POND PINE CLONES VARY IN RESISTANCE TO CRONARTIUM FUSIFORME

H. R. Powers, Jr. and O. Gordon Langdon

Senior Plant Pathologist and Principal Silviculturist, Forest Service, U. S. Department of Agriculture, Southeastern Forest Experiment Station, Athens, Georgia and Charleston, S. C., respectively.

The authors would like to express appreciation to Mr. John E. Mocha of the Westvaco Corporation who furnished the seed used in this study.

ABSTRACT

Three clones of pond pine, a species intermediate in resistance to fusiform rust, were evaluated for rust resistance in a field test. Significant differences in rust infection and height growth were observed. Selection for both rust resistance and rapid early growth is feasible in this species.

Plant Dis. Reptr. 61: 916-918.

Additional key words: southern pines, disease resistance.

Fusiform rust of southern pines, caused by Cronartium fusiforme Hedgc. & Hunt ex Cumm., is the most serious forest tree disease in the South. Damage caused by this disease on slash (Pinus elliottii var. elliottii) and loblolly (P. taeda) pine alone is conservatively estimated at $28 million annually (3). Pathologists and foresters have been aware of the differences in the resistance of different species of southern pines to infection by the rust fungus (2). In some areas of high rust hazard, the choice of species for planting may be dictated by this disease. Highly susceptible slash pine has been discriminated against in favor of more tolerant loblolly pine. Pond pine (P. serotina), which is intermediate in resistance, has been considered as an alternative species in areas where even loblolly is seriously damaged by rust.

In addition to variation among species, wide differences in rust susceptibility among selections within a pine species have been demonstrated. In particular, certain open-pollinated families derived from specific clones of slash and loblolly pines are recognized for their resistance to infection which far exceeds that of standard nursery stock (1,4).

This study was designed to evaluate the relative levels of resistance to infection by C. fusiforme in three clones of P. serotina. Pond pine might have potential for use on sites where it would grow well.

MATERIALS AND METHODS

The seedlings used in this study were members of half-sib families from three clones in seed orchards of the Westvaco Corporation, Summerville, S. C. Clones selected were from the North Carolina State University - Industry Cooperative tree improvement program. They had demonstrated superior growth and yield characteristics, as well as freedom from infection by fusiform rust.

The seedlings were grown in nursery beds at Athens, Georgia, and planted in February, 1970 at the Santee Experimental Forest near Charleston, S. C. Each half-sib family was planted in plots containing 72 seedlings (8 rows of 9 seedlings each) at a 8 x 8-foot spacing, in a randomized block design with four blocks. In each 72-tree plot only the center 20 trees (0.0294 acres) were used as a measurement plot. Appropriate analysis of variance was carried out with the following variables: survival, total height, and stem, branch and total infections by the fusiform rust fungus at 2, 3, and 6 years after planting. Two height variables were analyzed: average height of all trees and average height of the four tallest trees on the 20-tree measurement plots (equivalent to the tallest 136 trees per acre). The latter may be a more sensitive measurement because trees of lower vigor which might not survive are not included.

RESULTS

Survival and Height: Survival differences among the three half-sib families were nonsignificant at age 2, 3, and 6, but height differences were significant (Table 1). At 2 and 3 years after planting, average height (all trees) of Family 11-518 was greater than the other two families. After 6 years, however, differences in average heights (all trees) were nonsignificant.

Table 1. Average survival and height growth of three half-sib families of pond pine at 2, 3, and 6 years after planting.

Variable	Years after planting	Half-sib Family 11-550	11-518	11-546	Average	Significance level
			Percent			
Survival	2	66	71	85	74	NS[a]
Survival	3	64	69	84	72	NS
Survival	6	64	69	81	71	NS
			Feet			
Height (all trees)	2	2.4	2.9	2.3	2.5	NS
Height (all trees)	3	3.3	3.8	3.1	3.4	5%
Height (all trees)	6	10.5	11.1	11.1	10.9	NS
			Feet			
Height (4 tallest)[b]	2	3.1	3.6	3.0	3.2	5%
Height (4 tallest)	3	4.1	4.8	4.2	4.4	10%
Height (4 tallest)	6	12.4	13.3	14.2	13.3	5%

[a]NS = nonsignificant.
[b]Based on 4 tallest per 20-tree measurement plot or equivalent to the tallest 136 per acre.

Table 2. Stem, branch, and total fusiform rust infections of three half-sib families of pond pine at 2, 3, and 6 years after planting.

Variable	Years after planting	Half-sib Family 11-550	11-518	11-546	Average	Significance level
			Percent			
Stem Infection	2	0	0	0	0	NS[a]
Stem Infection	3	0	1.7	1.5	1.1	NS
Stem Infection	6	7.3	26.5	2.8	12.2	5%
Branch Infection (only)[b]	2	0	1.8	0	0.6	NS
Branch Infection (only)	3	0	7.5	0	2.5	10%
Branch Infection (only)	6	13.7	21.8	10.2	15.2	NS
Total Infection	2	0	1.8	0	0.6	NS
Total Infection	3	0	9.2	1.5	3.6	NS
Total Infection	6	21.0	48.3	13.0	27.4	5%

[a]NS = nonsignificant.
[b]The trees included under "Branch Infection (only)" did not include any trees observed to have a stem infection.

The average height of the four tallest trees showed similar trends at 2 and 3 years, with Family 11-518 having significantly better growth at the 5 and 10% levels, respectively. At 6 years, however, the height (four tallest) of Family 11-546 was nearly a foot more than Family 11-518, and almost 2 feet more than Family 11-550.

Fusiform Rust Infection: Differences in rust infection started to develop 3 years after planting, when percentage branch infection for Family 11-518 was greater ($P = .10$) than that of the other families (Table 2). Significant differences between families for both stem and total infections were apparent after 6 years. Family 11-518 had the highest proportion (49%) of its trees infected either on the stem or a branch and Family 11-546 had the lowest infection rate (13%).

Rust incidence within families was compared by dividing each family into slow- and fast-growing groups, based on mean family height at 6 years. Within specific families, the total rust infection for slow- and fast-growing groups did not differ appreciably (Table 3).

Table 3. Total rust infection on slow- and fast-growing groups within three half-sib families of pond pine 6 years after planting.

Half-sib Family	Slow growers	Fast growers
	Percent	
11-550	22.7	17.2
11-518	43.8	56.5
11-546	12.5	12.0

DISCUSSION

The almost fourfold difference in the percentage of total rust infection between the most resistant and the most susceptible clone is significant. This much variation, observed on only 3 clones, indicates that pond pine as a species varies in its response to fusiform rust as much as slash or loblolly pine. The average infection of the three families in this study (27%) was close to the 26% infection level of the pond pine mass planting reported on in an earlier species evaluation (2). In that earlier study, the infection level on loblolly pine was 50%. Therefore, it should be possible to reduce the number of rust-infected trees in plantations at least 50% by substituting the moderately resistant pond pine for loblolly pine. Careful selection of resistant clones within pond pine could increase the level of rust resistance from moderate to high, with resulting lower levels of damage due to fusiform rust.

A question often raised when selecting for rust resistance is: are resistant selections the slowest-growing portion of the population, or conversely, are the fast-growing selections more susceptible? In this limited sample of three pond pine selections, Family 11-518 was the fastest grower in the first 3 years after planting, and had more rust infections than did the other two half-sib families (Table 2). In the second 3 years the fastest-growing family (11-546) had the lowest percent infection.

When the families were compared in the "4 tallest" measurement, we found that the rust incidence on stems was almost equal for all families. The numbers of stem infections were 2, 2, and 1, for families 11-550, 11-518, and 11-546, respectively. This indicates that the growth data were not biased by stem infections reducing height growth, which would discriminate against the most-infected families. Therefore, it appears that faster growth is not necessarily associated with higher incidence of rust. This conclusion is strengthened when rust infection percentages of slow and fast growers within a family are compared. By using mean family height at 6 years for separating slow and fast growers within a family, we found that rust infection for the two groups did not differ consistently or appreciably.

The results from this study indicate that pond pine clones vary widely in their resistance to fusiform rust. Thus it may not be difficult to find specific clones that combine both rust resistance and rapid growth.

Literature Cited

1. DINUS, R. J. 1971. Phenotypic selection for fusiform rust resistance. Eleventh Conf. South. For. Tree Improv. Proc. 1971: 68-75.
2. POWERS, H. R., Jr. 1975. Relative susceptibility of five southern pines to Cronartium fusiforme. Plant Dis. Reptr. 59: 312-314.
3. POWERS, H. R., Jr., J. P. McCLURE, H. A. KNIGHT, and G. F. DUTROW. 1975. Fusiform rust: forest survey incidence data and financial impact in the South. U. S. For. Serv. Res. Pap. SE-127. 16 pp.
4. ZOBEL, B., R. BLAIR, and M. ZOERB. 1971. Using research data-disease resistance. J. For. 69: 486-489.