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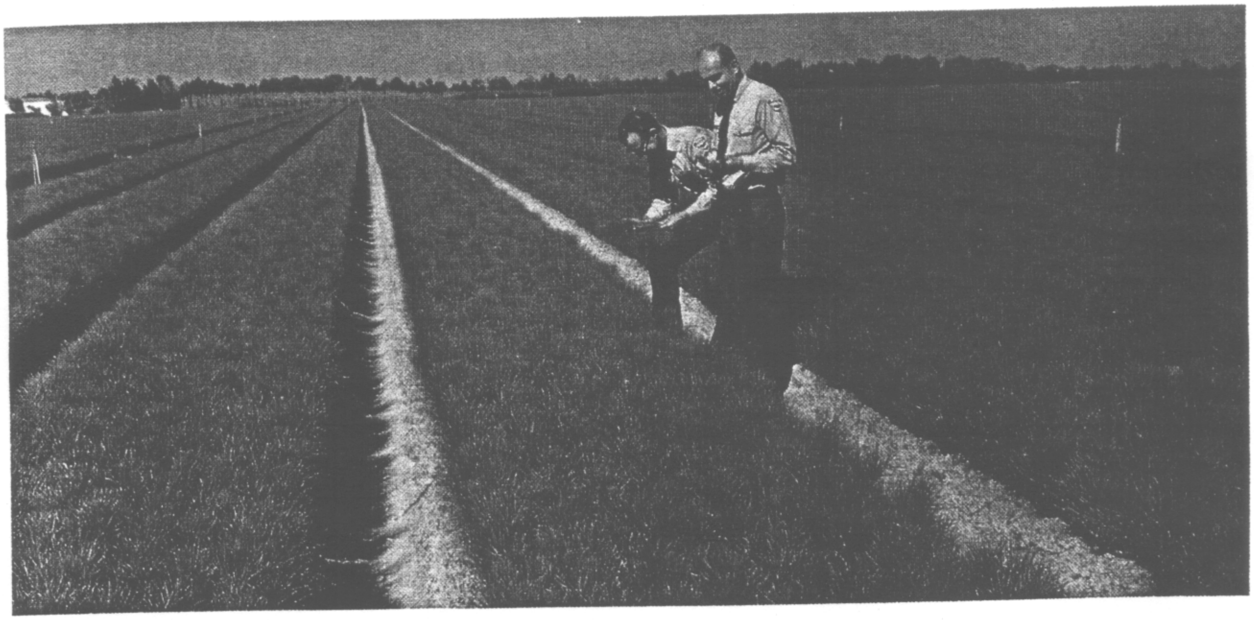

GEORGIA'S SEED ORCHARD TREES

A REPORT ON THE FIRST-GENERATION SELECTIONS

BY

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ABSTRACT

Measurements of progeny of first-generation slash and loblolly pine selected trees were used to estimate the percentage of improvement obtained thus far from the Georgia Forestry Commission seed orchards. For slash pine these data showed a 22 percent improvement in volume per tree and a 27 percent improvement in resistance to the fusiform rust disease. In loblolly pine the improvement was 7 percent for volume per tree and 8 percent for resistance to fusiform rust.

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Georgia's tree improvement program began in 1954 (7). This program was designed to provide Georgia landowners with better tree seedlings by eliminating the then current practice of purchasing pine cones collected from trees cut in logging operations, or from unevaluated standing trees of unknown potential for growth rate and resistance to disease.

THE PROGRAM

The first stage of this program consisted of selecting slash pine (Pinus elliottii var. elliottii) and loblolly pine (P. taeda.) which were apparently fast-growing, straight-stemmed, and free of apparent disease and insect infection (Figure 1). Twigs collected from these trees were then grafted onto young seedlings, and the resulting small trees were established in large seed orchards (Figure 2). These seed orchards were planted at a spacing which encouraged rapid growth and managed by using cultural practices designed to encourage seed production rather than timber production.

The first seedlings produced from seed orchard seed were sold by the Georgia Forestry Commission in 1963 (4). Since that time over 233 million slash pine seedlings and 277 million loblolly pine seedlings produced from seed orchard seed have been sold by the Georgia Forestry Commission to large and small land owners all over the state, almost enough seedlings to plant a half-million acres of each pine species.

Even though the trees selected for use in the seed orchards were apparently excellent specimens for their species, there was no guarantee that they would produce seedlings better than those produced from the old commercial collections. To test these first-generation selections and to identify those that were capable of producing improved seedlings, it was necessary to plant progeny tests to establish the genetic worth of the parent (Figure 3). Seed for these tests were produced by control-pollinating each of the selected trees with a mixture of pollen from 15 or more of the other selected trees. The seedlings grown from this controlled-pollinated seed were then planted in field tests along with seedlings grown from commercially collected seed for comparison (14). In this way most of the first-generation slash pine selections were tested on a flatwoods and Coastal Plain site, and most of the loblolly pine selections were tested on both the Piedmont and the Coastal Plain sites.

As these tests grew, data were collected at 5-year intervals on survival, height growth, diameter growth, stem straightness, and the occurrence of disease caused by fusiform rust (Cronartium quercuum f. sp. fusiforme).With this information, the trees that were producing inferior seedlings could be identified and removed from the seed orchards, thus improving the average genetic quality of seed-orchard trees and the seedlings they produce (9).

Table 1 and Table 2 summarize the results of a number of these tests for slash and loblolly pines. The information in the

Table 1.--Summary of Georgia Forestry Commission first-generation slash pine progeny tests.

Test (No.)	Selected trees in test (No.)	Age (yr)	Test location (county)	Improvement over checks 1/ Height	d.b.h.	Tree Volume	Rust free	Crown/Ht. ratio
				Percent				
57	15	20	Bleckley	9.1	2.8	15.3	107.1	7.0
58	12	16	Bleckley	.2	2.5	4.8	21.1	8.8
60	6	10	Bleckley	4.5	5.3	14.5	2.2	4.9
61	9	10	Bleckley	10.1	5.3	25.6	19.7	5.6
63	7	15	Ware	4.0	1.7	-3.7	---	.2
65	4	15	Houston	10.7	5.6	22.7	71.9	6.2
67	13	15	Bleckley	6.1	5.1	20.4	-43.2	6.3
68	13	15	Bleckley	8.2	4.9	12.8	-35.1	5.6
70	16	15	Ware	7.0	8.9	23.3	3.0	2.3
71	8	15	Houston	.5	3.4	3.2	-66.4	5.9
78	14	15	Houston	-1.3	-2.6	4.4	-67.4	.0
79	13	15	Houston	-8.5	-9.6	97.0	---	---
82	8	10	Bleckley	11.2	8.6	31.2	273.3	11.5
85	9	10	Houston	6.2	-6.3	-2.0	191.1	3.1
87	10	10	Ware	10.9	9.8	32.8	.3	8.1
88	10	10	Houston	5.6	4.5	17.2	-2.1	.7
89	9	10	Ware	6.5	7.0	21.5	-2.5	-1.9
90	12	11	Houston	3.0	.0	2.0	61.2	---
98	8	10	Bleckley	18.0	13.6	52.5	127.6	6.4
99	9	10	Ware	7.3	3.5	15.2	---	16.8
100	5	10	Ware	10.9	9.5	33.9	---	5.9
101	5	10	Houston	9.7	13.3	40.6	0.0	---
122	15	5	Bleckley	8.1	---	---	38.3	---
123	12	5	Bleckley	7.6	---	---	8.6	---
124	16	5	Ware	7.2	---	---	2.6	---
125	12	5	Ware	-.8	---	---	3.0	---
	Weighted average			5.7	3.9	21.9	26.6	5.3

1/ Plantation means for progenies of clones retained in the seed orchard.

tables does not include the data from the selected trees removed from the seed orchard because they produced inferior progeny. The weighted average values at the bottom of each table give a rough estimate of what the seed now coming from the seed orchards are capable of producing.

The soils and topography of potential planting sites in the state of Georgia are highly variable, and the potential for infection by fusiform rust is generally much higher in the central part of the state than it is in the flatwoods and Piedmont. Therefore, these estimates are not strictly applicable to any one site.

On some soils, and with good control of competing vegetation and a low incidence of fusiform rust, the improved seedlings now being produced by the Georgia Forestry Commission may do much better than the values shown in the tables. On other soils, with little or no site preparation and left unattended after planting, improved seedlings may not have the opportunity to express their full potential. The use of improved seedlings is no guarantee of high survival. Only good planting will result in a living tree.

Figure 1.--Typical fast growing, straight-stemmed, narrow-crowned first-generation slash pine selected tree.

BENEFIT TO LANDOWNERS

In 1958 it was estimated that an improvement in wood production of only 1 or 2 percent would justify the establishment of pine seed orchards to produce genetically better trees (12). In Tables 1 and 2 it can be seen that all weighted average gains from Georgia Forestry Commission trees are at least 2 percent.

To gain a better perspective, we can compare these gains with those reported by others in the Southeast who are working with slash pine or loblolly pine. One report, based on data from nine 10-year old and three 9-year old slash pine tests in south Georgia and north Florida, shows a 15-percent improvement in tree volume and a 5-percent decrease in fusiform rust resistance (15). Another series of tests of slash pine in Florida showed a 16-percent gain for volume and a 6-percent improvement in fusiform rust resistance 5 years after planting (5). The improvement shown by the Georgia Forestry Commission slash pine in Table 1 compares favorably with these results.

In two loblolly pine progeny tests the height improvement of all selected families was 6 percent; when only the best 10 percent of the families were considered, the height gain increased to 12 percent (11).

Gains of similar magnitude are commonly reported for other crops. For example, in a recent agricultural journal a sampling of gains in six reports showed: a 17 percent increase in green weight of tobacco (6), a 32-percent gain in disease resistance of corn (10), a 10-percent and a 13-percent increase in yield of rice (8 and 2), and 5-, 8-, 22-, 4-, 3-, and 1-percent increases in yield of wheat (1 and 3). We mention these gains to illustrate two points: the great variation among gains per generation achieved in both forest trees and agronomic crops, and that even small gains can justify the introduction of new strains of trees and crops.

Some people have asked: of what value is a genetic gain of 5 percent when we are living in a period of double-digit inflation and the prime interest rate is over 15 percent? The answer is that genetic gain has no direct relationship to rates of return on investment. Genetic gain is simply an improvement on some component of crop yield, such as growth rate or disease resistance. To put this another way, if we do not continue to breed for genetic gains, the return on investment to the landowner of producing food and fiber will drop even lower when he is faced with inflation and high interest rates.

Table 2.--Summary of Georgia Forestry Commission first-generation loblolly pine progeny tests.

Test (No.)	Selected trees in test (No.)	Age (yr.)	Test location (county)	Improvement over checks 1/ Height	d.b.h.	Tree volume	Rust free	Crown/ht. ratio
				Percent				
59	15	15	Bleckley	3.5	-0.1	0.5	5.6	2.7
62	12	10	Bleckley	3.1	9.5	22.2	-23.5	-1.1
64	6	15	Jasper	.0	-5.3	-10.5	-17.0	9.8
66	4	15	Houston	3.5	.0	3.1	12.5	3.5
69	18	15	Bleckley	1.3	2.0	6.2	-15.2	4.4
76	19	15	Bleckley	3.8	1.3	6.6	90.7	1.9
77	16	15	Bleckely	6.1	5.6	17.5	-62.8	3.6
84	9	10	Bleckley	3.7	1.7	6.7	80.0	9.7
86	8	15	Ware	.0	-1.6	- 6.3	- 1.5	4.7
92	10	11	Putnam	8.8	6.7	22.3	13.5	8.2
93	11	10	Troup	4.4	5.4	18.5	1.4	12.8
94	6	12	Jasper	7.0	3.7	13.3	.1	10.7
95	16	10	Putnam	-0.2	.6	.0	7.0	5.3
96	16	10	Troup	3.7	.7	3.5	-12.0	12.0
97	22	10	Ware	4.5	3.4	12.7	---	4.3
104	18	10	Putnam	5.3	3.3	11.6	11.5	---
105	18	10	Heard	.0	-3.6	-6.7	23.7	---
	Weighted average			3.4	2.1	7.5	8.0	5.6

1/ Plantation means for progenies of clones retained in the seed orchard.

Figure 2.--Young grafted slash pine seed orchard.

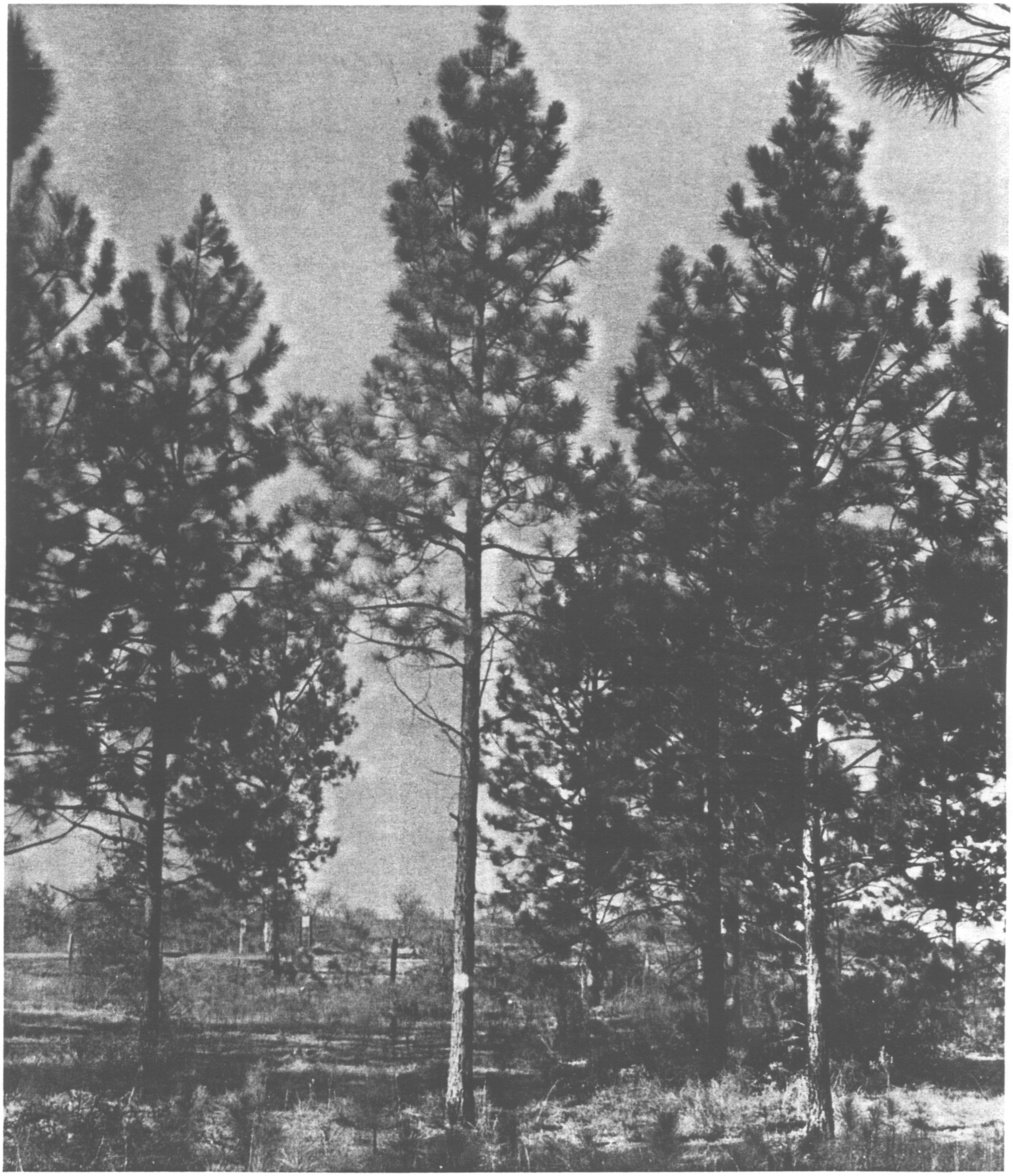

Figure 3.--A young slash pine progeny test in central Georgia.

POTENTIAL GAINS IN SECOND- GENERATION ORCHARDS

Second-generation seed orchards are assembled by selecting the best trees in the best families from the progenies of the first-generation seed orchard trees. Because of the leverage which this "family selection" provides us the genetic gains we obtain in these second-generation orchards should be much greater than those obtained in the first-generation. This increase in genetic gain due to family selection has been realized with most crops, and there is no reason for it not to occur with forest trees.

In addition to identifying trees that produce inferior seedlings, progeny tests also identify some of the first-generation selections as being much better than average. The Georgia Forestry Commission already has established new orchards which include the exceptionally good first-generation selections and newly selected trees obtained from other agencies having tree improvement programs of their own. There is every reason to expect that seed produced from these new orchards will produce seedlings with even better potential for good growth than the first-generation orchards. In addition, since fusiform rust is such a devastating disease in some portions of the state, special seed orchards have already been established which contain only trees which have shown they are capable of producing seedlings with better than average resistance to this disease. (13).

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