PROJECT NO: BJKX62, BJKX63

TITLE: Variety screening for BYDV resistance in Idaho

PERSONNEL: Dr. Arash Rashed, Entomology Specialist, Aberdeen R & E Center
Dr. Juliet Marshall, Ext. Crop Mgmt Specialist, Idaho Falls

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JUSTIFICATION: For the past few years, various arthropod and pathogen pests have threatened the Idaho wheat industry. Among those, Barley Yellow Dwarf Virus (BYDV) has caused significant damage in winter wheat in some production areas of Idaho. Increases in corn acreage in conjunction with mild fall temperatures have facilitated the transfer of BYDV from corn to small grains. The virus is transmitted by a range of cereal aphids, but very efficiently by the bird cherry-oat aphid, *Rhopalosiphumpadi* (L.) and the English grain aphid (*Sitobionavenae*). While bird cherry-oat aphid is one of the most economically damaging aphids in both winter and spring wheat, the indirect effect of BYDV transmission can be devastating in winter cereals. Losses due to BYDV can exceed 70% in individual fields in Idaho (Bishop and Sandvol 1984, as cited by Jimenez-Martinez & Bosque-Perez (2004)). There is no treatment for virus-infected plants. Chemical approaches to control aphids may only have limited affect on reducing the risk since virus can be transmitted within hours of insect feeding. While cultural practices have proven successful in reducing disease incidence, the use of less susceptible cultivars to both aphids and/or BYDV remains the most effective way to reduce disease spread and minimize yield-loss. Although the use of resistant varieties is highly recommended, to our knowledge, there are no field studies evaluating the susceptibility of most commonly used winter varieties in Idaho under aphid and BYDV pressure. This proposal is to address this shortfall in central and southeast Idaho by an initial screening of four commonly used winter varieties.

Hypothesis and Objectives: We hypothesize that there is variation in levels of susceptibility to BYDV among the four evaluated winter cultivars.

Objective 1: To compare foliar and root biomass, as well as grain yield, test weight and other agronomic characteristics among the four evaluated cultivars infected with aphids and / or BYDV

Objective 2: To evaluate aphid host preference for different winter wheat cultivars

Objective 3: To recommend winter wheat cultivars that are the least susceptible to the BYDV and least preferred by the aphid vectors to our wheat producers

Approach: To address objective 1, field experiments will be conducted at University of Idaho Aberdeen Research and Extension Center experimental farm. Wheat varieties SY Ovation, WB-Junction, Stephens (known susceptible), and Brundage will be planted in September, 2014. There are no known resistant varieties to be included as control. In each of the 5-by-13' plots, tent-shaped field cages (100x100x100-cm) will be setup prior to plant emergence. There will be 10

experimental cage–replicates for each of the varieties, plus two control cages (per variety). Thus, in total there will be 48 cages/plot.

Experimental cages will be infested with 10-15 BYDV-carrying aphids, 2 to 3 weeks post plant emergence, to mimic naturally occurring fall infections. Aphids will be allowed to feed, and thus transmit BYDV, for one week. When one-week period elapses, insects will be removed by 2-3 chemical applications. At various growth stages, plants will be harvested to determine dry weights of foliage and root tissues, and grain yield will be compared among the cultivars.

To address objective 2, aphid-choice experiments will be conducted under greenhouse conditions. Wheat varieties will be planted in separate 1-gallon pots. One pot of each variety will be placed into a 60x60x60 bugdorm cage (4 pots in each cage). Twelve aphids (4/pot) will be released into a cage where they have the choice to alight and feed on any of the four varieties. Insect numbers on each pot/variety will be counted and compared after 24 hrs. There will be 20 repetitions for this experiment.

Based on results from objectives 1 and 2, recommendations (objective 3) would be made regarding winter wheat varieties suitable for planting in high-risk areas.

DURATION: Two years - Fall 2014- Winter and Spring 2015

COOPERATION: This is a cooperative project between Dr. Arash Rashed and Dr. Juliet Marshall's laboratories.

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:
Information obtained from this study would be beneficial to Idaho wheat producers as it would compare levels of resistance to BYDV among four of the most commonly used winter wheat varieties. If differences in susceptibility are detected, more resistant varieties (and/or less preferred varieties by aphids) can be recommended for planting in high-risk areas and years. This study would provide preliminary results, which will allow us to determine feasibility of increasing the number of varieties in future screening tests and help develop future collaborative projects.

LITERATURE REVIEW:
Estimated losses to BYDV can range from 11 to 33%, in some cases exceeding 80% (see Miller and Rasochova, 1997; and references within). Among several other key cereal aphid species (Bruehl 1961; Halbert and Voegtlin 1998), bird cherry-oat aphid, *Rhopalosiphumpadi* (L.), is an efficient vector of BYDV (Jimenez-Martinez and Basque-Perez 2004). This aphid can induce damage by simply feeding on the phloem sap (Kieckhefer and Kantack 1980). Such effects can result in both yield and quality losses. Bruehl (1961) has suggested that wheat varieties may vary in their susceptibility to BYDV. However, no true resistance to the virus is known in wheat plants. Differential susceptibility may result from BYDV-plant and/or aphid-plant interactions. For instance, aphid feeding (i.e. *R. padi*) might trigger responses resulting in photosynthesis reduction and chloroplast degradation (Franzen et al. 2008). Thus, the damage inflicted by the aphid may vary based on plant response to infestation (feeding) or aphid feeding preference for a particular variety.

REFERENCES:

Bruehl G.W. 1961. Barley Yellow Dwarf.Pp 52. The American Phytopathological Society.

Franzen L.D., Gutsche A.R., Heng-Moss T.M., Higley L.G. Macedo T.B. Physiological responses of wheat and barley to Russian wheat aphid, Diuraphisnoxia and bird cherry-oat aphid, *Rhopalosiphumpadi* (L.) (Hemiptera: Aphididae). Arthropod-Plant Interaction, 2: 227- 235.

Halbert S.E., Voegtlin D.J. 1998.*Evidence for the North American Origin of Rhopalosiphum and Barley Yellow Dwarf Virus*. Pp. 351-356. In: Aphids in natural and managed ecosystems, 5th international Symposium.

Hammerschmidt R. 1999. Phytoalexins: what have we learned after 60 years? *Annual Review of Phytopathology* 37:285-306.

Jimenez-Martinez and Basque-Perez 2004.Vriation in Barley Yellow Dwarf transmission efficiency By Rhopalosiphumpadi (Homoptera: Aphididae_ after acquisition from transgenic and nontransformed wheat gentypes. *Journal of Economic Entomology*.97: 1790-1796.

Kieckhefer R.W., Kantack B.H. 1980. Losses in yield in spring wheat in South Dakota and caused by cereal aphids. *Journal of Economic Entomology* 73: 582-585.

Miller W.A., Rasochova L. 1997. Barley Yellow Dwarf Viruses.*Annual Review of Phytopathology*.35: 167-190.

COMMODITY COMMISSION BUDGET FORM

Allocated by	Idaho Wheat Commission	during FY 2013	$ -
Allocated by	Idaho Wheat Commission	during FY 2014	$ 7,800

REQUESTED FY 2015 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	CO	Grad Fees	TOTALS
Idaho Wheat Commission	$ -	$ 1,980	$ 1,020	$ -	$ 4,800	$ -	$ -	$ 7,800

OTHER RESOURCES (not considered cost sharing or match):

a) Industry	$ -
b) UI (salaries, operating)	$ 10,000
c) Other (local, state)	$ 3,500
d)	$ -
e)	$ -
TOTAL OTHER RESOURCES	$ 13,500

TOTAL PROJECT ESTIMATE FOR FY 2015:	$ 7,800 *(Requested)*	$ 13,500 *(Other)*	$ 21,300 *(Total)*

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	Rashed	*Marshall*	*(PI name)*	*(PI name)*
Salary	$ -	$ -	$ -	$ -
Temporary Help	$ 1,650	$ 330	$ -	$ -
Fringe Benefits	$ 850	$ 170	$ -	$ -
Travel	$ -	$ -	$ -	$ -
Operating Expenses	$ 4,450	$ 350	$ -	$ -
Capital Outlay	$ -	$ -	$ -	$ -
Graduate Student Fees	$ -	$ -	$ -	$ -
TOTALS	$ 6,950	$ 850	$ -	$ -

Total Sub-budgets $ 7,800

10.29.2013 - Version

CURRENT AND PENDING SUPPORT Form:

Name: Arash Rashed

NAME (List PI/PD #1 First)	SUPPORTING AGENCY AND AGENCY NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITT-ED	TITLE OF PROJECT
	Current:				
Rashed and Marshall	Idaho Wheat Commission	7,800	2013-2014	2%	Variety screening for BYDV resistance in Idaho
Rashed	USDA-SCRI-minigrant	7,000	2013-2014`	1%	Quantifying Lso-potato interactions post-harvest under industrial storage condition
Rush et al. (17 Co-PIs)	USDA-SCRI	$2,822,422	2012-2014	1%	Development of an integrated research and management program for Zebra Chip of potato
	Pending:				
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
Rashed, Bosque-Perez, Eigenbrode	Idaho Wheat Commission	29,950	2014-2017	5%	*Metapolophiumfestucaecerealium* distribution in Southern Idaho and it potential role as a vector of barley yellow dwarf virus in wheat
Rashed and Marshall	Idaho Wheat Commission	36,000	2014-2017	8%	A survey of central and eastern Idaho wireworm species and evaluating ecological and chemical approaches to maximize cereal production

Rashed and Marshall	Idaho Barley Commission	15,000	2014-2017	2%	A survey of central and eastern Idaho wireworm species and evaluating combinations of ecological and chemical approaches to limit damage to barley crops
Wenninger, Wharton, Rashed, Karasev	Potato Research Consortium	64,225	2014-2015	2%	Quantifying effects of vector density and time of infection on ZC disease development and tuber physiology both at harvest and during storage
Rashed and Marshall	Idaho Wheat Commission	7,800	2014-2015		Variety screening for BYDV resistance in Idaho

CURRENT AND PENDING SUPPORT Form:

Name: Juliet Marshall

NAME (List PI/PD #1 first)	SUPPORTING AGENCY AND AGENCY NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITT-ED	TITLE OF PROJECT
	Current:				
Marshall, J.M., and Johnson (Schroeder)	Idaho Wheat Commission	$29,090	7/1/13 - 6/30/14	10	Extension Wheat Nurseries
Marshall, J.M. and Johnson (Schroeder)	Idaho Barley Commission	$13,000	7/1/13 - 6/30/14	8	Education for Barley Production / Extension Nurseries
Marshall, J.M. and Patterson, P.	Idaho Wheat Commission	$9,746	7/1/13 - 6/30/14	7	Production Systems and Wheat Varieties for Dryland Grain
Marshall, J.M.	USDA-ARS SCA	$9,000	10/1/13 - 9/31/14	10	Management of Wheat and Barley Root Pathogens in Idaho

Marshall, J.M.	Monsanto, Syngenta, Limagrain, etc	$28,250	7/1/13 - 6/30/14	2	Private breeding company entries into the Extension Variety Trials
Marshall, J.M.	Bayer Crop Sciences, BASF, Syngenta, etc	$53,092	8/1/13- 7/31/14	8	Seed Treatment / Specialty Trials / Product Evaluation
Marshall, J.M.	Federal 047	$1800		1	South Idaho Crop Management
Marshall, J.M.	Idaho State Funding	$17,847	7/1/13 – 6/30/14	10	Barley Enhancement
Marshall, J.M.	Hatch Funding	$1118	10/1/13 - 9/31/14	10	Foot Rot
Rashed, A. and Marshall, J.M.	Idaho Wheat Commission	$7,800	7/1/13 – 6/30/14	2	Variety Screening for BYDV Resistance in 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 SCA	$6,042	10/1/14 - 9/31/15	10	Management of Wheat and Barley Root Pathogens in Idaho
Rashed, Marshall, Bosque-Perez, Pappu, Wallis, Eigenbrode	Idaho Wheat Commission	$19,069	7/1/14 - 6/30/15	2	Wheat variety response to BYDV infection at different developmental stages
Rashed, A and Marshall, J.M.	Idaho Wheat Commission	$36,400	7/1/14 - 6/30/15	2	A survey of central and eastern Idaho wireworm species and evaluating ecological and chemical approaches to maximize cereal production

Rashed, A and Marshall, J.M.	Idaho Barley Commission	$15,540	7/1/14 - 6/30/15	2	A survey of central and eastern Idaho wireworm species and evaluating combinations of ecological and chemical approaches to limit damage to barley crops
Marshall, J.M. and Schroeder, K.	Idaho Wheat Commission	$9,000	7/1/14 – 6/30/15	5	Collaborative Nitrogen by Variety Interaction Study with LCS
Marshall, J.M. and Schroeder, K.	Idaho Wheat Commission	$14,000	7/1/43 – 6/30/15	5	Biostimulant Efficacy Field Trial
Moore, A. and Marshall, J.M.	Idaho Wheat Commission	$19,110 (SA $547)	2014-2015	5	Long-Term Impacts of Manure Application on Production of Wheat 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

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INTERNAL PEER REVIEW/PRINCIPAL INVESTIGATOR VERIFICATION FORM

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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: Steve Love _____ 8 Jan 14
(Type/Print name) (Signature) (Date)

Reviewer 2: KatherineO'Brien Katherine O'Brien 1-8-2014
(Type/Print name) (Signature) (Date)

Dept. Head/ PAUL McDANIEL _____ 1/9/14
Unit Administrator (Type/Print name) (Signature) (Date)

PROGRESS REPORT

PROJECT NO: BJKX62, BJKX63

TITLE: Variety screening for BYDV resistance in Idaho

PERSONNEL: Arash Rashed and Juliet Marshall

ADDRESS: Arash Rashed, University of Idaho, Aberdeen R & E Center, 1963 S. 2700 W., Aberdeen, ID 83210; 208-397-7000 ext. 114; arashed@uidaho.edu

ACCOMPLISHMENTS:

The 4 wheat cultivars SY Ovation, WB-Junction, Stephens (known susceptible), and Brundage were planted in 5-by-13' plots, on October 16, 2013. Plants were covered with tent-shaped field cages (100x100x100-cm) prior to emergence. There are 10 experimental cage-replicates per variety, plus two uninfected controls (48 cages, total). Experimental cages were infested with 30 viruliferous aphids on November 25, 2013. Cages were sprayed in December 13 to remove aphids. However, temperatures were extremely low prior to chemical application and the likelihood of aphid survival was minimal, regardless. Heads, foliage, and roots will be harvested at the end of the season to compare yield and plant biomass among different varieties.

Greenhouse choice experiment trials are about to start. We have planted about 20 seeds of each variety, individually in 50ml tubes. Seedlings will be used to assess host preference by the infective aphids. The 4 experimental varieties used in choice experiments are: SY Ovation, WB-Junction, Stephens, and Brundage.

PROJECTIONS: Following harvest, yield and plant biomass will be compared among the infected plants of the four varieties. A subset of 10 plants/cage will be tested with ELISA to assure the inoculation success within cages. The 4 varieties will be ranked based on their yield, test weight, and aboveground and underground biomasses.

Aphid preference for different cultivars will be assessed under greenhouse conditions. Most, and least, preferred wheat cultivars will be identified throughout this experiment.

Overall, experiments would allow us evaluate and compare variety susceptibilities to BYDV among four of the commonly used winter wheat varieties.

PUBLICATIONS: The project has just started and publications following the second year (after replication).