# Project Final Report

**Project title:** Integrating Disease Forecasting, Cultivar Selection, and Timely Fungicide Application for Effective Wheat Disease Management.

**Reporting period: 2015/2016**

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**Summary:**

Wheat is susceptible to several fungal diseases throughout the growing season and up to three fungicide applications can be applied to control these diseases. These applications cut into the profits of wheat production. This project deployed a disease forecasting tool to help producers determine the need and timing of the fungicide application in wheat. This project also evaluated the efficacy of fungicides applied at various timings (growth stages) in wheat. The web-based Small Grains Disease Forecasting System was accessed over 1300 times when wheat was around flowering during 2015 and 2016 growing seasons. This indicates a few hundreds of crop managers were assisted in making wheat disease management decisions. Fungicide applied at flowering reduced Fusarium head blight (FHB) index compared to 2, 4 or 6 days after flowering in the susceptible cultivar. Samson and Velva were the most FHB susceptible spring wheat cultivars among the 19 cultivars that were evaluated. These findings indicate that the integration of cultivar resistance, disease forecasting system, and timely fungicide application is effective in the management of fungal diseases in wheat.

**Introduction**

Wheat is susceptible to multiple diseases throughout the growing season. Early diseases like leaf spots limit tillering capacity and reduce plant vigor. Midseason diseases reduce the number of spikelets per spike and may lead to spike abortion, while late season diseases may lead to poor grain fill (reduced grain weight) and poor grain quality (due to mycotoxins in grain).

Fungicides are effective against fungal diseases in wheat, if timed correctly. The first fungicide timing is at tillering. The fungicide at this timing is usually mixed with the herbicide to save on application costs. This treatment aims at controlling early fungal leaf spots mainly tan spot which is common in no-till wheat or wheat on wheat stubble fields. The second fungicide application timing is at flag leaf growth stage. This treatment becomes crucial especially in seasons where stripe rust develops at this growth stage. The last fungicide timing is applied at flowering growth stage and is targeted towards management of Fusarium head blight or scab.

With low grain prices, three fungicide applications in wheat are not profitable. A disease forecasting system that can alert producers on the potential for fungal diseases to develop can help reduce the number of fungicides applications per season. Forecasting systems have been effective in increasing efficiency of the fungicide but can help prevent unnecessary fungicide application when the disease risk is perceived to be low.

In order for disease to develop, three factors need to be present; a susceptible host, a viable pathogen and a favorable environment. Since the host (wheat) and pathogens are always present, the only unpredicatable factor then is the environment. The main environment factors are moisture (provides leaf wetness required for fungal infection to take place) and temperature.

One of the disease forecasting tools that has been developed is the Fusarium head blight (scab) forecasting. South Dakota is among the top five states in the nation that use this tool. This suggests that wheat growers are benefiting from this resource. In addition to the scab forecasting tool, several small grains diseases prediction models have been developed and implemented in North Dakota and Minnesota. These models are based on accumulated favorable weather conditions for the diseases to develop (mainly moisture and temperature). Growers and crop consultants can access this forecast information from the website by selecting a weather station nearest to their location (Figure 1).

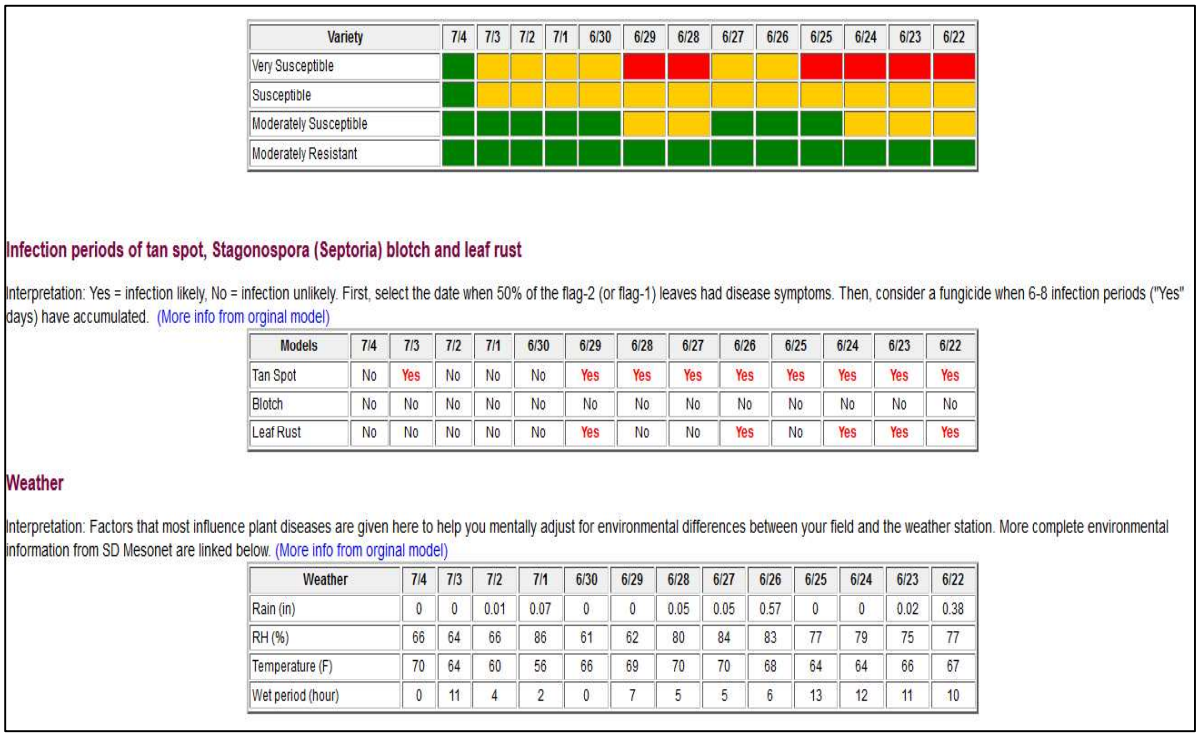
**Study objectives were:**

I. To avail a reliable small grains disease prediction system readily accessible on the internet.
II. To avail growers, crop consultants, agronomists information on disease alerts, updates, and disease management.

**Description of the study and accomplishments**

**Objective 1:**

The South Dakota Small Grains Disease Forecasting online tool was uploaded and hosted by the SDSU Climate Center. (http://climate.sdstate.edu/smallgrains/). This tool started running in April, 2015. The tool predicts the likelihood of foliar fungal diseases on wheat by accumulating days with favorable weather for diseases to develop. The tool also has indication for Fusarium head blight (scab) risk starting at wheat flowering stage (Figure 1). To date, there are over 1300 web page views of this tool. Peak web visits occurred when wheat was flowering, an indication that producers and crop consultants referred to this tool when most of the fungicide application decisions were made. The most viewership was in north east SD, an area that receives high amounts of rainfall, therefore most likely to apply fungicides in wheat. **The web viewership data is an indication that possibly over 1000 individuals benefited from this tool**. This data demonstrates the potential for this tool to aid farmers in making disease management decisions. As more people become aware and familiar to the tool, it is likely that it will benefit several wheat crop managers. Promotion for this tool was done and will continue to be done during grower meetings, pesticide applicator trainings, Ag horizon meeting and other avenues.



| Variety | 7/4 | 7/3 | 7/2 | 7/1 | 6/30 | 6/29 | 6/28 | 6/27 | 6/26 | 6/25 | 6/24 | 6/23 | 6/22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Very Susceptible | | | | | | | | | | | | | |
| Susceptible | | | | | | | | | | | | | |
| Moderately Susceptible | | | | | | | | | | | | | |
| Moderately Resistant | | | | | | | | | | | | | |

**Infection periods of tan spot, Stagonospora (Septoria) blotch and leaf rust**

Interpretation: Yes = infection likely, No = infection unlikely. First, select the date when 50% of the flag-2 (or flag-1) leaves had disease symptoms. Then, consider a fungicide when 6-8 infection periods ("Yes" days) have accumulated. (More info from orginal model)

| Models | 7/4 | 7/3 | 7/2 | 7/1 | 6/30 | 6/29 | 6/28 | 6/27 | 6/26 | 6/25 | 6/24 | 6/23 | 6/22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tan Spot | No | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Blotch | No | No | No | No | No | No | No | No | No | No | No | No | No |
| Leaf Rust | No | No | No | No | No | Yes | No | No | Yes | No | Yes | Yes | Yes |

**Weather**

Interpretation: Factors that most influence plant diseases are given here to help you mentally adjust for environmental differences between your field and the weather station. More complete environmental information from SD Mesonet are linked below. (More info from orginal model)

| Weather | 7/4 | 7/3 | 7/2 | 7/1 | 6/30 | 6/29 | 6/28 | 6/27 | 6/26 | 6/25 | 6/24 | 6/23 | 6/22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rain (in) | 0 | 0 | 0.01 | 0.07 | 0 | 0 | 0.05 | 0.05 | 0.57 | 0 | 0 | 0.02 | 0.38 |
| RH (%) | 66 | 64 | 66 | 86 | 61 | 62 | 80 | 84 | 83 | 77 | 79 | 75 | 77 |
| Temperature (F) | 70 | 64 | 60 | 56 | 66 | 69 | 70 | 70 | 68 | 64 | 64 | 66 | 67 |
| Wet period (hour) | 0 | 11 | 4 | 2 | 0 | 7 | 5 | 5 | 6 | 13 | 12 | 11 | 10 |

Figure 1. A screen-shot of the Small Grains Disease Forecasting Tool showing the risk for scab (upper table), risk for leaf diseases (middle table) and weather (bottom table) for a two week period in late June-early July. The tool is accessible at http://climate.sdstate.edu/smallgrains/

**Objective 2:**

Fungicide trials were established to generate information on the most effective fungicide timing for the management of Fusarium head blight in spring wheat as well as evaluating spring wheat cultivars resistance to FHB. Both scab and cultivar evaluation were planted at Northeast Research Farm near South Shore.

**Fungicide timing for scab management:** We evaluated the effect of Prosaro fungicide applied at flowering, 2, 4, and 6 days after flowering in three spring wheat cultivars with varying levels of FHB resistance. **We found that Prosaro fungicide applied at flowering reduced FHB index the most in the susceptible cultivar Samson compared to other timings** (Figure 2). For the FHB moderately resistant cultivars Brick and Prevail, FHB was significantly lower in non-treated plots compared to even the treated plots for the susceptible cultivar Samson. This suggests that **integration of cultivar resistance and timely fungicide application** is more effective.

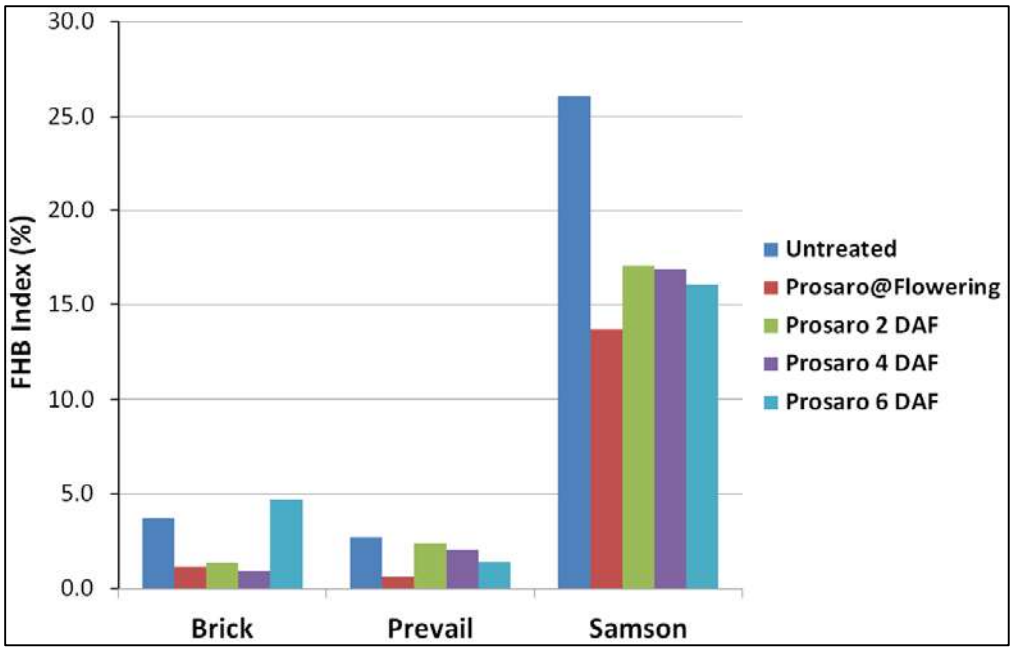



*Figure 2. Effect of fungicide Prosaro applied at flowering, 2, 4 or 6 days after flowering on Fusarium head blight (FHB) index for the three spring wheat cultivars during the 2015 wheat growing season.*

**Spring wheat cultivars evaluation for FHB management:** We evaluated the performance of 19 commonly planted spring wheat cultivars in South Dakota for FHB resistance/susceptibility. The majority of the evaluated cultivars had low levels of FHB (Table 1). Samson and Velva were the most FHB susceptible cultivars. Although the majority of the cultivars evaluated had low levels of FHB, these cultivars may still accumulate the mycotoxin due to FHB. The most effective approach is to combine FHB resistant cultivars and a timely fungicide application at flowering.

*Table 1. Fusarium head blight (FHB) index, yield, and test weight of commonly planted spring wheat cultivars evaluated during the 2015 wheat growing season.*

| Cultivar | FHB index | | Yield (bu/ac | | Test weight (lb/bu) | |
|---|---|---|---|---|---|---|
| Brick | 1.03 | C | 56.22 | Bc | 59.55 | a |
| Forefront | 1.54 | C | 53.73 | Bc | 59.60 | a |
| Sabin | 2.09 | Bc | 64.02 | Ab | 58.33 | abc |
| Prevail | 2.99 | Bc | 62.18 | Abc | 58.42 | abc |
| Norden | 4.13 | Bc | 68.46 | A | 59.35 | a |
| SY Soren | 4.35 | Bc | 63.90 | Ab | 58.51 | abc |
| Select | 4.53 | Bc | 52.99 | Bc | 58.80 | abc |
| Faller | 4.72 | Bc | 50.70 | C | 54.94 | gh |
| Barlow | 5.12 | Bc | 54.36 | Bc | 59.32 | a |
| SY Ingmar | 5.12 | Bc | 60.42 | Abc | 57.82 | bcd |
| Prosper | 5.35 | Bc | 53.07 | Bc | 55.42 | fg |
| Breaker | 6.42 | B | 56.29 | Bc | 58.91 | ab |
| LCS Albany | 6.86 | B | 55.32 | Bc | 56.07 | ef |
| LCS Iguacu | 6.90 | B | 56.96 | Bc | 57.43 | cd |
| Elgin-ND | 7.06 | B | 53.39 | Bc | 57.87 | bcd |
| Advance | 8.83 | B | 51.42 | C | 56.87 | de |
| Samson | 21.67 | A | 57.65 | Bc | 54.29 | h |
| Velva | 23.53 | A | 39.92 | D | 50.89 | i |
| CV | 28.46 | | 8.75 | | 1.16 | |
| P-value | 0.0001 | | 0.0001 | | 0.0001 | |

**Provision of disease alerts and general information on wheat disease management:**
Producers, crop consultants, agronomists and other stake holders were availed information on diseases that were or were likely to develop on wheat. This information also included management options for various diseases. Information was disseminated through various channels including, wheat walks, iGrow articles, newsletter articles, radio interviews, tweets, wheat plot tours and Ag horizon.

**Publications associated with the project**

**2015**

**Abstracts:**

Yabwalo D., K.Ruden, S. Ali, R. Geppert, K. Glover, B. Bleakley, and E. **Byamukama.** 2015. Spring wheat cultivar performance against Fusarium head blight in natural infestation. USWBSI Forum, St. Louis, MO.

Murthy, N. K. S., Bleakley, B. H., Yabwalo, D. N., **and Byamukama**, E. 2015. 2014 and 2015 filed plot trials for biological control of Fusarium head blight in South Dakota using Bacillus anyloliquefaciens strains. USWBSI Forum, St. Louis, MO.

Salgado, J.D., K. Ames, G. Bergstrom, C. Bradley, **E. Byamukama,** J. Cummings, V. Chapara, M. Chilvers, R. Dill-Macky, A. Friskop, P. Gautam, N. Kleczewski, L.V. Madden, E. Milus, M. Nagelkirk, J. Ransom, K. Ruden, J. Stevens, S. Wegulo, K. Wise, D. Yabwalo and P.A. Paul. 2015. Robust Management Programs to Minimize Losses due to FHB and DON: A Multi-state Coordinated Project. USWBSI Forum, St. Louis, MO.

**Extension publications:**

Byamukama, E. and Beck, R. Disease or Injury? How to tell the two apart. Published on 5/22/2015. http://igrow.org/agronomy/corn/disease-or-injury-how-to-tell-the-two-apart/

Byamukama, E., and Strunk C. Predicting Fusarium head blight in small grains. Published 5/28/2015. http://igrow.org/agronomy/wheat/predicting-fusarium-head-blight-in-small-grains/

Byamukama, E., and Strunk, C. Stripe rust and viral diseases developing in wheat. Published on 6/1/2015. http://igrow.org/agronomy/wheat/stripe-rust-and-viral-diseases-developing-in-wheat/

Byamukama, E. Stripe rust continues to develop in winter wheat fields. Published on 6/5/2015. http://igrow.org/agronomy/wheat/stripe-rust-continues-to-develop-in-winter-wheat-fields/

Byamukama, E., and Strunk, C. Wheat Diseases Update. Published on 6/19/2015. http://igrow.org/agronomy/wheat/wheat-diseases-update/

Byamukama, E.  Leaf rust and scab developing in wheat. Pushed on 6/26/2015. http://igrow.org/agronomy/wheat/leaf-rust-and-scab-developing-in-wheat/

Byamukama E. Assess for Fusarium Head Blight (Scab) in winter wheat Published on 7/9/2015 http://igrow.org/agronomy/wheat/assess-for-fusarium-head-blight-scab-in-winter-wheat/

Byamukama, E., Back, R., Strunk, C. and Graham, C. Ergot reported in grain at grain elevators. Published on 8/6/2015. http://igrow.org/agronomy/wheat/ergot-reported-in-grain-at-grain-elevators/

**2016**

**Extension publications:**

Byamukama, E. Beck, R., Ali, S., and Strunk, C. 2016. Stripe Rust: Earlier than normal detection in wheat is concerning. Published on 4/19/2016 http://igrow.org/agronomy/wheat/stripe-rust-earlier-than-normal-detection-in-wheat-is-concerning/#sthash.023A4tHz.dpuf

Byamukama, E. 2016. Wheat Diseases: What to watch for this spring. Published on 4/21/2016. http://igrow.org/agronomy/wheat/wheat-diseases-what-to-watch-for-this-spring/

Byamukama, E., and Ali, S. 2016. Winter Wheat Diseases: Powdery mildew and tan spot increasing. Published on 5/5/2016 http://igrow.org/agronomy/wheat/winter-wheat-diseases-powdery-mildew-tan-spot-increasing/#sthash.mnfNzOQu.dpuf

Byamukama, E. and Yabwalo, D. 2016. Wheat Fungicide Applications: Apply at flag leaf or wait for flowering growth stage? Published on 5/19/2016. http://igrow.org/agronomy/wheat/wheat-fungicide-applications-apply-at-flag-leaf-or-wait-for-flowering-growt/#sthash.y2FXh162.dpuf

Byamukama, E., Varenhorst, A., and Backmann, A. 2016. Barley yellow dwarf virus on the increase. Published on 5/26/2016 http://igrow.org/agronomy/wheat/barley-yellow-dwarf-virus-on-the-increase/

Byamukama, E., Ali, S., Beck, R., and Varenhorst, A. 2016. Differentiating between wheat head diseases and disorders. Published on 6/30/2016. http://igrow.org/agronomy/wheat/differentiating-between-wheat-head-diseases-and-disorders/#sthash.cSJtV8lC.dpuf

Byamukama, E., Varenhorst, A., Ali, S., and Langham, M. 2016. Winter Wheat Planting: Plan ahead to effectively manage wheat diseases. Published on 8/24/2016 http://igrow.org/agronomy/wheat/winter-wheat-planting-plan-ahead-to-effectively-manage-wheat-diseases/#sthash.fPfS2arS.dpuf

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