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Effect of Growing Medium and Cultivar on the Container Culture of Pecan Seedling Rootstocks

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Abstract. **Container-grown rootstocks of pecan [*Carya illinoensis* (Wang) K. Koch] partitioned more dry matter into the roots when grown in a 4 pinebark : 1 sand (v/v) medium than when grown in a 1 pinebark : 1 sand (v/v) mixture. Water retention, nutrient retention, and aeration porosity differences between the media did not explain the partitioning difference observed. Greater depth of taproot penetration was observed in the lighter (4 : 1) mixture. 'Farley' and 'Yawn School' seedlings were lower in total dry weights when grown in a 4 : 1 mixture compared with a 1 : 1 mixture. Leaf analyses showed no nutritional disorder. No method could be offered other than an empirical one for testing compatibility between growing medium and cultivar.**

One of many decisions to make when planning to grow pecan seedling rootstocks in containers is what medium to use. Media for growing pecan rootstocks are often composed of shredded pinebark, sphagnum peatmoss, sand, and soil mixed in various combinations and proportions (9, 11). Whatever the composition, a growing medium should conform to certain bulk density, porosity, and water and nutrient retention specifications (10, 13). Even after all of these criteria are met, the suitability of a growing medium for a particular crop needs testing.

One particular concern is the effect of the growing medium on the quality and/or quantity of the economically important part of the plant. Acock (1) observed differences in the root systems of pecan rootstocks grown in different media. The differences could not be attributed unequivocally to the growing medium because medium and fertilizer program were confounded. This study was therefore undertaken to demonstrate that the growing medium could affect overall growth and the amount of dry matter partitioned to the root system of pecan seedlings grown for rootstocks. Cultivar response to growing media was also evaluated.

One hundred nuts of each of the pecan cultivars 'Davis', 'Farley', 'Harris Super', 'Lewis', and 'Yawn School' were stratified in moist peat at 4°C from December 5, 1980 to June 15, 1981 to enhance germination uniformity (6). They were then placed in stacking boxes containing moist vermiculite 3–5 cm deep and kept in an unshaded greenhouse maintained between 18° and 43°.

Seedlings were first grown in 3.8-liter containers in a greenhouse, transferred to 11.4-liter containers, and placed outdoors on a concrete area on July 20, 1981. The experiment established consisted of a 5 × 2 factorial arrangement using a completely randomized design with 4 replications. The growing media were 4 pinebark : 1 sand (v/v) and 1 pinebark : 1 sand (v/v). Dolomitic limestone was added at the rate of 3.4 kg/m^3. Each container was treated with 500 ml of a solution containing 0.53 ml of Soluble Trace Element Mixture (STEM) per liter of water. This mixture contains 15.00% S, 1.45% B, 3.2% Cu, 7.50% Fe, 8.15% Mn, 0.46% Mo, and 4.50% Zn. Seedlings were fertilized weekly with 5 ml (4 g) of 20N–8.7P–16.6K and were watered daily. The N source contained 5.6% NO_3–N, 4.0% NH_3–N, and 10.4% urea–N. On October 5, 1981 seedlings were harvested and dry weights of leaves, trunks and roots were measured. Leaf mineral content was analyzed by direct reading emission spectrography and micro Kjeldahl procedures.

Water availability in the 2 media was determined by subtracting water content at permanent wilting point of cowpeas (*Vigna sinensis*) from water content at pot capacity. Air space in a fixed volume of medium was displaced by water and then the volume of drainage water collected was used to estimate pore space in the medium.

Media effects. Rootstocks grown in the 4 pinebark : 1 sand (v/v) mixture partitioned more dry matter into the root system compared with seedlings grown in the 1 pinebark : 1 sand (v/v) mixture. Mean root/shoot ratios were 1.88 and 1.62, respectively (Table 1).

Differences in water or nutrient retention, aeration porosity, or bulk density between

Table 1. Mean root/shoot ratios for 5 cultivars of pecan seedlings grown for 16 weeks (June 15–October 5, 1981).

Main effects	Root/shoot ratio
Medium (pinebark:sand)	
1 : 1	1.62 a[z]
4 : 1	1.88 b
Cultivar	
Davis	1.84 a[z]
Farley	1.65 ab
Harris Super	1.87 a
Lewis	1.97 a
Yawn School	1.41 b

[z]Mean separation by Student Newman Keuls' multiple range test, 5% level.

Table 3. Mean total dry weights for 5 cultivars of pecan seedlings grown in 2 (pinebark:sand) growing media for 16 weeks (June 15–October 5, 1981).

	Total dry weight in grams	
Cultivar	1 : 1 mix	4 : 1 mix
Davis	15.10 a[z]	14.05 a
Farley	11.00 a	7.03 b
Harris Super	10.40 a	9.68 a
Lewis	10.30 a	10.83 a
Yawn School	14.83 a	7.40 b

[z]Mean separation (4 observations) in rows by Student Newman Keuls' multiple range test, 5% level.

Table 2. Characteristics of the 2 pinebark and sand media (v/v) used for growing pecan rootstocks in containers.

Characteristic	Media: 1 pinebark : 1 sand	Media: 4 pinebark : 1 sand	Acceptable range	Ref.
Bulk density (g/ml)	0.813 b[z]	0.488 a	0.15–1.3	13
Water-holding capacity (%/v)	33 a[z]	34 a	30–60	10
Nutrient-holding capacity[y] (meq/100 ml)	7	11.4	10–30[x]	13
Aeration porosity (%/v)	13 b[z]	20 a	5–20	13
pH	8.1	7.6	5.5–6.5	4, 13

[z]Mean separation in rows by Student Newman Keuls' multiple range test, 5% level.
[y]Calculated from Brown and Pokorny (3).
[x]Given in meq/100 g.

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Table 4. Mean value for mineral leaf content of pecan seedlings grown in 11.4-liter containers for 16 weeks (June 15–October 5, 1981).

Main effects	Leaf concn (dry-wt basis) N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Mn (ppm)
Medium[z]							
1 : 1 mix	3.41 a [y]	0.46 a	1.53 a	1.07 b	0.81 a	83 a	94 a
1 : 4 mix	4.02 b	0.68 b	1.70 a	0.97 a	0.89 b	78 a	147 b
Cultivar							
Davis	3.47 ab[y]	0.69 a	1.55 a	1.04 a	0.80 b	82 a	137 a
Farley	3.57 ab	0.46 a	1.75 a	1.05 a	0.85 ab	91 a	111 a
Harris Super	3.33 b	0.44 a	1.60 a	1.00 a	0.79 b	81 a	129 a
Lewis	3.89 ab	0.61 a	1.50 a	1.09 a	0.94 a	70 a	129 a
Yawn School	4.04 a	0.65 a	1.67 a	0.93 a	0.87 ab	79 a	96 a

[z]Pinebark:sand

[y]Mean separation in columns by Student Newman Keuls' multiple range test, 5% level.

growing media have been shown to affect partitioning. Increasing soil moisture has been related to reduced root/shoot ratios (2). However, water-holding capacities between the 2 media studied were not very different (Table 2) and moisture release curves from 0.1 to 1 bar pressure were very similar (not shown).

Soil aeration is known to influence root behavior. Greenwood (5) concluded that root growth was affected severely only in soils containing less than 1% oxygen by volume in air spaces. The aeration porosity of the 2 media studied were different. However, pore space of both were adequate for gaseous exchange (Table 2).

Increased nutrient concentration in the growing medium has been found to correlate with a lower root/shoot ratio (2, 8). The 4 : 1 mixture should theoretically have a greater capacity for retaining nutrients (Table 2). On this basis, rootstocks in the 4:1 mixture should have a lower root/shoot ratio than those grown in the 1 : 1 mixture. In fact, the root/shoot ratio was larger (Table 1).

Bulk density of soils affects root penetration (12), with lighter soils favoring root penetration. The 4 : 1 mixture had a much lower bulk density (Table 2). Taproots of seedlings grown in this mixture had significantly greater penetration into the medium. Mean taproot depth was 14.9 cm for these seedlings, whereas taproots in the 1 : 1 mixture had a mean depth of only 9.8 cm. The lower mechanical resistance to root growth in the 4 : 1 mixture might have influenced root/shoot ratios.

Cultivar effects. Dry-matter partitioning differed among the cultivars studied. 'Yawn School' had the smallest proportion of total dry weight in the root, while 'Harris Super' had the largest (Table 1).

Media × cultivar interaction. The total dry weight of 'Farley' and 'Yawn School' seedlings was affected adversely by the 4 : 1 mixture (Table 3). Lunt and Clark (7) found that growth depression of some plant species grown in bark was overcome by N fertilization. However, nutrient status of the plants as measured by leaf analysis did not explain the adverse effect of the 4 : 1 mixture in this experiment. Leaf content of plants in that medium had higher N, P, Mg, and Mn levels, lower Ca levels, and no differences in K or Fe content compared with plants in the 1 : 1 mixture (Table 4).

The pH of the 2 media was too high (Table 2), indicating the application of excessive dolomitic limestone. The pH does not account for the differences in cultivar response to the media, however, since the medium with the pH nearer the acceptable range was the mixture that affected some cultivars adversely.

The reason for the cultivar response to different media has not been explained. Since differences exist, it is important to ensure that the cultivar and the growing medium are compatible so that strong, healthy pecan rootstocks may be produced.

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Cotyledon Detachment and Growth of Pecan Seedlings

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Abstract. **The cotyledons of pecan [*Carya illinoensis* (Wang.) K. Koch] seed remain fleshy and turgid throughout an attachment period of several weeks after germination. The growth (dry weight) of the developing seedling was dependent on the cotyledons for the first 3 weeks of the 6–10 week attachment period.**

The kernel of the pecan nut contains about 70% fat (8, 14). This is more than other nut crops; i.e., cashew, pistachio, almond, and filbert have 47%, 55%, 58%, and 64% fat, respectively (3, 14). The pecan seed is large; 'Curtis', a nut commonly used in nurseries, weighs about 5.5 g and contains about 59% kernel. A single pecan seed thus contains appreciable quantities of food reserves.

Germination of pecan seed is hypogeous with the cotyledons remaining enclosed within the stony endocarp. The cotyledons remain attached to the seedling in a fleshy and turgid condition for several weeks after germina-

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