All hands on deck

USDA-ARS, WSU SCIENTISTS TACKLE FALLING NUMBERS

By Camille M. Steber and Kimberly Garland Campbell

The 2016 growing season saw many Washington farmers crying in their coffee when a beautiful wheat harvest suffered stiff discounts for low falling numbers.

The much maligned, but still industry standard Hagberg-Perten falling number (FN) test is used to measure damage to wheat starch caused by the alpha-amylase enzyme. Overseas customers specify in their tenders a falling number of 300, which corresponds to the time it takes in seconds for a plunger to fall through a slurry of flour. Below the 300 level, customers have identified problems with end-use functionality.

Alpha-amylase is produced as a consequence of either preharvest sprouting or late-maturity alpha-amylase (LMA). Preharvest sprouting occurs when rain falls just before harvest, when the grain is mature but the plants are still drying down. During rain-induced preharvest sprouting, the grain produces alpha-amylase to digest starch as energy to fuel seedling growth. During LMA, the enzyme is induced much earlier in response to large temperature fluctuations during late grain filling. LMA is considered a developmental defect because starch should be synthesized, not degraded, during this soft-to-hard dough stage of development.

While part of the low FN problem in 2016 was due to rain-induced preharvest sprouting, our research showed LMA was responsible for the lion's share of the problem. We have been evaluating FN in the Washington State University's (WSU) Variety Testing Program wheat trials since 2013 and now realize that LMA has been a factor most years. With that realization, it's clear we need to expand LMA screening of breeding lines. At the same time, we cannot neglect to screen for preharvest sprouting resistance either.

Since LMA and preharvest sprouting susceptibility are

About 40,000 spikes were harvested in the 2017 field season and then packaged up into 40 black plastic bags fondly referred to as the "Falling Number Mountain."

The Falling Number team members who participated in the LMA and preharvest sprouting testing in the 2017 field season. Not all team members are pictured.

governed by different genes, wheat researchers at WSU have had to develop separate screening and mapping systems for the two problems. During the 2017 field season, researchers at the university teamed up with scientists from the Agricultural Research Service (ARS) of the U.S. Department of Agriculture to meet this screening challenge.

Since we cannot control the weather, the best strategy to combat low FN is to breed for genetic resistance to LMA and to preharvest sprouting. Until now, screening has been more reactive than proactive, focusing only on released or soon-to-be released varieties. The falling number project is now scaling up. In 2016, 10,000 spikes from 500 lines were harvested from the field for LMA testing in cold chambers at Spillman Farm. In 2017, more than 40,000 spikes of wheat from 1,200 lines were collected for LMA testing. Moreover, about 1,500 mapping and breeding lines were harvested for preharvest sprout testing in 2017. Our team fondly refers to the collected wheat spikes as the "Falling Number Mountain." The Steber Lab will spend the winter performing LMA and sprout tests in the lab and greenhouse and an article in the January 2018 issue of *Wheat Life* will chart our progress thus far.

Resources to perform this work were contributed by the Washington Grain Commission, the ARS and WSU. Along with our two programs, winter wheat breeder Arron Carter and spring wheat breeder Michael Pumphrey contributed vehicles and personnel to the project. In the end, more than 30 people including graduate and undergraduate students, technicians and faculty participated in the research.

Much more remains to be done. In 2017, the falling number team screened elite breeding lines and mapping populations. In order to effectively select for LMA and sprout resistance in the breeding programs, Campbell estimates the project will need to test approximately 200 elite breeding lines, 800 mid-level breeding lines and 5,000 early breeding lines each year.

Because screening 5,000 early breeding lines is not possible, the falling number research group will initially map resistance genes so that DNA markers can be used as the first line of defense against LMA and preharvest sprout in the early breeding material. Field screening will confirm the presence of resistance in mid- and elite-breeding material.

As the project moves forward, new varieties released by WSU and the ARS will have increasing resistance to low falling numbers. If we do our job right, farmers will no longer notice when we have LMA-inducing weather because their wheat will be resistant. ■