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Moderator, Dr. Scott S. Pauley

20. GRAFTING TECHNIQUES USED IN PROPAGATING SPECIES OF PINE IN THE SOUTHEAST FOR EXPERIMENTAL AND SEED ORCHARD USE

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The recent upsurge in forest tree improvement and genetics in the Southeast and elsewhere in the United States has made necessary better methods of vegetative propagation. Although only a tool of the forest geneticist, vegetative propagation, either by grafting or by the rooting of cuttings, is an important aid in carrying out effective studies in a reasonable time. Without these techniques his work would be considerably hampered.

Both the rooting of cuttings and the grafting of scion shoots have their place in these programs. For many purposes, however, rooting is more desirable than grafting especially where root systems genetically identical to the parent tree are required. The more widespread use of grafting is of course due in large part to the better success generally associated with this method.

Unfortunately rooting becomes increasingly more difficult with material from older trees. A high percentage of cuttings from young trees may root but only a few or none at all from trees beyond 10 years of age. Grafting, on the other hand, does not share this age limitation. Trees from seedlings to mature individuals can be readily grafted provided, of course, that vigorous tissue is available. If necessary, vigor of old valuable trees can be improved considerably by preparatory fertilizing and even by watering.

This difference in success of grafting and rooting associated with the age of the tree can be graphically illustrated by work on shortleaf pine in connection with the littleleaf disease. Trees ranging in age from 30 to 81 years have been propagated successfully by grafting. In several cases 90 percent success has been attained. Ten out of 10 grafts were successful using scion material from one 81-year-old tree.

However, attempts at rooting cuttings from many of these same trees have been unsuccessful. In the selection and breeding work aimed at developing littleleaf resistant shortleaf pine an effective rooting technique is sorely needed. The resistance which we seek must be found in the root system of the tree. It must be a resistance

to a combination of factors involving a soil fungus, poor soil aeration, and generally poor site conditions. Only the rooting of cuttings can provide root systems genetically identical to the selected tree for testing under controlled conditions. Several large-scale attempts have been made to root this species. In a recent experiment cuttings were collected from 3- and 4-year-old seedlings and from three 35-year-old trees every three weeks from August to March. Only 16 percent of the seedling material rooted. Only eight percent of the cuttings from one mature tree rooted,

Work by Chase and Galle, Mergen, and Zobel in the Southeast indicates that grafting is a practical technique for propagating vegetatively many species of pine. In many instances it is used in preference to rooting simply because it works well.

Grafting on its own merits has many important applications in tree improvement and genetics work. Zobel's study of the inheritance of wood specific gravity in loblolly pine is an example. He grafted scion twigs from trees having different wood densities onto a single rootstock. If, after several years, the newly developed woods of the different scions have the same density then it can be said that environment is partially, or wholly, in control of this important characteristic. On the other hand, should the specific gravity of the wood in each scion remain unchanged then it can be said with good certainty that wood density is inherited. This same technique can be employed in determining the inheritance of other anatomical and physiological characteristics of selected material.

Another good example is the inducement of early flowering of seedling tissue by grafting it into the crown of a mature tree. Or young material may possibly flower early when grafted upon stock of different species or even genera.

A large share of the grafting of forest trees today, and in the future, concerns the establishment of seed orchards. This technique has been used successfully for many years by horticulturists in developing fruit and nut orchards. Rooted cuttings have seldom been used principally because grafting is simpler and generally more successful. Then too, grafting allowed the use of rootstocks of other varieties or species resistant to various soil-inhabiting pests or adapted to certain site conditions.

Seed orchards in Europe, Australia, and the United States are being started. with grafted trees. Both greenhouse and field grafting is being employed. Mergen and others have shown that the bottle graft is suitable for direct grafting in the field using previously established seedlings as stock. In greenhouse grafting, with the maintenance of a high relative humidity, the side, veneer, and related grafts can be used. with good results.

A type of graft not used too often may be well suited for seed orchard work especially for the enlargement or expansion of the orchard. It is the soft or succulent tissue graft. Actually it is merely a variation of the common cleft graft where very young shoots are used as scion material. The technique is quite simple and the results generally excellent. Small scale tests at Athens have been 60 to 70 percent successful. Good results were had in making the following antra- and inter-specific grafts:

Shortleaf on shortleaf
Loblolly on loblolly
Loblolly on shortleaf
Shortleaf on loblolly
Slash on loblolly
Slash on shortleaf
Loblolly on Virginia
Shortleaf on Virginia
Eastern White Pine on Virginia

Most of these grafts were made outdoors under shade. In making the graft, succulent scion shoots with needles only slightly developed were cleft-grafted into the succulent shoot of the stock seedling. Only about an inch-long scion shoot was used. A corresponding length of the growing tip of the stock tree was removed and the cleft cut made. Unlike most other grafting methods the shock upon the stock plant is of no consequence since only a small bit of tissue is removed. Very little, if any, pruning is done later. No great care was exercised in inserting the wedge-shaped base of the scion into the cleft cut of the stock. Likewise little effort was made to align the cambial zones, Fusion appeared to proceed rapidly. Very likely a high proportion of tissue other than the cambium may become meristematic in such young stems and so effect a quick joining. The rapid healing which does occur certainly must be aided by the intact crown of the stock seedling. Adequate food can thus be manufactured by the plant to maintain a high rate of tissue formation.

After the scion was inserted into the stock stem the graft was firmly wrapped with a soft cotton thread. Instead of tying the thread it was found expedient to merely smear a small bit of soft grafting wax along one side of this wrapping. This prevented unravelling and held the graft firmly. The upper portion of the stock tree including the newly grafted scion was then enclosed in a 2-pound cellophane bag having a few small holes for aeration. Transpiration from the enclosed foliage quickly raised the humidity within and thus prevented wilting of the scion. The completed graft as then placed under a light unbroken shade. After three weeks the bag was partially cut open to reduce the humidity. The following week it was completely removed and the tree placed in the lath house. A month later it was moved into the open.

At first the method seems difficult because of the small stems and the delicate tissues involved. Actually it was found that more grafts of this type could be made per hour than either the conventional side, veneer, or bottle grafts.

Work during the past summer suggests that soft tissue grafting can be successfully done throughout most of the growing season. Equally good results were obtained in early spring, in mid and in late summer. Some of the grafting was done when air temperatures ranged near 95 $^{\circ}$F., with no apparent adverse effects.

An important problem associated with this method concerns the availability, transportation, and storage of scion material. On large vigorous trees the young shoots may be too large and thick for use with this method. This difficulty can be overcome by different forms of pruning to stimulate the development of epicormic and needle bundle shoots. Such treatment can possibly be applied successfully to shortleaf and loblolly pine by making the pruning three or four weeks before the material is needed. Tip moth damage on small trees of these species often results in an abundance of suitable shoots. Such shoots have been observed in the crowns of adult shortleaf pine where tip moth or some other agency has destroyed the bud or tip of the stem. Further work will be done during the coming summer to find ways of stimulating desirable scion material in the crowns of mature shortleaf, loblolly, and slash pines.

This method of grafting possibly will find its greatest use in expanding or multiplying the existing clones already in a seed orchard. After one or two years in the orchard grafted trees will have sufficient crown to provide the necessary scion material. Very light pruning or even tip moth damage will encourage the development of suitable shoots. Each such small tree should be capable of supplying 10 or 15 shoots without harm to the tree. Thus, from a clone of 1.0 trees we might obtain as many as 150 scion shoots for grafting.

The transportation and storage of scion material should not be a problem when this method is used for seed orchard expansion. All work will be done on the same area using established seedling stock. It will, of course, be necessary to maintain these succulent shoots in a turgid condition at all times from the time of removal from the scion tree until the new graft is firmly joined and established. A small container filled with moist sphagnum moss can be used to carry the material from tree to tree. After the cellophane bag is placed over the completed graft it will be necessary to provide shade to prevent heat build-up within. This means an individual shade for each grafted tree. Possibly an inverted paper bag stapled on a slat will serve the purpose. Other devices will be tried during the coming summer.

Recently the state of Georgia has embarked upon an ambitious project--that of establishing seed orchards of loblolly and slash

pine. The Georgia Forestry Commission in cooperation with the Southeastern Forest Experiment Station has developed plans aimed at the eventual establishment of several hundred acres of grafted trees. Scion material from selected individuals having good seed-bearing ability, apparent resistance to fusiform rust, and with good growth and form characteristics will be used. Progeny tests of the selected trees will be carried on concurrently under another project.

Over 2,500 seedlings will be grafted early in 1955 using scion material from as many as 50 selected trees. This grafting will be done in a humidified greenhouse using the side and veneer grafts. Early in the spring and throughout the summer various forms of field grafting will be tried. These will include the bottle, soft tissue, and other grafts. It is hoped that in 1956 all grafting can be done in the open on seedlings outplanted in the orchard. The different grafted clones will be considerably expanded within each area through the use of soft tissue grafts.

A spacing of 16 x 16 feet is contemplated allowing 170 grafted trees per acre. One-year-old seedlings were outplanted on the areas this past fall-two at each spot. Both will be grafted with the hope that one of the two grafts will be successful. The duplicate seedling will be removed, If both fail they will be regrafted later in the season. This work is in large part experimental in an effort to develop suitable techniques for large scale use.

Tip moth damage to grafted trees may be a serious problem in the management of these orchards, During the first year after grafting heavy infestations may badly stunt the tree or even kill it. For the next few years, the damage may be slight or even beneficial by encouraging the development of a thick crown. Actually, this will be done by artificial pruning so as to produce a squatty and full-crowned tree. The greatest damage, if this pest is not controlled, may come when the grafted trees begin flowering. A late fall or early spring infestation of the buds containing embryonic female flowers would mean a poor seed crop two years hence.

Grafting, or more specifically pine grafting, has found considerable use in the overlapping fields of forest tree improvement and genetics. Workers in these phases of forestry have and will continue to use this technique of vegetative propagation in research and in practical applications. Together with methods of rooting, grafting will allow us to take advantage of shortcuts so much sought after in this work, We certainly can expect earlier results as these tools of the forest geneticist are further improved and perfected.

There still are many problems confronting the casual use of this technique with southern pine species. Difficult forms of grafting, such as the needle bundle graft, must be developed in order that desirable seedlings can be propagated vegetatively without destroying the original plant. Cheaper methods of propagating by

grafting are also essential. This will probably come as large scale seed orchard grafting is put to greater use.

(This paper was illustrated with kodachrome slides.)