THE DISEASE PROBLEM IN RELATION TO TREE IMPROVEMENT[1]

By Ralph M. Lindgren[2]

If the work done on other crop plants is any indication, adequate resistance to disease will be one of the most important phases of a forest—tree improvement program. I don't think any of you need to be convinced of this, but if such history with other plants isn't enough, we have a tree case in our own territory which is one of the worlds most striking examples of the need for properly recognizing diseases. This example is the chestnut blight disease, which in about 40 years resulted in the practical extinction of an entire species. The blight alone already has resulted in a fairly large amount of work of the type that we are discussing. In fact, such work represents some of the earliest on forest—tree genetics in the United States.

Before considering the possibilities and difficulties in planned studies on increasing resistance, let's spend a few moments on the general disease situation in virgin stands and in stands of today. Theoretically, virgin or undisturbed stands were largely a case of the survival of the fittest so that natural selection for disease resistance probably was a continuing operation. Since the chances of introduced diseases were remote and since native diseases seldom cause widespread devastation in natural stands, epidemic conditions must have been rare. Furthermcre, stands undoubtedly were often dense so that many trees could be lost without serious effect on final stocking. Similar tree losses today would be much more damaging, particularly in plantations with a limited number of trees and from which intermediate as well as final products are expected.

The situation now on disease liability depends on the practices that have been followed in cutting and reproducing the stands. For instance, the widespread early practice of "high grading" has worked to decrease rather than build up the resistance of the new forest. This practice still continues to some extent, particularly in the harvesting of hardwood stands. Even under the best management practice today, however, it is difficult to judge whether the chances for disease escape are better or poorer than under undisturbed natural conditions. To the extent that diseased trees are being eliminated early, mixtures are encouraged where pure stands existed before, and the best sites are favored for species — we are tending to improve the disease picture. On the other hand, disease liability tends to be increases to the extent that mixed stands are replaced by pure ones, trees are grown outside of their natural range, and plantations are favored over natural regeneration, particularly if the seed source is from some distant place.

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2/ U. S. Division of Forest Pathology, in cooperation with Southern Forest Experiment Station, New Orleans, Louisiana.

It is very doubtful whether natural selection for disease resistance is now operating as effectively as under an undisturbed stand condition. One reason for this is that the use of direct methods of disease control often permits the survival of susceptible as well as resistant individuals. One case in point is longleaf in areas where brown spot is heavy. In the absence of prescribed burning or fungicidal sprays, the plants making earliest height growth are likely to be the most resistant ones. These tend to comprise a larger proportion of the final stand than when brown spot control measures are employed. Finally, one cannot overlook the present real threat of introducing new diseases from other countries, plus the fact that abused and depleted sites often confront the tree with a changed natural environment that often may increase the disease hazard.

In a tree improvement program, the disease more than any other phase could eventually find us guilty of having looked through rose-colored glasses. It may seem from the following that I am substituting opaque ones instead, which is not the case, but we must be realistic and recognize some of the possible obstacles in our path. Among the foremost is that diseases of trees are largely caused by fungi, although there is a good possibility that the little-known virus agents will become increasingly important. If so, the problem will only become more complicated. Anyway, fungi, being plants, hybridize as we now talk of changing trees, and furthermore, mutations are net uncommon for many of them. Generations in their case are a matter of hours and days, not years or decades. This means that new varieties or biologic forms might arise that would make last year's resistant tree a susceptible one today. Among annual plants, the stem rust of wheat is an outstanding example of a disease that continues to produce new forms that periodically relegate resistant Wheats into the susceptible class. Among trees, there is recent suspicion that the resistant Buisman elm may be susceptible to a new form of the Dutch elm disease fungus. Variability within species for a number of other fungi, including those causing heart rots and mimosa wilt, is known to occur. Fortunately, the present evidence is that such tree rusts as those causing white pine blister rust and fusifom. canker diseases have not given rise to new forms differing in parasitism. However, it would be foolish to ignore the threat, considering the short time diseases have been observed and the long time needed for rotations or the development of superior individuals.

Another possible difficulty is that stock bred for resistance against certain diseases may prove susceptible to diseases normally harmless to the tree being replaced. This has been the case with some of the fast-growing poplars, and Asiatic and hybrid chestnuts. It has been strikingly true of the hybrid London plane, which showed resistance against sycamore anthracnose but has succumbed in large numbers to the canker stain disease. With the hybrid poplars and London plane, susceptibility to disease and hybrid vigor were associated. One advantage that trees have had over annual crop plants is what they are much hoe heterozygous. The closer genetic uniformity is reached in large populations the greater is the risk of heavy losses from epidemic diseases. Hazards would be very high, for instance, in extensive Plantings of clonal propagated stock since this would be a great refinement of pure stands of species. Such clonal varieties as Lombardy poplar, Norway poplar, and London plane already have been seriously troubled by diseases that apparently caused minor damage on the closely related native trees. As Hartley and Boyce have warned, unless mixtures of superior clones are at least used, the disease status in planted forests could easily approach that already apparent in our present-day orchards.

What has been said is not intended in any way as an argument for placing our entire reliance in unselected planting stock. Such diseases as the chestnut blight, white pine blister rust, and littleleaf are good examples of why we want and need the advantages that superior strains would offer. A brief history of work in this direction, for trees other than the southern pies, is that in 1909 the chestnut blight provided the first strong incentive in this country to select and breed resistant forest-trees. In 1924, poplar improvement was started, with diseases partly in mind. About 1935, research began for elms resistant to the Dutch elm disease and to phloem necrosis, a desructive virus disease. At about the same time the work of selecting white pines resistant to the blister rust was undertaken. In 1939, Hepting and his coworkers embarked on the selection of mimosa strains resistant to the wilt disease. Among the encouraging results so far are a number of selections that have continued to show high resistance against mimosa wilt end phloem necrosis. In both cases, vegetative propagation has been found possible through the rooting of stem and root or leaf bud cuttings. A hybrid between a Chinese and the American chestnut has indicated promise for forest plantings but is in an early stage of testing. Resistant selections have been obtained against the white pine blister rust, and both rooted cuttings and grafting have been employed with some success in propagating such strains.

As to our southern pines, each of the important species would be considered a better tree in some localities if diseases were not present. For longleaf, brown spot is often troublesome in delaying early height growth and even causing mortality. In the case of slash pine, the fusiform rust canker disease proves a limiting factor for this species in local areas, and also causes losses of varying degrees in widespread places. Loblolly is afflicted with fusiform cankering in a manner similar to slash, and also has the little-leaf disease confronting it. For shortleaf, the littleleaf disease has been exacting such a high toll that the future of the species in rather extensive areas is very doubtful. For each of these trees, there are several other diseases of lesser importance. Included among them are the fairly common heart and butt rots of virgin stands. With shorter rotations, fire control, and reasonably good management practices, the heart rots should fade into relative insignificance in future stands.

In dealing with these diseases, emphasis first has been placed on the indirect method of control through modified silvicultural and management practices. This has seemed the soundest approach, if workable, for the same reason that one would not employ a high—priced specialist using costly antibiotics to do what some self-administered aspirin would do. For brown spot and fusiform rust, the present evidence is that nursery sprays plus modified silvicultural methods may enable us to live with them without too much discomfort. However, it has seemed both wise and necessary to at least skirt the possibilities of increasing resistance to these diseases. The same has been true, but to a much greater degree, for shortleaf in relation to the important littleleaf disease. It will be evident from the following that the work done so far along these lines is in an early stage of development.

Considering the littleleaf disease, apparently healthy shortleaf trees are found at times in the midst of large numbers of killed ones. Selection for resistance, therefore, offers some promise but if this is not successful, breeding for resistance would still be a possibility. Some progress on such a program already has been made through the development of successful cleft-grafting methods of propagating shortleaf pine. Such methods should at least simplyfy the breeding work that may be necessary.

For brown spot of longleaf, the field evidence has been strong that resistant strains could be selected. Early work indicated that a high resin content of the needles, as well as freedom from disease, might also be a criterion of resistance. Since unsprayed nursery seedlings under uniform environmental conditions provide one of the quickest and most certain ways of detecting differences in resistance, work along this line has been started at the Ashe Nursery in Mississippi. Selections made from these beds will be transplanted to a "disease resistance" plot for possible propagation and establishment in disease exposure plots at some later time.

The approach to increased resistance against the fusiform rust canker disease has included geographic seed source and 1-parent progeny plantings in a number of places. Wakeley has already presented strong evidence that different geographic strains of loblolly in the same plantation may vary widely in susceptibility to cankering, and that local strains are likely to be least diseased. Siggers later found that the most heavily cankered strain in the planting mentioned by Wakeley broke dormancy earlier in the spring than did the local strain. This early initiation of growth tended to expose highly susceptible new shoot tissue at the time when the spores that infect pine were at peak production. Further evidence on geographic strains of lob-lolly in relation to fusiform cankering should be forthcoming from Forest Pathology plots that are in the early stages of yielding results.

As to slash pine, a number of geographic strains have been under test in several localities for as long as 9 years. The oldest of these comparisons involved conventional types of slash pine from South Carolina to Louisiana. In more recent plantings, a native "South Florida" strain and one from Cuba were also included. To date, significant differences in cankering between the various strains have only been shown by the "South Florida" and Cuban slash, the former being strikingly resistant and the latter highly susceptible in comparison with all other strains, in plantings in Mississippi. The "South Florida" strain also has differed greatly in growth characteristics and appearance from all other collections. Within the past year, a slash pine of British Honduras origin has been added to the study. Although exceptional vigor characterized its growth in the seedbed, susceptibility to winter injury (true of the Cuban strain also) may easily prove a limiting factor, regardless of performance against the rust disease.

In conducting the so—called "1 parent progeny" studies, seed have been collected from healthy versus heavily diseased loblolly and slash pine in areas of high rust incidence. Seedlings from both types of parents were established in several plantings that now range from 2 to 5 years in age. The evidence so far has been that the offspring from healthy trees are of little or no greater resistance to cankering than those from diseased trees. Therefore, limiting seed collection to healthy trees is indicated to be of dubious value, This does not mean, however, that the selection of resistant individuals in the field is precluded. In the case of white pine blister rust, for instance, 1-parent progeny comparisons likewise showed little promise in increasing resistance; nevertheless, resistant selections have been made and are now being propagated.

To summarize the pathologist's role in a forest—tree improvement program, I have tried to point out that the phrase "improving the disease situation in future stands" could be easily misinterpreted. This would be true if one visualized the stable type of improvement that is expected for volume production, form, and most other tree qualities. To assume such changes in the disease situation would be too optimistic, in view of our limited experience and what has happened with increased cultivation of other crop plants. Instead, the pathologist's role probably will be that of struggling constantly to keep disease losses within reasonable limits and to sustain some of the gains that are being made inother tree qualities.To makethis fight more effective,I believe we should:

1. Recognize that the indirect silvicultnral methods of control will always be a mainstay against many of our diseases, and that the development and application of effective methods are of primary importance wherever the indirect approach can be used. Better application of available methods could improve the health and probably the resistance of our stands today. Such shortcomings in employing indirect control should be increasingly avoided in the future.

2. Accept the belief that increasing the resistance of the tree, population is an essential part of every study on important disease problems. This means that geographic seed source and 1-parent progeny comparisons should be made. It also means being on the constant alert for resistant selections, and if such are found, collecting and establishing them in disease resistance plots or recording their location for future use. Eventually, very promising selections should be propagated and widely compared in disease exposure plots. Material also should be supplied foresters, entomologists, and others in the event that additional comparisons seem necessary for other important qualities.

3. Breed for resistance when necessary, particularly in connection with important introduced diseases. If hybrids of definite promise are obtained, they should be widely planted to test disease resistance and other qualities under field conditions. If one parent is of foreign origin, the disease exposure plots should also be established in other countries, particularly in the home of that parent. In fact, such foreign exposure would be advisable for selections as well as hybrids in order to determine and help safeguard against the threat of other foreign diseases.

4. Make every effort to have adequate attention given to the disease phase in all tree—improvement programs. This would include such cooperation as offering to test, or to advise on testing, the disease resistance of all new selections or hybrids that show promise for other qualities.

My concluding remarks are along the lines of the last point mentioned. If the hoped-for progress in tree improvement is to be made, the close cooperation of all interested groups will be a prerequisite. Such cooperation will have to involve the pooling of methods, materials, and even thoughts. There will be less room for independent and guarded effort in this program than in any other type of endeavor in the plant research field.