

RECENT ADVANCES IN FOREST TREE IMPROVEMENT
IN THE LAKE STATES

Forest Tree Improvement Activities

at the Lake States Station During the Past Two Years

by Robert D. McCulley¹/

The genetics work at the Lake States Station comes in several different packages. During the past 2 years laboratory and greenhouse facilities have been completed at the Hugo Sauer State Forest Nursery near Rhineland, Wis., and our geneticist, Hans Nienstaedt, has moved there from St. Paul. This Northern Institute of Forest Genetics is the current location of a part of the work to be reported. Progeny tests dating back as much as 25 years are maintained by the Station's centers for research at East Lansing, Mich., Marquette, Mich., Wausau, Wis., and Grand Rapids, Minn. The work at these field stations is included. Also included is the work of the Forest Diseases Division in St. Paul on races of white pine blister rust.

Research Under Way During Past Two Years

I'll begin by outlining the physiological studies now being made as the most recent component of the Station's program. From there I'll move on to the white spruce project, the species currently receiving the most emphasis. Then there are several items in connection with seed source tests and other outplantings. And finally brief mention will be made of the study of races of white pine blister rust.

Physiology

The emphasis in this phase of the program is on auxin metabolism. In the preliminary stages of the initial studies, problems developed in applying standard procedures of bio-assay. Resin contamination proved more serious than expected. Work on now or different techniques therefore is a necessary prerequisite to advancement in this project. Studies under way that are dependent on auxin assay are:

1. A study of the role of an auxin inhibitor (TIBA) on root formation and elongation. Work was begun on this problem because vegetative propagation is at present a limiting factor in studies of many species. A better understanding of the mechanism of rooting should lead to more effective use of the various means of stimulating root development that now show promise or have been effective with some of the less difficult species.

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2. A study of the role of auxin in the initiation of flowers and in sex expression of forest trees.
3. A study of the role of auxin in the transition from springwood to summerwood. Collections at intervals during the growing season will relate auxin concentration to the type of wood being formed.

White Spruce

We have a 1936 planting that includes seven sources from the Lake States, Ontario, and the Black Hills. Collections for a more comprehensive study of racial variation in white spruce have been completed with the exception of three Canadian and one U. S. source. Twenty-eight sources are involved, covering the botanical range of the species. Seed will be sown in the nursery in spring, 1958. Tests of seven collections made in 1955 showed marked differences in seed dormancy between sources.

Studies of the characteristics of spruce and of the techniques that are well adapted to use in genetics research on spruce have been made to provide the basis for future work on this species group. One of these has to do with fall grafting of material obtained at the time of seed collection. Aids to success at this season were studied in 1956. Black spruce and Norway spruce were included, in addition to white spruce. Day length and temperature for the stock plants were varied both before and after grafting. Results:

1. Pretreatment seemed to have little effect on survival of the grafts provided the stock plants were maintained in good growing condition throughout the summer.
2. Treatment after grafting had a marked effect on survival. Radical changes in the physiology of the plant brought on by treatment were associated with low scion survival.
3. Growth of the scions was little affected by pretreatment but markedly affected by post-grafting treatment. Chilling for about 8 weeks is necessary to break dormancy and produce maximum growth. Long day compensates in part for lack of chilling.

A similar study with more vigorous root stock showed better overall results. Tests of the uses of day length variations and low temperature to stimulate early and long-sustained growth of white spruce seedlings were made in 1956. If successful, such treatments could make it possible for seedlings to go through 2 or more normal growth cycles in 1 year's time and thus hasten their development to certain desired stages. Preliminary results indicate that 4 to 6 weeks' chilling at 36° F. is sufficient to overcome dormancy completely. Long-day treatment (20 hrs.) compensates for chilling but the breaking of dormancy is considerably delayed.

In 1956 the Station began a study of white spruce with the threefold objective of determining and describing (1) the first appearance of primordial male and female flowers and their development through one complete cycle, (2) determining and describing the developmental stages in flower formation during the period of pollination, and (3) the time interval between pollination and fertilization. Observations were made and material collected at specified intervals from early spring to late fall. Microscopic examination of this material has given some basis for early identification of male flowers, female flowers, and vegetative buds. Observations are being continued during 1957 and more complete analyses of material will be made.

A study of the effect of gross climatic changes over short geographic distances on the development of ecotypes in white spruce is under way. In the Upper Peninsula of Michigan there is a range of average frost-free season from 80 to 140 days within a distance of 40 miles. Nineteen seed sources have been collected within this area and these are undergoing preliminary testing under controlled conditions in the greenhouse.

A study of controlled pollination, was made in 1956:

1. To determine the most, effective bag type or combination.
2. To determine the developmental stage at which female strobili show greatest receptivity.
3. To make preliminary observations on species and self-compatibility.
4. To develop techniques for overcoming species incompatibility.
5. To work out control methods for cone insects.

Results showed that:

1. A combination of sausage casing and kraft bags was best.
2. Female flowers were receptive to pollination for a maximum of 5 days beginning at the first pollen shedding.
3. Several interspecies crosses yielded seed
4. None of the hormones tested overcame species incompatibility.
5. Lindane gave partial. control, of cone insects,

A modified repetition of the study was made in 1957 but was limited by poor flower production.

A part of the white spruce project but also bearing on work with other species is the selection of superior trees on the national forests. After the publication of the Guide for Selecting Superior Forest Trees and

Stands in the Lake States,^{2/} the national forests in the region were asked by the Regional Forester to supply data on trees that they believed were in the superior category. Two forests have sent in these descriptions and the trees have been checked in the field. Continued and widespread participation by management foresters is required and requested to make this phase of the program fully successful. The selected trees will be used in studies of variation, the inheritance of tree characteristics, and seed orchard and breeding techniques.

Progeny Tests and Other Miscellaneous Studies

As noted before, some of the outplantings now under observation were made in the early thirties. Among these are seed source installations for red pine with plots remaining in two areas of northern Minnesota. The problems of thinning, accentuated by a row-by-row arrangement of sources, have been argued back and forth in connection with one of these tests. In general, it is a reminder to us that progeny testing needs thorough planning, wise decisions on the necessary compromises on objectives, and a fair measure of good fortune.

The regional seed source study of jack pine seems to be off to a good start. The plantings the Station is maintaining close check on have had good survival with one exception. No attempt has been made to compare sources at this early date and no differences have been so prominent that they excited comment from field examiners. A few minor insect attacks have been reported.

Sixteen sources of white pine seed have been assembled from throughout the botanical range of the species as part of an inter-regional seed source study in cooperation with the Southeastern, Northeastern, and Central States Forest Experiment Stations, and the Ontario Department of Lands and Forests, Seeding in the nursery is scheduled for next spring.

The Station succeeded in obtaining a number of Russian and Siberian sources of Scotch pine, Norway spruce, and a number of other species in a recent seed exchange. They were sown in the spring of 1957 and are developing well in the nursery. The sources of Norway spruce will help to round out an older study of this species.

Older plantings that are remeasured periodically include:

- a. Scotch pine seed sources
- b. Norway spruce seed sources - International Union
- c. European and Siberian larch sources

^{2/} Prepared by Paul O. Rudolf of the Lake States Forest Experiment Station with the assistance of the Subcommittee on Tree and Stand Selection, and published by the Lake States Station (Station Paper No. 40, 1956).

- d. Hybrid poplars
- e. Eastern x western white pine hybrids
- f. Jack pine x lodgepole pine hybrids
- g. Some 65 exotic tree species from random sources

Blister Rust Races

Research on blister rust races was begun informally at the University of Minnesota in 1950. Limited financing was furnished by the U. S. Department of Agriculture in 1951. The Station entered the picture in 1952 when Ralph L. Anderson joined the staff. In 1955 evidence of racial difference was found on a species of Ribes.

Subsequent research has confirmed the initial evidence of racial differences. Preliminary evidence of possible racial variation has been noted on other Ribes species.

The next step is to determine whether racial differences also show up on the pine host. For this purpose clonal lines are being built up through grafting. A good start has been made with: Eastern white pine of a Lake States source, Korean pine, limber pine, and Balkan pine. We hope to add clonal lines of the following: A northeastern source of eastern white pine, a rust-resistant selection of eastern white pine, a normal western source of western white pine, and a rust-resistant selection of western white pine. Tests on pine hosts will begin in the immediate future.

Plans

The outlook for genetics research at the Lake States Station in the period just ahead includes considerable development work. However present facilities are good and there are only the normal problems lying in the way of improving them.

The emphasis on spruce will continue for a number of years. Problems in connection with other species are enticing and cannot all be taken care of by other research agencies in the region. No doubt variety will creep in more rapidly than the financing to take care of it.

There is a feeling of optimism on our part due to the quality and not the quantity of our research staff and because of a formally recognized program established in a field that received only sporadic attention in the past.