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UTILIZING AIR ROOT PRUNING IN NURSERY SEEDLING PROPAGATION

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Judkins Nursery decided to diversify its product line by starting two new operations: tree growing in 5-gallon containers, and field production of large-caliper trees. A new propagation facility was needed to supply a broader range of plant species and better quality liners to the new operations.

Why use the air root-pruning system? *First*, it produces a superior root system without the winding common in other types of container-grown seedlings. *Second*, it offers accelerated growth through controlled growing conditions. *Third*, the liners can be moved to the next step in the production cycle without shock or loss of the momentum gained from the accelerated growth. *Fourth*, the transplanting can be done in the late summer or early fall when the nursery work load is at its lowest point. This system was brought to management's attention by the writer, who had observed the work of Dr. Carl Whitcomb and his students in experimenting with growing seedlings in milk cartons. These experiments were reported at Oklahoma State University Nursery Research Field Days over a period of several years.

There were two main objectives of the new system. *First*, to produce a salable 6- to 8-foot tree in a 5-gallon container in two growing seasons from a seed. *Second*, to produce a better quality liner for the field that could be transplanted in late summer or early fall.

FACILITY AND MATERIALS

The site was graded to assure good drainage and covered with approximately 2 in. of ¾-in. aggregate crushed limestone. Three water lines were installed 30 feet apart with risers 32 feet apart in each line. This spacing allowed the placement of five raised

benches between each set of risers.

The benches were constructed by laying three rows of landscape timbers on the ground, each row 80 feet long. On top of these were placed five cattle or corral panels, each measuring 52 inches wide by 16 feet long. This created a bench approximately 4-in. off the ground, measuring 52 in. wide by 80 feet long.

Each bench accommodates 153 Lerio plastic flats in 51 rows, three flats wide. The flats have grid bottoms, which allow air root pruning. Each flat holds 25 square, bottomless pots measuring 3⅝ in. by 6 in. deep.[1] Thus, each bench holds 3,825 pots.

The potting mix used was the same as the nursery's container mix and consists of four parts fine ground pine bark and one part concrete sand. To each cubic yard of this mix is added 12 pounds of dolomitic limestone, six pounds of Osomocote 18-6-12, and 1½ pounds of Micromax.

OPERATIONS

Seed stratification was carried out for each species in the normal manner using, by volume, 50 percent sand and 50 percent peat as the stratification medium. The sand and peat were screened so that the particles would be smaller than the seed being stratified. This was to facilitate screening out the seed at the time of seeding.

Flats were prepared for pots by placing a folded sheet of newspaper in the bottom of each flat. Pots were filled individually and tamped to prevent the mix from sifting out the bottom during handling. The newspaper in the flats kept the mix from washing out the bottoms of the pots once they were in place. By the time the newspaper had deteriorated, the mix had settled enough to stay in place. Each person in the pot-filling crew filled and placed on the benches 35 flats per day, or 875 pots. Pot filling was managed so that pots were filled seven to 10 days ahead of seeding.

As each species of seed came due for seeding, the stratification medium was screened out of the seed to facilitate seeding. Small seeds were sown in multiples in each pot according to germination projections. Large seeds (the *Quercus* species) were pre-germinated and seeded one per pot as soon as a radicle was apparent. These seeds were examined every one or two days and only those ready were planted. All seeds were covered with sand to the appropriate depth. Seeding began on March 3, 1986, and was completed on April 25, 1986.

After seeds had germinated, some pots had no seedlings in them. When it was time to thin the multiple seedlings, some of these were transplanted to the pots having none.

Weeds were controlled by hand, and spraying was done on an

[1]McCalif Growers Supplies, Inc., 2215 Ringwood Avenue, San Jose, CA 95131, (408-946-5773).

as-needed basis to control insects and diseases. Fertilizer in the mix was supplemented with both hand fertilization and overhead sprinkler-applied fertilizer. This was begun the first week in June. Ammonium nitrate was hand-applied at the rate of ¾ lb. per 100 ft.^{2}, once each week. Liquid 12-3-3 fertilizer was also applied once each week through the irrigation system at the rate of 2.9 lbs. per 100 ft.^{2}. The fertilizer was discontinued on September 1.

Beginning on September 22 liners that had previously been graded and pruned were shifted up to 5-gal. containers. The container mix previously cited was used except that a 12-6-6 nursery fertilizer was substituted for the Osmocote. The rate was 5 lbs. per yd.^{3} These containers were placed can-to-can and were mulched with straw to carry them through the winter. The remaining liners were planted in the field in 6½-foot rows, four feet apart in the row. Every fourth row was skipped to leave a drive for digging later. These liners were planted in October and November when weather permitted, and will be grown to 2 in. and larger caliper. Plans called for the installation of drip irrigation of these trees when possible.

COSTS

To arrive at a cost per seedling, the durable materials were amortized over their estimated useful life. Container yard space and benches were amortized over five years, and pots and flats were amortized over three years. These indirect costs were 8.1 cents per pot and direct costs for materials and labor were 28.3 cents per pot. The total cost per pot was 36.4 cents. The average percentage of pots producing usable liners was 59.5, making the average cost per usable liner 61.2 cents. This somewhat high figure was caused by the almost total failure of two or three species of the 18 that were attempted. However, most of the *Quercus* species were highly successful, yielding 92 to 96 percent usable seedlings. Table 1 lists the species attempted and the estimated percentage of pots producing usable seedlings.

Table 1. Species attempted and the estimated percentage of pots producing usable seedlings.

Species	Percentage	Species	Percentage
Acer rubrum	0	*Pistacia chinensis*	96
Betula nigra	1	*Quercus acutissima*	88
Cercis canadensis	50	*Quercus alba*	25
Elaeagnus angustifolia	50	*Quercus falcata* var. *falcata*	50
Koelreuteria paniculata	84	*Quercus nigra*	96
Liquidambar styraciflua	96	*Quercus palustris*	96
Liriodendron tulipifera	25	*Quercus phellos*	96
Pinus sabiniana	50	*Quercus rubra*	50
Pinus strobus	10	*Quercus shumardii*	92

PROBLEMS AND POSSIBLE SOLUTIONS

As mentioned, seeds of some species totally failed to germinate. Some failure was attributed to incorrect stratification procedures. In other cases, poor germination was due to covering the seed too deeply. In those cases where corrective action cannot be determined with reasonable certainty, the species will be dropped from the propagation schedule. Some seeds germinated successfully, but the seedlings were frozen shortly afterwards. Therefore, planting should probably begin about two weeks later.

Overcrowding was a problem with species that had heavy foliage, such as *Cercis canadensis, Koelreuteria paniculata,* and *Liriodendron tulipifera.* The large pot size helped but did not give the plants enough space near the end of the growing season. These plant types need to be shifted or transplanted earlier in the summer. Unfortunately, the container area being constructed to hold these was not ready in time.

Some of the *Quercus* seedlings did not make as much top growth as they should have. They appeared to be stunted with no discernible cause. In a conversation with Carl Whitcomb, he explained that when *Quercus* seeds are planted after the radicle is showing, auxins will have already sent a "message" to the radicle as to which direction is down. Therefore, it is highly likely that some *seed are planted upside down, based on this orientation. Dr.* Whitcomb stated that it would be better not to plant until the radicle had actually turned, indicating its orientation, and allowing it to be planted pointing downward.

Another problem was that some species did not air root-prune properly at the bench height used. Evidently there was not enough air circulation to kill the roots as they emerged from the bottoms of the pots. While no roots actually grew into the ground, they did extend 2 or 3 in. from the bottom of the pot. The remedy for this, of course, is to place some blocks under the landscape timbers supporting the benches. This will allow for cross ventilation.

SUMMARY

The operation will be expanded next year and the refinements and corrections mentioned will be made. The system offers advantages over conventional growing methods that make the extra effort worthwhile. *These are as follows:* (1). A better quality liner with accelerated growth characteristics! (2). A reduction in growing time to produce a salable sized tree. (3). A liner that can be shifted up to a larger container or transplanted during late summer or early fall when work loads are lightest in the nursery.