Seedling Propagation in Bottomless Bands

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INTRODUCTION

S & S Nurseries, Inc., produces both container- and field-grown trees and shrubs for the landscape and garden center industries. For many years our tree production started with bareroot seedlings purchased from other nurseries. The quality of these plants was variable at best, and often poor. Because of the need to improve on the quality and the availability of bareroot seedlings, our own tree seedling production was started 11 years ago. It was determined from the beginning that a bottomless container for air pruning the roots was the way to go.

Seedling Containers. When we first started, a tray with 38 cone shaped cells 5.1 cm (2 inches) wide at the top and 12.7 cm (5 inches) deep, was used. After 3 years and numerous problems, we switched to the Anderson bottomless bands. This container is 9.2 cm (3.6 inches) square at the top by 15.2 cm (6 inches) deep with a very slight taper. Twenty-five of these fit in a Lerio 46-cm (18-inch) square tray.

Greenhouse Propagation Facilities. We construct frames 1.2 m (4 ft) wide, which rest on concrete blocks placed two high [38 cm (15 inches)]. The frames are made of 5 cm × 10-cm (2 inch × 4 inch) treated lumber, which is laid on top of the blocks. A 1-cm (0.5-inch) hardware cloth is stretched and nailed to the framework. Last year, because of the cost of materials and labor, we tried using two rows of 5 cm × 5 cm (2 inch × 2 inch) treated lumber under each row of trays. The hardware cloth benches worked very well for air pruning the seedling roots, but due to age, water, and people walking on the wire, the first ones we built needed to be replaced. The 5 cm × 5 cm-(2 inch × 2 inch) treated lumber has worked well the past 2 years. We can utilize 19,700 bands (liner pots) per 7.3 m × 29.3 m (24 ft × 96 ft) house at three trays wide per bed and four beds per house. We have 29 houses dedicated to seedling production.

Seed Requirements and Pretreatment. It is important to know the approximate number of seeds per pound and average viability for each species in order to calculate your requirements. We buy most of our seed from seed specialists. Several genera do not do well if the seed is not immediately collected and used fresh. For this reason I specify fresh seed with all our species, when possible. *Acer rubrum, A. palmatum, Cornus florida*, and *Prunus caroliniana* are collected on or near our nursery. Until last year, seedling oak production had been a problem. Frequently 20% to 50% of the acorns we bought had weevil holes. Last year we changed our seed source. Not only was the price as much as 50% less, there were virtually no bad acorns. It is very important to compare price and quality from several seed sources, and to keep good records on performance. Seed orders are placed each September.

As the seed start arriving they are placed in airtight containers in our cooler at 1.7 to 4.4C (35 to 40F) until we are ready to use them. Preplanting treatments vary by species and condition of the seed. Seed of species such as *Betula, Metasequoia,* and *Cercidiphyllum* require no pretreatment. Hence, they are sown in flats and placed in a heated house early enough in the year to have seedlings ready to transplant by March 15th.

The medium used for stratification is either 100% sand or sand and peat (1 : 1, v/v). The fungicide captan is added at 149 g m^{-3} (4 oz yd^{-3}). The sand is sifted through a fine wire screen so there are no large particles to separate from small seed after propagation. The peat is also sifted through a 0.6-cm (0.25-inch) screen to break down any large pieces. The medium is moistened to a point where water drips out when a hand full is tightly squeezed.

Information on seed count, stratification, and media can be found in Table 1. The complied information was initially taken from references (Dirr 1990; Dirr and Heuser 1987: Schopmeyer, 1974; and Vertrees, 1987), and then modified by our experience over the years as to what best fits our propagation systems.

Seed Propagation Schedule. A schedule is established each year so that rather than having all seed ready to plant at the same time, seed propagation is staggered over a 6- to 8-week period. This schedule is based on length of stratification, planting to emergence time, hardiness, and average growth rate. We usually start planting seed and seedlings during the first week in March. We try to be finished before the 1st of May. Timing and early planting is very important. This year because of a delay in receiving new bands, part of our dogwoods were not planted until after the 1st of June. After 4 months, those seedlings were only about 0.3 m (1 ft) tall. All seed and seedlings planted before April 10th are maintained in a covered, unheated house. We have never had any cold damage, although a couple of years we have had to use temporary heat for short periods because of late, hard freezes.

Seed Sowing. As the seed are removed from the cooler, the medium used in stratification is removed. The seed are spread out and allowed to dry just enough to be able to handle easily. The seed are then carried to the houses and planted by hand. Our people work in pairs, one on each side of the bed. With most species each team can plant seed into 15,000 to 16,000 bands per day. Because we plant four birch seedlings per band (for clumps), transplanting this genus is very slow and labor intensive. We experimented this year with broadcasting the seed on top of the media-filled bands, and later thinning to 4 to 5 seedlings. This worked very well with much less labor.

After the oaks have received their required stratification, the acorns are spread out on burlap and covered with more burlap in a heated house. They are watered 3 to 4 times per day. We do not plant acorns until the radical has emerged and turned. The acorns are then planted one per band on their side with the radical downward. This assures us a very high percentage of bands with plants, and gives us a good straight plant.

Because of frequent poor percentages with *Cercis canadensis,* this species is planted 8 seed per band. All other species are planted 2 to 4 seed per band depending on past germination experience. When the seedlings are 5 to 7.6 cm (2 to 3 inches) tall they are thinned, leaving only the strongest seedling in each band.

Volume of Seedling Production and Finished Seedling Liner Size. Our production was less than 100,000 plants the first couple of years, but has increased annually since that time. Seedling production is now up to 500,000 tree bands and 150,000 pots this year. Flowering dogwood (*C. florida)* is the primary species (300,000) that we propagate. We use about one-third of the plants ourselves and sell the rest. Overall, we cull-out approximately 20% as inferior plants.

By the end of the growing season, most of the trees are 0.9 to 1.2 m (3 to 4 ft) tall with a 0.6- to 1-cm (0.24 to 0.38 inch) caliper. Some species, *Betula, Cercidiphyllum,* or *Metasequoia*, will be 1.5 to 1.8 m (5 to 6 ft) tall. This compares to a maximum of 0.5 to 0.6 m (1.5 to 2 ft) height obtained when we were using the smaller cone-shaped liner cells. By the time the plants go dormant in the fall, they have a very good fibrous root system due largely to air pruning during propagation. We go directly to 19-liter (5-gal) containers or to the field in October-November. We experience virtually no loss, which certainly could not be claimed when trees were planted bareroot. We also get more growth during the following year compared to bareroot seedlings.

One thing we have observed is that every year one species of oak grows much slower than other species. What is peculiar is that slower growth occurs in different species each year, but never the same species for two consecutive seasons.

Our other major seed crop is *Hydrangea quercifolia* (100,000 were propagated this year). Seed are collected in late December and planted in seed flats under heat and mist. As soon as seedlings are 1.9 to 2.5 cm (0.75 to 1 inch) tall they are transplanted into 10-cm (4-inch) pots in April in clumps of 4 to 5 seedlings. They are pruned heavily 2 to 3 times during the growing season, and produce a heavy 20- to 25-cm (8- to 10-inch) tall plant by fall.

Sanitation, Disease, and Weed Control During Propagation. During propagation we reuse as many bands as possible to reduce our production costs. These are thoroughly cleaned before use. Regretfully, we do not have the capacity to sterilize the large volume of soil 688 m^3 (900 yd^3) required to produce a half million liner bands. However, the bark used does go through a heat treatment.

After planting, all bands are treated with fungicide every 7 days during the first month to 6 weeks, after which, they are treated as needed. Dogwoods are treated every 7 days throughout the growing season. One note of interest — we tried growing dogwood under shade to get more growth, but were unable to control powdery mildew. Insecticides are applied only as needed. Most years we have few insect problems, although this year we have had major problems with white flies. All houses are cleaned and treated with an herbicide 2 to 3 weeks before the seedling trays are moved in. No herbicide is used until the seedlings are approximately 1 ft tall. At that time an application of Scott's Ornamental Herbicide II is applied (mid June). A second application is applied in mid September.

Soil Mix and Fertilization for Seedling Production. The bands are set up in the Lerio trays and filled with soilless medium using a Bouldin and Lawson canning machine. The mix consists of peat moss, perlite, and bark (2 : 5 : 11, by volume). To this is added 4.8 kg m^{-3} (8 lb yd^{-3}) of Nutricote Total 18N-6P-8K, 2.1 kg m^{-3} (3.5 lb yd^{-3}) dolomitic lime, and 1.2 kg m^{-3} (2 lb yd^{-3}) magnesium sulfate. Seedlings are top-dressed usually two times during the growing season with 17N-17P-17K fertilizer.

Concerns. The chance of poor germination is always a concern. No matter where you acquire your seed, nor how careful you are in handling the seed, there is always something that can go wrong. Rodents and birds are always a potential problem. A fungal pathogen can wipe out an entire species within a few days if not monitored closely.

This year consistently high temperatures [97 days at 32C (90F)] slowed seedling growth, particularly with species such as *Betula* and *Magnolia*.

Table 1. Seed count, seed handling, and stratification requirements of species propagated at S&S Nurseries.

Plant	Seed per pound	Special seed pretreatment	Cold stratification (days)	Propagation medium
Acer burgerianum	29,000	Soak in warm H_2O for 2 days	90	Sand : peat
A. tartaricum subsp. ginnala 'Flame'	17,000	Soak in warm H_2O for 2 days	90-150	Sand : peat
A. palmatum f. atropurpureum	19,000	Soak in warm H_2O for 2 days	120	Sand : peat
A. palmatum (small seed)	25,000	Soak in warm H_2O for 2 days	120	Sand : peat
A. rubrum	22,000	Collect and plant in spring		
A. saccharinum	1700	Collect and plant in spring		
A. saccharum	7000		40-90	Sand : peat
A. truncatum	6400	Soak in warm H_2O for 2 days	120	Sand : peat
Betula nigra	375,000	Sow on surface of flats under mist	30-60	Sand
B. platyphylla var. *japonica*	410,000	Sow on surface of flats under mist	30-60	Sand
Cedrus deodora	3700	Use dryer propagation media	14	Sand
Cercidiphyllum japonicum	64,000	Sow on surface of flats under mist		
Cercis canadensis	18,000	Scarify for 30-60 min with H_2SO_4, followed by hot H_2O soak for 24 h	60-90	Sand : peat
Chionanthus retusus	14,400	Warm stratification for 1-3 months	90	Sand : peat
Cornus florida	4500		120	Sand
C. kousa var. *chinensis*	9700		120	Sand : peat
Cotinus coggygria Rubrifolium Group	44,000	Scarify for 30-60 min with H_2SO_4	80	Peat
Crataegus phaenopyrum	29,000	Scarify for 30-60 min with H_2SO_4	120	Sand : peat
Fraxinus pennsylvanica	17,000	Soak in H_2O for 14 days, change H_2O daily	90	Sand : peat
Gymnocladus dioica	230	Scarify for 8 h with H_2SO_4, followed by 24 h water soak		

Koelreuteria paniculata	2900	Scarify for 60 min with H_2SO_4	90	Sand : peat
Liquidambar styraciflua	82,000		30	Sand
Liriodendron tulipifera	15,000		90	Sand : peat
Magnolia grandiflora	6400		120	Sand : peat
Magnolia virginiana	7500		120	Sand : peat
Metasequoia glyptostroboides	300,000	Sow on surface of flats under mist		
Myrica cerifera	84,000	Remove wax coating	90	Sand : peat
Nyssa sylvatica	3300		90	Sand : peat
Oxydendrum arboreum	2,000,000+	Plant on surface of flats, cover flat with plastic and use continuous light		
Pinus densiflora	52,000	Soak in H_2O for 2 days	20-30	Sand
P. elliottii	13,500	Soak in H_2O for 2 days	60	Sand
P. nigra	26,000	Soak in H_2O for 2 days	60	Sand
P. strobus	26,500	Soak in H_2O for 2 days	60	Sand
P. thunbergii	34,000	Soak in H_2O for 2 days	30-60	Sand
P. virginiana	55,400	Soak in H_2O for 2 days	30	Sand
Pistacia chinensis	7200		90	Sand : peat
Platanus occidentalis	149,900	Sow in flats—cover with 0.6cm (0.25 inch) medium, propagate under mist	60	Sand
Prunus caroliniana	1200		90	Sand : peat
Pyrus calleryana	41,000		60-90	Sand : peat
Quercus acutissima	110		90	Sand : peat
Q. lyrata	140		40	Sand : peat
Q. nigra	400		30-60	Sand : peat
Q. texana (syn. *nuttallii*)	110		60-90	Sand : peat

Q. palustrus	410		90	Sand : peat
Q. phellos	480		90	Sand : peat
Q. rubra	125		30-60	Sand : peat
Q. shumardii	100		30-60	Sand : peat
Q. virginiana	350	Plant in fall as soon as collected		
Sophora japonica	480	Soak in hot H_2O for 2 days		
Taxodium distichum	5200	Soak in ethyl alcohol for 30 min, then soak in H_2O for 3 days, daily changing water. Use very wet peat.	90	Peat
Ulmus parvifolia	120,600		60-90	Sand : peat
Zelkova serrata	32,000		60-90	Sand : peat

SUMMARY

Tree production in bottomless bands has become an important part of our business. We are always looking for ways to improve the quality of our production system. Cost of materials, seed, and labor are always a concern. As with all other aspects of our industry, production cost, plant quality, and profit margin must be watched closely and kept in balance.

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