HEIGHT GROWTH PERFORMANCE OF WHITE SPRUCE (PICEA GLAUCA (MOENCH)VOSS) PROVENANCES IN CENTRAL MAINE

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ABSTRACT.--Height growth measurements were made in a range-wide geographic seed source test of white spruce on the Penobscot Experimental Forest, Bradley, Maine, after 10- and 15-growing seasons. After 15 years in the field, 14 of 24 seed-sources exceeded the plantation mean in height growth. Most of the fastest growing seed-sources are from the southeastern part of the range of white spruce. Trees from the more northern sources were poorly adapted to the planting site and had slow overall growth. The local source exceeded plantation mean height growth by 15 percent. Six other seed sources exceeded the mean by 18 to 32 percent. The six tallest seed-sources after 15 years were also the tallest at 10 years and among the 9 tallest at 5 years. Two sources, one from Beachburg, Ontario, and the other from northcentral Michigan were 12 and 15 percent faster growing than the local source. Significant improvement could be made by simply introducing seed from these two sources into the region represented by the test plantation site.

INTRODUCTION

Range-wide provenance tests of many tree species have provided basic information on genetic variation and evolutionary patterns, and they have also been useful in identifying well-adapted and rapid-growing seed-sources for local and wide-spread reforestation. A range-wide test of white spruce (Picea glauca (Moench)Voss) initiated by the Institute of Forest Genetics, USFS, Rhinelander, Wisconsin, that was field-planted in 14 locations across the northern United States and southern Canada has shown that seed-source differences in seedling height growth after five years were highly significant (Nienstaedt 1969).

In this same test, trees from several seed-sources; most notably one from Minnesota, one from Quebec, and two from Ontario grew well on all outplanting sites. Trees from seed collected in the Beachburg area in Ontario grew particularly well with height growth 35 percent better than average. Based on these results

and those from other provenance tests of white spruce (Teich L970) Carlisle and Teich (1971) estimated that. an increase in yield of 15 percent can he obtained by using superior provenances of white spruce for reforestation.

The objective of my study was to evaluate height-growth performance of these range-wide white spruce seed-sources after 10- and 15-years of growth on the Penobscot Experimental Forest in central Maine and to specifically identify those sources that are fast-growing and well-adapted to the New England region.

MATERIALS AND METHODS

The range-wide provenance test plantation on the Penobscot Experimental Forest in Bradley, Maine, (latitude 44.5 N - longitude 68.4°W) contains 24 seed-sources of white spruce originating from Alaska to Maine. A complete description of the origin of these seed sources is presented in Table 1; adapted from Nienstaedt (1969). One source, number 1655, originated on the Penobscot Forest and represents the local source against which the other sources can be compared in growth performance.

The seedlings, received as 2-2 stock from the nursery in Rhinelander, Wisconsin, were field-planted in 1962. The plantation location is an open-field site, and the seedlings were planted on the existing sod which received no prior or subsequent preparation, weed control, or fertilization. The plantation design is a 10-block randomized block design with 4-tree-square-plots. Trees were spaced at 6' x 6'.

I measured height growth in the fail of 1971 and 1976; the end of the tenth and fifteenth growing seasons in the field. Each set of data, including 5-year height (Nienstaedt 1969), was analyzed by an analysis of variance using a least-squares analysis with unequal subclass numbers based on plot means. A one-way analysis of cross products was used to obtain seed-source and individual tree correlations between height growth at 5-, 10-, and 15-years.

RESULTS AND DISCUSSION

Fifteen year survival and mean height growth at 10-, and 15-years for each seed source are listed in Table 2. Height growth is also expressed as a percentage of the plantation mean and as a percentage of the height of the local seed source (1655) at both ages.

Table 1.--White spruce seed source locations.

Seed source number	State or province	Latitude ° N	Longitude ° W	Number trees in sample [a]
1628	S. Dakota	44-10	103-55	13
1630	Montana	46-48	109-31	5
1631	Manitoba	49-51	99-30	S
1644	New York	44-23	74-6	10
1645	Wisconsin	45-41	89-7	10
1647	Minnesota	47-33	94-10	2
1649	New Hampshire	44-51	71-26	10
1653	Alaska	63-45	144-53	S
1654	Alaska	66-35	145-11	1
1655	Maine	44-50	68-38	15
1657	Labrador	52-36	56-26	S
1658	Labrador	53-46	60-05	S
1659	New Brunswick	47-50	68-21	S
1660 [b]	Quebec	46-32	76-30	S
1661	Quebec	48-18	71-22	S
		48-13	71-38	S
1662	Ontario	48	81	S
1663	Ontario	45-44	76-51	S
1664	Manitoba	54-39	101-36	S
1665	Saskatchewan	59-19	105-59	S
1669	Minnesota	47-33	94-8	6
1676	Michigan	44-30	83-45	17
1677	British Columbia	54	123	S
1686	Ontario	52-15	81-40	25
1687	Ontario	48-30	89-30	S

[a] indicates stand collection from many parent trees.

[b] This seed source includes samples from two areas.

Table 2.--Fifteen-year survival and mean height growth after 10-, and 15-years for range-wide seed sources of white spruce growing in central. Maine.

Seed source number	State or province	Survival (percent)	[a] 10-year height			15-year height		
			Mean (meters)	Percent of plantation mean	Percent of local source	Mean (meters)	Percent of plantation mean	Percent of local source
1628	S. Dak.	70	1.27	80	68	2.50	83	72
1630	Mont.	70	0.90	57	48	1.76	58	51
1631	Man.	75	1.68	106	90	3.32	110	96
1644	N. Y.	70	1.77	112	95	3.46	115	100
1645	Wis.	95	1.95	124	105	3.56	118	1.03
1647	Minn.	87	1.78	113	96	3.39	112	98
1649	N. H.	75	1.82	116	98	3.66	121	106
1653	Alaska	55	0.81	51	43	1.62	54	47
1654	Alaska	47	0.66	42	35	1.15	38	33
1655	Me.	82	1.86	118	--	3.46	115	--
1657	Lab.	72	0.98	62	53	1.93	64	56
1658	Lab.	75	1.36	86	73	2,56	85	74
1659	N. B.	75	1.96	125	106	3.63	120	105
1660	Que.	92	2.01	127	108	3.62	120	105
1661	Que.	62	1.56	99	84	3.04	101	88
1662	Ont.	75	1.68	106	90	3.18	105	92
1663	Ont.	77	2.15	136	116	3.86	128	112
1664	Man.	67	1.37	87	74	2.67	88	77
1665	Sask.	55	1.02	64	55	1.98	66	57
1669	Minn.	85	1.74	110	94	3.38	112	98
1676	Mich.	70	2.17	138	117	3.97	132	115
1677	B. C.	77	1.31	83	70	2.64	87	76
1686	Ont.	90	1.57	100	85	2.98	99	86
1687	Ont.	82	1.68	106	90	3.32	11.0	96

[a] Variation among seed-source means are significant at the .01 level.

Average survival for the entire plantation was 74 percent. Girdling of several trees of each seed source by label wires is responsible for much of the mortality but has not affected survival comparisons between seed sources. The two sources from Alaska and one source each from Quebec, Manitoba, and Saskatchewan had the poorest survival: 47-67 percent. Survival in the remaining sources was 70 percent or higher.

Seed-sources differences in height growth were highly significant after 10 and 15 years (Table 2) and after 5 years; data from Nienstaedt (1969). Seed-source variation was 51 percent, 59 percent, and 65 percent of the total variation after 5-, 10-, and 15-years, respectively. Most of the fastest growing seed-sources are from the southeastern part of the range of white spruce. Trees from the more northern sources were poorly adapted to the planting site and had slow overall growth. The western sources from South Dakota 1628, Montana 1630, and British Columbia 1677 were also slow growers.

After 15 years in the field, 14 of the 24 seed-sources exceeded the plantation mean in height growth. The local source (1655) exceeded the plantation mean height by 6 percent at 5-years (Nienstaedt 1969), 18 percent at 10-years, and 15 percent at 15-years. However, six other seed sources exceeded the mean by 18 to 32 percent at 15 years.

Two sources, one from Beachburg, Ontario, (1663) and the other from northcentral Michigan (1676) were 12 and 15 percent faster growing than the local source at 15 years. At 5-years the source from Beachburg was 35 percent above the average at all fourteen plantation locations, and it was the first or second fastest growing source in eleven of these plantations (Nienstaedt 1969). The source from Michigan was only 16 percent above the average over all fourteen locations at 5-years, but it grew extremely well at one location in Minnesota, two in Michigan, and one of two sites in New Brunswick, Canada; the closest site to the Penobscot Forest Plantation.

The other four sources that exceeded the local source in height growth were 1649 from New Hampshire, 1669 New Brunswick, 1660 Quebec, and 1645 from Wisconsin. However, only the mean height of the sources from Michigan and Beachburg, Ontario, were significantly different from the height of the local source at the 5 percent level of probability.

Selection of the fastest growing seed-sources at 15-years could have been made at 10-years or even 5-years. The six tallest seed-sources after 15-years were also the six tallest at 10-years, and they were among the nine tallest at 5-years.

Correlation coefficients between height growth at 15-years and 10-years for seed-sources and individual trees were .99 and .96, respectively; and .97 and .74 at 15-years and 5-years.

Significant improvement of height growth in white spruce in New England could be made by simply introducing seed from the Beachburg, Ontario, source (1663) and the Michigan source (1676) into the region represented by the test plantation. Lester (1973) has recommended the introduction of seed from the Beachburg source into the Lake States as a method of improvement of white spruce in that region. Further gains could be made by selecting the fastest growing trees of the best seed-sources. Another possibility would be to start tests of new selections made in the region of origin of the best sources (Nienstaedt 1969).

Seed from the Beachburg source is not available in Ontario; but in order to insure a supply of seed, agencies, universities, and private companies in the Lake States are developing provenance seed orchards of source 1663. Beginning in 1970, the Minnesota Department of Natural Resources, the Blandin Paper Company, and Potlatch developed grafts of Beachburg source 1663 from Lake States test plantations. Potlatch and Blandin Paper Companies established their clonal orchards and the Minnesota Department of Natural Resources started planting grafted trees in 1977. The University of Wisconsin and Wisconsin Department of Natural Resources have established a progeny test-seedling seed orchard with open-pollinated southeast Ontario progenies and some outstanding Wisconsin parents provided by the Institute of Forest Genetics, Rhinelander, Wisconsin.

CONCLUSIONS

The range-wide provenance test of white spruce has served the dual purpose of determining patterns of geographic variation and identifying sources of potentially superior seed. The local source is not always the best for rapid growth. A source from Michigan was the fastest growing in Maine and also grew fast in New Brunswick, Canada. The source from Beachburg, Ontario, also grew rapidly and has a proven track record in several locations. Collection of seed from these two sources for reforestation or establishment of seedling seed-orchards, or collection of scions for grafting into clonal orchards should be an integral part of any improvement program for white spruce in New England.

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