USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY07 Final Performance Report (approx. May 07 – April 08)
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Cover Page

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Fiscal Year:	2007
USDA-ARS Agreement ID:	59-0790-3-083
USDA-ARS Agreement Title:	Management and Resistance Sources for Control of FHB in Barley.
FY07 ARS Award Amount:	$ 62,635

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
CBCC	Preharvest Management Strategies in Barley to Reduce FHB and DON.	$22,639
HGR	Accelerated Screening of Hordeum Germplasm for FHB Resistance.	$ 28,216
VDUN	Screening Barley Lines for Scab Resistance in Cross-State and Region Uniform Nurseries.	$ 11,780
	Total Award Amount	**$ 62,635**

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Principal Investigator Date

* CBCC – Chemical, Biological & Cultural Control
EEDF – Etiology, Epidemiology & Disease Forecasting
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GET – Genetic Engineering & Transformation
HGR – Host Genetics Resources
HGG – Host Genetics & Genomics
IIR – Integrated/Interdisciplinary Research
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Preharvest Management Strategies in Barley to Reduce FHB and DON.*

1. What major problem or issue is being resolved and how are you resolving it?

Weather conditions in North Dakota during barley harvest slow crop maturity and can result in non-uniform crop maturity within a field. In most years barley producers choose to use windrowing or pre-harvest herbicides as desiccants to accelerate crop maturity and drying and allow clean threshing. Windrowing involves cutting the crop near ground level and then pushing it up into rows 3-4 ft wide and 1-2 ft high. Current pesticide registration in North Dakota permits preharvest application of 2,4-D ester, metsulfuron and glyphosate. In addition paraquat and dicamba have been used experimentally.

In contrast to wheat, barley is susceptible to infection by *Fusarium* from head emergence through to harvest. Windrowing and pre-harvest herbicide usage can significantly influence the effectiveness of the best fungicides, resistance and management practices for control of FHB if infection occurs late after fungicide effectiveness is reduced and when active plant resistance has ceased. In addition, these late season influences on FHB and DON levels in the grain can complicate the interpretation of predictive disease models which rely on climatic data collected during the flowering and grain ripening period.

To provide recommendations for preharvest management strategies both plus and minus windrowing and 14 desiccant herbicide treatments were applied to both 2-rowed and 6-rowed barley. Grain was assessed for number of visually infected kernels immediately before swathing. Treatments were then swathed and standing barley. Swathing treatments followed commercial practice. Irrigation schedules to simulate rainfall were applied at regular intervals after the crop was windrowed. After 2 weeks the grain was harvested and assessed for FHB incidence and severity as well as DON.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

Accomplishment:

In 2007 we demonstrated that while simulated rainfall increased both the incidence and severity of FHB in both Robust and Conlon there was no significant effect of swathing versus harvesting of the standing crop. A similar result was seen for DON accumulation, simulated rainfall increased DON in the crop but there was no significant effect of swathing versus harvesting of the standing crop on DON accumulation. As expected due to the stage of crop maturity when the simulated rainfall was applied, extra water had no effect on yield.

In 2007, flooding of the trial site for a two week period destroyed the desiccant study and no data was able to be collected.

Impact:

During the three years that we undertook this research we got one year in which swathing increased FHB or DON and two in which it did not, so it is difficult to give definitive information to farmers about the effect of preharvest swathing except to say that environmental conditions can influence the result of this treatment and farmers must weight the benefit of the treatment against potential for increased disease.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?:

An awareness that preharvest treatments in barley can in some years affect FHB incidence and severity as well as DON accumulation.

Project 2: *Accelerated Screening of Hordeum Germplasm for FHB Resistance.*

1. What major problem or issue is being resolved and how are you resolving it?

Resistance to FHB in barley currently relies on only a few original sources of resistance and comprehensive screening of the US barley germplasm collection and the barley collection from the Dutch centre for genetic resources have found only few potentially new resistance sources. To broaden the genetic base of FHB resistance in barley, additional sources of resistance need to be identified and exploited as soon as possible. The project involves an accelerated screening in replicated experiments at several locations in North America, diverse *Hordeum* germplasm from as yet unscreened genebank collections around the world.

To achieve this aim 550 lines were screened simultaneously in irrigated an inoculated nurseries at Fargo and Langdon ND. The two areas were chosen as they are climatically and geographically different. In addition this allows us to spread the load as Fargo ripens a week earlier than Langdon. Experimental units in ND nurseries consisted of single short rows and arranged in an augmented block design. Checks were Stander (FHB susceptible six-rowed cultivar), Chevron (FHB resistant six-rowed cultivar), Conlon (FHB susceptible two-rowed cultivar), and CIho 4196 (FHB resistant two-rowed accession) as well as IB1 and IB2. Checks were sown every 50 entries. Entries were inoculated using two applications of grain spawn, once before head emergence and the second prior to early dough. Fusarium head blight severity was determined at the mid dough stage by rating on a scale of 1-5, 20 spikes per row. Entries were scored for flowering date, height and other important agronomic characteristics. At maturity DON analysis was undertaken.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

Accomplishment:

Seventy eight of the 550 lines at Langdon had a rating of 1 which was comparable to the resistant checks CI4196 and Chevron. The susceptible checks Stander and IB2 had mean ratings of 3-4. At Fargo 64 of the 550 had a rating of 0 or 1 which was comparable to the resistant checks CI4196 and Chevron. The susceptible checks Stander and IB2 had mean ratings of 2-3. Twenty three lines were selected as having low FHB symptoms and they were tested for DON accumulation. The 23 best lines had a mean DON of 6.3ppm with a range from 2.8-11.1 ppm. The resistant check Chevron had a mean of 4.8 while CI4196 had a mean of 4.1. The susceptible check Stander had a mean of 22.1 while IB2 had a mean of 10.8.

Impact:

It is clear that from this first round of testing that there are at least 20 lines that have both low FHB severity and low DON accumulation which approaches that found in the current resistant checks and these lines should now be tested in multiple field sites to ensure they

remain resistant under different environmental conditions and under a range of disease pressures. Once these lines are proven to be stable across environments they will be moved into the next stage of genotyping to ensure they are unique and crossed to breeding lines adapted to the upper Midwest.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?:

We now have potentially 23 new sources of resistance to FHB and DON accumulation in barley. These are available breeders and pathologists for pre-breeding or breeding now or as more site years of testing become available.

Project 3: *Screening Barley Lines for Scab Resistance in Cross-State and Region Uniform Nurseries.*

1. What major problem or issue is being resolved and how are you resolving it?

Regional uniform nurseries for crops are a standard method of comparison of advanced breeding lines and allow comparison of the relative advances made in the different breeding programs and foster germplasm exchange between diverse breeding programs.

Within the nurseries advanced barley lines with putative FHB resistance were tested in mist-irrigated sites as well as under rainfed conditions. Rainfed conditions represent those experienced by farmers in the regions in which the nursery is sown. Mist-irrigated nurseries that are artificially inoculated with *Fusarium graminearum* are needed so data can be collected in years when environmental conditions are not conducive for natural infection and to determine the stability of the putative resistance under high disease pressure. The series of FHB screening nurseries in this project has been carried out for more than 10 years and is currently known as the North American Scab Evaluation Nursery (NABSEN) nurseries. In 2007 the nurseries were grown at Fargo, Langdon, Osnabrock and Carrington, ND; St. Paul and Crookston MN; Brandon Canada and Hangzhou, China. This nursery includes breeding lines with putative FHB resistance from NDSU 2-rowed and 6-rowed, Minnesota State University, Busch-Ag and Agriculture & Agri-Food Canada barley breeding programs. FHB severity and DON accumulation are determined as well as agronomic characters such as heading date and environmental data such as rainfall.

The objective of this project is to coordinate the screening in uniform FHB screening nurseries in North America of elite barley germplasm from breeding programs developing cultivars adapted to the upper Midwest barley growing region.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

Accomplishment:

The 2007 North American Barley Scab Evaluation Nursery (NABSEN) was grown at Fargo, Langdon, Osnabrock and Casselton, ND; St. Paul and Crookston MN, Brandon, Manitoba; El Batan, Mexico and Hangzhou China. The nursery contained 54 lines including 6 resistant and susceptible controls.
In Casselton the Busch Ag trial experienced seasonal conditions caused problems in the nursery, so that data is not available. All other sites experienced adequate to good conditions for the development of disease and the recording of relative levels of resistance in the different breeding programs.

The resistance of the cultivars relative to the resistant and susceptible checks varied by location. Brandon had very high severities, Crookston was high, that remaining sites were

moderate to high except for El Batan which was low. For the ranking of lines, in general the inoculated irrigated sites or dryland sites with high rainfall had the highest correlations among themselves and low correlations with other dryland sites. Similarly, for the ranking of lines dryland sites had the highest correlations sites among themselves but low correlations with irrigated sites.

When averaged over all sites, with 3 of the NDSU 6-rowed line and several of the the M and FEG lines from the University of Minnesota displaying the best resistance although all were short of Chevron the resistant 6-rowed check and CI4196 the resistant 2-rowed check. Similar trends were seen with DON accumulation.

Environmental data was again added to this years NABSEN report so that breeders can better analyze performance and understand how environmental conditions influenced the disease present.

Significant progress is being made toward developing FHB resistant barley cultivars. The project has allowed breeding programs with slower progress access to genetic material from the more advanced programs.

Impact:

All North American barley breeders have access to the data collected in this project. The information is made available electronically and in hard copy by the USWBSI meeting in December and even earlier by request. The breeders are able to use the relative performance data make decisions about continuing or dropping development of particular breeding lines. The project has also allowed breeding programs with slower progress to have access to genetic material from the more advanced programs or make decisions on the use of material being developed in foreign breeding programs such as the three Canadian programs and the CIMMYT/ICARDA program who submit entries to the nursery.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?:

Breeders now have 1) tests of the resistance stability of their breeding lines across a range of environments and disease pressures, 2) a measure of the resistance in their advanced breeding material compared to those of the other barley breeders in North America and CIMMYT/ICARDA, and 3) access to unique germplasm with resistance to FHB and DON accumulation.

Include below a list of the publications, presentations, peer-reviewed articles, and non-peer reviewed articles written about your work that resulted from all of the projects included in the grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Williston Research and Extension Centre Field day 12 July 2007, (5 talks each to 50 people)

Carrington Research and Extension Centre Field day 19 July 2007, (5 talks each to 50 people)

Langdon Research and Extension Centre Field day 20 July 2007, (3 talks each to 40 people)

Franckowiak, J.D., Horsley, R.D., Neate, S.M. and Schwarz P.B. (2007) Registration of 'Rawson' Barley. Journal of Plant Registrations 1:37–38.

Burlakoti, R.R., Ali, S., Secor, G.A., S. M. Neate, S.M., M. McMullen, M. and Adhikari, T. (2007) Genetic relationships among populations of *Fusarium graminearum* from cereal and non-cereal hosts. Phytopathology 97:S15.

Burlakoti, R.R., Ali, S., Secor, G.A., S. M. Neate, S.M., M. McMullen, M. and Adhikari, T. (2007) Impact of cereal and non-cereal hosts on trichothecene producing genotypes of *Fusarium graminearum*. Phytopathology 97:S15.