winter hardiness of such plants. The data recorded on the 1954-55 winter protection tests indicate that some plant types might survive the winters with little or no protection. These were: *Juniperus chinensis Armstrong; Juniperus chinensis Hetz; Kerria japonica; Ligustrum obtusifolium Vicary; Lonicera japonica chinensis; and Taxus cuspidata.* The other less hardy plant types, which would seem to need some type of protection, depending to some extent upon what was desired of the plant the following spring, include: *Abelia grandiflora; Berberis thunbergi atropurpurea; Cornus florida; Deutzia gracilis; Forsythia intermedia spectabilis; Liquidambar styraciflue; Mahonia aquifolium; Pyracantha coccinea lalandi; Syringa vulgaris;* and *Thuja orientalis aurea nana.* Only where Pyracantha was mulched up to the top of the container did it flower and fruit heavily this past

spring and fall. On the other hand, flowering was heavy on Deutzia only where the tops were protected by wall of baled straw.

Similar protection tests have been set up for the winter of 1955-56. Here the plants have been set tightly together into five 4-foot wide beds as was done the previous winter. One of these beds has been left unprotected for the check, while the others have been protected with one of the following: *mulch around and up to the top of the container*, baled straw wall around all sides, lath snow fence around all sides, and roofing paper spread over lath snow fence around all sides.

With these three years of growing ornamental trees and shrubs experimentally in containers, there seems little doubt but that this is an entirely feasible method of producing nursery stock in Ohio.

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MODERATOR MATKIN: Thank you, Mr. Barker. It occurs to me that possibly the reason you think these Plaintainers are too small is because you have five-gallon-sized plants in them. Perhaps in the West we move them earlier than you do. We will postpone questions and discussion of the various papers until the end of the session.

Next on the program is a discussion of a typical operation in that great State of Texas. We have with us from Verhalen Nursery Company of Scottsville, Texas, Mr. John Roller.

Mr. Roller presented his paper entitled "Container-Grown Trees in Texas." (Applause)

CONTAINER-GROWN TREES IN TEXAS

JOHN B. ROLLER
Verhalen Nursery Company
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Container-grown trees in Texas are a fairly important subject. In the beginning, may I be permitted just a little missionary work. Container-grown plants and container-grown trees, just like the State of Texas, are with us whether you like it or not. At least, I am firmly convinced they are both here to stay.

There has been a great increase in population and a very great building boom in the Southwest as in all other parts of the country. As a result, there is an excellent market for plants and trees of all types. In some of our cities you can see from one place one or even two thousand homes that are under construction or have just been completed.

As each home is completed, the home owner wants to plant the garden and it makes no difference if he gets there in June, July, or August. With container-grown material he can immediately plant trees and shrubs and they live.

At Verhalen's Nursery, our program for this year called for about 20,000 shade trees in containers. They are not the best types of trees, but consist primarily of chinese elm, sycamore, poplar, Arizona ash and quite