**U.S. Wheat and Barley Scab Initiative**
**FY02 Final Performance Report (approx. May 02 – April 03)**
**July 15, 2003**

**Cover Page**

| | |
|---|---|
| **PI:** | **Gregory Shaner** |
| **Institution:** | **Purdue University** |
| **Address:** | **Department of Botany and Plant Pathology<br>1155 Lilly Hall<br>West Lafayette, IN 47907-1155** |
| **E-mail:** | **shaner@btny.purdue.edu** |
| **Phone:** | **765-494-4651** |
| **Fax:** | **765-494-0363** |
| **Year:** | **FY2002 (approx. May 02 – April 03)** |
| **Grant Number:** | **59-0790-9-065** |
| **Grant Title:** | **Fusarium Head Blight Research** |
| **FY02 ARS Award Amount:** | **$ 85,854** |

**Project**

| **Program Area** | **Project Title** | **USWBSI Recommended Amount** |
|---|---|---|
| CBC | Uniform Fungicide Trials for Control of Fusarium Head Blight. | $7,000 |
| EDM | Forecasting Fusarium Head Blight Based on weather and Pathogen Monitoring. | $37,000 |
| GIE | New Sources of Resistance to Fusarium Head Blight of Wheat. | $44,000 |
| | **Total Amount Recommended** | **$88,000** |

_______________________________________________
Principal Investigator                                        Date

(Form – FPR02)

**Project 1: Uniform Fungicide Trials for Control of Fusarium Head Blight.**

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

Scab has become a serious disease of wheat and barley in many areas of the US. Effective control will likely require a combination of disease management strategies, including use of fungicides. This project is part of a uniform fungicide evaluation project, in which the same treatments are applied at several locations in the U.S.

2. What were the most significant accomplishments?

Fungicide trials were conducted at 3 locations in Indiana during 2002: 2 sites at the research farm (ACRE) near West Lafayette, and at the Southeast Purdue Agricultural Center (SEPAC), near North Vernon. Surface coverage by corn residue was 40% at ACRE and 70% at SEPAC**.** All experiments were randomized complete blocks with 4 replications. Rainfall at ARC for the week prior to heading and 2 weeks past flowering was 70 mm. Average high temperature for the same period was 19 °C and average low temperature was 6 °C. At SEPAC, average high and low temperatures were 20 °C and 8 °C for the week prior to heading and into flowering. Rainfall at SEPAC was 244 mm during the same period. Disease developed from natural inoculum. Fungicides were applied with a $CO_2$-pressurized wheeled sprayer that delivered 253 L/ha at 276 kPa, with a boom that had 5 TJ 60-8002 nozzles spaced at 38 cm. Fungicides were applied at flag leaf emergence (GS 8) and beginning of anthesis (10.51) at ACRE and at early boot (9.5) and mid flowering (10.52) at SEPAC. Incidence of *Fusarium* head blight (FHB) was estimated by counting the number of blighted heads in 10 arbitrarily selected 30-cm lengths of row.

Incidence of FHB was 9.5% at one site at ACRE in the untreated plots. Four treatments, all applied at GS 10.51, reduced incidence significantly: a combination of AMS 21619 480 SC at 416 ml/ha plus Folicur 3.6 F at 292 ml/ha, BAS 505 03 F at 468 ml/ha, and the biological agent TrigoCor. Also, a combination of Stratego 250 EC at 365 ml/ha applied at GS 8 followed by Folicur 3.6 FL at 292 ml/ha at GS 10.51 reduced incidence. Incidence in the untreated control at the other site at ACRE was only 5.1% and there were no significant differences among treatments. Incidence at SEPAC was 6.1% and there were no differences among treatments. DON levels from both trials at ACRE were low (0.5 to 1.2 µg/g) and there were no significant differences among treatments. DON levels at SEPAC ranged from 1.5 to 2.3 µg/g. The treatment effect was significant, but no treatment reduced DON level compared to the untreated control. There were no differences in yield or test weight in any of the tests.

Results of this trial suggest that there are fungicides that, when applied at the appropriate growth stage, will reduce the incidence of head blight.

**Project 2: Forecasting Fusarium Head Blight Based on weather and Pathogen Monitoring.**

1. What major problem or issue is being resolved and how are you resolving it?
Effective management of scab requires a thorough understanding of the relation between weather and inoculum production, inoculum dispersal, and disease development. This information is necessary to develop disease forecasts, which can be used to assess risk of scab in various regions, for making decisions about whether and when to use fungicides, and for decisions about marketing and utilizing grain. Also, understanding the conditions that favor scab will permit creation of epidemics in the field that are essential for effective selection for resistance, for evaluation of experimental fungicides, or evaluation of other control measures.

2. What were the most significant accomplishments?
We monitored weather, inoculum, and head blight in field plots in which various combinations of wheat cultivar and planting date resulted in anthesis dates that ranged from 22 to 29 May 02. Natural inoculum was from corn residue on the soil surface.
A brief warm spell in mid April was followed by unusually cool weather during most of May. During the 2 wk prior to 22 May, rain fell on 8 days, but mean daily temperature was above 15 °C only on 16 May. Daily mean temperatures began rising after 26 May, near the end of anthesis, but by that time there was little rainfall. Daily airborne spore concentrations estimated from a Burkard sampler were low (0 to 164 cfu 10 $m^{-3}$ $d^{-1}$). A second sampler, located in a fungicide experiment about 1 km away, revealed similar numbers of spores (r=0.95 for data from the 2 samplers). There was large daily variation in number of airborne spores. On only one occasion, 28 and 29 May, were there 2 consecutive days with high counts.
We also quantified inoculum by quantitatively recovering spores from wheat heads. Numbers of spores recovered from heads ranged from 0 to 750 $head^{-1}d^{-1}$. The higher values occurred later in the season, at the grain filling stage. Numbers of spores collected from heads in the epidemiology study site were similar to numbers collected from the fungicide trial site (r=0.75). Sampling airborne inoculum with a Burkard volumetric sampler or by head washing gave similar estimates (same order of magnitude) of the number of spores that impact a head each day, but correlations between daily values were low.
Incidence and severity of head blight both increased linearly from 5 June, when symptoms first appeared, through 21 June. Incidence increased from 3 to 16% (0.8% per day) and severity increased from 30 to 83% (3.5% per day). Among the cultivar-planting date treatments, mean incidence ranged from 1.4 to 9.2%. The effects of cultivar, planting date and their interaction were all highly significant. Incidence of FHB was highly correlated to the sum of spore densities (Burkard data) 4 and 5 days after GS 10.51 ( r= 0.97). Our results suggest that the abundance of inoculum during early flowering strongly influences FHB incidence.
We used data from this study to evaluate 2 weather-based forecast models developed by DeWolf et al (2000). These models predict the probability of a "severe" epidemic of FHB, defined as an incidence greater than 10%. For all data sets, the models predicted that the epidemic would not be severe, as was indeed the case.

**Project 3: New Sources of Resistance to Fusarium Head Blight of Wheat.**

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

Resistant cultivars will be an important component of an integrated disease management strategy for FHB. Most wheat breeding programs are utilizing the Sumai 3 resistance. While this resistance appears to be the best available, and reasonably effective, it does not totally prevent disease development. Also, if most wheat breeding programs rely on the same source of resistance this could result in genetic vulnerability. This project is designed to find other sources of resistance to scab, to characterize the inheritance of this resistance, and to obtain a higher degree of resistance by combining resistance genes from different sources.

2. What were the most significant accomplishments?

We previously selected lines from several germplasm accessions for a high degree and consistent expression of type II resistance. In this project, we evaluated them simultaneously for both type I resistance and for type II resistance. There was a weak but significant correlation between the 2 types of resistance ($r=0.39$, $P<0.05$). Two lines with a high degree of type II resistance, had very little type I resistance. Two other lines had a high degree of type I resistance, but only moderate type II resistance. One of the susceptible check cultivars, Norm, showed a moderate degree of type I resistance, possibly because in the greenhouse it did not extrude anthers.

Previously we evaluated a population of recombinant inbred lines (RILs), derived from a cross between wheat cultivars Chokwang and Clark, for type II resistance. Chokwang was moderately resistant; Clark was susceptible. There was transgressive segregation for resistance. We evaluated this same population for type I resistance. Family mean severities at 15 days after inoculation were normally distributed and ranged from 2 to 14 blighted spikelets. Chokwang averaged 9 blighted spikelets; Clark averaged 11.6. Of 77 RILs, 53% had a lower severity than Chokwang. This transgressive segregation suggests that both Chokwang and Clark contribute genes for type I resistance and that these genes act additively. There was no significant correlation ($r=-0.21$) between type I and type II resistance in this population, indicating that these two types of resistance are controlled by different genes, which agrees with the results with the germplasm lines.

Progeny-parent correlations for type II resistance are often low in early segregating generations. Although the environment and inoculum dose can be reasonably controlled in the greenhouse, there is often large within-family variation. To investigate the relative contributions of genetic effects and experimental error to this variation, we compared a random set of 100 $F_3$ families from 3-way crosses with a corresponding set of $F_2$ families from the same crosses. We evaluated 6 plants of each family derived from a tested $F_2$. If plant-to-plant variation in severity in the $F_2$ was mainly of genetic origin, this variation should diminish in $F_3$ families from selected $F_2$ plants. However, the standard deviations for severity within $F_3$- and $F_2$ families were essentially equal. There was a low correlation between the severity of the parent $F_2$ plant and the mean of its $F_3$ progeny. Resistant (i.e. <4 blighted spikelets) $F_2$ plants gave rise to progeny families that ranged from resistant to very susceptible, susceptible $F_2$ plants (> 4 blighted spikelets) gave rise to only susceptible families. Partial dominance of resistance would explain this pattern of reaction. In early generations, it is possible to practice negative selection, but resistant plants may produce susceptible progeny.

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.

1. Bai, G., Chen, X., and Shaner, G. 2002. Breeding for resistance to Fusarium head blight of wheat in China, in K. J. Leonard and W. R. Bushnell (eds) Scab of Small Grains, APS Press.
2. Shaner G, Buechley G. 2002. Development of Fusarium head blight in Indiana, 2002. p 178 in Canty SM, Lewis J, Siler L, Ward RW (editors). 2002 National Fusarium Head Blight Forum Proceedings. Available at http:www.scabusa.org.
3. Shaner G. 2002. Resistance in hexaploid wheat to Fusarium head blight. P 208-111 in Canty SM, Lewis J, Siler L, Ward RW (editors). 2002 National Fusarium Head Blight Forum Proceedings. Available at http:www.scabusa.org.
4. Shaner, G. E. 2002. Epidemiology of Wheat Scab in North America, in K. J. Leonard and W. R. Bushnell (eds) Scab of Small Grains, APS Press.
5. Shaner, G., Buechley, G. 2002. Control of wheat diseases in Indiana with foliar fungicides, 2001. Report no. 57:CF04. Fungicide and Nematicide Tests, http://www.scisoc.org/online/FNTests/vol57/top. htm.
6. Zhou, W, Kolb, FL, Bai, G, Shaner, G, Domier, LL. 2002. Genetic analysis of scab resistance QTL in wheat with microsatellite and AFLP markers. Genome 45:719-727.