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CARE OF PINE SEEDLINGS USED IN BREEDING AT INSTITUTE OF FOREST GENETICS

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This note describes methods developed and practiced by the Institute of Forest Genetics to insure the high survival and thrifty seedlings needed for some types of research. The special care begins with seed extraction and extends through the early years in plantation. While the methods were developed primarily for longleaf, which in ordinary practice is notorious for poor survival and slow height growth, they are also applicable to other tree species or hybrids.

The essentials are: transfer of nursery seedlings to pots for a few months between lifting and outplanting, clean cultivation of plantations, and control of diseases and insects. Over several years 11,000 longleaf pines have been planted by this method. First-year survivals have ranged from 95 to 97 percent, and 94 percent of the trees have begun height growth their second year in the field. In July of their fourth year the tallest trees were more than 10 feet in height.

In comparison, barerooted seedlings, planted directly from the nursery bed, had first-year survivals of 82 percent and averaged 7 feet tall

after 4 years on an exceptionally productive site that was thoroughly cultivated. For bare-rooted stock planted on unprepared sites, average height at 4 years was only 1 foot, even though the brown spot disease had been controlled.



These longleaf pines were planted from pots on a prepared site, cultivated 2 years, and mowed the third. This photo was taken in July of the fourth year.

Seed Handling

Cones are dried and seeds extracted in a 28-bushel kiln designed by McLemore.¹ The Institute's model is modified to hold 48 small lots, and the drawers are additionally screened on the top to prevent loss of seeds. After extraction, seeds are dewinged by hand and partially cleaned in a fanning mill.

Final separation of sound from hollow seed without loss of some of the sound seed requires a more sensitive device than the fanning mill. Electronic methods are under development but meanwhile alcohol flotation is practiced for all but longleaf seed, which is separated on a sensitive balance.

Nursery Practice

The nursery beds are 4 feet wide, elevated to provide drainage, and enclosed with side boards. Each year before sowing begins, old roots and other trash are removed and the beds are fertilized and reworked. Applications per acre of bed area (excluding paths) consist of 2,000 pounds of 20-percent superphosphate, 200 pounds of 50-percent muriate of potash, and 50 pounds of nitrogen in urea form. After these are distributed uniformly over the beds, the soil and fertilizers are mixed to a depth of 8 inches with a small rototiller and the beds are raked level. Every three to four years pine sawdust, four to five years old, is applied $\frac{3}{4}$ -inch deep along with the fertilizers.

Allyl alcohol is applied to the beds for pre-sowing weed control and to combat early damping-off.² One quart is mixed in 50 gallons of water and applied uniformly over 200 square feet of bed area with a sprinkling can. Sowing is deferred until at least 3 days after the alcohol application.

Every third year one-fourth pint of 75-percent emulsifiable chlordane is added to each 50 gallons of the allyl alcohol solution to control white grubs.

Sufficient seeds are sown to produce nursery densities of 15 seedlings per square foot for longleaf, 25 for slash and loblolly, and 30 for shortleaf and spruce pines. Seeds of loblolly, shortleaf, and spruce pines (and of hybrids whose female parent belongs to one of these species) are stratified at 40° F. for 30 to 60

days. Seeds from longleaf and slash trees are not stratified, though slash seeds are sometimes soaked in water for 6 hours prior to sowing to hasten germination. In sowing, the seeds are equally spaced with a seedboard in drills 6 inches apart across the bed. They are then pressed into the soil and covered with fine-mesh burlap or loblolly pine needles. The cover is removed after seeds germinate.

During the growing season the beds are watered with an overhead sprinkler system and weeded by hand.

Post-sowing applications of nitrogen are made by dissolving ammonium nitrate in water and applying it as a side dressing at the rate of 25 pounds of elemental nitrogen per acre per application. Two, or occasionally three, applications are made per year, with the last one completed by mid-September. Immediately after each application the trees are sprinkled to rinse all salts off the needles.

Potting

Planting shock is minimized by growing the seedlings in individual pots for 1 to 4 months after they are lifted from the nursery bed. Potting begins early in December after the seedlings have hardened off in the nursery and may continue until about March 1. As the root system formed in the pots is not disturbed during outplanting, field growth of the seedlings is prompt.

When the seedlings are to be kept in containers less than 4 months, they are potted in standard quart milk cartons $2\frac{3}{4}$ inches square and 7 to 10 inches deep. The cartons are easy to store and handle, and their cost is low. They must either be waxed or plastic-coated, since chemicals from uncoated paper will poison the seedlings. Waxed cartons, shaped for planting, are available at about 3 cents each from local milk plants. Collapsed plastic-coated cartons may be purchased from paper companies for about 2 cents apiece, but the bottoms must be shaped and heat-sealed by the potter. The additional operation brings the total cost to about 3 cents also. In either case, four $\frac{1}{4}$ -inch drain holes are punched in the bottom of the cartons. Semi-automatic machines are being developed to heat-seal cartons and punch the holes. If the seedlings are to be held longer

¹ McLemore, B. F. 1960. Small, fast-drying cone kiln. *Forest Farmer* 19(13): 10-11, 15, illus.

² Lindgren, R. M., and Henry, B. W. 1949. Promising treatments for controlling root disease and weeds in a southern pine nursery. U. S. Dept. Agr. Plant Dis. Rptr. 33: 228-231.

than 4 months, large tar-paper pots 6½ to 9½ inches deep, costing about 7 cents each, are obtained from nursery supply houses.

Topsoil with about 60 percent sand is used in the potting mixture. It is screened through ½-inch mesh hardware cloth. One cubic yard of soil is mixed with 9 cubic feet of peat moss and 2 pounds of 5-10-5 fertilizer. To control root diseases, the soil mixture is fumigated under polyethylene sheeting by applying 1 pound of methyl bromide to each cubic yard.

For the potting operation the soil is loaded on a pickup truck, which is driven as close as possible to the concrete troughs in which the potted seedlings are held until ready for field planting. A five-man crew is efficient. Two men lift the seedlings from the nursery beds, prune their roots, and bring them to the truck, along with the empty pots. Longleaf needles are pruned to about 5 inches to ease handling and spraying the potted stock; other species are not top-pruned. The two potters work at the back of the truck, whose rear wheels are run up on ramps until the bed is at convenient height. The potters fill the cartons completely and vigorously jar them to prevent the soil from settling appreciably after it is wetted. The fifth man places the potted plants in the concrete troughs. In a day, the crew can pot 2,000 seedlings in milk cartons or 750 in tar-paper pots. This includes lifting, sorting, tagging, pruning, and transport.

The concrete troughs (8 inches deep, 50 inches wide, and 35 feet long) are designed for watering potted plants from below. Their slightly sloping bottoms are covered with gravel; a water faucet and drain plug are at the lower end.

Site Preparation

The areas selected for experimental plantations are recently cleared pine forest land or formerly cropped fields that have been abandoned. Sites are chosen for uniformity in desirable soil properties such as depth, texture, and fertility. Relatively level areas are selected, so that erosion will be at a minimum.

The stumps and logging debris on cutover pine sites are removed with land-clearing equipment. Clearing is contracted for, at \$50 to \$75 per acre. The land is then leveled by plowing and disking. To insure that the site

will be in suitable condition at planting time, clearing and leveling are done about 1 year in advance.

Abandoned fields that are free of woody vegetation are much less expensive to prepare, since plowing and disking with light equipment usually suffice. However, if long-time studies are contemplated, the lower cost on old fields should be weighed against the higher hazard from *Fomes annosus* root rot.²

Triangular Spacing

In most of the Institute's experimental plantations on prepared sites, rows are spaced either 10 or 12 feet apart. These distances provide ample space for root and crown development and afford clearance for cultivation for 2 or 3 years with a 6- or 8-foot tandem disk.

Equilateral triangular spacing has certain advantages over square spacing and has been used in recent plantings at the Institute. It provides more uniform space for crown and root development both within and between rows. It also permits cultivation in three directions, which aids in erosion control and reduces the area adjacent to the trees that requires hoeing. Distances on the row spacing line should be set at intervals which are 0.866 times the designated tree spacing. Spacing tapes can be made or acquired commercially.

After the field has been surveyed the ends of the rows are located and marked with stakes. Spacing lines with anchor rods at each end are suspended between two end stakes to locate the trees in the row. These spacing lines are moved across the field from row to row as planting progresses. When large areas are being planted, however, tree locations are pre-marked with 10-inch pot labels.

Transplanting Seedlings in Field

At the Institute the season for field-planting potted seedlings is January through June. So far, June planting has given nearly as good survival as earlier planting.

A six-man planting crew is employed. The potted trees are hauled to the field on a truck. While three men distribute trees to the planting points, the other crew members begin planting. One man digs holes with a 6-inch power-driven auger and two men plant. After they have distributed the seedlings the three

² Powers, H. R., Jr., and Verrall, A. F. 1962. A closer look at *Fomes annosus*. *Forest Farmer* 21(13): 8-9, 16-17, illus.

men on the truck form a second planting crew. To reduce fatigue, workers alternate in operating the auger.

The planting hole is dug about 10 inches deep to provide space for rapid root growth, and then is partly back-filled with topsoil. The carton is taken from the seedling roots by ripping off the bottom and sliding out the block of soil. Approximately 200 seedlings potted in milk cartons can be planted per man-day. Considerably fewer transplants from tarpaper pots can be made, because the pots require more time for transport. Three man-days are required to pot 400 seedlings in milk cartons and subsequently plant them on an acre of prepared site.

Cultivating the Plantations

The plantations are cultivated with a 6-foot tandem disk operated from a light tractor equipped with hydraulic lift. Shallow disking within 1 foot of the young trees has not appreciably damaged the roots. The direction of disking is alternated in successive operations to destroy vegetation in the tree rows. The small areas surrounding the trees are hoed by hand. Normally three or four diskings per season have been adequate to control grasses and weeds.

After cultivation is discontinued the plantation may be seeded to carpetgrass to aid in erosion control and mowed to keep down unwanted vegetation. The sod reduces fire hazard and improves accessibility. A 5-foot rotary mower drawn by a light tractor is used.

Disease and Insect Control

To control brown spot disease, bordeaux mixture is applied when the secondary needles of longleaf appear in the nursery—about June 15—and thereafter at 6-week intervals: August 1, September 15, November 1. Slash and loblolly pines also receive the August and November sprays. Outplanted longleaf is sprayed May 1, July 1, and September 1. Applications are made routinely until seedlings are 18 inches tall and if necessary continued until the dis-

ease is no longer damaging. The bordeaux is prepared by dissolving 5 pounds of copper sulfate in 25 gallons of water, and 1.6 pounds of lime (freshly slaked quicklime or fresh, finely divided hydrated lime) in another 25 gallons of water. The two solutions are then mixed, and $\frac{1}{2}$ pint of Santomerse S is added. It is also desirable to add 3.2 ounces of sugar to the copper sulfate solution if the sprayer lacks adequate agitation or if there is a chance the fungicide will be stored overnight.

Loblolly and slash pine are sprayed weekly for fusiform rust from the time of their germination until June 15. (In some areas with high infection rates nurseries regularly spray 2 or 3 times a week.) The rate per acre for each application is 2 pounds of ferbam and $\frac{1}{3}$ pint of Santomerse S in 75 gallons of water. If one of the objectives is to bring the trees through free of fusiform rust, special control measures are justified for the outplantings subject to high rust infection. These measures include pruning of infected branches and sprays as proposed by Foster and Krueger.*

Loblolly and shortleaf pine plantations are sprayed against tip moth monthly from mid-February to mid-September, inclusive. The formulation is 4 gallons of 25-percent DDT emulsifiable concentrate in 100 gallons of water.

Red spiders appear most years in the nursery and sometimes on recently planted trees. When spider damage is seen, trees are sprayed with a malathion formulation of 2 tablespoonfuls of 57-percent concentrate per gallon of water. The application is repeated in 10 days.

Precautions additional to those mentioned above are sometimes necessary. For example, where pine trees on or near the planting site have recently been cut, the pales and other weevils may cause a plantation failure. Similarly, white grubs may be destructive if the planting site is or was recently in sod. Webworms and sawflies sometimes build up on longleaf and slash pines because seedlings of these species do not regularly receive the DDT spray.

*Foster, A. A., and Krueger, D. W. 1961. Protection of pine seed orchards and nurseries from fusiform rust by timing ferbam sprays to coincide with infection periods. Ga. Forest Res. Paper 1, 4 pp., illus.