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BOTTOMLAND HARDWOODS RESEARCH ON SITE PREPARATION,
PLANTATION ESTABLISHMENT, AND CULTURAL TREATMENTS,
AT THE SOUTHERN HARDWOODS LABORATORY^{1/}

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Abstract.--The South contains about 219 million acres of forests, 70 million acres of which are most productive when managed as hardwoods. Bottomland hardwoods cover about 22 million of this 70 million acres. Hardwood plantation management has been increasing during the last few years, but natural stand management still accounts for more than 99 percent of hardwood production in the South. This paper summarizes research and experience at the Southern Hardwoods Laboratory that have solved some of the problems in plantation management. Proper site selection, good site preparation and cultivation, high quality seedlings, and proper planting techniques are musts if hardwood plantations are to be successful. Planting large seedlings may reduce costs of site preparation and cultivation, as well as get more desirable seedlings into an area.

The South contains more than 532 million acres of land. Forests cover 41 percent of this land area. Of the 219 million acres of forest land, 70 million acres are most productive when managed for hardwoods. Bottomland hardwoods total 22 million acres, with upland and mountain hardwoods comprising the remaining 48 million acres. In 1977, 54 percent of the hardwoods harvested in the eastern United States came from the South.

Hardwoods were the primary object of earliest forest management practices in the United States, but the emphasis shifted rapidly to conifers that were demanded by industry and more easily managed. High-grading, fire, grazing, and poor markets for intermediate products have caused hardwoods to be neglected in forest management.

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Recently, the demand for hardwood products such as furniture, pallets, pulpwood, construction material, and fuelwood has increased. To meet the higher demand for hardwood products, better forest and plantation management with supplemental planting of desired species in natural stands will have to be practiced.

This paper summarizes some research results on plantation establishment, site preparation, and cultural treatments at the Southern Hardwoods Laboratory.

SITE PREPARATION AND CULTIVATION

One of the first prerequisites for successful hardwood plantations is proper site selection. Species must be adapted to the site. The most desirable sites would be moist but well-drained sandy loams and silt loams in most southern river bottoms. Best growth for all species occurs at sites receiving ample moisture during the growing season (McKnight 1970). Many hardwoods can withstand flooding during the dormant season if the water is cool and moving or does not stay on the ground for extended periods during the growing season. Our experience has shown that flooding during the first growing season can be very damaging to young hardwood plantations, but trees can withstand prolonged flooding after the first growing season.

Sites which are recommended for planting are inherently fertile, and the climate in the South is well suited for excellent growth. Weeds as well as trees grow rapidly, but most hardwoods are intolerant and can stand little if any competition for light and moisture when trees are young. Careful site preparation is essential to get trees established and to make weed control easier during the first growing season (McKnight 1970).

Site preparation is the most costly phase in establishing southern bottomland hardwood plantations. In 1976, contract clearing, raking, windrowing, burning, and disking costs were about \$150 per acre (Johnson 1977). This cost may be as much as \$200 or more per acre now. Such intensive site preparation is required to do the straddle cultivation essential to achieve nearly complete control of vines, weeds, sprouts, and other seedlings while planted seedlings are being started. Also added to the clearing costs would be \$50-60 per acre for first-year cultivation. The plantation needs to be cultivated at 3- to 4-week intervals five to six times the first growing season. Clearing costs under contract programs may be bettered by companies using their own equipment.

Best sites for most hardwoods are on land recently cleared of timber. The soil is in good physical condition and weeds are usually not plentiful (McKnight 1970). Trees should be sheared and the site thoroughly cleaned and disked to facilitate planting and first-year cultivation. Stumps left after logging and standing unmerchantable trees and shrubs should be cut at or just below the groundline. The sheared material should be windrowed and burned. Some of the debris from near the edge of the clearing operation can be used to construct crude fences to exclude deer if they are a problem. These fences need to be 10 to 12 feet in height and about 20 feet across the base.

Use of "old-field sites" will eliminate the cost of clearing. Experience and research have shown, however, that these sites need to be deep plowed (fallowed) before planting. Plowing breaks the sod, reduces competition from weeds, eliminates compaction, aerates the soil, and allows rapid infiltration of moisture from rainfall. Baker and Blackmon (1978) reported on summer fallowing as a simple technique for improving old-field sites for cottonwood. This technique should also work for other hardwoods.

For cultivation, most forest managers prefer tractors of about 100 horsepower, a size large enough for clearing, fallowing, and planting, but small enough for cultivating (Kennedy and Henderson 1976). One tractor per 200 acres is required for adequate results. Commercial planters are straddle cultivating one row at a time with conventional front-mounted farm cultivators until trees are about 2 feet tall. Front-mounted cultivators allow the driver to have better visibility and control and therefore cause less damage to trees than with rear-mounted cultivators. Cultivators equipped with chisel- or shovel-type plows allow tillage close to young trees without appreciable damage. Equipment most frequently used consists of: (1) large front-mounted cultivators with 19 to 21 shanks that will straddle one row while covering the space within rows, or (2) offset front-mounted cultivators equipped with 5 to 6 shanks that straddle the row while covering a small area on each side; with this system, a disk or spring-tooth harrow drawn behind the tractor covers the area between rows. When trees are too tall to straddle, the cultivators are removed, and tillage between rows is accomplished with a disk or harrow.

PLANTATION ESTABLISHMENT

In the past few years plantation acreages have been increasing and today there are between 100,000 and 150,000 acres (Johnson 1977). However, in the eastern United States, natural stands still account for over 99 percent of the hardwood production.

Research and experience have solved many of the problems of growing cottonwood and other hardwoods in plantations (Johnson 1977). Species being grown in plantations today are cottonwood, sycamore, sweetgum, green ash, and black walnut.

After site preparation, the area is ready for planting. The planting operation can be accomplished by hand with dibbles or with machines, whether planting hardwood seedlings or cottonwood cuttings. Good planting techniques and quality seedlings are a must if the plantation is to be a success. Forest owners are now looking for quality seedlings with a root collar diameter at least 1/4- to 3/8-inch or larger and tops 30 to 36 inches tall (McKnight and Johnson 1980, Weber 1972). Cottonwood cuttings should be 3/4- to 1-inch at the large end and a minimum of 3/8-inch at the small end.

High site preparation cost is probably the main deterrent of hardwood plantation establishment at this time. Ongoing research at the Southern Hardwoods Laboratory is aimed at overcoming the expensive site preparation and cultivation costs by planting large seedlings. Work is currently underway with cottonwood, sycamore, and four oaks. The objective is to improve early height growth by planting trees up to 3 years old, 10 to 15 feet tall, and 2 inches in diameter at the root collar (Johnson 1979). Trees have been planted with and without top and root pruning in 9-inch diameter auger holes. Other work is being done on growing large seedlings for 1 to 2 years in containers (9 inches diameter by 24 inches tall) and planting seedlings with undisturbed root systems. Potential early benefits are rapid early growth, planting trees large enough that cultivation can be kept to a minimum, and a planting height beyond the range of deer. Early results with this method are very encouraging.

BENEFITS OF CULTURAL TREATMENTS

At the Southern Hardwoods Laboratory, three levels of cultural intensities were tested with six hardwood species. Cultural intensities were: disk (clean cultivation), mow, and control (no treatment). Species were sycamore, green ash, cottonwood, sweetgum, Nuttall oak, and sweet pecan. After four growing seasons, trees in disked plots were significantly taller and had larger diameters than trees in mowed and control. There were no real differences between mowed and control. Disking increased heights from 42 percent for green ash to 130 percent for sycamore over trees in control plots. Diameter increases ranged from 144 percent for cottonwood to 240 percent for Nuttall oak.

Survival was best in disked plots (91 percent), with mowed next (80 percent), and control lowest (76 percent). Disked plots ranged from a low of 84 percent survival for sweetgum to 99 percent with sycamore. Green ash survived best in mowed and control plots with sycamore a close second.

Trees in disked plots had significantly higher foliar N and Ca concentrations and significantly lower P and Mg than trees in mowed and control plots. Trees in mowed plots had significantly lower K than control; those in disked plots were intermediate with no difference between mowed and disked. Although foliar nutrient concentrations were lower for some nutrients in trees in disked plots, if we assume weight to be proportional to size, then nearly

twice as much of each nutrient would have been accumulated in trees in disked plots as in mowed and control. Cottonwood had the highest nutrient concentrations for most elements tested. Sycamore was lowest or tied for lowest for N, P, and K; fourth for Ca; and third for Mg.

Cultural treatments, particularly disking, did not cause any significant reductions in soil nutrient levels. One of the major benefits of disking was probably vegetation control. However, it also improves soil structure, water infiltration, gas exchange between the soil and atmosphere, organic matter, and nutrient availability.

SUMMARY AND CONCLUSIONS

Research and experience have solved many of the problems in planting cottonwood and other priority hardwoods. Our recommendations entail intensive site preparation and clean cultivation through at least the first growing season. Proper site selection, good site preparation and cultivation, high quality seedlings, and proper planting techniques are musts if hardwood plantations are to be successful. Planting large seedlings may reduce the costs of site preparation and cultivation. In addition to competition control, other benefits of disking include better soil nutrient and moisture availability, incorporation of organic matter and mineralization, gas exchange between the soil and atmosphere, and improved soil structure.

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