# Berichte

## Selection and Breeding of Slash and Longleaf Pine at Lake City, Florida

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### Introduction

The selection of better strains as parents for numerous agricultural crops has brought great returns to the various industries. Foresters were at first slow to grasp the great possibilities of selection and breeding of superior trees, but during the last decade the accomplishments in the allied fields of agriculture have stimulated a growing interest in the possibilities of improving our forest trees. The short rotations for merchantable timber products, along with the vast tree planting program in the South, makes the southern part of the United States a most promising region for fruitful investigations in species improvement.

The species improvement program at the Lake City Florida Research Center is concerned with the selection, propagation and improvement of superior slash *(Pinus eliottii* ENGELM. var. *eliottii)* and longleaf *(Pinus palustris* MILL.) pines. Most of the field work is carried out at the Olustee Experimental Forest, where various aspects of timber management and gurn naval stores production are also being studied. The work in experimental breeding at present is directed toward solving the basic techniques of selection, vegetative propagation and controlled breeding. These techniques are the tools necessary to carry the program through the various stages. Additional studies deal with silvicultural breeding. These studies stress the consideration of hereditary qualities when thinnings or regeneration cuts are being made and when trees are selected for seed supply. The methods used for these studies are rather crude but they should lead toward eugenic forestry practices, since the can be applied without delay by foresters almost everywhere.

### Selection of Trees

*Single Tree Selection*

When the Species Improvement program was initiated in 1941, its objective was the development of superior strains of pine to produce naval stores products. The first phase of the project was to identify and select high-gum-yielding trees in natural stands. These superior trees were to be used as parent stock for controlled pollinations or as a source of material for vegetative propagation. Many trees were reported to the Station by naval stores operators from all parts in the naval stores belt, but most of these high yielders were discarded since their superiority in gum-yield could be explained on the basis of favorable location, size and age of tree, and intensity of work. The most promising trees were selected for further detailed study. As a result of this selection for high gum yields, 12 trees have been located in Georgia and Florida which produced at least twice as much gurn as the average tree of the same diameter growing on the same site. They have been used as parents in the past breeding work at this Station and have been propagated vegetatively by the rooting of cuttings taken from the crown.

It is a well-established fact that propagation by vegetative means assures progeny having characteristics identical with those of the parent. As a result of this technique, we now have a 7-year-old plantation of rooted slash and longleaf pine cuttings from various high-yielding trees. Within a few years some of these trees will be large enough to compare true gum-yielding capacity as well as other characteristics. We collected the first cones last fall in this plantation. The largest slash pine cutting is now 25 feet tall and has a good erect form (fig. 1).

Fig. 1. — This 25-foot slash pine originated from a rooted cutting. The cutting was taken eight years ago from the crown of a high-gum-yielding slash pine (Pinus eliottii ENGELM. var. eliottii).

Using the yield records from other naval stores studies on the Olustee Experimental Forest, additional superior trees have been located. In connection with these selection studies, trees which produced aberrant types of gurn were also found. One tree produced bright yellow gum, and the gurn of another tree was pea green in color.

Initially selection of superior trees by KEITH DORMAN (1945) was based on gurn yields, but now primary emphasis is placed on fast growth-rate and good form. Fast-growing pines reach chipping size sooner and at a given age are of larger size and hence produce more gurn than trees of average growth. In addition to the selection for desirable characteristics, trees of very undesirable traits such as excessive forking, heavy persistent branches, and unduly large crowns have been located. We hope to get

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some data on inheritance of undesirable characteristics, in slash pine trees from the open-pollinated progeny. The information obtained from these mono-hybrid crosses should be of value in demonstrating the need for more desirable trees for seed collection. In the southern U. S. most of the seed used in public nurseries is collected from trees having heavy persistent crowns which can be climbed easily. The relationship between cone size, seedling size, seedling vigor, and growth are being studied by carrying these experiments through the various stages from cone collection to sapling behavior in the plantation. One slash pine tree has been located which had exceptionally large cones with correspondingly large seeds.

In 1935, wind-pollinated cones were collected from longleaf pines whose gum-yielding capacity had been determined during experiments with commercial turpentining practice, and a progeny testing plantation was established on the Olustee Experimental Forest. Using micro-tapping techniques (fig. 2), the gum yields of the progeny were determined in July 1952 on 34 of the 17-year-old longleaf saplings. The statistical analysis of the results indicated that gum yield is an inherited character in longleaf pine. Yields of the 17-year-old longleaf pines from above-average mother trees were significantly higher than the yields from below-average trees.

Fig. 2. — Micro-tapping technique used to collect gum samples in longleaf plantation. A 3/4-inch bark patch is lifted out with a metal punch and the wound is sprayed with 50-percent sulfuric acid to prolong the gum flow. Gum collects in the paper cup.

*Nursery Bed Selection*

Thanks to the cooperation of the Nurseryman from the Florida Forest Service, it has been possible to make selection among a large number of seedlings growing in the State nursery, which is also located at Olustee, Florida. This selection was carried out among many millions of seedlings where the seed has come from innumerable places and where there is no record of parentage. There appears to be a good chance of discovering a few exceptionally vigorous seedlings or some mutations which will come true from seed. Mass selection in a forest restricts the selection to a rather limited number of individuals, while in nursery selection several million seedlings can be examined within a relatively short time.

A small outplanting with selected seedlings from the Olustee Nursery has been established in our experimental area to demonstrate the extremes in seedling development under current nursery practices. These seedlings include excessively large specimens, dwarfed seedlings, and seedlings having long, short, or twisted needles. These seedlings will be closely observed to obtain data on the relationship between seedling characteristics and subsequent development. Cytological studies will be made on the dwarfed seedlings to see whether the mutation has occurred as the result of an alteration or change in number of chromosomes.

*Mass Selection*

Forest genetics and good silviculture go hand-in-hand and no tree-breeding program will remove the need for sound silvicultural treatment. These two sciences supplement each other and in many instances are dependent upon each other. Progressive forestry programs can incorporate the principles of forest genetics into their management programs, and take advantage of new findings in this field step by step, and should not wait until the „superior" tree is available. When selecting seed trees, or trees for cone collection, good judgment and common sense will help toward the perpetuation of good pine stands. When trees are selected for seed source, outstanding individuals can be chosen from trees growing in groups where comparisons of the growth characteristics are possible. The forester should select trees having good form, combined with rapid growth, as mother trees to reforest the timber land.

Last summer two selection areas were established to demonstrate existing variations between individual slash pines. One is an acre plot in an old-field stand and contains 165 trees, averaging 8.5 inches diameter at breast height, with a volume of 24 cords per acre. Twentyeight of these trees, selected for good vigor, have a d. b. h. of 11 inches or more. Five of these 28 trees have been selected as „phenotypically superior" trees, since in addition to good growth they also exhibit excellent form, good natural pruning and small knots. Fourteen of the remaining 137 trees have forked tops and should not be retained in the stand. The second slash pine selection plot is located in a 70-year-old stand in a pond and covers an area of 2 acres. From a total of 211 trees, 32 trees have been selected for good vigor and five of these „plus" trees are thought to be phenotypically superior.

These two selection plots help to demonstrate the existing variation between trees in natural stands and help to stress the similarity between good silviculture and forest genetics. These two sciences have indentical objectives. These plots have been used to demonstrate the selection of desirable trees for cone collection, the conversion of existing stands into seed orchards, and the practice of eugenic thinning operations. Results of open-pollinated progeny studies with pines indicate that the mother tree greatly influences the form and vigor of its progeny. Most of these traits are very important to foresters when managing timber lands. Characteristics such as form, vigor, disease resistance, and branching habits are inheritable, and trees with desirable traits should be selected for seed production.

Mass selection on a much broader scale is being undertaken through cooperative studies of geographic strains of slash pine under the sponsorship of the Southern Forest

Tree Improvement Committee. Seed has been collected for testing at various stations, and a plantation with slash pines from various geographical origins is being established.

### Techniques of Vegetative Propagation

*Rooting of Cuttings*

Although the rooting of cuttings has already been used to perpetuate selected superior gum-yielding pines at Lake City, the percentage of rooting was low and quite variable. Special studies of rooting techniques commenced by HAROLD L. MITCHELL, CLIFFORD S. SCHOPMEYER, and KEITH W. DORMAN have been continued intermittently since 1941.

Improvements have been made, but much remains to be done. Last fall we started rooting tests with 1400 slash pine cuttings in greenhouses at Olustee and at Gainesville to develop more efficient techniques for the vegetative propagation program. A total of 23 treatments and rooting conditions are being tested including various growth regulators, rooting media, nutritional factors, and watering conditions. At Olustee the moisture content of the cuttings is maintained by an automatic overhead water system which sprays a fine mist on the cuttings for a portion of each 10-minute cycle during the daylight hours.

*Grafting*

A suitable grafting technique is an invaluable tool for any species improvement program, since grafted material can be used to estimate the genotype of selected trees, to perpetuate desirable germ plasm, for hybridization studies, for seed orchards, and for a great number of related specialized studies. Swedish and Danish forest tree breeders have devoted most of their efforts for the past decade to the selection and perpetuation by grafting of the „plus" trees suitable for seed plantations. Some 10,000 grafts are made every year in Sweden from these phenotypically superior trees, and at many stations in Europe grafted material is already being used to good advantage in controlled breeding work.

At Olustee, empirical and fundamental tests are being started in the field and in the greenhouse to develop suitable grafting techniques for slash pine. Wildling slash pine seedlings were potted during 1952 and are in excellent condition for grafting. Three types of grafts, veneer, cleft, and bottle graft, will be tested under four different environments. Anatomical studies will also be made of graft unions to determine the basic factors involved in securing a union in pines.

In order to induce early flower formation, 1-year-old slash pine seedlings will be grafted into the crowns of mature trees in autoplastic grafts, i. e., within the same species. In addition, heteroplastic grafting between different species will be tested as a method for hastening flower development in slash pine seedlings. Young slash pines several months old will be grafted on seedlings of several other species using micrografting techniques. HERRMANN (1951), a German scientist, has been able to stimulate flower formation in a pine at the age of 8 to 9 months using this method, and thus to reduce the time lag between two generations.

### Breeding of Slash and Longleaf Pines

Vegetative propagation helps to multiply the germ plasm of superior trees but it does not improve on its qualities. Selective pollinations aim beyond this objective by attempting to develop germ plasm of improved qualities. Controlled breeding programs deal with particular characteristics or traits of individual trees and attempt to develop new types with a combination of the desirable qualities of the parents.

When the controlled breeding program was initiated in 1943 at this Station it was aimed at the development of high-yielding strains of naval stores pines. Crosses were made between selected superior slash pines in an attempt to produce superior progeny. Seedlings from the first breeding work with high-yielding slash pine are now growing in two progeny testing plantations, along with seedlings from so-called average trees. Slash pines in the plantation which was established in 1946 have grown very rapidly and some are 24 feet in height (fig. 3). The first mature

Fig. 3. — Seven-year-old hybrids in progeny testing plantation. F. MERGEN checks one of the hybrids which measures 5-inches diameter at breast height. A slash pine × longleaf pine hybrid and a loblolly pine × slash pine hybrid are marked by the two signs. KEITH W. DORMAN established this plantation in 1946 (loblolly pine — *Pinus taeda* L.).

cone was found on one of these young pines in the fall of 1952, less than 7 years after seed germination. In some instances crosses of the same origin show a remarkably uniform branching habit and similar needle characteristics (fig. 4). During the end of last year every tree was photographed to obtain some information on inheritance of form and vigor. Present plans are to start testing gum-yielding capacities in this progeny plantation within the next two or three years. The female flower development on these slash pine saplings is watched carefully in order that they may be pollinated at the proper time to take full advantage of early flowering habits.

To take advantage of hybrid vigor, or heterosis, crosses of slash pine × longleaf pine and loblolly pine × slash pine were attempted in 1943 (loblolly pine — *Pinus taeda* L.). These crosses resulted in four putative hybrids in a plantation. The slash-longleaf hybrids did not go through a grass stage but started height growth without any delay. This may be a very important development, as it might be

possible to develop a strain of longleaf pine without the characteristic grass stage by back crossing either longleaf-slash, or slash-longleaf hybrids with longleaf pine.

Interspecific crosses were also attempted in 1952 between longleaf pine and slash pine; pond pine (*Pinus rigida* var. *serotina* [MICHX.] LOUD.) was pollinated with sand pine (*Pinus clausa* [ENGELM.] SARG.), longleaf pine and slash pine pollen. The seed will be ready for collection in 1953, at which time it will be planted out with normal seed from each of the parents in alternating rows to observe their behavior.

The problems which confront the forest-tree breeder are many and quite varied. Not only do technical difficulties such as vegetative propagation and hybridization have to be overcome, but also the trends in industry must be anticipated in order to meet the objectives. There is confident hope that these objectives can be reached and that this program will aid in increasing the supply of raw materials from the pine forests of the South.

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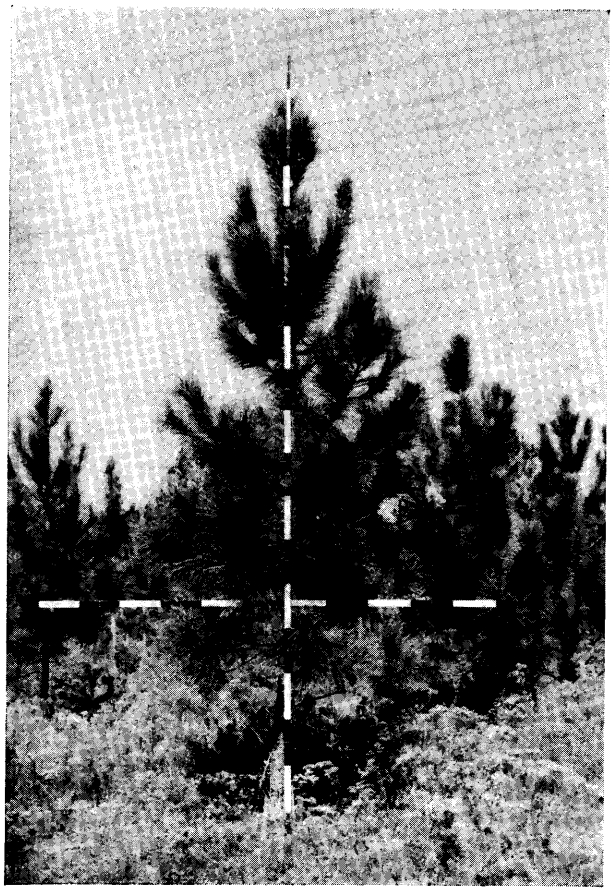

Fig. 4. — Progeny testing from phenotypically superior trees is an important part of a species improvement program. These seven-year-old slash pines, originating from the cross, show close resemblance in needle and branching characteristics. The measuring sticks are marked at one-foot intervals.

Fig. 5. — Bagged slash pine conelets for controlled pollinations. The female flowers are plainly visible through the walls of the bag made of plastic sausage casing. The piece of black tape at the upper right covers the puncture made by the pollen injector.