Washington Grain Commission
Wheat and Barley Research Annual Progress Reports and Final Reports

Project #: 7599

Progress Report Year: _3__ of _3__ *(maximum of 3 year funding cycle)*

Title: Developing Washington Wheat with Stable Hagberg Falling Numbers

Cooperators: Stephen Guy, Craig Morris, Kimberly Garland Campbell

Executive summary: This project was initiated because Washington farmers experienced serious losses due to low Falling Numbers in 2011 and in 2013. The overall goal was to breed for stable Falling Numbers (FN) in Washington wheat. To achieve this goal, we first needed to assess whether the problem was due to Late Maturity Alpha-Amylase (LMA), susceptibility to low FN in response to cold shock during grain maturation, or to preharvest sprouting (PHS), low FN that occurs when mature grain gets rained on before harvest. Much of the problems in 2011 and 2013 were a result of preharvest sprouting. Using additional WGC funding in 2013, we turned the sprouting problem of 2013 to our advantage by performing FN testing of the WSU cereal variety trials. This allowed us to create an online database of FN by cultivar and location that can provide farmers with a good tool to find cultivars with good yield potential in their region that also have less PHS susceptibility (see website: http://steberlab.org/project7599.php). In the course of this project, we discovered that LMA-susceptibility is an emerging problem in Washington, Idaho, and Oregon wheat breeding programs.

Objective 1. Characterize wheat varieties grown at multiple locations as part of the Cereal Variety Trials in 2011, 2012, 2013, and 2014 using the Falling Number test.
FN has been tested in 2011, 2012, and 2013. FN testing of 2013 winter wheat from the Cereal Variety Trials grown in Spillman Farm is now complete. Bruneau, Bruehl, Xerpha, and Selbu had low FN, whereas Ovation, Puma, and Cara had higher FN.

Objective 2 and 3. Characterize spring and winter wheat varieties for degree of LMA susceptibility using methods for simulating LMA-inducing cold shock in greenhouse growth chambers. Determine if LMA susceptibility correlates with previously published molecular markers linked to LMA in Australian wheat cultivars.
Greenhouse LMA testing examined alpha-amylase levels in lines used the the soft white spring wheats grown in the Cereal Variety Trials by comparing lines grown without cold shock (22°C Day/16°C Night) and with a cold shock (18°C Day/7.5°C Night) treatment at 25 days after pollen shedding. LMA susceptible lines should show higher alpha-amylase levels (correlated with low FN) with cold treatment than without cold treatment. Alturas was the only named soft spring cultivar show to show a statistically significant increase in alpha-amylase with cold-treatment. Lines that appeared to be LMA susceptible included: Alturas, WA8124, ARS503174, and IDO854. WA8124 and Alturas also showed low FN in 2011. This very preliminary result suggests that selection against LMA susceptibility in breeding material is needed, but that the problem is not yet wide-spread in released spring cultivars. Molecular marker analysis will be performed once greenhouse testing of winter wheat is completed.

Objective 4. Determine if low Hagberg falling numbers in the field are correlated to with high alpha-amylase levels in greenhouse LMA testing or to PHS susceptibility.
Preharvest sprouting susceptibility was examined using the spike-wetting test followed by scoring for visible sprouting. Based on this assay, some sprouting resistant cultivars had higher FN (Ovation, Masami) and some sprouting susceptible cultivars had very low FN (Bruneau, Xerpha, Selbu). But overall, there was not a strong correlation (r = -0.22; p-value = 0.09) between sprouting tolerance in the spike-wetting test and FN of the winter variety trials grown at Spillman Farm in 2013. This lack of correlation may result from the fact that while greenhouse spike-wetting tests take maturation date into account, field FN data does not. Or it suggests that a better testing method is needed to predict susceptibility of wheat cultivars to low FN/high alpha-amylase in response to rain.

Impact: Wheat in all market classes is dramatically discounted if testing shows that it has low falling numbers (below 300). Moreover, a consistent problem with low FN could damage the reputation of Washington wheat in foreign markets. Selection against The discovery that LMA susceptbility has made its way in Washington cultivars is bad news in the sense that we have to deal with breeding against this problem, but it is good news in that it appears to be a problem mainly in WSU and USDA breeding lines. This means that we have the opportunity to correct the problem before it negatively impacts our market and reputation. Selection of wheat varieties with consistently higher falling numbers. is the most practical and straightforward strategy of controlling this problem.

WGC project number: 7599
WGC project title: Developing Washington Wheat with Stable Hagberg Falling Numbers
Project PI(s): C. Steber, M. O. Pumphrey, A.H. Carter
Project initiation date: 07/01/12
Project year: 3 of 3

Objective	Deliverable	Progress	Timeline	Communication
1. Characterize wheat varieties grown at multiple locations as part of the Cereal Variety Trials in 2011, 2012, and 2013 using the Falling Number test and examination for signs of preharvest sprouting in order to determine which varieties are susceptible to LMA or have significantly lower falling numbers.	Knowledge about the susceptibility of spring and winter wheat varieties to low FN both in years when there was not a serious problem (2012) and in years when there was a problem with low FN (2011, 2013, 2014)	The Falling Numbers of the Spring and Winter Variety Trials were analyzed at selected locations in 2011 and 2012 to determine which lines tended to have lower falling numbers. With supplementary funding, the project was able to analyze FN for all available locations in 2013, and 2014 is in progress. All Falling Number data plus a tool for comparing FN to yeild have been entered into a database that is available on the website: steberlab.org/project7599.php	Year 1. FN testing of breeding lines and variety trials from select locations in 2011 and 2012. Year 2. FN testing of breeding lines and all locations available from the 2013 Cereal Variety Trail. Year 3. Single repetition data has been completed for the soft white winter and spring variety trials at multiple locations. Remaining variety trial and beeding samples will be analyzed by June 2014.	Results were communicated through talks at the Wheat Research Review, the Western Wheat Quality Council, and at two conferences, through annual Wheat Life articles, abstracts submitted to the Lind and Spillman Field Days, and through the project website: steberlab.org/project7599.php.
2. Characterize spring and winter wheat varieties for degree of LMA susceptibility using methods for simulating LMA-inducing cold shock in greenhouse growth chambers. The techniques will be developed in 2012 and used for wide-scale evaluation in 2013 to 2014.	Knowledge about the susceptibility of spring and winter wheat varieties to low FN resulting from alpha-amylase expression in response to cold shock during late grain maturation. This LMA is genetically different from preharvest sprouting, and does not require a rain event after maturation to see damage.	Greenhouse testing for LMA has been performed for entries in the 2013 Spring and Winter Cereal Variety Trial entries.	Year 1. Developed LMA Greenhouse testing method using known resistant and susceptible lines. Year 2. LMA testing of spring wheat. Year 3. LMA testing of winter wheat.	Results were communicated through talks at the Wheat Research Review, the Western Wheat Quality Council, and at two conferences, through annual Wheat Life articles, abstracts submitted to the Lind and Spillman Field Days.
3. Determine LMA susceptibility in Washington cultivars is associated with previously published molecular markers for LMA on chromosomes 3B and 7B.	If LMA susceptiblity in Washington wheat is associated with the known molecular markers for this problem, then this will provide breeders with a tool to select against LMA	Genomic DNA has been prepared from lines identified as LMA susceptible and resistant, and markers will be run by June 2015.	This objective was dependent on completion of Objective 2. Marker analysis will be completed in Year 3.	Results will be communicated at the Wheat Research Reviews. Information will be communicated to farmers through annual Wheat Life articles, and as abstracts submitted to the Lind and Spillman Field Days.
4. Determine if low Hagberg falling numbers in the field are correlated to with high alpha-amylase levels in greenhouse LMA testing or to PHS susceptibility.	Knowledge about preharvest sprouting susceptbility based on the spike wetting tests. Information about with LMA or preharvest sprouting susceptiblity is associated with the low FN problem.	Preharvest sprouting based on visible sprout in the spike wetting test did not strongly correlate with low FN. However, it was concluded that most of the problems in 2011 and 2013 were due to rain-induced preharvest sprouting. This suggests that we need a better method to determine which cultivars tend to induce alpha-amylase in response to rain events. LMA susceptibility was associated with low FN in the field in Mayview 2011, and in Mayview and Walla Walla in 2013.	Analysis of the association between LMA and low FN in Wahsington will be performed upon completion of the greenhouse LMA testing.	Results were communicated through talks at the Wheat Research Review, the Western Wheat Quality Council, and at two conferences, through annual Wheat Life articles, abstracts submitted to the Lind and Spillman Field Days.