Growth Differences Among Patented Grafts, Seed Orchard Seedlings, and Nursery-Run Seedlings of Black Walnut

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*A major consideration in short-rotation management of black walnut (*Juglans nigra *L.) is the planting of genetically improved stock. Two sources of improved planting stock were compared with nursery-run (i.e., average seedlings obtained from the nursery) seedlings to evaluate differences in diameter, height, and stem form quality. Purdue #1 patented grafts, seedlings developed from direct-seeded nuts (TVA seed orchard), and nursery-run seedlings were compared after 4 years of intensive management. No significant differences were found between patented grafts and the seed orchard material, but both outperformed nursery-run material by 20 to 30% growth increases.* Tree Planters' Notes 40(3):29-32; 1989.

Black walnut, perhaps more than any other hardwood species, is intensively managed in plantations for short-rotation veneer logs. Successful plantation establishment is now fairly common, with growers recognizing the importance of intensive cultural practices such as weed control, pruning, thinning, and in some situations, fertilization *(3-5, 9)* .

Also important for the production of veneer-quality logs in short-rotation management is the planting of genetically improved stock. Possible diameter and height gains of from 15 to 30% above nursery-run stock (average nursery seedlings) have been projected (8), whereas Wright (11) states that "25-year veneer log rotations are entirely possible if we start with a fast-growing variety and care for it intensively."

Although improved seedlings from seed orchard sources have been recommended for more than 20 years, Beineke (1) has advocated the merits of grafted stock from superior trees. Growth and form comparisons between 9-year-old patented Purdue #1 (USDA patent granted Purdue University) grafts and nursery-run seedlings showed net increases for the grafts of 31% in height, 29% in dbh, and 61% in form. In addition, comparisons between seedlings from Purdue #1 grafts and nursery-run seedlings showed increases for the Purdue seedlings of 11% (height), 19% (dbh), and 18% (form), over the nursery-run material.

The purpose of this paper is to report diameter, height, and form differences for a 4-year-old plantation of Purdue #1 grafts, seed orchard nut-seedlings from Tennessee, and nursery-run seedlings from Missouri.

Materials and Methods

The test plantation is located at Harrison, OH, about 20 miles NW of Cincinnati. Soils consist of a Martinsville silt loam (surface layer typically 9 inches thick, subsoil about 35 inches thick), and an Eldean loam (surface layer typically 7 inches thick, subsoil about 29 inches thick). Site index for a 20-year-old, 1-acre intensively managed planting directly adjacent to the study plantation suggests a value of 80+ for black walnut (10).

In spring of 1984, grafts, nuts, and seedlings of the three sources of black walnut were planted in a fescue field. The 1-year-old Purdue #1 grafts (2-year rootstock) were bareroot material, about 10 to 15 inches tall, from West Lafayette, IN; the field-planted nuts were from a Tennessee Valley Authority (TVA) clonal seed orchard (seed sources from Tennessee and northern Alabama) at Norris, TN; and the 1 +0 nursery-run seedlings were barerooted, about 20 to 30 inches tall, from the Missouri State Department of Conservation nursery at Licking, MO. A systematic planting design at 10 by 10-foot spacing was used, with the grafts planted at 40-foot intervals, the seed orchard nuts at 20-foot intervals, and the nursery-run seedlings as "spacer" trees where needed (fig. 1). All sources received similar cultural treatment: sod was removed from the spot (2 by 2 feet) at planting; the spot was sprayed twice annually for weed control with glyphosphate/sim-

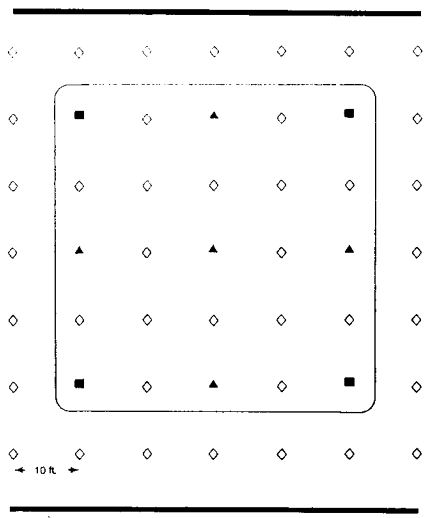

Figure 1—*Plantation design for the patented Purdue #1 grafts* (solid squares), *TVA seed orchard seedlings* (solid triangles), *and Missouri nursery-run seedlings* (open diamonds).

azine, mowed three times annually between rows, and fertilized annually with a 15-15-15 NPK formulation (100 pounds/ acre) beginning in 1985.

Growth and form measurements were taken in fall 1987. Twenty-five Purdue grafts existed in the plantation and all were measured. To keep sample size among the sources approximately equal, 40 seed orchard and 40 nursery-run seedlings were sampled systematically throughout the plantation. Stem diameter was measured at 0.5 and 4.5 feet (dbh) above the ground. Six inches was selected rather than ground level because of the lower stem swelling at the graft unions. Total height was measured to the nearest half foot. Stem form was determined by counting the number of terminal shoots. We used this procedure instead of the 5-point stem rating system employed by Beineke (1) because it seemed less subjective to researchers' rating abilities.

Growth and form measurements for the three sources were analyzed by analysis of variance (P = 0.05). The general linear model procedure and Duncan's multiple range test were used to test variable means.

Results

No significant differences were found between the patented Purdue #1 grafts and the TVA seed orchard seedlings for diameter growth (both ground level and dbh), total tree height, and number of terminal shoots (table 1). Mean values for all but total tree height were very similar for the two genetically improved sources.

Both Purdue #1 grafts and seed orchard seedlings outperformed nursery-run material for growth but not stem form (P= 0.05). Percentage growth differential of the grafts over the nursery-run seedlings were 8.9 for ground level diameter, 28.3 for dbh, 30.7 for total height, and 10.1 for form (table 1). Similar increases were found for seed orchard material versus nursery stock, except that Patented grafts were 9.4% taller than seed orchard material. The

Table 1—*Average diameter, height growth, and stem form for a 4-year-old black walnut plantation comparing patented graft, seed orchard, and nursery-run planting stock*

		Diameter (in)			
Planting stock	N	at 0.5 ft	at breast height	Height (ft)	Form (no. of shoots)
Purdue #1 grafts	25	2.57 ab	1.36 a	10.82 a	1.48 a
Seed orchard seedlings	40	2.61 a	1.37 a	10.04 a	1.48 a
Nursery-run seedlings	40	2.37 b	1.06 b	8.28 b	1.63 a
Percent differential between Purdue #1 grafts and nursery-run seedlings		8.9	28.3	30.7	10.1
Percent differential between seed-orchard seedlings and nursery-run seedlings		10.1	29.2	21.3	10.1

Means within a column followed by the same letter do not significantly differ at the 0.05 level, based on the Duncan's multiple range test.

average gain of 30.7% (2.54 feet difference) in total tree height of grafted stock over the nursery-run seedlings is visually obvious within rows of the plantation (fig. 2).

Discussion

The 28.3% increase in dbh and 30.7% increase in height growth of the Purdue #1 grafts over the nursery-run stock are within the 15 to 30% growth differentials projected for genetically improved material by Rink and Stelzer (8). The two figures are also strikingly close to the 29% dbh and 31% height increases obtained by Beineke (1) for Purdue #1 grafts versus nursery-run material. If these juvenile growth differences can be maintained or improved, perhaps a 30- to 40-year rotation can be reality for black walnut.

Kung (6) and McKeand (7) have both shown through comparison studies of seedlings and mature trees that the height growth and cubic foot volume correlations for black walnut tend to stabilize around ages 3 to 4. For example, Kung (7) found the correlation between juvenile height and cubic foot volume at 30 years reached a plateau at age three. However, form tends to show much more long-term variation.

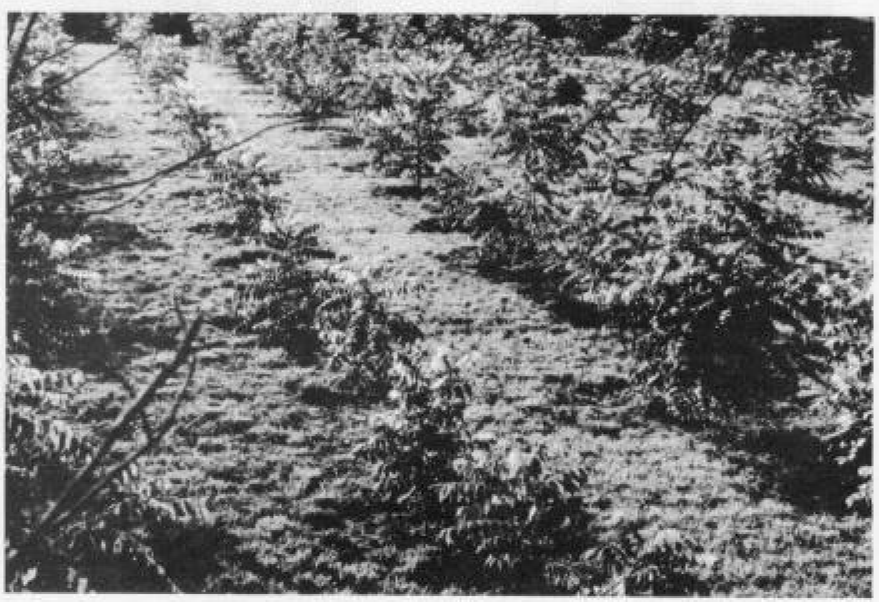

Figure 2—Growth differences can be clearly seen between the genetically improved stock and nursery-run seedlings. The shorter trees in the center row are nursery-run stock. Trees are 2½ years old at the time of the photograph.

Although Purdue #1 grafted material showed a significant growth increase over nursery-run stock, it was no better than the seed orchard improved stock from Tennessee, except for a slight difference in total height. This is somewhat unexpected, since the grafts were 2-year-old root stock and therefore, had an initial growth advantage of 2 years over the nuts of the TVA stock. Part of the growth increase in Tennessee seed orchard stock is probably due to the fact that it is planted approximately 200 miles north of the originating sources in Tennessee and Northern Alabama, and the Purdue grafts are planted approximately 60 miles south of their source. Bey (2) recommends planting sources about 150 miles north of their geographic origins.

One of the major attributes of the Purdue #1 grafted stock has been terminal dominance, leading to excellent stem form (1). Beineke obtained a 61% improvement in stem form for grafts versus nursery stock in Indiana. However, his data and those reported in this paper cannot be compared, due to the different methods used to evaluate stem form in the two studies. Beineke used a 5-point subjective rating system that evaluated the entire stem, whereas in this study only the number of terminal shoots were reported.

Counting the number of terminal shoots revealed no difference between grafts and seed orchard material, and general observation shows both improved sources to have good overall stem form. Even though form is of great importance in black walnut management, 4 years is too early to assess long-term differences. When re-evaluating the three black walnut sources in another 4 years, the Beineke rating system will be used to better detect long-term differences in growth form.

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