ROJECT NO: New Project

Title: Wheat variety response to BYDV infection at different developmental stages

PERSONNEL: Arash Rashed, Juliet Marshall, Nilsa Bosque-Perez, Hanu Pappu, Christopher Wallis, Sanford Eigenbrode, Katherine O'Brien (collaborator)

ADDRESS: Arash Rashed, Assistant Professor, University of Idaho, Aberdeen R & E Center, 1063 S. 2700 W., Aberdeen, ID 83210; 208-397-7000 ext. 121; arashed@uidaho.edu

JUSTIFICATION: In the past three years, barley yellow dwarf virus (BYDV) has become a widespread problem that has significantly reduced yields and quality in the Magic Valley and Burley areas of Idaho, and was also seen in western Washington in 2013.

Losses to BYDV alone reached 50% in severely affected winter wheat fields in southern Idaho in 2013 (Marshall, personal observation). Among several other key cereal aphid species, bird cherry-oat aphid, *Rhopalosiphum padi* (L.), is an efficient vector of BYDV. This aphid also may be causing wheat yield and quality losses by feeding damage and triggering photosynthesis reduction. Since BYDV can be transmitted in relatively short periods of times, chemical approaches to control aphids may only offer limited help to reduce the risk. While cultural practices have proven somewhat successful in reducing disease incidence, studies are yet to quantify variety susceptibility and quality loss due to BYDV infection, which may occur at different developmental stages of wheat. Different varieties are expected to show different levels of susceptibility to BYDV/aphid infestation occurring at different developmental stages. Moreover, it is possible that only infestations happening at earlier developmental stages inflict significant quantity and quality loss; late-season infestations may not require intense aphid treatment if changes in biochemical properties and yield are negligible. This knowledge may not only help to reduce cost of chemical applications by identifying least susceptible developmental stages of different wheat varieties to BYDV infection, but it would also contribute into future development of less susceptible wheat genotypes (breeding programs).

This collaborative interdisciplinary proposal invites scientists from WA, CA, and across ID to investigate various aspects of aphid-wheat-virus interactions. The response of three wheat varieties to infections at difference developmental stages and its impact on grain quality treats will be quantified.

HYPOTHESES and OBJECTIVES: We hypothesize that there is significant among cultivar variability in response to BYDV infection at different developmental stages. Such variations would result in differences in the degree of susceptibility to the infection.

Objective 1: Compare physiological responses of different wheat cultivars, infested at different developmental stages, to BYDV infection
Objective 2: Quantify BYDV titer and score symptom development following infection at different developmental stages
Objective 3: Obtain an objective measure of grain quality traits following infection at different developmental stages

PROCEDURE: Greenhouse experiments will be conducted at the University of Idaho Aberdeen R & E Center. Soft winter varieties, WB-Junction, Stephens, and SY Ovation will be planted in the greenhouse in October 2014. The aim will be to infest plants with viruliferous *Rhopalosiphum padi* at different wheat growth stages. The first set of infestations (20 plant/variety) will be conducted two weeks after emergence under greenhouse conditions. This first set of infestations would mimic naturally occurring infestations in the fall. All seedlings will then be transferred into growth chambers (5°C: °C, 12: 12 hrs, light: dark) and remain there for a minimum of 8 weeks. When 8 weeks have elapsed, plants will be placed back into the greenhouse. Greenhouse conditions will be set to mimic those of March-April. The next three sets of infestation will occur at different developmental stages of tillering, stem extension, and flowering, with 10 infective aphids. The three infestations conducted after cold treatment would simulate infections occurring in the spring. Insects will be removed after one week, and leaf tissue will be collected at 3, 6, and 9 weeks post infestation. Leaf tissues (500 mg) will be analyzed by Dr. Wallis in Parlier, CA, to assess fluctuations in phenolic compounds, amino acids and carbohydrate levels **(Objective 1)**. Changes in plant symptomology will be objectively measured (reflectance and area) over time. Additional leaf tissue (100 mg) will be sent to Dr. Hanu Pappu's laboratory in WSU for titer quantification **(Objective 2)**. Changes in biochemical properties in each cultivar will be compared to the uninfected controls to assess pathogen manipulation of plant chemistry. Grain quality traits (e.gs. protein value, hardness, gluten quantity, etc.) will be quantified by Katherine O'Brien at the University of Idaho, Aberdeen R&E Center Wheat Quality Laboratory, in plants that survived to produce head (**Objective 3**).

DURATION: The study will be conducted 2014-2016.

COOPERATION: This is a comprehensive interdisciplinary project led by the University of Idaho through a network of laboratories located at the University of Idaho (Moscow campus and Aberdeen R&E Center), Washington State University (Pullman, WA), and United State Department of Agriculture (Parlier, CA).

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:
Evaluating plant responses to infection, and at the same time quantifying pathogen/symptom development, would not only allow to objectively measure plant susceptibility but also would reveal the developmental stages that wheat varieties are most impacted by BYDV infection. Quantifying changes in biochemical properties among cultivars following infection would help to set thresholds beyond of which control measures become essential. For example, if changes in plant biochemistry, and subsequently grain quality, are negligible at later developmental stages then chemical vector control might not be cost efficient. Results of this study will be transferred to our cereal producers through extension publications (online and hard copies), personal communications, and presentations at appropriate stakeholder meetings. A minimum of one refereed publications is expected from this comprehensive study.

LITERATURE REVIEW:
Barley Yellow Dwarf Virus (BYDV) is a vector-borne pathogen, which can be a limiting factor in cereal growing regions production. 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, *Rhopalosiphum padi* (L.), is an efficient vector of BYDV (Jimenez-Martinez and Basque-Perez 2004), which may also cause damage by simply feeding on phloem sap (Kieckhefer and Kantack 1980); it has been suggested that the injury caused through aphid feeding (i.e. *R. padi*) might trigger responses that would result in reductions in photosynthesis and chloroplast degradation. Such effects can result in both yield and quality losses. Similarly, pathogen infections can trigger plant physical and biochemical responses to either limit pathogen multiplication by making the host environment unsuitable for pathogen growth or by targeting and eliminating the invading microorganism (Hammerschmidt 1999). The extent of damage, however, in different plants and varieties could be influenced by the time of infection and the developmental stage of the host plant.

REFERENCES:

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

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 E.S., Basque-Perez N.A. 2004. Vriation in Barley Yellow Dwarf transmission efficiency by *Rhopalosiphum padi* (Homoptera: Aphididae_ after acquisition from transgenic and nontransformed wheat genotypes. *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	$ -

REQUESTED FY 2015 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	CO	Grad Fees	TOTALS
Idaho Wheat Commission	$ -	$ 4,300	$ 1,269	$ 1,500	$ 12,000	$ -	$ -	$ 19,069

OTHER RESOURCES (not considered cost sharing or match):

a) Industry	$ -
b) UI (salaries, operating)	$ 3,180
c) Other (local, state)	$ -
d)	$ -
e)	$ -
TOTAL OTHER RESOURCES	$ 3,180

TOTAL PROJECT ESTIMATE FOR FY 2015:	$ 19,069 *(Requested)*	$ 3,180 *(Other)*	$ 22,249 *(Total)*

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	Rashed	*Eigenbrode*	*Marshall*	*Bosque-Perez*
Salary	$ -	$ -	$ -	$ -
Temporary Help	$ 3,300	$ -	$ -	$ 1,000
Fringe Benefits	$ 974	$ -	$ -	$ 295
Travel	$ 500	$ -	$ 1,000	$ -
Operating Expenses	$ 9,995	$ 300	$ 1,000	$ 705
Capital Outlay	$ -	$ -	$ -	$ -
Graduate Student Fees	$ -	$ -	$ -	$ -
TOTALS	$ 14,769	$ 300	$ 2,000	$ 2,000

Total Sub-budgets $ 19,069

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 conditions
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	29,851	2014-2017	5%	*Metapolophium festucae cerealium* distribution in Southern Idaho and its potential role as a vector of barley yellow dwarf virus in wheat

Rashed and Marshall	Idaho Barley Commission	15,540	2014-2017	2%	A survey of central and eastern Idaho wireworm species and evaluating ecological and chemical approaches to maximize cereal production
Rashed and Marshall	Idaho Wheat Commission	36,400	2014-2017	6%	A survey of central and eastern Idaho wireworm species and evaluating ecological and chemical approaches to maximize cereal production
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

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

CURRENT AND PENDING SUPPORT Form:

Name: Nilsa Bosque-Perez

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:				
N.A. Bosque-Pérez and Lana Unger	Idaho Wheat Commission	40,191	2013-2014	5%	Development of resistant wheat cultivars for management of Hessian fly in northern Idaho
M. Pumphrey, N.A. Bosque-Pérez and K. Campbell	Washington Grain Commission	15,750	2013-2014	3%	Evaluation of wheat breeding lines for management of Hessian fly in the Pacific Northwest
L. Waits, N.A. Bosque-Pérez, L. Hormel and L. Vierling	NSF-Coupled Natural Human Systems Program	248,733	2013-2016	5%	Quantifying linkages among land-use policies, agricultural intensification, habitat fragmentation and social-ecological resilience in a tropical biological corridor
N.A. Bosque-Pérez, S.D. Eigenbrode, et al.	NSF-IGERT	3,200,000	2009-2014	25%	Evaluating resilience of ecological & social systems in changing landscapes
	Pending:				
N.A. Bosque-Pérez and Lana Unger	Idaho Wheat Commission	37,005	2014-2015	5%	Development of resistant wheat cultivars for management of Hessian fly in northern Idaho
M. Pumphrey, N.A. Bosque-Pérez and K. Campbell	Washington Grain Commission	16,000	2014-2015	3%	Evaluation of wheat breeding lines for management of Hessian fly in the Pacific Northwest

A. Rashed, N. Bosque-Perez, S. Eigenbrode	Idaho Wheat Commission	19,069	2014-2016	2%	Wheat variety response to BYDV infection at different developmental stages
A. Rashed, N. Bosque-Perez, S. Eigenbrode	Idaho Wheat Commission	29,851	2014-2017	2%	*Metapolophium festucae cerealium* distribution in Southern Idaho and its potential role as a vector of barley yellow dwarf virus in wheat

CURRENT AND PENDING SUPPORT Form:

Name: Hanu Pappu

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:				
Snyder et al.	USDA NIFA RAMP	90,000	10/01/2011-09/30/2014	5%	Potato Pests
Schroeder et al.	USDA NIFA SCRI	24,000	10/01/2012-06/30/2014	5%	Onion IPMpipe
	Pending:				
Pappu	USDA NIFA Western Region IPM Center	29,436	2014/-2015	10%	Novel IPM Tactics For Reducing The Impact of Thrips-Tospovirus Pest Complex
Pappu and Waters	WA State Commission for Pesticide Registration (WSCPR)	28,000	2014-2015	10%	Epidemiology of Iris yellow spot virus in onion
Pappu and Sankaran	WA State Potato Commission	35,000	2014-2015	5%	Non-invasive imaging for disease diagnosis

Pappu, Brown and Sankaran	WSCPR	28,000	2014-2015	5%	Emerging virus threats to potato in the Pacific Northwest
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

CURRENT AND PENDING SUPPORT Form:

Name: Christopher M. Wallis

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:				
Stenger, D., Bakus, E., Chen, J., Krugner, R., Ledbetter, C., Lin, H., Ramming, D., Rogers, E., Sisterson, M., Wallis, C.	USDA ARS Research Project Number 5302-22000-010-00D	$817,536 estimated	10/01/12 to 09/30/17	94%	Epidemiology and management of Pierce's disease and other maladies of grape
Rush, C.M., Wallis, C.M., Wallingford, A., Rashed, A.	SCRI Potato Zebra Chip Mini-Proposal Program	$43,200	06/01/13 to 08/31/13	3%	Exploring changes in tuber physiology and zebra chip symptom development in tubers stored under different conditions
	Pending:				

Rashed, A., Marshall, J., Bosque-Perez, N., Pappu, H., Wallis, C., Eigenbrode, S., O'Brien, K. (collaborator)	Idaho Wheat Commission	19,069	2014-2016	3%	Wheat variety response to BYDV infection at different developmental stages

CURRENT AND PENDING SUPPORT Form:

Name: Sanford Eigenbrode

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:				
Eigenbrode, S. D.	IDA Hatch	$688K	7/31/2012-7/31/2017	10	Interdisciplinary Research on Climate Change and PNW Agriculture
Eigenbrode et al.	NIFA-AFRI Regional Approaches to Climate Change CAP	$20M	1/1/2011-12/31/2016	20	Regional Approaches to Climate Change in the Pacific Northwest
Bosque-Perez, N., Eigenbrode, S.D., Force, J.E., Waits, L., Wulfhorst, JD	NSF-IGERT	$3,340K	9/1/09-8/31/14	5	Evaluating resilience of ecological and social systems in changing landscapes: a doctoral research and education program in Idaho and Costa Rica
Eigenbrode et al.	USA Dry Pea and Lentil Council	$25,998	5/1/13-4/30/14	5	Monitoring populations of pest cereal aphids and their associated viruses in the Palouse region
	Pending:				

Eigenbrode et al.	USA Dry Pea and Lentil Council	$25,998	5/1/14-4/30/15	5	Monitoring populations of pest cereal aphids and their associated viruses in the Palouse region
Rashed, Marshall, Bosque-Perez, Pappu, Wallis, Eigenbrode	Idaho Wheat Commission	$19,069	2014-2016		Wheat variety response to BYDV infection at different developmental stages
Rashed, Bosque-Perez, Eigenbrode	Idaho Wheat Commission	29,851	2014-2017		*Metapolophium festucae cerealium* distribution in Southern Idaho and its potential role as a vector of barley yellow dwarf virus 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: _Phillip Wharton_____ P Wharton
(Type/Print name) (Signature) (Date)

Reviewer 2: _Pamela J.S. Hutchinson__ Pamela JS Hutchinson
(Type/Print name) (Signature) (Date)

Dept. Head/ ___Paul McDaniel_____ 1/6/14
Unit Administrator (Type/Print name) (Signature) (Date)