Blister Rust Inoculation Trials for Whitebark Pine (*Pinus albicaulis*) in the Canadian Kootenay Region

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Abstract—Controlled inoculations of whitebark pine (*Pinus albicaulis*) families in British Columbia (BC), Canada, took place in 2013 and 2014 at the Kalamalka Forestry Centre in Vernon. This effort has focused on 40 families from the Kootenay region with results (identification of disease-resistant families) expected over the next 5 years. Meanwhile, demand continues for further screening of whitebark pine from other regions in Canada. New funding from the BC Forest Genetics Council will permit work to continue. Our plan is to inoculate 40 additional families per year (2016–2018). Seedlings will be collected by multiple partners such as national and provincial parks and possibly mining companies.

INTRODUCTION

Whitebark pine (*Pinus albicaulis*) is a widespread and valuable tree species in western Canada that continues to suffer widespread mortality due to the introduced blister rust disease (agent: *Cronartium ribicola*). The decline appears to have increased during the last 20 years. In 2000, Campbell and Antos (2000) reported on 54 stands across the range in British Columbia (BC) and remarked that on average about 50 percent of whitebark pine was killed or infected by white pine blister rust. They noted the worst rates of rust infection were in the northwest (Smithers) and southeast (Fernie). A more recent survey of the Rocky Mountains in Canada and Montana (USA) (Smith et al. 2008) found mortality had increased from 26 percent (1996) to 61 percent (2004). Due to steep declines, the Canadian government declared whitebark pine as endangered under the Species at Risk Act in June 2012.

As many denuded populations have few surviving trees, their future is jeopardized. Several authors predict that whitebark pine will be locally extirpated where it is less favored and rust thrives (Krakowski et al. 2003; Smith et al. 2008; Tomback and Achuff 2010). Screening selected families for rust resistance is a critical component for maintaining whitebark pine (Environment Canada 2013; Schoettle and Sniezko 2007). To do this, artificially inoculating seedlings with *Cronartium ribicola* followed by post-inoculation assessments of seedling health and survival are useful for identifying disease-resistant families (Sniezko et al. 2011).

LAUNCH (2013)

During August 2013 an inoculation trial was performed at the Kalamalka Forestry Centre (KFC), Vernon, BC, operated by the BC Ministry of Forests, Lands and Natural Resource Operations. Seedlings representing 10 whitebark pine families from BC's Kootenay region were used. These same families were also submitted to the U.S. Department of Agriculture, Forest Service (USDA FS) facility, Dorena Genetic Resource Center

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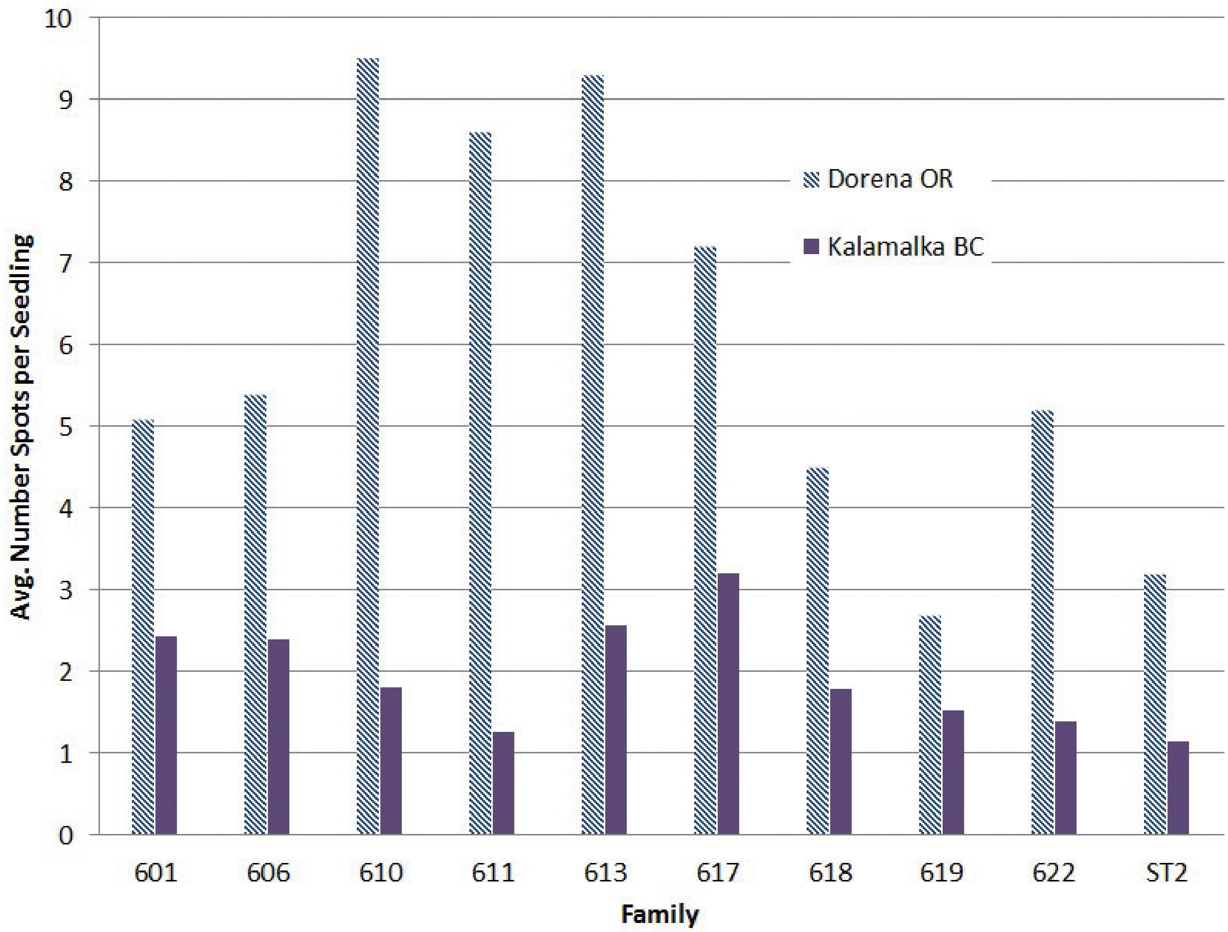

Figure 1—Spots counts observed on needles of inoculated seedlings at 9–10 months post-inoculation.

(DGRC), for tandem inoculations to provide a comparison of results. Each family consisted of 50 individuals per inoculation run (10 families × 50 seedlings × 2 runs = 1,000 seedlings). Our methods were adapted from the protocol in use by DGRC (Danchok et al. 2004). This included randomized blocks of seedlings and achieving a basidiospore load of 3,000 cm^{-2}.

The first run took place within a greenhouse where a plastic frame (polyvinyl chloride piping) formed an inoculation chamber. The second run was conducted in a growth chamber room. Temperatures were maintained near 20 °C and relative humidity was kept in the high 90s (percent). We achieved a target spore loading of about 3,000 spores cm^{-2} in our greenhouse run. However, there were no basidiospores produced in the growth chamber run; this was due to overmature telia on the *Ribes* leaves. Thus, these uninoculated seedlings were allocated to a field trial in Glacier National Park (BC).

During the following spring (2014) separate surveys were conducted by DGRC and Kalamalka personnel for needle spots and cankers associated with the inoculated seedlings. In comparing spot counts between KFC and DGRC, there is notable incongruence (fig. 1). A subsequent survey for cankers was conducted in November 2014 (14 months post-inoculation). Again, surveys indicated very low numbers of cankers on seedlings inoculated at Kalamalka (fig. 2). Although germination of spores was verified, we cannot explain the low incidence of symptoms. A variety of factors may have intervened, including additional biological agents, seedling physiological traits, and low virulence.

2014 AND BEYOND

Seedlings from an additional 30 Kootenay families were inoculated at KFC in August 2014. All inoculations were conducted in the chamber room with spore

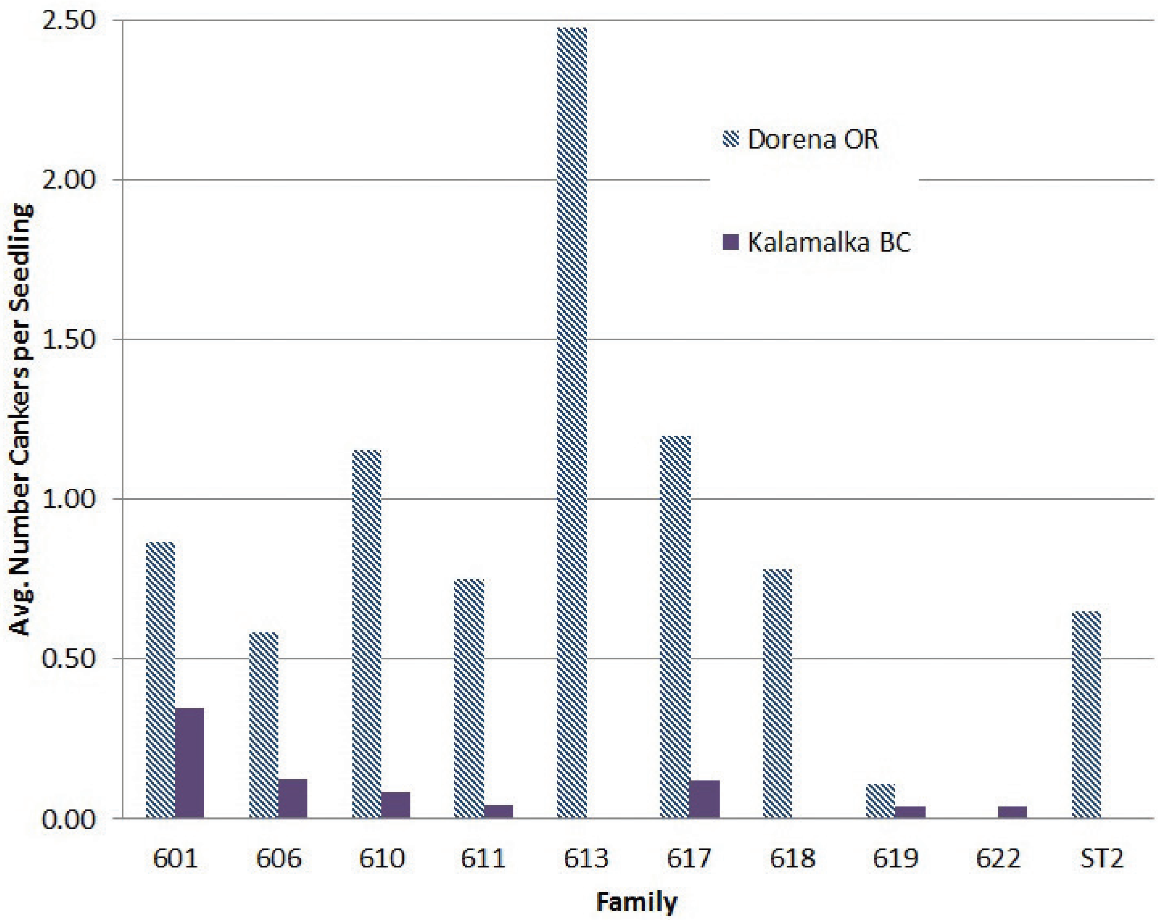

Figure 2—Canker counts observed on inoculated seedlings at 14 months post-inoculation..

loads averaging 4,400 cm^{-2}. In September 2014, three field screening trials were established to screen non-inoculated seedlings from the same 40 families in natural (uncontrolled) environments. About 50 seedlings from each family were planted at each site (fig. 3). During the same week in September, a fourth screening trial was established in Glacier National Park near Golden, BC. This trial used only 10 families (from the failed inoculation run of 2013).

Demand continues for screening additional families. New funding from the BC Forest Genetics Council will permit work to continue. In December, cones and seeds from 26 new families were submitted by Parks Canada. These seedlings will be ready for inoculating in 2016. Our plan is to perform controlled inoculations on up to 40 additional families per year until 2018. The number of families is likely to vary each year based on cone production and capabilities of cone collecting partners. These partners include national and provincial parks and possibly First Nations groups. In addition, coal and gold mining operations are expanding in whitebark pine habitat. The industry is expressing an interest in using whitebark pine for rehabilitation (Moody and Clason 2013).

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Figure 3—Planting a rust screening trial at Idaho Peak, above Slocan Lake, BC (September 2014).

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