EARLY TESTING OF LOBLOLLY PINE

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Abstract: Cones were collected from individual trees in natural stands of loblolly pine (Pinus taeda L.) in southeast Texas. Seed from each tree were evaluated for characteristics such as size, weight, percent filled seed, germination time and stratification requirements. The percent filled seed, mold on the seed during germination, stratification requirements and growth in the nursery and greenhouse were used as criteria in a step-wise screening procedure. The selected families and controls were outplanted for future evaluations to determine the effectiveness of the screening procedure. Early results indicate that information gained from seed, germination times, and early growth, can be used to increase the proportion of fast growing families in the selected group.

Additional keywords: Pinus taeda, early testing, seed germination, early growith, stratification.

Progeny testing of superior loblolly pine phenotypes is necessary before the generic worth of the individual selection can be ascertained. This is costly not only because of the expense of progeny testing, but also because of the time lost waiting for progeny test results to become available. Because of this time lag, several workers have attempted to find correlations between early growth habits and mature field performance. Two such studies by Zabel (1953) on outstanding seedlings selected in the nursery bed and Brown (1959) on outstanding loblolly and shortleaf from seed production area trees were early approaches to this problem in southern pines.

Working with cotton, Bird and Presley (1965) and Bird (1972) developed a method for early selection of cotton for disease resistance, improvements in earliness and yield by selecting for germination at reduced temperature and absence of mold on the seed.

For loblolly pine the situation is more complicated than for cotton, since loblolly pine has a stratification requirement. Therefore a preliminary study was carried out using 9 known fast growing and 5 known slow growing families, comparing their germination without stratification, and their germination at 13°C after stratification.

This study showed that of the slow growing families more than twice as many seedlings germinated without stratification than of the fast growing families. Mold growth was also somewhat more serious on the slow growing families. There was no difference in germination at 13°C. On the basis of these results it was decided to go ahead with a larger study to determine if

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it is possible to use stratification requirements as a means of rapidly screening a large number of families. Even a modest gain would be worthwhile since it could be done very rapidly and inexpensively.

A number of additional selection criteria were added to reduce the number of families finally outplanted for testing. At each step of the screening procedure bulk lots were made up for field planting to determine the effect of that particular step.

A second major consideration in establishing this study was the need for preserving a portion of the existing gene pool in mature loblolly pine stands. As native stands are harvested the gene pool is seriously depleted and trees which could possibly be used in future breeding programs are lost.

METHODS

Core Collection

In 1973 cone collections were made in good natural stands of loblolly pine as they were being harvested for sawlogs. Most of these stands were being clearcut. Five healthy cones were collected from each of several good trees after felling. If possible the best trees in good stands were sampled. Approximately 100 trees per stand were sampled in 10 widely scattered stands. A total of 1000 loblolly pines were sampled.

Cone and Seed Handling

Seed were extracted from the cones as soon as they opened. Hand extraction was used to get as many seed as possible from the cones short of cone destruction. Each seedlot was floated in distilled water to separate empty seed from filled seed. An electronic seed counter was used to count all seedlots for both empty and filled seed. Ten seed from each seedlot were picked to form the baseline check seedlot.

At this step in the procedure about half of the seedlots were screened from the test by eliminating them if the number of filled seed per cone was below average. This was done separately for each collection area. The remaining seedlots were weighed and stored at 1-2°C until further testing started. Five seed from each of the selected seedlots were composited to form the bulk seedlot used for evaluating the effect of screening for above average number of seeds per cone.

Germination and Mold

Germination without stratification studies were conducted on all seedlots remaining after screening for filled seed per cone. For germination tests a 1.5% water agar medium in sterilized petri dishes was used. Forty seed from each selected seedlot were placed in petri dishes and placed in continuous incandescent light at 20-21°C. Germination counts were initially made at 12 and 15 days. This was later changed to 15 days after enough data was accumulated to indicate this interval gave adequate information for measuring germination and mold.

Germination was counted if any portion of the root was visible outside the seed coat. Seed was counted as moldy if any fungus was present on the seed

whether a known pathogen or not. Among the fungi identified on the seed were: Penicillium Rhizopus sp., Alternaria sp., Aureobasidium sae, Botrytis and Fusarium sp.

The seedlots from each collection site with the least number of seed germinated and the least susceptibility to mold were selected for further testing. Each collection area was treated separately and a standard for mold infection as well as a separate standard for nonstratified germination was developed for each seed collection area. In this second step of the screening procedure approximately 50 percent of all remaining seedlots were selected for further testing. Five seeds of each selected seedlot were composited to form a bulk seedlot to check the effect of this step in the screening process.

Seed from all selected families was stratified at 2-4°C for 30 days. After stratification seed from each family was planted in the greenhouse and at Indian Mound Nursery. The greenhouse seedlings were grown in coarse sand in the greenhouse benches.

Greenhouse and nursery plantings were randomized and replicated. Greenhouse seedlings were subirrigated with a nutrient solution. Damping off was controlled with weekly Captan spray for the first two months. The nursery portion of the test received exactly the same treatments as regular progeny tests. Monthly height measurements were made from July through November and diameter measurements were made in December on the Five tallest seedlings in each family of greenhouse-grown seedlings. Nursery height measurements were made in October.

Six additional traits were used to select the final families for field planting in addition to the various seedlots established to check on the effect of the steps in the screening procedure. The variables used were final height in the greenhouse, final diameter in the greenhouse (average of the five tallest trees in each plot) and final height in the nursery.

Since these measurements were correlated with seed size (table I) and in case of the greenhouse study with position in the bench, values adjusted for these variables were also calculated as deviations from the regression line. The 14 or 15 highest ranking families in each of the categories were finally selected for field planting, if a sufficient number of seedlings were available.

Table 1.--Correlation between seed weight and growth char acteristics

Traits	Correlation Coefficient
Seed weight-diameter of greenhouse grown seedlings	.48
-height of greenhouse grown seedlings	.37
-height of nursery grown seedlings	.51

Because of the environmental differences between greenhouse and nursery, only seedlings grown at Indian Mound Nursery were outplanted. Six replications of 8 tree row plots were planted at the Spurger progeny test area.

RESULTS AND DISCUSSION

Field results will not be available until the fall of 1979. The results summarized in tables 2, 3, and 4 are therefore limited to laboratory, greenhouse and nursery data.

Table 2.--Ranking of families according to six different traits

Family	Nursery Height	Adjusted Nursery Height	Greenhouse Height	Adjusted Greenhouse Height	Greenhouse Diameter	Adjusted Greenhouse Diameter	Number of Seedlings
A-2	4	6					84
A-31		13					79
A-53	14	12	12	14		6	66
A-57			13		4		53
A-76	2		2		5		72
A-82	1	2	4		9		90
A-85			1	1	2	10	63
D-113	13	5					72
D-125			8	4			83
D-154	6	4					75
D-159	10						79
E-2					6	1	56
E-95						14	89
F-48	11		3	9	1		62
L-1					10	7	74
L-34		8		8			62
L-77		14	14	10			78
L-79			11	11			73
L-88			7	7			53
L-89			10	6			51
M-128	5	1					89
N-8					14	9	100
N-51			5	2	7	4	54
S-34	3	3					75
S-65	7						72
S-68		7					65
S-74	8	9					75
Z-106	9						92

Table 3.--Seed weight, germination, and growth of families selected for field planting

Parent Tree	Weight. 100 seed (g)	Percent Germination (Unstratified)	'ercent Mold Infection	Nursery		Greenhouse		Diameter Growth cm Greenhouse	
				Actual	Adjusted	Actual	Ad'usted	Actual	Adjusted
A-2	2.96	0	0	25.7	4.79	19.5	-1.30	.361	-.027
A-31	1.93	5.0	0	20.6	3.73	21.1	3.42	.345	.013
A-53	2.44	2.5	0		4,19	24.0	4.28	.416	.061
A-57	2.73	5.0	0	18.7	-1.25	23.8	1.63	.452	.047
A-76	3.50	5.0	0	26.2	3.16	28.0	3.64	.447	-.014
A-82	3.38	5,0	0	28.4	5.85	27.4	3.79	.434	-.012
A-85	2.58	0	0	18.9	-0.51	28.2	7.07	.457	.052
D-113	2.19	7.5	15.0	23.0	5.19	20.7	2.72	.333	-.020
D-125	2.06	7.5	10.0	20.7	3.36	25.7	6.01	.381	.019
D-154	2.46	0	12.5	24.2	5.23	19.3	-0.21	.350	-.036
D-159	2.84	5.0	10.0	23.4	2.97	19.0	-0.54	.343	-.035
E-2	2.58	0	7.5	20.0	0.60	23.4	2.86	.444	.073
E-95	2.21	5.0	2.5	16.7	-1.23	18.3	-0.08	.411	.049
F-48	3.03	0	10.0	23.4	2.18	27.9	4.88	.462	.041
L-1	2.61	0	0	17.2	-2.35	21.8	2.58	.432	.058
L-34	1.80	2.5	0	20.8	4.54	21.3	4.93	.328	.003
L-77	2.13	5.0	0	21.3	3.72	23.7	4.66	.358	-.005
L-79	2.63	5.0	0	18.1	-1.53	24.0	4.61	.381	.018
L-88	2.48	5.0	0	16.5	-2.53	26.0	5.42	.389	.014
L-89	2.53	5.0	0	17.8	-1.39	24.3	5.62	.371	.022
M-128	2.59	0	2.5	25.4	5.97	21.3	1.21	.391	.014
N-8	2.47	5.0	0	19.7	0.78	19.0	0.20	.422	.054
N-51	2.58	0	5.0	19.3	-0.08	26.5	6.51	.444	.066
s-34	2.83	2.5	0	25.8	5.41	20.5	0.52	.325	-.046
S-65	2.78	15.0	5.0	23.8	3.66	18.6	-2.15	.320	-.060
S-68	2.08	15.0	0	22.2	4.74	16.2	-3.13	.333	-.021
s-74	2.54	2.5	2.5	23.8	4.53	20.4	1.44	.381	.009
2-106	3.32	0	2.5	23.7	1.35	14.6	-5.24	.328	.051
Average	2.58	3.9	3.0	21.7	2.32	22.3	2.33	.387	.014

Table 4.--Effect of the different steps of the screening seed and seedling characteristics

	Nursery Height	Adjusted Nursery Height	No. Filled Seeds/Cone	Moldy Seeds, %	Germination without Stratification,%
Base population	20.2	1.90	71.54	NA	NA
Families with above average filled seed/cone	20.1	1.64	95.66	10.2	9.4
Families with lower mold and prestratification germination	18.4	.05	95.00	3.2	2.7
Families selected for field planting	21.7	2.32	93.09	3.1	4.1

Seed

As would be expected there was a considerable difference between collection sites in the average number of seed per cone, average number of filled seed, average weight per 100 seed and number of seed per pound. However, there were no readily discernable geographic trends evident in these measurements. For most collection areas the variation within the area was generally as great as variation between areas. This parr of the study will be summarized and published in a separate article.

Molds

Percent moldy seed ranged from 0 to 75 with an average of 10.2. Percent mold of the seedlots passing the screening process ranged from 0 to 17.5 with an average of 3.0.

Germination without Stratification

Germination without stratification ranged from 0 to 67.5 percent with an average of 9.4. The seedlots passing the screening process had an average germination without stratification of 3,9 percent ranging from 0 to 17,5 for individual seedlots.

Growth in the Greenhouse and Nursery

Average height of the seedlings grown in the greenhouse was 19.2 cm, with the family means ranging from 12.8 cm to 28.3 cm. The average of the group selected for height growth in the greenhouse was 25.8 cm.

The height values adjusted for seed size and edge effects in the greenhouse benches averaged 0, since they were deviations from regression, and ranged from -5.2 to +7.1 cm. The average of the selected group was 5.4 cm.

Average height of the seedlings in the nursery was 18.3 cm. Family means ranged from 10.2 cm to 28.4 cm. The mean of the group selected for height growth in the nursery was 24.6 cm.

The family averages for nursery height adjusted for seed size, again expressed as deviations from the regression, ranged from -5.5 cm to +6.0 cm, averaging 0. The average of the group selected for adjusted nursery height was 4.8 cm.

The families averaged .361 cm in diameter (measured on the 5 tallest trees in each plot in the greenhouse), ranging from .264 cm to .462 cm. The average of the group selected for diameter was .444 cm,

The diameter adjusted for seed size and edge effects ranged from -.079 cm to +.074 cm, averaging again 0. The average of the group selected for adjusted diameter was .058 cm.

Discussion

The effect of the various steps in the screening process are summarized in table 4. Selection for number of filled seed per cone had no effect on height growth in the nursery. On the other hand selection for freedom of mold and low germination without stratification resulted in somewhat decreased growth in the nursery, although the difference was not statistically significant. All these families have been field planted and are now in their third growing season. Field observations show that some of the outstanding families are still maintaining their initial superiority. Since experience with progeny tests has shown that early field measurements do not correlate well with measurements taken at 20-years and later, the first measurements on these field plantings will be taken in 1979, when they have completed their fifth growing season in the field. Although even those measurements will be preliminary, they should give a good indication if any of the steps in the screening procedure have been effective.

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