Bringing the laboratory to the field

Molecular markers provide wheat breeders with a new tool **by Deven See,** *Research Geneticist, USDA ARS*

Science progresses through the accumulation of knowledge. As new insight is acquired, new technology is developed to take advantage of it. In the field of genomics, specifically molecular markers, new technology is finding application in traditional wheat breeding.

The observation of genetic potential in the field has been at the core of wheat breeding for generations. In recent years, research has provided a better understanding of the wheat genome and an ever increasing inventory of useful molecular markers. Molecular markers enabled scientists to identify the expected genetic potential of a wheat plant and select for it in early generation germplasm screening in the laboratory. This concept is known as marker assisted selection.

The synergy of field-based breeding and laboratory-based analysis has the potential to further wheat breeding in a more precise and rapid way than was previously envisioned. To increase scientific understanding of a plant's genetic potential, the United States Department of Agriculture developed small grains genotyping centers across the nation. The concept at the core of each genotyping lab is to provide molecular marker profiles for wheat and barley to breeders and other scientists as a means to facilitate the emerging concept of molecular plant breeding.

It's fitting that Kansas State University, the first land grant university developed under the Morrill act of 1862, receive inaugural funding for a genotyping lab, followed in successive years by funding for three other labs in Fargo, North Dakota; Raleigh, North Carolina; and finally, Pullman in 2005. While the three labs funded in earlier years have full funding, due to the late start of the genotyping effort in Pullman, funding is currently set at only 44 percent of the national level.

The geographic positioning of the genotyping labs in Raleigh, Fargo, Pullman, and Manhattan, Kansas concentrates the labs' expertise on relevant diseases, market classes, and regional growing conditions. With the hiring of a full-time scientist in early 2007, the USDA-ARS Western Regional Small Grains Genotyping Lab (WRSGGL), on the campus of Washington State University, has ramped up production to service the research needs of more than 25 cereal scientists in Washington, Oregon, Idaho, Montana and California. In spite of the partial funding, the now fully-operational genotyping lab has, in the past two years, processed more than a quarter-million samples for scientists in all five states.

Genotyping labs provide a very informative snapshot of what prevailing issues are at the core of each breeding program's new germplasm development. At the WRSGGL, the primary concern is identification of the molecular markers that track the resistant genes for stripe rust. In 2008, 65 percent of all molecular marker work was for marker assisted selection for disease resistance. Other diseases of interest to breeders the genotyping lab addresses includes leaf rust, strawbreaker foot rot, *septoria tritici* blotch, and Hessian fly resistance.

Following disease resistance, agronomic characteristics account for 26 percent of genotyping work. These traits include winter growth habit (vernalization), reduced plant height, photoperiod response, seed color, and preharvest sprouting.

Quality traits make up the remainder of the workload and consist mainly of both high and low molecular weight glutenins, grain protein content, grain texture (hardness), cadmium uptake (durum wheat), and pasta color characteristics (polyphenol oxidase) genes.

Work outside the breeder community includes varietal purity screening for farmers, seed producers and the crop improvement association. This work consists of screening the DNA of seeds in question against a diagnostic panel of molecular markers to determine if the seed stocks are pure or contain a certain percentage of different wheat.

Also, independent research to identify new useful molecular markers is currently in progress in collaboration with multiple scientists. Some specifics include identifying molecular markers that are more predictive of how a wheat plant reacts to day length (photoperiod response), and correlating molecular marker profiles with glutenin information from the wheat quality lab to enable early generation selections of good glutenin genes. Recent collaborative work has resulted in preliminary results indicating that molecular markers may be predictive against falling numbers in wheat, an important issue in light of recent sprout discounts.

With two years under our belts, the genotyping lab is still growing, both in capacity and in capability. A generous contribution from the Washington Wheat Commission and the Washington Tree Fruit Commission allowed us to dramatically increase genotyping capacity with the purchase of a new $100,000 sequencer.

As science progresses and new information is added, the genotyping lab will continue to provide cutting edge molecular marker assisted selection techniques to Washington's breeding programs. This important work will help maintain both the competitiveness of PNW wheat, and keep US wheat in the global market. ■