FOREST GENETICS WORK AT THE LAKE STATES FOREST EXPERIMENT STATION [1/] *

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Almost from its inception the Lake States Forest Experiment Station showed an awareness of the importance of forest genetics. In 1928, only five years after its establishment, the Station began a study of red pine seed sources. This study, planned by the late Carlos G. Bates, was followed by other seed source projects concerning Scotch pine, Norway spruce, white spruce, green ash, ponderosa pine, European larch, and jack pine. In addition, a number of exotic forest trees have been planted to test their adaptability to this region. Except for an attempt with sugar maple in 1928, the Station's tree breeding program has been confined to field-testing of poplar and pine hybrids developed elsewhere.

SEED SOURCE STUDIES

Red Pine

Because of its valuable wood properties, hardiness, relative freedom from insect pests and diseases, and adaptability to sandy soils, red pine (Pinus resinosa) was, and has remained, the most widely planted forest tree species in the Lake States. However, stands suitable and readily available for seed collection were somewhat limited. It was logical, therefore, that the first genetics project of the Station was a study to determine how much racial variation there might be in red pine. Three groups of plantings were made.

Prior to any field planting, laboratory tests of cold resistance were made on 1-b seedlings of 30 seed sources in the fall of 1929. Trees were hardened at 0°C. for one week and then held at -6.5°C. for one day. Results showed in general that seedlings of northern origin adjusted themselves to low temperatures better than those of more southern origin.

In 1931, red pine stock of 39 Lake States and 2 New Ragland origins was field-planted on the Superior and Chippewa National Forests in Minnesota and the Huron National Forest in Lower Michigan.

In 1933, stock of 146 Lake States, 4 Northeastern, and IF Ontario localities was planted in the same three localities.

1/ Maintained by the U. S. Department of Agriculture, Forest Service, in cooperation with the University of Minnesota.

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* Titles marked by an asterisk represent papers which have been condensed to some degree over the presentation given at the Conference.

The drought of 1936 largely eliminated the Chippewa and Huron plantings, but those on the Superior came through with only light (1931) to moderate (1933) mortality.

An analysis of results from the 1931 planting, when the trees were 16 years old (from seed), indicated that the best lots were from northeastern Minnesota, with some from northwestern Minnesota, north-central Minnesota, and northeastern Wisconsin nearly as good. Lots from New England, Lower Michigan, central Wisconsin, and northwestern Wisconsin did not show up so well.

In 193L, stock of 51 red pine seed sources from the Lake States and the Northeast was planted on the Chippewa National Forest. At the end of 14 growing seasons in the field, growth had been generally excellent and there appeared to be no striking differences between sources. Stock of the same lots was planted in northwestern Pennsylvania at the same time. Distinct differences between sources were reported in Station Paper No. 49 of the Northeastern Forest Experiment Station.

General

Increasingly valuable results should be forthcoming from these plantations as the trees grow older and have more opportunities to express their adaptation to the environment of the planting site.

Scotch Pine

Scotch pine (Pinus sylvestris) was one of the first forest trees planted in the Lake States, probably because it was familiar to European immigrants and because nursery stock was available. Because many of the plantings did not develop satisfactorily, a study of seed sources seemed advisable. The Station made three groups of plantings including a number of seed sources.

In 1931, Scotch pine stock of 20 origins, representing both northern and central European types, was planted on the Superior and Chippewa National Forests in Minnesota and the Huron National Forest in Lower Michigan.

In 1933, stock of 8 additional sources was planted in these same localities.

Drought and fire destroyed the Chippewa and Huron plantations leaving only that on the Superior National Forest for continued observation. Up to 19 years from seed, there had been marked differences between sources with the more rapid growth of central European sources offsetting their poorer form. However, during the winter of 1947-48, the Scotch pines of central European origin were injured much more severely than those from northern European or Asiatic sources. Many succumbed to this injury.

In 1937, stock of 24 seed sources of Scotch pine was planted on a good site on the Chippewa National Forest. Nineteen of these lots were of central European origin; they were severely damaged during the winter of 1947-48.

In 1941, Scotch pine stock from 10 European sources, received from the International Union of Forest Research Organizations, was field-planted on the Chippewa National Forest in Minnesota and the Manistee National Forest in Lower Michigan.

On the Chippewa National Forest, the winter of 1947-48 caused severe damage to those sources which originated in areas of milder climate than the Chippewa. On the other hand, those sources which came from climatic zones similar to the Chippewa suffered little or no damage. On the Manistee National Forest, severe winter conditions were not experienced and Scotch pine survivals were good -- better than native red pine planted as a check. Height growth also was better than for red pine but varied considerably according to source at the end of 11 years in the field (13 years from seed). Except for one source from Finland and one from Romania, however, all Scotch pine lots had been heavily attacked by the white pine weevil.

General

In the Lake States, Scotch pine of a number of sources has suffered so much injury and mortality from climatic and biotic factors that its general use as a forest tree cannot be recommended. Since it does have some value for special purposes (Christmas tree production, sand blow planting, etc.) and possibly for growing in southern parts of the Lake States where the European pine shoot moth limits the use of red pine, some search should be continued for hardy races of good growth characteristics.

Ponderosa Pine

Because of its drought resistance, ponderosa pine is probably the best pine for planting in the prairie-plains region. Its wide natural range makes it certain that ponderosa pine has developed a number of races. It is important to learn which races are best for various localities.

Ponderosa pines (Pinus ponderosa) grown from seed originating in western North Dakota, eastern Montana, western Nebraska, and the Black Hills of South Dakota, were planted on a sandhills area in north-central North Dakota in the spring of 1940. Differences in growth between sources are not great, but there have been distinct differences in amount of winter foliage injury. The nearest-native sources, western North Dakota and eastern Montana, have had distinctly less injury than the Black Hills and western Nebraska sources.

Jack Pine

Primarily because of its rapid early growth, its use for pulpwood, and its suitability for rather poor sandy soils, jack pine has been planted extensively in the Lake States and probably will continue to be planted widely. To help guide future plantings the Station has undertaken some seed source and age of mother tree studies.

In 1937, jack pine stock of three Minnesota sources and one Lower Michigan source was planted on the Chippewa National Forest adjacent to red pine plantings. Early differences between sources were insignificant and no recent appraisals are available.

In 1937, on the Huron National Forest in Michigan, the Station planted jack pine grown from seed gathered from trees within the same stand which were 1-10, 11-20, 21-40, 41-60, and 61+ years old. In 1939, the Huron National Forest planted jack pine grown from seeds collected from trees aged 11-20, 21-30, 31-40, 41-50, 51-60, 61-70, and 71-80 years. Although there was a general tendency for the oldest age classes to produce smaller cones and smaller seeds than those which were younger, little difference was apparent in the nursery stock they produced. At the end of 10 and 14 years from seed, plantations of this stock displayed no significant differences attributable to age of mother tree.

In 1943, jack pine stock of nine seed origins (four from Wisconsin, four from Michigan, and one from northern Indiana) was planted on the Manistee National Forest. At the age of 10 years from seed (all favorable growing seasons) there were no distinct differences between sources in survival, growth, or susceptibility to weevil attack.

Currently under way is a jack pine seed source study in cooperation with the University of Minnesota, the Conservation Departments of Wisconsin, Minnesota, and Michigan, and some industries. This includes 29 seed collections in the three Lake States, each representing a stand considered good for that locality. One-year-old stock now is in the State nurseries at Rhinelander, Wisconsin and Willow River, Minnesota. Field plots will be set out in several localities in each State in the spring of 1954.

Spruces

Spruces are premium pulpwood trees and there is increasing interest in planting them. It is advisable to know how far afield it is safe to go in obtaining seed, and whether any of the exotics are suitable for this region. For these reasons, the Station has undertaken two sets of tests concerning spruce seed sources.

In 1936, the Station planted stock of nine spruces, as follows: white spruce (Picea glauca), six sources from the Lake States and Ontario; Norway spruce (P. abies), six sources, mostly from the U.S.S.R.; red spruce (P. rubens), two sources from Pennsylvania and North Carolina; black spruce (P. mariana) from the Chippewa National Forest, Minnesota; western white spruce (glauca var. albertiana) from South Dakota; Sakhalin spruce (P. glehnii) from northern Japan; oriental spruce (P. orientalis) from the Caucasus region; and Serbian spruce (P. omorika) from Jugoslavia. Plantings were made on the Nicolet National Forest in northeastern Wisconsin, the Superior and Chippewa National Forests in northern Minnesota, the Hiawatha National Forest in Upper Michigan, and

the Huron National Forest in Lower Michigan. The severe drought and heat conditions during the summer of 1936 largely eliminated the plantings on the Chippewa, Hiawatha and Huron National Forests and caused considerable mortality in the Superior National Forest planting. That on the Nicolet escaped with relatively light injury, largely because it was protected by an aspen overstory.

The Nicolet planting has demonstrated the unsuitability of the red, Sakhalin, Serbian and oriental spruces for this locality and some distinct differences in growth, survival, and hardiness among the several sources of white and Norway spruces. The unfavorable winter of 1947-48 caused no damage to western white spruce, and northern sources of white spruce. All Norway spruces suffered more needle damage than any of the white spruces, but trees of northern sources suffered less than those from milder climates. In spite of severe defoliation, however, there was little or no mortality in any lots. Fifteen years after planting, the white spruces generally looked better than any other species. Some Norway spruce lots have done quite well, although weevil injury is becoming more general among them.

In 1941, stock of 12 European sources of Norway spruce, received from the International Union of Forest Research Organizations, was field-planted on the Chippewa National Forest in Minnesota and the Manistee National Forest in Lower Michigan. Sources ranged from Norway south to Switzerland and east to Jugoslavia, Romania, and Poland.

During the open winter of 1943-44 most of the lots on the Chippewa National Forest suffered serious mortality. Those planted on the Manistee had survived better and suffered less weevil damage after 11 years in the field than white pines (Pinus strobus) grown with them as check lots. Their growth was less than that of the pine, although two lots were about equal in height to associated white pine.

European Larch

European larch makes very rapid growth in its homeland and in some parts of the eastern United States. It has been planted on farms in the southern Lake States, but information on variations traceable to seed origin has been lacking. To obtain some information on racial variation of this species, stock of 11 sources of European larch (Larix decidua) and one source of Siberian larch (L. sibirica) (grown from seed furnished by the International Union of Forest Research Organizations) was field-planted as 2-1 transplants in the spring of 1949 on the Chippewa National Forest in Minnesota, Nicolet National Forest in Wisconsin, and in Kent County in Lower Michigan. Check lots of native tamarack (Larix laricina) were planted in each block.

Unfortunately, the stock was injured in shipment, so that mortality was severe in Lower Michigan, moderately heavy in Wisconsin, and moderate in Minnesota. In view of this circumstance and the short time since planting, results are not yet available.

Green Ash

In 1934, green ash (Fraxinus pennsylvanica var. lanceolata) seed was collected from $3 trees in 39 localities of North Dakota, South Dakota, Minnesota, Iowa, Nebraska, Kansas, and Oklahoma. In 1935 and 1936, laboratory tests showed that seed from the northwest part of the region produced the most drought resistant plants, while southern and eastern seed produced those least drought resistant.

Stock grown from these seed collections in two nurseries (one in North Dakota and one in Nebraska) exhibited variations as follows: seed from northern areas germinated more slowly and produced stock which was smaller, had smaller, darker green leaves, and grew for a shorter period than did stock from southern areas. Winter &Image in the North Dakota nursery increased almost directly with the southerliness of seed origin. Unfortunately, field plantings of this stock were damaged so that valid follow-up results were not available.

TESTS OF EXOTIC SPECIES

In addition to the seed source projects, the Station since the 1920's has tested over 100 tree species native to Europe, Asia, and other regions of North America, in addition to those included in provenience tests. Those which have the ability to grow under Lake States conditions may have some value in future breeding programs.

The following 60 species have been planted: Austrian, Balkan, Bosnian, Chinese, Corsican, Japanese black, Japanese red, Japanese stone, Japanese white, Korean, limber, lodgepole, pinyon, pitch, Siberian stone, table mountain, western white, whitebark, and Virginia pines; blue, Engelmann, Maximowicz, and Schrenk spruces; Dahurian, Japanese, Korean, and Siberian larches; alpine, Manchurian, Maries, and momi firs; Chinese, Mexican, one-seed, Rocky Mountain, and Utah junipers; oriental arborvitae, baldcypress, bigtree, Douglasfir, European speckled alder; Altai, Asian, white, Dahurian, European white, and Schmidts birches; Russian, Scotch, and Siberian elms; Manchurian linden; Amur and Norway maples; European mountainash, Russian mulberry, osage-orange, Russian-olive, Amur tamarix, Persian walnut, and golden willow. Several other species proved unsuitable in the nursery and were not field-planted.

TREE BREEDING

Tree breeding probably represents one of the greatest opportunities for increasing the productivity of our forests. To be successful, tree breeding must be based on (1) a good understanding of variation within species, and the extent to which it is heritable, and (2) the participation of trained geneticists. Neither were available in the early days of the Station's work.

Sugar Maple

In 1928, an attempt was made at the Upper Peninsula branch to cross-pollinate between bird's-eye maples and at the Forest Products Laboratory in Madison to graft on root cuttings from such trees. Both efforts failed. Seed collected in the fall of 1928 from trees having high and low chances of carrying any hereditary bird's-eye factors were sown at the Upper Peninsula branch, but largely failed to germinate. A large number of cuttings were made in 1929, but the grafting method employed at Madison was unsuccessful. Some observations indicated that the bird's-eye character was closely associated with suppression of young seedlings. The hereditary nature of this character, however, was neither proved nor disproved.

Hybrid Poplars

Because poplars produce wood useful for a number of products, are rapid growing, and many are relatively easy to propagate from cuttings and to hybridize, they have been widely used in tree breeding work. Beginning in 1924, the Oxford Paper Company of Rumford, Maine, in cooperation with the New York Botanical Garden, developed hybrid poplars representing combinations between 34 different species, varieties, and hybrids. Cuttings of 30 clones were sent to the Lake States Station, and field tests were made between 1935 and 1940 in several localities in Michigan, Wisconsin, Minnesota, and North Dakota.

Most of the hybrids grew 5 to 7 feet tall the first year in the nursery, and about 3 feet more when they were left for a second year. Growth was less in the field, averaging about 3 feet per year for the best conditions -- good soil, complete ground preparation, and thorough cultivation the first few years. Under other conditions growth was poor. By the end of 10 years those clones which had shown climatic adaptability either had succumbed to or were on the way out from cankers.

All these hybrids were developed from black poplars and balsam poplars and none from species native to the Lake States. Hardy, fast-growing hybrids doubtless can be developed from other species.

Hybrid Pines

Pines in general are among our most valuable timber trees. Possibilities of increasing their productivity and hardiness through breeding are under investigation at the Institute of Forest Genetics, Placerville, California.

Early in 1950 the Institute sent seed of 10 hybrids to the Lake States Station. Included were 5 hybrids of western white pine (Pinus monticola) and eastern white pine (P. strobus) and 5 hybrids of lodgepole pine (P. contorta var. latifolia) and jack pine (P. banksiana). Stock of the latter hybrids grown in the Hugo Sauer Nursery at Rhinelander will be planted in three localities (one each in Michigan, Wisconsin, and Minnesota) in the spring of 1953. Stock of the parent species, including one of local origin, will be planted along with the hybrids. Stock of the white pine hybrids will be planted in 1954.

AN EVALUATION

Since its establishment the Lake States Forest Experiment Station has made seed source studies of eight forest tree species and field tests of about a score of exotic tree species. It made some early attempts at breeding sugar maple, has field-planted stock of 31 hybrid poplars, and has stock of 10 hybrid pines in the nursery in preparation for field testing.

In view of the immense amount of work needed in forest genetics these studies do not loom large. Yet they have already made some contributions, and because of their long-time nature will yield more. They have demonstrated racial variation in red pine, Scotch pine, ponderosa pine, white spruce, Norway spruce, and green ash. They have also illustrated the unsuitability of a number of hybrid poplars for this region. Results have emphasized the need for replication of field tests in a number of localities to avoid unpredictable losses. Finally, these studies have pointed to the need for a great deal more research in forest genetics in the Lake States.

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