U.S. Wheat and Barley Scab Initiative
FY00 Final Performance Report (approx. May 00 – April 01)
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Cover Page

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Grant Number:	**59-0790-9-065**
Grant Title:	**Fusarium Head Blight Research**
2000 ARS Award Amount:	**$90,743**

Project

Program Area	Project Title	Requested Amount
Epidemiology & Disease Management	Forecasting wheat scab based on weather and pathogen monitoring.	$48,368.00
Chemical & Biological Control	Uniform fungicide trials to identify safe products that are effective against FHB.	$4,783.00
Germplam Introduction & Enhancement	New sources of resistance to FHB in wheat.	$39,861.00
	Requested Total	$93,012.00[1]

Principal Investigator Date

[1] Note: The Requested Total and the Award Amount are not equal.

(Form – FPR00)

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Grant: 59-0790-9-065
Project 1: Forecasting wheat scab 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 can be used to develop disease forecasts, which can be used to assess risks of scab in various regions, for making decisions about whether and when to use fungicides, and for decisions about marketing and utilizing grain. Understanding these relations will permit creation of conditions that permit effective selection for resistance in the field, or for evaluation of experimental fungicides or other control measures.

2. What were the most significant accomplishments?

There were 2 winter wheat research sites near Lafayette, IN. Wheat at site 1 was drilled into disked corn residue; wheat at site 2 followed soybeans, but was adjacent to a field with corn residue on the surface. A Campbell weather station was established at site 1. We monitored production and dispersal of spores of the *Fusarium graminearum* with Burkard volumetric samplers and by recovering spores washed from wheat heads. The Burkard sampler recovered spores from 2-29 May. No spores were recovered from 29 May through 8 June, the last day of sampling. There were large daily fluctuations in number of airborne spores. On either side of most "peak" days, numbers recovered were very low. There was one broad peak in mid May when 200-250 spores per 100 cu. m of air were recovered on each of 3 successive days. Fewer spores were recovered at site 2. There was a general correspondence between peaks at the 2 sites, although there was a large peak at site 1 on day 142 when almost no spores were trapped at site 2. There were several small peaks during the first week of May at site 1 when no spores were detected at site 2. An irrigated nursery was located about 50 m southeast of the sampler at site 1, so some of the peaks at site 1 that occurred when no peaks were detected at site 2 may have been the result of irrigation.
The alternative spore sampling procedure consisted of washing spores from 5 heads collected each day and plating the washing on a medium selective for *Fusarium*. Head sampling began on day 132 and continued through day 156. Spores were recovered on most days from days 132 to 145, but were low from then until the end of sampling on day 156. The day-to-day fluctuations in spore numbers seen in the Burkard data were not evident in the head washing data, possibly because viable spores recovered from heads may have represented spores that had been airborne and lodged on heads over a period of 2 or 3 days, whereas the Burkard samples represented spores only airborne during a 24-hour period. There was not a consistent association between number of spores recovered from heads and number of spores trapped by the Burkard samplers. The incidence of blighted heads at site 1 was 6.4% and at site 2 was 4.4%. The frequency of visibly scabby kernels in harvested grain from site 1 was only 2.2%, suggesting that many scabby kernels were eliminated from the grain during harvest. The head washing data suggest that most heads were exposed to inoculum, yet few showed blight. This suggests that weather may have been more limiting for infection than for spore production.

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Project 2: Uniform fungicide trials to identify safe products that are effective against FHB.

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. Although resistance will be an important component of a disease management strategy, fungicides may be required to augment resistance under conditions highly favorable for scab, and may be effective on cultivars that lack effective resistance.

2. What were the most significant accomplishments?

Fungicide trials were conducted at the Purdue Agronomy Research Center (ARC) in Tippecanoe County and at the Southeast Purdue Agricultural Center (SEPAC) in Jennings County, Indiana during 2000. At each location wheat cultivar Clark was drilled on 7-in. row spacing into disked corn stalks. Fungicides were applied at flag leaf emergence (Feekes stage 8) and beginning of anthesis (stage 10.51) at ARC and at early boot (stage 10) and full head emergence (stage 10.5) at SEPAC. Incidence of Fusarium head blight was low at SEPAC (2.6% in the untreated control) and moderate at ARC (6.4% in the untreated control). No fungicide treatment at SEPAC reduced head blight incidence compared to the untreated control. At ARC, Caramba, Stratego, and Folicur, when applied at stage 10.51, reduced head blight incidence significantly (incidence = 2.7, 4.0, and 3.3%, respectively). These 3 treatments, even though applied later than is normal for leaf disease control, reduced the severity of powdery mildew, leaf rust, and Stagonospora leaf blotch compared to the untreated control. Four treatments at ARC reduced the percentage of scabby kernels compared to the untreated control. Among these was a Cornell biological material that did not reduce the incidence of head blight. Five treatments also reduced the level of DON in grain, three of which were among those that reduced incidence of scabby kernels. At SEPAC, DON levels were generally lower than those at ARC (0.5 versus 2.6 ppm in the untreated controls), and no treatment had less DON than the untreated control. Several treatments, however, had significantly greater levels of DON than the untreated control. These were mostly treatments that included a strobilurin fungicide. The correlation between visibly scabby kernels and DON level, calculated on a plot basis for the ARC experiment, was significant, but low (R=0.41). Yields at SEPAC were high (81-94 bu/A), but those at ARC were average (45-63 bu/A).

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Project 3: New sources of resistance to FHB in wheat.

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. Resistant cultivars will be an important component of an integrated disease management strategy. Most wheat breeding programs are utilizing resistance from Sumai 3 or the closely related cultivar Ning 7840. Both are spring wheats from China. While this resistance appears to be the best available, and reasonably effective, it does not totally prevent disease development. Total reliance on this one source of resistance is also a concern. If any of the *Fusarium* species capable of causing scab were to adapt to this resistance, millions of acres of wheat could become vulnerable to the disease. This project is designed to find other sources of resistance to scab, with two objectives: to provide genetic diversity for resistance and to enhance the degree of resistance conferred by the Sumai 3 source of resistance.

2. What were the most significant accomplishments?

We selected several lines from accessions in the USDA wheat germ plasm collection for resistance to *F. graminearum*. The original accessions were heterogeneous for reaction, but by repeated cycles of inoculation and selection, we developed lines with a high degree and consistent expression of Type II resistance. We crossed these to susceptible cultivars, to Sumai 3 or Ning 7840, and to each other. During the fall greenhouse cycle of 2000, we devoted most effort to making further crosses for genetic studies. During the spring of 2001, we evaluated progeny from several test cross and backcross populations. The Korean winter wheat cultivar Chokwang has shown a high degree of resistance to *F. graminearum*. We evaluated Type II resistance in F1 progeny of Clark x Chokwang backcrossed to each parent and of a test cross to Norm. Distributions of the backcross to Clark and of the test cross to Norm were trimodal but were not consistent with a model of 2 dominant genes for resistance in Chokwang. None of the progeny of the backcross to Chokwang were fully susceptible, but 62% fell into an intermediate category, which also argues against a 2 dominant gene model. The backcross to Clark and the test cross to Norm gave rise to resistant progeny, indicating that this resistance can be transferred into a susceptible cultivar by conventional backcrossing.
Several new sources of resistance were intercrossed, followed by a test cross to the susceptible cultivar Clark. The range of segregation in each of these crosses suggests that the genes for resistance in Mentana and Paula VZ 434 differ from those in Sumai 3. CIMMYT 211, Futai 8944, and Y5418 probably share at least one resistance gene with Sumai 3.
Genes for resistance do not appear to be completely dominant. For example, when the F1 of Futai 8944 x Norm was backcrossed to Futai 8944, progeny ranged from highly resistant to moderately susceptible. Likewise, when the F1 of Futai 8944 x Paula VZ 434 was backcrossed to Futai 8944, progeny ranged from highly resistant to moderately susceptible. When the F1 of Futai 8944 x Sumai 3 (or Ning 7840) was backcrossed to Futai 3, all progeny were resistant or moderately resistant, further suggesting that Futai 8944 has one or more genes in common with Sumai 3.

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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. 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 (in press).
2. Bai, G., Kolb, F., Shaner, G., and Domier, L. 1999. Amplified fragment length polymorphism markers linked to a major quantitative trait locus controlling scab resistance in wheat. Phytopathology 89:343-348.
3. Bai, G., Plattner, R., Shaner, G., Kolb, F. 2000. A QTL for deoxynivalenol tolerance in wheat. (Abstr.) Phytopathology 90:S4, Pub. No. P-2000-0024-AMA
4. Bai, G.-H., Shaner, G., Ohm, H. 2000. Inheritance of resistance to *Fusarium graminearum* in wheat. Theor. Appl. Genetic. 100:1-8.
5. Bai, G-H., Plattner, R., Shaner, G., Kolb, F. 2000. Molecular mapping of a QTL for deoxynivalenol tolerance in wheat. p. 13-15. In. Proc. 2000 National Head Blight Forum, Ward, R. W., Canty, S. M., Lewis, J., Liler, L. eds.
6. Buechley, G. and Shaner, G. 1999. Resistance in wheat cultivar Chokwang to *Fusarium graminearum*, p. 123-126, in Wagester, J., Ward, R., Hart, O. P., Hazen, S. P., Lewis, J., and Borden, H. eds. Proc. of the 1999 National Fusarium Head Blight Forum.
7. Francl, L., Shaner, G., Bergstrom, G. Gilbert, J., Pedersen, W., Dill-Macky, R., Sweets, L., Corwin, B., Jin, Y., Dallenberg, D., and Wiersma, J. 1999. Daily inoculum levels of *Gibberella zeae* on wheat spikes. Plant Dis. 83:662-666.
8. Guo, P-G., Shaner, G., Bai, G-H. 2000. Fine mapping of a quantitative trait locus for wheat scab resistance using PstI-AFLP. p. 27. In. Proc. 2000 National Head Blight Forum, Ward, R. W., Canty, S. M., Lewis, J., Liler, L. eds.
9. Shaner, G. Epidemiology of Wheat Scab in North America, in K. J. Leonard and W. R. Bushnell (eds.) Scab of Small Grains, APS Press (in press).
10. Shaner, G. and Buechley, G. 1998. Control of wheat diseases with foliar fungicides, 1997. Fungicide and Nematicide Tests 53:315-316.
11. Shaner, G. and Buechley, G. 1999. Control of wheat diseases with foliar fungicides, 1998. Fungicide and Nematicide Tests 337-338.
12. Shaner, G. and Buechley, G. 2000. Control of wheat diseases with foliar fungicides, 1999. Fungicide and Nematicide Tests 55:349-350.
13. Shaner, G., Buechley, G. 2000. Control of Fusarium head blight of wheat with foliar fungicides. p. 110-113. In. Proc. 2000 National Head Blight Forum, Ward, R. W., Canty, S. M., Lewis, J., Liler, L. eds.
14. Shaner, G., Buechley, G. 2000. Sampling spores of *Fusarium graminearum*. p. 182-186. In. Proc. 2000 National Head Blight Forum, Ward, R. W., Canty, S. M., Lewis, J., Liler, L. eds.

15. Thomas, D., Buechley, G., Shaner, G. 1999. Epidemiology of Fusarium head blight of wheat in Indiana, 1999, p. 100-104 in Wagester, J., Ward, R., Hart, O. P., Hazen, S. P., Lewis, J., and Borden, H. eds. Proc. of the 1999 National Fusarium Head Blight Forum.
16. Zhou, W. C., Kolb, F. L, Bai, G-H., Shaner, G., Domier, L. L. 2000. SSR mapping and sub-arm physical location of a major scab resistance QTL in wheat. p. 69-73. In. Proc. 2000 National Head Blight Forum, Ward, R. W., Canty, S. M., Lewis, J., Liler, L. eds.