HANDLING VALUABLE NURSERY STOCK

by

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The Norris Experimental Nursery, located below Norris Dam and operated by TVA since 1933 as part of its program in watershed protection and development, has provided significant information on the production of improved trees.

During the first twelve years a diversity of trees and shrubs of 100 species, totaling 1,035,000 trees, were produced. Stock was used in wildlife, reforestation and erosion control plantings. Between 1940 and 1943 methods were developed for production of straight-stem black locust stock by root propagation. Since 1939 emphasis has been on producing propagated selections of black walnut and other nut trees under sound nursery practices, Sixteen thousand Thomas black walnut were raised over an 11-year period for demonstration plantings. Promising varieties of black walnut, Chinese chestnut, and filbert averaging 500 grafted or budded trees per year have been grown for use in experimental plantings throughout the Valley. That these are valuable trees is attested to by the fact that commercial nurseries now charge $2.50 to $8.00 each for similar stock. Our first pine grafting studies were begun in 1950.

The nursery is situated on the Clinch River below Norris Dam on a colluvial bottomland soil most suitable for growing hardwoods. The cultural practices described are for out-of-door production, since there are no greenhouse facilities. A shaded cloth house was used for some of the pine propagation studies. A refrigerated cold storage room in the basement of the nursery building has proved a most effective and necessary adjunct to program needs.

Seed Collection and Treatment

Large seed are best for understock production because they produce more vigorous and larger seedlings than small seed. In selecting black walnuts for seed, kernel weight should be considered rather than nut size alone, for nuts with larger-than-average kernels result in seedlings of better caliper and height (2). Kernel weights below 3.0 grams should not be used for root stock production. Uniformity of seedlings is also desirable in nursery practice and can more readily be obtained from use of a single seed source than from mixed seedlots where a range in seed size is encountered. These relationships no doubt hold true for the other nut tree species.

Black walnuts should be collected in late September or early October, hulled immediately, and air-dried on wire trays for one week. The seed is stored dry in an unheated building in bulk lots until time of fall planting or stratification. Preference is given to fall planting in November. Seedlings from fall planted nuts emerge sooner and total germination is greater than for indoor stratification in a cold room. Nuts stratified outdoors in the fall for spring planting germinate as readily as fall planted nuts. Pecan, hickorynut, filbert and heartnut seed are handled the same as black walnut. Persian walnuts are stored dry for spring planting. The seed is soaked in water 10 days before planting in early April.

Chinese chestnut seed is collected in September, husked and partially air-dried on screens for one week. The chestnuts are treated for weevils, the larvae of which feed on the plant embryos. The nuts are placed in a fiva»gllon lard can and a jar lid half-filled (20 cc) with carbon disulphide is laid on top of the seed. A tight lid is placed on the can, which is kept closed for 24 hours. The seed must then be aired briefly before storing dry in either one- or five-gallon cans, depending on whether storage is in a refrigerator or cold room at about 34°F. In storage, the can lids are closed completely only after condensation on the inside of the lid stops accumulating. Fall planting is preferred to cold storage and spring planting. In either case seed must not be allowed to become dry or germination failures occur.

Oak acorns, like chestnut seed, must also be treated for weevils. Fumigation procedure is the same as for chestnut seed. Acorns of the white oak group must be planted immediately after collection, since the seed soon sprouts. Other oak species can be either stratified outdoors or in a cold room for spring planting or planted directly in the nursery in the fall.

Honeylocust seed matures in early September, although pods remain on the trees much longer. The seed are removed from the pods and stored dry. Stratification is from 60 to 90 days. Black locust seed is handled like honeylocust seed, except only a 30-day stratification period is needed.

Yellow-poplar seeds mature by middle October (10). The best seed can be obtained by shaking the tree limbs and collecting the seed on large sheets or a canvas spread beneath the tree. The heavier seeds shake out more readily and fall together to the sheets below. The best time for collection is on calm days, especially early morning. The seeds with wings are stored in a dry room at air temperature for almost immediate stratification (9).

Redcedar berries are immediately pulped after collection and the seed is cleaned with a strong soap or household lye solution to dissolve any remaining resin. After drying, the seed is stored in sealed containers in a cold room (9). November planting is simpler and as

satisfactory as stratification, which requires storage in sand in a cold room, plus a 30-day period outdoors, to allow for alternate freezing and thawing.

Seeding and Planting

Walnuts for understock production are planted in the nursery in 42-inch rows and six inches apart in the row. The seed is covered with 2-1/2 inches of soil to allow for a 2-inch soil cover after settling. Black walnuts planted at this depth give earlier germination and hence produce larger seedlings than nuts planted at a 3 or 4 inch depth (2). Germination percent for good seed (90 percent filled nuts) will average 75 percent. About one-fourth of the trees must be thinned to give a desired spacing of a tree to a foot of row.

Seedbeds are used to produce 1-0 oak, black locust, honeylocust, yellow-poplar and redcodar seedlings. Large seed like the oaks are planted in a six-by-six-inch spacing in the seedbed. A screen wire (16-mesh) may be placed on the floor of the seedbed to stop tap-root development and encourage secondary root growth.

The seedling rate for the other species is based on seed quality except for yellow-poplar,where weight of seed is taken into account (9). If stock for grafting purposes is needed, 1-0 trees are lined out in the nursery row the following year.

Black locust seed sown as late as June will still produce plantable stock in one year (9). Small lots are sown in cross rows six inches apart. Seed is covered with 1/4 to 3/8 inches of soil.

Honeylocust seed is removed from stratification and planted as soon as danger of frost is past. The seed is covered with 1/2 inch of soil and can either be broadcast or sown in rows.

Yellow-poplar seed is broadcast by hand in March or early April (9). The seeds are pressed into the soil with a roller and covered with one inch of sawdust or compost.

Redcedar seed is sown in 6-inch cross rows and covered with 1/8 inch of soil. The beds are covered with plastic sheets until germination begins in the spring.

Care During Growing Season

Cultural practices are generally the same for all hardwood species. Nursery rows are cultivated with power garden equipment. Spacing of trees in the row will allow for hoe cultivation. The trees are watered about four times during the growing season with a portable, 3-inch aluminum pipe sprinkler system. Seedbeds require some early weeding but tree growth soon shades out weed growth.

Few insect and disease problems are encountered with hardwood nursery stock but if once detected they should be controlled immediately. Look for leafhopper to attack the underside of chestnut leaves and midge to attack the upper surface of the leaves. DDT controls the leafhoppers and Malithon or nicotine sulfate, the midges. These sprays have been found effective for most of the problems that occur. Examples are the cottonwood leaf beetle and black walnut lacebug. Aphids are easily controlled with nicotine sulfate. Lead arsenate continues to be an effective control for leaf-chewing insects.

The common fungicide, Bordeaux mixture, is used effectively in control of leaf spot and other diseases. Phomopsis blight on redceder seedlings can be controlled by constructing well-drained seedbeds and roguing out infested seedlings. Semesan sprays have not been too successful in controlling the blight at Norris Nursery.

In recent years many new insecticides and fungicides have entered the market. Some are proving very effective, while others must undoubtedly be tested further. Always follow the manufacturer's directions in mixing and applying chemicals. [1/]

Vegetative Propagation

Named varieties of black walnut and other nut trees are propagated by budding and grafting (1). Limited production by commercial nurseries and erratic survival of buds and grafts are reflected in the cost of stock, A grafted nut tree will cost several times the price of a budded peach or apple tree. The need for large numbers of improved nut trees for the cooperative test planting program led to development of economic practices in improved nut tree production, Main savings include the elimination of seedbeds and operations of lifting, grading, and lining-out seedlings. Growing time in the nursery was reduced by one full year.

Black walnut and most other nut tree seedlings reach sufficient caliper for propagation in the first growing season, provided attention is given to proper seeding and cultural practices. Understock should be at least 3/8" in caliper by August when they are budded. Much of the stock is usually 1/2-inch to 3/4-inches in caliper by then. A Jones patch-budding tool, used to remove a rectangular patch of bark from the understock and a similar patch with a bud from the scion, works exceptional) well. Width of the patch-bud is 1/2-inch but the tool can be modified to cut a 3/8-inch patch.

Three-eighths-inch strips of waxed muslin cloth are used to tie the buds in place. A dab of wax at the top of each wrap prevents them from loosening on the understock, Within three weeks the buds have grown

[1/] Formulae for some of the common insecticidal sprays are: Malithon at 2 tablespoons per gallon of water; DDT wettable powder (50% DDT) at 2 teaspoons per gallon; and nicotine sulphate (40% nicotine) at 1 teaspoon per gallon with addition of soap for a spreader.

tight. The wraps are then removed to prevent girdling of the seedling.

During the dormant season, a U-shaped digger blade is run under the budded seedlings to check taproot development. When growth commences in the spring the stocks are cut back to the top of the patch bud. Sprouts that develop on the understock are kept removed. This forces all new growth into the patch bud. Buds are staked and tied to produce straight, well-formed trees. Budded trees average 20 to 30 inches in height at the end of the season.

Understock on which buds fail to "take" can still be utilized. They are grafted at the time budded trees are "cut back" in the spring. Amodified-cleft-graft has been used most, although the whip-and-tongue graft can also be employed. The understocks are cut back to 3 inches above the groundline two weeks before the grafting is done to allow the sap flow, characteristic of black walnut, to cease. This profuse "bleeding' would "wash out" arid sour the grafts. The grafts are tied with raffia and then waxed with a preparation made of beeswax (6 pounds), rosin (16 pounds) and linseed oil (1 pine). When the grafts begin growth all but the dominant shoot are removed from the scion.

The trees, both budded and grafted, are lifted in late fall. A digger blade pulled by a heavy duty farm tractor is run under the trees to facilitate lifting operations. Trees are root pruned of damaged and heeling-in bed. Stock to be held until spring is removed from the heeling-in bed to the cold room.

An example of propagations of Thomas black walnut made in a season were 1,165 cleft-grafts and 6,470 patch-buds. Survival record for 12 seasons on cleft-grafting of Thomas was 58 percent and for 10 seasons on patch-budding Thomas was 50 percent (14). A better quality tree can be produced at lower cost by patch-budding than by grafting. Propagation trials (1) with chip, shield and patch-budding in the spring, bench-grafting, and modifications in cleft-grafting did not improve on the practice of patch-budding in summer and cleft-grafting in the spring. The U.S. Department of Agriculture Farmers' Bulletin 1501 constitutes a most useful reference for anyone interested in propagating nut trees (8).

A source of scionwood of promising nut tree selections and varieties has been developed at nearby locations by establishing orchards, arboretums and topworking wild trees. Scionwood for spring grafting is collected during the dormant season from vigorous shoots of the previous year's growth and stored in damp sphagnum moss at 34° F.

For summer budding, bud sticks are collected at the beginning of the day and again after lunch on the day that budding operations are performed. Budwood is obtained from the current year's growth. Leaf petioles are removed with a sharp knife and care is used so as not to injure the bud at the leaf axil. Buds from the base of the budsticks are easier to work and fit on the understocks.

Extreme care is taken to keep scionwood of the numerous selections and varieties from becoming mixed. Trees from which scionwood is collected are mapped as well as permanently labelled in the field. Scionwood is tied in bundles and labelled with wooden wire tags. Labelling in the nursery row is done with redcedar stakes and stamped aluminum labels.

Propagation of some of the nut trees requires procedures differi slightly from those in use with black walnut.

Pecan seedlings can be either budded or grafted, but it takes two years in the nursery row for trees to reach buddable size.

Hickories take 3 to 5 years in the nursery row to reach bud. size. The hickories are generally grafted in the spring, since in patch-budding it is difficult to get the patch with bud free from the budwood without damage to the bud. Bitternut, C. cordiformis, and shagbark, C. ovata, hickory seedlings are more satisfactory for understock than either the shell bark, C. laciniosa, or mockernut, C. tomentosa, seedlings.

Persian walnuts are more easily grafted than budded since the patch buds are hard to remove from the budstick. Understocks used are black walnut and heartnut, J. sieboldiana cordiformis.

All chestnut varieties are propagated by grafting. For speed, the whip-and-tongue graft is best; the saddle graft (inverted cleft-graft) also gives good results. Survival of chestnut grafts has run as high as 95 percent.

Filberts are multiplied by root suckers. Selections on their own roots are planted two feet apart in nursery rows. Trees are left to grow for two years during which time suckers are produced from the roots. Then the entire block of trees is lifted and the new trees of plantable size are separated from the parent clones. Four to six trees with adequate root systems can be obtained from a single parent. Trees may also be produced by root-grafting.

Propagation of straight-stem black locust is by root cuttings. During the winter months roots from trees grown in the nursery row are cut into 4-inch cuttings, bundled in lots of 50 and store in sand boxes at 34° F. In early spring the cuttings are planted vertically in nursery beds on a 6 x 6-inch spacing or in nursery rows with 3 six-inch rows planted every 42 inches across the nursery block. The cuttings ranging from 1/4 to 3/8 inches in diameter are planted 3-1/2 inches deep with not more than the upper half-inch of the cuttings remaining above the ground lin Boards with pegs are used to mark the position of cuttings while planting, Hand dibbles help to deepen the planting hole to th e proper depth and to tamp around the cuttings, Before lifting in the fall a digger blade is run under the trees to sever the roots at an 18-inch depth. The 6 x 6-inch spacing is more satisfactory

an either a 4 x 4-inch or 3 x 3-inch spacing with regard to survival, yield of plantable trees and yield of root cuttings.

Honeylocuat, Gleditsia triacanthos, is easily budded and grafted. Selection of buds from thornless shoots of thorny trees results in the development of trees free from dangerous and undesirable thorns (3). The technique has application in producing thornless trees bearing pods high in sugar content for pasture tree planting. Commercial nurseries have patented varieties that are thornless and staminate, resulting in a tree much in demand for ornamental plantings, Selections of yellow-poplar for figured wood studies are whip-grafted in the spring after understock has grown in the nursery row one year. Root-grafting is also a very satisfactory method. Potted grafts fay be kept in a shade house to develop or the grafts may be planted directly in the nursery. One-year wood is used for scions.

Cottonwood planting stock is produced from stem-cuttings. In the nursery 12-inch cuttings are planted flush with the ground in 42-inch rows and 6 inches apart in the row. The cuttings are made in late winter, stored in boxes in sphagnum moss in a cool cellar until March planting time. During the growing season the trees are watered frequently, especially during dry spells. Cultivation is required during the first two months of growth. Heights of 10 to 15 feet in one season are not uncommon. Stems from the new production are cut off in late winter to make additional stem cuttings for both nursery and field needs. The root stubs, which are also plantable, are lifted following removal of the stems from the trees.

American holly can be successfully rooted under a polyethylene covered frame, using a mixture of sand and peat moss. One-inch softwood cuttings made August to October with a single leaf and bud are plunged into the rooting medium so that one-half to two-thirds of the leaf is exposed. Only occasional watering with a sprinkling can is required to maintain needed moisture. Hormone powder hastens rooting. Holly can also be dormant grafted by the side graft method. A four-inch scion with a few leaves attached works well when the graft union is waxed and the entire graft is covered with a polyethylene bag.

The pines are not as easily propagated as some of the hardwoods, Experimental studies have been conducted for developing techniques for the production of pine clonal material by numerous investigators (5), (7), (11), (12). The report by Mergen and Russell (6) illustrates methods for air-layering, grafting succulent tissue, dormant grafting and in-arching of slash pine. Since the methods described have application in the propagation of other pine species, it is recommended as a reference for anyone beginning work in this field. Zak (13), in a continuation of studies begun in 1947, has attempted to find more practical methods for multiplying shortleaf and loblolly pine.

Investigations by TVA have been concerned mostly with loblolly, shortleaf and white pine (4). Modifications and trials of procedures found successful by other workers have been tested at Norris both in the nursery row and under a shaded cloth house.

Handling of pine seedlings for understocks is the same for all species. One-year-old seedlings, except white pine, which is 2-0, are potted in 3-1/2-inch clay pots with "woods' soil and plunged in sawdust under partial shade. The seedlings are allowed to grow another year for dormant grafting but may be succulent grafted the same spring, In the shade house, watering is required only 2 to 3 times a year, depending on rainfall. Stock that is not potted is lined out in the nursery row.

We find the side-graft very successful for dormant grafting onto potted stocks under partial shade. Dormant grafting may be carried out from mid-January until early April. Success in grafting of shortleaf, loblolly and white pine is dependent on the use of polyethylene film as a cover for the grafts.

Cleft-grafting when the stock and scion are in a succulent condition proves a very satisfactory method with shortleaf and loblolly pine. Grafted trees can be obtained the same year the seedlings are potted. The methods work well in the nursery row if the polyethylene bag is covered with a kraft paper bag to provide shade for the graft. Holes are cut in the paper bag to provide ventilation. May is the best month for succulent grafting at Norris, Tennessee.

Air-layering attempts have not proved toosuccessful. Only a 30 percent survival was obtained with loblolly pine in 1955 tests. Shortleaf and white pine air layers failed to produce roots. In 1956, roots were induced on shortleaf pine in trials of the needle-cluster method of rooting. Failure of airlayered branches to root on trees growing in the nursery may be caused by unduly high temperatures within the rooting medium. Use of reflective insulation around the polyethylene cover may result in better success with air layering.

Loblolly pine and shortleaf pine have been successfully grafted on understock of the following species: loblolly, Jack, Virginia, Scotch, shortleaf, and mugo pines: Graft survival was highest for loblolly and shortleaf pine when they were grafted on understocks of their own species.

Shipping Plant Materials

The proper packaging of trees or scionwood for shipment is important to assure that plant materials will arrive at their destination in good condition. The bulk of the propagated nut trees for use in the variety test program are shipped by parcel post. Stamped aluminum labels

are wired to each tree to identify varieties. (In planting, the label is removed from each tree and nailed to a stake placed near the tree.) Trees are tied in lots of 4 to 6 trees by variety with as many as 5 varieties being packaged in a bundle. Damp sphagnum is packed around the roots and this portion of the package is covered with heavy kraft paper. Then the entire package is covered with burlap followed by an outside wrap of kraft paper. The bundles are tied with heavy twine to prevent loosening of trees and loss or damage in transit. Consignees have always reported favorably on the condition of stock on arrival.

For larger express shipments, sisal kraft paper is wrapped around the tree roots and then the entire package is covered with burlap. The burlap is tied and then sewed with cotton cord.

Savings in shipping costs can now be made with the use of nursery wraps made of kraft paper coated with polyethylene plastic. It is important in shipping large trees that the weight of the wrapping material be strong enough to prevent tearing.

In the dormant season, pines are packed root to root with a layer of moist sphagnum placed around the roots. The tops of the trees are left open in wrapping with sisal kraft paper. During the early growing season pine trees can be shipped successfully by packaging the roots in damp moss and covering the tops with polyethylene film.

Shipment of scionwood has been made easy with the use of polyethylene film. However, if plastic film is not available, wrapping the budsticks in a layer of damp newspapers and then covering the package with waxed paper before finally wrapping with kraft paper proves very satisfactory.

Summary

The Norris Nursery was established in 1933 to produce stock for experimental and developmental purposes in TVA's watershed protection program. Early production was mostly seedling trees for wildlife and erosion control projects. Then, as the improved nut and forest tree phase of the program developed, vegetative propagation of clonal plant material became important. Many of the trees propagated were not generally available from commercial nurseries. Methods found successful for producing improved trees of black walnut, black locust, Chinese chestnut, filbert and honey-Locust and findings based on lesser experience with cottonwood, hybrid poplar, yellow-poplar and shortleaf and loblolly pine are reported, since they may have application in forest tree improvement programs.

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