

Progeny Testing **Longleaf** Pine At Two locations

E. BAYNE SNYDER AND CALVIN F. BEY

SUMMARY

Means for brown-spot infection and **3-** and **8-year** height growth were determined in progeny testing of 540 parents in two **Gulfport**, Mississippi, **plantings** and an Alexandria, Louisiana, planting, and of **60** of the **parents at** a subsequent Alexandria planting. To estimate growth at ages 5 and 8, both degree of brown-spot infection and height growth at age 2 were necessary independent variables, but for growth at age 8, **3rd-year** height growth alone was sufficient. Families selected for rapid growth and brown-spot resistance in one location may not be the ones selected in another. Likewise, those **selected** in a brown-spot free area differed from those selected in **an area where brown spot was** prevalent. Implications for future breeding and seed orchard development are discussed.

Additional keywords: *Pinus palustris*, genotype x environment **interaction**, survival, growth, brown-spot needle blight.

IMPROVING BREEDING PROCEDURES

Longleaf pine (*Pinus palustris* Mill.) is recognized as a species with good wood, form, and growth potential. **Natural regeneration techniques** have **been** developed, and new plantations are being established. Through the use of genetically improved seed, increased planting success and production **seem** promising. In this study we determine what effect variation in infection by brown spot [*Scirrhia acicola* (Dearn.) Siggers] has relative to that of early height

growth in predicting later growth, **examine** family x environment effects, and recommend genotypes for advanced generation breeding programs;

METHODS AND MATERIALS

Four open-pollinated progeny tests of the same natural growth parents were **established**—three in 1883 and one in 1989. The 1969 test was a retest of some parents included in the **1963** tests.

The 1963 tests included progeny from 540 parents selected from Louisiana, Mississippi, Alabama, Georgia, and Florida (Snyder and Derr 1972). Of **these, 417 were** from a Louisiana area known to have been severely infected with brown spot. One progeny test was established near Alexandria, Louisiana, and two near Gulfport, Mississippi. Each was laid out in a randomized, complete block design with 10 replications of single tree plots.

At Alexandria, trees were spaced 3 feet **apart** in furrows placed every 8 feet. Numerous infected volunteer seedlings between rows provided brown-spot inoculum. The two sites at **Gulfport** were **disked a year** before planting. At one site, disease spreader trees were established every 3 feet in rows 12 feet apart. A **year** later, test seedlings were planted in the same rows between each two **disease** spreader trees. At the other **Gulfport** site, test seedlings were planted at the same spacing but without disease spreader trees, and brown spot was

controlled by spraying with Bordeaux mixture in May, June, and September. After three seasons in the field, the proportion of current needle tissue lost to brown spot in the three 1965 tests was estimated as a percentage of total needle tissue. Heights of all trees were measured at age 3 and those of some trees at age 8.

To test the goodness-of-fit for the family x location effects in the sprayed versus unsprayed plots at Gulfport, we used a chi-square procedure. Values corresponding to probabilities of less than 0.05 were considered significant. To determine the importance of early growth and brown-spot incidence as predictors of later growth (Draper and Smith 1988), we used stepwise regressions on individual trees.

To follow-up the 1983 brown-spot test, we established a fourth test at Alexandria in 1989, using newly collected seed from 80 parents randomly selected from the original 540. Added to these as resistant, wind-pollinated controls were two Alexandria families, Abe and 1.1E, that displayed good early growth in previous tests (Derr 1963). A susceptible Alexandria family, PR, was also included. (Abe x W) x W was entered to determine the effects of backcrossing. Spring-sown seedlings were lifted in the fall, transplanted to 1-quart milk cartons, and planted in the spring.

The 1969 test site was open and devoid of natural seedlings, but brown-spot infection was heavy in an adjacent longleaf plantation. The area was burned, then furrowed with a fireplow. Seedlings were planted in the furrow at 6 x 6 foot spacing in a randomized, complete block design with four replications of 10-tree row plots. At age 2, the proportion of current needle tissue lost to brown spot was estimated as it was for the 1963 tests. At ages 2 and 5, the heights of all trees were measured. In summary, the four experiments were: 1963 brown-spot test at Alexandria, 1963 brown-spot test at Gulfport, 1963 sprayed test at Gulfport, and the 1969 brown-spot follow-up test at Alexandria.

RESULTS

Early prediction

Brown-spot infection and 3- and 8-year height means for the four experiments are given in table 1. For each of 202 random individuals in the 1963 brown-spot test at Gulfport and 154 in the one at Alexandria, individual and family means for 3-year-old height and brown-spot damage were entered into stepwise regressions

Table 1.-Mean brown spot and height

Test	Brown spot ¹	Early height*	Later height ²
	Percent	Inches	Feet
1963 brown-spot test at Alexandria, La.	55	3.0	16.5
1963 brown-spot test at Gulfport, Ms.	71	6.4	19.1
1963 sprayed test at Gulfport, Ms.	0	23.6	23.2
1969 brown-spot test at Alexandria, La.	49	5.3	7.2

¹ Percentage of needle tissue killed at age 3 (1963 tests) or age 2 (1969 test).

² Heights at 3 year (1963 tests) or 2 year (1969 test).

³ Heights at 6 year (1963 tests) or 5 years (1969 test).

to determine their contributions to the 8-year height variation. Numbers of trees chosen were proportional to survivals at the two locations. With only 3-year individual growth included, R² values were 0.52 and 0.46 for Gulfport and Alexandria, respectively. Inclusion of any combination of the other three traits did not change the R² values by more than 0.01. Thus, for practical purposes, selections at age 3 could be based solely on an individual's height-additional variables explain little of the 8-year height variation.

The 1969 test was used to relate 2nd-year growth and brown spot to 5th-year growth. When considered together variation in height and brown spot at age 2 explained 71 percent of the variation in 5-year heights. With only P-year heights or only brown spot in the equation, R² = 0.36. This correlation indicates that, unlike the test above, the predictive index requires both 2-year height and brown-spot resistance. Thus, the use of brown-spot damage as a selection criterion in these tests depended on age of trees at time of selection.

Roguing a progeny test may be necessary before trees are mature, particularly if the test is to be converted into a seedling orchard. The breeder should be aware that selection criteria may change with time. Roguing for brown-spot susceptibility could start in the greenhouse as early as 6 months of age, and badly diseased families could be eliminated from subsequent expensive field tests (Kais 1975). A similar

E. Bayne Snyder and Calvin F. Bey are Principal plant Geneticista, Southern Forest Experiment Station, Forest Service—USDA, Gulfport, Mississippi.

roguing for brown-spot susceptibility could be performed after one season in the field.

Since only a few families began height growth during the 2nd year, there was only minimal opportunity for brown spot to have an impact on height growth. Consequently, at age 2 both brown spot and height were needed in a predictive index. By age 3, height growth alone becomes a satisfactory predictor of 8-year growth since damage from brown spot is almost completely translated into decreased height growth.

Comparison of family performances in two tests at one location

Results of the two brown-spot tests at Alexandria show that a single preliminary selection test is not necessarily the best solution. The correlation between family means for age 3 heights in the 1963 test with age 5 heights of the 1969 test was 0.31. If the best 30 percent were selected on the basis of age 3 heights, the 1969 average of the selected trees would be 7.6 feet versus an average of 6.7 feet for the worst 30 percent. Four families, or two-thirds of the best six 1969 performers would have been isolated. To illustrate the types of relationships found, we contrasted mean heights of families performing best and worst in 1969, with their 1963 performance (table 2). Wind-pollinated families of Abe, 1.1E, and PR, which had

been tested in former Alexandria tests but not represented in the 1963 tests, performed as expected in the 1969 test. Also as expected, the growth potential of Abe was reduced by the backcrossing effect of wind pollination in the progeny of (Abe x W) x W.

The lack of high correlation between the 1963 and the 1969 tests is not too surprising. The test material was from a different seed year and perhaps had some different pollen parents. The earlier test was planted in a more severe brown-spot infection year (55 versus 40 percent). Yearly variation in weather may have influenced establishment. Thus, it seems appropriate to use results from several progeny tests where they are available.

Comparison of family performances at two locations

Although 3-year data from the 540 trees of the 1963 study showed a significant family x location interaction, earlier speculation was that the best families for breeding could be selected from combined data. The following results, however, suggest the need to conduct progeny tests in the area where the seed is to be used.

Using 3rd-year data of the 1963 test, we ranked the top 5 percent of the 540 families adapted to Guifport and, similarly, the top 5 percent adapted to Alexandria. The 17 families selected only for Guifport were, on the average, in the 42nd percentile in the 1963 Alexandria test (table 3). The 22 families selected only for Alexandria were in the 40th percentile in the 1963 Guifport test. The 1989 Alexandria test generally supports the 1963 ranking at Alexandria and supports the suggestion that single location results such as those at Alexandria may not be adequate for selection for broad geographic areas.

If we limit families selected to those in the upper 10 percent in the two 1963 brown-spot plantings, eight families (1.5 percent) appear to be generally adapted (last columns, table 3). Several more are included on the basis of the 1969 test. The scarcity of generally adapted types indicates the need for supplementing them with a breeding procedure using more specifically adapted types. Using generally adapted types would permit interchange of material over large sections of the range, but to obtain gains equal to those for specifically adapted types, the selection and testing program necessarily would have to be large. We believe that breeding the best specifically adapted 5 percent and the best generally adapted 10 percent is realistic. Control pollinations are in progress, and progeny tests will reveal which of

Table 2.—Mean heights of fastest and slowest growing families in the 1969 brown-spot test at Alexandria compared to their mean heights in the 1963 brown-spot test

Family	1963 test	1969 test
	d-year ht.	5-year ht.
	Inches	Feet
Fast growing		
168	13.5	10.4
305	2.1	10.4
98	5.6	9.4
163	3.4	9.3
216	2.0	9.2
61	8.0	9.1
1.1E		8.8
Abe x W		7.9
Slow growing		
(Abe x W) x W		5.4
301	2.2	5.4
433	2.0	5.2
145	1.9	5.2
396	1.8	5.2
395	1.6	4.8
202	3.4	3.6
PR		2.0
General Mean	3.0	7.2

