PROJECT NO: BJK968

TITLE: Development of resistant wheat cultivars for management of Hessian fly in northern Idaho

PERSONNEL: Nilsa A. Bosque-Pérez and Lana Unger

ADDRESS: Nilsa A. Bosque-Pérez, Professor Dept. of PSES, University of Idaho, Moscow, ID 83844-2339; 208-885-7544; nbosque@uidaho.edu

JUSTIFICATION: Economically damaging infestations of Hessian fly, *Mayetiola destructor* Say, have occurred in northern Idaho in the last 17 years. When environmental conditions favor the pest, populations have the potential to increase rapidly from one generation to the next. Spring wheat is the preferred host plant for Hessian fly. We have conducted surveys of grower's fields to determine the distribution of the fly and its parasites in northern Idaho. Hessian fly was found in all counties surveyed, confirming the pest is widespread in the northern part of the state (Bullock et al. 2004). In field trials we conducted at Kambitsch farm in 2002, 97% of susceptible variety Lolo plants were infested with Hessian fly, while resistant varieties had no infested plants. Additional surveys of growers' fields in northern Idaho in 2004 showed that 0 to 14% of resistant plants were infested compared to 15 to 62% of susceptible plants, illustrating the continuing importance of the fly in this part of the state. Since it is not always possible to predict when economically damaging infestations of Hessian fly will occur, control methods are mostly preventive in nature. The favored control method is the utilization of resistant wheat varieties. However, the potential emergence of fly biotypes (or genetic variants) capable of attacking resistant wheat, as has occurred in other parts of the US, always exists. Due to the existence of virulence against the *H3* resistant gene in northern Idaho fly populations (Ratcliffe et al. 2000), utilization of multiple genes for resistance is important. We continue collaborative efforts with plant breeders to develop spring wheat varieties with fly resistance, including hard white, soft white and hard red wheats. It is important to continue the development of resistant varieties so as to provide more options for growers. The availability of adapted, fly resistant varieties will provide Idaho wheat producers with an option to minimize the potentially increasing economic losses associated with this pest.

Damage due to Hessian fly in northern Idaho increased during the last decade likely as a result of several factors. These include increased adoption of conservation tillage practices and more acreage planted to spring wheat, partly as a result of tillage and rotation programs designed to reduce soil erosion. Such practices result in more cereal stubble being left on the soil surface. Hessian fly survives on infested cereal stubble and thus, reduced tillage systems could potentially increase survival frequency of this pest. The sustainability of wheat production in northern Idaho will be influenced by our ability to effectively control Hessian fly under conservation tillage. This will require the continuing development of resistant varieties, which effectively control the fly under both reduced tillage and conventional tillage practices (Castle del Conte et al. 2005).

HYPOTHESIS & OBJECTIVES:

1. Screen segregating populations and advanced breeding lines for resistance to Hessian fly in the laboratory.

2. Assist the breeding program in the development of effective molecular markers for the *H3* gene for fly resistance.

3. Examine the effectiveness of presently deployed resistant genes in controlling fly populations.

PROCEDURES: Spring wheat continues to be the primary focus of this project. Screening of segregating populations originating from crosses with several resistance sources will continue. This includes sources that carry the *H25* gene for fly resistance, which is of interest because it confers resistance to a broad spectrum of Hessian fly biotypes. Other sources to be utilized carry the *H3* gene for resistance. Lines that potentially carry both resistance genes will also be tested. Genotypes to be tested include hard white, soft white, and hard red lines. In addition, mapping populations will continue to be screened for fly resistance to assist in the development of molecular markers for the *H3* gene. Lines will be seeded in pots, placed in cages and infested at the two-leaf stage with Hessian fly females to lay eggs for 24 hours. Response of plants to larval infestation will be evaluated 21-days later. Plants will be dissected and the number of Hessian fly larvae and puparia per plant determined. Measurements of plant height will be taken twice, one-day and 21-days after infestation. Severe stunting is an indication of fly susceptibility. The number of resistant and susceptible plants per entry will be recorded.

Infestation and survival of Hessian fly on conventional tillage fields will be monitored at Kambitsch farm to assess the effectiveness of presently deployed resistance genes. Fields are part of a long-term tillage study established in 2000 (Castle del Conte et al. 2005). During the 2012 growing season, Hessian fly susceptible and resistant spring wheat varieties will be monitored. Plots in each of four replications per variety will be sampled three times during the growing season (10 plants per plot per sampling date for a total of 40 plants per variety) to monitor Hessian fly larvae and puparia. Mean number of insects per plant determined and percent plants infested will be calculated.

DURATION: 3 years (2012-2014; 1st year of project)

COOPERATION: UI: J. Chen; WSU: S.O. Guy, D. See, K. Campbell

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER: Results of this work will provide growers with new spring wheat varieties with resistance to Hessian fly. The availability of resistant varieties will enhance implementation and adoption of conservation tillage that is critical for reducing soil erosion in the region. Additionally, the project will provide information on the effectiveness of currently deployed fly resistance genes that is needed in order to ensure long-term stability of control. Results will be made available to growers through field days, extension publications, and presentations at grower meetings. Results also will be published in journals and presented at scientific meetings.

LITERATURE REVIEW: The Hessian fly was identified as a pest of wheat in the US shortly after its accidental introduction into the country over 200 years ago. The fly is a severe pest known to be present in all major wheat growing areas of the US, including the Atlantic Coast, the Great Plains and the Pacific Northwest (Ratcliffe and Hatchett 1997). Feeding by fly larvae on cereal plants results in stunting, reduced grain filling which lowers yield and quality, and weak stems that can break and fall to the ground. Climatic conditions in northern Idaho are

suitable for survival and development of the pest. At least two generations per year, one in the spring and one in the early summer, occur in this area (Castle del Conte et al. 2005). Adult flies emerge from infested cereal stubble or wild hosts in the spring. Insects mate and females lay eggs on leaves of young cereal plants. As many as 200 to 300 eggs are laid per female. Adults die 3 to 4 days after emergence. Once eggs hatch, larvae migrate to the crown of the young seedlings where they feed on plant sap. In approximately 2 to 3 weeks larvae form puparia (or "flaxseeds"). Larvae survive the summer within puparia in spring wheat or dry stubble. The puparial stage allows survival during adverse weather conditions in both summer and winter (Ratcliffe and Hatchett 1997). Resistant varieties are the most reliable means for Hessian fly control (Ratcliffe et al. 2000, Schotzko and Bosque-Pérez 2002). Thirty-two genes for resistance have been identified (Sardesai et al. 2005). Utilization of multiple genes for resistance coupled with the enhancement of existing natural enemies has the potential to enhance durability of resistance. Planting date modifications to escape infestation (i.e. early seeding of spring wheat), destruction of volunteer wheat, and crop rotation also are considered valuable Hessian fly management tools.

References

Castle del Conte, S.C., N.A. Bosque-Pérez, D.J. Schotzko, and S.O. Guy. 2005. Impact of tillage practices on Hessian fly-susceptible and resistant spring wheat cultivars. Journal of Economic Entomology. 98: 805-813.

Bullock, D.G, N.A. Bosque-Pérez, J.B. Johnson, and F.W. Merickel. 2004. Species composition and distribution of Hessian fly (Diptera: Cecidomyiidae) parasitoids in northern Idaho. Journal of the Kansas Entomological Society. 77: 174-180.

Ratcliffe R.H. and J.H. Hatchett. 1997. Biology and genetics of the Hessian fly and resistance in wheat. pp. 47-56 In: K. Bondari (ed.), New Developments in Entomology, Research Signpost, Scientific Information Guild, Trivandrum, India.

Ratcliffe, R.H., S.E. Cambron, K.L. Flanders, N.A. Bosque-Pérez, S.L. Clement, and H.W. Ohm. 2000. Biotype composition of Hessian fly (Diptera: Cecidomyiidae) populations from the southeastern, mid-western, and northwestern United States and virulence to resistance genes in wheat. Journal of Economic Entomology. 93: 1319-1328.

Sardesai, N., J.A. Nemacheck, S. Subramanyan, and C.E. Williams. 2005. Identification and mapping of *H32*, a new wheat gene conferring resistance to Hessian fly. Theoretical and Applied Genetics. 111: 1167-1173.

Schotzko, D.J. and N.A. Bosque-Pérez. 2002. Relationship between Hessian fly infestation density and early seedling growth of resistant and susceptible wheat. Journal of Agricultural and Urban Entomology. 19: 95-107.

COMMODITY COMMISSION BUDGET FORM
BJK968

Allocated by	**Idaho Wheat Commission**	**during FY 2010**	**$ 14,000**
Allocated by	**Idaho Wheat Commission**	**during FY 2011**	**$ 27,000**

REQUESTED FY 2012 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	CO	Grad Fees	TOTALS
Idaho Wheat Commission	$ 17,504	$ 7,715	$ 7,817	$ 2,000	$ 2,000	$ -	$ -	$ 37,036

OTHER RESOURCES (not considered cost sharing or match):	
a) Industry	**$ -**
b) UI (salaries, operating)	**$ 15,600**
c) Other (local, state) STEEP grant	**$ 4,500**
d) F&A (30.3%)	**$ 11,222**
	$ -
TOTAL OTHER RESOURCES	**$ 31,322**

TOTAL PROJECT ESTIMATE FOR FY 2012:	**$ 37,036** *(Requested)*	**$ 31,322** *(Other)*	**$ 68,358** *(Total)*

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

		(PI name)	*(PI name)*	*(PI name)*
Salary		$ -	$ -	$ -
Temporary Help		$ -	$ -	$ -
Fringe Benefits		$ -	$ -	$ -
Travel		$ -	$ -	$ -
Operating Expenses		$ -	$ -	$ -
Capital Outlay	$ -	$ -	$ -	$ -
Graduate Student Fees	$ -	$ -	$ -	$ -
TOTALS		$ -	$ -	$ -

Total Sub-budgets $ -

11.3.2010 - Version

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CURRENT AND PENDING SUPPORT Form:

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Name: **Nilsa Bosque-Pérez**

Instructions:

1. Complete all columns.
2. Record information for active and pending projects. Include this project under pending section.
3. All current research to which principal investigator(s)/project director(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
4. Provide analogous information for all proposed projects which are being considered by, or which will be submitted in the near future to, other possible sponsors.

NAME (List PI/PD #1 First)	SUPPORTING AGENCY AND AGENCY NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMIT TED	TITLE OF PROJECT
	Current:				
S.O. Guy, N.A. Bosque-Pérez, and J. Johnson-Maynard	USDA-CSREES, STEEP III	85,442	2008-2011	5%	Assessing the impact of direct seeding (no-till) and conventional-till on nitrogen fertility, soil, and insect responses
N.A. Bosque-Pérez	Idaho Wheat Commission	27,000	2010-2011	5%	Development of resistant wheat cultivars for management of Hessian fly in northern Idaho
K. Campbell and N.A. Bosque-Pérez	Washington Wheat Commission	8,000	2010-2011	2%	Evaluation of wheat breeding lines for management of Hessian fly in the Pacific Northwest
S.D. Eigenbrode, N.A. Bosque-Pérez, and A. Karasev	USDA-AFRI	349,993	2009-2012	10%	Vector responses to virus-induced changes in the host plant: Implications for disease spread
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	37,036	2011-2012	5%	Development of resistant wheat cultivars for management of Hessian fly in northern Idaho
K. Campbell and N.A. Bosque-Pérez	Washington Wheat Commission	8,000	2011-2012	2%	Evaluation of wheat breeding lines for management of Hessian fly in the Pacific Northwest

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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: _Sanford Eigenbrode_____ _____ Dec. 8, 2010
(Type/Print name) (Signature) (Date)

Reviewer 2: _Alex Karasev_____ _____ 12/8/10
(Type/Print name) (Signature) (Date)

Dept. Head/ ___James B. Johnson_____ _____ 10 Dec. 2010
Unit Administrator (Type/Print name) (Signature) (Date)

PROGRESS REPORT

PROJECT NO: BJK968

TITLE: Development of resistant wheat cultivars for management of Hessian fly in northern Idaho

PERSONNEL: Nilsa A. Bosque-Pérez, Professor
Lana Unger, Research Support Scientist 1

ADDRESS: Nilsa A. Bosque-Pérez, Dept. of PSES, University of Idaho, Moscow, ID 83844-2339; 208-885-7544; nbosque@uidaho.edu

ACCOMPLISHMENTS:

Resistance screening. The Hessian fly colony established in our laboratory in 1998 continues to be used regularly to conduct resistance screening tests. The laboratory screening procedure is working very effectively. We have continued our screening efforts and over 80 advanced breeding lines and varieties were evaluated for fly resistance in the laboratory during 2010. Lines originating from crosses with several Hessian fly resistant sources were tested. This included hard red spring wheat lines derived from the crosses WPB926/WA7702, IDO558*2/JFSN, JFSN*4/IDO584, JFSN*2/Alsen, [McNeal/JFSN]F3 seln//2*JFSN, Pavon 1RSv.1ALp/2*Jerome, Sunstar2/JFSN (HF-R, Jan03)//IDO592, Sunstar2/JFSN (HF-R, Jan03)//Jerome, IDO592*2//Lolo*2/WGRC17, Grandin*3/Js-12-Mu-6//2*JFSN, IDO593*2//Grandin*6/Js-12-Mu-6, 96WY51407/Jerome, and Hank//Minivet/2*Sunstar 1/3/IDO558. Hard white spring lines derived from the crosses Oasis/IDO377, Lolo//Klasic*3/Amidon, IDO//JFSN/2*IDO470, Jerome*2/Lolo, JFSN*2/Alsen, and Lochsa*2/Pavon 1RSe.1ALp were also tested. In addition, soft white spring lines derived from the crosses Alturas*2/Hank, and Alturas*2/Cadoux were screened. Several of the lines evaluated had a high proportion of resistant plants (Table 1).

Table 1. Percent plants resistant to Hessian fly in the laboratory, Moscow, ID, May, 2010.

Genotype	Pedigree	Class	% Resistant plants
A00491-E-2	Alturas*2/Hank	SWS	0
A00007S-H-4	Alturas*2/Cadoux	SWS	0
Lolo	Oasis/IDO377	HWS	0
IDO856	Lolo//Klasic*3/Amidon	HWS	5
A02652S	IDO//JFSN/2*IDO470	HWS	6
A01103-B	Jerome*2/Lolo	HWS	100
A02610S-17	JFSN*2/Alsen	HWS	6
A040260S-A	Lochsa*2/Pavon 1RSe.1ALp	HWS	67
IDO865	IDO558*2/JFSN	HRS	100
IDO868	JFSN*4/IDO584	HRS	83
IDO867	JFSN*2/Alsen	HRS	10
IDO866	JFSN*2/Alsen	HRS	5

A03813S-A-6	[McNeal/JFSN]F3 seln//2*JFSN	HRS	100
A04881S	Pavon 1RSv.1ALp/2*Jerome	HRS	0
A03698S	Sunstar2/JFSN (HF-R, Jan03) //IDO592	HRS	100
A03680S	Sunstar2/JFSN (HF-R, Jan03) //Jerome	HRS	100
A03142S-SEL	IDO592*2//Lolo*2/WGRC17, H25(likely WGRC20)	HRS	6
A03018S-E	Grandin*3/Js-12-Mu-6//2*JFSN	HRS	5
A05230S-A	IDO593*2//Grandin*6/Js-12-Mu-6	HRS	18
A00618S-2	96WY51407/Jerome	HRS	100
A00070S-3	Hank//Minivet/2*Sunstar 1/3 /IDO558	HRS	16

Means of 15 to 20 plants per genotype.

We also tested Idaho lines that were included in the Hard Red and Hard White Spring Western Regional Nurseries (Table 2). Some of the lines are derived from the crosses Hank/JFSN//IDO558, JFSN*2/IDO557, JFSN*2/Hi-Line, Lolo//Klasic*3/Amidon, Blanca Grande/2*Lolo, Lolo*2/WGRC17, H25//JFSN, and Hank/JFSN//IDO558. IDO702 and IDO704 were 100% resistant to Hessian fly, while other lines exhibited varying levels of resistance or susceptibility to the fly.

Work continued in collaboration with Drs. Jianli Chen at Aberdeen and Deven See at WSU-USDA to develop molecular markers for Hessian fly resistance genes.

Table 2. Percent plants resistant to Hessian fly in the laboratory, Moscow, ID, December, 2010.

Genotype	Pedigree	Class	% Resistant plants
IDO702	Hank/JFSN//IDO558	HRS	100
IDO704	JFSN*2/IDO557	HRS	100
IDO706	JFSN*2/Hi-Line	HRS	5
IDO856	Lolo//Klasic*3/Amidon	HWS	0
IDO859	Blanca Grande/2*Lolo	HWS	10
IDO860	Lolo*2/WGRC17, H25//JFSN	HWS	0
IDO862	Hank/JFSN//IDO558	HWS	16
IDO377S	Susceptible Check	HRS	5
Clear White	Resistant Check	HWS	100
Hank	Resistant Check	HRS	94

Means of 18 to 20 plants per genotype.

PROJECTIONS:

The goal of this work is to provide growers with new spring wheat varieties with resistance to Hessian fly. Evaluation of breeding materials and mapping populations will continue in the

laboratory during 2011-2012. Examination of the effectiveness of presently deployed resistant genes in controlling fly populations will be done via field samplings during the 2011 growing season. Information from this work will help growers manage pest populations and optimize productivity.

PUBLICATIONS:

Chen, J., E.J. Souza, N.A. Bosque-Pérez, M.J. Guttieri, K.L. O'Brien, J.M. Windes, S.O. Guy, B.D. Brown, X.M. Chen, and R.S. Zemetra. 2010. Registration of 'UI Winchester' wheat. *Journal of Plant Registrations.* 4(3): 224-227.

Odubiyi, S.I., N.A. Bosque-Pérez, L.M. Unger, and K.G. Campbell 2010. Laboratory evaluation of regional hard and soft spring wheat genotypes for resistance to Hessian fly. Entomological Society of America Pacific Branch Annual Meeting, Boise, Idaho, April 11-14, 2010. (Abstract).