Cronartium ribicola Resistance in Whitebark Pine, Southwestern White Pine, Limber Pine and Rocky Mountain Bristlecone Pine - Preliminary Screening Results From First Tests at Dorena GRC

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Extended Abstract

All nine species of white pines (five-needle pines) native to the United States are highly susceptible to *Cronartium ribicola*, the fungus causing white pine blister rust. The presence of genetic resistance will be the key to maintaining or restoring white pines in many ecosystems and planning gene conservation activities. Operational genetic resistance programs are well underway for western white pine (*Pinus monticola*), sugar pine (*P. lambertiana*), and eastern white pine (*P. strobus*). However, very little is known about the frequency and types of resistance in the high elevation species of white pines, and in particular little or no data is available on family or seed source variation within species such as southwestern white pine (*P. strobiformis*, SWWP), whitebark pine (*P. albicaulis*, WBP), limber pine (*P. flexilis*, LP) and Rocky Mountain bristlecone pine (*P. aristata*, RMBCP). Separate trials to evaluate resistance within these four high elevation species are now underway using seedling families from individual parent tree seed collections. Parent tree selections aregenerally from canker-free trees in natural stands vary in incidence of rust, for example SWWP selections were from stand where >90% of the trees are infected while many ofthe LP and all of the RMBCP selections were from stands not yet invaded by the rust in preparation for proactive intervention (Schoettle and Sniezko 2007). The WBP were selected on the basis of cone availability and not necessarily putative blister rust resistance; however, most of the WBP selections were canker-free.

Artificial inoculation of young seedlings of WBP (from tree selections in Oregon and Washington), RMBCP (from Colorado), LP (from Colorado and southern Wyoming) and SWWP (from New Mexico) with *C. ribicola* were undertaken recently (Table 1). Protocols for inoculation and assessment followed established Dorena Genetic Resource Center (Dorena GRC) standards used for western white pine and sugar pine, as well as prototype research work on these species at Rocky Mountain Research Station (RMRS). In the traditional operational rust resistance screening, seedlings are assessed for five years after inoculation to help elucidate different types of resistances. In a separate short-term operational test, very young seedlings are assessed for six months to two years, particularly to note the presence or absence of a hypersensitive response in the needles (HR) and the presence/absence of stem symptoms. The number of families per species the tests discussed here varies from 10 to >100 (Table 1).

For SWWP, WBP and RMBCP, 2- to 3-year-old seedlings were utilized, and seedlings are being evaluated for a range of possible resistance responses including: number of needle spots, presence and number of stem symptoms, latent stem symptoms, associated morphological and growth patterns, mortality, time of mortality, and combinations of these responses. Two-month-old LP seedlings were inoculated in 2006 and are being evaluated for presence of needle spots, stem symptoms, morphological traits as well as mortality. For SWWP, LP and WBP seedlings of some families are also being evaluated for presence of hypersensitive response (HR) in the needles. Previous inoculations of young seedlings at Dorena GRC and Institute of Forest

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Genetics (IFG) revealed evidence of families with HR in SWWP (Dorena GRC, unpublished data; Kinloch and Dupper 2002; Vogler, pers. comm.) and presence of HR in a bulked seedlot of LP (Kinloch and Dupper 2002); evidence for HR in RMBCP is currently being evaluated at IFG in cooperation with RMRS (Vogler and others 2006).

Inoculation success was very high in all trials. Final results are still pending for all trials. Early results show that genetic variation in resistance exists for all four species and suggest at least a small number of families of each species have high levels of one type of resistance (low levels of stem symptoms). Sniezko and others (2007) reported some early results from a 2004 inoculation in WBP; in a second trial of additional WBP families (2005 inoculation), results one year after inoculation showed a range in family stem infection from 3% to >85% and continue to suggest a geographic trend in this resistance trait (unpublished data). The phenology of disease symptomology appears slower on RMBCP than other species; stem symptoms were only becoming obvious on seedlings 22 months after inoculation. Sugar pine and western white pine seedlings included as controls in the RMBCP 2005 inoculation appear to be much more susceptible than the RMBCP families, displaying many more needle spots, earlier stem symptoms, and earlier mortality. Assessments of the RMBCP seedlings will continue for several more years. Results from testing of SWWP progenies indicate that two of the SWWP parents tested have HR. However, the other families in the test display other types of resistance including low number of needle spots, moderate levels of canker-free seedlings, and to this point, low mortality of infected trees. Young LP, inoculated in 2006, showed a range in family stem infections from 9% to 100% one year after inoculation (preliminary unpublished data). At this early stage in the study, several LP families have a large proportion of their seedlings remaining free of stem symptoms; these and all the families will be assessed further over the next year. In testing of high elevation white pines at Dorena GRC, HR resistance has only been noted in SWWP, and thus the resistance in the other species may be due to other resistance mechanisms.

The frequency, types, and levels of genetic resistance shown in these early screening results are encouraging. Further assessments in all trials are underway. In addition, inoculation of hundreds of new WBP families is planned for 2008, as is inoculation of two-year old LP families to evaluate a suite of resistance responses.

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Table 1—Ongoing C. ribicola resistance screening in high elevation white pines at Dorena GRC.

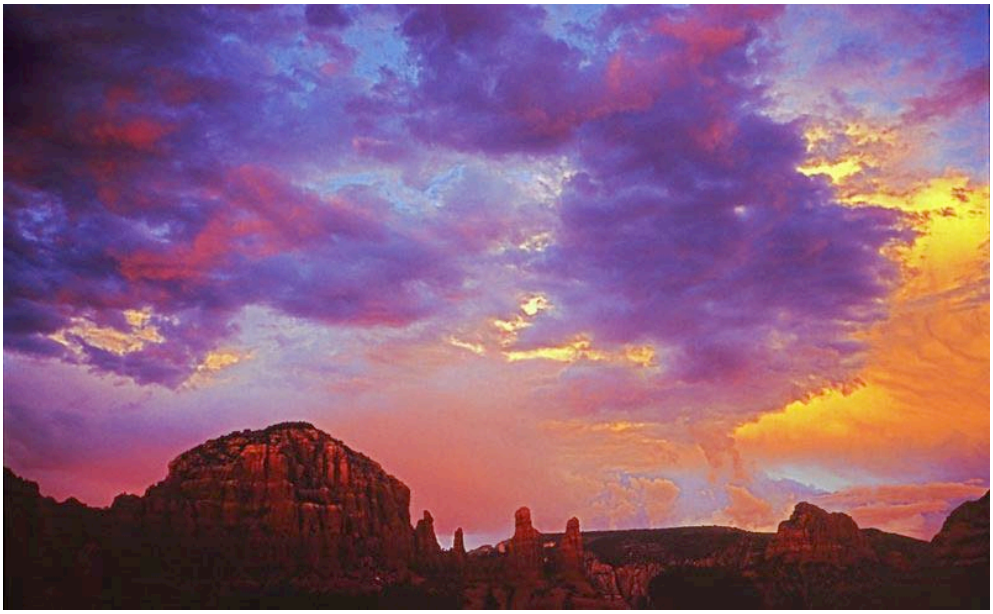
Species[a]	# Families	Test Type[b]	Seed Sources	Sow Year[c]	Inoculation Year[d]
WBP	43	Traditional	Oregon/Washington	2002	2004
WBP	101	Traditional	Oregon/Washington	2004	2005
WBP	24	Traditional	Oregon/Washington	2005	2006
WBP	236	Traditional	range-wide	2007	scheduled for 2008
SWWP	8	Traditional	New Mexico	2002	2003
SWWP	5	Short-term	New Mexico	2003	2003
SWWP	1	Short-term	New Mexico	2007	2007
RMBCP	184	Traditional	Colorado	2002	2005
LP	77	Short-term	Colorado/southern Wyoming	2006	2006
LP	74	Traditional	Colorado/southern Wyoming	2007	scheduled for 2008

[a]Where WBP = whitebark pine, SWWP = southwestern white pine, RMBCP = Rocky Mountain bristlecone pine, and LP = limber pine

[b] Traditional testing consists of inoculation of 2- to 3-year old seedlings and assessment over a period of five years for development of disease symptoms and mortality. Short-term testing involves inoculation of very young seedlings and assessment for the presence of a hypersensitive reaction in the needles and subsequently the presence/absence of stem symptoms and mortality

[c] Year in which the trial was sown for testing

[d] Inoculations are conducted in late August or September.



Sunset over the red rocks outside Sedona, Arizona. Wikipedia.org. October 2008