HARDWOOD NURSERY MANAGEMENT

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More hardwood seedlings are being planted than ever before because the demand for hardwood timber has increased, the high price paid for hardwood stumpage have been well publicized, and because better ways have been found to establish plantations. Many early plantings failed because the seedlings could not compete successfully with the other vegetation or because the trees were planted on unsuitable sites. As more was learned about the need for careful site selection and adequate weed control, and as more landowners started tending their planted trees to improve survival and growth, the demand for hardwood seedlings progressively increased.

As a result of the increased demand for hardwood seedlings, nurserymen have found it necessary to increase production. In 1970, more than 17 million hardwood seedlings were grown in forest nurseries in 14 southern States (Rowan 1972). This represents an increase of 29 percent since 1965. The demand for hardwood seedlings is likely to continue to increase for several more years, and nurserymen will face continuing pressure to increase not only the quantity but also the quality of the hardwood seedlings.

There are some rather specific requirements for production of high-quality hardwood seedlings. Some that can be controlled by the nurserymen are soil fertility, seed source, seed collection and handling, and seedbed care. Summarized here are our present recommendations on these important aspects of hardwood nursery management, especially as they pertain to production of some of the fine hardwoods, such as black walnut.

SOIL FERTILITY

Soil characteristics of each section of the nursery, and the characteristics and requirements of each species grown or contemplated should be known. If not already available, a detailed soils map of the nursery should be prepared to show areas with similar soil texture in the surface and subsoil, depth to evidence of restricted drainage (mottling), and other characteristics critical for seedling growth. Some hardwoods require high soil fertility and a pH near 6. So, if both hardwoods and conifers are grown in the nursery, it may be necessary to grow the hardwoods in the most fertile soils. European alder and river birch are two hardwoods that develop best when soil pH is near 5, the recommended pH for many conifers. Some hardwoods, therefore, can be grown in rotation with conifers.

SEED SOURCE

Seed source plays an important role in the development of the seedling in the nursery and of the tree in the field. Most nurserymen realize this; 71 percent of those questioned by Abbott and Eliason (1968) knew the seed source of the seedlings produced in their nurseries. Generally, seed should be collected in the region of the planting site, although seedlings from a distant seed source may grow faster than those from a local seed source. In the Ohio Valley, black walnut seedlings produced from seed collected south of the planting site grew faster than seedlings from local seed sources (Bey et al. 1971). However, survival and growth may be reduced if seed is moved too far north. In a test in Minnesota, trees from sources more than 200 miles south generally did not survive as well or grow as large as trees from sources within 200 miles of the planting site.[1/]

SEED COLLECTION AND HANDLING

Seed should be collected from trees growing in stands rather than from isolated individuals. Proximity of other trees of the species assures better cross pollination and generally better seed. Nevertheless, cutting or cracking tests should be made to determine the percent of sound seed to be expected from a tree before its seed is collected.

Seed viability can be destroyed by careless handling. Freshly collected fruit of some species heats or ferments killing the seed. Black walnuts heat if piled too high, and the seed of dogwood and some other fleshy-fruited species may lose viability by fermentation. However, controlled fermentation helps in extraction of dogwood, osage-orange and other seed.

Seed of many species should be extracted soon after collection. Extraction equipment used varies with the type of seed. Black walnut husks are removed in a huller that processes about 50 bushels of fruits per hours. Immediately after hulling, the cleaned walnuts are usually floated to separate the good from bad seed. Autumn olive, one of the fleshy-fruited species, may be cleaned in a Dybvig[2/] cleaner.

Storage requirements for hardwood seeds vary greatly among species. The tiny sycamore seed should be stored dry and cold (below freezing), while the large acorns and walnuts are usually stored moist and above freezing. Recent information, however, shows that the viability of black walnut seed can be preserved best at above-freezing temperature, but black walnuts can be stored at subzero temperatures if the seed

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1/ Bey, C. F. Progress report, March 10, 1972.
2/ Mention of trade names does not constitute endorsement by the USDA Forest Service.

moisture content is reduced to less than 20 percent (Williams 1971). Heit (1967) was confident that successful storage techniques could be developed for all species, at least for a long enough period to meet nursery needs during the intervals between good seed crops.

In the northern States most seed is sown soon after it is collected and extracted, spring or fall. But in the South where nature does not provide the cold stratification necessary for some species, more seedlings might be grown from a given quantity of seed if the period in stratification were lengthened. This is especially true for yellow-poplar and black walnut. Germination of yellow-poplar seed increased after each year in a stratification pit through the third year. From 69 to 81 percent of black walnut seed stratified at 32° F. for 19 months germinated 3 weeks after seeding, while only 10 to 25 percent of the nuts stratified 7 months had germinated 12 weeks after sowing (Von Althen 1971).

Hardwood seed has various shapes and sizes, so many species are sown by hand. Some seed, such as European alder, may be drilled with equipment used for conifers, and machines have been adapted for sowing other species. In Missouri, unhulled black walnut seed is sown with a manure spreader, and covered with sawdust and mulch net. In Ohio, yellow-poplar seed, wingless from 3 years in stratification, is sown with a sawdust spreader equipped with a ½-inch mesh shaker screen (Wood 1967). Mechanical sowing reduced sowing labor by 90 percent and the resulting stand was more uniform than previous hand sown stands. Bonner and Switzer (1971) prepared yellow-poplar seed for drill sowing by clipping the wings in a clipper debearder. Then, using a gravity separator, they were able to upgrade the wingless seed.

Sowing depth varies by species and usually depends on seed size. Most seed would probably germinate if sown at a depth 1-½ to 2 times its diameter, but optimum sowing depths have not been determined for many species. In a pot study, Bonner (1967) found that germination of sweetgum seed decreased for 74 percent to 5 percent as sowing depth increased from 1/8 inch to 1½ inches. Seed sown too deep or too shallow either doesn't germinate or it germinates and dies. Germination of black walnut seed was delayed as sowing depth was increased from 1 inch to 4 inches (Chase 1947). Although there was little difference in total germination, seed that germinated first produce the largest seedlings.

Seedbed density is often governed by circumstances. When seed is scarce, it may be sown at low rates to produce the maximum number of plantable seedlings from a minimum amount of seed. On the other hand, if bed space is limited, seed may be sown at higher rates to produce the maximum number of plantable seedlings in the minimum amount of space. Webb and Darby (1967) recommended that sweetgum be grown at a density of 15 to 25 seedlings per square foot to produce the maximum number of plantable seedlings with the least amount of time required for culling. Densities greater than 25 drastically increased the cost of grading. Moreover, large diameter, high-quality seedlings must be grown in low density seedbeds.

Varying seedbed density is the best way to regulate seedling size, and seedling size is presently the best indicator of quality. Large diameter seedlings survive and grow better than small ones. This is true for sweetgum (Webb 1969) yellow-poplar (Funk 1964; Limstrom et al. 1955), sycamore (Ike 1962), and black walnut (Williams 1970), and probably for other hardwoods planted in the South. Although large seedlings have definite advantages, they are harder to plant. And some nurserymen would rather provide small seedlings because they are easier to lift, pack, and ship. Basically, of course, nurserymen should produce seedlings that will survive and grow best. Once the nursery customer becomes convinced that large seedlings are worth the extra effort required, nurserymen should provide them.

SEEDBED CARE

Weed control in hardwood seedbeds is more difficult than for conifers. Herbicides normally used with conifers would kill many of the hardwoods. Fumigation furnishes partial weed control, but some hand weeding usually is still required. A mechanical cultivator has been devised to use where seedlings are sown in rows, but suitable herbicides are needed also. Some hardwood species are more susceptible than others to herbicide injury. We are trying to find suitable techniques for controlling weeds in black walnut seedbeds. The best weed control with the least amount of seedling damage in a sandy soil has been to fumigate in the fall with 1 pound of methyl bromide per 100 square feet, then follow up in the spring with 1 pound of 80 percent WP simazine per acre.

Root pruning and the nursery soil type influence the root system of black walnut seedlings bur root fibrosity has little effect on survival or growth of the planted seedlings (Williams 1972). Walnut seedlings that were top pruned to 1 inch before planting survived as well and were about as tall after four growing seasons as unpruned seedlings.[3/] It may be practical to top prune at the nursery, thus making it easier to pack and ship large seedlings.

The specific pathogens or insects affecting hardwood seedlings probably vary by locality. In Indiana, for example, black walnut root rot was caused by Phytophthora citricola (Green and Pratt 1970), while in Kentucky and North Carolina the root-rot pathogen of black walnut was identified as Cylindrocladium scoparium (USDA Forest

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3 / Manuscript in progress.

Service 1972). Root rot causes most damage during winter storage and in the packing shed. Nurserymen in Ohio and Wisconsin have reduced losses by lifting seedlings in the spring as they are needed to fill orders. Green and Pratt (1970) recommended that poorly drained seedbeds (also heeling-in beds) be avoided and that seedlings not be held long at temperatures above 40 F.

Hardwoods lifted in the fall and stored over winter survive and grow as well as seedlings left in the seedbed over winter and lifted in the spring (Williams 1963). Generally, hardwoods should not be lifted for over-winter storage until the leaves have fallen, and the time of leaf drop varies among species. Walnut, hickory, and cottonwood drop their leaves early and may be lifted before species with intermediate leaf fall such as sycamore and yellow-poplar, or those that lose their leaves late, such as the chestnuts, oaks, and alders.

Leaf abscission can be hastened with chemicals, but the techniques are still in the experimental stage. Tree species sprayed in October with 5,000 p.p.m. Ethrel were defoliated 5 days after being treated (Kozel 1969). Complete defoliation of the same species took twice as long when rates of 1,000 to 2,500 p.p.m. Ethrel were used.

Most seedling lifters or harvesters were designed for conifers, so the cross frame of the machines may damage the taller hardwood seedlings by barking them or scraping off their terminal buds. Such damage has been alleviated to some extent by raising the rear end of the cutting blade to cause a forward tilt of the seedlings as they are undercut. It may be necessary to develop special seedling harvesters or modity existing harvesters for use with hardwoods.

Although nurseries growing the same species generally follow the same basic procedures, each nurseryman must find the best combination of techniques and schedules for his soils, climate, equipment, and facilities. Careful records of practices and results will simplify establishing a satisfactory routine. When a new species is added to the production list, special records should be kept to show the effects of the nursery practices used. Belcher (1964) described the benefits and how to establish and use "history plots" which would provide the records necessary to evaluate nursery practices.

CONCLUSION

Producing enough high-quality hardwood seedlings to meet the increasing demand may be difficult inasmuch as the demand in 14 southern States increased more than 29 percent from 1965 to 1970. It will be necessary to grow many of the hardwoods in the most productive parts of the nursery using the best seed sources. New information, skills, and equipment will be needed. And because much nursery research is in progress, it will be necessary to remain current with new recommendations.

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