Making breeders look good

TECHNICIANS ARE KEY TO RELEASING IMPROVED VARIETIES

By Arron Carter

It’s breeders who get the accolades for releasing a superior new variety, but to paraphrase an old proverb, “Behind every great plant breeder stands a great technician.” Or in my case, multiple technicians.

Although the goal of most plant breeding programs is to develop and release new varieties, there are multiple objectives that must be accomplished before that happens. In the winter wheat breeding program at Washington State University (WSU), our overarching objective is to release cultivars that lead to sustainable wheat production in Washington.

To accomplish this, I break down the winter program into three core objectives: 1) increase yield potential and agronomic adaptability; 2) provide genetic resistance to biotic and abiotic stresses; and 3) maintain acceptable, end-use quality for target markets. Even with these objectives defined, however, a plant breeding program still needs to identify how they are going to get new cultivars that meet them.

Objectives don’t just give you the targets to shoot for in a new cultivar, they help provide a roadmap to create genetic variation. Without genetic variation, it is very difficult to make new cultivars better than current cultivars. You also have to be able to select upon the variation that you have created. If you make a cross between a resistant and susceptible cultivar, for instance, you have to be able to identify which progeny are resistant and which are susceptible. Without the ability to make selections, it’s very difficult to develop improved cultivars.

A successful wheat breeding program is less about the breeder than it is about the team the wheat breeder assembles. Arron Carter (center), winter wheat breeder at Washington State University, stands among his technicians beneath the school’s mascot. On Carter’s left are Tong See, end-use quality technician, and Kerry Balow, greenhouse technician. On his right are Gary Shelton, field technician, and Adrienne Burke, molecular lab technician. Photo courtesy of Washington State University

Our winter wheat breeding program at WSU has a complex maze of strategies to develop new cultivars, all which require a significant investment of time. I may be the one talking to farmers about new cultivars, but my ability to develop varieties would be tremendously compromised were it not for my technicians who provide the input, data and hard work.

Most of my time is spent making decisions on which lines to advance and release as cultivars, as well as how best to test and select different breeding lines, not to mention general oversight. My technicians’ time is spent making hybridizations and selections and gathering data, which in turn allows me to more effectively do my job, which is releasing varieties targeted to all the different production regions of the state.

KERRY BALOW, my greenhouse technician, is an expert in creating genetic variation. Growing plants in the greenhouse year round is a complex task. Add on the fact that you have to plan ahead two months with winter
wheat (because of the vernalization requirement), and it becomes even more difficult. Kerry has been able to manage this with consummate skill.

Currently, Kerry manages 12 greenhouse bays and keeps plants moving through them year round and with little disease pressure. She carefully plans what needs to be planted and vernalized and when material will be harvested. Leaving a week or two of down time between projects to keep the bays disease free, plants are constantly moving through the greenhouse with few setbacks.

Apart from managing space (not only for our program, but for graduate students as well), Kerry also makes all of the cross hybridizations in the program, upwards of a 1,000 annually. This not only requires planning, but it’s also a skill to successfully emasculate and pollinate plants with the correct donor. Without Kerry, we would not be able to create the needed variation in breeding lines to meet the diverse requirements of farmers in Washington.

Another technician who helps create genetic variation is ANNA KONDRATIUK. Although she’s not a technician in the winter wheat breeding program per se, Anna runs WSU’s Doubled Haploid Laboratory, which creates doubled haploid lines. After technicians make the initial F1 cross, seeds are given to Anna who creates doubled haploids.

We give Anna anywhere from 100 to 120 crosses a year. In return, she generates 4,000 to 5,000 doubled haploids. This again requires careful planning and skill. Doubled haploid production requires emasculation and corn pollinations, tissue culture to rescue embryos, chemical treatment of rescued haploid plants and subsequent increasing of the lines for seed production. I am grateful to Anna for her dedication in developing lines for the breeding program.

Now that genetic variation has been created, selections must occur. One part of our selection process prior to field testing is done on the genotypic level. ADRIENNE BURKE is the technician who manages the winter wheat breeding program’s molecular laboratory. She has the technical skills and organization to optimize many difficult protocols to screen. Using DNA markers, she screens more than 150,000 potential breeding lines each year.

Adrienne developed protocols to increase efficiency in the screening process including planting wheat in small, six-inch boxes and extracting DNA using magnet technology. A great deal of time and effort goes into managing the large number of lines and data, tweaking molecular marker protocols and ensuring the correct plants with the desired trait are selected and advanced for field testing.

Adrienne also assists with other selection in the greenhouse, such as herbicide tolerance and disease resistance. Additionally, she helps direct the genomic selection efforts of the program. She also runs marker profiles on
around 300 breeding lines in advanced testing, which helps identify the traits they’re carrying. This information is vital in allowing us to make the best crosses in the breeding program. Adrienne’s expertise has allowed us to fully utilize high-throughput genotyping to advance selection in the breeding program.

The process becomes even more complex transitioning to the field, but I sleep well at night knowing that another technician, GARY SHELTON, is the man in charge of managing upwards of 20 unique locations. At each location, plants must be cared for; weeds must be controlled; and data must be collected. This requires coordination and planning and multiple trips to each location to ensure data is collected in a timely manner.

In addition to taking care of plots, Gary coordinates planting and harvesting. At most locations, we have about six weeks of time from finishing harvest to beginning to plant. That’s not much time to collect all the post-harvest data, make selections and then get the seed ready for planting. With our span of climatic zones, we are often planting in the dry country before we are finished harvesting in the high rainfall areas.

Gary’s job has become even more time consuming as we now have two open field technician positions. While we have tried to refill the full-time position, it has been difficult. We are now competing in a world of private companies that are filling positions as they expand their plant breeding programs. For the time being, the remaining technicians have stepped up to take on additional duties, but we are confident the right person will be found to fill an essential role in the program.

After lines are harvested, our attention turns to end-use quality. Our end-use quality technician is WORAPONG (TONG) SEE. She does double duty working with both the winter and spring program. Once again, careful planning is required to manage the more than 2,000 samples she receives on an annual basis. Further complicating the task, about 20 different tests need to be performed on lines coming from both hard and soft crosses. These tests can be labor intensive and tedious in nature, but Tong is able to quickly return the data to the breeding programs so further selections can be made.

I have only given a snapshot of the daily activities of the technicians associated with the winter wheat breeding program, and as I read back over what I have written, it does not do justice to what they actually contribute. I have left out the ordering they do, the bills they pay, the machines they fix, the students they mentor, the collaborations and researching they do and much, much more.

I started off by saying that behind every great plant breeder are great technicians. Actually, I like to think that I stand among my technicians. I may lead the program, but without the entire team on the field, we couldn’t provide the variety releases that will meet the needs of growers throughout the state.

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