# Containerized and Nursery Production of Paulownia Tomentosa[1]

**Peter R. Beckjord**
*Ass't Professor of Forestry, Department of Horticulture, University of Maryland, College Park*

***Paulownia tomentosa*** *seedlings were grown in containers in a greenhouse for 110 days and a nurserybed for 193 days. Paulownia growth was slow during the first several weeks of growth in both situations. Later in the season, growth accelerated considerably. Top and root growth was checked when nursery seedlings were root-pruned; however, roots were more fibrous than non-root-pruned seedlings. Detailed procedures for seedling production are presented.*

*Paulownia tomentosa* (Thunb.) Steud., of the Bignoniaceae, is an Asian tree species accidentally introduced in the Northeastern United States nearly 150 years ago (*5*). It has become naturalized in a scattered distribution primarily throughout the southern and central hardwood forest regions (*7*). Paulownia grows remarkably fast (comparable to hybrid poplar). It is used as an ornamental, in shelterbelts (*3*), and as a crop tree for wood products exportable to Japan (9). It also has potential use in reclamation of surface mines (1, 2). These ecological and economic characteristics and the paucity of American literature concerning the silviculture of this species indicated the need to investigate propagation techniques for containerization and nursery production of Paulownia.

1This study was supported in part by McIntire-Stennis Cooperative Forestry Research Funds. The author extends his appreciation to Lori Graunke, Graduate Research Assistant, and the Buckingham Forest Tree Nursery, Maryland Forest Service, Harmans, Md. for their technical assistance.

## Materials and Methods

***Containerized production of seedlings in a greenhouse.*** Paulownia tomentosa capsules were collected from a single tree (about 15 years old) located on the University of Maryland campus on November 21, 1979. Capsules were air dried for 6 days, and seeds were separated by sieving and then stored in a brown-stained glass jar at 3° C. Ninety-five percent of the stored seeds germinated within 6 days on moistened blotter paper in Petri dishes on a windowsill at room temperature.

A loamy topsoil, pH = 5.1, was collected from under a mature Paulownia and autoclaved at 121° C for 2 hours. The growing medium consisted of 14:53 parts by volume moist loam and #3 vermiculite, 1 gram of 14-14-14 (NPK) 3- to 4-month slow-release Osmocote, and 28 milligrams of trace micronutrient per 145-cubic-centimeter growing-cavity per seedling (four cavities per book in a Spencer-Lemaire Hillson container).

Seeds that had been stored 17 days were sown onto the surface of the growing medium on December 14, 1979, and water-misted frequently. The photoperiod was extended to 2100 hours with incandescent lights. Containers were covered with transparent plastic wrapping to maintain high humidity. Seeds germinated in 9 days and plastic wrap was removed 15 days later. Seedlings were thinned to two seedlings per cavity (480 cavities) 30 days after sowing and then to one seedling per cavity 15 days later.

In a separate planting of Paulownia with nonautoclaved loam, damping-off was quick and severe (96 percent mortality within a 7-day period 34 days after germination). A precaution was taken to safeguard all seedlings from possible damping-off with the application of a 1:1 by volume fungicide mixture of 3 grams of Terraclor and 3 grams of Dexon to 8 liters of water. All 480 seedlings were drenched with this mixture. Seedlings were also drenched with 11 liters of water containing 1.4 liters 20-20-20 NPK stock solution of a soluble fertilizer.

Spencer-Lemaire books (with four seedlings per book) were

separated 7 centimeters from edge to edge on a greenhouse bench. Random samples of seedlings were collected for destructive analyses 68, 94, and 110 days from the date of seed germination.

**Nursery production of seedlings.** Seeds were obtained as they were for containerized production in a greenhouse, but stored at 3° C until April 5, 1980, when they were removed and placed on moist paper blotters on a tray, which was covered with a clear window glass. Trays were placed on greenhouse benches, exposed to daylight for 13 days, and then relocated under benches in cooler shade conditions for an additional 4 days until nearly all seeds had germinated.

Sixty-one and a half linear meters of nurserybed previously used for white pine production were rototilled twice, bedded-up, and grooved for planting. Eight planting blocks 7 meters long were delineated with 1.83-meter buffer spacings between them.

Germinating seeds were mixed in a 30.75-liter solution of 1.6-percent Laponite-508 (magnesium silicate). The seed/solution was squeezed from plastic bottles through a narrow opening into the grooves of the bed on April 22, 1980, at approximately 16 seeds per centimeter. Rows were 15.2 centimeters apart. Seeds were mulched with 2 to 4 millimeters of composted sawdust and then irrigated. The nursery soil (pH = 6.3) was a sandy loam with 213, 383, and 225 kilograms per hectare of Mg, $P_20_5$, and $K_20$, respectively. Weeding was done frequently by hand. Dry fertilizer (1:2.mixture by weight of 10-10-10 NPK granular fertilizer to cotton seed meal) was broadcast at .45 kilogram per block only once on June 27, 1980. Seedlings were thinned or transplanted (to vacant areas) within the beds to create a uniform density of seedlings on July 1, 1980, at a 15.2- by 15.2-centimeter spacing. Subsamples of seedlings were removed 113, 127, 141, and 193 days after planting for destructive analyses. Three blocks of seedlings were irrigated and root-pruned on August 11, 1980, by a tractor-pulled lifting bar.

## Results and Discussion

***Containerized production of seedlings in a greenhouse.*** Young *Paulownia* seedlings are subject to damping-off unless proper precautions are taken (e.g., fungicide applications or sterilizing growing media). Young seedlings were small and appeared to be stagnating during the first 30 to 45 days of growth (fig. 1). A taproot with an associated fibrous lateral root system, which extended to a length of the container (15 cm) within 45 days (fig. 2) developed rapidly after germination.

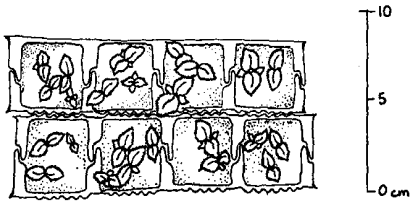


**Figure 1.—***Containerized* Paulownia *seedlings 32 days after planting seed (overhead view). Note secondary leaves about 1 centimeter long.*

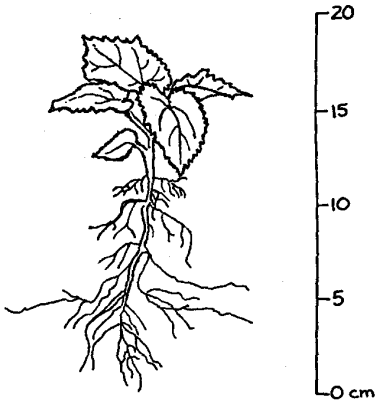


**Figure 2.-***Containerized* Paulownia *seedlings 56 days after planting seed, Note root growth about 12 centimeters long with numerous lateral roots.*

Seedling growth parameters were measured 68, 94, and 110 days after seed germination (table 1). The data indicate Paulownia was in the log phase of growth during the 68- to 110-day period. Immel and others (*6*), Sanderson (*8*), and Downs and Borthwick (*4*), provide more in-

formation on the effects of photoperiods on *Paulownia* growth. Seedlings were quite succulent and required crown space for good development., Crowding encouraged spindliness and defoliation of lower leaves. Overhead watering became difficult because of the tight canopy of adjoining seedlings with large leaves. Frequent waterings are necessary when using containers with restricted volume. Fallen leaves over container openings hindered irrigation.

***Nursery production of seedlings.*** Sheet erosion by wind and rain removed and displaced seeds and sawdust mulch. Mulch accumulated on the sticky surface of the Laponite-508 solution, thus inhibiting seed germination. Laponite-508, which desiccated between irrigations and rains to a crystal-like crust, killed germinating seeds. Increased irrigation and/or more dilute solutions of Laponite-508 may be necessary. Young seedlings developed slowly during the first 45 to 60 days of growth (2 to 6 cm tall after 65 days) like the container-grown seedlings. Transplanting of young seedlings followed with immediate irrigation was successful at 71 days of growth. However, I recommend that transplanting be done no later than this age or when seedlings are not more than 4 centimeters tall, whichever occurs first.

Root-pruning after 112 days of growth reduced top growth and

**Table 1.—***Means and standard deviations[1] of several growth variables for containerized, greenhouse-grown Paulownia* tomentosa *seedlings 68, 94, and 110 days after* seed *germination*

| Growth variables | 68 days old | 94 days old | 110 days old |
|---|---|---|---|
| Height (cm) | 7.9 (8.5 ) | 17.6 (2.86) | 22.2 (3.5 ) |
| Diameter (mm) | 2.99 ( .26) | 3.98 ( .53) | 4.96 ( .42) |
| Fresh weight stems (g) | .68 ( .15) | 2.83 (1.77) | 2.89 ( .52) |
| Fresh weight leaves (g) | 2.82 ( .82) | 6.96 (1.98) | 9.02 (1.43) |
| Fresh weight roots (g) | 1.86 ( .58) | 6.54 (1.88) | 8.50 (2.91) |
| Fresh weight total plant (g) | 5.39 (1.57) | 16.83 (4.31) | 20.59 (3.62) |
| Fresh weight root volume (ml) | 2.83 ( .71) | 5.46 (2.56) | 8.52 (2.64) |
| Dry weight stems (g) | .07 ( .02) | .32 ( .06) | .66 ( .13) |
| Dry weight leaves (g) | .38 ( .13) | 1.13 ( .38) | 1.89 ( .48) |
| Dry weight roots (g) | .15 ( .04) | .48 ( .19) | 1.24 ( .50) |
| Dry weight total plant (g) | .78 ( .55) | 1.94 ( .64) | 3.81 ( .77) |
| Root/shoot fresh | .53 | .67 | .71 |
| Root/shoot dry | .33 | .33 | .49 |
| Number per sample | 15 | 10 | 10 |

[1] Standard deviation in parentheses.

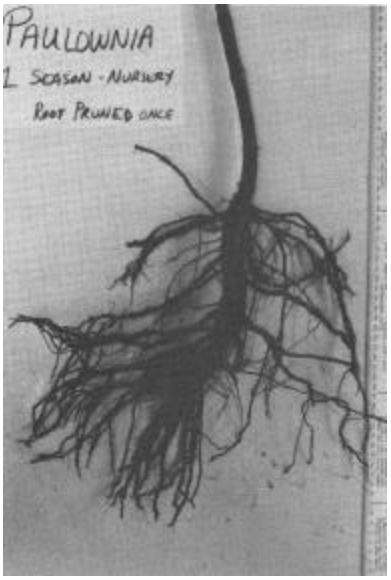


**Figure 3.—***Roots of nursery-grown, root-pruned* Paulownia*. Seedlings 193 days old, root-pruned at 112 days of age.*

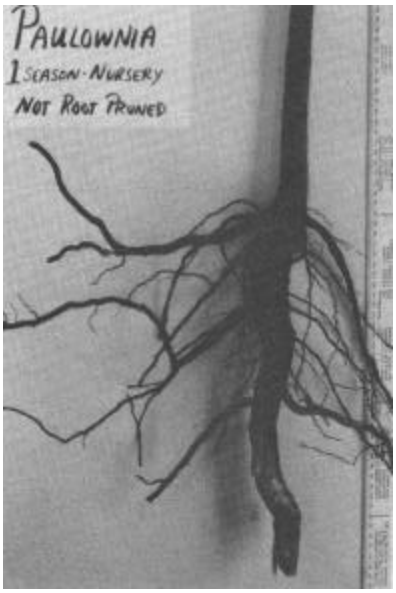


**Figure 4.—***Roots of nursery-grown, non-root-pruned* Paulownia *seedlings 193 days old.*

stimulated development of a fibrous root system. Figures 3 and 4 illustrate the difference in root system fibrousness between root and non-root-pruned seedlings. Seedlings approximately 60 centimeters had tops bent, broken, and damaged by the low clearance of machinery. Bent seedlings were S shaped and retained that shape throughout the season.

Seedling growth accelerated during the 35-day period between 106 and 141 days of growth (about 8.4 times) for non-root-pruned seedlings whereas one root-pruned treatment (on day 105) checked both top and root growth allowing less seedling growth (3 times for the same 35-day period. Growth was quite variable among the seedlings within root-pruning treatments during the season (table 2 and fig. 5). Non-root-pruned seedlings averaged approximately 1 meter in height with a stem diameter of 1.5 centimeters (10 cm from the root collar). The taproot penetrated the soil to a maximum depth of 50 centimeters. Leaf drop occurred late in the fall and dieback of the terminal shoot occurred with freezing temperatures.

**Table 2.—***Means and standard deviations*[1] *of several growth variables for nursery grown* Paulownia tomentosa *seedlings during the growing season*

| | Number of days after planting germinating seed in nurserybed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth variable | 71 | 78 | 85 | 92 | 106 | 113 | 127 | 141 | 141 (Root-pruned)[2] | 193 | 193 (Root-pruned) |
| Top dry weight (g)[3] | —[4] | — | — | 2.15 (3.73) | 5.17 (8.98) | 4.52 (6.74) | 11.82 (13.41) | 35.47 (15.82) | 11.70 (10.01) | 39.11 (28.74) | 12.52 (5.59) |
| Root dry weight (g) | — | — | — | .29 ( .61) | 1.05 (2.19) | .84 (1.08) | 2.81 (3.26) | 9.39 (6.11) | 4.90 (4.24) | 30.11 (22.70) | 18.07 (6.10) |
| Total dry weight (g) | .1 (.13) | .45 (.64) | .58 (1.30) | 2.44 (4.35) | 6.23 (11.17) | 5.37 (7.81) | 14.63 (16.65) | 44.86 (20.26) | 16.61 (14.16) | 69.41 (50.95) | 30.60 (11.30) |
| Number per sample | 32 | 15 | 50 | 39 | 22 | 16 | 20 | 10 | 18 | 16 | 14 |
| | July 1 | July 8 | July 15 | July 22 | Aug. 5 | Aug. 12 | Aug. 26 | Sept. 9 | Sept. 9 | Nov. 1 | Nov. 1 |

[1] Standard deviation in parentheses.
[2] Root-pruned on August 11.
[3] Top dry weight = stem plus leaves for all periods except 193d day, which is for stem only.
[4] – =not available.

**Figure 5.—***Nursery-grown* Paulownias *141 days old. Root-pruned seedlings (left) and non-root-pruned seedlings (right).*

## Literature Cited


1. Carpenter, S. B. This "princess" heals disturbed land. Amer. For. 83: 22-23; 1977.
2. Carpenter, S. B.; Graves, D. H. Paulownia: A valuable new timber resource. Lexington, KY: University of Kentucky, College of Agriculture, Cooperative Extension Service; 1979; FOR 11. 7 p.
3. Dickerman, M. P.; Duncan, D. P.; Gallegor, C. M.; Clark, F. B. Forestry today in China, report of a month's tour by a team of American foresters. J. For. 79: 71-79; 1981.
4. Downs, R. J.; Borthwick, H. A. Effects of photoperiod on the growth of trees. Bot. Gaz. 117: 310-326; 1956
5. Hu, S. Y. A monograph of the genus Paulownia. Quart. J. of Taiwan Museum. 12(1-2): 1-53; 1959.
6. Immel, M. J.; Tackett, E. M.; Carpenter, S. B. *Paulownia* seedlings respond to increased daylength. Tree Plant. Notes 31(1): 3-5; 1980.
7. Larson, R. O. The Paulownia tree. Sheboygan, WI: American Paulownia Corp.; 1981. 3p. Available from American Paulownia Corp., Box 554, 1221 A. Superior Ave., Sheboygan, WI.
8. Sanderson, K. D. Effect of photoperiod on the growth of empress tree (*Paulownia tomentosa*) seedlings. Ala. Agric. Expt. Sta. Hort. Ser. 18: 10-11; 1972.
9. Tang, R. C.; Carpenter, S. B.; Wittwer, R. F.; Graves, D. H. Paulownia-A crop tree for wood products and reclamation of surface-mined land. So J. of App. For. 4: 19-24; 1980.