White pine blister rust resistance in a seven year old field trial of 28 western white pine (*Pinus monticola)* families in the Coast Range of Oregon

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Introduction

Western white pine (WWP, *Pinus monticola*) is a forest tree species with a wide natural distribution, ranging from California to British Columbia. As with the other eight species of white pines native to the U.S. or Canada, WWP is highly susceptible to white pine blister rust (WPBR), caused by the non-native, invasive pathogen *Cronartium ribicola*. Regional programs to develop resistance to WPBR have been underway for several decades and have used artificial inoculation of young seedlings to evaluate resistance (see, for example, Kegley and Sniezko 2004). However, there are relatively few field trials that have been followed closely. This report focuses on a field trial of 28 families of WWP planted in 2003.

Fig 2. Distant view from north of Coast Plum planting after a light snowstorm, March 2010.

Materials & Methods

Twenty-eight seedlots (half-sib and full-sib 'families') were planted in a field test in the Coast Range of Oregon on land provided by the Plum Creek Timberlands Company. Based on previous seedling screening results, one highly susceptible family and 27 families with low to high levels of resistance were selected for this test. Most of the families were from coastal or western Cascade regions in Oregon, Washington, and British Columbia (Fig. 1). Twenty-five of the families were from the USDA Forest Service's Pacific Northwest Region program, and three of the families were from the British Columbia Ministry of Forests' rust resistance program.

Plum Creek's planting site in the Siletz River drainage of the Oregon Coast Range (elevation 539 m, ~1770 ft) was logged in 2002, and slash concentrations were burned. The area was aerially sprayed with herbicides in fall 2002 for vegetation control. Seed were sown in March 2002, and seedlings planted in February 2003. Seedlings were planted at 1.8 m x 3 m spacing (6ft x 10ft) in a randomized complete block design. All families were represented in six of the blocks (usually 5 trees/family/block in row plots) with a subset of the families planted in three additional blocks.

In March 2010, the trees were assessed for height, survival, incidence of stem infections, severity of stem infections and type of stem infections (normal, partial bark reactions, bark reactions). Severity was rated qualitatively, ranging from 1 (low) to 8 (very severe), with the "very severe" rating indicating that the canker had encompassed >100% of the diameter of the tree.

Literature Cited

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Fig 4. Variety of canker ages observed: a) Incipient canker with the 'point-of-entry' needle still alive in the center, b& c) Canker with partially girdling stem, d) Older canker with aecia and girdling stem.

Fig 3. Heavily cankered tree showing bushiness characteristic of such trees (left). Canker free tree (right).

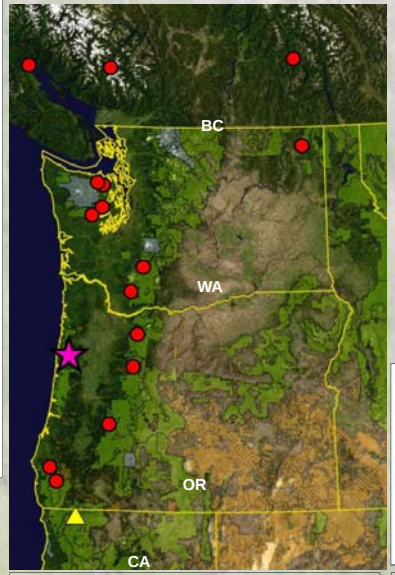

Fig 1. Map showing general locations of study tree parents ● and plantings. Coast Plum ★; Happy Camp ▲.

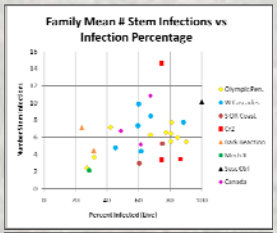

Fig 5. Average number of stem symptoms per tree vs. infected percentage – by family.

Fig 6. Distribution of average number of stem infections per tree and percent of trees with stem infections– by family.

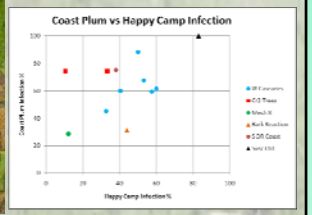

Fig 7. Comparison of infection percentages for 12 families planted at both Coast Plum and Happy Camp. Orange squares are for families with the Cr2 gene (Champion Mine sources).

Results

Most infections were relatively recent (on 2007 & 2008 wood), but older basal cankers were also present on some trees, indicating several infection events have occurred since planting (Fig. 4).

The majority of the trees (64.7%) had stem infections by 2010, with family means ranging from 23.8 to 100% (Fig. 6B). The susceptible control was the only family with 100% of trees infected (Fig. 5). One of the least infected families was one which has an unknown resistance mechanism (Mech X), and which has performed well in a variety of field and nursery tests. There were two Olympic Peninsula families which performed very similarly to it (Fig. 5).

Of significant note is the fact that three families with an R gene for blister rust resistance (*Cr2*) showed rather high cankered percentages. The family with the highest average number of both bole and branch cankers on infected trees was one of these families (Fig. 5).

The number of total infections per tree varied from 0 to 91; family means varied from 2.1 to 14.6 (means exclude trees with no infections, Fig. 6).

Discussion

Families varied greatly in the incidence and severity of blister rust infection. Most infections were recent and low in severity. The severity of infection is expected to increase in the next few years, and additional infection events are also likely.

The three families with R-gene resistance were highly infected (74 – 86%), indicating that the virulent strain of rust (*vcr2*) is present at the site – the northernwestern-most known occurrence of *vcr2* observed to date. (see Kinloch *et al.* 2004 for discussion of the known distribution of *vcr2*.)

The overall level of infection at this field site is lower than that in artificial inoculation trials of seedlings. This site likely represents a moderate rust hazard, and presents an opportunity to be able to discern partial resistances that might be overwhelmed at a higher hazard site or in an artificial inoculation test.

An earlier field trial at Happy Camp, CA included 12 of the families from this study. It also showed a lower infection rate relative to the artificial inoculation trials (Sniezko *et al.* 2004) The results for the 2 field trials are roughly comparable except for two families containing the *Cr2* gene (Fig. 7).

The current stage of infection allows us to compare families for infection percentage and number of stem infections. The level of field resistance in the families is very encouraging. Some families are also expected to show levels of bark reaction or other resistances once infected, but several more years in the field will be needed to evaluate those traits further.

An array of field sites has been established since 1996 which will permit more extensive evaluation of resistance at sites which vary in rust hazard. Long term monitoring of these field trials will help evaluate durability of resistance.

Breeding efforts currently underway are expected to increase the levels of resistance.