A GENETIC IMPROVEMENT PROGRAM FOR VIRGINIA PINE CHRISTMAS TREES

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Abstract.--In 1981, a cooperative effort was initiated to provide genetically improved Virginia pine seedlings to Christmas tree producers in the state of Texas. A total of 50 parental selections were evaluated in four genetic tests located in east Texas. Concurrent with the establishment of genetic tests was the planting of a ten acre seedling seed orchard.

The orchard has been rogued once on the basis of results obtained from genetic tests and first seed production was realized in 1987. As seed production increases additional roguing is anticipated.

Second-generation selections have been made using criteria suitable for evaluation of Christmas trees. These selections have been preserved by grafting into a scion bank. A breeding program utilizing the concept of matings within breeding groups has been developed to provide for additional genetic gain in future generations.

Keywords: Christmas trees, Pinus virginiana Mill.

INTRODUCTION

The production of Christmas trees has become a substantial industry in the state of Texas with approximately one million Virginia pine (Pinus virginiana Mill.) seedlings being planted annually. Because of the potential for loss of the existing seedling supply and a desire to achieve as much genetic improvement as practical, the Texas Christmas Tree Grower's Association (TCTGA) expressed a desire to develop an on-going tree improvement program for Virginia pine selected for use as Christmas trees. Thus, in October, 1981 the Virginia Pine Christmas Tree Improvement Program was formally begun.

ORGANIZATION

The Virginia pine improvement program is a cooperative effort among the TCTGA, the Texas Agricultural Extension Service (TAEX) and the Texas Forest

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Service (TFS). The grower's association provides monetary support, the TAEX provides technical assistance and the TFS is responsible for tree improvement activities. The cooperative is guided by a steering committee composed of representatives of the three organizations which meets periodically to review program status and activities.

While the TFS is responsible for seed orchard production, one-half of all seed produced is made available to the grower's association for the cost of cone harvest and seed extraction. Nursery contracting for growing of TCTGA seedlings remains the option of that organization. The remaining one-half of the seed is retained by TFS to be grown for open-market sales.

TREE IMPROVEMENT PROGRAM

The Virginia pine improvement program follows many of the same procedures utilized by other southern pine improvement programs (Figure 1) and consists of four principal components: 1) selection, 2) testing, 3) orchard establishment and management and 4) breeding.

Selection

Selection of parental material was accomplished from within the native range of Virginia pine using two procedures.

1. Selection from within native stands

Forty trees were selected from native stands in central Alabama and cones collected in fall, 1981. Although straightness, apparent growth rate and general appearance were considered, the primary selection criteria was the presence of cones from which to extract seed. An effort was made to select parents which were geographically distributed sufficiently such that related individuals were not chosen.

2. Selection of previously tested material

Trees in progeny tests belonging to several industrial and state organizations were inspected and evaluated for potential merit as Christmas trees. Following evaluation, open-pollinated seeds from the best families were obtained from seed orchard ramets. Seeds from a total of 15 parents from three orchards were obtained in this manner. Because orchard seed was involved, some relatedness due to the pollen source was possible.

Testing

Following cone extraction, seeds from 50 of the selected individuals were stratified and planted into the Texas Forest Service nursery near Alto, Texas. Seedlings were grown for one year using standard nursery practices except that no undercutting, lateral pruning or top pruning was done.

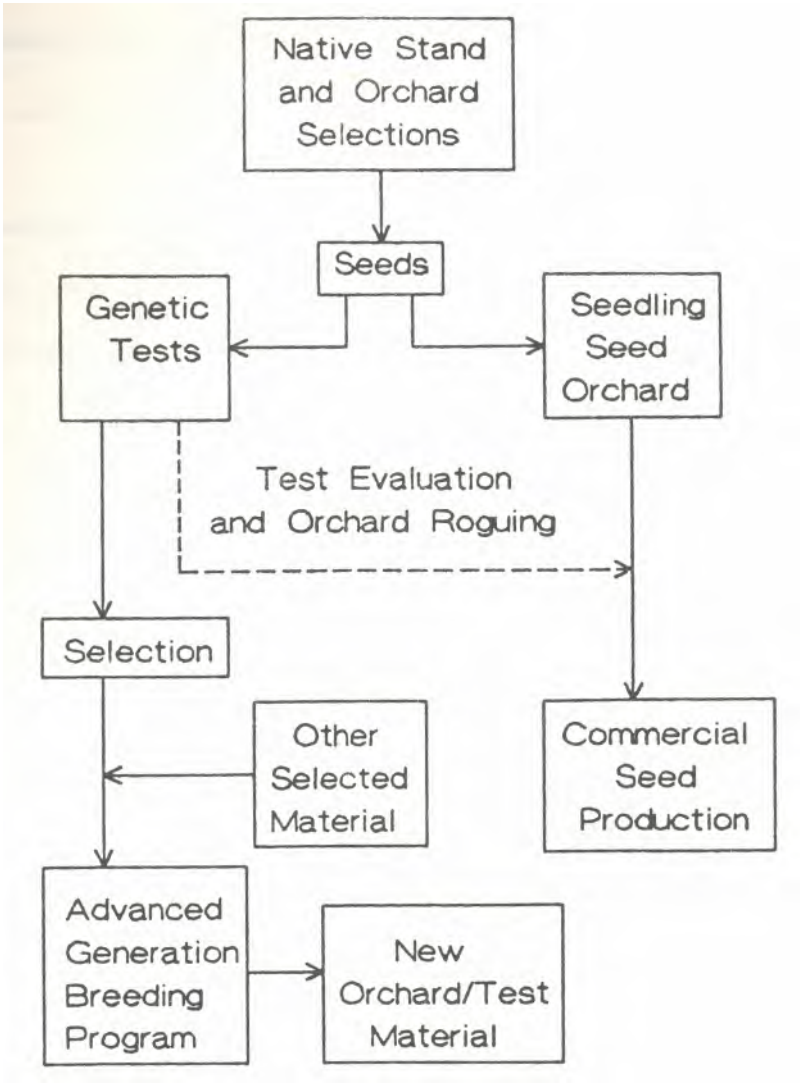

Figure 1. Diagram of major activities associated with Virginia pine improvement program.

Seedlings were lifted in March, 1983 and planted into four progeny tests in east Texas (Figure 2). Planting sites were located from near the gulf coast to the northeast corner of the state. Each planting consisted of six replications with eight trees per replication/family.

Genetic tests were established on lands belonging to private Christmas tree growers with the agreement that the tests be maintained until commercial harvest. No specific instructions were provided these growers other than to manage the tests as operational plantings with any treatments be applied uniformly.

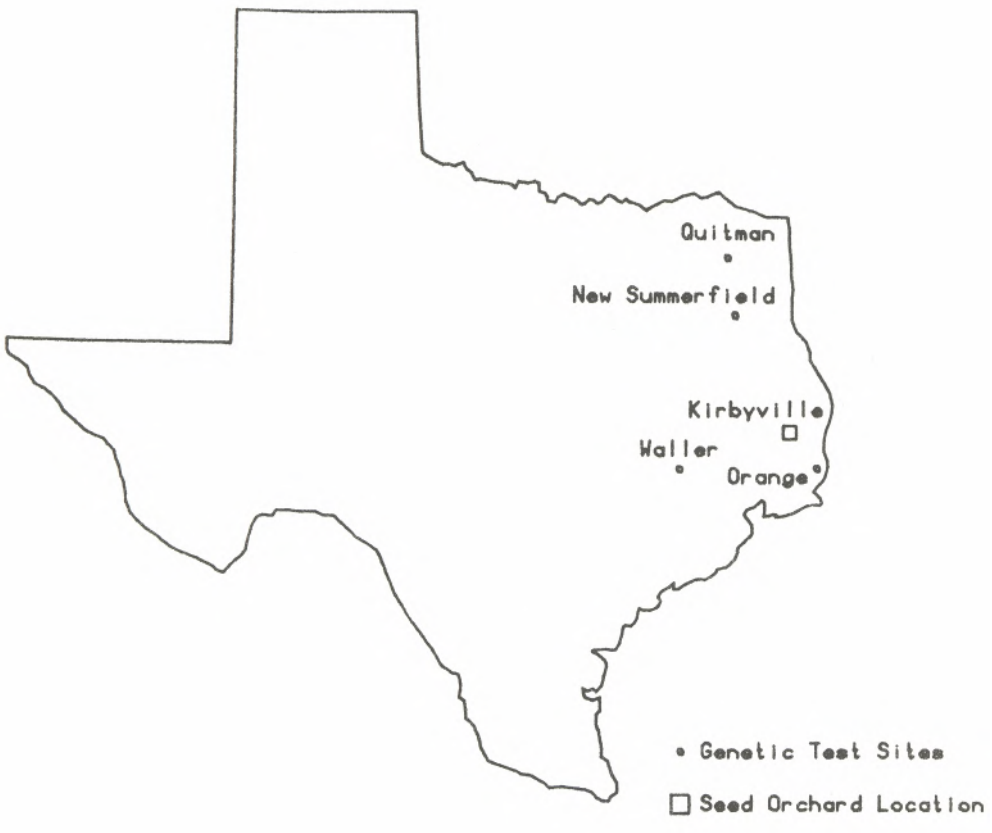

Figure 2. Location of genetic tests and seed orchard for Virginia pine improvement program.

Test measurements (Table 1) consisted of first-year survival and height, second-year height and third-year height. After the second growing season, seedlings were also evaluated for number of whorls, straightness and potential for Christmas trees. The latter evaluation is referred to as grade, although it does not represent the commercial grade often used for marketing. Statistical analysis indicated significant (P<,05) family differences for all traits within each location with relatively small family by location effects. Using the information obtained, a selection index was developed for use in determining the best families. Individuals within each test were assigned a value based on this index and the highest ranking families across all tests were identified. Orchard roguing utilized the results of this ranking. While several traits were considered, second-year height had the greatest impact on which families were selected.

The tests were released to the cooperating growers after selection of advanced-generation material which was the end of the fourth growing season.

Table 1. Summary of Virginia pine planting means for four genetic tests in East Texas.

	Location			
	Orange	Waller	New Summerfield	Quitman
Number of Sources	48	51	51	44
First-Year Survival (%)	78.9	96.1	98.0	57.7
First-Year Height (cm)	38.2	38.5	45.9	26.3
Second-Year Data				
Height (cm)	98.5	65.6	98.4	67.7
Straightness (0,1)1/	.14	.13	.38	.19
Grade (0-4) [1]/	1.98	1.34	1.89	1.93
No. whorls	4.69	4.11	6.14	4.12
Third-Year Height (cm)	122.7	96.0	147.3	117.5

[1]/ Higher values represent better scores.

Orchard Establishment and Management

Concurrent with the establishment of the four genetic tests, a ten-acre seedling seed orchard was established near Kirbyville, Texas. Initial spacing was 8'x 14' with either one or two seedlings planted at each location. Seedlings from each of the 50 original selections were planted in a design to minimize the likelihood of potentially related individuals being adjacent to each other.

The orchard was rogued in 1985 to the best 25 families following second-year evaluation of genetic tests. In winter 1986, approximately 300 trees were transplanted within the orchard to provide more uniform spacing. The current spacing is 24' x 28' leading to approximately 65 trees per acre.

The orchard has been managed similar to other southern pine seed orchards although with Virginia pine, greater attention must be paid to control of tip moth (Rhyacionia spp.). Insecticide treatments early in the life of the orchard proved quite beneficial. Likewise, seed and cone insect control has been intensified as cone production has increased.

First seed production was realized in 1987 with nine pounds being produced for the entire orchard. In 1988, 35 pounds of seed was produced from 45 bushels. At age ten, it is projected that 8-10 pounds of seed per orchard acre will be produced. Additional roguing is anticipated as seed production increases. While timing is not yet specifically determined, the

orchard will be placed on an advancing-front schedule relative to removal and re-establishment. This schedule will provide for incorporation of improved material while maintaining a required level of seed production.

Breeding

In fall 1986, the best 25 families were identified on the basis of third-year height in two of the four genetic tests. The other two tests were deemed unsuitable for use based on number of existing trees. Selection of the best individual from within each of these families was then made using criteria applicable for Christmas trees (height, straightness, grade and general appearance). These selections were first grafted into a scion bank in 1987 with additional grafts made in 1988 and 1989. Approximately 45 of these selections remain preserved as some selections were lost due to initial grafting mortality. Of the original 50 families, 37 were represented in the advanced-generation population.

Although not yet initiated, an advanced-generation breeding program is proposed utilizing 100 selections distributed among 10 breeding groups (Figure 3). Included in the 100 selections would be the 45 selections from genetic tests as well as material obtained from other organizations working in Christmas tree improvement. Additionally, several trees of selected families located in the seed orchard can be utilized to replace those selections lost by graft failure.

Control pollination within groups is proposed utilizing a partial diallel mating design. Progeny would then be established in several tests (8-10) throughout east Texas for purposes of evaluation and advanced-generation selection. Evaluation and selection procedures are expected to be similar to those used in the first generation. Selection within each of these tests would be accomplished in order to reconstitute each of the ten breeding groups with 10 to 12 individuals per group, leading to a perpetuating system. New orchards would be established using seed from the best control-pollinated families.

SUMMARY

The Virginia pine improvement program was established to meet the seedling needs for Christmas tree growers in the state of Texas. To date, first-generation selection, genetic testing, orchard establishment, and advanced generation selection have been accomplished. The seed orchard has been rogued once and has provided for commercial seedlings for the past two years.

The next challenge is to initiate a systematic breeding program utilizing the advanced-generation selections, and to establish progeny tests of this material for parental evaluation and future selection.

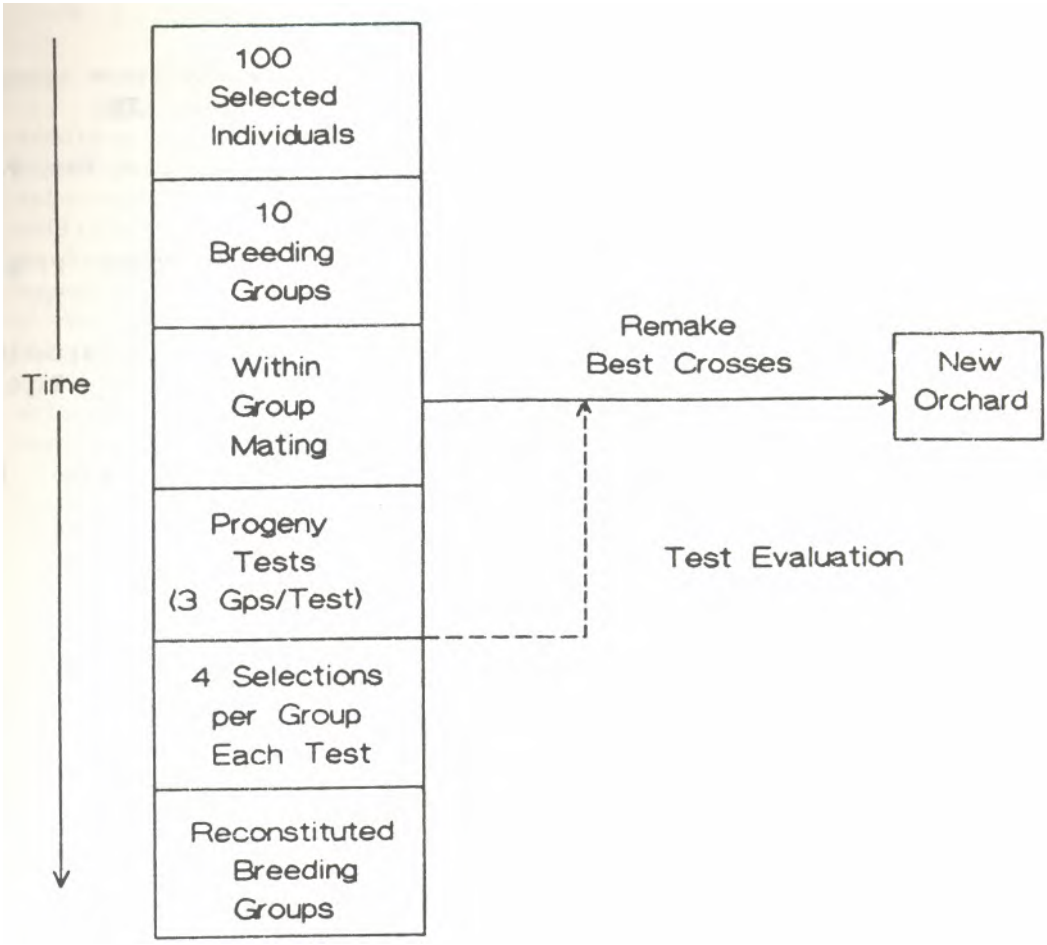

Figure 3. Proposed breeding and selection scheme for advanced-generation material.

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