The Western Gulf Forest Tree Improvement Program - History and Accomplishments

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ABSTRACT

The Western Gulf Forest Tree Improvement Program was formed in 1969 with 13 charter members. Currently, the program has 11 industrial members and 5 state agencies representing Arkansas, Louisiana, Mississippi, Oklahoma and Texas. The objectives of the program are to provide coordinated and sustained leadership and technical guidance to its members, allow for the open exchange of plant material and information among its members, and support pertinent tree improvement research.

The members are concentrating on improving the performance of loblolly and slash pine. Some members are also conducting tree improvement programs for longleaf and shortleaf pine. Approximately 2,100 acres of seed orchard have been established to produce the seed required for artificial regeneration programs. In 1988, these orchards produced over 15 tons of improved seed. Almost all of the planting programs in the Western Gulf region are using only genetically improved seed.

A breeding population of over 4,000 first generation slash and loblolly pine selections has been developed by the members. Control-pollinated breeding and progeny testing programs are being conducted to develop the next generation of improved selections. The best genetic selections are being incorporated into new seed orchards utilizing the advancing-front concept.

Research is being conducted in areas of applied tree improvement to insure that a continued supply of genetically superior seed with increasing quality will be available in the future in a cost-effective system.

INTRODUCTION

The Texas Forest Service initiated tree improvement efforts in 1951. At that time, research was the major thrust of the program because the standard procedures used in tree improvement programs had not been developed. Initial efforts concentrated on selection techniques, grafting, seed orchard management and progeny testing. Support was predominantly supplied by the State of Texas; however, several industrial

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organizations supplied land and funding. Information and material were freely exchanged among the participants; however, most efforts were concentrated on research.

In 1969, the program was restructured and the Western Gulf Forest Tree Improvement Program (WGFTIP) was formed and the major emphasis was placed on service instead of research. Thirteen organizations, eleven industrial and two state organizations, originally formed the WGFTIP. The objectives were to provide coordinated and sustained leadership and technical guidance to the members, allow for open exchange of plant material and information among members, and support pertinent tree improvement research.

MEMBERSHIP AND ORGANIZATION

Currently, the WGFTIP has eleven industrial members and five state agencies representing the states of Arkansas, Louisiana, Mississippi, Oklahoma and Texas. An executive committee, which is composed of one voting representative from each member, is the governing body and determines policy at an annual meeting. The chairmanship of the program is rotated among the members on an annual basis. The chairman and three elected members form a steering committee. This committee meets three times a year and conducts business between executive committee meetings. Contactmen meetings are held annually to provide for technology transfer among seed orchard managers and other tree improvement workers.

PROGRAM SCOPE

Most of the planting program within the Western Gulf Region involves loblolly pine. Slash pine is used by some members on flatwood sites along the Gulf Coast and limited planting programs are conducted with shortleaf and longleaf pine. The combined regeneration program of the members results in approximately 500,000 acres of plantation being established each year. Major emphasis for genetic improvement is placed upon improving volume growth for all species except slash pine where increasing resistance to fusiform rust is most important. Stem quality traits, straightness and forking, must meet minimum standards. Specific gravity is usually maintained at a regional average.

To develop a large breeding population, each cooperator located 100 first generation selections for each of their orchard types. This resulted in over 4,000 first generation slash and loblolly pine selections. This base population has been divided into 115 breeding groups for loblolly pine and 34 breeding groups for slash pine. These selections are grafted in scion banks for preservation and breeding efforts.

Approximately 1,700 acres of first generation and 400 acres of advanced generation seed orchard are being managed to produce the seed required for the artificial regeneration programs. Over 15 tons of seed was collected from these orchards in 1988 which was sufficient for most of the members' regeneration programs.

SEED ORCHARD MANAGEMENT

Seed orchard management programs are divided into two phases: establishment and production. The objective of establishment phase management is to promote vigorously growing healthy grafts. Practices generally include a balanced fertilization program for growth, full-season irrigation and disease and insect control. Depending upon the results of soil tests, a balanced fertilizer is applied in early spring. Typically, rates of 50 pounds per acre of nitrogen, phosphorus, and potassium are used. The irrigation regime is used to supplement natural rainfall so that total precipitation is at least one inch per week. In loblolly and shortleaf pine seed orchards, insecticides are used to control tipmoth which is the most common insect pest. Control of fusiform rust in slash pine seed orchards by fungicide sprays or pruning is very important.

When the orchard is between four and six years old, production phase management is initiated. The objectives of this phase are to maximize cone and seed production. Management practices involve fertilization for flower stimulation, a cone and seed insect control program, and subsoiling to help offset soil compaction, develop a deeper root system and attempt to drought stress the trees. High rates of nitrogen fertilizer (150 pounds per acre) applied in late July or early August have been shown to stimulate flower production. This fertilizer is applied annually while lime and other nutrients are applied on the basis of soil test results. There are six species of cone and seed insects which can destroy over 50 percent of the potential seed crop. In extreme cases, these insects have destroyed over 85 percent of a seed crop. The timely use of registered insecticides to control these insects is one of the most important aspects of production phase management. If irrigation is available, its use is stopped around the first of July to promote flowering.

New seed orchards are established using the advancing-front concept. Small blocks of seed orchard are established on a regular time interval with this concept. Each time a new block of seed orchard is established, it is designed to obtain maximum genetic gain. A five year establishment interval has been effective with the most of our members. In this situation, 20 percent of the required acreage is established every five years. This procedure allows the incorporation of new genetic material with superior gain into production populations as it is developed in the breeding population.

PROGENY TESTING

Progeny testing is the most expensive part of a tree improvement program; however, it is its backbone. In operational tree improvement programs, progeny testing has two main objectives: 1) evaluate parents and 2) provide a base for selection. The genetic quality of future seed and the rate at which future increases in quality are obtained are determined by the breeding and testing program.

Each cooperator is responsible for breeding and testing their own selections. Each cross is established in three control-pollinated progeny tests to evaluate the parents and develop second generation selections. Progeny tests are intensively managed to allow detection of genetic differences at an early age. Initially, it was believed that a progeny test should be grown to at least one-half of the projected rotation before selection. Later research has shown that earlier measurements (5 to 10 years) are good predictors of family rank for mature performance. Because of this, most selection activity is now completed by age ten. Survival, growth, form and infection by fusiform rust are evaluated on all tests at age five. At age ten, growth and rust infection are reevaluated on all tests. Additional evaluations, until at least age 20, are completed on a portion of the tests. Currently, the members of the WGFTIP have established over 650 progeny tests.

Progeny test results indicate that genetic gains of 8 to 12 percent in volume production can be obtained in the first generation of selection and testing. This should be increased to 15-20 percent in the second generation. Substantial improvements have been made in increasing fusiform rust resistance for slash pine. Numerous selections have been identified that will have 15 to 30 percent less infection by fusiform rust than unimproved controls.

If a progeny test meets a set of quality standards, it is screened for second generation selections after the fifth year measurement. The purpose of second generation selection activities is to pick the best tree from the best families in the test. Midparent values are used to select the families which will be screened for second generation selections. Each tree in the selected families is then compared to its plot average to rank the trees within the family. The best performing trees are reviewed in the field for competition, form, fusiform rust or other disqualifying traits.

Soon after a second generation selection is made, preferably in the same season, it is grafted into a scion bank. In addition to preservation and breeding, this also serves to increase scion availability. All second generation selections are incorporated into the second generation breeding program and the best selections are used in new seed orchards using the advancing-front concept.

ACCELERATED BREEDING

A breeding cycle is defined as the period of time to complete one generation of selection. Currently, the first generation breeding cycle has taken over 20 years. Table 1 shows a sixteen year breeding cycle that is possible using current technology. The major components of this cycle are the time delay between grafting and flowering and the time required to grow a progeny test prior to selection. Procedures that shorten either of these time periods can increase the amount of gain obtained annually.

Table 1. Sixteen-year breeding cycle

Year	Activity
1-3	Selection and grafting
6-8	Control-pollination program
10	Grow seedlings
11	Establish field tests
16	Make next generation selections

Research efforts regarding flower stimulation have shown that fertilization, selected hormone treatments, drought stressing and wire girdling have been effective in stimulating flower production in young loblolly pine. Early testing procedures (age five months) have been developed for loblolly pine that allow rejection of below average performing families prior to field testing. This reduces the costs associated with conducting a progeny testing program. Additional research efforts in these areas could increase the efficiency of operational tree improvement programs.

NURSERY EFFICIENCY

The efficiency of nursery operations has a direct impact upon the efficiency of a tree improvement program. When woodsrun seed (valued at $5-$10 per pound) was used in the nursery, the seed to seedling ratio was not very important. Seed was cheap and extra could be sown to insure that enough seedlings were produced to satisfy the planting demand. The increased value of genetically improved seed ($300 or more per pound) places greater emphasis upon nursery efficiency. When the supply of genetically improved seed is insufficient to satisfy the regeneration demand, any increase in nursery efficiency results in more acres being planted with genetically improved seedlings. An additional 1 to 2 acres can be planted for each additional 1,000 seedlings that are grown from a pound of seed.

Organizations with nurseries that have a high efficiency can support a fixed regeneration program with fewer acres of seed orchard than organizations supported by lower efficiency nurseries. Nurseries that obtain 8,000, 10,000 or 12,000 plantable seedlings per pound of seed, require 2,500, 2,000 or 1,666 pounds of seed, respectively, to produce 20 million seedlings. Seventeen fewer acres of seed orchard would be required if nursery efficiency was increased from 8,000 to 10,000 plantable seedlings per pound of seed. An increase to 12,000 plantable seedlings per pound of seed would result in a reduction of 29 acres of seed orchard.

SUMMARY

The Western Gulf Forest Tree Improvement Program is a cooperative effort among 16 industrial and state organizations in the area of applied tree improvement. The members share plant material and information from all aspects of their tree improvement programs.

Sufficient seed orchard acreage has been established to produce the seed required for the members' regeneration programs. Loblolly and slash pine are the most important species in the Western Gulf Region; however, seed orchards have also been established for shortleaf and longleaf pine. New blocks of seed orchard are established on regular time intervals to incorporate additional genetic gains made in the breeding and testing program.

The members of the WGFTIP have selected a large breeding population to support the future seed orchards. Selections for the next generation of improvement are being made from a control-pollinated breeding and testing program. This will insure additional genetic gain in the future.