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# Research Note INT-290

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### COMPARATIVE GROWTH RATES OF WESTERN WHITE PINE VARIETIES RESISTANT TO BLISTER RUST

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#### ABSTRACT

Compared was the growth of seedlings of western white pine that displayed specific mechanisms of resistance in response to white pine blister rust. These growth statistics were then compared to those of seedlings that had blister rust cankers. No difference was detected among these categories.

KEYWORDS: Resistance, white pine blister rust, western white pine.

Breeding for resistance in western white pine (*Pinus monticola*) to white pine blister rust (caused by *Cronartium ribicola*) started in 1950. By 1974, a grafted seed orchard, three seedling seed orchards, and a breeding arboretum were established.

Mechanisms of resistance to blister rust were of several types (Bingham and others 1973; Hoff and McDonald, in press). One question frequently asked was: What is the impact of these various mechanisms on other traits, mainly growth? This paper compares the growth rates of young white pines in a natural forest that contain various mechanisms of resistance.

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#### MATERIALS AND METHODS

The trees used in this study were grown from seed planted in the nursery at Moscow, Idaho, in 1964, 1965, and 1966. Seedlings were from phenotypically blister rust resistant parents growing in natural stands. The seedlings were the first generation  $(F_1)$  produced after selection by blister rust. The second generation seedlings  $(F_2)$  were produced from the  $F_1$  seedlings that survived intense artificial inoculation with blister rust. This inoculation took place when the seedlings were two years old, using methods described by Bingham (1972). To determine presence or absence of blister rust fungus, and to identify any resistance mechanisms, inspections were conducted using procedures described by Hoff and McDonald (in press).

In 1971, the surviving seedlings were labeled, lifted, and outplanted in the Canyon Creek drainage of the Priest River Experimental Forest in north Idaho. The site, a gently sloping stream bottom aluvial plain, supports the Hemlock-Pachistima type vegetation. The seedlings were planted 8 feet apart in a random design.

The trees were measured in 1976 and 1977. Data are presented for 1976 height, and 1977 growth adjusted for 1976 height. The adjustment was made because trees when planted were of various heights due to rust resistance testing methods, because trees broke out of transplanting shock at different times, and because cankered trees were about 10 percent shorter than noncankered ones.

The data are grouped by the year seedlings were sown in the nursery (1964, 1965, 1966) progeny type ( $F_1$ ,  $F_2$ , self), and by the following mechanisms of resistance:

- 1. No needle spots and no cankers: fungus did not infect the tree in any manner.
- 2. Needle spots only: fungus infected needles but was killed or eliminated before it could enter the stem.
- 3. Stem symptoms: fungus infected needles and grew into stem but was killed soon after entering stem, leaving a readily noticeable reddish-brown dead patch of stem tissue.
- 4. Canker death: fungus developed extensively but was then killed.
- 5. Cankered: fungus fully progressed from needle spots to typical stem canker; however, slowing of fungus growth or tolerance for the rust allowed tree to survive.

#### RESULTS AND DISCUSSION

Total 1976 height and adjusted 1977 growth are tabulated in tables 1, 2, and 3.

Trees that were cankered (category 5) were 10-15 percent shorter than those noncankered. There was little difference, however, between cankered and noncankered in the adusted 1977 growth. For some reason cankers affected the early growth of these trees but not later growth. Bingham and others (1973) report that cankers did not affect the growth of young trees. In fact, the infected trees were slightly taller. Transplanting the fairly large stock (trees 6, 5, and 4 years old) may have had more adverse affects on the cankered trees. Table 1.--Mean adjusted 1977 growth and total 1976 height of western white pine  $F_1$  trees infected with blister rust or not infected because of several mechanisms of resistance

Mechanism of resistance	1964 PT*		Total height	1965 PT*		Total height
	Trees	77 growth	1976	Trees	77 growth	1976
	No.	CM	СТ	No.	CM	СТ
No spots, no cankers	671	29	100	141	32	119
Needle spots only	641	29	104	70	31	117
Stem symptoms	770	29	99	57	32	114
Canker death	440	28	104	65	33	116
Cankered	48	27	85		-	-
Total	2570	x 29	101	333	x 32	117

\*1964 PT (progeny test), 1965 PT seed were sown in autumn 1964 and 1965, respectively.

Table 2.--Mean adjusted 1977 growth and total 1976 height of western white pine  $F_2$  trees infected with blister rust or not infected because of several mechanisms of resistance

Mechanism of resistance	1965 PT*		Total height	1966 PT*		Total height
	Trees	77 growth	1976	Trees	77 growth	1976
	No.	CM	CM	No.	CM	CM
No spots, no cankers	98	33	115	184	27	94
Needle spots only	60	33	116	761	27	92
Stem symptoms	29	29	121	63	27	93
Canker death	50	31	103	33	25	92
Cankered	-	-	-	47	27	84
Total	237	x 32	114	1088	x 27	92

\*1965 PT and 1966 PT seed were sown in autumn 1965 and 1966, respectively.

Mechanism of resistance	1964 PT*		Total height	19	65 PT*	Total height
	Trees	77 growth	1976	Trees	77 growth	1976
	No.	CM	CM	No.	CM	CM
No spots, no cankers	109	20	67	22	20	80
Needle spots only	82	19	70	_	-	-
Stem symptoms	85	21	71	-	-	-
Canker death	34	20	81	11	24	82
Cankered	4	18	60	-	-	-
Total	314	<del>x</del> 20	70	44	x 22	81

Table 3.--Mean adjusted 1977 growth and total 1976 height of western white pine selfed trees infected with blister rust or not infected because of several mechanisms of resistance

\*1964 PT, 1965 PT seed were sown in fall of 1964 and 1965, respectively.

Among the noncankered categories no consistent pattern emerged in the variation of total height. And after adjustment of 1977 growth on 1976 total height, differences among all categories were insignificant.

For the  $\mathrm{F}_1$  progenies in the 1964 test, correlations between traits were as follows:

1. Resistance types and 1976 height r = 0.003 N.S.

2. Resistance types and 1977 growth r = 0.015 N.S.

3. Resistance types and 1977 adjusted growth r = 0.021 N.S.

4. 1976 height and 1977 growth r = 0.65 signif. 0.001.

One weakness in this test is that there were no truly susceptible control plants. They all died from blister rust in the nursery or soon after outplanting. The trees most closely approximating a control group were those with living cankers, but even these are probably still alive because of some resistance or tolerance to the fungus. Nevertheless, it seems unlikely that if blister rust resistance were negatively related to growth that it would occur uniformly over all resistance types. Further, Bingham and others (1973) found no difference in young seedling growth among controls and  $F_1$  and  $F_2$  blister rust resistant stock. The controls were standard nursery stock with little or no resistance. Thus, we conclude (within the limits of the data presented) that growth rate and resistance to blister rust are independently inherited characteristics.

In addition, we have not noticed any association between resistance types and other traits such as tree form or the occurrence of other pests.

We intend to measure the trees in the plantation every 5 years and to continue looking for associations between resistance types and other traits.

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