Grant Code: AN2710

Title: Marker Development and Mapping of Falling Numbers Associated with Fungicide Application

Personnel: Dr. Juliet Marshall, Ext. Crop Mgmt. Specialist (SC and E Idaho)
Dr. Arron Carter, Wheat Breeder, Washington State University
Chad Jackson, Research Specialist, Aberdeen, Cereal Extension Program
Linda Beck, Technician, Aberdeen, Cereal Extension Program

Address: Dr. Juliet M. Marshall, 1693 S. 2700 W, Aberdeen, ID 83210, 208-397-181; jmarshall@uidaho.edu.

Justification/Rationale: Despite renewed focus on the issues associated with low falling numbers (FN), much remains to be understood about the physiological processes that contribute to low falling numbers. Results from this year's extension variety trial testing will be helpful in determining the environmental impacts on LMA and sprout thanks to the installation of weather monitoring stations funded by the Idaho Wheat Commission. We know that environmental factors (elevation, temperature conditions, untimely rains) interact with certain varieties that result in increased likelihood of LMA and / or sprout damage. We also understand that a few varieties (Yellowstone hard red winter wheat) have shown an increased tendency to have low FN when strobilurin fungicides were applied at specific plant growth stages (late boot) (Mary Burrows, *personal communication*). Given the development of a recombinant inbred line population developed by Dr. Arron Carter (WSU winter wheat breeder) from the parents Yellowstone and breeding line WA7976, we can investigate and potentially map the genetic basis of the stimulation of LMA via fungicide application.

In addition, with this experiment, we would have material available to collaborators that could utilize plant and seed material to investigate additional hypotheses. The results of this experiment would be important to:

- growers (reducing risks associated with LMA stimulation and low FN)
- industry (increasing stability of quality from the PNW)
- scientific community (enhancing understanding of factors that contribute to LMA)

Hypothesis & Objectives: The hypothesis to be tested: The application of strobilurin fungicides on varieties of susceptible genetic backgrounds results in physiological modifications that impact endosperm development and starch accumulation, resulting in stimulation of LMA.

Objective:

1) Utilize a recombinant inbred line population developed by Dr. Arron Carter at WSU to map the fungicide-inducible LMA.
2) Identify or develop a molecular marker that can be used to screen parental lines or varieties to exclude the trait from PNW wheat.
3) Phenotype the population for additional agronomic and disease characteristics while sampling for additional objectives.

Procedures/Plan of work: In 2016-2017, headrows of the RIL population were established for seed increase at the Aberdeen R&E Center in order to have enough seed for a replicated fungicide trial. Most (90%) of the head rows survived the winter. However, due to ponding at the western edge of the field, 15-20 lines were lost. In 2017-2018, remnant seed of those lines were replanted to obtain a seed increase. At the end of 2018 season, they were harvested and represent the same generation of plant material that were successfully harvested in 2017. In the fall of 2018 (October 2, 2018) the entire set of 206 lines with the recurrent parents were planted in a field at the Aberdeen R&E Center.

Seed were equally divided for a replicated study of fungicide treated versus non-treated plots. Plots were planted under irrigation at the Aberdeen R&E Center and will be managed under best management practices. Strobilurin fungicide (Quadris EC 12 fl oz/A) will be applied at late boot in order to initiate or stimulate physiological response. Agronomic characteristics will be measured throughout the growing season (disease response, plant height, heading date, etc.) and after harvest (yield, test weight, grain protein, FN, etc.). Samples will be sent to the genotyping lab under the cooperation of Dr. Deven See for genotyping. After harvest in July and August of 2019, the experiment will be replanted in September for the second year of the study.

Duration: Year 2 of 3 years

Cooperation/Collaboration: Dr. Bill Price and Dr. Julia Piaskowski will assist in statistical analysis. Dr. Arron Carter has provided the RILs of the parental cross Yellowstone x WA7976. We will continue to work with Dr. Carter on experimental protocol and other phenotyping for which this population could be used. We are coordinating the genotyping with Dr. Deven See, geneticist at USDA-ARS Wheat Genetics, Quality, Physiology and Disease Research Unit Western Regional Small Grains Genotyping Center Johnson Hall 209. *Pullman*, WA USA 99164. Email: *deven_see@wsu*.edu.

Anticipated Benefits, Expected Outcomes and Impacts, and Transfer of Information: Successful completion of this project should be able to contribute substantially to the body of knowledge of LMA and the impact on falling numbers. Through genotyping, we should be able to enhance our understanding of the genetics and physiology behind the genes involved in LMA. Marker development of the associated traits in response to fungicide application may be able to tell us if LMA is more involved in protein or starch formation. The results will be published in a peer-reviewed journal and available to researchers in the PNW. Results will be reported to the IWC and to our growers through presentations at cereal schools and CALS information bulletins.

Literature Review: Rain on mature grain results in sprout damaged wheat with limited utility for end-users. Utilization of the falling numbers test on seemingly sound grain has resulted in significant dockage to our producers. However, the falling numbers test may indicate "sprout damaged" grain (low falling numbers) in the absence of rain directly prior to harvest. Previous research has shown that some varieties treated with fungicides will have increased likelihood of having low FN (Svensson, 1990). Other factors that contribute to low falling numbers include heat or cold shock at a specific growth stage during grain fill (Biddulph et al., 2008; Mares and Mvra, 2008; Mvra and Mares, 1996), fungicide application of certain varieties at a specific

growth stage, extremely low nitrogen fertility (Svensson, 1990; Kindred et al., 2005), and specific varieties with susceptibility to late-maturity alpha amylase induction at high elevations or temperature extremes (Craven, et al., 2007).

LMA expression is also related to plant height / dwarfing genes (*Rht*) that confer sensitivity to gibberellins (Mvra and Mares, 1996). Plant growth hormones (such as gibberellins) regulate growth and influence many factors in the plant, including stem elongation, germination, dormancy, flowering, and enzyme induction. Previous research has shown that some varieties treated with strobilurin fungicides will have increased likelihood of having low FN. There are plant health effects related to strobilurin application that are independent of disease control, including changes in the hormonal balance of wheat which results in improved yield (Vincelli, 2002). It may be possible that the 'plant health effect" associated with strobilurins have an effect on hormonal regulation and therefore affect LMA induction.

References

Biddulph, T. B., Plummer, J. A., Setter, T. L. and Mares, D. J. 2008. Seasonal conditions influence dormancy and preharvest sprouting tolerance of wheat (*Triticum aestivum* L.) in the field. Field Crops Research 107:116-128.

Craven, M., Barnard, A. and Labuschagne, M. T. 2007. The impact of cold temperatures during grain maturation on selected quality parameters of wheat. Journal of the Science of Food and Agriculture 87:1783-1793.

Johansson, E. 2002. Effect of two wheat genotypes and Swedish environment on falling number, amylase activities, and protein concentration and composition. Euphytica 126:143-149.

Kettlewell, P.S. 1999. The response of alpha-amylase activity during wheat grain development to nitrogen fertilizer. Annals of Applied Biology 134:241-249.

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Mvra, K. and Mares, D.J. 1996. Expression of late maturity alpha amylase in wheat containing giberellic acid insensitivity genes. Euphytica 88:69-76.

Svensson, G. 1990. Linkages between sprouting resistance and some agronomic traits in wheat. In: Ringlund, K., Mosleth, E., Mares, D.J. (Eds.), Fifth Annual Symposium on Pre-harvest Sprouting in Cereals. Westview Press, Boulder, CO, USA, p.227-232.

Vincelli, P. 2002. Updated 2012). Q_oI (Strobilurin) Fungicides: Benefits and Risks. *The Plant Health Instructor.* DOI: 10.1094/PHI-I-2002-0809-02. https://www.apsnet.org/EDCENTER/ADVANCED/TOPICS/Pages/StrobilurinFungicides.aspx

FY2020

IDAHO WHEAT COMMISSION - BUDGET FORM

Principal Investigator: Juliet Marshall

Allocated by	Idaho Wheat Commission	during FY 2018	$	-
Allocated by	Idaho Wheat Commission	during FY 2019	$	33,239

REQUESTED FY2020 SUPPORT:

Budget Categories	(10) Salaries (*staff, post-docs, etc.*)	(12) Temp Help	(11) Fringe	(20) Travel	(30) OE	(70) Graduate Tuition/ Fees	TOTALS
Idaho Wheat Commission	$ 15,600	$ -	$ 593	$ 2,500	$ 7,984	$ 7,131	$ 33,808

TOTAL BUDGET REQUEST FOR FY 2020: $ 33,808

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

Budget Categories	*(Insert CO-PI Name)*	*(Insert CO-PI Name)*	*(Insert CO-PI Name)*	*(Insert CO-PI Name)*
(10) Salaries	$ -	$ -	$ -	$ -
(12) Temp Help	$ -	$ -	$ -	$ -
(11) Fringe Benefits	$ -	$ -	$ -	$ -
(20) Travel	$ -	$ -	$ -	$ -
(30) Other Expenses	$ -	$ -	$ -	$ -
(70) Graduate Student Tuition/F	$ -	$ -	$ -	$ -
TOTALS	$ -	$ -	$ -	$ -

Total Sub-budgets $ -

Explanatory Comments:

Fall 2018 Version

ANNUAL REPORT

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Accomplishments: The Objectives of this project are:

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Projections: Successful completion of this project should be able to contribute substantially to the body of knowledge of LMA and the impact on falling numbers. Through genotyping, we should be able to enhance our understanding of the genetics and physiology behind the genes involved in LMA. Marker development of the associated traits in response to fungicide application may be able to tell us if LMA is more involved in protein or starch formation. The results will be published in a peer-reviewed journal and available to researchers in the PNW. Results will be reported to the IWC and to our growers through presentations at cereal schools and CALS information bulletins.

Publications: None as yet.