Frequently asked questions – Low Falling Number and Wheat

“Falling numbers” refers to a test for increased alpha amylase activity, an enzyme which when present can significantly reduce grain quality. The lower the number, the higher the enzyme activity, and thus the lower the quality.

1. What is the falling number test? What exactly does it measure and why is this important to the buyers of PNW wheat?
Falling number (FN) is a test designed to predict the presence of alpha amylase (AA) enzyme activity in grain. The FN test makes gravy out of a flour sample and uses a falling paddle to test how thick the gravy remains over time. The FN time is the number of seconds it takes to mix the sample and have the paddle fall through the gelatinized starch. The grain trade has adopted FN as a risk management tool. When FN is below 300 seconds the chance that AA enzymes are active increases exponentially. High AA activity, indicated by low (<300) falling numbers, is a danger in grain because the digested starch compromises the ability to produce good quality products.

2. What are the end-use quality effects of low FN in wheat and high AA?
The effect depends on the product. Low FN and high AA activity are harmful to any product that depends on the gravy-like viscosity produced by starch. AA is highly detrimental in high moisture, batter-based products like cakes, muffins and batter coatings. High fat and sugar doughs, like cookies, can tolerate some AA activity. In bread baking, AA is actually added in many commercial formulas but this only works if there are some intact starch granules. AA is a big problem for all products if the damage is so severe that the starch granules have been destroyed. Even though some AA can be tolerated, flour mills produce flour for many different types of products from a single mill run, so low FN grain is hard to use.

3. Why has FN been such a problem the last several years?
Falling numbers are affected by both temperature fluctuations and precipitation patterns. Washington wheat growers have experienced record-setting summer temperatures the past few years, coupled with mid- to late-summer rain events. Both have caused regional occurrences of low FN.

4. What are the causes of low FN?
There are two main causes of low FN: 1) preharvest sprouting (PHS), the initiation of germination by cool, rainy conditions after the wheat turns from green to gold; and 2) Late maturity alpha amylase (LMA), caused by a large temperature increase or decrease during grain maturation (26-30 days past pollen shedding).
5. **Why is the falling number test so variable?**

   Variation can result from: 1) micro-environments within the field leading to variation in the FN of harvested grain; 2) sampling error inherent in collecting a small grain sample that represents a truckload or bin; and 3) variability inherent in the testing procedure itself.

6. **How important are genetics and environment in influencing FN?**

   Both genetics and environment influence FN. Genetics is responsible for about 15% of the total variation for FN based on ratings of the WSU Variety Trials. The environment is responsible for about 40%. The rest of the variation is due to other factors. To compare, 15% of the total variation for grain yield is due to genetics and 75% is due to the environment, with the rest due to other factors. Breeding for higher FN requires that we identify and control other factors that add to the variation in the results, as we have learned to do for grain yield.

7. **Are particular market classes and/or varieties more or less susceptible to low FN?**

   In general, hard red wheat is more tolerant of PHS than soft white wheat. Late-maturity alpha amylase has similar effects on all market classes. Some cultivars show tolerance to PHS and LMA. WSU and USDA scientists are conducting research needed to provide growers with cultivar information.

8. **How/should I select a wheat variety based exclusively on FN potential?**

   Keep in mind that there are a myriad of factors to consider when choosing a variety to plant. Choosing a variety based solely on FN potential is probably not the best course of action. Consider yield potential, disease resistance, winter-hardiness, etc. as well as FN in your selection. The website [http://steberlab.org/project7599.php](http://steberlab.org/project7599.php) presents FN data on varieties measured from 2013-2016 WSU Variety Testing trials and is updated with new information regularly. In environments that trigger FN issues due to either LMA or PHS, varieties that seem to be more prone to low FN are: Bruehl, Curiosity CL+, Jasper, Mela CL+, Pritchett, SY Ovation, WB-Junction and Xerpha. Varieties that seem to be less prone to low FN are: ARS-Crescent, Cara, Coda, Legion, Mary, Masami, Otto, Puma, SY 107, WB-528 and WB 456. Choosing varieties with different maturities can help to minimize risk of low FN since weather conditions (temperature and rain) at specific stages have such a strong influence.

9. **Can FN be increased if I store my grain?**

   Studies are limited but suggest that grain may slightly recover from low FN following storage, especially at higher temperature. An increase in FN of 50 seconds was observed with 3 months storage at 100°F. However, increases may also be due to sampling. The first sample may have been from a part of the field that had more moisture causing more sprouting. If all the grain is stored and a second sample taken, that sample may represent a different part of the field that had higher FN.
10. Can I blend low FN grain with high FN grain to increase the average FN in the grain lot?
Low FN grain can't be reliably mixed with high FN grain to increase the average above 300. As little as 5% grain with low falling number can significantly decrease the falling number of a larger sample of grain with a FN above 300. Very large quantities of high FN grain are required to blend up low FN wheat. Most growers do not handle the quantities needed to blend up FN.

11. Why have I never heard about falling numbers until the past year or two?
There was a large PHS event that caused low falling numbers in the early 1980’s but no widespread problems with PHS or LMA until recently. Every year, some grain is harvested with lower than 300 second FN. This usually occurs in small quantities, and there are very large quantities of grain with FN >300 seconds, so the grain industry is able to absorb the low FN grain and still meet market specifications. Wheat is discounted in years when large quantities of grain have low FN because there isn't enough high FN grain to blend to meet export specifications. We often see a similar trend with protein content when there is an oversupply of soft white wheat with > 13% protein and high protein wheat is discounted.

12. Can we replace the falling number test?
The FN test is the industry standard. Even though this is the standard, ways to improve the test should be investigated.

13. What research efforts are underway to address this problem?
Collaborative efforts between WSU and the USDA, in consultation with industry stakeholders, are underway to investigate various aspects of falling numbers. These include:
- Testing grain of different FN values to determine the effect on milling and baking of various products.
- Developing an NIR calibration to rapidly estimate FN values.
- Developing a rapid test for AA and determining its correlation with low FN.
- Making crosses to sources of PHS resistance from other parts of the country.
- Making crosses with sources of PHS resistance that we have developed ourselves through mutation breeding.
- Screening breeding material and released varieties for LMA and for PHS in field and greenhouse settings so that we can select for higher FN.
- Determining the genetic control of LMA and PHS, with associated DNA markers, which can be used for selection.
- Meeting regularly to compile data and provide the best and most accurate information to growers and the grain industry.
Future efforts:

- Determine whether on-farm storage increases falling numbers and how this can be managed.
- Determine how growers can mitigate their risk through better management of planting date, variety selection, harvest date, fertility, grain protein content, etc.
- Analysis of the genetic aspects of susceptibility as a basis for future breeding efforts.
- Develop long term climate models to forecast how often we can expect PHS or LMA events. Have climatic patterns shifted so that we will see PHS and LMA events more often?
- Conduct predictive environmental modeling to identify geographical regions that are more prone to LMA or PHS events. This will assist growers to decide which cultivars to plant.

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