SITE FACTORS IN FOREST GENETICS RESEARCH

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In this paper, I should like to re-emphasize what we all know but sometimes forget; namely, that hardiness as regards cold resistance is only one aspect of the adaptation of a plant to its environment. For a tree to survive and to thrive, it needs to be suited in all respects to its planting site. The air surrounding the tree is naturally an important element of this site, and the importance of the description of this air in terms of climatic factors can hardly be over-emphasized. On the other hand, we cannot forget that the roots of the tree are surrounded by soil from which comes most of the nutrition and water required for life. A species must be adapted to the soil fully as much as it must be adapted to the climate.

Our problem, then, is not really to develop hardier trees, for we have lots of species that are hardy under the most extreme climates of the Lake States. Rather, it is to develop races and species which will be adapted to the various sites needing afforestation in our region.

REQUIREMENTS FOR A GOOD FOREST TREE SPECIES

We may well begin by asking ourselves what sort of a tree do we want. The requirements are more or less obvious, but they may well be reiterated to point up the problem that faces us in Lake States tree breeding work.

First, of course, the species must be adapted to the climate. This means that the tree must be of such a genetic constitution that it is suited to the temperature range, seasons, annual rainfall and its seasonal pattern, day length, evaporation, and to all the other climatic factors characteristic of an area. As has already been pointed out, the basic problem in the Lake States is to develop coniferous species suitable for use in the southern half of the Lake States where native conifers are either lacking or where they thrive poorly. The problem of extending the range of a species south is much more complicated -- and in the long run may prove to be more difficult -- thar that of finding a race that can be planted north of its natural range. In picking a species for its climatic adaptation, we cannot content ourselves merely with the regional climate, but we must also examine the microclimate. We are all aware of the danger of growing trees in frost pockets. Perhaps we are somewhat less aware of the fact that the characteristics of the local climate may change within a few feet in accordance with vegetation and topographic control. We must have species suitable not only for planting in a given region, but also for planting on a given topographic site in a given region.

Second, the species must be adapted to the soil and to the amount of moisture in that soil. In general, we know that certain species do best on limestone and other alkaline soils, whereas other species seem to prefer more acid soils. We are also aware of the general water

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requirements of most species. A good deal has yet to be learned, however, concerning the relationship of the mineral composition of the soil and of the water in that soil to the growth of the various species of trees on it. In particular, we need to know the importance of genetic control in determining these ecological adaptations.

The above factors lie within the area of the present discussion. In passing, we may note, however, that there are other requirements for a good forest tree species. First of all, for growth on open sites, the species must be pioneer in successional status. It must be a tree suited for survival and growth in open exposed sites. Again, the tree must be resistant to insects and diseases. More often than not, lack of resistance of a given species varies to the degree that the tree is moved out from its optimal range. In this respect, resistance of a species to insects and diseases cannot be segregated from the adaptation of the same species to climate and soil. Finally, a good planting species must be of high economic value to justify the high cost of getting it established in the first place.

American foresters frequently talk about the wide variety of species available for forestry programs. Looking at the above list of qualifications for a good species, we should note how very few species meet these requirements for planting in the Lake States. Only two trees, red pine and jack pine, fulfill these specifications for any large part of our region. This is demonstrated by figures published in U.S.D.A. Technical Bulletin 1010, giving the cumulative number of trees planted by all public agencies, 1926-1944. In the three states of Michigan, Minnesota and Wisconsin, 84 percent of all the planting by public agencies consisted of these two species. Still another pine, white pine, accounted for an additional 9 percent. It is fairly obvious that our native pines have proved almost the sole acceptable large—scale planting species in the Lake States, having accounted for 93 percent of the planting by public agencies during this period. Most of the residual 7 percent was white spruce and miscellaneous conifers, with hardwoods accounting for less than 1 percent of the grand total.

Despite the figures given above, it is obvious that a wide range of sites and climatic zones occur in the Lake States. Red and jack pines are not suitable trees for all conditions. In general, all conifers have been planted too far south of their native range. The many difficulties arising from insects and disease, together with purely climatic difficulties, testify to the need for conifers suitable to the sites and climates of the southern half of the Lake States. To some extent, this need may be met by isolating ecotypes of existing conifers suitable for planting under these conditions. In the long run, however, reliance must inevitably be placed either on exotics or on hybrids carefully bred for suitability to these planting conditions. Where satisfactory native species do not exist, the only recourses are to bring in trees from afar or to develop new trees.

At the same time, we must not forget the possibility of hardwood culture. The almost universal failures of our hardwood plantings are not attributable in most cases to lack of climatic adaptation. Rather, they are due to lack of knowledge of proper cultural techniques coupled with failure to protect the hardwoods against browsing by deer, rabbits, and other animals. We now know that most of our hardwoods are not trees that can be stuck into a piece of low-grade denuded land, and left to their own devices with any chance of success. If we wish to culture hardwoods successfully, we must borrow technical knowledge from the horticulturist rather than from the silviculturist trained solely in the handling of coniferous stock. Generations of experience in growing fruit and nut trees and other arboricultural crops point the way to proper hardwood timber culture. We must plant our hardwoods on good sites, cultivate them for several years after planting, and in general, give them care and attention throughout their life. If we have the right species and the right site, it is wholly possible that such intensive culture may well prove economic, at least in years to come. At any rate, most of our hardwoods are not species for poor planting sites. Practically all of the Lake States contain valuable endemic hardwood species. The possibility of isolating high-grade hardwoods suitable for specific climatic zones and for specific soil types should not be neglected by the forest geneticist and the silviculturist.

RESEARCH NEEDED

The purpose of the above discussion is not to summarize the literature or to present anything new to the geneticist and silviculturist in the Lake States region. Rather, by emphasizing well-known facts, it is intended to point out that we have a very real problem here in the Lake States in isolating and identifying strains of trees suitable to our various climatic zones, soils, and topographic locations. Furthermore, we are so limited in our satisfactory species as to be able to use a wide variety of improved strains and hybrids when they become available.

In dealing with the problem of site adaptation, we enter a realm where cooperative research between the forest geneticist and the ecologist is essential. It is not sufficient merely to isolate a new race or species. Neither is it satisfactory to determine what local and native plants thrive best on a particular site. The only solution is to achieve a better understanding of interactions between genetic control and environmental adaptation. A given strain, variety or species may be worthless under one condition and highly valuable in another environment. Mass selection techniques will never be a satisfactory answer to this problem. Too many possible genetic combinations, climatic situations, and soil conditions exist to permit testing them by purely empirical mass-selection studies.

The only answer, therefore, is fundamental research designed to develop an understanding of the interrelationships between a tree's genetic makeup and its adaptation to environmental conditions.

For any site needing forest establishment, we must know first how to recognize what sort of forest tree is required. Second, we must know where to go to look for such a tree. Third, in the event that we do not find it in nature, we must then know how to breed it. If possible, we should derive such a new strain within our naturally occurring species, this is, by relying on intraspecific breeding. In the event that no present species are suitable, we must then be able to set out and derive a hybrid that will meet our requirements. Then, and only then, can we fit the tree to the site. Then, and only then, will we be able to establish good forest stands wherever they are needed.