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J. P. Overcash examines 'Cape Fear' pecan trees in 3-gallon containers. The trees have three-year-old roots and two-year old tops.

Research With Pecan Nursery Trees in Containers and Orchards

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Summary

A number of nurseries now are producing container-grown, grafted pecan trees for commercial orchards and home landscapes. Success with this technique requires careful attention to the details of cultural procedures, some of which are as follow:

(1) Seed source should be selected carefully. Large, heavy nuts generally germinate well and produce larger seedlings than do those from poorly filled, small nuts (5). Nuts from one cultivar are better than nuts from randomly selected seedlings or cultivars.

(2) Seed should be stratified to encourage prompt and uniform germination. Store seed with moist peat moss at about 40°*F* for six weeks or longer before planting.

(3) Germinating seedlings often are disturbed (eaten) by pests such as rats, squirrels and various bird species. It is sometimes necessary to protect seedlings from these pests by covering them temporarily until they are well established. This can be done by covering them with a fine wire screen or loose mesh shade cloth or by germinating them in a greenhouse or wire cage. In research, three seed often are planted per container to assure one strong seedling. However, many seed can be germinated in containers or in a bed with a cage covered with a screen cloth. Strong seedlings are selected shortly after germination for transplanting, one per container, in the growing area. This is the most efficient use of seed.

(4) Several types of containers are available, but the 3-gallon black plastic nursery container is used most often. It holds enough potting mixture to permit supplemental addition of nutrients to grow large trees over a period of two to three years (2,3). Seedlings grown in the 10 x 20-inch nursery container have a larger root volume at transplanting time and may produce more tree growth when transplanted to the orchard.

(5) The Bostian-Overcash (3) potting mixture generally has been satisfactory for growing pecan nursery trees in container research. The mixture is about 50% pine bark ⅛- to ⅞-inch diameter, 38% mason sand and 12% fumigated soil (with weed-insect-disease control). The pH of the potting mixture must be adjusted to the proper range (6.0-6.5) if optimum plant growth is to be attained. Dolomitic lime (Ca & Mg) often is used. The pH should be checked at the end of each year and adjusted if needed. After three growing seasons the potting mixture still will support trees up to 4-7 ft tall. Other potting mixtures also may be fully satisfactory.

(6) Mineral nutrients must be supplied. "Slow release" minerals (N-P-K) plus other elements often are blended with the potting mixture at planting time. Small quantities of boron, calcium, copper, iron, magnesium, manganese, molybdenum, sulphur and zinc also must be supplied to the potting mixture, as dry supplements before blending or as liquid additions after the plants begin to grow.

Supplemental applications of N-P-K, and sometimes other elements, must be made to promote normal growth. During year two or three "slow release" NPK and other elements, or water soluble NPK, must be added to the top of the mixture regularly. Supplemental NPK should be added in the summer at regular intervals (weekly for water soluble and monthly for "slow release" nutrients).

(7) Frequent irrigation of nursery containers is very important because the container severely restricts the amount of roots a the water available to them. Co mercial nurseries often use overl ping sprinklers controlled or au mated by a time clock and solen valve. Overwatering seldom occ with the open, well-drained potti mixture. Trickle irrigation can used with an emitter or dripper each container, and this also can automated by time clock.

(8) When the seed are stratifi and planted at the proper time the spring and proper irrigati and fertilization practices are follo ed, it is possible to grow seedlin large enough to bud in August graft in the following spring.

(9) Diseases and insects must controlled if plants are to ma optimum growth. Some nurse men, who also have pecan orchar design their nursery so that an a blast sprayer can be used with regular orchard chemicals. Perio soil application of recommen chemicals can be effective for c trolling diseases and insects with spraying.

(10) Skilled propagators can l the seedlings effectively in l summer so that they will "tal and be ready for growth in the n spring. Other propagators ef tively use whip grafts at the en the dormant season. In any eve the "grafts" must be handled pro ly so that they will not break ou the graft union. Grafts should set as high as possible on the se ling trunk.

(11) When the rootstock is of a quate size and healthy in ea spring, it is possible to grow strong new trunk for the sc variety in one growing seas Often they will grow from 2 to and harden off. If the scion is large enough to sell or set in orchard, it can be grown a sec summer in the container.

Research with Pecan Nursery Trees in Containers & Orchards

Pecans, *Carya illinoensis* (Koch), re an important horticultural crop. he latest Census of Agriculture ported 4.6 million bearing pecan ees and 2.3 million non-bearing uvenile) trees in the United States. he average annual production arvested) from 1977 through 1982 as 236 million lbs, and the average eld/acre was about 1000 lbs for ature bearing trees.

With 2.3 million juvenile trees -10 years) in the United States, it apparent that pecan producers re interested in either expanding eir present acreage or starting ew orchards. Nurserymen in veral states annually produce large numbers of grafted nursery trees in field nurseries. The trees are dug in the dormant season and are sold bare-rooted to growers for transplanting to orchards in late winter or early spring.

Standard nursery techniques consist of grafting or budding a named cultivar on a seedling rootstock growing in soil in a nursery. Rootstocks are established by planting nuts (often from known cultivars) in rows in late winter or early spring. The germinated seedlings require hand weeding, cultivating, fertilizing and pesticide spraying until they are large enough to bud or graft and the cultivar tree is large enough to sell. Establishing the seedlings usually requires from one to three years, and one or more years then are required to grow the cultivar grafts to a size suitable for sale.

Research and practical experience have shown the possibility of producing pecan nursery trees in containers (Figure 1) and transplanting them to the orchard (Figure 2). Production of nursery plants in containers (especially ornamental plants) has increased in the United States in the last two decades (11). The many advantages to nurserymen are (1) more plants can be grown per acre, (2) need for large fields of good soil is eliminated, (3)

Figure 1. Mr. and Mrs. Bob Williams display a 'Melrose' pecan tree grown on a seedling rt in their nursery at Newellton, Louisiana. The rootstock is three years old and the n variety is one year old (Photographed October 1980).

Figure 2. Mr.and Mrs. Bob Williams of Newellton, Louisiana produce pecan nursery trees in containers in their nursery. This is a 'Candy' tree in its fifth leaf and was transplanted from a 3-gallon nursery container.

many phases in container plant production can be mechanized, (4) the potting mixture can be prepared to provide suitable pH and nutrient requirements, (5) the potting mixture can be fumigated to reduce diseases, insects and weeds, and (6) plants grown in containers can be sold and transplanted to landscapes or orchards during the dormant or growing season.

Container production of pecan nursery trees requires well-drained potting mixtures that have good nutrient holding capacity and are of light weight (9,10). Containers restrict the root zone; therefore, frequent watering is required during the growing season. This can be automated for daily or more frequent applications to larger trees. Trickle devices or overhead sprinklers can be used to provide water.

Nursery site preparation for efficient container plant production requires provisions for water runoff as well as irrigation. Black containers exposed to full sun in the hottest part of summer may cause root injury unless containers are placed close together. Sprinkler irrigation at mid-day may be used to reduce build-up of heat in the nursery. Pecan nursery containers may need to be mulched with sawdust in the winter to protect the plants from severe cold. We have not observed winter killing of containerized pecan trees that were adequately mulched, even when the ambient temperature dropped to 0°F.

Mineral nutrition for container-grown nursery trees represents a complex problem (4,6). Nitrogen, phosphorus and potassium are recognized as major elements of the 15 recognized as essential for plant growth, because of the relatively large amounts needed. In recent years the N-P-K group has been developed as "coated" pellets with "slow release" availability. These generally are available in rated time-of-release groups, such as three-to-four or eight-to-nine months. Uniform soil moisture and ambient temperatures contribute to uniform release of these elements over time. However, soil moisture and ambient temperatures are not uniform o time, and nutrient release can v with differences in growing-sea conditions such as warm, high very high air temperatures normal or excessive natural rain (4,6). Elements in addition to N-P sometimes are included in the "s release" pellets.

Several commercial formulati are Agriform®, Mag-Am Osmocote®, Sulfurkote® and Green®. In addition to N-P-K, r tively small amounts of other ments are required for plant grow These are boron, calcium, cop iron, magnesium, mangane molybdenum, sulphur and zi Carbon, hydrogen and oxygen other essential elements.

Studies reported in this revie our research involved potting m ture, shape and size of contain basic fertilizer types and ra winter culture of pecan seedli and transplanting experiments v container-grown pecan nurs trees.

Potting Mixture

Based on his experience with ornamental nursery plant production and pecan nursery trees in containers, Dr. A. J. Laiche, Jr., Horticulturist at the South Mississippi Branch Experiment Station at Poplarville, developed an empirical formula (Bostian-Overcash Mixture, Table 1) in 1974 (3). It has served as a basically successful mixture for several experiments with pecan nursery trees in containers. (1,2,7,8,12,13,14,15,16). About 50% of the potting mixture is southern pine bark obtained from a pole-peeling mill. It is worked through a soil shredder until it can be screened through 1-inch mesh. This gives a mixture of bark sized from less than ⅛-inch to ⅞-inch diameter. This fraction of the potting mixture adds lightness and porosity to the mixture and provides adhesion for mineral additions.

Table 1. Preparation of the Bostian-Overcash potting mixture used i production of pecan nursery trees in a container size-fertilizer study, Mississippi State University, 1978.

14 cu ft pine bark (screened below 1 inch)
10 cu ft mason sand
3 cu ft good soil (preferably fumigated with methyl bromide or oth soil fumigants or steamed to 180°F for 30 minutes amd then allowed cool slowly)
Add following chemicals, then mix thoroughly to insure even distrib tion of chemicals and potting mixture:
4.4 lb Osmocote® 18-6-12 (8-9 months)
6.6 lb Dolomitic limestone (Ca-Mg)
2.2 lb 20% superphosphate
1.1 lb Calcium sulfate
.55 lb Iron sulfate
.14 lb Peter's Fritted Trace Elements® (FTE No. 503) (18% Fe, 7.5% Mn, 7% Zn, 3% B, 3% Cu, and .2% Mo)

About 38% of the mixture is coarse ason sand, the type commonly ed to make mortar for brick lay- g. The sand is a filler between the arse bark particles and provides lhesive surfaces for good drainage nd aeration.

The remainder of the potting ixture is silt or sandy loam soil, hich is added as a source of small nounts of mineral elements. It so is a filler between coarse pine ark particles and provides lhesive surfaces for mineral addi- ns to the mixture.

The pine bark and mason sand are relatively free of insect, disease or weed problems and are not fumigated. The soil is fumigated because of these problems. We steam fumigate the soil to 180°F for 30 minutes and then let it cool slowly. Proper use of MC²® (or other gaseous, solid or liquid fumigants) can effectively control pests.

Ingredients of the potting mixture are blended or mixed in a small electric concrete mixer or a commercial soil mixer or blender. The chemicals are added after the basic ingredients are partially blended. The iron sulfate and Peter's Fritted Trace Elements® are hand mixed with 1 gallon of moist sand and then added uniformly over the surface of the moving mixture. This precaution with the micronutrients is an effort to distribute the small quantities of these elements uniformly throughout the mixture. Mixing is continued for 15 minutes after the micronutrients are added. The potting mixture usually is prepared at the beginning of each experiment. The chemicals in the basic mixture sometimes are varied in research efforts to improve growth of pecan seedlings.

Experiments with Container Sizes Shapes and Fertilization

Evaluation of the long-held belief at nursery trees with long taproots 3 ft or more) are needed for suc- ssful establishment of pecan chards was triggered by the up- aval of mature pecan trees by rricanes such as "Camille" in uth Mississippi in 1969. The up- oted trees had been transplanted th long taproots but were blown er with relatively shallow root lls, and no strong, deep taproots re present.

We made a study of seedling pecan es grown in containers of various apes and sizes. The five container es selected for the study are strated in Figure 3 and described Table 2.

Figure 3. Average seedlings after one growing season in the nursery-container experiment. Containers are A, 3 x 24 inch; B, 4 x 24 inch; C, 6 x 24 inch; D, 10 x 20 inch; E, 10 x 10 inch.

Table 2. Dimensions of nursery containers used to produce pecan nursery seedlings in a container size-fertilizer study, Mississippi State University, 1978.

Code	Container	Height	Diameter Top	Diameter Bottom	Volume
		inches			gallons
A	3 inch PVC pipe	23.8	3.1	3.1	.8
B	4 inch flexible plastic sleeve	23.8	4.1	4.1	1.4
C	6 inch PVC pipe	23.8	6.0	6.0	3.0
D	6 gallon nursery can	19.9	10.2	8.6	5.9
E	3 gallon nursery can	10.2	9.9	9.6	2.9

Procedure

Nuts of the 'Stuart' cultivar were harvested in November 1977 and were stored dry at 40°F until March 1978. Nuts for planting were selected for uniformity at an average of 35/lb and were stratified by refrigeration in moist peat moss at 40°F until immediately before planting.

The eight- to nine-month type of 18-6-12 (N-P_2O_5-K_2O) Osmocote® was blended with Bostian-Overcash potting mixture at 4.4 lb per cubic yard of potting mixture (X rate), 6.6 (1.5 X rate) or 8.8 (2 X rate). The potting mixture with the X rate of Osmocote was poured into 80 containers of each shape and size, that with the 1.5 X rate into 40 containers of each shape and size and that with the 2 X rate into 40 containers of each shape and size. All containers were bumped to leave head space of 0.5 inch or more for watering. Three nuts were planted May 13, 1978 near the center of each container at a depth of twice the diameter of the nuts. The nuts were planted promptly after removal from stratification.

Seedling emergence was facilitated and seedling injury was prevented by moistening the surface of the growing medium when the seedlings started to emerge. Watering at that time and throughout the study was by hand. We used a water-breaker nozzle to reduce spatter of the potting mixture from the containers.

Seedlings in each container were thinned to the strongest if more than one emerged, and a healthy seedling was transplanted from another container if none emerged. The 160 containers were placed in full sun on a concrete floor of the greenhouse and plant-growing complex of the Mississippi State University Horticulture Department and were spaced equidistant and far enough apart to eliminate shading as a problem. The containers were supported by a frame constructed of 2 x 4-inch lumber, and spaces were subdivided into 10-inch segments by wood slats running across the width of the frame. Containers that would not stand independently (2 x 24-, 4 x 24- and 6 x 24-inch) were wired to the subdividing slats.

The surface of the mixture was kept moist throughout the study. Water was applied as needed, often daily in the absence of rain.

Fungicides and insecticides were supplied as needed to control diseases and insects.

One-half (40) of the containers filled with the potting mixture containing the X rate of Osmocote were fertilized with supplemental N-P-K, beginning 42 days after planting and once each week thereafter until September 24, 1978. A stock solution was made by mixi[ng] 2 lbs of water-soluble Peter['s] 20-20-20 (N-P_2O_5-K_2O) in 1 gallon [of] water. Part of the stock soluti[on] was diluted in 200 parts of wat[er] and two thirds of 1 pt of the dilut[ed] solution was applied each week.

Results

Trunk height and trunk diame[ter] at the surface of the potting mixtu[re] were greatest for seedlings gro[wn] in the standard 10 x 10-in[ch] 3-gallon nursery container (Ta[ble] 3). Taproot diameter at 4 inch[es] below the surface of the potti[ng] mixture was greatest in the 10 x [20] and 10-20-inch containers (Table [4]).

Overall performance (Tables [3] and 4) was poorest for seedlin[gs]

Table 3. Trunk height and trunk diameter at the surface of the potting mixture of pecan seedlings grown one season in a pine bark-sand-soil potting mixture, by size of nursery container, Mississippi State University, 1978.

Container size	Trunk height	Trunk diameter at surface
inches	inches	
3 x 24	8.9* D**	.28 D
4 x 24	9.5 CD	.33 C
6 x 24	10.0 C	.36 C
10 x 20	12.0 B	.42 B
10 x 10	13.5A	.46A

*Average of 8 replications of 4 fertilizer programs.
**Numbers in a column not sharing a letter in common differ significantly at the 5% level of probability as judged by Duncan's new multiple range test.

Table 4. Taproot diameter 4 inches below the surface of the potting mixture and trunk diameter 4 inches above the surface of the potting mixture of pecan seedlings grown one season in a pine bark-sand-soil mixture, by size of growth container, Mississippi State University, 1978.

Container size	Taproot diameter 4 inches below surface	Trunk diameter 4 inches above surface
inches	inches	
3 x 24	.41* E**	.18 C
4 x 24	.50 D	.21 B
6 x 24	.67 C	.22 B
10 x 20	.87 B	.30 A
10 x 10	1.09 A	.32 A

*Average of 4 replications of 4 fertilizer programs.

**Numbers in a column not sharing a letter in common differ significantly at the 5% level of probability as judged by Duncan's new multiple range test.

vn in the 3 x 24-inch plastic
s. Pecan seedlings grown in
ch pipes have been transplanted
essfully to an orchard where
grow well, but not as well as
lings from larger containers

ne X rate of Osmocote did not
ide enough NPK to sustain
imum growth throughout the
on, and average tree weight
only 4.4 oz (Table 5). The best
vth was by seedlings that receiv-
he X rate of Osmocote plus
plemental NPK.
edlings grown in the 10 x 10-
10 x 20-inch containers were
est, and those grown in 3 x 24-
4 x 24-inch containers were
llest (Table 5). Size of seedlings
vn in 6 x 24-inch containers
intermediate.

Table 5. Average fresh weight of dormant pecan seedlings after one growing season in a pine bark-sand-soil potting mixture, by size of growth container and fertilization rate, Mississippi State University, 1978.

Container size	Fertilization rate: X*	1.5X	2.0X	X + NPK**	Average
inches	oz				
3 x 24	2.6 fg***	3.2 efg	1.6 g	3.4 efg	2.7 C
4 x 24	2.0 fg	4.5 cdefg	3.1 efg	4.2 cdefg	3.5 BC
6 x 24	3.9 defg	5.3 bcdef	4.7 cdefg	4.7 cdefg	4.6 B
10 x 20	8.3 ab	7.3 abcd	7.7 abc	10.6 a	8.5 A
10 x 10	5.3 bcdef	6.5 bcde	8.4 ab	9.9 a	7.5 A
Average	4.4 E****	5.4 DE	5.1 E	6.6 D	

*Basic Osmocote® rate, 4.4 lbs per cubic yard.
**Basic Osmocote rate plus supplemental NPK applied once each week, beginning 42 days fter planting.
***Means within a column not sharing a letter in common differ ($P < .05$) as judged by Duncan's new multiple range test.
****Means not sharing a letter in common differ ($P<.05$) as judged by Duncan's new multiple range test.

Osmocote Monthly Supplement Experiment

hiform nuts of 'Cape Fear' were
cted in November 1980 and
tified from December 18 to
uary 10, 1981. They were then
ted in 1-gallon nursery con-
ers (three per container) using
asic Bostian-Overcash potting
ure (3).
e containers were kept in the
nhouse at 65°F or higher until
130. They were then transplant-
3-gallon containers with the
e potting mixture and trans-
d to an outdoor concrete floor
50% shade.
hiform seedlings were selected
fertilizer supplement study.
teen one-tree replicates were
. A no supplemental fertilizer
k and four supplemental ferti-
rates ranging from 0.14 to 4.44
f Osmocote 18-6-12/3-gallon
ainer were used at monthly
vals from May through August.
e plants were transferred June
an outdoor concrete floor and
ed 2 ft between plants. They
were watered as needed at one- or two-day intervals. The pH analyses of potting mixture in July indicated 6.0 to 6.7, which is within the desirable range. At the end of the growing season five plants from each fertilizer treatment were washed clean, and the weights of the roots (below surface) and trunks were recorded (Table 6). The root constituted 84% of the total plant weight.

The supplemental fertilizer rates were selected in an effort to range up to the toxic level. No differences in trunk size between treatments were significant ($P< .05$). Responses to no supplement and to .14 oz of Osmocote monthly did not differ. The best root growth followed monthly treatment with 0.44 oz or 1.41 oz. The highest rate of Osmocote retarded growth of the seedlings.

Table 6. Fresh weights of container-grown 'Cape Fear' pecan seedlings after one season of growth in Bostian-Overcash potting mixture supplemented monthly with Osmocote® 18-6-12, by rate of fertilizer application.

Osmocote applied monthly	Total plant	Roots	Trunk
	oz		
0.00	10.4ab	8.7 bc	1.7a
0.14	9.3 bc	7.8 cd	1.5a
0.44	13.0a	11.1a	1.9a
1.41	12.6a	10.5ab	2.1a
4.44	7.3 c	6.0 d	1.3a

Mean separation in columns by SNK at $P < 0.05$. Means in a column not followed by the same letter are statistically different.

Day Length and Growth of Pecan Seedlings

earchers have shown that
plants can be grown from
nuts, and that the trunks can be large enough to bud in a few months. The application of gibberellic acid (GA) to a small trunk accelerates

its growth and makes budding feasible at an earlier date.

Our experiment explored the feasibility of growing seedlings in a greenhouse in winter. Day lengths and GA stem applications were included because pecan trees appear to thrive during long summer days or long natural photoperiods.

Nuts were harvested in November 1973 and stratified in moist peat moss at 40°F from December 1973 to September 1974 (3). They were planted in 3 x 12-inch plastic pipes containing Bostian-Overcash potting mixture. Seedlings emerged by October 3 and made good growth.

All plants received eight hours of natural daylight (8 am to 4 pm daily). Supplemental light (100 watt incandescent bulbs maintaining 50 foot candles at seedling level) was used for either eight or 16 hours daily. Plants were spaced 6 x 8 inches in cages covered with black cloth as needed to restrict day length periods to eight, 16 or 24 hours of illumination.

The GA was applied as the potassium salt prepared as a 5000 ppm solution in water and was mixed mechanically 1:2 (v/v) with USP lanolin to form a paste. The GA-lanolin paste application was centered around the trunk in a 1-inch band at 1 inch above the potting mixture surface. The lanolin kept the GA in place, and the trunks subsequently enlarged rapidly. Four applications were made, one each week beginning October 3.

Each increase in length of daily light period with or without GA application increased trunk height and numbers of leaves per plant (Table 7). Differences in height and numbers of leaves per plant due to GA treatment were slight. Trunk cross-sectional area was least for the shortest daily photoperiod b was increased appreciably by G treatment in each photoperi group.

Treatment of stems of you pecan seedlings with GA in a lano paste can produce stems lar enough to bud or graft earlier th is possible without treatment. U of longer daily photoperiods (16 24 hours duration with 50 f candles at plant height) makes possible to grow seedling pec plants during the winter to s ficient size for budding in late win or grafting in early spring.

Table 7. Plant height, numbers of leaves per plant and trunk cross-sectional area of pecan seedlings grown in 3 x 12-inch plastic pipes containing Bostian-Overcash potting mixture, by length of daily photoperiod, with and without gibberellic acid (GA) treatment[1].

Photoperiod daily	Height		Leaves/plant		Trunk cross section*	
	GA	none	GA	none	GA	none
hours	------inches------		-----number------			
8	8.4 c**	6.7 c	8.8 b	7.4 c	.93 b	.34a
16	10.8 b	10.9 b	9.9a	9.0 b	1.23a	.32a
24	12.6a	13.7a	9.4 a	10.1a	1.22a	.24
Average	10.6	10.4	9.4	8.8	1.13	.30

[1]Seed planted September 18, 1974 and grown until December 15 in a greenhous at 65-85°F.
*Calculated as a fraction of 1/4 sq. in.
**Means in a column not followed by the same letter are significantly different at .05 level.

Pecan Nursery Tree Transplanting Experiment

Nursery trees in containers have been transplanted to orchards readily, with unusually good liveability and subsequent growth (8, 12, 14). An experiment was established in 1974 on a Savannah sandy soil at Poplarville, Mississippi to study the influence of several preplant treatments on growth of trees for two years (12).

One-year-old seedlings that had been grown in 2-gallon nursery containers were included. Seedlings with taproots coiled around the inside of the container were used. One half of the taproot was removed from seedlings in one treatment for comparison of growth with that of seedlings that were not root pruned. The seedlings that were not root pruned weighed about 30% more than pruned trees after two years. Trees that were not root pruned also had larger primary roots and larger trunk diameters at 12 inches above the soil. Primary root diameters at 18 and 24 inches below the soil surface, two years after transplanting, were 80 and 160% larger, respectively, for trees that were not root-pruned.

Other treatments involved root pruning (one half of length remov of the taproot of barerooted nurs trees. These trees lived and g well but generally were somew smaller in subsequent years t where the whole taproot planted. Small nursery trees wi ft-long taproots were establis by removing all side roots and pl ing in a 1½-inch diameter bored with a soil auger. These t all lived and grew satisfacto but not as well as trees plan differently.

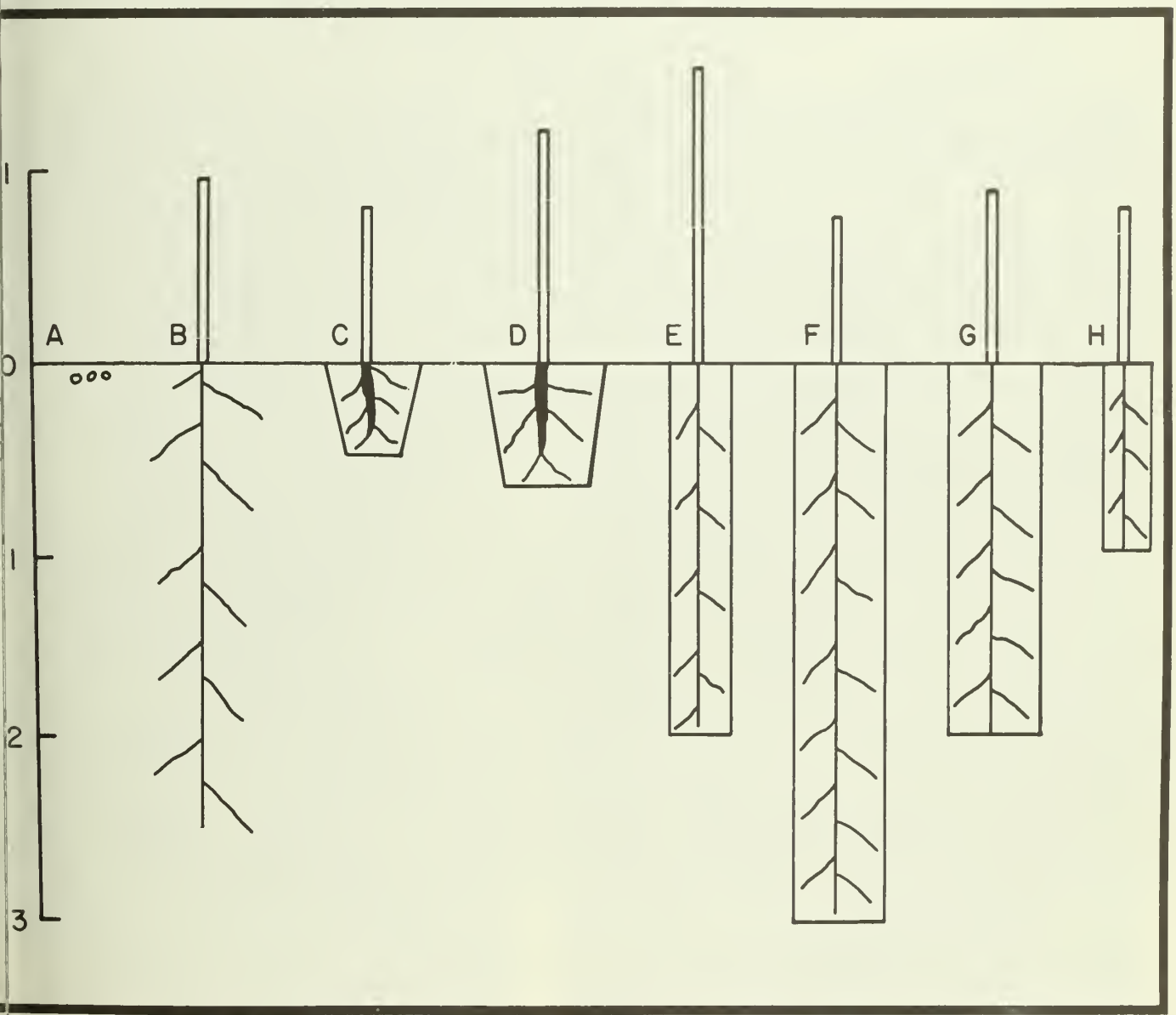
Another experiment invol planting nuts in the orchard, b

ot planting of seedlings with 30 ch taproots and planting seedgs grown in six different types of ntainers (Figure 4). Seedlings nerging from the planted nuts ere thinned to the strongest. Seedgs were removed from the coniners and planted in holes dug ghtly larger than the respective ntainers.

One half of the trees (four replites) were trickle irrigated as eded to maintain optimum growth, with one emitter per tree at eight inches from the trunk the first two years and two emitters per tree at 12 inches from the trunk thereafter. Weeds were controlled manually, and the middles were disked the first year. A 4-ft wide weed-free band was maintained along the tree row by use of herbicides (paraquat, diuron and Roundup®) as needed after the first year. Native grasses formed a sod the second year, and this was mowed at two-week intervals.

The trees were maintained in the orchard for five years, and measurements were made annually. Branching was controlled by removing undesirable scaffold limbs when they were small and developing a central leader trunk where feasible. Trunk cross-sectional area often has been correlated closely to total tree top.

Irrigation had a profound influence on pecan tree growth (Table



e 4. Diagram of pre-transplanting treatments in the pecan nursery tree transplanting experiment. Treatments are A, seed; B, bare rooted; C, 6-quart nursery iner; D, 8-quart nursery container; E, 4 x 24-inch plastic tube; F, 6 x 36-inch plastic pipe; G, 6 x 24-inch plastic pipe; H, 3 x 12-inch plastic pipe..

8 and Figure 5). The average increase in trunk cross-section area was 77%. Trees from 2-gallon containers that were irrigated had almost a 100% gain in cross-section area. Nursery trees from the 2-gallon containers, 4 x 24-inch plastic sleeves and 6 x 24-inch pipes had the largest trunks. Barerooted trees transplanted with taproots 2.5 ft long had the smallest trunks after five years, except for the trees grown

Table 8. Trunk cross section and total length of branches of pecan seedlings grown in an orchard for five years, by method of planting, with and without irrigation.

Treatment	Trunk cross section*			Length of branches		
	Check	Irrig.	Av.	Check	Irrig.	Av.
	sq inch			linear ft		
2 gallon can	6.3	12.4	9.4A**	121	156	138A
4 x 24 inch sleeve	6.1	11.8	8.9A	74	163	118 B
6 x 24 inch pipe	6.7	9.8	8.3A	96	99	97 B
1.5 gallon can	4.9	9.3	7.1 B	56	116	86
6 x 36 inch pipe	4.0	9.1	6.6 B	65	104	84
Bare root	4.8	6.7	5.8 C	63	94	78
3 x 12 inch pipe	5.6	9.1	7.4 B	56	87	71
Nuts planted in orchard	3.1	5.4	4.3 D	32	50	41
Average	5.2	9.2		70	110	

*Measured at 24 inches above orchard floor.
**Means in a column not sharing a letter in common differ significantly (P<
as judged by Duncan's new multiple range test.

Figure 5. Pecan trees five years after transplanting to the orchard. Trees were grown in 2-gallon containers for one year before transplanting. Tree on left was irrigated and tree on right was not.

m seed, which were a year nger (Figure 6).

'otal length of branches also is a od criterion for tree size. Trees m 2-gallon containers had the st branch growth, and trees from x 12-inch pipes had the least wth, except for trees from nuts nted directly in the orchard. Five-ar-old orchard trees from several tainers were substantially larger n trees from seedlings that were nsplanted barerooted.

Trees from 2-gallon containers were larger than those from 1.5-gallon containers. These differences were maintained year-after-year. Direct-seeded trees remained smaller than all others, and these trees had trunk cross section and total length of branches less than one half that of trees from 2-gallon containers.

No logical explanation has been found for better growth of trees from 6 x 24-inch pipes than that from 6 x 36-inch pipes. The results of this test clearly show that a pecan tree can be established under orchard conditions from trees grown in various shapes and sizes of containers. Trees from the smallest container (3 x 12 inch) were successfully established and made good growth, but not nearly as much as that from larger containers (e.g., 2 gallon).

re 6. Pecan seedling trees after five years in the orchard. Tree on left was grown from a barerooted nursery tree with a 30-inch taproot. Tree on right was grown ace from a nut planted when the barerooted tree was set in the orchard.

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'Cape Fear' pecan trees with two-year-old roots and one-year-old scions in October and February (diameter of containers is 10 inches).

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