A Practical Method for Production of Paulownia tomentosa[1]

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A practical method for producing Paulownia tomentosa *planting stock in the nursery is presented. The maximum mean seedling height (85 centimeters) was obtained from seedlings thinned to 20 per square meter, and the maximum root collar diameter (1.6 centimeters) was obtained from seedlings thinned to 10 per square meter. Unthinned beds yielded 200 to 300 seedlings per square meter with an overall mean height of 37 centimeters and a mean root collar diameter of 0.4 centimeter.* Tree Planters' Notes 37(2):8-11; 1986.

Expectations of significant returns from exports of Paulownia tomentosa logs cut from naturalized trees have spurred interest in its cultivation. Experimentation and planting trials were initiated in the 1970's by several private entrepreneurs as well as researchers at the University of Kentucky to determine the suitability of paulownia as a highvalue species for surface mine reforestation (3,7). As paulownia exports increased, the potential of planting specifically for timber production gained widespread publicity (6). During this time researchers worked at developing techniques for storing and germinating seed, seedling production, and outplanting (1,4). Unfortunately most of the successful methods developed for producing planting stock incorporated greenhouses or other facilities not normally available for widespread use. The utilization of artificial environments raised the cost of seedlings far above the costs of most other tree species ($0.55 per seedling). These costly methods were used because many of our normal nursery practices led to total failures or at best sporadic successes when applied to paulownia. To date, even nursery practices developed specifically for paulownia have proved less than adequate (1). Because of these failures, it became increasingly apparent that new tactics were needed if a successful means of producing low-cost paulownia planting stock was to be established.

In 1981 a study was initiated to determine a practical method of producing various types of paulownia planting stock. The study was undertaken with the premise that the methods and equipment utilized would allow not only tree nurseries but many landowners to produce their own planting stock. The search for a successful procedure meeting the above criteria led to the incorporation of a technique commonly used by tobacco farmers in the southeastern United States. Tobacco seed are very small, as are paulownia seed, and many of the same problems are encountered in nursery bed production of both species. A summary of successful procedures derived from this study is given below. Specific study methods and results will also be discussed.

Procedures

The procedures outlined here are general guidelines for nursery bed production of paulownia planting stock. Individual situations may necessitate minor changes or additions to these procedures; however, the techniques employed for germinating the seed should produce adequate results over a wide geographical range.

Nursery beds should be located in areas with good drainage. Maintenance of sandy or heavy loam soil is imperative, for the young plants are susceptible to waterlogging. A minimum soil porosity of 50 percent, with a noncapillary porosity of at least 10 percent is recommended (8). Soil pH should be maintained between 5 and 8. Avoid locating beds in frost pockets. Early autumn frosts can injure the succulent foliage of this plant, and extreme winter cold can lead to root collar wounding and rootstock mortality.

The beds should be cultivated in early spring and covered with clear plastic (4 mil). Methyl bromide should be applied to kill unwanted seeds, nematodes, and fungi harbored in the soil. After the danger of frost has passed, the plastic can be removed and fungicide (such as

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captan 50 W) incorporated to a depth of 10 to 15 centimeters. The beds should be raked to produce a relatively smooth surface. Fertilizer should also be applied at this time. Detailed fertilizer requirements are not known for *Paulownia tomentosa*; however, the need for certain micronutrients has been expressed by several workers. The following fertilizer regime proved successful under our soil and climatic conditions: a slow-release NPK fertilizer such as Osmocote (14-14-14) at 400 grams per square meter, a slow-release micronutrient additive such as Micromax at 80 grams per square meter, and gypsum and dolomite at 200 grams per square meter each. A single fertilizer application should be sufficient for the entire growing season and should not produce any significant problems with the dormant or germinating seeds. After the beds are moistened, seeding can be undertaken at a rate of approximately 0.2 gram per square meter. Scattering the seed can best be accomplished by hand on a windless day.

Maintenance of a moist environment during germination and initial seedling development is one of the most important steps for ensuring successful germination and establishment. Desiccation for even short periods can be fatal during the early development of the radicle. Desiccation of radicles has been observed between irrigations during afternoons when temperatures were high and relative humidities were low. The small seeds on the soil surface are able to support only one attempt at radicle emersion, making the microenvironment surrounding the seed critical. A soil amendment, mulch, or a covering over the bed is necessary to maintain an adequate moisture regime. Trials with soil amendment or mulch have led to sporadic results. This is due to movement of the mulch, amendment, and/or seed by wind or by the direct impact of water from precipitation and irrigation.

Maintenance of the proper environment, while avoiding the problems mentioned above, can be accomplished by covering the nursery bed with a spunbonded polyester or nylon canvas, commonly known as a "tobacco plant bed cover" (figure 1). This covering suspended above the bed allows light, which is necessary for paulownia seed germination, to filter through while alleviating the adverse effects of water and wind. The covering disperses the incoming water droplets, allowing only a fine mist to reach the soil surface and provides a warm, moist, and undisturbed environment at the soil surface (figure 1). This type of covering is used extensively in the United States for growing tobacco transplants. Light-weight cotton or cheesecloth could also be used, but the synthetic material is much less expensive and readily avail-

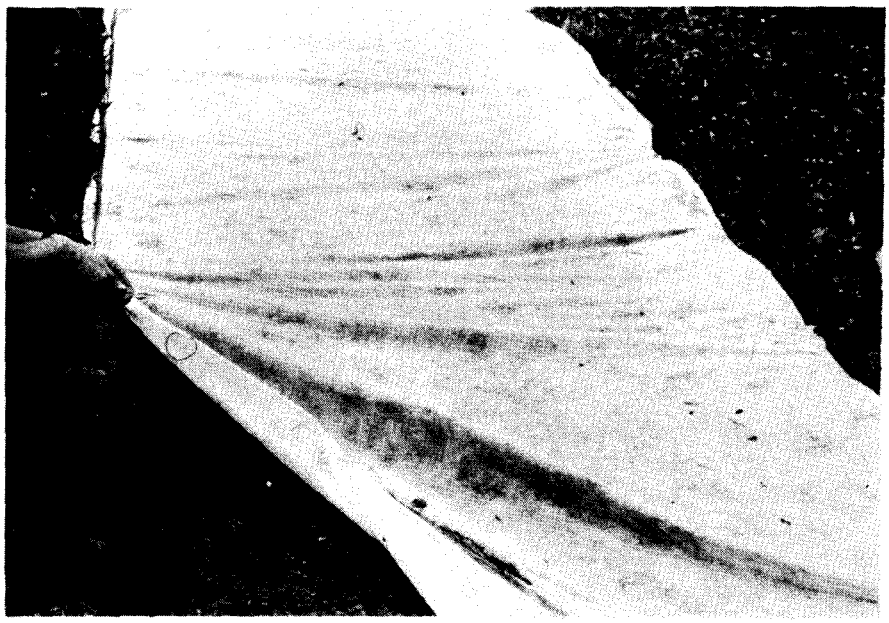

Figure 1—*Paulownia plant bed with tobacco plant cover suspended above the soil surface. Seedlings are less than 1 centimeter high.*

able. The covering can be suspended over the soil surface by a series of arched wires placed along the center line of the bed, by attaching it to a wooden frame surrounding the plant bed, or by a very small amount of straw spread over the soil. If the covering is allowed to contact the soil the plants will grow through the cover and it will not be possible to remove the cover without damaging the seedlings. The covering can be removed when the seedlings average 4 to 8 centimeters in height.

Seedling density is important in producing good planting stock. Thinning should be completed when plants average 20 centimeters in height. Postponing the thinning leads to small spindly plants. Thinning is necessary for proper development, but the specific level depends upon the type of planting stock being produced. Thinning is best accomplished by hand, leaving the most vigorous seedlings intact. Thinning levels will be discussed in a later section.

Overhead irrigation can be used to ensure maintenance of a moist seed bed. Overwatering, however, can quickly lead to seedling decline. Irrigation should be reduced in September. Normally, either entire root systems or root cuttings should be used as planting stock. The use of bareroot seedlings is not recommended. Leaves should be allowed to abscise prior to pruning the main stem at the groundline. Rootstocks should overwinter in the beds, covered with 5 cm of a mulch such as sawdust. Mulch is necessary when ground temperatures are expected to fall below 0 °C. The rootstocks can be outplanted in the spring or allowed to grow a second year in the nursery bed or moved to a transplant bed to produce 2-0 or 1-1 planting stock, respectively. A good review of handling procedures for paulownia planting stock is given by Kundt (S).

Study Methods

The 1.2- by 15.2-meter beds were elevated 20 centimeters above groundline and were composed of equal parts sand, topsoil, and sawdust. In mid-April the beds were covered with 4-mil-thick plastic and treated with methyl bromide (two 1-pound cans of Brom-O-Gas). One week later the plastic was removed. Fertilizer and seed were then scattered over the bed as described in the procedures section. A supplemental fungicide treatment was not applied in 1981. However, captan 50 W was incorporated to a depth of 10 to 15 centimeters in 1982. The seeding rate of 0.2 grams per square meter equaled approximately one-half cup for the 1.2- by 15.2-meter bed. In 1981 three-quarters of the bed was covered with a spunbonded polyester canvas suspended approximately 2 to 10 centimeters above the bed surface, and the remainder left uncovered. Overhead irrigation was necessarily increased on the uncovered portion of the bed.

In 1982 four thinning treatments were applied when mean seedling height was 20 centimeters. Various portions of the bed were hand thinned, leaving 10, 20, and 100 seedlings per square meter, and an unthinned control. Total height and root collar diameters were measured at the end of the growing season.

Results and Discussion

1981. The seeds in the uncovered portion of the bed failed to germinate or were desiccated after germination even though they were irrigated daily. The direct impact of water droplets from both precipitation and irrigation allowed much of the seed to be washed into concentrated areas or buried by the shifting soil. Seed burial resulted in reduced germination by decreasing the level of light reaching the seeds to below that necessary for germination.

The covered portion of the bed produced approximately 300 plants per square meter with a mean height of 30 centimeters. However, over the course of the growing season, the seedlings stagnated and portions of the bed exhibited dieback. Pathological investigation identified a root decay fungus *(Rhi*zoctonia sp.) and an anthracnose fungus (*Colletotrichum* sp.). Therefore, the initial methyl bromide treatment was supplemented with captan 50 W in 1982 to provide

continued protection against fungal invasion.

1982. The thinned seedlings had increased height and root collar diameters compared with the unthinned seedlings (table 1). The unthinned treatment yielded approximately 200 seedlings per square meter with a mean height of 37 centimeters and a mean root collar diameter of 0.4 centimeter. There was no dieback in the unthinned treatment as in 1981, possibly due to the increased protection afforded by captan 50 W. Root collar diameters and observed root sizes were inversely related to seedling density. Between the thinned treatments, diameters ranged from 0.5 centimeter (100 per square meter) to 1.6 centimeters (10 per square centimeter). Average height ranged from 85 to 61 centimeters for the 20 and 100 seedlings per square meter treatments. The 20 seedlings per square meter treatment also produced the smallest range (10 centimeters) in seedling height.

The thinning level selected depends upon the type of planting stock required. A thinning level with a high residual density can be employed if 1-0 or 1-1 seedlings or rootstocks are to be outplanted. However, if 2-0 stock is being produced, one of the heavier thinning levels should be utilized. Subsequent thinnings may also be necessary if 2-0 stock is being produced. Regardless of the planting stock being produced, tops of seedlings should be pruned at groundline for outplanting as well as for increasing winter survival.

Table 1—*Response of* Paulownia tomentosa *to various thinning levels*

	10/m²	20/m²	100/m²	Unthinned
Mean height (cm)	76	85	61	37
Range height (cm)	63–92	81–91	52–65	21–63
Root collar diameter (cm)	1.6	1.1	0.5	0.4

Conclusions

Although establishing *Paulownia* plantations is still a popular idea, past planting failures have caused many to become disillusioned with the species. As with any new species, it will take time to successfully determine all the techniques necessary for plantation culture. However, the procedures outlined in this article should help to rectify some of the problems normally encountered during seed germination and planting stock production. Beckjord (2) has compiled further information on plantation culture; however, it must be realized that the cultivation of paulownia is a recent phenomenon in the United States and only long-term results will determine the effectiveness of our current recommendations.

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