CONTAINERIZED HARDWOODS: A PARTIAL SUMMARY OF CURRENT WORK IN PRODUCTION, ESTABLISHMENT, AND CULTURAL NEEDS 1/

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Abstract.--Containerized hardwood seedlings are in the exploratory stage. Faster early growth is a primary goal in most field studies. Production and establishment are not overly difficult. Outplantings show no clear-cut advantage for containerized seedlings with respect to growth or survival.

INTRODUCTION

Containerized conifer seedlings are produced primarily to extend the planting season. Hardwoods, of course, may be containerized for the same reason, but promotion of fast early growth has been at least as important a reason for testing containers. Species differ with respect to difficulty of establishing successful plantations; most of our commercially important upland species--especially oaks--fall into the hard-to-establish class. Planting techniques, species-site relationships, and seedling quality all enter the picture, but competition is the chief reason for establishment problems on good sites recently clearcut. Vigorous sprouts from large root systems have too big an advantage over planted, bare-root seedlings. Specially prepared containerized seedlings, planted undisturbed, have been considered likely to exhibit a faster growth rate than their bare-root cousins. However, a big difference is necessary if competition is to be met successfully.

CURRENT WORK

Considerable work is under way in Scandinavia and other European countries, including Soviet Russia. For those workers interested in detail, a partial list of abstracts can be obtained from this author.

A number of workers in this country are trying or have tried adapting different hardwood species to available containers. All work to this time has been exploratory; the competition question must be resolved before any commercial production can be contemplated.

Current pilot production work is aimed at container development; matching species with appropriate containers; and learning species' greenhouse requirements with respect to day-length, nutrition, CO_2 content of air, temperature, potting media, and time to reach plantable size. Establishment work has been scarce but has had some success; it parallels work with conifers and may not be needed if the competition problem is not licked. Cultural work during and shortly after establishment is proceeding briskly since it is the key to successful hardwood plantations.

Marrero (1965) at the Institute of Tropical Forestry in Puerto Rico raised cadam (Anthocepalus cadamba), a fast-growing hardwood; and primavera Cybistax donnell-smithii), a valuable furniture wood, in polyethelene bags then outplanted half bare-root and half in bags. Bagged seedlings showed no growth or survival superiority.

The State of Arkansas (Tiner, 1974) worked with black walnut (Juglans nigra) containerized seedlings but checked only for survival. There were no differences among the various treatments employed.

Johnson (1974) reported on work by C. B. Briscoe at the Stoneville office of the

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Southern Forest Experiment Station working with cherrybark oak (Quercus falcata var. pagodaefolia), sycamore Platanus occidentalis), and sweetgum (Liquidambar styraciflua) in plastic bullets. Briscoe grew all three species in the greenhouse in 18 mm (inside) diameter bullets 65, 90, 115, and 140 mm long. The longest bullet produced best results but allowed seedling development for only three to four months. Several waterings per day were required once seedlings became too large for the bullet. Mortality became a problem two to four months after seeding containers. Early indications from out-plantings suggest a high correlation between seedling size and survival and growth. Largest seedlings were best in both categories.

Goodwin (197)-i-) reported on work by the State of North Carolina in establishing a hardwood tubeling study with eight species. Green ash (Fraxinus pennsylvanica), yellow birch (Betula alleghaniensis), and paper birch (Betula papyrifera were greenhouse-grown in the summer of 1972. Black birch (Betula lenta), white ash (Fraxinus americana), southern red oak (Quercus falcata), cherrybark oak, and cucumber (Magnolia acuminata) were grown during the winter in the greenhouse. Summer batches took 4 1/2 to 9 weeks to reach plantable size; winter batches took 19 weeks. Most were hardened off outside. A peat-soil mixture was used in 1 x 8 inch split Ontario styrene tubes. Complete planting results, Conclusions, and recommendations can be obtained (see Literature Cited). To summarize, tubelings were planted in punched holes in late summer or spring, depending on time of origin. Competition soon became heavy and made later survival checks and measurements impossible due to difficulty of finding stems, even though flagged. Container removal is recommended if the 1 x 8 inch tube is used; it restricts development. Larger sizes are described and recommended.

Hicks, Adekiya, and Somberg (197-i-) tested five containerized eucalyptus species (Eucalyptus tereticormis x maculata, E. camaldulensis, E. citriodora, E. grandis, E. saligna) in Texas and indicate the tubeling method of propagation was successful for species tested. Plants were grown in green-house flats for five weeks during the winter of 1972, then transferred to spiral wound Kraft paper tubes 10-inches long and 1.5 inches in diameter with a 0.06-inch wall ickness. Tubelings remained in the green-ice until April 1972, then were field anted in punched holes. The site was eared, burned, and disked prior to planting. rtical roots extended well, and laterals netrated the paper. Other results seem to ve been confounded by probable preferential obit browsing.

Forbes (1974) included very large Kraft paper containers in a study designed to produce seedlings capable of good survival and fast early growth. Black cherry (Prunus serotina), black walnut, and white oak Quercus alba were tested. Container diameters were about 5, 3 1/2, and 2 1/2 inches; cross-sectional areas equaled those of seedling spacings of 6, 9, and 12 per square foot for the bare-root test portion. Containers were filled while stacked in nursery seedbed sections dug out and lined with window screen bottoms and board sides and ends. Media was the same soil-fertilizer mix in which bare-root seedlings were grown. The mix was heaped slightly to allow for settling. Seeds were hand planted (2 for oaks and walnut, 3 for cherry) unstratified in the fall, then mulched with decayed sawdust. Settling was more than anticipated and sawdust occupied the upper one to two inches in most containers. Decay organisms must have utilized part of applied fertilizer to further reduce the sawdust, because containerized seedlings were generally smaller than others. Seedlings were thinned to one per container. At lifting in the spring, containers were packed in meat boxes (heavy duty) and hauled to the planting site, an island with rich soil of high site index. A few were lost in handling, but the paper had stood up well over winter and during the growing season. Boxes of seedlings were very heavy and had to be carried on a tractor-mounted pallet. Holes were drilled with a two-man power-auger then the containers inserted, packed in, and covered with about 1/2-inch of augered soil.

The field planting was divided into two parts for a study of competition. One area containing cherry and walnut was uncontrolled; the other area containing cherry, walnut, and white oak was clean cultivated. To date, containerized seedlings are still slightly behind others in height; growth rates are about equal. Where competition was not controlled, survival and growth rates were much lower for both types. Containerized seedlings showed no advantage. In the clean cultivated area all seedlings are doing well. Preliminary evidence shows large-sized containers are not the solution to the early growth problem; economically feasible competition control is the major problem to be overcome.

Tinus (1974) has done as much as anyone in this country with respect to greenhouse production of containerized hardwoods. His approach has been to learn everything practically possible about physiology of a species, then assemble a pilot scale green-house to grow plantable trees rapidly. First work was with hardwoods added to a system designed for ponderosa pine (Pinus ponderosa) and Scotch pine (P. sylvestris). A description may be obtained from Tinus. Bur oak (Quercus macrocarpa) is the first hardwood for which a system is being designed. Growth chamber and greenhouse experiments on optimum temperature and photoperiod are nearing completion. Indications are that separate greenhouses are needed for different species unless they are known to have same or very similar requirements.

Tinus uses a 5 x 5 x 21 cm. book planter, a size that will allow growth of, a tree large enough to be successfully outplanted. His strategy is to put on height growth quickly, gain lots of photosynthetic area, then put on diameter growth, lignify the stem, and, if necessary, obtain dormancy and develop cold hardiness. Using big-seeded species he has been able to produce seedlings 20 cm. tall, ready for outplanting in 2 1/2 months. The book container directs the root system downward where individual rootlets and the taproot stub off without a wound.

Tinus' primary trouble came from irregular germination--some hardwood seed lots took 2 1/2 months to complete. He recommends using a germinator and refrigerator system for large-seeded species. As seed germinates it would be transferred to the refrigerator and held until all seed was ready to plant.

Individual species information from containerized lots added to the ponderosa pine system follows [from Tinus (1974)]:

Green Ash

A 24-hour cold water seed soak caused seed to germinate promptly. A long day will not keep the seedlings growing. The equivalent of a 1-0 seedling is obtained under the ponderosa pine system mentioned earlier.

Black Walnut

The 100-day stratification recommended in the Woody Plant Seed Manual did not produce prompt germination. Prior to planting, nuts were floated in cold water. Sinkers showed 75 percent germination; floaters about 20 percent. Best results came from planting germinating nuts. Long days did not keep the shoot growing; it reached about 30 to 35 cm. and stopped. The tree can be outplanted 2 1/2 months from seed. In forcing dormancy, prompt leaf abscission is hard to get; short days do help.

Oaks

Bur, northern red (Quercus rubra) and black oak (Q. velutina) were included. Even with recommended stratification bur oak germinated over a 24-month period to 80 to 90 percent of total acorns. Northern red and black oak seed all had radicals showing and produced a 100 percent stand quickly. Long days did not keep bur oak growing; the same is indicated for northern red and black oak. New specialized work on bur oak shows it grows best under the hottest day (31°C) and hottest night (25°C) treatments. This growth chamber work uses high CO2 and long days, approximately the same conditions as those in Tinus' production greenhouse. Under the ponderosa pine regime bur oak put out one whorl of leaves then quit growing. In the growth chamber most trees flushed three to five times. Those in hottest regimes were over 50 cm. tall after four months. Under high CO2 conditions multiple flushing occurs even at low temperature, but flush size is small. Northern red oak responds similarly.

Taproots stubbed off nicely. Leaf abscission was not prompt during hardening off, but neither is it under natural conditions. Outplantings show 80 percent survival; no growth measurements have been made as yet.

Many fast-growing individuals in the growth chamber showed signs of either mineral deficiency or solarization, possibly a combination. Oaks are probably unable to tolerate intense light as well as conifers. However, suboptimal nutrient conditions could also be responsible for the symptoms. They would not normally appear on slow-growing trees, but when other conditions are optimized, mineral nutrition could become limiting.

Hackberry (Celtis occidentalis)

A 60-day stratification resulted in excellent germination. Tinus has no photoperiod or temperature response data yet, but seedlings in the greenhouse are growing well.

Pecan (Cara illinoensis)

A long day keeps pecan growing. Other data are lacking, but trees have reached 30-38 cm. and set a bud under greenhouse conditions.

Honey Locust (Gleditsia triacanthos)

Poor seed germination is a problem. An acid treatment is necessary, but too much will kill the seed. Long days are of no value. This is the poorest responding hardwood so far.

Kentucky Coffeetree (Gymnocladus dioicus)

This is another species that puts on one flush and quits. Long days do not help.

SUMMARY

Work with containerized hardwoods to date indicates successful greenhouse or outside production is likely with a number of species. But field trials show the problem of slow early growth of some species compared to sprouts of the same species and other competition is still there and is not likely to be overcome with containers, even large ones. Containers may well aid in reforestation of disturbed areas (strip mines, etc.) and other very poor sites by providing a better microclimate for early development. In most cases, however, hardwoods will be planted on better sites where competition will be very heavy. Here smaller containerized seedlings will be hard put to survive, much less compete favorably. Because of this situation, acceptable establishment practices, including competition control, should be worked out before any full-scale container development program is begun.

LITERATURE CITED

Forbes, D. C.
1974. Unpublished work. Tenn. Valley Auth., Norris, Tenn.

Goodwin, 0. C.
1974. Personal communication. State of N. C., Raleigh, N. C.

Hicks, R. R., Jr., F. Y. Adekiya, and S.I.Somberg
1974. Tree Planters' Notes. Feb. 1974. pp. 27-28.

Johnson, R. L.
1974. Personal communication. Sou. For. Exp. Sta., Stoneville, Miss.

Marrero, Jose.
1965. Survival and growth of bagged and bare-rooted Honduras pine, cadam, and primavera. USFS Res. Note ITF-3.

Tiner, J.
1974. Personal communication. Arkansas For. Comm., Little Rock, Ark.

Tinus, R. W.
1974. Personal communication. Rocky Mtn. For. and Range Exp. Sta., Shelterbelt Lab., Bottineau, N. Dak.