How Can Genetic Control of Diseases Aid the Forest Manager?

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Forest diseases caused mortality and growth losses during 1952 of more than 5 billion cubic feet of growing stock and almost 20 million board feet of sawtimber in the continental United States, according to the Forest Service's Timber Resource Review (1958). Diseases were responsible for 45 percent of the losses from all causes, including fire and insects. In the South, fusiform rust alone accounted for 97 million cubic feet of growing stock and 281 million board feet of sawtimber. The situation is probably not any better today. Obviously, we must improve our control of forest diseases if we are to obtain maximum production on our forest lands.

The control of tree diseases in the forest by chemical or cultural means has been historically difficult, usually being temporary, expensive, and generally unsatisfactory. The application of chemicals, even antibiotics (Lemin et al.), gives at best short-term and expensive protection. The one cultural method in general use in southern forests, i.e., burning for the control of the brown spot needle disease of longleaf pine, is a drastic treatment that often has questionable results. An important avenue of attack on the overall control problem is through genetics and tree breeding. Develop a resistant tree and you will have built-in control with no further manipulation required.

With agricultural crops, the geneticists and plant breeders have been able, through selection, progeny testing, and use of plant hybrids, to produce disease-resistant varieties that have been a major force in revolutionizing agricultural production in this country. For example, of 90 new crop varieties released by the U. S. Department of Agriculture and the State experiment stations in 1959, more than half were developed with specific disease resistance in mind (U. S. Agr. Res. Serv. 1960). Some of the findings in disease-resistance research have virtually saved valuable crops from becoming lost to commercial production.

So the principles of disease control through resistance have been proven and are available for application to forest trees. We have begun that application at the Institute of Forest Genetics in our attack on the fusiform rust of slash and loblolly pines. Our first efforts were aimed at determining if resistance could be incorporated into the susceptible slash pine by crossing it with the naturally resistant shortleaf pine. Selection, breeding, and progeny tests under conditions of both artificial and natural infection have shown that this hybrid does indeed carry a considerable amount of resistance to fusiform rust (Jewell 1961; Jewell and Henry 1961).

Our next efforts were to find whether or not resistance to this rust exists naturally in individual trees of the susceptible species, slash pine. Open- and control-pollinated progenies of selected rust-free parents were artificially inoculated with the rust along with progenies from check parents. The open-pollinated progenies of certain of the selected parents exhibited significantly fewer galled individuals than the progenies from check parents. When the selected rust-free parents were crossed with one another, the progenies showed still greater resistance (Jewell 1961). So resistance does exist in individuals within the susceptible slash species.

Therefore, there are two sources of resistance to fusiform rust. Resistance can be bred into slash pine by crossing it with shortleaf, or resistant strains of slash itself can be developed by crossing individual trees whose progenies have been shown to be resistant. Both these methods appear promising.

The concept of individual-tree resistance to fusiform rust is actually already in practice in the South, thanks to the foresight of many early workers in tree improvement programs. By their insistence that slash and loblolly pine selections be free of fusiform rust, an appreciable amount of resistance is apparently already incorporated into the clonal seed orchards (N.C. State Col. School Forestry 1963). Future progeny tests for rust reaction and subsequent roguing should result in a still higher percentage of resistant material in these orchards.

The discussion so far has dealt with resistance to only one forest disease. However, we have evidence that the same principles of control by resistance can be applied to others as well. The crossing of western white pine trees selected for resistance to blister rust yields a high percentage of resistant progenies (Bingham 1963). The first-generation, F1, progenies are put into seed orchards and the next generation, F2 , will be used as planting stock.

Another disease that possibly will be susceptible to genetic control is the brown spot of longleaf pine. Under field conditions the open-pollinated progeny from a selected longleaf has consistently shown less infection than control progenies (Derr 1963). Progeny from a cross of this selected parent and nonresistant longleaf were far less susceptible than the open-pollinated progenies from the nonresistant parents. He concludes that resistance to brown spot is genetically controlled and that there are distinct possibilities for developing and producing resistant longleaf pines.

The three examples just mentioned illustrate the prospects of controlling forest tree diseases through resistance. The prospects appear good: not only does it seem likely that research will be able to find and produce resistant trees, but control of diseases may well be among the earliest practical results of genetics programs.

Now for the question that forms the title of this paper, "How can genetic control of diseases aid the forest manager?" In essence, it can eliminate one of his most plaguing problems—having to plan a management program in the face of disease losses that must be expected, but in unknown quantity. It can enable him to establish the species he wants on the site he wants without regard to disease hazard; it can free him from having to establish and maintain heavy stocking to compensate for disease losses. With genetic control he can have the thinning regime he wants, rather than one dictated to him by the necessity of removing trees made infirm by disease. And he can carry his stand on to maturity without fear of disease loss, because resistance lasts for the life of the tree.