Genetic Diversity for Stripe Rust and Stem Rust Resistance in Wheat Landraces

Nearly half of the world’s population depends on wheat for their daily food supply, and more than 500 million Mg of grain are produced every year. Unfortunately, 25 to 30% of the potential yield of this crop is lost every year because of plant diseases and weather-related stress. Some of the most damaging diseases are the wheat “rusts,” caused by a number of species of parasitic fungi.

Stem rust and stripe rust are caused by the fungi *Puccinia graminis* and *Puccinia striiformis*, respectively. Both rusts have caused significant crop destruction throughout recorded history and continue to be major problems with frequent emergence of new races of the pathogens. More importantly, rust diseases can be easily disseminated by wind to new areas, making it a global concern. This was seen with the recent spread of stem rust race Ug99, which was first reported in Uganda and has now spread as far as Iran, a distance of more than 3,000 miles. Stripe rust is also important regionally as there has been an increase in races of the pathogen with heavier disease pressure in the Pacific Northwest (PNW) of the U.S.

Developing resistant cultivars is the most efficient and environmentally friendly method to control wheat rusts. Classical and modern plant-breeding techniques in wheat have increased yield and resistance; however, genetic diversity has been narrowed as a consequence of selection for desired traits. Genetic diversity of resistance has the potential to protect crops from circumstances similar to the Ug99 outbreak where all wheat-growing regions are at risk due to deployment of a limited number of major resistance genes.

Exotic germplasm, including wild species and wheat landraces from different parts of the world, are a potential source for unexploited genetic diversity that can be introduced into modern wheat-breeding programs. In the September–October 2014 issue of *Crop Science*, researchers report on their search of novel rust resistance genes by examining 652 wheat landraces from 54 countries. These landraces were previously screened for stem rust resistance in Kenya and were screened for resistance to current races of stripe rust in the Pacific Northwest. Stripe rust resistance was found in 165 landraces, 30 of these also were resistant to stem rust race Ug99.

By comparing the landraces using nearly 9,000 DNA markers, a family tree and the measures of genetic similarity among the landraces were generated. The phylogenetic tree and the graph showing relatedness can be viewed in the *Crop Science* article (see below). Landraces resistant to both stripe and stem rust grouped into distinct clusters; this indicates that the resistant landraces are genetically diverse, meaning there likely are multiple genes available that can confer resistance to one or both of these rusts.

By using DNA markers and molecular phylogenetics, efficient exploration of genetic diversity can be accomplished. Resistant landraces from distinct clusters can be used to evaluate unique novel resistance genes that could be incorporated into elite breeding materials. Genetically different landraces with disease resistance have both global and regional application as sources to develop new and diverse germplasm that will help combat severely yield-limiting pathogens of this important food crop.