Fungicide Treatment Increases Sprouting Percentage and Sprout Growth for *Paulownia tomentosa* Root Cuttings

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Root cuttings are widely used to propagate paulownia— Paulownia tomentosa (Thunb.) Steud.*—for nursery bed establishment, and they can be used to establish plantations. However, the success of outplanted cuttings may be limited by rot. This study showed that paulownia root cuttings soaked in a general-purpose fungicide solution had higher sprouting success (68.3%) than untreated cuttings (21.2%) when planted in silty clay soils. When planted in silty loam soils, sprouting success was similar for treated and untreated cuttings. But treated cuttings in silty loam soils produced sprouts of greater average height (74.1 cm, or 28.9 in) at midseason than did untreated cuttings (48.6 cm, or 19.0 in).* Tree Planters' Notes 45(3):101–103; 1994.

Vegetative propagation via root sprouts is one of the primary methods used throughout the world for establishing *Paulownia* spp. (Stephen 1988). Although root cuttings are relatively easy to obtain and outplant, survival of the root sprouts and subsequent sprout growth can be influenced by cutting size (Fang and Hwang 1979), desiccation (Rin 1979), and cutting rot (Stringer 1994). Root cuttings are generally obtained from plant beds containing 1- or 2-year-old trees. Root systems are excavated and divided into cuttings; then fibrous roots are removed and the cuttings are exposed to the air until the ends have dried. Investigation of the sprouting success and growth of Taiwan paulownia (*Paulownia taiwaniana*) found that after 7 days of ventilated drying, cuttings had lost less than 7% of their moisture, and survival of planted root cuttings exceeded 92% (Rin 1979). However, continued moisture loss was negatively correlated to root cutting survival. Survival decreased to less than 25% when the cuttings were at 54% moisture content (MC), and to 0% when they were at 34% M.C. The timing of sprout development, sprout root weight, and sprout top growth were also correlated to loss of MC (Rin 1979).

Although maintaining root cutting MC at relatively high levels is important for successful plantation establishment, initial air-drying of cuttings is critically important in protecting from rot after cuttings are outplanted. Initial drying seals cutting ends, forming a barrier to fungal penetration. But despite initial drying, outplanted paulownia (*Paulownia tomentosa*) root cuttings in North America remain susceptible to rot, especially if subjected to saturated soil conditions (Stringer 1994). Outplanting at appropriate ground temperatures and moisture levels may reduce rot formation. But rot has been found to decrease sprout growth even when planting conditions are reasonably good; it is the most important factor in planting failures (Stringer 1994). Fungicide treatments have been used to reduce rot in root cuttings of several hardwood species (Keresztesi 1988) and have been suggested for use in paulownia propagation (Beckjord 1984, Graves and Stringer 1989, Stringer 1994).

The objective of this study was to determine the effectiveness of a fungicide treatment on the sprouting percent and initial sprout growth of paulownia root cuttings. The study was conducted on two sites, one with soils considered good for paulownia growth, and one with a history of rot in outplanted cuttings but with acceptable subsequent sprout growth (Stringer 1994).

Methods

Root cutting treatment. Paulownia root cuttings were obtained from 1-year-old half-sib field-grown sprouts averaging 1.92 m (6.34 ft) in height. The root systems of these sprouts were excavated in March 1991. A total of 640 root cuttings from 7.6 to 22.8 cm (3 to 9 in) in length were excised from primary roots and laterals between 1.3 and 5 cm (0.5 and 2 in) in diameter (see Stringer 1994). Cuttings were air-dried in a ventilated shed for 10 days until ends were dry to the touch. One-half of the cuttings (325) were randomly selected and submerged in a fungicide solution for 15 minutes. The solution was a mixture of captan (47.3% ai) and benomyl (Benelate® 50% ai) at 1 g per 416 ml water (2 lb per 100 gal) and 1 g per 833 ml water (1 lb per 100 gal), respectively. Cuttings were allowed to air-dry another 7 days prior to outplanting.

Field planting. On April 12, 1991, cuttings were planted into two fescue-dominated fields in Woodford County, in the outer bluegrass region of Kentucky. Field 1 was located along an alluvial floodplain with less than 5% slope (see Stringer 1994, Study I, for a description). The soils in Field 1 were classified as Ashton silt loam (McDonald and others 1983) and were rated "suitable" for paulownia (Stringer and others 1994). Field 2 was located at the top of a 10% north-facing slope (see Stringer 1994, Study II, Site II, for a description). Soils were classified as Faywood silt loam (McDonald and others 1983) and were rated "questionable" for establishment of paulownia (Stringer and others 1994). Previous studies had shown this field to produce acceptable sprout growth, although rot developing in outplanted root cuttings had resulted in less than 50% survival of the cuttings (Stringer 1994).

Prior to planting in both fields, competing vegetation, primarily Kentucky 31 tall fescue (*Festuca elatior*), was treated with a 2% glyphosate solution (Roundup®) in a 0.75-m (2.5-ft) radius around each planting spot. Planting spots were arranged on a 1.5- by 3-m (5- by 10-ft) grid, and each planting hole was 15 cm (5.9 in) wide and 30 cm (11.7 in) deep. Cuttings were placed vertically in each hole, with the basipetal end approximately 2.5 cm (1 in) below the surface. Holes were backfilled with extracted soil after planting. Each field consisted of four linear planting blocks (or rows) containing 80 cuttings each. Treatments were systematically assigned to blocks, with even-numbered blocks containing treated cuttings and odd-numbered blocks containing untreated cuttings. This resulted in a total of 160 cuttings per treatment in each field. The plantings received no cultural treatments other than the initial competition control. Sprouting percent, total height (to apical bud), and basal diameter were measured in July 1991. Arc sin transformation of sprouting percentage (Steel and Torrie 1980) along with untransformed data of other variables were subjected to statistical analysis using two-sample *t*-tests ($P \leq 0.05$). Comparison between treatments, both within and among sites, were made.

Results and Discussion

Sprouting percent. In Field 2, fungicide treatment produced a significantly ($P \leq 0.05$) higher sprouting rate (68.3%) than did nontreatment (21.1%; figure 1).

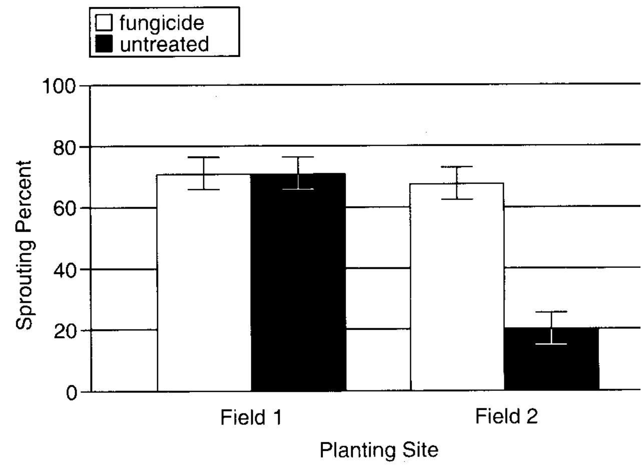

Figure 1—*Sprouting percent of Paulownia tomentosa root cuttings. Bars represent mean and associated standard error of treated (fungicide-soaked) and untreated cuttings planted into tu fields.*

However, fungicide treatment had no effect on sprou ing rate in Field 1, where both treated and untreated cuttings had sprouting rates of about 72%. The treatment/site interaction may have resulted from lower clay content and better soil drainage in Field 1, whict inhibited rot development in the cuttings. Sprouting percent for treated cuttings in Field 2 and for all cuttings in Field 1 was within the range of 67.5-92.5% (mean = 82%) found by Fang and Hwang (1979) for cuttings of Taiwan paulownia of similar size.

Height and basal diameter growth. Although sprouting rates were similar for both treated and untreated cuttings in Field 1, treated cuttings produc sprouts significantly ($P \leq 0.001$) taller by midseason, averaging 74.1 cm (28.9 in) in height compared to an average of 48.6 cm (19.0 in) in height for untreated cuttings (figure 2A). Despite a similar disparity in Fi 2 in height growth of sprouts from treated and untreated cuttings, in this case the difference was not significant. Previous observations indicated that increased rot in root cuttings decreases sprout growt (Stringer 1994). Loss of carbohydrate supply or rot moving from the cutting to the sprout could account for the reduction in sprout growth.

But it is unclear why sprouts from untreated cuttings did not perform as well in Field 1 as they di in Field 2. Perhaps untreated cuttings that sprouted i Field 2, though fewer in number than those in field 1 were substantially free of rot, and therefore capable matching the height growth of sprouts from treated cuttings. Untreated cuttings in Field 1, however, ma have contained enough rot to inhibit sprout growth,

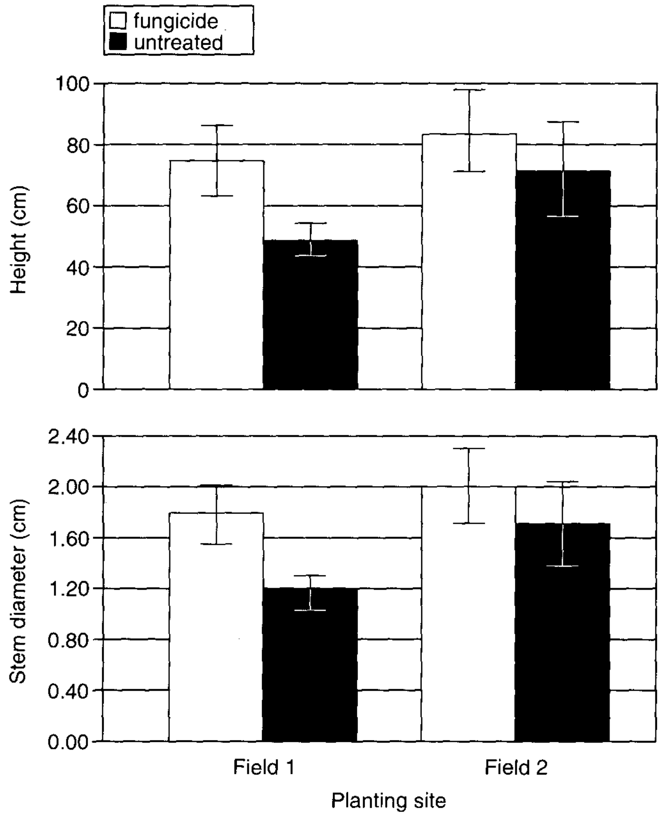

Figure 2—*Height (A) and basal diameter (B) of Paulownia tomentosa root cutting sprouts at midseason (July 1991). Bars represent mean and associated standard error of treated (fungicide-soaked) and untreated cuttings.*

but not enough to produce sprout failure.

These results indicate that soils in Field 2 may not be as conducive to root cutting establishment as soils in Field 1. But after root cuttings are successfully established, soils in Field 2 may produce as much sprout growth as those in Field 1. Although fungicide treatment produced different effects on the different sites, it improved planting success on both sites by increasing sprouting percent on one site and height growth on the other.

Basal diameter growth showed a trend similar to height growth (figure 2B). Field 2 showed no significant difference between sprouts of treated (2.0 cm, or 0.8 in) and untreated (1.7 cm, or 0.7 in) cuttings. But in Field 1, sprouts from treated cuttings averaged 1.8 cm (0.7 in) in diameter, compared to 1.2 cm (0.5 in) for sprouts from untreated cuttings, a significant difference at $P \leq 0.01$.

Conclusions

The success of new plantations using paulownia root cuttings can be enhanced by soaking air-dried cuttings in a general-purpose fungicide solution. In soils considered questionable for paulownia growth, and where previous studies had shown unacceptable sprouting success, 68% of cuttings soaked in fungicide sprouted, compared to 21% of untreated cuttings. In soils considered suitable for paulownia establishment, fungicide treatment had no effect on sprouting percent, but did produce greater sprout height and diameter growth. Fungicide treatments are relatively inexpensive and should be considered for use under all planting conditions for paulownia root cuttings.

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Literature Cited

Beckjord PR. 1984. *Paulownia tomentosa*: A brief guide for the tree farmer. Misc. Publ. 984. College Park, MD: University of Maryland. 13 p.

Fang Y-K, Hwang W-J. 1979. Experiment on the propagation of Taiwan paulownia by root cutting. Quarterly Journal of Chinese. Forestry 12(1):47-62.

Graves DH, Stringer JW. 1989. Paulownia: A guide to establishment and cultivation. FOR-39. Lexington, KY: University of Kentucky, College of Agriculture. 7 p.

Keresztesi B. 1988. The black locust. Boca Raton, FL: H. Stillman Publishers. 197 p.

McDonald HP, Sims RP, Isgrig D, Blevins RL. 1983. Soil survey of Jessamine and Woodford Counties, Kentucky. Washington, DC: USDA Soil Conservation Service. 94 p.

Rin U-C. 1979. Silvicultural studies on Taiwan paulownia (*Paulownia taiwaniana* Hu et Chang) in Taiwan. Taichung, Taiwan: National Chung Hsing University, College of Forestry. 228 p.

Stephen P. 1988. The paulownia: Project report. VCAH-Dookie Campus, Australia. 97 p.

Stringer JW. 1994. Sprouting and growth of *Paulownia tomentosa* root cuttings. Tree Planters' Notes 45(3):00-00.