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Initiative Aids in Development of Barley Varieties with Improved Scab Resistance

One of the world's oldest cultivated grains, barley is the fourth most important global cereal crop after wheat, rice and corn. Within the United States, 3.0 million acres of barley were harvested in 2013, yielding more than 215 million bushels. The crop is utilized in three primary ways: as malt for the making of beer and other beverages; for human consumption; and for animal feed.

Like wheat, barley production faces threats from a myriad of diseases – one of the most important being Fusarium Head Blight (FHB), or scab. Since the early 1990s, scab has inflicted billions of dollars in damages to U.S. wheat and barley crops by causing lower yields and test weights and by triggering formation of a mycotoxin known as DON (short for deoxynivalenol). Above a certain level, DON can make barley unhealthy for direct human or animal consumption and likewise can make it unsuitable for malting and brewing purposes.

That's why barley has been part and parcel of the U.S. Wheat & Barley Scab Initiative (USWBSI) since the group's establishment in the latter 1990s. Through funding support and information exchange venues, the USWBSI provides substantial assistance to barley researchers as they strive to combat scab via the development of cultivars with higher levels of resistance to this disease, as well as improved crop management practices.

While there are, as yet, no barley varieties that can be considered "highly resistant" to scab, progress definitely has been – and is being –

made. In 2010, for instance, the University of Minnesota released a new six-rowed barley variety called "Quest," which is significantly more resistant to scab and DON accumulation, compared to most other Upper Midwest barley varieties. And North Dakota State University has released a two-rowed malting barley variety, "Conlon," that accumulates less DON than any other currently malting-approved variety.

University of Minnesota barley breeder Kevin Smith says one of his program's main priorities is to develop and test methods that improve the efficiency of breeding barley with lower DON, high yield and acceptable malting quality. His work is intertwined with research conducted by other scientists in the U.S. Wheat & Barley Scab Initiative. For example:

• Smith works closely with the laboratory of UM cereal plant pathologist Brian Steffenson to screen for new genetic sources of resistance and conduct genetic mapping studies.

• He also develops and shares genetic stocks that are used by UM molecular geneticist Gary Muehlbauer's lab to conduct experiments to illuminate the genetics of resistance and identify important genes.

• Smith likewise collaborates with Richard Horsley, North Dakota State University barley breeder, in field disease and yield screening to identify superior breeding lines and potential new varieties.

The Minnesota barley breeder says that the financial support provided by the U.S. Wheat & Barley Scab Initiative has been integral to the progress made by his program in the development of enhanced scab resistance. "We have invested a lot of resources into FHB/DON breeding because this is an important disease in our region," Smith states. "The large field-based disease screening effort, multiple genetic studies and marker-based selection

approaches would not be possible (or only on a very small scale) without the USWBSI."

Gary Muehlbauer says the Scab Initiative is the source of all his lab's funding for its work on barley and wheat resistance gene identification and resistant-line development. "Our work has already benefited stakeholders through the more-efficient selection of FHB-resistant barley varieties," Muehlbauer points out.

Brian Steffenson explains that controlling scab takes on added importance considering that "even low amounts of mycotoxins can render the grain useless to end users." His lab focuses on enhancing FHB resistance of barley cultivars from "more-distant sources" (i.e., landraces and wild species) outside the regular gene pools. The lab engages in "pre-breeding" - taking the original sources of resistance and then backcrossing them several times to produce more agronomically advanced lines. Selected lines are then provided to Kevin Smith for his breeding program.

Support provided by the U.S. Wheat & Barley Scab Initiative is "absolutely vital" to his laboratory's work, Steffenson stresses.

NDSU breeder Horsley, who develops both six-rowed and two-rowed barley varieties, says that a key challenge when developing a malting barley variety with improved FHB resistance is "making sure that the variety also has agronomics acceptable to the producer and the malt quality acceptable to the maltster." Much of the resistance used by the NDSU and Minnesota breeding programs originates from Chinese sources of resistance that are unsuitable for the Upper Midwest (e.g., too tall, very weak straw and very late in maturity; also of very poor malting quality). That reality can add

several years to the already-long process of developing a new malting barley variety acceptable for release to producers.

The NDSU barley breeding program has been among those benefiting from the U.S. Wheat & Barley Scab Initiative's support, Horsley reports. "Finding the potential variety that has improved FHB resistance – and acceptable agronomic performance and malt quality – is a 'numbers game,' " he observes. "To identify variety candidates, we had to increase the size of our breeding program, which would have been extremely difficult without the USWBSI funding."

USWBSI funding also has been critical to the screening of more than 3,000 samples from Horsley's program for DON content each year. The NDSU malt barley quality laboratory, directed by Dr. Paul Schwarz, conducts those analyses.

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