USDA-ARS / USWBSI
FY03 Final Performance Report (approx. May 03 – April 04)
July 15, 2004

Cover Page

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Year:	**FY2003 (approx. May 03 – April 04)**
FY03 ARS Agreement ID:	**59-0790-3-083**
FY03 ARS Agreement Title:	**Resistance screening, stubble management and split fungicide application for control of FHB in barley.**
FY03 ARS Award Amount:	**$ 48,425**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
VDUN	Screening barley lines for scab resistance in uniform nurseries.	$ 10,411
CBC	Prevention of sporulation of Fusarium in plant residue to reduce FHB and DON.	$ 22,050
CBC	Split fungicide application and crop management to control FHB in barley.	$ 15,964
	Total Amount Recommended	**$ 48,425**

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Principal Investigator Date

* BIO – Biotechnology
CBC – Chemical & Biological Control
EDM – Epidemiology & Disease Management
FSTU – Food Safety, Toxicology, & Utilization
GIE – Germplasm Introduction & Enhancement
VDUN – Variety Development & Uniform Nurseries

Project 1: ***Screening barley lines for scab resistance in uniform nurseries.***

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

Regional uniform nurseries for crops are an established method of comparison of advanced breeding lines. These nurseries provide data on advanced lines in a wider range of environments than those for which the lines were bred, allow comparison of the relative advances made in the different breeding programs and foster germplasm exchange between programs. Advanced barley lines with putative FHB resistance were tested in mist-irrigated sites as well as under rainfed conditions similar to those experienced in farmers fields. 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 higher than normal disease conditions. A rainfed and mist-irrigated uniform FHB screening nursery, called the NABSEN nursery, was grown at Fargo, Langdon, Osnabrock and Carrington, ND; St. Paul and Crookston MN; Brandon Canada and Toluca Mexico. This nursery includes breeding lines with putative FHB resistance from NDSU 2-rowed and 6-rowed, Minnesota State University, Busch-Ag, Agriculture & Agri-Food Canada and CIMMYT/ICARDA barley breeding programs. Between 25-50 entries have been grown in the nursery each of the past eight years and FHB severity and DON accumulation are determined.

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

2. What were the most significant accomplishments?

In 2003, 51 lines were evaluated in the NABSEN trials grown at nine locations. All locations were successful and good resistance information was obtained at each site. The resistance of the cultivars relative to the resistant and susceptible checks varied by location. When the FHB symptoms and DON accumulation rankings of the lines were compared between the different sites, in general, the best correlations were between the FHB severity and DON accumulation data from Brandon, Langdon and Crookston. These locations are all inoculated irrigated sites and all located between 37.8^0 N and 39.8^0 N and therefore may experience similar disease due to similar environmental conditions.

Although none of the breeders' lines had FHB resistance as good as the resistant checks (CIho 4196 and Chevron), at each site there were lines better than the susceptible checks (Robust and Stander) that can be used as the basis for further breeding efforts. Environmental data was added to this years NABSEN report so that breeders can better analyze performance and understand how environmental conditions influenced the disease present.

Project 2: ***Prevention of sporulation of Fusarium in plant residue to reduce FHB and DON.***

1. What major problem or issue is being resolved and how are you resolving it?
The majority of the previous research with chemical application on barley has focused on protecting the grain spike from FHB infection at head emergence and once it is infected by spores. Our principle objective is to reduce the spore load experienced by the plant by 1) evaluating methods that would alter sporulation by modifying the inoculum on the residue and by 2) developing an in vitro screening technique to evaluate the effects of treatments on the sporulation of *F. graminearum* so that larger numbers of treatments can be pre-screened before field testing.

Field trials were conducted at Langdon in 2002 and Langdon and Fargo in 2003 to evaluate fungicides that would reduce perithecia development and sporulation. Five classes of fungicides were applied to the residue at two timings. In addition to yield and disease assessment, at the boot stage 30 heads were bagged in each plot, then on 5 sample dates the bags were removed on 5 heads for 24 hours. The heads were excised, shaken in water to dislodge any spores and the spore solution frozen for later spore counts. Burkhardt spore traps were ordered as soon as USWBSI funds were available but not delivered in time for use during 2003. In a second field trial at Fargo, 14 commercial or research biological control agents were applied to stubble in the field. This trial had to be abandoned when the plants were at tillering stage due to heavy rain and flooding causing extensive plant death.

Several studies have been undertaken and are currently on-going to develop a consistent method of perithecia and spore production on stubble in-vitro. Treatments included the use of chambers containing saturated salt solutions to establish a range of relative humidity's, different substrates, placement of stubble, lighting and temperature. Studies have been conducted with *F. graminearum* infected barley kernels and are on-going with barley straw.

2. What were the most significant accomplishments?
The study efforts indicate the difficulty in working in the field environments. Natural infection techniques were used at all locations on barley planted on small grain stubble. Disease development was minimal at all sites. No *F. graminearum* colonies were found on the spikes in 2002 and very low quantities were found in 2003 and indicate that the head trapping method is most useful when inoculum is at high levels. Other *Fusarium* sp. were also detected at low levels. Water sensitive paper placed on the soil surface demonstrated good coverage of the sprays thru the canopy at Feekes 6 & 9 growth stages when using drop nozzle spray equipment.

The in vitro experiments have had problems in getting a consistent level of perithecia development and sporulation. Continuing efforts are on-going to develop a screening technique to evaluate the effects of compounds applied in the field.

The six Burkhard volumetric spore collectors and two Anderson samplers will be used in the field in 2004 and 2005 to compare the head wash technique with a spore collector system. The Burkhard spore collectors which will be placed in the crop canopy, use a selective agar media plate to allow enumeration of developing cultures of *F. graminearum* and related species.

Project 3: ***Split fungicide application and crop management to control FHB in barley.***

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

Fusarium head blight (FHB) has reduced the quality of barley grown in the Midwest for the last decade due to fungus infected kernels, pinched grain and most importantly the presence of the toxin, deoxynivalenol (DON). Individual cultural and chemical control measures have reduced disease, but have been unsuccessful in getting the level of control necessary

Barley has a significantly greater FHB problem than wheat because,

- Zero or low DON tolerance is required by the malting industry.
- Fungicides are less effective on barley.
- Less effective resistance has been identified in barley
- Barley is susceptible from flowering through to harvest.

It is likely that the reduced control with fungicides in barley is due to the long period during which the plant is susceptible to infection and the relatively short period of effectiveness of the fungicides used for control. Field experiments were designed to test the effectiveness of multiple fungicide applications on both FHB disease and DON accumulation by barley.

2. What were the most significant accomplishments?

Factorial experiments of two cultivars (Robust and Conlon), two chemicals (Folicur and JAU 6476), two spray regimes (single application, two applications) and two rates (recommended and 1/2 recommended) were established at Langdon and Bottineau in North Dakota. In preliminary experiments we determined the differences in planting date necessary to ensure that the two cultivars flower at the same time which allows us to make more valid comparisons of treatments. A 2-3 day difference in flowering date has an environmental component and requires 6-7 days difference in planting date.

At Langdon, FHB symptoms were low, and while selected treatments reduced both disease and DON, we have demonstrated that there was no significant advantage to using a split application of fungicide under these low disease conditions. At Bottineau, FHB symptoms were too low to be assessed and DON was undetected except for one treatment, however the fungicides were beneficial in controlling leaf disease. The leaf disease control in the absence of FHB would help to offset the cost of the fungicides making application for FHB control less of a risk and more likely to be adopted by producers. These experiments need to be repeated under a range of environments and under higher disease pressures to confirm the usefulness of split application of fungicides for controlling FHB symptoms 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 you grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Presentations (Scientific and Industry)

1. American Malting Barley Association Industry Barley Tour, Carrington and various field sites, July 30th 2003
2. Dickinson Research and Extension Center Malt Barley Management Tour, July 9th 2003
3. Williston Research and Extension Center Field Day, July 10th 2003
4. Langdon Research and Extension Center Field Day July 17th 2003
5. AMBA and ND Barley Council Barley Day Jan 15 2004. Barley Diseases from A to Z
6. ND State Barley Show, Osnabrock, March 25th 2004 Disease Resistance: A priority for new NDSU barleys

Publications (peer reviewed)

1. Neate, S.M., McKay K.R,. and Halley S.A. (2003) Split Application of Fungicides for Increased Control of FHB and DON on Barley. p104 Proceedings of the 2003 National Fusarium Head Blight Forum Proceedings, Minneapolis Dec , 2003.

Publications (non-peer reviewed)

1. Neate, S.M and Gross, P.L. (2002) 2003 North American Barley Scab Evaluation Nursery (NABSEN) Interim Report. 2003 National Fusarium Head Blight Forum, Minneapolis Dec , 2003.