

**PROJECT NO:** New Project

**TITLE:** Marker development and mapping of Falling Numbers issues associated with fungicide application

**PERSONNEL:** Dr. Juliet Marshall, Ext. Crop Mgmt. Specialist (SC and E Idaho)  
Collaborators:  
Katherine O'Brien (Aberdeen)  
Dr. Jianli Chen, UI Wheat Breeder (Aberdeen)  
Dr. Arron Carter, WSU Winter Wheat Breeder (Pullman, WA)

**ADDRESS:** Dr. Juliet Marshall, 1776 Science Center Dr, Suite 205, Idaho Falls, ID, 83402; 208-529-8376; jmarshall@uidaho.edu

**JUSTIFICATION:** Low falling numbers associated with sprout damage may not be easy to solve, but the blame is easy to affix to rain damage after physiological maturity of the grain. However, many times in the previous ten years there have been low falling numbers issues associated with non-sprouted grain. In the absence of rain or sprout damage, growers have been docked at the elevator with no obvious explanation of the cause. In 2011, stripe rust was severe and fungicides were applied widely to reduce yield losses. Low falling numbers (FN) were shown in varieties in locations where no rain had fallen six weeks prior to harvest, but were sprayed with fungicides. Additional research (Mary Burrows, MSU) showed one variety, the hard red winter wheat Yellowstone, had inducible low FN problems when fungicides were applied at full flag leaf, but not when fungicides were applied at tillering. Understanding the physiology behind inducible LMA may provide insight on improving methods of prevention.

**HYPOTHESIS & OBJECTIVES:** We hypothesize that the fungicide-inducible LMA phenotype can be mapped, we can develop molecular markers associated with fungicide-induced low FN, and we can possibly associate a physiological mechanism such as induction of plant growth hormones. Markers could then be used to screen parental lines and exclude those in the breeding program.

**Objective:**

- 1) Utilize a recombinant inbred line population developed by Dr. Arron Carter at WSU to map the fungicide-inducible LMA induction.
- 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 (stripe rust).

**PROCEDURES:** Dr. Arron Carter at Washington State University had developed a Recombinant Inbred Line (RIL) population from the cross of Yellowstone by WA7976. F6 seed derived via single seed descent from a F2 population was obtained from the WA 7976/Yellowstone cross. A total of 222 entries were planted in the fall of 2013 at the Aberdeen R&E Center to increase the seed for replicated studies in 2014-2015. Remnant seed was reserved for future genotyping. In the 2013-2014 growing season, the parental lines will have fungicides applied after full flag leaf emergence (spring 2014) to stimulate induction of the LMA trait to confirm susceptibility in the parental line Yellowstone and non-inducibility in WA7976.

Headrows will be harvested (August 2014) and the population will be planted in fall 2014 for the full experiment.

In the 2014-2015 growing season, the population will be treated with a foliar application of Twinline, a combination of strobilurin and triazole fungicides, when flag leaves are fully emerged, but prior to heading (Feekes growth stage 10) to initiate the physiological response to fungicide application. Checks will include the non-inducible genotypes and the parental lines. Harvested F8 seed will be tested for FN. Other agronomic characteristics will also be measured.

**DURATION:** Three years: FY2015

**COOPERATION:** Dr. Arron Carter, WSU, Pullman, WA. Katherine O'Brien, University of Idaho. Dr. Jianli Chen, University of Idaho. Drs. Carter and Chen will provide advice on mapping techniques and appropriate software and statistical design. Katherine O'Brien will assist in quality testing protocols.

**ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:**

Through the process of elimination and collaboration with PNW breeding programs, we hope to be able to identify factors contributing to induction of high alpha amylase, thereby reducing production of LMA-prone varieties and reducing risk of non-sprout FN damage for our producers. The information should be publishable in a peer-reviewed journal and will contribute to our knowledge of the FN situation that will be conveyed to the PNW wheat production community through appropriate extension bulletins and cereal schools.

**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. However, the falling numbers test may indicate "sprout damaged" grain (low falling numbers) in the absence of rain directly prior to harvest. Other factors that contribute to low falling numbers include heat or cold shock at a specific growth stage during grain fill, fungicide application of certain varieties at a specific growth stage, extremely low nitrogen fertility, and specific varieties with susceptibility to late-maturity alpha amylase induction at high elevations or temperature extremes.

- 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. 2007a. 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.
- Kindred, D. R., Gooding, M. J. and Ellis, R. H. 2005. Nitrogen fertilizer and seed rate effects on Hagberg falling number of hybrid wheats and their parents are associated with alpha-amylase activity, grain cavity size and dormancy. *Journal of the Science of Food and Agriculture* 85:727-742.
- Mares, D. and Mrva, K. 2008. Late-maturity alpha-amylase: Low falling number in wheat in the absence of preharvest sprouting. *J. Cereal Sci.* 47:6-17.

# **COMMODITY COMMISSION BUDGET FORM**

Allocated by Idaho Wheat Commission during FY 2013 \$ -

Allocated by Idaho Wheat Commission during FY 2014 \$ -

## **REQUESTED FY 2015 SUPPORT:**

|                        | Salary    | Temporary<br>Help | Fringe | Travel   | OE       | CO   | Grad Fees | TOTALS    |
|------------------------|-----------|-------------------|--------|----------|----------|------|-----------|-----------|
| Idaho Wheat Commission | \$ 17,548 | \$ -              | \$ 250 | \$ 2,500 | \$ 2,100 | \$ - | \$ 9,374  | \$ 31,772 |

## **OTHER RESOURCES (not considered cost sharing or match):**

|                              |             |
|------------------------------|-------------|
| a) Industry                  | \$ -        |
| b) UI (salaries, operating)  | \$ -        |
| c) Other (local, state)      | \$ -        |
| d)                           | \$ -        |
| e)                           | \$ -        |
| <b>TOTAL OTHER RESOURCES</b> | <b>\$ -</b> |

|                                            |                    |                |                  |
|--------------------------------------------|--------------------|----------------|------------------|
| <b>TOTAL PROJECT ESTIMATE FOR FY 2015:</b> | <b>\$ 31,772</b>   | <b>\$ -</b>    | <b>\$ 31,772</b> |
|                                            | <i>(Requested)</i> | <i>(Other)</i> | <i>(Total)</i>   |

## **BREAKDOWN FOR MULTIPLE SUB-BUDGETS:**

|                          | (PI name)   | (PI name)   | (PI name)   | (PI name)   |
|--------------------------|-------------|-------------|-------------|-------------|
| Salary                   | \$ -        | \$ -        | \$ -        | \$ -        |
| Temporary Help           | \$ -        | \$ -        | \$ -        | \$ -        |
| Fringe Benefits          | \$ -        | \$ -        | \$ -        | \$ -        |
| Travel                   | \$ -        | \$ -        | \$ -        | \$ -        |
| Operating Expenses       | \$ -        | \$ -        | \$ -        | \$ -        |
| Capital Outlay           | \$ -        | \$ -        | \$ -        | \$ -        |
| Graduate Student Fees    | \$ -        | \$ -        | \$ -        | \$ -        |
| <b>TOTALS</b>            | <b>\$ -</b> | <b>\$ -</b> | <b>\$ -</b> | <b>\$ -</b> |
| <b>Total Sub-budgets</b> |             |             |             | <b>\$ -</b> |

**CURRENT AND PENDING SUPPORT Form:**

**Name: Juliet Marshall**

| NAME<br>(List PI/PD #1<br>first)              | SUPPORTING<br>AGENCY<br>AND<br>AGENCY<br>NUMBER   | TOTAL \$<br>AMOUNT | EFFECTIVE<br>AND<br>EXPIRATION<br>DATES | % OF<br>TIME<br>COMMITT-<br>ED | TITLE OF PROJECT                                                            |
|-----------------------------------------------|---------------------------------------------------|--------------------|-----------------------------------------|--------------------------------|-----------------------------------------------------------------------------|
|                                               | Current:                                          |                    |                                         |                                |                                                                             |
| Marshall, J.M.,<br>and Johnson<br>(Schroeder) | Idaho Wheat<br>Commission                         | \$29,090           | 7/1/13 -<br>6/30/14                     | 10                             | Extension Wheat<br>Nurseries                                                |
| Marshall, J.M.<br>and Johnson<br>(Schroeder)  | Idaho Barley<br>Commission                        | \$13,000           | 7/1/13 -<br>6/30/14                     | 8                              | Education for Barley<br>Production /<br>Extension Nurseries                 |
| Marshall, J.M.<br>and Patterson,<br>P.        | Idaho Wheat<br>Commission                         | \$9,746            | 7/1/13 -<br>6/30/14                     | 7                              | Production Systems<br>and Wheat Varieties<br>for Dryland Grain              |
| Marshall, J.M.                                | USDA-ARS<br>SCA                                   | \$9,000            | 10/1/13 -<br>9/31/14                    | 10                             | Management of<br>Wheat and Barley<br>Root Pathogens in<br>Idaho             |
| Marshall, J.M.                                | Monsanto,<br>Syngenta,<br>Limagrain,<br>etc       | \$28,250           | 7/1/13 -<br>6/30/14                     | 2                              | Private breeding<br>company entries into<br>the Extension Variety<br>Trials |
| Marshall, J.M.                                | Bayer Crop<br>Sciences,<br>BASF,<br>Syngenta, etc | \$53,092           | 8/1/13-<br>7/31/14                      | 8                              | Seed Treatment /<br>Specialty Trials /<br>Product Evaluation                |
| Marshall, J.M.                                | Federal 047                                       | \$1800             |                                         | 1                              | South Idaho Crop<br>Management                                              |
| Marshall, J.M.                                | Idaho State<br>Funding                            | \$17,847           | 7/1/13 -<br>6/30/14                     | 10                             | Barley Enhancement                                                          |
| Marshall, J.M.                                | Hatch<br>Funding                                  | \$1118             | 10/1/13 -<br>9/31/14                    | 10                             | Foot Rot                                                                    |
| Rashed, A. and<br>Marshall, J.M.              | Idaho Wheat<br>Commission                         | \$7,800            | 7/1/13 -<br>6/30/14                     | 2                              | Variety Screening for<br>BYDV Resistance in<br>Idaho                        |

|                                            |                         |                          |                  |    |                                                                                 |
|--------------------------------------------|-------------------------|--------------------------|------------------|----|---------------------------------------------------------------------------------|
| Marshall, J.M. and Schroeder, K.           | Idaho Wheat Commission  | \$9,000                  | 7/1/13 – 6/30/14 | 5  | Collaborative Nitrogen by Variety Interaction Study with LCS                    |
| Marshall, J.M. and Schroeder, J.           | Idaho Wheat Commission  | \$14,000                 | 7/1/13 – 6/30/14 | 5  | Biostimulant Efficacy Field Trial                                               |
| Moore, A., and Marshall, J.M.              | Idaho Barley Commission | \$16,000 (SA \$547)      | 2013-2014        | 1  | Long-Term Impacts of Manure Application on Production of Barley and Other Crops |
| Moore, A. and Marshall, J.M.               | Idaho Wheat Commission  | \$18,210 (SA \$547)      | 2013-2014        | 1  | Long-Term Impacts of Manure Application on Production of Wheat and Other Crops  |
| Chen J., Wang, Y., and Marshall, J.M.      | Idaho Wheat Commission  | \$44,973 (SA \$7462.35 ) | 7/1/13 – 6/30/14 | 2  | Digging the genetic factors underlying LMA in wheat                             |
| Murray, T., Carter, A., and Marshall, J.M. | Idaho Wheat Commission  | \$52,980 (SA \$4000)     | 7/1/13 – 6/30/14 | 1  | Enhancing Resistance to Snow Mold Diseases in Winter Wheat                      |
| Marshall, J.M.                             | Idaho Wheat Commission  | \$12,888                 | 7/1/13- 6/30/15  | 1  | Endowment funding                                                               |
|                                            | Pending:                |                          |                  |    |                                                                                 |
| Marshall, J.M., and Schroeder, K,          | Idaho Wheat Commission  | \$31,437                 | 7/1/14 - 6/30/15 | 10 | Extension Wheat Nurseries                                                       |
| Marshall, J.M. and Schroeder, K.           | Idaho Barley Commission | \$14,672                 | 7/1/14 - 6/30/15 | 8  | Education for Barley Production / Extension Nurseries                           |
| Marshall, J.M. and Patterson, P.           | Idaho Wheat Commission  | \$9,746                  | 7/1/14 - 6/30/15 | 7  | Production Systems and Wheat Varieties for Dryland Grain                        |

|                                                                       |                            |                           |                      |    |                                                                                                                                                                                  |
|-----------------------------------------------------------------------|----------------------------|---------------------------|----------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Marshall, J.M.                                                        | USDA-ARS<br>SCA            | \$6,042                   | 10/1/14 -<br>9/31/15 | 10 | Management of<br>Wheat and Barley<br>Root Pathogens in<br>Idaho                                                                                                                  |
| Rashed,<br>Marshall,<br>Bosque-Perez,<br>Pappu, Wallis,<br>Eigenbrode | Idaho Wheat<br>Commission  | \$19,069                  | 7/1/14 -<br>6/30/15  | 2  | Wheat variety<br>response to BYDV<br>infection at different<br>developmental stages                                                                                              |
| Rashed, A and<br>Marshall, J.M.                                       | Idaho Wheat<br>Commission  | \$36,400                  | 7/1/14 -<br>6/30/15  | 2  | A survey of central<br>and eastern Idaho<br>wireworm species<br>and evaluating<br>ecological and<br>chemical approaches<br>to maximize cereal<br>production                      |
| Rashed, A and<br>Marshall, J.M.                                       | Idaho Barley<br>Commission | \$15,540                  | 7/1/14 -<br>6/30/15  | 2  | A survey of central<br>and eastern Idaho<br>wireworm species<br>and evaluating<br>combinations of<br>ecological and<br>chemical approaches<br>to limit damage to<br>barley crops |
| Marshall, J.M.<br>and Schroeder,<br>K.                                | Idaho Wheat<br>Commission  | \$9,000                   | 7/1/14 –<br>6/30/15  | 5  | Collaborative<br>Nitrogen by Variety<br>Interaction Study<br>with LCS                                                                                                            |
| Marshall, J.M.<br>and Schroeder,<br>K.                                | Idaho Wheat<br>Commission  | \$14,000                  | 7/1/14 –<br>6/30/15  | 5  | Biostimulant Efficacy<br>Field Trial                                                                                                                                             |
| Moore, A. and<br>Marshall, J.M.                                       | Idaho Wheat<br>Commission  | \$19,110<br>(SA<br>\$547) | 2014-2015            | 5  | Long-Term Impacts<br>of Manure<br>Application on<br>Production of Wheat<br>and Other Crops                                                                                       |

|                                                           |                         |                     |                  |   |                                                                                 |
|-----------------------------------------------------------|-------------------------|---------------------|------------------|---|---------------------------------------------------------------------------------|
| Moore, A. and Marshall, J.M.                              | Idaho Barley Commission | \$16,000 (SA \$547) | 2014-2015        | 5 | Long-Term Impacts of Manure Application on Production of Barley and Other Crops |
| Rashed, Marshall, Bosque-Perez, Pappu, Wallis, Eigenbrode | Idaho Wheat Commission  | \$19,069            | 2014-2016        | 3 | Wheat variety response to BYDV infection at different developmental stages      |
| Strawn, D., Chen, J., McDaniel, P., and Marshall, J.M.    | Idaho Wheat Commission  | \$73,907            | 7/1/14-6/30/15   | 2 | Field-based study of factors affecting cadmium uptake by wheat from Idaho Soils |
| Chen, J., Wang, Y., and Marshall, J.M.                    | Idaho Wheat Commission  | \$64,205            | 7/1/14 – 6/30/15 | 2 | Digging the genetic factors underlying LMA in wheat                             |

\*\*\*\*\*  
**INTERNAL PEER REVIEW/PRINCIPAL INVESTIGATOR VERIFICATION FORM**  
\*\*\*\*\*

**INTERNAL PEER REVIEW VERIFICATION**

Commodity commissions/organizations require internal peer review by colleagues familiar with the subject matter. This proposal has been peer reviewed by the following individuals:

Reviewer 1: Jeff Stark Jeff Stark 1/3/14  
(Type/Print name) (Signature) (Date)

Reviewer 2: Phil Nolte Phil Nolte 1/3/14  
(Type/Print name) (Signature) (Date)

Dept. Head/ Dr. Paul McDaniel Dr. Paul McDaniel 1/6/14  
Unit Administrator (Type/Print name) (Signature) (Date)