Western white pine resistance in western Washington: Operational planting and the latest in resistant stock types

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INTRODUCTION

Western white pine (*Pinus monticola* Dougl., WWP) is a native conifer species in western North America. The species is susceptible to the introduced fungal pathogen *Cronartium ribicola* J.C. Fisch., the causative agent of white pine blister rust (WPBR). The impacts of WPBR have reduced the incidence of WWP in natural ecosystems as well as led to a reluctance in using the species in both restoration and reforestation. Research and operational programs to develop genetic resistance to WPBR have been ongoing for more than five decades, with regional programs based in Oregon (OR), Idaho (ID), British Columbia (BC) and California. Progeny of thousands of parent trees have been screened for rust resistance in short-term artificial inoculation trials and several types of resistance have been uncovered. Seed orchards have been established using the products of the earlier resistance work and breeding to increase the level of genetic resistance continues.

In western Washington (WA) Douglas-fir forests, laminated root rot is caused by the fungus *Phellinus sulphurascens* Pilát and is one of the primary disturbance agents. The disease can cause decreased tree growth and mortality in its host, with impacts occurring across multiple stand ages and harvest rotations. While there are multiple management strategies than can be implemented based on the severity and distribution of root disease, mitigation is often carried out during the reforestation stage by planting affected areas with less susceptible species. On Washington Department of Natural Resources (WA DNR) managed lands, the alternate species are often the immune red alder, the resistant western redcedar, and occasionally western hemlock, grand fir and western white pine intermixed with the highly susceptible Douglas-fir.

This study examines the current WPBR incidence and impacts in operational plantings of WWP and compares the results to the most recent data from a series of WWP field trials examining a diverse set of WPBR resistant families and orchard families.

METHODS

Thirty-five WA DNR sites with operationally planted WWP that is now 9-14 years old were assessed for WPBR incidence and severity across western WA. Outplantings originated from seed from the Inland Empire Tree Improvement Coop, Moscow, ID seed orchard. Aspect, elevation and plant associations were recorded for each site. The first 100 trees accessed were examined for WPBR cankers and overall tree health. Only the most severe canker class was

recorded for each tree. Canker classes included: dead from WPBR, no infections, on the bole, within 6 in (7.5 cm) of the bole, 6 to 24 in (7.5-60 cm) from the bole, and greater than 24 in (60 cm) from the bole. For analysis of operationally planted sites, mortality causing infections were defined as either infections directly on the bole or within six in of the bole.

Six, three-acre sites were established in 2006 across western Washington. A total of thirty-six seedlots were planted across the sites, with 1269-1365 individual seedlings planted at each site. The study design consisted of seven blocks, or reps, per site and three to seven seedlings per seedlot per block. The seedlots originated from many areas across the region, including the Gifford Pinchot National Forest (NF), Mt. Baker/Snoqualmie NF, Olympic NF, Wenatchee NF and Colville NF in Washington; Mt Hood NF, Umpqua NF, Confederated Tribes of Warm Springs in Oregon; British Columbia; and the Bingham seed orchard in Idaho.

White pine blister rust incidence and severity assessments were made in 2010, 2011, 2013 and 2015. During the assessments tree damage, tree vigor, rust severity, including the number of white pine blister rust cankers, were measured. During the 2013 and 2015 assessments, tree height and reproductive status were recorded. For analysis of WPBR resistance trial sites, mortality causing infections were defined only as infections on the bole since distances from the bole to the canker were not measured in the assessments on these sites.

Incidence and severity of WPBR were summarized and operationally planted WWP and individual families from the WPBR resistance trials were compared.

RESULTS and DISCUSSION

Significant variability occurred in WPBR infection levels across all sites. The average percent of uninfected trees on the operationally planted sites ranged from 5 to 100, with a mean of 59% among all sites. Average white pine blister rust caused mortality ranged from 0 to 61%, with a mean of 7% among all sites. An average of 34% of the trees across all sites had cankers that caused mortality or were likely to cause mortality, defined as infections on or within 6 in (7.5 cm) of the bole.

Among the 36 seedlots examined in the resistance field trials, infection levels and mortality caused by rust ranged from 0-100%, depending on seedlot and site (Figure 1). Six seedlots had an average of 34% or greater of mortality causing cankers, including those that were on the bole and had not yet caused mortality. Three seed orchard seedlots were included in the trials and had an average of 26, 34, and 36% of mortality and likely to cause mortality cankers, defined in this trial series as infections on the bole. The seed orchard seedlots blister rust infection levels were similar to those observed in the operational planting assessments. Five seedlots had an average of 10-20% mortality causing and likely to cause mortality cankers and four seedlots had an average of less than 10% cankers. Included in these is a highly resistant seedlot with 0% infection on two of the six sites.

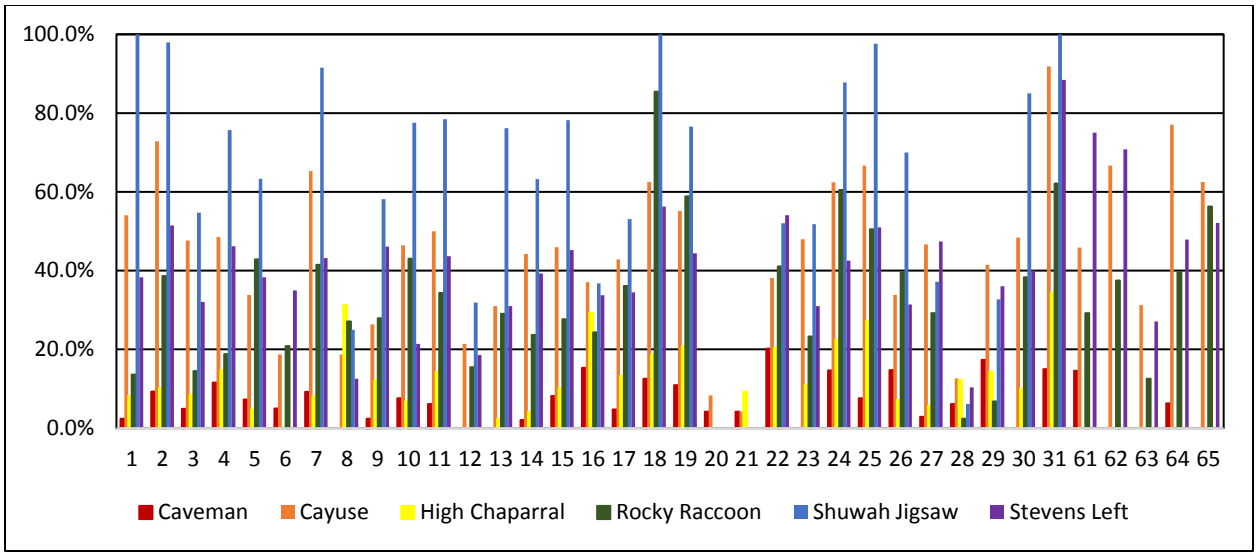

Figure 1. Average Percent of WPBR Infections (bole and branch) by Site and by Family.

It should be noted that 27 out of 36 seedlots in the WPBR resistance trials have an average of less than 30% mortality and likely to cause mortality cankers, less than the 34% average found in the operationally WWP planted assessments. This data suggests that there are seedlots available with greater WPBR resistance levels than are currently being operationally planted. A more detailed analysis is required to suggest specific high performing WWP that, in regards to growth and WPBR resistance, may be good candidates for incorporating into existing and new WWP seed orchards. These trials will continue to be assessed to evaluate the resistance over time, but early indications show the potential of planting resistant WWP in many sites in Washington.

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