

Genetic Variation in Height and White Pine Blister Rust Resistance in Sugar Pine (*Pinus lambertiana*)—15-Year Field Trial Results of Three Six-Parent Half Diallels From Three Breeding Zones

J. Hamlin¹, R.A. Snieszko^{2,*}, F. Isik³, D.P. Savin², A. Kegley², S. Long², and R. Danchok²

¹ USDA Forest Service, Umpqua National Forest, Roseburg, Oregon, USA

² USDA Forest Service, Dorena Genetic Resource Center, Cottage Grove, Oregon, USA

³ North Carolina State University, Department of Forestry and Environmental Resources, Raleigh, North Carolina, USA

* rsnieszko@fs.fed.us

Sugar pine (*Pinus lambertiana*) is a long-lived conifer species found in forest ecosystems from southern California to northern Oregon (USA). It is highly susceptible to white pine blister rust (WPBR), caused by the fungal pathogen *Cronartium ribicola*. Two long-term operational programs to develop populations of sugar pine with genetic resistance to WPBR, one in Oregon and one in California, have been ongoing for more than four decades. Most of the resistance work involves artificial inoculation of young seedlings. A small percentage of sugar pine parents have complete resistance (a hypersensitive-like response in the needles in the absence of a virulent strain of the rust) under the control of a single major dominant gene. In addition, there is a low frequency of partial resistance in some sugar pine parents. Partial resistance is thought to be under the control of multiple genes and more durable than the hypersensitive-like needle resistance. Both types of resistance could potentially be combined to increase survival at most field sites. However, detailed field trials to examine partial resistance in sugar pine are relatively rare.

In 1998, a large field trial was established in Happy Camp, California, to examine partial resistance, its inheritance, and its durability. The trial was established with 39 full-sib families, produced from crosses among three six-parent half diallel mating designs

(18 parents). The parents of the three diallels, all field selections from the early years of the Oregon program, represented three different breeding zones for sugar pine in southern Oregon. Prior rust resistance screening of seedling progeny showed only low levels of partial resistance (at least for 2-year-old seedlings) in these full-sib families. Post-planting survival was excellent, and height averaged 88, 312, and 537 cm in 2001, 2007, and 2012, respectively. Rust infection (stem cankers) was extremely low until 2007. In 2007, the site averaged 73-percent infection, with full-sib family means ranging from 50 to 96 percent; in 2012, the site averaged 89-percent infection, and family means ranged from 66 to 100 percent. The number of stem infections per tree averaged 4.7, and full-sib family means ranged from 1.9 to 14.3 in 2007; number of stem infections increased to 8.0 in 2012, with family means ranging from 3.2 to 19.1. Mortality from rust was relatively low through 2012, with full-sib family means ranging from 3 to 47 percent. The level of partial resistance exhibited by some sugar pine families is encouraging. The results will be used to help examine genetic differences in growth and rust resistance among the breeding zones, examine inheritance of some components of partial resistance, and provide possible selections for sugar pine seed orchards and for future breeding to increase rust resistance.

In: Schoettle, Anna W.; Snieszko, Richard A.; Kliejunas, John T., eds. 2018. Proceedings of the IUFRO joint conference: Genetics of five-needle pines, rusts of forest trees, and Strobosphere; 2014 June 15–20; Fort Collins, CO. Proc. RMRS-P-76. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 245 p.

Papers published in these proceedings were submitted by authors in electronic media. Editing was done for readability and to ensure consistent format and style. Authors are responsible for content and accuracy of their individual papers and the quality of illustrative materials. Opinions expressed may not necessarily reflect the position of the U.S. Department of Agriculture.