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JUVENILE PERFORMANCE OF HYBRIDS BETWEEN WESTERN AND EASTERN WHITE PINE

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ABSTRACT

The growth and performance of Pinus monticola, P. strobus, and their hybrids were investigated at several sites in northern Idaho and western Montana. At three sites in northern Idaho, two hybrid progenies were approximately twice as tall and markedly excelled corresponding P. monticola progenies (having the same female parents) in height growth at age 8 years. At one site in western Montana none of the few P. monticola, P. strobus, and hybrid progenies performed satisfactorily. All except a high-elevation P. monticola source from California were severely damaged by snow.

Interspecific hybridization is a useful method in forest tree improvement. Its possibilities and difficulties have been ably discussed and summarized by Duffield and Snyder (1958) and Righter (1960). Because of the relatively fast juvenile growth of eastern white pine (Pinus strobus L.) and its inherently greater resistance to the blister rust fungus than western white pine (Pinus monticola Dougl.), one would hope to incorporate in the hybrid between these species the rapid early growth and rust resistance of the former and the adaptability, form, and staying power of the latter. Observations of the juvenile performance of western X eastern white pine in northern Idaho and western Montana are reported in this paper.

¹ Research forester and plant pathologist, respectively, Intermountain Forest and Range Experiment Station, Moscow, Idaho. The authors acknowledge the work of A. E. Squillace who started both studies herein described and examined and measured seedlings at the Randolph Creek site through 1957.

Hybrids between Pinus monticola and P. strobus were first produced at the Institute of Forest Genetics, Placerville, California (Righter 1945), and subsequently grown and studied by a number of scientists. Duffield and Righter (1953) reported that the hybrid grew faster than either parent in numerous experiments at the Institute of Forest Genetics. Riker and Patton (1954) observed some reciprocal crosses showing hybrid vigor when 2 years old. Generally in Wisconsin, however, the hybrid is intermediate in most respects between the parents.² Bingham, Squillace, and Patton (1956) found that many individual hybrids displayed hybrid vigor during the first 2 years at Spokane, Washington; further, hybrid progeny height at 2 years was highly and significantly correlated with that of corresponding intraspecies progenies. However, juvenile progenies of P. strobus and the hybrid were more severely damaged by snow than the stockier, slower growing P. monticola progenies.

PINUS STROBUS PLANTATIONS IN NORTHERN IDAHO AND WESTERN MONTANA

Seldom in the United States is it possible to study extensively the growth and adaptability of a hybrid's exotic parent in habitats of the native parent. We are, however, fortunate that from 1911 until about 1932 more than 2,000 acres were planted with P. strobus in northern Idaho and western Montana. Today, more than 1,000 acres of P. strobus in approximately 14 plantations still exist.³

The juvenile performance of P. strobus was studied by foresters, most notably David S. Olson, nurseryman and later chief of planting in Region 1, U.S. Forest Service, from 1915 until 1934. Olson⁴ observed poor survival of P. strobus in several blocks of one plantation, presumably unsuited to the species because of aspect, exposure (south and southwest slopes), and rocky, shallow soil. In other areas within this plantation, growth was excellent. He noted that although eastern white pine was damaged by snow during the first 10 years, it outgrew the deformities and thereafter grew rapidly.

Eastern white pines in five plantations were observed and their growth and form compared with those of adjacent plantations or intermingled individuals of western white pine. The source of P. strobus seed was known only by the state in which the seed was purchased. In three plantations (planted 1913-1916) P. strobus had failed on the poorer sites. Where the site was favorable, P. strobus grew well and exhibited relatively good stem form. However, height growth during the last 10 years has diminished and some crown damage was observed. Western white pines, intermingled with eastern white pines in these plantations are now faster growing. In one 30-year-old

² Personal communication, R. F. Patton, Associate Professor of Plant Pathology, University of Wisconsin, Madison, March 6, 1962.

³ The numbers of plantations and acres are approximate because records are incomplete, not all plantations have been observed recently, and fire has destroyed parts of the most extensive plantations.

⁴ Olson, David S. Final report of Little North Fork Plantations, Misc. Projects 18-32, St. Joe National Forest, U.S. Forest Service, Unpublished Report: 15 pp. 1928.

plantation (Fedar Creek, Kaniksu National Forest), eastern white pine was markedly inferior in form and vigor in comparison to an adjoining plantation of western white pine of the same age (source unknown). From subjective observations, it appears that although P. strobus may grow faster in youth, western white pine can surpass it within 50 years. Because of the better adaptation of western white pine to the environmental conditions of its native habitat, it probably can markedly excel eastern white pine in an 80- to 120-year rotation.

The most important observation in these P. strobus plantations from the standpoint of interspecific hybridization is that P. strobus of essentially randomly selected sources can compete successfully with western white pine during the first 20 to 40 years on certain favorable sites. Only a few sources of P. strobus were represented in the plantations, and occasionally seed from two or three sources was planted at the same location. Thus, extensive provenance tests would be required to show which sources of P. strobus compete most favorably with western white pine.

PERFORMANCE OF HYBRID WHITE PINES

The juvenile performance of the hybrid and its parents was compared in two experiments. One experiment was established in an area of heavy rust infection at Randolph Creek, Coeur d'Alene National Forest, in 1954, to study the rust resistance and vigor of interspecific white pine hybrids. Further comparisons are possible from a second experiment consisting of vigor-quality outplantings established at three sites in northern Idaho in 1957 (Deception Creek Experimental Forest, Coeur d'Alene National Forest; Priest River Experimental Forest, Kaniksu National Forest; Emerald Creek, St. Joe National Forest).

RANDOLPH CREEK HYBRID EXPERIMENTAL PLOT

In the spring of 1954, white pine species and hybrids were planted in three randomized blocks at Randolph Creek, a deep-snow area in Mineral County, Montana (elev. 4,240 feet). Seedlings were measured and examined periodically for blister rust cankers. Differences in percent of trees infected per progeny (range 0 to 32 percent)⁵ were largely attributable to seedling height (table 1). The number of cankered trees per progeny showed a highly significant positive correlation with mean total height of the progeny ($r = 0.840$).

Results of the growth measurements in 1961 of the 11-year-old trees reveal that no source of P. monticola, P. strobus, or their hybrids is performing satisfactorily (table 1). All progenies except Eldorado County, California, P. monticola have been severely damaged by snow. An inadequate number of surviving individuals within progenies prevented a meaningful comparison in either blister rust susceptibility or growth rate between P. strobus and P. monticola and their hybrids. Thus far the best overall performance was shown by the hybrid between P. strobus and P. monticola from Eldorado County, California.

⁵ Progenies with fewer than 10 living trees in 1957 were excluded.

Table 1.--Survival and growth of *Pinus monticola*, *P. strobus*, and
their hybrids at Randolph Creek, Montana ¹

Seed parent	Pollen parent	Seedlings	Survival			Cankered trees		Av. total height			Form
		planted	Spring	Fall	Fall	Trees	Percent	Fall	Fall	Fall	
		1954	1954	1954	1961	living	cankered	1954	1956	1961	
		Percent			Feet						
<u>P. monticola</u> ² (Montana)	Wind	30	100	87	30	30	0.41	0.77	1.77	Poor ⁷	
<u>P. monticola</u> (S. central Wash.) ³	Wind	29	100	45	22	18	.33	.69	1.41	Poor	
<u>P. monticola</u> ⁴ (Montana) ⁵	Wind	30	93	37	28	14	.38	.63	1.18	Poor	
<u>P. monticola</u> (Calif., Eldorado Co.) ³	Wind	30	97	67	29	0	.23	.37	1.10	Fair	
Mean <u>P. monticola</u> progenies		30	97	59	27	16	.34	.62	1.36		
<u>P. strobus</u> (New Hampshire)	Wind	3	100	67	2	50	.28	.52	1.36	Poor	
<u>P. strobus</u> (Wisconsin)	Wind	7	100	0	2	50	.37	.38	0	--	
Mean <u>P. strobus</u> progenies		5	100	20	2	50	.32	.45	1.36		
<u>P. monticola</u> (S. central Wash.)	<u>P. strobus</u> mix (Canada)	30	100	20	21	19	.46	.72	.92	Poor	
<u>P. monticola</u> (S. central Wash.)	<u>P. strobus</u> mix (New Hampshire)	30	100	13	16	12	.45	.74	1.45	Poor	
<u>P. monticola</u> (S. central Wash.)	<u>P. strobus</u> mix (Wisconsin)	15	93	0	3	33	.40	.76	0	--	
Mean <u>P. monticola</u> (S. central Wash.)	X <u>P. strobus</u> progenies	25	99	13	13	18	.44	.74	1.18		
<u>P. monticola</u> (Calif., Eldorado Co.) ²	<u>P. strobus</u> mix	30	97	53	28	32	.55	.89	1.80	Poor	
<u>P. monticola</u> (Calif., Eldorado Co.) ⁶	<u>P. strobus</u> (Ontario, Can.)	30	100	13	19	32	.46	.80	1.87	Poor	
Mean <u>P. monticola</u> (Calif.) X <u>P. strobus</u> progenies		30	98	33	24	32	.50	.84	1.84		

¹ Seed for all progenies except the two Montana *P. monticola* progenies was obtained by personnel at the Institute of Forest Genetics, Placerville, California, under the supervision of F. I. Righter and J. W. Duffield.

² Kootenai National Forest, drainage and elevation unknown.

³ Probably collected in the vicinity of the Wind River Experimental Forest, Gifford Pinchot National Forest.

⁴ 2-2 stock when outplanted in spring 1954; all other lots 2-1 stock when outplanted.

⁵ Rainy Creek, Mineral County, Montana, elevation 4,000 feet.

⁶ A mix of seed from two areas: 6,300 feet and 7,300 feet elevation.

⁷ *P. monticola* progenies compared by Duncan's multiple range test; any two values not having a common line are statistically significant ($P < 0.05$).

This test gives no satisfactory evidence for or against hybrid superiority. It shows that two nearby P. monticola sources are not well adapted to the site and points up the importance of provenance in studying species and hybrid growth performance.

VIGOR-QUALITY PROGENY EXPERIMENTS

In 1957 extra seedlings from the blister rust progeny experiment were outplanted at three locations in northern Idaho: Priest River Experimental Forest, Kaniksu National Forest (elev. 2,500 feet), Deception Creek Experimental Forest, Coeur d'Alene National Forest (elev. 3,650 feet), and Emerald Creek, St. Joe National Forest (elev. 2,800 feet). The seedlings were weeded in 1957, 1959, and 1960, but otherwise received no cultural care. Height measurements of trees in two hybrid progenies and western white pine progenies having the same female parents were made in September 1961. The hybrid progenies were approximately twice the height of corresponding western white pine progenies at all sites (fig. 1).

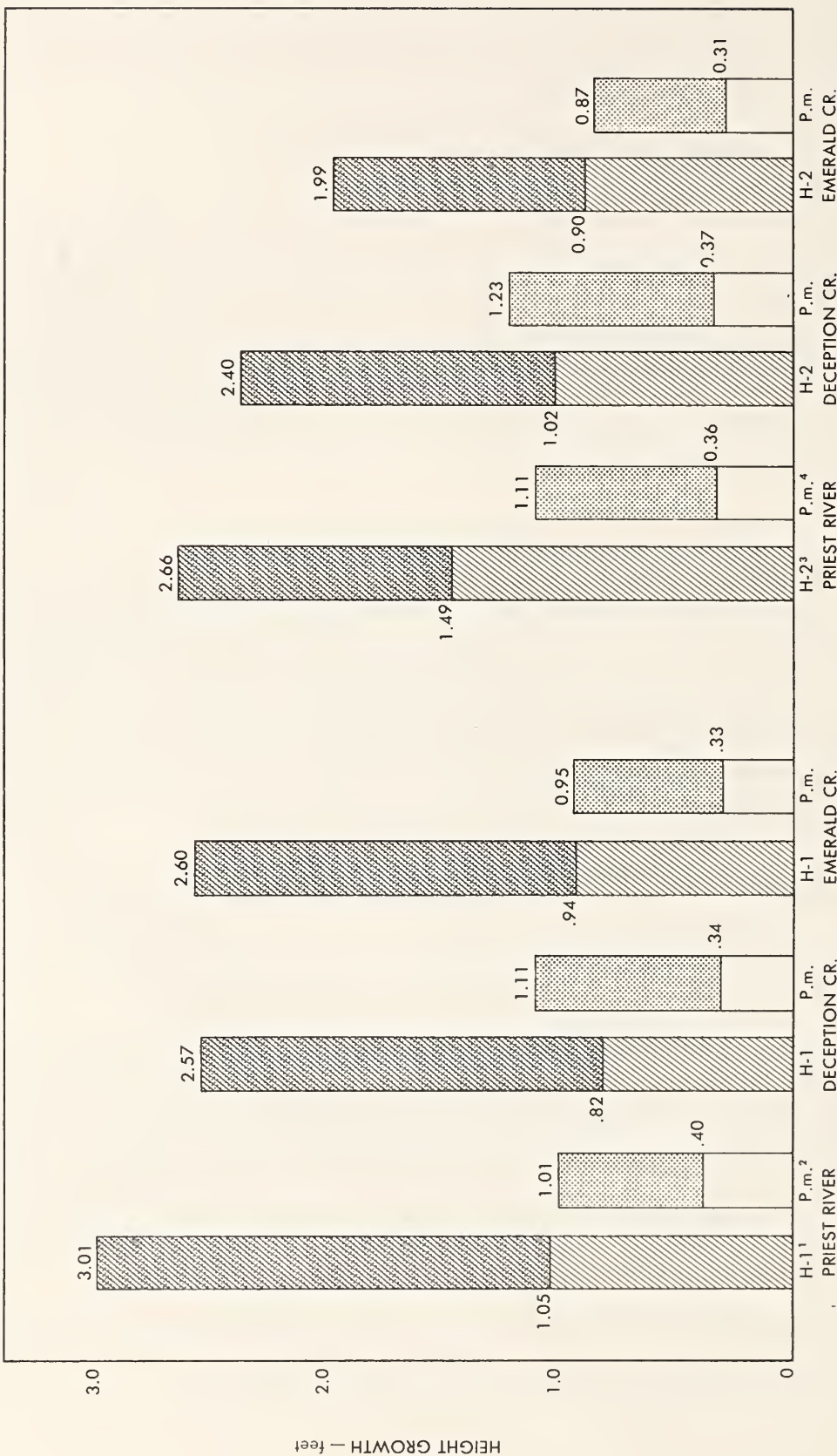
DISCUSSION AND CONCLUSIONS

The excellent juvenile performance of the hybrid at three northern Idaho sites is encouraging; the early fast growth of the P. strobus parent apparently has been transmitted to the hybrid. The fast growth is also heartening since, except for blister rust resistance, parents can be considered a chance combination. The progress of the hybrids will be watched with interest to see if they continue to outperform western white pine. If racial and individual selection were practiced within both species prior to hybridization, hybrid progenies might be produced that would be faster growing and better adapted to certain sites than the two hybrid progenies discussed.

At the three northern Idaho sites snow damage has not yet become a problem. If it should become a serious problem, the alternative decisions would be to: (1) discontinue all efforts with the hybrid, (2) find provenances of P. strobus better adapted to mountainous conditions, or (3) backcross the hybrid to P. monticola.

The poor performance of the hybrid progenies at the Randolph Creek experimental plot is not discouraging, since even the presumably local western white pine progenies tested there were equally poor. Also, it is not necessary that the hybrid be planted on all sites--just on those where it would compete equally well with, or excel, P. monticola. The apparent adaptability of the high elevation California P. monticola to this deep-snow site, and a growth boost from the P. strobus parent, perhaps combined to make this hybrid the best performer. However, the cross, P. monticola California X P. monticola Idaho, was not tested and might have proved equally good or better.

Although an interspecific hybridization program has promise, no further breeding is planned until races and individuals of both species are screened.



KEY

- HYBRID
- P. monticola
- GROWTH - 1959-1961

¹P. monticola 63 × P. strobus CCH Br 3 (Ontario)

²Average: P. monticola 63 × P. monticola 20
and P. monticola 63 × P. monticola wind

Figure 1. --Total height of 8-year-old western white pine and growth in three localities in northern Idaho.

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