Susceptibility of Shortleaf Pine Seedlings to Infection by *Cronartium quercuum* f. sp. *fusiforme*

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ABSTRACT

Kraus, J. F., and Powers, H. R., Jr. 1984. Susceptibility of shortleaf pine seedlings to infection by *Cronartium quercuum* f. sp. *fusiforme*. Plant Disease 68:324-325.

Seedlings from 14 open-pollinated seed lots of *Pinus echinata* (shortleaf pine) and two open-pollinated seed lots of *P. taeda* (loblolly pine) were artificially inoculated with basidiospores derived from two sources: rust galls on shortleaf × loblolly pine hybrids and galls on loblolly pine. The objective was to determine if basidiospores from the hybrid inoculum sources would be more virulent than those from loblolly pine on the shortleaf seedlings. All seed lots of shortleaf pine were highly resistant (97–100% disease-free), whereas both loblolly pine seed lots were much less resistant (47–62% disease-free) to inoculum from both sources.

Hybrids between *Pinus echinata* Mill. (shortleaf pine) and *P. taeda* L. (loblolly pine) resist fusiform rust infection caused by *Cronartium quercuum* (Berk.) Miyabe ex Shirai f. sp. *fusiforme*. Ninety percent of trees with a genetic base of one-fourth shortleaf pine in advanced-generation strains of hybrid loblolly pine are resistant (8,15). Breeding programs to develop rust-resistant strains of loblolly pine with the resistance of shortleaf pine are under way. However, questions remain whether strains of *C. quercuum* f. sp. *fusiforme* with increased virulence to shortleaf pine will develop on the hybrid pine trees or whether the hybrids could provide a genetic bridge for the pathogen from loblolly to shortleaf pine. Natural selection for increased virulence of *C. quercuum* f. sp. *fusiforme* has been shown to occur in one generation on infected individuals of highly resistant families of slash pine (*P. elliottii* Engelm. var. *elliotii*) (12,16) and loblolly pine (11). It is not known whether virulent strains of rust capable of infecting shortleaf pine can develop on hybrid populations. This research tests the hypothesis that there is no difference in the percentage of infection of shortleaf pine seedlings by inoculum from hybrid trees compared with that collected from pure loblolly pine.

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MATERIALS AND METHODS

The pine seedlings used in this study were grown from seed of 14 lots of shortleaf pine and two of loblolly pine (Table 1). These included bulk lots from shortleaf pine seed orchards and unimproved seed from different areas within the shortleaf pine range.

Seeds were stratified for 2 mo before

Table 1. Percentage of rustfree loblolly and shortleaf pine seedlings 9 mo after inoculation with basidiospores derived from spores of *Cronartium quercuum* f. sp. *fusiforme* collected from naturally infected loblolly pine and shortleaf × loblolly pine hybrids

	Inoculum source	
Seed source	**Hybrids**	**Loblolly**
Shortleaf pine		
East Ouachita National Forest, seed orchard	100	100
Twiggs County, GA	100	100
Burke County, NC	100	100
GCIA[a] commercial check, Georgia mountains	100	100
Jackson County, KY	100	100
Ozark National Forest, seed orchard	99	100
Texas National Forest, seed orchard	100	99
East Ouachita National Forest, general forest collection	99	100
Scott County, MS	99	100
Texas National Forest, general forest collection	99	99
Ozark National Forest, general forest collection	98	100
Rabun County, GA	100	98
Kisatchie National Forest, seed orchard	99	98
Pendleton County, WV	98	97
Loblolly pine		
Livingston Parish, LA	62	53
GCIA[a] seed orchard check lot	58	47

[a]Georgia Crop Improvement Association.

planting. Shortly after germination, seedlings were transplanted to plastic flats, 20 seedlings per flat.

Aeciospores were collected from sporulating galls on shortleaf × loblolly pine hybrids in a 7-yr-old progeny test plantation in Houston County, GA, and from galls on loblolly pines in the same plantation. Presumably, all infections in this plantation originated from the same local rust population. Basidiospores were produced by inoculating leaves of northern red oak (*Quercus rubra* L.) seedlings with aeciospores from two mixtures of eight single-gall collections, one mixture from eight hybrid pines and one from eight loblolly pines.

After telial development, oak leaves were collected and basidiospores harvested using the technique of Matthews and Rowan (9). An inoculum suspension was prepared containing 5×10^4 basidiospores per milliliter. Seedlings were inoculated when 4 wk old at the rate of 8 ml of inoculum per flat, using the concentrated basidiospore spray system (9). Six flats of seedlings of each seed lot were inoculated with each inoculum source. After inoculation, the seedlings were placed in a mist chamber at 21 C for 24 hr. Seedlings were kept in the greenhouse for 9 mo before being examined for infection. Percentages of seedlings without galls were analyzed by analysis of variance.

RESULTS AND DISCUSSION

There was no significant difference between inoculum sources for percentage of rustfree seedlings (Table 1). In addition, there were no significant differences in percentages of rustfree trees among the various shortleaf pine seed lots. The shortleaf pine seed lots were significantly more resistant than the loblolly pine seed lot from Livingston Parish, LA, which in turn was significantly more resistant than the loblolly pine seed check lot from Georgia Crop Improvement Association.

Shortleaf and loblolly pines grow near one another in many places throughout the area in which their natural ranges overlap. Both research and circumstantial evidence from loblolly pine provenance tests indicate that natural hybridization between these two pines occurs (1,2,4,5–7, 10,14,17,18). The hybrid is easily produced by controlled pollination (3,13). If the shortleaf × loblolly pine hybrid could provide a genetic bridge to pure shortleaf pine for the transmission of a virulent strain of *C. quercuum* that infects loblolly pine, this probably would have occurred long ago. Although this could still happen, the results of this test indicate that over a wide portion of its range, pure shortleaf pine is resistant to strains of *C. quercuum* f. sp. *fusiforme* that infect shortleaf × loblolly pine hybrids in central Georgia.

The results of this test may serve as an incentive to further develop and test the shortleaf × loblolly pine hybrid in southern pine breeding programs for possible use in areas where fusiform rust is a severe problem.

LITERATURE CITED

1. Bilan, M. V. 1966. Natural hybridization between loblolly and shortleaf pine of east Texas. Int. Union For. Res. Organ. Sec. 22 Meet., Zagreb, Yugoslavia.
2. Cotton, M. H., Hicks, R. R., Jr., and Flake, R. H. 1975. Morphological variability among loblolly and shortleaf pines of east Texas with references to natural hybridization. Castanea 40:309-319.
3. Critchfield, W. B. 1963. Hybridization of the southeastern pines in California. Pages 40-48 in: For. Genet. Workshop Proc. Macon, Ga. 1962. 97 pp.
4. Florence, L. Z., and Hicks, R. R., Jr. 1976. Fusiform rust resistance of progeny from natural loblolly × shortleaf pine hybrids. Pages 10-19 in: Proc. Northeast. For. Tree Improv. Conf. 23rd. Rutgers Univ. 1975. 187 pp.
5. Florence, L. Z., and Hicks, R. R., Jr. 1976. Further evidence for introgression of *Pinus taeda* with *P. echinata*: Electrophoretic variability and variation in resistance to *Cronartium fusiforme*. Silvae Genet. 29:41-43.
6. Hare, R. C., and Switzer, G. L. 1969. Introgression with shortleaf pine may explain rust resistance in western loblolly pine. U.S. For. Serv. Res. Note SO-88. 2 pp.
7. Kraus, John F. 1967. A study of racial variation in loblolly pine in Georgia—Tenth-year results. Pages 78-85 in: Proc. South. For. Tree Improv. Conf. 9th. Knoxville, Tenn. 138 pp.
8. La Farge, T., and Kraus, J. F. 1980. A progeny test of (shortleaf × loblolly) × loblolly hybrids to produce rapid-growing hybrids resistant to fusiform rust. Silvae Genet. 29:197-200.
9. Matthews, F. R., and Rowan, S. J. 1972. An improved method for large-scale inoculations of pine and oak with *Cronartium*. Plant Dis. Rep. 56:931-934.
10. Mergen, F., Stairs, G. R., and Snyder, E. B. 1965. Natural and controlled loblolly × shortleaf pine hybrids in Mississippi. For. Sci. 11:306-314.
11. Powers, H. R., Jr., Matthews, F. R., and Dwinell, L. D. 1978. The potential for increased virulence of *Cronartium fusiforme* on resistant loblolly pine. Phytopathology 68:808-810.
12. Powers, H. R., Jr., and Zoerb, M. 1983. Field resistance of slash pine families affected by interactions with local rust populations. Pages 427-430 in: Proc. Biennial South. Silvicult. Res. Conf. 2nd. U.S. For. Serv. Gen. Tech. Rep. SE-24. 514 pp.
13. Righter, F. I., and Duffield, J. W. 1951. Interspecies hybrids in pines. J. Hered. 42:75-80.
14. Schoenike, R. E., Van Lear, D. H., and Benson, J. D. 1977. Comparison of shortleaf, loblolly, and putative hybrid pines in the Piedmont of South Carolina. Silvae Genet. 26:182-184.
15. Sluder, Earl R. 1970. Shortleaf × loblolly pine hybrids do well in central Georgia. Ga. For. Res. Pap. 64. 4 pp.
16. Snow, G. A., Dinus, R. J., and Walkinshaw, C. H. 1976. Increase in virulence of *Cronartium fusiforme* on resistant slash pine. Phytopathology 66:511-513.
17. Wells, O. O., and Wakeley, P. C. 1966. Geographic variation in survival, growth and fusiform-rust infection of planted loblolly pine. For. Sci. Monogr. 11. 40 pp.
18. Zobel, B. 1953. Are there natural loblolly-shortleaf pine hybrids? J. For. 51:494-495.