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When seed are stratified, one hour of light is sufficient for optimum germination and some germination occurs in darkness. For optimum germination, a grower may use non-stratified seed and supply three hours light (3), or use stratified seed and supply one hour light. If stratified seed are used, germination occurs to some extent even in darkness.

For practical application, further research into liner, container and field production would be useful to the grower.

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Effects of Container Size, Root Pruning, and Fertilization on Growth of Seedling Pecans[1]

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Abstract

Seedling pecan top growth was greater in 38 l (#10) containers and shallow 19 l (#5) containers when compared to deeper 19 l (#5) containers and 11 l (#3) containers; however, all trees were large enough to bud by July of the first growing season. Root pruning at transplanting did not affect top growth, but increased root branching and total root growth. Increased rates of a complete fertilizer increased root growth, but did not affect top growth.

Index words: *Carya illinoinensis*, container production, fertility

Introduction

Demand for container-grown pecans (*Carya illinoinensis*) has increased substantially in recent years. Trees are typically produced by budding or grafting the desired cultivar onto 1- or 2-year-old seedlings with at least one additional growing season required before marketing. Although kinked and circling roots occur and production costs are higher, container-grown pecans can be transplanted year round and with greater success than bare root trees (1). In general, root pruning induces branching and creates a more desirable root system although conflicting results have been obtained with pecan (1, 2, 4, 7). Container size and shape have also been shown to influence the growth of several woody species (3). This study evaluated the effects of container size and shape, root pruning, and fertilization rate on growth of pecan seedlings prior to budding with the objective of minimizing the time required to reach the budding stage.

Materials and Methods

Experiment 1. 'Elliott' pecans were stratified for 6 weeks at 6.7° C (44° F) in closed plastic bags filled with moist peat moss. Pecans were sown January 27, 1983, in 3.8 l

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(#1) containers using a milled pine bark:sandy loam soil (7:1, by vol) growth medium amended with 3.6 kg (6 lb) dolomitic limestone + 1.2 kg (2 lb) single superphosphate + 1.2 kg (2 lb) gypsum + 0.9 kg (1.5 lb) Micromax per cubic meter (yard). Containers were placed in a heated greenhouse (10° C (50° F) minimum temperature) and after germination, fertilized weekly with 100 ppm N from 20N-8.6P-16.6K (20-20-20) soluble fertilizer. Seedlings were transplanted April 25 into the containers described in Table 1. The milled pine bark-sandy loam soil (10:1, by vol) growth medium was amended as before except that Osmocote 17N-3P-10K (17-7-12) at 7.2 kg/m^3 (12 lb/yd^3) was added. Plants were placed outside in full sun and irrigated with overhead impact sprinklers. Supplemental N (100 ppm from ammonium nitrate) was applied weekly for 6 weeks. There were 15 single-plant replicates arranged in a completely randomized design.

In experiments 2 and 3, nuts were stratified for 6 weeks and sown February 3, 1984, at a depth twice their width in 3.8 l (#1) containers filled with milled pine bark. Growth medium was amended with 3.6 kg (6 lb) dolomitic limestone, 1.2 kg (2 lb) gypsum, and 0.9 kg (1.5 lb) Micromax per cubic meter (yard). Containers were placed in a heated greenhouse (10° C (50° F) minimum temperature) and, after germination, fertilized weekly with 100 ppm N from 20N-8.6P-16.6K (20-20-20) soluble fertilizer. On May 15, 1984, seedlings were root pruned (tap root pruned 9.0 cm (3.5 in) below the nut), unless otherwise noted (see Experiment 2 below), and transplanted into 19 l (#5) containers of milled pine bark-sandy loam soil (10:1, by vol) amended with the same materials and at the same rates as the germination medium. An 18N-3P-8.3K (18-7-10) fertilizer at 100 g/container (9 lb/yd^3) was surface applied 2 weeks later, unless otherwise noted (see Experiment 3 below). Containers were placed outdoors in full sun and drip irrigated. In each experiment, 40 single-plant replicates were arranged in a completely randomized design. Plants were evaluated in September, 1984.

Experiment 2. 'Elliott' pecan seedlings (5.6 g or 0.20 oz/nut) were either root pruned or left unpruned at transplanting.

Experiment 3. An 18N-3P-8.3K (18-7-10) fertilizer was topdressed at 3 rates in 3.8 l (#1) containers of 'Elliott' pecan seedlings (5.6 g/0.20 oz nut) 2 weeks after transplanting. Rates were 100, 135, and 170 g/pot (equivalent to 9, 12, and 15 lb/yd^3).

Results and Discussion

Experiment 1. Greatest tree caliper and height occurred in 38 l (#10) and shallow 19 l (#5) containers (Table 1); however, all trees were of sufficient size for budding in July, 1983. Budding was unavoidably delayed, but on August 30, 1983, 'Cheyenne' pecan scion wood was patch-budded onto the 'Elliott' stock. Ninety-six percent of attempted buds were still green 4 weeks after budding with no treatment effect (data not shown). It is not known why seedlings grew more in the shallow 19 l (#5) containers compared to the deeper 19 l (#5) containers; while growth was similar in 11 l (#3) containers of different depths. Shallow containers were more stable during windy conditions. The general trend of greater top growth in larger containers is supported by other research (1, 3, 5) and, in many cases, may be a response to greater fertilizer (where incorporated on a volume basis) or water reserves, or a more temperature-buffered growth medium.

Table 1. Effect of container size and shape on caliper and height of 'Elliott' seedling pecans 7 months after sowing.

Container size			
Volume	Dimension	Trunk	Tree
liters (trade)	(width × height, cm)	caliper[z] (mm)	height (cm)
38 (#10)	43.2 × 38.1	9.7 a[y]	68.6 a
19 (#5)	33.0 × 29.8	8.9 a	61.7 a
19 (#5)	22.9 × 50.8	7.6 b	49.3 b
11 (#3)	26.7 × 22.9	7.4 b	50.3 b
11 (#3)	22.9 × 38.1	7.1 b	49.3 b

[z]Caliper measured 20 cm (8 in) above container medium surface.
[y]Mean separation within columns by Duncan's multiple range test, 5% level.

Experiment 2. Root pruning did not affect tree height, caliper, top dry weight, or tap root dry weight (data not shown). However, there was a significant increase in both the number of main roots per tree and the fibrous root dry weight (Table 2). Root growth in the non-pruned treatment resulted in a single tap root, twisted and knotted at a depth corresponding to the bottom of the propagation container. The tap root circled the bottom of the container with secondary and feeder roots developing in greatest numbers toward the distal end. When the tap root was pruned at transplanting, 3–4 main roots developed, all producing secondary and feeder roots. No twisting of the main roots occurred, and there was less root circling in the bottom of the container than with non-pruned treatments (Fig. 1). Davis and Whitcomb (1) observed similar root growth response from pecan seedlings grown in bottomless containers that provided air root pruning compared to conventional containers with bottoms. Other research has also observed improved root growth (2) from root pruning without a reduction in top growth (4). Timing may also be important in determining whether root pruning increases or decreases top growth. Harris *et al.* (2) reported beneficial effects of root pruning when done early, while later root pruning was detrimental. This may explain the reported reduced growth of root-pruned plants in some studies (7).

Experiment 3. Increasing fertilization rate from 100 g/container (9 lb/yd^3) to 170 g/container (15 lb/yd^3) quadratically increased root dry weight (Fig. 2). Fertilization rates above 100 g/container (9 lb/yd^3) did not significantly affect tree height, caliper, number of main roots, or top dry weight. Overcash *et al.* (5) reported no change in seedling

Table 2. Effect of root pruning at transplanting on the number of main roots per tree and the fibrous root dry weight of 'Elliott' pecan seedlings.

Treatment	No. main roots/tree	Fibrous root dry weight (g)
Pruned	2.8 a[z]	9.1 a
Unpruned	1.0 b	6.4 b

[z]Mean separation within columns by Duncan's multiple range test, 5% level.

fresh weight when Osmocote 18N-2.6P-10K (18-6-12) incorporated at 2.6 kg/m^3 (4.4 lb/yd^3) was increased to 5.2 kg/m^3 (8.8 lb/yd^3). Although there was not a top growth response to increased fertilization above 100 g/container (9 lb/yd^3), this does not mean that the higher rates were not beneficial, as indicated by the root growth increase. Romberg (6) reported that in the first year, pecan seedlings make very little top growth, in proportion to that of the tap root; but the ratio of root to top decreases in succeeding years. Thus, the greater root growth during the first year would provide more reserves and greater nutrient and water absorption capacity for increasing top growth in subsequent years.

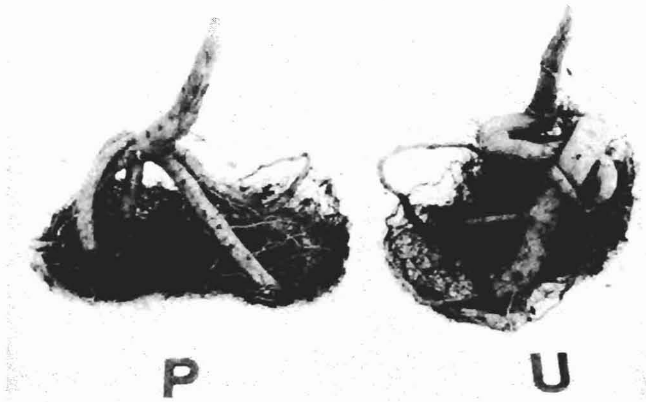

Fig. 1. **Effect of root pruning at transplanting on root growth patterns of seedling pecan. (P = pruned; U = not pruned).**

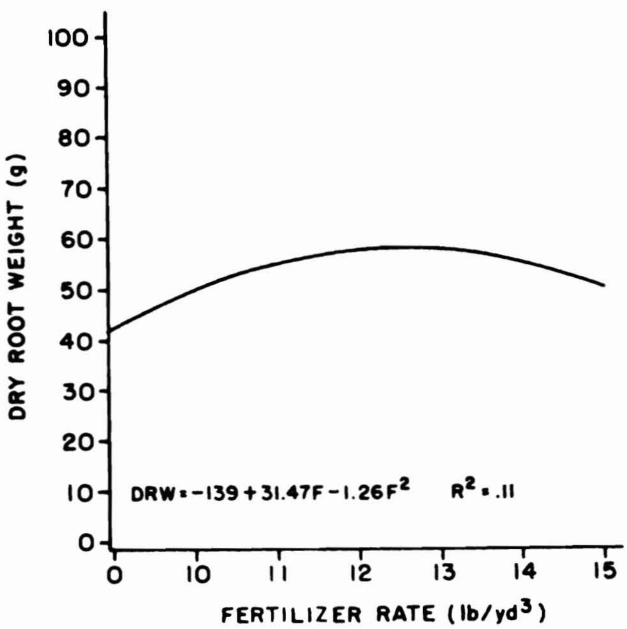

Fig. 2. **Influence of fertilization rate on root dry weight of seedling pecan.**

Significance to the Nursery Industry

Container-grown seedling pecans can be sown and budded in one growing season. Since early budding is limited by seedling size this study indicates that shallow containers at least 19 l (#5) in volume should be used to maximize growth. One year-old budded trees would allow earlier field transplanting which should enhance survival. Root pruning at transplanting can increase branching of the tap root and produce a more desirable root system for subsequent field transplanting without reducing top growth.

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