

TREE GENETIC AND IMPROVEMENT RESEARCH AT THE UNIVERSITY OF MINNESOTA

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The School of Forestry's Tree Improvement Research Project was initiated in 1955. Studies in this area during the past fourteen years have been designed to accumulate information on genetic diversity in native and exotic tree species and isolate genetically superior lines for direct use in Minnesota forest plantings or for further selective breeding. Nursery facilities and outplanting cooperation have been provided chiefly by the University's North Central Experiment Station and the Blandin Paper Company at Grand Rapids, the Cloquet Forest Research Center at Cloquet, and the USDA Forest Service Nursery at Eveleth, Minnesota. Indispensable cooperation has also been provided by the University's Departments of Horticulture, Plant Pathology, Entomology, Fisheries, and Wildlife; the North Central Forest Experiment Station of the USDA Forest Service; The Quetico-Superior Wilderness Research Center; the Minnesota Conservation Department, and other institutions.

Most of the studies carried on under the Tree Improvement Project are conducted by graduate student assistants as part of their graduate training program. In most cases the results

obtained from these investigations are also used as the basis for their degree dissertations. Aside from purely research objectives, the Tree Improvement Project thus serves a useful graduate training and educational function. Twenty-nine graduate students have thus far participated in the Tree Improvement Project.

Major effort to this point has been directed to provenance experiments. During the past 10 years this work has been greatly facilitated by our participation in a cooperative Regional Research Project (NC-51: Forest tree improvement through selection and breeding) sponsored by the U.S. Department of Agriculture. Seed source experiments of 14 North Temperate Zone species have been established in more than 30 permanent outplantings throughout the State.

Results from the older experiments (e.g., white spruce, Scotch pine and Japanese larch) have provided information on the best adapted seed sources for direct use in various localities throughout Minnesota. Some of these species have now reached sexual maturity and our future research will be increasingly directed to selective breeding studies within and between the most promising sources.

Details regarding some of the studies are presented in the material describing the Conference Field Trip.

¹ *This was prepared by Professor Pauley prior to his death, April 18, 1970.*

FIELD TRIPS
TREE IMPROVEMENT PROJECT
SCHOOL OF FORESTRY, UNIVERSITY OF MINNESOTA

D. M. Gunn Memorial Park

D. M. Gunn Memorial Park is located on the west side of Prairie Lake, about four miles north of Grand Rapids on State Highway 38. The park was established in 1956 by the Charles K. Blandin Foundation and was designed primarily for recreation. However, the north portion of the park was designated as a tree improvement research and demonstration area. The first outplantings were made in 1956.

Japanese Larch (*Larix Leptolepis*)

Seed Source Study

This outplanting of seven Japanese larch sources was established in cooperation with Michigan State University in 1960 as a part of the North Central Region Forest-tree Improvement Project (NC-51).

Initial mortality of the 2-0 seedlings was high (46 percent) necessitating replacements with 2-2 stock in 1962 which resulted in high survival. A single border row of European larch (*L. decidua*) surrounds the plantation and a number of failed spots have subsequently been replaced with sources of native tamarack (*L. laricina*).

Height measurements have indicated significant differences among sources but no apparent relationship between growth and latitude, longitude, or elevation of parent stands was found. Such a random pattern of geographic variation is not unexpected since the native range of the species is restricted to approximately 140 square miles on Honshu Island where it is found in small discontinuous populations.

Several trees were damaged or killed by sunscald in the winter of 1967-68 and Japanese larch is susceptible to the endemic larch sawfly (*Pristiphora erichsonii*) which was found and controlled in the plantation during the current season. In spite of these shortcomings the rapid growth of Japanese larch gives it considerable potential for use in Minnesota.

White Spruce Seed Source Study

This test plantation was established in 1962 in cooperation with the North Central Forest Experiment Station of the USDA Forest Service.

The study consists of 25 white spruce seed sources and a single Itasca County black spruce source. The stock was 2-2 when planted. Mortality has been less than 1 percent.

Height growth of the sources represented clearly indicates that high latitude or high altitude short growing season sources (e.g., Alaska and Montana) are the slowest growing. Best growth has been made by an eastern Ontario source (Beachburg, Ontario) which was significantly better than the next best which are local (Itasca Co.) sources (table 1).

The plantation has been sprayed annually in late June or early July during the past several years to control the yellow-headed spruce sawfly (*Pikonema alaskensis*). This insect is a locally serious pest of open-grown white spruce in this area. A duplicate of this plantation established at Cloquet where no control was practiced indicated no apparent variation in susceptibility among the white spruce sources. The black spruce plots in this planting were, however, ignored by the sawfly.

Forest Tree Improvement Arboretum

During the period 1956-57 the School of Forestry established a Breeding Arboretum at Gunn Memorial Park. The collections consist chiefly of seed sources of *Populus* and *Betula* species, including varieties and hybrids and serve as a reservoir of potentially useful genes.

North Central Experiment Station Nursery University of Minnesota

A portion of the North Central Experiment Station Nursery has been used as the principal propagation area of the Tree Improvement Project since 1955. The Nursery is under the supervision of Professor William H. Cromell.

Dwarf Jack Pine (*Pinus banksiana*) and Eastern White Pine (*Pinus strobus*)

This study of seed-transmitted dwarfism in jack pine and white pine is being carried on in cooperation with Albert G. Johnson of the University's Horticulture Department, St. Paul Campus.

Table 1.—Gunn Park, Plantation B (1962) white spruce seed sources (ranking by Duncan's Multiple Range Test based on height in autumn 1966 at 9 years from seed)¹

Acq. No. :	Seed Source Location :	Height :
		cm.
1663	Beachburg, Ontario	140
1647	Third River Rd., Itasca Co., Minnesota	127
3512	Itasca Co., Minnesota	125
1644	Adirondack Mountains, New York	119
1669	Grand Rapids, Minnesota	119
1662	Ashley Mines, Bannockburn, Ontario	117
1645	Monico, Wisconsin	116
1649	Coos County, New Hampshire	111
1655	Bangor, Maine	111
1660	Maniwaki, Quebec	111
1676	Huron National Forest, Michigan	110
3511	Itasca Co., Minnesota	105
1631	Spruce Woods Reserve, Manitoba	104
1659	Edmonston, New Brunswick	104
1661	Chicoutimi + St. Joan's City, Quebec	104
1687	Kakabeka Falls, Ontario	101
1664	Flin Flon, Manitoba	84
1628	Black Hills, South Dakota	83
1686	Moosonee, Ontario	83
1658	Lake Melville, Labrador	71
1665	Stony Rapids, Saskatchewan	66
1677	Summit Lake Region, Fort McLeod, B.C.	61
1657	Port Hope Simpson, Labrador	57
1654	Fort Yukon, Alaska	42
1653	Gerstle, Alaska	41
1630	Lewis & Clark National Forest, Montana	39

^{1/} All seed sources are white spruce except 3512 which is black spruce.

A normal-dwarf ratio of 1:1 characterizes the segregation ratio of plants grown from open pollinated witches' broom seed of jack pine and white pine (table 2). In the absence of any evidence that the witches' brooms tested were due to a pathogen, the conclusion has been made that the observed segregation was genetically determined since such a 1:1 segregation ratio was that to be expected from a simple Mendelian dominant gene for dwarfism when fertilization is accomplished by normal pollen. This hypothesis is supported by the observed total absence of male strobili on the brooms studied.

In all segregating populations the distinction between normal and dwarfed trees was sufficiently clear to permit classification during the first season of growth. Aside from the gross differences characterizing dwarf and normal seedlings, there is a distinct difference between the progeny of different brooms. These differences are reflected chiefly in the height and crown density of the seedlings.

Blackberry Experimental Area

This experimental area, established by the Blandin Paper Company in 1960, is located about

5 miles southeast of Grand Rapids on the south side of U.S. Highway 2.

Scotch Pine Seed Source Study

Scotch pine (*Pinus sylvestris*), a native tree of Europe and Asia, has the most extensive natural distribution of any pine species in the world. It is the most important pine species throughout most of its natural range, especially in northern Europe, where it is used chiefly for lumber, piling, and pulpwood. Scotch pine has been grown in Minnesota for many years as an ornamental and in recent years has gained wide acceptance as a Christmas tree.

The seed source outplanting at the Blackberry Experimental Area was established in 1962 with 2-1 stock supplied by Michigan State University. The planting represents one of the approximately 50 similar outplantings of Scotch pine seed sources in the North Central Region of the United States established under a Cooperative Regional Research Project (NC-51) sponsored by the U.S. Department of Agriculture. A summary of results based on measurements made in September 1966 (at which time the trees were eight years old from seed) is shown in table 3. The results may be briefly summarized

Table 2.—Chi-square tests of goodness of fit to a 1 : 1 ratio for normal - dwarf segregates of open-pollinated jack pine brooms

Broom No. -	Year tested -	Nursery (N) or Greenhouse (GH) :	Survival :	Normal 1-0 seedlings :	Dwarf 1-0 seedlings :	Chi-Square :	Probability (1 d.f.) greater than :
			Percent	Number	Number		
1-1957-N	--		--	42	48	0.400	0.50
1-1961-N ^{1/}	--		--	146	132	.705	.30
1-1962-GH ^{1/}	55		55	120	98	2.220	.10
2-1962-GH	75		75	73	77	.107	.70
3-1962-GH	70		70	81	59	3.457	.05
4-1962-GH	68		68	68	67	.007	.90
5-1962-GH	57		57	55	59	.140	.70
1-1962-N ^{1/}	51		51	240	269	1.652	.15
2-1962-N	54		54	128	143	.830	.30
3-1962-N	52		52	125	133	.248	.50
4-1962-N	68		68	181	158	1.560	.20
5-1962-N	61		61	136	168	3.368	.05
All tests:	--		--	1,395	1,411	.091	.70

^{1/} Combined samples of seed from broom No. 1 collected in different years.

Table 3.—Relative height of Scotch pine varieties in autumn 1966 (8 years from seed) Blackberry Plantation A (1962)

Variety and seedlot numbers	Mean height ^{1/} in September 1966	Percent of Plantation mean	Origin
	Cm.	In.	
North European and Siberian varieties			
1. Altaica: 227	111	44	73
			Altai Mts., Siberian USSR
2. Rigensis: 223, 224, 550, 3513	154	61	101
			Latvia, Sweden
3. Septentrionalis: 201, 222, 228, 230, 273, 274, 276, 521, 522, 543, 544, 545	126	50	82
			Norway, Sweden, Finland
Central European varieties			
4. Borussica: 209	186	73	122
			Northeast Germany
5. Haguensis: 252, 253	179	71	117
			West Germany
6. Hercynica: 203, 208, 248, 305, 306, 308, 312	187	74	122
			Southwest Germany, Czechoslovakia
7. Polonica: 211, 317	198	78	130
			Poland
South European varieties			
8. Iberica: 219	86	34	56
			Spain

^{1/} Plantation mean = 153 cm. (60 inches)

by stating that in terms of growth rate and survival the best adapted sources for north central Minnesota are of Central European origin. Spanish sources are not frost hardy in this area.

Extreme northern sources are slow growing and from the Christmas tree growers' standpoint are undesirable because of a foliage color change from green to various shades of yellow in autumn.