PERFORMANCE OF NORTHERN WHITE-CEDAR IN CENTRAL ILLINOIS

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ABSTRACT.--Growth and survival of 20 provenances of northern white-cedar in the nursery and to age 12 in 3 test plantings in east central Illinois were examined. Survival at age 12 exceeded 95 percent in all tests. Total height differed significantly among provenances at age 4 in the nursery and at greater ages in all tests except after the first and second growing seasons following extensive and severe foliage injury during the winter of 1970-71. Height rankings of provenances varied between test sites and with age on the same site. Provenances from isolated occurrences south of the main range of the species were shortest at age 12. Lack of a well defined geographic pattern of variation may reflect the influence of localized lowland and upland ecotypes. The excellent performance of the species in all tests supports its use for a variety of types of barrier and shelter plantings.

Northern white-cedar (Thuja occidentalis L.) is widely distributed on a variety of lowland and upland sites in southern Canada from Manitoba to Nova Scotia and in the United States and northeastern Minnesota, northern and eastern Wisconsin, northern and central Michigan, New York, and northern New England. It occurs locally in Illinois, Indiana, Ohio, southern New England, and in the Appalachian Mountains from western Pennsylvania to eastern Tennessee and western North Carolina. Its occurrence in Illinois is limited chiefly to bluffs and cliffs of St. Peter sandstone in extreme northeastern portions of the State and occasionally to rock outcroppings along the Illinois River in LaSalle County. From an 1853 record, it is known to have occurred as far south as Peoria (Jones 1963).

The first range-wide provenance study of northern white-cedar was initiated by Scott S. Pauley in 1964 when he obtained seed collections from 32 stands located throughout the botanical range of the species.

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Seed of various provenances was sown in nurseries in Illinois, Michigan, Minnesota, and Wisconsin for the production of planting stock for tests in these States under the North Central Regional Project NC-51 (currently NC-99).

Early results from these studies suggested to Wright (1976) that northern white-cedar was genetically uniform throughout its range. In contrast, Jeffers (1976) found significant height differences among provenances in a northern Wisconsin and a western Upper Michigan planting 9 years old. He concluded that genetic variation does exist in the species, at least in terms of height growth. On the basis of his finding of no significant differences in the nursery and those of Wright, he speculated that genetic differences may not be expressed when trees are grown under optimum conditions.

This paper reports on the performance of 20 provenances through age 12 in Illinois.

MATERIALS AND METHODS

Three field tests were established in east central Illinois with planting stock raised in the Mason State Tree Nursery, Havana, Illinois. Twenty seed lots were stratified in moist sand at 36-40°F for 40 days prior to being sown on April 11, 1965. The seedbeds were mulched with 1 to 2 inches of well rotted sawdust and maintained as a regular production bed. Germination and yield of 2-0 seedlings varied greatly among provenances; however, these differences were not measured because the quantity and undoubtedly the quality of seed sown varied among provenances. The seedlings were lifted and transplanted into regular nursery beds in a randomized complete block design with three replications on May 17-18, 1967. Total heights of 10 transplants in each plot were measured to the nearest .05 feet before lifting in April 1969.

A 3-row windbreak was established with 2-2 bare root transplants on Drummer silty clay loam (Typic Haploquoll) in the Illini Forest Plantations, Urbana, in April 1969. Trees were planted 6 feet apart in rows spaced 9 feet apart. Each of the 20 provenances was represented by a 6-tree plot in two rows oriented diagonally across the break in each of four replicates. The remaining nursery stock was planted in a nearby holding plot.

A second test, a 3-row audio-visual screen, was established in April 1970 with 2-2-1 stock with intact soil balls, on Sidell silt loam (Typic Argiudoll) and Flanagan silt loam (Typic Aquiargiudoll) on the University Veterinary Research Farm located one-third mile east of the first test. Trees were planted 10 feet apart in the two outer rows and 5 feet apart in the middle row. Rows were spaced 8

feet apart. Each provenance was represented by a 4-tree plot--a row of three trees oriented diagonally across the screen plus an additional tree in the center row at 5 feet spacing. The provenances occurred in up to six replicates if stock was available. Data for only the 17 sources that occurred in the first five replicates (the sixth replicate was destroyed by herbicidal drift from an adjacent field) are reported herein.

The stock remaining in the holding bed was planted as 2-2-2 transplants in April 1971 in a visual screen at the Vermilion River Observatory located approximately 30 miles east of Urbana. The soil, a Vance Silt Loam (Typic Hapludalf), is a timber soil in contrast to the prairie soils of the other tests. Trees were planted with intact soil balls around their roots. Various numbers of trees of 16 provenances, totaling 264, were planted completely at random at a 7-foot spacing in an outer row of a multi-row planting.

Weeds were controlled by mulching or disking the first growing season and subsequently by one or two mowings annually.

Total heights of surviving trees were measured annually except after the first growing season in the Veterinary Research Farm Test, and at ages 9 and 11 in all field tests.

RESULTS AND DISCUSSION

Survival

Tree survival at 12 years of age averaged 99, 98, and 96 percent in the Illini Forest, Veterinary Research Farm and Vermilion River Observatory plantings, respectively. All the mortality was attributed either to pilferage or mowing accidents, so it can be concluded that all provenances survived equally well. Sporadic bagworm infestations have been sufficiently severe on occasional trees to suggest that bagworms might cause lasting crown injury or death. All trees survived the record drought of 1976 and 1977 without apparent injury.

Winter Injury

The foliage of northern white-cedar is subject to winter injury in Illinois. The most severe injury observed in the test plantings occurred during the winter of 1970-71 when most trees in the Illini Forest Plantation incurred some degree of injury and 30 percent lost at least half their foliage. Severity of injury showed no definite geographic pattern. The most severely injured provenances were southern Ontario (UMN 33), northeastern Vermont (UMN 17), and Illinois (UMN 34). The least severely injured provenances were central Minnesota (UMN 18), northern Ontario (UMN 40), and western Upper Michigan (UMN 32). Winter injury was much less extensive on the better drained, more exposed site on the Veterinary Research Farm. In subsequent years,

only minor, isolated instances of winter injury have been noted except during the winter of 1976-77 when most trees in the Vermilion River Observatory test suffered light to moderate injury. The buds were not injured, so all trees recovered.

Total Height

Total height growth in the test plantings has equaled or exceeded that of red, white, and Scots pine on adjacent sites at comparable ages. Contrary to earlier results from tests in the Lake States, significant differences were found at 4 years of age in the nursery and at greater ages in field tests. These significant differences occurred under near optimum growing conditions, but they were obscured after the first and second growing seasons following the winter of 1970-71 when winter injury was unusually severe (table 1).

Table 1.--Significance of differences in total height among provenances

Plantation	Age (years)						
	4	5	6	7	8	10	12
Nursery	**	-	-	-	-	-	-
69-2	-	**	**	NS	NS	*	**
70-4	-	-	-	NS	*	**	**
71-1	-	-	-	-	**	**	**

* Significant at .05 level of probability.
** Significant at .01 level of probability.

Although significant differences were found, ranking of provenance means varied from test to test. Simple correlation coefficients, computed from provenance means at age 4 in the nursery, age 2 in three central Illinois tests and age 9 in a Wisconsin and a Michigan test (Jeffers 1976), are low to moderatly high (.19 - .77) (table 2).

Ranking also varied with age in the same plantation. Changes in rank reflect varying seasonal growth effected by varying environmental factors favoring or disfavoring certain genotypes. A season's growth is a major component of total height at young ages and may be large relative to real differences among provenances, so early results from provenance tests may be less reliable than they are often purported to be. This is illustrated by the change in the relative ranking of two Ontario sources (fig. 1). Trees from northern Ontario source

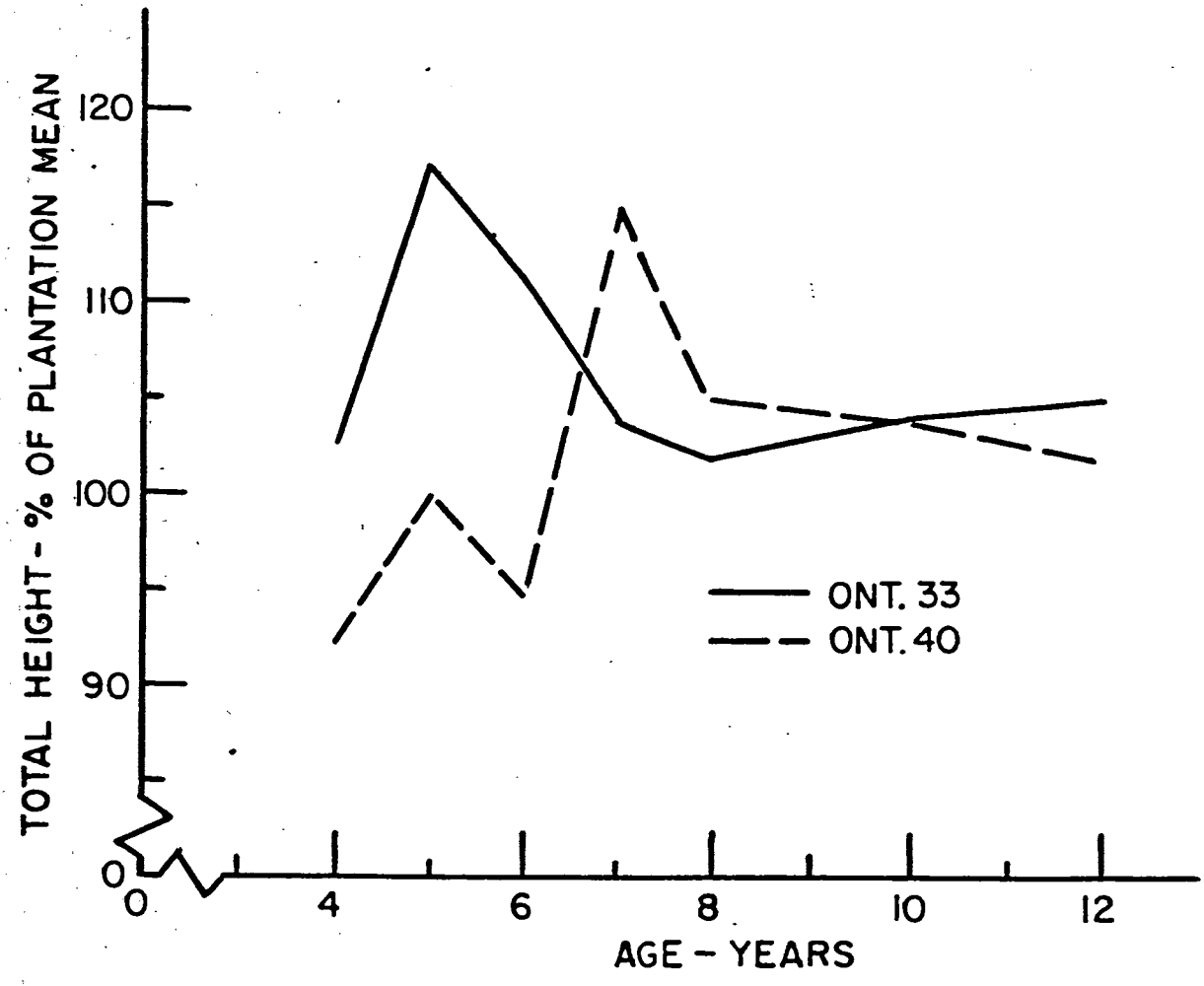

Figure 1.--Relative ranking of provenances with the least (Ont. 40) and the most (Ont. 33) foliage during the winter following the sixth growing season (Illini Forest Plantations).

(UMN 40), which incurred the least foliage injury in the Illini Forest Plantation during the winter of 1970-71 and had previously been one of the slowest growing, was the second tallest after the 1971 growing season. Trees from the southern Ontario source (UMN 33) were the most severely injured.

Table 2.--Between plantation correlations in mean height of provenances expressed as simple correlation coefficients with significance levels

	Nursery (age 4)	69-2	70-4	71-1	Wisconsin
Illinois (age 12)					
69-2	.77*				
70-4	.22	.57**			
71-1	.68**	.73**	.62**		
Wisconsin (age 9)	.20	.40*	.19	.20	
Michigan (age 9)	.26	.49*	.21	.48*	.55**

* Significant at .05 level of probability.
** Significant at .01 level of probability.

Provenance means at age 4 in the nursery and at age 12 in the three field tests, expressed as a percentage of the plantation mean, are given in table 3. Provenances from Washburn County, Wisconsin (UMN 29), Grand Isle County, Vermont (UMN 28), Shawano County, Wisconsin (UMN 21), and Chippewa County, Michigan (UMN 31) were generally the tallest. The first two were among the fastest growing and the last two were average in tests in northern Wisconsin and western Upper Michigan (Jeffers 1976). The slowest growing provenances were from Kenora District, Ontario (UMN 35), Bland County, Virginia (UMN 19), Kane County, Illinois (UMN 34), and Annapolis County, Nova Scotia (UMN 38). The lack of a definite geographic pattern of variation in growth rate and susceptibility to winter foliage injury may reflect the existence of localized lowland and upland ecotypes described by Habeck (1958) and Musselman, Lester, and Adams (1975).

The excellent survival and growth of northern white-cedar in the test planting encourage greater use of this species in Illinois. The dense evergreen foliage and compact crowns create tidy, attractive, living barriers. It would be particularly useful for audio or visual screens, windbreaks, and wildlife cover plantings where space is at a premium.

Table 3.--Relative height of provenances of northern white-cedar in the nursery at 4 years and in three Illinois plantations at 12 years of age

UMN source no.	Seed origin: County	State or Province	Lat.	Long.	Plantation: Nursery	69-2	70-4	71-1
			(deg.N)	(deg.W)	(% of plantation mean)			
19	Bland	VA	37.1	81.1	83	92	93	82
34	Kane	IL	42	88.2	97	93	99	--
37	Herkimer	NY	42.9	75.1	118	105	96	--
33	Blandford Twp.	ONT.	43.3	81	112	105	101	--
36	Clinton	NY	44.6	73.7	95	98	107	97
28	Grand Isle	VT	44.6	73.3	113	103	105	111
21	Shawano	WI	44.6	88.4	105	103	106	115
17	Orleans	VT	44.7	72.0	100	98	96	97 1/
38	Annapolis	N.SCOT.	44.9	65.2	85	90	94	93
30	Somerset	ME	45.6	70.3	106	99	97	95
22	Forest	WI	45.8	88.9	92	102	103	98
29	Washburn	WI	46	92	107	105	111	108
23	Forest	WI	46.0	88.9	98	99	97	97
31	Chippewa	MI	46.3	84.2	105	104	107	108 1/
18	Itasca	MN	47	93	103	99	--	--
32	Houghton	MI	47.1	88.6	104	100	97	92
16	St. Louis	MN	48.0	91.6	103	96	--	--
39	Frost Twp.	ONT.	49.5	84.7	108	103	97	111
40	Gurney	ONT.	49.5	82.2	92	102	107	98 1/
35	Kenora Dist.	ONT.	51.5	90.3	80	94	--	--
Mean (meters)					.40	3.02	3.02	1.86
Probability of >F					<.005	<.01	<.001	<.005

1/ Based on less than 15 observations.

LITERATURE CITED

Habeck, J. R. 1958. White-cedar ecotypes in Wisconsin. Ecology 39: 457-463.

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