Disease Resistance Studies in Tree Improvement Research

by

F. F. Jewell, Plant Pathologist
Southern Institute of Forest Genetics
Southern Forest Experiment Station, Gulfport, Miss.

The term tree improvement research suggests different things to different people. It takes in a variety of sciences which, though often working separately, all have primarily the same purpose: to produce better trees. One phase of this expanding and important program is disease-resistance research. This is not a new field of work in forestry. Resistance studies have achieved varying degrees of success with such important diseases as mimosa wilt, littleleaf, white pine blister rust, chestnut blight, and several diseases of poplars. More recently research on resistance to fusiform rust has begun in the South. As this subject is of immediate interest, its application in the field of tree improvement will be discussed on the basis of present knowledge.

First, the fungus concerned is Cronartium fusiforme, a heteroecious long-cycle rust, requiring two hosts, pine and oak. The destructive stage occurs on the pine. Of the four major southern pines, slash and loblolly are the species most susceptible, longleaf is less susceptible, and shortleaf is considered resistant.

Chemical control in pine nurseries is common practice to provide rust-free stock for field planting. Chemical field control is considered impractical, at present. The application of disease resistance research to this problem is one of the most promising approaches. Though not far advanced, research findings indicate that the development of rust-resistance pines is a definite possibility.

It is a common observation that not all trees in a plantation are rust-infected even though the infection rate is very high. Usually a few individuals either escape infection or possess inherent ability to resist establishment of the fungus. If the latter be true, it is reasonable to assume that this resistance would, to some degree, be transmitted to the progeny from such trees. The heritability of resistance is suggested, though not confirmed, by results from Georgia (1) where after 2-3 years in the field considerable less infection was observed among one-parent slash pine progeny than in 4 lots of control slash seedlings. Progeny from one selection in particular showed a consistently low infection rate. At Gulfport, Mississippi, two local and one Georgia selection have shown indications of resistance in one-parent progeny tests under artificial inoculation conditions. Some of these progeny have been inoculated 2 years consecutively, and are still free of the disease. These

findings are encouraging in that apparently some inherent resistance to fusiform rust is present in slash pine. Assuming this to be true, several applications are possible.

The establishment of grafts from tested selections in seed orchards would produce seed yielding a higher percentage of rust-resistant seedlings than would be obtained from bulk collections. To go a step further, it is reasonable to assume that if resistance is transmitted by a selected individual to open-pollinated progenies, intraspecific crosses between selected parents should increase the degree of resistance in the progenies. Seed orchards yielding such progenies would be a valuable asset to forest management in the South. Research is aimed at producing such parent stock.

We have information on the rust-resistance of interspecific hybrid progenies of shortleaf x loblolly, shortleaf x slash, and slash x loblolly. No fusiform rust has been observed in a small planting of shortleaf x loblolly put out as 1-0 stock 7 years ago, although a surrounding slash plantation is from 70-80 percent infected (2). These hybrids have good form and average 29. 7 feet in height and 4. 8 inches in diameter -- in some contrast to 15. 0 feet and 1. 9 inches for a shortleaf x shortleaf cross. In artificial inoculation of 1-and 2-year-old shortleaf x slash progenies, no rust galls have been observed, while comparable bulk slash pines were 80 percent infected. After 3 years in the field, shortleaf x slash and shortleaf x loblolly hybrids produced by R. M. Allen and N. M. Scarbrough 1/ show no rust infection and average 1.5 to 2. 0 feet more in height than the shortleaf checks.

The most important lead gained from interspecific crosses involving shortleaf is that apparently whatever factor possessed by this species for resistance to fusiform rust is transmitted to its inter species progenies in a dominant manner. Another encouraging point is the good growth and form of most shortleaf x loblolly, and shortleaf x slash hybrids.

The progenies from two slash x loblolly crosses in the aforementioned Allen-Scarbrough planting were of particular interest, These involved two slash trees crossed with one loblolly. The average height of the 94 hybrids from these crosses is about 6. 5 feet, compared to 5. 8 feet for 75 open-pollinated plants from the slash mother trees. Rust-infection on the hybrid progenies averaged 89 percent, with those from one cross having 46 of a total of 47 representatives infected; one tree had 41 rust galls, The rust-infection of the open-pollinated slash checks averaged 44 percent, or about half as much as the hybrids. As these are the only progenies of this interspecific cross in the area in any number, it is not known if the high rust susceptibility of the hybrid is unusual or to be expected with this type of cross. The point

1/ Allen, R. M. and N. M. Scarbrough. Data to be published.

is important, because in inheritance studies, susceptibility cannot be divorced from the resistance aims. Also, if such a cross consistently gives a high percentage of susceptible plants, these can then be used as check material against which to judge resistance in other progenies.

The ultimate aim of disease resistance research is to be able to incorporate the factors for resistance, in this case to fusiform rust, into trees possessing other superior traits as well. At present, geneticists and pathologists are working independently, for the most part, on particular problems in the two fields. However, once certain facts become known, i. e. how resistance increases or decreases with age of the host, how the pollen parent affects progeny resistance, type of intraspecific crosses among suscepts that produce resistance, etc. , then the pathologist and geneticist will be able to combine their findings for improving our pines and be able to supply foresters with trees that are not only fast growing, of good form and desirable specific gravity, but also resistant to disease.

Literature Cited

1. Barber, J. C. , K. W. Dorman, and E. Bauer. 1957. Slash pine progeny tests indicate genetic variation in resistance to rust. Southeastern Forest Experiment Station Research Note 104.

2. Henry, B. W. and T. E. Bercaw. 1956. Shortleaf-loblolly hybrid pines free of fusiform rust after 5 years exposure. Journal Forestry 54:779.