

FIFTEEN-YEAR PERFORMANCE OF EASTERN WHITE PINE SEED SOURCE TESTS  
IN THE LOWER OHIO VALLEY

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Abstract .--White pines originating in 16 stands throughout the natural range were outplanted in Illinois, Indiana, and Kentucky. The ranking of the seed sources by growth rate has changed little at successive measurement dates and is also consistent among the three plantations. An extensive collection zone is recommended for white pine seed to be used in Ohio Valley plantings.

Key words: Pinus strobus, provenance, seed-collection-zone.

Eastern white pines of various sources were planted by the former Central States Forest Experiment Station in 1959 as part of a larger study sponsored by the Northeastern Forest Experiment Station. Four-tree plots, replicated 12 times, were established on the Kaskaskia Experimental Forest, Hardin County, Illinois; Hoosier National Forest, Perry County, Indiana; and the Bald Rock Experimental Forest, Laurel County, Kentucky. Total height and d.b.h. of the two tallest trees in each plot were measured after the 1973 growing season.

#### HEIGHT GROWTH

The plantations have grown well; 25-year site index for the tallest seed source calculated at 44, 53, and 54 in Indiana, Illinois, and Kentucky, respectively. The Kentucky and Illinois plantations are growing as well as the average of 78 plantations surveyed by Vimmerstedt (1962) in North Carolina, Tennessee, and Georgia.

Trees originating in the mountains of Tennessee, North Carolina, and Georgia continue to exceed the average plantation height by 8 to 28 percent with an 18 percent average height superiority for the 3 seed sources at 3 locations. But as previously reported (Funk 1971), the relative difference between trees of northern and southern origin continues to diminish (table 1). On the other hand, although a table of relative values may provide a convenient means of comparing plantations, ages, and seed sources, it should not be overlooked that the absolute height advantage of the southern Appalachian seed sources is continuing to increase. For instance, in the Illinois plantation at ages 6, 10, and 15, trees of Tennessee provenance were taller than those from Maine by 3.8, 9.1, and 16.7 feet.

The Michigan trees in our plantations are one year younger from seed than the others and were outplanted at 2+1 transplants. To allow comparison,

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Table 1.--Relative height (seed source mean as a percentage of plantation mean) of white pines from 16 seed sources at successive plantation ages (add 2 years for age from seed)

No.	Seed source	Plantation location										
	Location	North	Illinois			Indiana			Kentucky			
		latitude	age 6	10	15	age 5	10	15	age 5	8	15	
		Degrees										
1	Union Co., Ga.	34.8	126	125	121	119	117	119	124	124	119	
2	Transylvania Co., N.C.	35.2	124	114	108	138	125	114	141	136	115	
3	Greene Co., Tenn.	36.0	143	131	128	128	128	121	129	124	115	
30	Pulaski Co., Va.	37.1	97	93	89	109	105	103	103	101	97	
5	Greenbrier Co., W. Va.	38.0	108	99	103	100	100	98	105	112	109	
16	Ashland Co., Ohio	40.8	120	112	110	117	123	122	115	111	106	
6	Monroe Co., Pa.	41.1	110	110	109	126	124	113	119	115	112	
15	Allamakee Co., Iowa	43.5	73	78	84	84	81	77	72	73	78	
32	Newaygo Co., Mich.	43.5	130 <sup>1/</sup>	126 <sup>1/</sup>	121 <sup>1/</sup>	137	142 <sup>1/</sup>	123 <sup>1/</sup>	154	129 <sup>1/</sup>	119 <sup>1/</sup>	
20	Lunenburg Co., N.S.	44.4	105	110	107	78	84	90	83	87	100	
12	Franklin Co., N.Y.	44.4	85	92	91	77	83	93	74	80	85	
14	Penobscot Co., Maine	44.9	62	70	71	70	67	79	65	72	79	
18	Forest Co., Wis.	45.9	99	101	105	102	109	112	101	106	107	
25	Algoma Dist., Ont.	46.2	74	78	89	76	82	89	76	86	90	
19	Cass Co., Minn.	47.4	76	87	86	74	72	82	63	71	87	
23	Pontiac Co., Quebec	47.5	68	71	78	68	58	64	75	73	82	
Mean height, cm.			142	455	887	90	344	760	105	314	981	
Mean height, ft.			4.7	14.9	29.1	3.0	11.3	24.9	3.4	10.3	32.2	

<sup>1/</sup> Trees of Michigan source 32 are one year younger from seed than the others; where necessary, data were adjusted to equal age.

15-year height and diameter values for the Michigan seed source were computed by adding one year's growth--the average of the past 5 years (Illinois and Indiana) or 7 years (Kentucky). Following adjustment of the Michigan figures, all data were subjected to analysis of variance and statistically significant differences were determined (table 2).

Table 2.--Probability that variation was due to chance

Source of variation	Dependent variable			
	Height (H)	Diameter (D)	H/D	D <sup>2</sup> H
Seed source (S)	.0000	.0000	.0000	.0000
Plantation location (P)	.0000	.0000	.0000	.0000
S X P	.09	.04	.01	.0000

In addition to trees from the three southernmost sources, those from Michigan, Ohio, Pennsylvania, and Wisconsin are notably taller than average in all three plantations. These results tend to confirm the findings of Garrett, Schreiner, and Kettlewood (1973) who tested 15 of these same white pine seed sources (and 16 others) at 13 locations in the Northeast. For latitudes at least as far north as central Pennsylvania, they recommend planting white pine originating in Georgia, Tennessee, North Carolina, southeastern New York, eastern Pennsylvania, and southern Ontario. Their favored Ontario and New York seed sources were not included in our planting, and our Michigan source 32 was not tested in theirs.

#### CONSISTENCY OF PERFORMANCE

The relative ranking of the 16 provenances for total height is quite consistent for these three Ohio Valley plantations. Rank correlation coefficients are .93, .91, and .89 for the Illinois:Kentucky, and Indiana:Kentucky plantation comparisons. The Illinois:Indiana correlation continues to increase with time, having been .87 and .91 at plantation ages 6 and 10 (Funk 1971).

Age:age correlations of rankings for total height are also good in each plantation; no serious mistakes would have been made in an attempt to select the presently 'superior' seed sources at age 5 or 6:

<u>Correlated ages</u>	<u>Illinois</u>	<u>Plantation</u>	
		<u>Indiana</u>	<u>Kentucky</u>
10:15	.98	.96	
8:15			.94
6:15	.97		
5:15		.89	.93

There are at least a couple of anomalies in the growth of these provenance test plantations. It is easy enough to generalize that trees from areas with warm winters and long growing seasons have grown fastest, but as pointed out by Wright (1970), such a simplification could obscure an interesting part of the variation pattern. First, the white pines from Pulaski County, Virginia, have not performed as well as those from the other southern Appalachian sources. Over the past 10 years they have declined from a point of being about 3 percent taller than average to be about 4 percent shorter (in the three plantations considered in this report). The Pulaski County trees have grown relatively poorly wherever planted, from southern Maine (Garrett, Schreiner, and Kettlewood 1973) to western North Carolina (Sluder and Dorman 1971), and we are confident that our results really do represent the growth potential of white pine originating in this stand. Furthermore, these unpredictably slow growing trees may be typical of a fairly large area. In some younger plantings in Michigan, more than half of the white pine collections from the ridge-and-valley section of western Virginia and nearby West Virginia produced trees that were notably slower growing than those from Kentucky, Pennsylvania, Tennessee, and the Carolinas. 2/ A few more years' study may verify that this area should be deleted from the recommended seed collection zone.

The growth of white pine originating in Forest County, Wisconsin, is even more interesting. Far from being an area with warm winters, the frost-free season in Forest County is estimated at only 90 days (Fowler and Heimburger 1969). Nevertheless, trees from this source, about average in height at age 5, have consistently increased their status until they are now about 8 percent taller than the average for the three plantations.

#### VOLUME GROWTH

To obtain an indication of volume growth,  $d^2h$  values were calculated (table 3). Differences in  $d^2h$  are even more pronounced than those for height, with trees of Tennessee origin averaging more than 5 times as much 'volume' as those from Maine or Quebec. Furthermore,  $d^2h$  values are somewhat more consistent among plantations than those for height; rank correlations for the seed sources were .94 for Illinois:Indiana and Illinois:Kentucky, and .97 for Indiana:Kentucky.

#### CONCLUSIONS AND RECOMMENDATIONS

From these findings, as well as those of Garrett, Schreiner, and Kettlewood (1973), it seems reasonable to recommend an extensive collection zone for white pine seed to be planted in the Ohio Valley. The recommended zone is shown in figure 1, and from the present and previous (Wright 1970) findings, seed collected within it should be suitable for use at least throughout Limstrom's (1965) planting zones 5b, 6a, 6b, and 7a, which comprise most or all of Ohio, Indiana, Illinois, Kentucky, and Missouri, and southeastern Iowa. Conservative nurserymen might consider mixing seed from three diverse sources such as 1, 3, and 32. The seedlings produced could be expected to have genetic potential for 70 to 80 percent greater volume growth

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2/ Letter from J. W. Wright, September 12, 1974.

than the species average for eastern white pine, and at the same time contain great genetic diversity and thus a measure of built-in protection against damage by unusual climatic conditions, disease, or insect attack.

Table 3.-- $d^2H$  (d.b.h.<sup>2</sup> x height) of eastern white pine from sixteen seed sources grown in Illinois, Indiana, and Kentucky (seed source mean as a percentage of plantation mean)

Seed source	Plantation location			
	Illinois	Indiana	Kentucky	Mean
1 GA	152	150	174	161
2 NC	124	153	155	143
3 TN	219	194	184	199
30 VA	69	109	91	86
5 WV	91	74	113	97
16 OH	120	138	104	116
6 PA	113	140	115	119
15 IA	58	50	45	51
32 MI	166	185	184	178
20 NS	112	58	66	81
12 NY	70	66	58	65
14 ME	33	38	38	36
18 WI	107	127	133	122
25 ON	61	55	55	57
19 MN	62	40	46	51
23 PQ	43	21	37	36
Mean $d^2h$ , m <sup>3</sup>	.26	.14	.32	.24
Mean $d^2h$ , ft <sup>3</sup>	9.3	4.9	11.4	8.5

Any seed collection zone is only an approximation; not all good sources are within, nor are all undesirable sources excluded. For instance, our recommended zone includes the relatively poor source 30 from Virginia. A southern Appalachian white pine progeny test, sponsored by cooperative regional project NC-99 and including almost 200 parent trees and stands, is now underway. This test should eventually define much more precisely the desirable seed collection zone in the southern mountains.

Our recommended zone also omits the promising Forest County, Wisconsin, source 18. We would not hesitate to recommend using seed from source 18, but collections from nearby Iowa, Minnesota, upper-peninsula Michigan, and Sauk County, Wisconsin, have produced generally average-to-slow growing trees in our plantations and elsewhere. Furthermore, source 18 trees were reported as slow growing at several other locations (Garrett, Schreiner, and Kettlewood 1973). For the interim, we believe that use of seed from our recommended zone for Ohio Valley white pine plantations should maximize the genetic potential for growth rate.

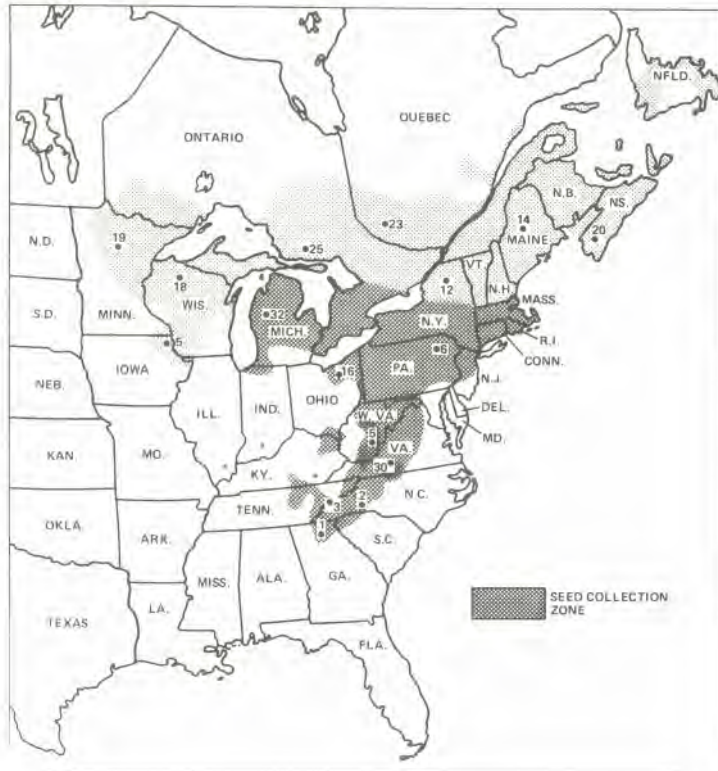


Figure 1.--The range of eastern white pine (the shaded areas combined) and the seed collection zone recommended for Ohio Valley planting. The numbers mark the seed sources; the \*'s mark the experimental plantings in Illinois, Indiana, and Kentucky.

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