FHB MANAGEMENT

EFFECTIVENESS OF FHB INDICES IN ESTIMATING STRAW DON ACCUMULATION IN WINTER WHEAT CULTIVARS

K.M. Bissonnette[1], F.L. Kolb[1], Y. Dong[2], K.A. Ames[1] and C.A. Bradley[3*]

[1]University of Illinois, Urbana, IL; [2]University of Minnesota, St. Paul, MN; and [3]University of Kentucky, Princeton, KY
[*]Corresponding Author: PH: (270) 365-7541 ext. 215; Email: carl.bradley@uky.edu

ABSRACT

Little is known about how deoxynivalenol (DON) accumulates in wheat straw tissue as a result of *Fusarium graminearum* infection in wheat heads. Finding a way to estimate DON concentration in the straw through the use of visual disease ratings and Fusarium head blight (FHB) indices is a challenge. Much research has focused on the advancement of FHB-resistant breeding lines through the use of the FHB index. FHB index has been used for the advancement of many wheat lines for FHB resistance. Results of recent research suggest that the incorporation of proportions of *Fusarium*-damaged kernels (FDK) with incidence and severity (known as the ISK index) offers a better index to evaluate and advance wheat lines. Research results have also suggested that incorporating grain DON along with incidence, severity, and kernel damage (known as the DISK index) might offer an even greater improvement in selecting for FHB-resistant lines. The two main purposes of this study were a) to determine the accuracy of different FHB indices to DON accumulation in the grain for the advancement of wheat lines and b) determine of these indices can be used to relate to DON accumulation in the straw.

This study was conducted over three growing seasons (2011, 2013 and 2014) and consisted of a selection of 16 to 20 winter wheat cultivars from the University of Illinois FHB nursery. FHB incidence and severity, and FDK were recorded for each cultivar. Immediately after harvest, the bottom 25 cm of straw was collected for each cultivar, dried in a forced air drier, and ground. DON concentrations were determined for both grain and straw.

All analyses were performed using PROC MIXED and PROC CORR in SAS with cultivar and resistance classes treated as fixed effects. Cultivars evaluated varied from year to year, and for this reason, years were analyzed separately. Evaluated cultivars ranged in their susceptibility to FHB. The FHB index was calculated by the formula Incidence*Severity/100, the ISK index was calculated by the formula (0.3*Incidence) + (0.3*Severity) + (0.4*FDK), and the DISK index was calculated by (0.2*Incidence) + (0.2*Severity) + (0.3*FDK) + (0.3*Grain DON). Correlation analysis was conducted to determine the relationships of the indices with DON in the grain and straw.

In all years, there was a large amount of variability in the DON concentrations in both grain and straw for all cultivars and classes, especially for the moderately susceptible and moderately resistant cultivars. The correlation between the DON in the grain and the DON in the straw was significant ($P < 0.05$) in 2011 and 2014 with a coefficient of 0.5 in both years, but this correlation was not significant in 2013.

In every year, resistant cultivars differed significantly ($P < 0.05$) from susceptible cultivars for all indices. In 2011 and 2014, each class was significantly different from one another in both ISK and DISK. Differences were not significant across all classes in 2013. The correlation between grain DON and FHB index was significant in all years with a correlation coefficient of 0.4 in all three years. The correlation between grain DON and the ISK index was significant in 2011 and 2014 with correlation coefficients of 0.7 in both years. The correlation between grain DON and DISK index was significant in all years, with a correlation coefficient of 0.8, 0.3, and 0.7 in 2011, 2013, and 2014, respectively.

The correlation between the DON in the straw and each of the indices may prove to be a useful indicator of which rating system provides the best estimate of the total DON accumulation in the straw. The correlation between straw DON and FHB index was significant in all years with a correlation coefficient of 0.4, 0.3, and 0.5 in 2011, 2013, and 2014, respectively. The correlation between straw DON and the ISK index was significant in all years with a correlation coefficient of 0.6, 0.3, and 0.7 in 2011, 2013, and 2014, respectively. The correlation between straw DON and DISK index was significant in all years with a correlation coefficient of 0.6, 0.3, and 0.6 in 2011, 2013, and 2014, respectively. For FHB index in all years, the correlation between FHB index and grain DON or straw DON was significant. However, the correlation coefficients indicated that these correlations were weak.

In conclusion, adding FDK and/or DON concentrations to the FHB index would provide some improvement in determining cultivar resistance to FHB and the accumulating DON toxin. The ISK index and DISK index were better measures of the resistance of a cultivar to FHB, though may fall short for MS or MR varieties. For the advancement of resistant lines, these indices are useful in determining which cultivars offer the best resistance to *F. graminearum* infection and the subsequent DON accumulation in both the grain and the straw tissue. For this reason, a rating that includes the FHB index and FDKs and DON accumulation may result in a more accurate assessment of FHB resistance to DON accumulation in both grain and straw.

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture under Agreement No. 59-0206-9-076. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

EFFECTS OF WINTER WHEAT CULTIVARS, FUNGICIDE APPLICATION TIMING, AND THE FUNGICIDES PROSARO® AND HEADLINE® ON FHB AND DON

Carlos Bolanos Carriel[1], Stephen N. Wegulo[1*], Heather Hallen-Adams[2] and P. Stephen Baenziger[3]

[1]Department of Plant Pathology, University of Nebraska-Lincoln, Lincoln, NE; [2]Department of Food Science and Technology, University of Nebraska-Lincoln, Lincoln, NE; and [3]Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE
[*]Corresponding Author: PH: 402-472-8735; Email: swegulo2@unl.edu

ABSTRACT

Fusarium head blight (FHB), caused by *Fusarium graminearum*, is a disease of wheat whose frequency and severity have increased in Nebraska during the last 10 years. Major epidemics occurred in 2007, 2008, and 2015, and varying levels of the disease have occurred between 2008 and 2015. *Fusarium graminearum* produces the mycotoxin deoxynivalenol (DON). Therefore, in an FHB year, losses to the grower are manifested not only in yield and grain volume weight but also in discounts at the elevator if DON levels in grain exceed 2 ppm. Fungicide applications to control FHB are aimed at reducing disease intensity as well as DON. Because FHB infections occur on wheat heads mostly during flowering, optimal fungicide application is usually timed at early flowering. The narrow window (early flowering) of fungicide application presents challenges to the grower. Previous research has indicated that fungicides in the triazole class are more effective than those in the strobilurin class in suppressing FHB and DON, mainly because strobilurins are not as effective as triazoles in suppressing DON. The objectives of this research were to 1) Determine the effect of fungicide application timing at early flowering and 6 and 12 days later on FHB and DON in a susceptible and a moderately resistant cultivar and 2) Compare the effects of Prosaro® (a triazole) and Headline® (a strobilurin) on FHB and DON when applied at early flowering and 6 and 12 days later in a susceptible and a moderately resistant cultivar under Nebraska conditions. In 2015 two field trials (dryland and irrigated) were conducted in which Prosaro and Headline were applied at early flowering and at 6 and 12 days post early flowering (pef) (6 dpef and 12 dpef) to the cultivars Overley (susceptible) and Overland (moderately resistant). In the dryland trial in Overley, FHB index was similar between fungicides (Prosaro and Headline) and application timings (range 27-50%; 60% in the unsprayed check) and the same was true for DON (range, 33-46 ppm; 64 ppm in the unsprayed check). In the same trial in Overland, the results were similar except that FHB index (range 6-12%; 14% in unsprayed the check) and DON (range 6-14 ppm; 16 ppm in the unsprayed check) were significantly lower than in Overley. In the irrigated trial in Overley sprayed with Prosaro, FHB index was 42, 56, and 72% in the early flowering, 6 dpef, and 12 dpef treatments, respectively compared to 80% in the unsprayed check. The corresponding DON values were 19, 17, and 37 ppm, respectively compared to 91 ppm in the unsprayed check. In the same trial in Overley sprayed with Headline, FHB index was 62, 73, and 86% in the early flowering, 6 dpef, and 12 dpef treatments, respectively compared to 80% in the unsprayed check and the corresponding DON values were 41, 40, and 48 ppm, respectively compared to 91 ppm in the unsprayed check. In the irrigated trial in Overland, FHB index was similar between Prosaro and Headline (range 19 to 35% compared to 39% in the unsprayed check). Prosaro

DON values were 7, 11, and 18 ppm, in the early flowering, 6 dpef, and 12 dpef treatments, respectively compared to 46 ppm in the unsprayed check and the corresponding Headline DON values were 37, 18, and 29 ppm, respectively compared to 46 ppm in the unsprayed check. The results from this study can be summarized as follows: 1) FHB index and DON were significantly lower in Overland (moderately resistant) than in Overley (susceptible) as expected in both the dryland and irrigated trials, 2) the window of fungicide application to control FHB and DON can be widened from early flowering to 6 days later without loss of efficacy in suppressing FHB and DON, 3) Although Headline suppressed DON compared to the unsprayed check, DON in Headline treatments was significantly higher compared to the Prosaro treatments in the irrigated trial but not in the dryland trial, 4) Moderate resistance coupled with fungicide application can greatly reduce DON in grain.

ACKNOWLEDGEMENT AND DISCLAIMER

Carlos Bolanos Carriel is supported by a scholarship awarded by The Secretariat of Higher Education, Science, Technology and Innovation of Ecuador.

This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No. 59-0206-2-085. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

NATIONAL SURVEY OF U.S. WHEAT & BARLEY PRODUCERS ON SCAB MANAGEMENT PRACTICES

C. Cowger[1*], J. Smith[2] and J. Stegall[2]

[1]USDA-ARS, Plant Science Research Unit, Raleigh, NC; and [2]Department of Statistics, North Carolina State University, Raleigh, NC
*Corresponding Author: PH: (919) 513-7388; Email: Christina.Cowger@ars.usda.gov

ABSTRACT

In 2014, the USDA National Agricultural Statistics Service conducted a survey of wheat and barley producers' scab management practices that was commissioned by the U.S. Wheat & Barley Scab Initiative. The survey was carried out in 17 central and eastern U.S. states prone to scab and with significant acreages of wheat and/or barley. The purpose of the survey was to determine growers' perception of scab risk and best management practices (BMP), the extent of and barriers to BMP use, and how growers get their information about scab management.

The survey ultimately produced 5,107 usable questionnaires, with 4,683 farms that reported harvesting wheat for grain in the previous five years and 1,335 farms that reported harvesting barley for grain in the same period. Highlights of the findings:

Perception of scab as a problem varies geographically. On average, respondents in North Dakota, Minnesota, and the soft wheat states saw scab as a more serious problem than did those in AR, KS, NE, or SD. This was reflected in generally higher percentages in the former group of states who said that scab has reduced yields, caused problems with DON, and/or caused dockage or rejection of grain.

Use of varieties moderately resistant (MR) to scab. Overall, percentages of MR varieties varied significantly by market class. Out of the total acres reported by respondents in each class, the percentages planted to MR varieties were 47% for hard red spring (HRS) wheat, 29% for durum wheat, 21% for soft white winter (SWW) wheat, 15% for soft red winter (SRW) wheat, 11% for hard red winter wheat, and 8% for barley.

The percentages of respondents who said they reduced scab damage by growing moderately resistant (MR) varieties were not well aligned with the percentages of scab-resistant acres reported when growers were asked to name the top varieties they grew. An exception was in North Dakota and Minnesota, where respondents claimed relatively high rates of MR variety use (68% and 47%, respectively) and also reported relatively large percentages of specific MR variety acres (e.g., 46% and 67% of HRS acres, respectively). Also as an exception, New York respondents claimed a relatively low rate of MR variety use (37%) and reported relatively high percentages of variety acres that were MR (33% of SRW and 47% of SWW acres). By contrast, there was a substantial gap in many other SRW wheat states between the rate of perceived MR variety use (generally 35-70%) and the percentages of MR variety acreage reported (mostly <22%).

Use of a scab risk forecasting website. Growers were asked whether they had used a scab risk forecasting web site in the last five years. The highest percentage of positive responses was in North Dakota (18%), while in all the other states, the percentage was 8% or less. Of those who answered "yes," the large majority said the site was easy to understand and use, and useful for scab management.

Use of recommended fungicides to combat scab. The percentage of respondents who indicated they sometimes apply a recommended fungicide with scab as the target was highest in North Dakota (43%); intermediate in most soft wheat states (20-31%); and lowest in Kansas, Minnesota, Nebraska, New York, North Carolina, and South Dakota (9-17%). Growers were also asked which fungicide they applied the last time scab was the primary target. Overall, 1,222 responses of specific fungicide products were received, of which 54% were one of the most effective triazoles (Prosaro, Caramba, and Proline); 17% were another triazole; and 30% were strobilurins or strobilurin-triazole mixtures.

Rotation. There was a wide range in the percentage of respondents who said a graminaceous crop preceded wheat the last time the latter crop was harvested for grain. Percentages were relatively high (>50% of respondents) in Kansas, Kentucky, Maryland, New York, Pennsylvania, and Virginia. In the HRS states, as well as Indiana, Michigan, and Missouri, it depended considerably on district, with some parts of the state having low rates of wheat following an FHB host, and other parts having relatively high rates.

Barriers to use of BMP. Across all states, the barriers to using BMP that were most widely cited were weather (19% of respondents) and logistical difficulties (12% of respondents), such as problems engaging custom applicators, that prevent timely application of fungicides. The next most commonly experienced barriers were (1) the impracticality of rotations that keep wheat and barley from following other scab host crops, and (2) the difficulty of determining flowering dates in order to apply fungicides at the right time. This latter problem was cited by 10% of respondents overall, with the highest rates being 13-16% of respondents in Illinois, North Dakota, and Ohio. Information about scab resistance of varieties not being available or timely was a concern that varied significantly by state (e.g., 5-7% in Kansas, Indiana, Minnesota, Ohio, Pennsylvania, South Dakota, and Virginia, but 13% in New York and 21% in Kentucky).

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

EVALUATION OF INTEGRATED METHODS FOR MANAGING FHB AND DON IN WINTER WHEAT IN NEW YORK IN 2015

J.A. Cummings and G.C. Bergstrom*

Section of Plant Pathology and Plant-Microbe Biology, Cornell University, Ithaca, NY 14853

*Corresponding Author: PH: 607-255-7849; Email: gcb3@cornell.edu

OBJECTIVE

To evaluate the individual and interactive effects of moderately resistant cultivars and application timings of the fungicide Prosaro on wheat yield and the integrated management of Fusarium head blight (FHB) and deoxynivalenol (DON) in New York.

INTRODUCTION

In response to the USWBSI goal to validate integrated management strategies for FHB and DON, the Disease Management RAC of USWBSI initiated a multi-state, multi-year, coordinated field study. In New York during 2015, we observed the disease and yield impact of cultivar susceptibility, inoculation with *Fusarium graminearum*, and treatment with Prosaro fungicide at two timings.

MATERIALS AND METHODS

The trial was conducted at the Musgrave Research Farm in Aurora, NY in a Lima silt loam soil planted with four soft red winter wheat varieties, 'Otsego' (susceptible to FHB), 'Pioneer Brand 25R40' (moderately susceptible to Fusarium head blight (FHB), 'Emmit' (moderately susceptible to FHB), and 'Pioneer Brand 25R46' (moderately resistant to FHB), following corn harvest on 7 Oct 2014. The experiment was set up as a completely randomized block design with a split-plot arrangement, with cultivar as the main plot and the treatments as subplots, randomized in six replicated blocks. Main plots were sown with wheat at 118.8 lb/A with a 10 ft wide commercial grain drill. Subplots were 20 x 10 ft including 15 rows with 7-in. row spacing. The plots were fertilized at planting (200 lb/A of 10-20-20) and topdressed on 21 Apr (60 lb/A of urea, providing an additional 27.6 lb/A of nitrogen). The first Prosaro® application was at anthesis (Feekes growth stage, FGS 10.5.1) on 2 Jun including the surfactant Induce at 0.125% V/V. After the fungicide had dried, plots were spray-inoculated with a conidial suspension of *F. graminearum* (40,000 conidia/ml) to augment the development of FHB. The second Prosaro application occurred five days after anthesis on 7 Jun including the surfactant Induce at 0.125% V/V, and inoculated with a conidial suspension of *F. graminearum* (40,000 conidia/ml) after the fungicide had dried. Fungicide and *F. graminearum* treatments were applied with a tractor-mounted sprayer with paired TJ-60 8003vs nozzles mounted at an angle (30^o from horizontal) forward and backward, 20-in. apart, pressurized at 30 psi, and calibrated to deliver 20 gal/A. Incidence and severity (percent of symptomatic spikelets on symptomatic heads) of FHB in each plot were rated on 22 Jun and used to calculate FHB index, where FHB index = (FHB severity * FHB incidence)/100. Foliar diseases were rated on 22 Jun as percent severity on flag leaves (average rating for whole plot). Grain was harvested from a 20 x 5 ft area in each subplot using an Almaco plot combine on 23 Jul. Grain moistures, plot yields, and test weights were recorded. Yields and test weights were adjusted to bu/A at 13.5% moisture. *Fusarium*-damaged kernels (FDK) were evaluated post-harvest as a percentage of kernels visibly affected by FHB out of a 100 kernel subsample from each plot. Analysis of deoxynivalenol (DON) content in grain was conducted by Dr. Yanhong Dong at the University of Minnesota. Treatment means were calculated, subjected to analysis of variance, and separated by Fisher's protected LSD test ($P = 0.05$).

RESULTS AND DISCUSSION

The incidence of FHB over all plots ranged from 4 to 46%. The impact of supplemental inoculation with *F. graminearum* was determined by comparing the non-inoculated and inoculum only treatment. Overall, inoculation resulted in significantly reduced yield and significantly increased FHB and DON as compared with the non-inoculated plots. FHB and DON development in 2015 were attributed primarily to supplemental rather than background inoculum.

Significant cultivar responses to inoculation were observed for yield, FHB and DON for the moderately susceptible variety Emmit and the susceptible variety Otsego, but only for FHB and DON for the moderately susceptible variety P25R40, and only for FHB for the moderately resistant variety Pioneer 25R46. These data support the current qualitative designations of varieties as moderately susceptible (Pioneer 25R40), moderately resistant (Pioneer 25R46). However, according to the results of this study, the quantitative susceptibility of Otsego, Emmit, and Pioneer 25R40 was indistinguishable.

Under moderately low disease pressure, significant differences were detected in yield among varieties, with both Pioneer varieties yielding significantly higher than Otsego and Emmit, regardless of treatment. Otsego had significantly higher FHB incidence and *Fusarium*-damaged kernels (FDK) than all the other varieties, regardless of treatment, but had FHB index similar to that of Emmit and P25R40. P25R46 had significantly lower FHB incidence, FDK and DON than all the other varieties, regardless of treatment, but had similar FHB index to that of P25R40. With excellent choices of high yielding varieties in the moderately resistant category, we counsel New York growers to no longer plant susceptible or moderately susceptible soft red winter wheats.

When results of all the cultivars were combined, the overall impact of each of the two Prosaro application timings was to significantly decrease FHB incidence, index, FDK, DON, and to significantly increase yield, as compared with the inoculum only treatment. Though not statistically significant, the Prosaro application at 7 days after the initiation of flowering resulted in the lowest FHB incidence, index and DON as compared with the Prosaro application at FGS 10.5.1. But it is also worth noting that sufficient fungicide remained on spikes from the FGS 10.5.1 Prosaro application to give significant suppression of FHB and DON resulting from fungal spores deposited on plants at 7 days after 10.5.1. It is unlikely that we would have seen any advantage of the late fungicide application over the earlier if spores had only been applied at the early timing. This underscores the necessity to apply supplemental inoculum corresponding to all timings that fungicides are applied in an unbiased experiment to assess comparative efficacy of fungicide timings.

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported in part by the U.S. Department of Agriculture under agreement No. 59-0206-9-056. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed

in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

Table 1. Main effect of treatment on Fusarium head blight incidence, index, *Fusarium*-damaged kernels, deoxynivalenol contamination and grain yield at Aurora, NY in 2015.

Treatment	FHB incidence (%)	FHB index	FDK (%)	DON (ppm)	Yield (Bu/A)
Non-sprayed, non-inoculated control	17.5 b	2.7 b	7.3 b	0.9 c	67.8 a
Inoculated FGS 10.5.1, and inoculated 7 days later	31.3 a	8.6 a	11.7 a	1.9 a	60.9 b
Prosaro SC (6.5 fl oz) and inoculated FGS 10.5.1, then inoculated 7 days later	17.4 b	2.4 b	6.6 b	1.2 b	66.4 a
Inoculated FGS 10.5.1, then Prosaro SC (6.5 fl oz) and inoculated 7 days later	16.3 b	2.1 b	7.2 b	1.0 bc	67.7 a
LSD (*P*=0.05)	6.09	2.69	2.40	0.32	3.73
CV (%)	58.7	135.5	56.1	53.4	10.7

Table 2. Main effect of cultivar on Fusarium head blight incidence, index, *Fusarium*-damaged kernels, deoxynivalenol contamination and grain yield at Aurora, NY in 2015.

Cultivar	FHB incidence (%)	FHB index	FDK (%)	DON (ppm)	Yield (Bu/A)
Emmit	24.1 b	7.6 a	9.4 b	1.5 a	61.2 b
Otsego	29.8 a	5.2 ab	11.8 a	1.4 a	63.9 b
P25R40	21.0 b	2.8 bc	7.6 b	1.6 a	67.5 a
P25R46	7.6 c	0.3 c	4.1 c	0.6 b	69.9 a
LSD (*P*=0.05)	5.18	2.68	2.11	0.32	3.59
CV (%)	58.7	135.5	56.1	53.4	10.7

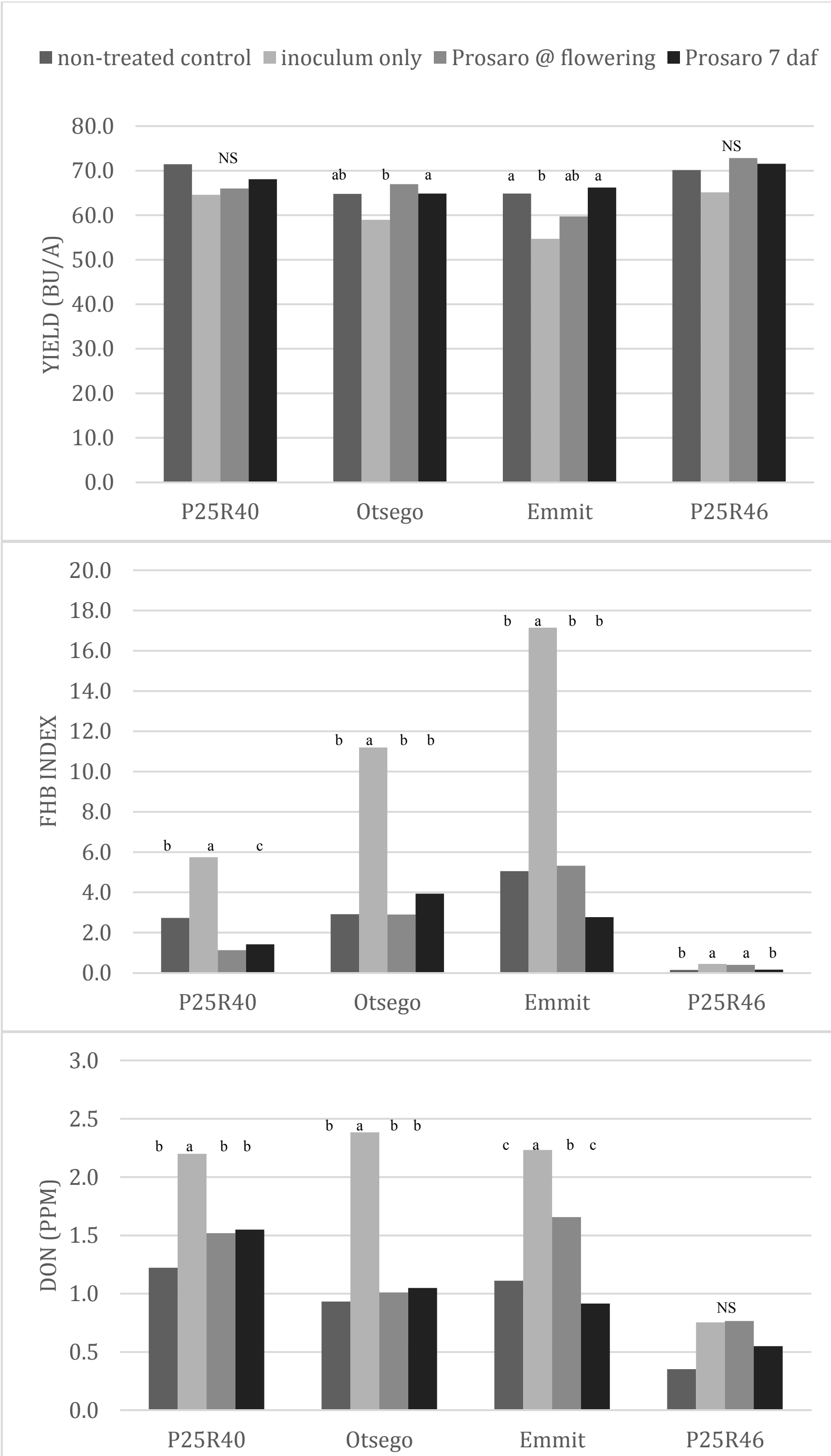

Figure 1. Effect of Prosaro® fungicide application and *F. graminearum* inoculation on yield, FHB index and DON contamination of four winter wheat cultivars in Aurora, NY in 2015.

IMPACT OF METEOROLOGICAL CONDITIONS AND PERITHECIA MATURITY ON *FUSARIUM GRAMINEARUM* ASCOSPORE RELEASE

Ray F. David[1*], David G. Schmale III[2] and Linsey C. Marr[1]

[1]Department of Civil and Environmental Engineering, 411 Durham Hall, and [2]Department of Plant Pathology, Physiology, and Weed Science, 413 Latham Hall, Virginia Tech, Blacksburg, VA
[*]Corresponding Author: PH: (765) 409-0962; Email: Rfrdavid@vt.edu

ABSTRACT

Cereal crops including wheat and barley will become increasingly stressed due to changing climate, growing populations, and harmful diseases. Fusarium head blight (FHB) is a harmful disease to cereal crops and is caused by the fungus *Fusarium graminearum*. The fungus produces ascospores capable of spreading the disease long distances (>500m) through the atmosphere. Information on the release of ascospores would be valuable in predicting FHB.

Our first research objective was to understand the meteorological conditions favorable for the release of ascospores. We investigated the numbers of ascospores released from perithecia and how far they traveled under controlled conditions. Ascospore release experiments were conducted with different combinations of temperature (15°C and 25°C) and relative humidity (60%, 75%, and 95%) for 12 hours in complete darkness. Ascospores released from perithecia were captured on microscope slides placed inside of 3D-printed spore discharge chambers. The number of ascospores released and the distances they traveled were quantified. The results showed that cold temperature and high relative humidity resulted in greater quantities and distances of ascospore release.

Our second research objective was to observe the relationship between the maturity of perithecia and the number of ascospores. A mechanical compression testing instrument was used to investigate the hardness of perithecia at various stages of maturity, resulting in a mean compression constant quantifying the uniaxial compression force required to rupture a perithecium. Results indicated that old (mature) perithecia contain the greatest amount of ascospores and require more force to rupture than young (immature) perithecia.

Collectively, our results may inform growers on the nature and timing of ascospore release, which could help inform FHB management decisions in the future.

VARIABILITY OF WHEAT TILLER GROWTH STAGES WITHIN SOFT RED WINTER WHEAT AND THEIR IMPACT ON FUNGICIDE TIMING DECISIONS

Anna N. Freije and Kiersten A. Wise*

Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907
*Corresponding Author: PH: 765-496-2170; Email: kawise@purdue.edu

ABSTRACT

A pilot field study was conducted in 2014 in West Lafayette, Indiana, to formally assess the range of growth stages across soft red winter wheat tillers during anthesis to determine the average growth stage of a plant when the primary tiller is determined to be at Feekes Growth Stage (FGS) 10.5.1. The goal of this research was to determine the potential contribution of secondary tillers to Fusarium head blight (FHB) in wheat and assess the growth stage at which fungicide is most effective at reducing disease incidence. This experiment was conducted within a larger fungicide timing experiment with a random complete block design. Tillers were evaluated from three replicates of the experimental plots, for a total of 21 plots. Within each plot, 3 plants were arbitrarily chosen on the pre-determined treatment date (anthesis + 0, 1, 3, 5, 8, 9, and 11 days after anthesis). The primary tiller was tagged, and then all tillers of the plant were growth staged. The growth stage of each tiller on the selected plants was determined in a clockwise direction, and was later rated for disease severity. Results indicated that when entire experimental plots were visually determined to be at 50% FGS 10.5.1, only 26% of rated tillers within the plot were at, or past, FGS 10.5.1. Not until 3 days after anthesis were over 50% of the rated tillers at or past FGS 10.5.1. Also, although tillers that were inoculated at FGS 10.5 to FGS 11 had the highest incidence of disease across all the inoculated, non-fungicide treated plots, tillers that had not yet reached FGS 10.5.1 when inoculated were able to become infected. This indicates that secondary tillers could be susceptible to infection past the optimum fungicide application timing and highlights the importance of including these secondary tillers in the determination of anthesis. Research will be conducted in 2016 to evaluate the contribution of secondary tillers to FHB and DON in wheat.

EVALUATING FUNGICIDE EFFICACY AND TIMING FOR MANAGEMENT OF FUSARIUM HEAD BLIGHT IN SPRING BARLEY IN NORTH DAKOTA

Andrew Friskop[1*], Scott Meyer[1], Elizabeth Crane[1], Venkata Chapara[2], Amanda Arends[2], Pravin Gautam[3] and Blaine Schatz[4]

[1]North Dakota State University, Fargo, ND 58108; [2]North Dakota State University, Research and Extension Center, Langdon, ND 58249; [3]Bayer CropScience, Beaver Crossing, NE 68313; and [4]North Dakota State University Research and Extension Center, Carrington, ND 58421
[*]Corresponding Author: PH: 701-231-7627; Email: andrew.j.friskop@ndsu.edu

ABSTRACT

The use of a well-timed fungicide is an important management tool when suppressing Fusarium head blight (scab) in barley production. With funding from the U.S. Wheat and Barley Scab Initiative, four fungicide trials were conducted on spring barley at two locations in North Dakota in 2014 and 2015. Two additional fungicide trials were conducted at another location. The primary objective at all three locations was to evaluate fungicide efficacy and timing on reducing disease and protecting yield in spring barley. Research sites were established at the Carrington Research and Extension Center (Carrington), North Dakota State University (Fargo) and Langdon Research and Extension Center (Langdon). Trials were conducted in a randomized complete block design with four replications. All plots were sown with the susceptible six-row barley variety Tradition. Trials were inoculated with *Fusarium* infested corn spawn at Fargo and Langdon; Carrington trials were seeded into wheat residue. Several fungicides and/or fungicide programs were evaluated and all trials included prothioconazole + tebuconazole (Prosaro®, Bayer CropScience) and metconazole (Caramba®, BASF). Other fungicides and fungicide rates evaluated varied among locations. All locations evaluated the application timing of Feekes 10.5 (fully-headed). Other timings evaluated were Feekes 9 (flag leaf), Feekes 10.3 (1/2 head emergence) and Feekes 10.5 + 4-5 days. Disease evaluations for foliar diseases and Fusarium head blight were conducted on all plots. DON levels were obtained from samples submitted to the NDSU Veterinary Toxicology Lab. Preliminary analysis indicates adequate disease pressure was achieved in five of the six trials as significantly lower DON levels were observed in fungicide treatments when compared to the non-treated control. Prothioconazole + tebuconazole and metconazole applied at Feekes 10.5 and at Feekes 10.5 + 4-5 days tended to have lower DON levels than all other treatment combinations. Future research to evaluate post-heading fungicide applications is needed to help strengthen current fungicide recommendations for scab management in barley.

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No. 59-0206-9-064. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

INFLUENCE OF TEMPERATURE AND RELATIVE HUMIDITYON DON PRODUCTION IN WHEAT AFTER FUSARIUM HEAD BLIGHT SYMPTOM DEVELOPMENT

Wanderson B. Moraes[1], Jonas A. Rios[2], Larry V. Madden[1] and Pierce A. Paul[1*]

[1]Department of Plant Pathology, The Ohio State University, OARDC, Wooster, OH 44691; and [2]Department of Plant Pathology, Viçosa, Brazil
[*]Corresponding Author: PH: (330) 263-3842; Email: paul.661@osu.edu

OBJECTIVE

Investigate the effects of temperature (cool-20ºC, warm-25ºC, and hot-30ºC) and relative humidity during the window between Fusarium head blight (FHB) visual symptom development and harvest on deoxynivalenol (DON) in grain from spikes with known levels of FHB index.

INTRODUCTION

FHB development and DON accumulation are strongly influenced by environmental conditions before, during, and even after anthesis. It is well known that major FHB epidemics and high levels of DON are associated with warm temperatures, high relative humidity, and adequate rainfall during the aforementioned periods (5, 6). However, very few studies have investigated the effects of potentially stressful environmental conditions on DON in diseased spikes during the post-anthesis window (1). In particular, the effects of different combinations of cool/hot and wet/dry conditions between visual symptom development and harvest on DON are still not fully understood. This constitutes a major knowledge gap in our understanding of the epidemiology of FHB. Producers and researchers alike have questioned the association between low FHB index and high DON or disproportionately low DON and relatively high index in some seasons. Anecdotal evidence and results from designed experiments have shown that post-anthesis environmental conditions may have contrasting effects on DON accumulation in harvested grain. For instance, in one study, moisture during the first 10 days after anthesis led to an increase in DON (2), but in a second study, a greater amount of total moisture between anthesis and harvest led to a reduction in DON (3). In addition, results from controlled-environment studies showed that post-anthesis moisture patterns may also play a role in DON exceeding critical thresholds even when FHB levels are relatively low. Andersen et al. (1) found that DON levels increased under certain patterns of intermittent moisture.

MATERIALS AND METHODS

Two different experiments were performed to evaluate the effects of temperature and moisture after FHB visual symptom development on DON production. In the first experiment, whole plants with FHB developed in growth chambers were used, whereas in the second, FHB-affected spikes were harvested from field-grown plants. For experiment 1, seeds of Cooper, an awnless, FHB-susceptible soft red winter wheat (SRWW) cultivar, were sown in batches, and after germination were allowed to vernalize in a cold (3°C) room for 10 weeks. Plants were then transplanted to individual containers containing autoclaved silt loam and transferred to growth chambers with a constant temperature of 23°C and RH 70%, and photoperiod of 16 h of light and 8 h of darkness until inoculated. Plants were treated with 50% triadimefon for powdery mildew control, fertilized, and watered as needed. For experiment 2, field plots of Bravo, an awnless, susceptible SRWW cultivar, were planted on 25 September 2014 at OARDC Snyder Farm near Wooster, OH into a field previously cultivated with oats, and managed according to standard agronomics practices for Ohio.

In both experiments, plants were inoculated at early anthesis (Feekes 10.5.1) with a spore suspension consisting of a mixture of equal proportions of 10 Ohio isolates of *Fusarium graminearum*. For experiment 1, a set of 120 plants was point inoculated at anthesis as previously described (4). Immediately after inoculation, plants were placed in mist chambers and subjected to 1, 2, or 3 days of mist for 12 h during each 24-hour period to enhance infection and generate a range of FHB levels. For experiment 2, plants were spray-inoculated at anthesis with a 1:1 mixture of ascospores and macroconidia (50,000 spores. ml^{-1}).

In both experiments, temperature and moisture treatments were imposed after visual symptom development (which occurred 16 and 21 days after inoculation). The experiments were performed simultaneously in three programmable walk-in growth chambers set a 20, 25, and 30ºC. In each chamber, the experimental design was a randomized complete block, with moisture as whole-plot, and five FHB index categories (8-15, 20-40, 41-60, 61-80, 90-100%) as sub-plot. For the first experiment, seven subsets of 4 plants with spikes in each FHB index categories were exposed to each combination of moisture (dry and wet) and temperature. The wet treatment (>95% RH) was established by using a portable humidity chamber, equipped with humidifiers programmed to run 30 min every 60 min for 24 hours every day, and the dry treatment (70%) was established by leaving plants outside of the mist chambers under chamber-regulated RH conditions. There were 7 replications, consisting of different cohorts of spikes at anthesis.

For the second experiment, different saturated salt solutions and water were used to achieve four levels of relative humidity: 70% (1:1 mixture of NaCl + KCl), 80% ($(NH_4)_2SO_4$), and 90% ($BaCl_2$), 100% (distilled water) (7, 8). A fixed volume of 250 ml of saturated salt solution or water was placed into 17-by-12-by-6-cm transparent chambers and sealed airtight to reach and maintain the desired RH. Four arbitrarily-selected spikes in each of the five index categories were assigned to each humidity chambers. There were 5 replicate chambers of each RH level.

Spikes were harvested and threshed, and kernels were ground and assayed for DON at the U.S. Wheat and Barley Scab Initiative-funded laboratory at the University of Minnesota.

RESULTS AND DISCUSSION

In all cases, as expected, DON increased as mean index increased, with the high-index categories having the highest mean levels of the toxin (Fig. 1A and C). However, the rate in DON increase per unit increase in index (slope of the DON/index regression line) varied among temperature-moisture treatment combinations (Fig. 1C and D). At all three temperatures, slopes were higher for plants exposed to relatively dry conditions (70% RH) after symptom development (Fig. 1B) than under wet conditions (> 95% RH). At >95% RH, the highest slope was observed at 20ºC, whereas at 70% RH the slope was highest at 25ºC (Fig. 1B).

Interestingly, for detached spikes from the field (experiment 2), the rate of DON increase per unit increase in index at 100% RH was higher (at least numerically) at 20ºC than at 25 or 30ºC (Fig 1D). However, at 25º and 30ºC, similar trends to those observed for intact spikes (experiment 1) were observed, with the slopes tending to be higher at 70 and 80% than at 90 and 100% RH (Fig 1D). This interaction effect of temperature and RH on the relationship between index and DON is better depicted in the response surfaces in Figure 2. At 20ºC, the highest levels of DON were observed at 90-100% RH (Fig. 2A), whereas at 25 and 30 C, for a similar level of index, the highest levels of DON were observed at 70-80% RH. Follow-up experiments were conducted to determine the consistency of the results presented here, but at the time of this report, DON results were not yet available.

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No 59-0206-4-018. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

REFERENCES

Andersen, K. F., Madden, L. V., and Paul, P. A. 2015. Fusarium head blight development and deoxynivalenol accumulation in wheat as influenced by post-anthesis moisture patterns. Phytopathology 105:210-219.

Cowger C., Patton-Ozkurt J., Brown-Guedira G., and Perugini L. 2009. Post-anthesis moisture increased Fusarium head blight and deoxynivalenol levels in North Carolina winter wheat. Phytopathology 99:320-327.

Culler M. D., Miller-Garvin J. E., and Dill-Macky R. 2007. Effect of extended irrigation and host resistance on deoxynivalenol accumulation in Fusarium-infected wheat. Plant Dis. 91:1464-1472.

Engle, J. S., De Wolf, E. D., and Lipps, P. E. 2000. A visual scale for estimating damage to soft red winter wheat kernels by Fusarium head blight. Pages 141-142 in: Proc. Natl. Fusarium Head Blight Forum. K. Y. Erlander, R. W. Ward, S. M. Canty, J. Lewis, and L. Siler, eds. Michigan State University, East Lansing.

McMullen M., Jones R., and Gallenberg D. 1997. Scab of wheat and barley: A re-emerging disease of devestating impact. Plant Dis. 81: 1340-1348.

McMullen, M., Bergstrom, G., De Wolf, E., Dill-Macky, R., Hershman, D., Shaner, G., and Van Sanford, D. 2012. A Unified Effort to Fight an Enemy of Wheat and Barley: Fusarium Head Blight. Plant Dis. 96: 1712-1728.]

Rockland, Louis B. 1960. Saturated salt solutions for static control of relative humidity between 5° and 40°C. Analytical Chemistry 32: 1375-1376.

Winston, P. W., and Bates, D. H. 1960. Saturated salt solutions for control of humidity in biological research. Ecology 41: 232-237.

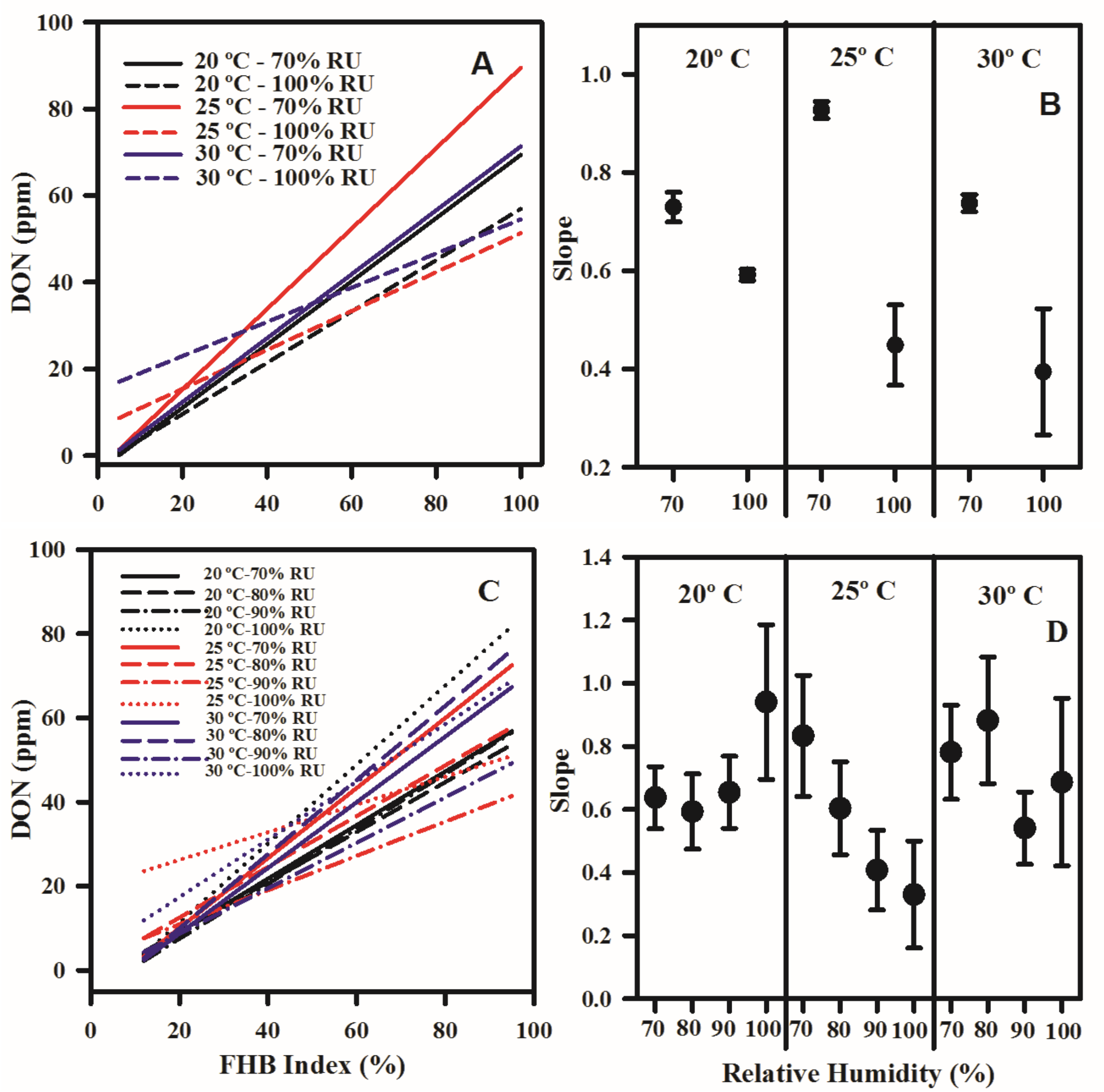

Figure 1. Relationship between Fusarium head blight (FHB) index and deoxynivalenol (DON) in spikes subjected to 70 to 100% relative humidity at 20 to 30°C after FHB visual symptom development. Diseased plants of Cooper were grown in growth chambers at 70 and > 95% RH (A, B), and detached diseased spikes of Bravo were harvested from the field after FHB symptom development (C, D) and placed in RH chambers. Lines are based on the estimated regression parameters from robust regression analysis (A, B). Slope for each temperature-RH combination are displayed in B and D along with their 95% confidence intervals.

.

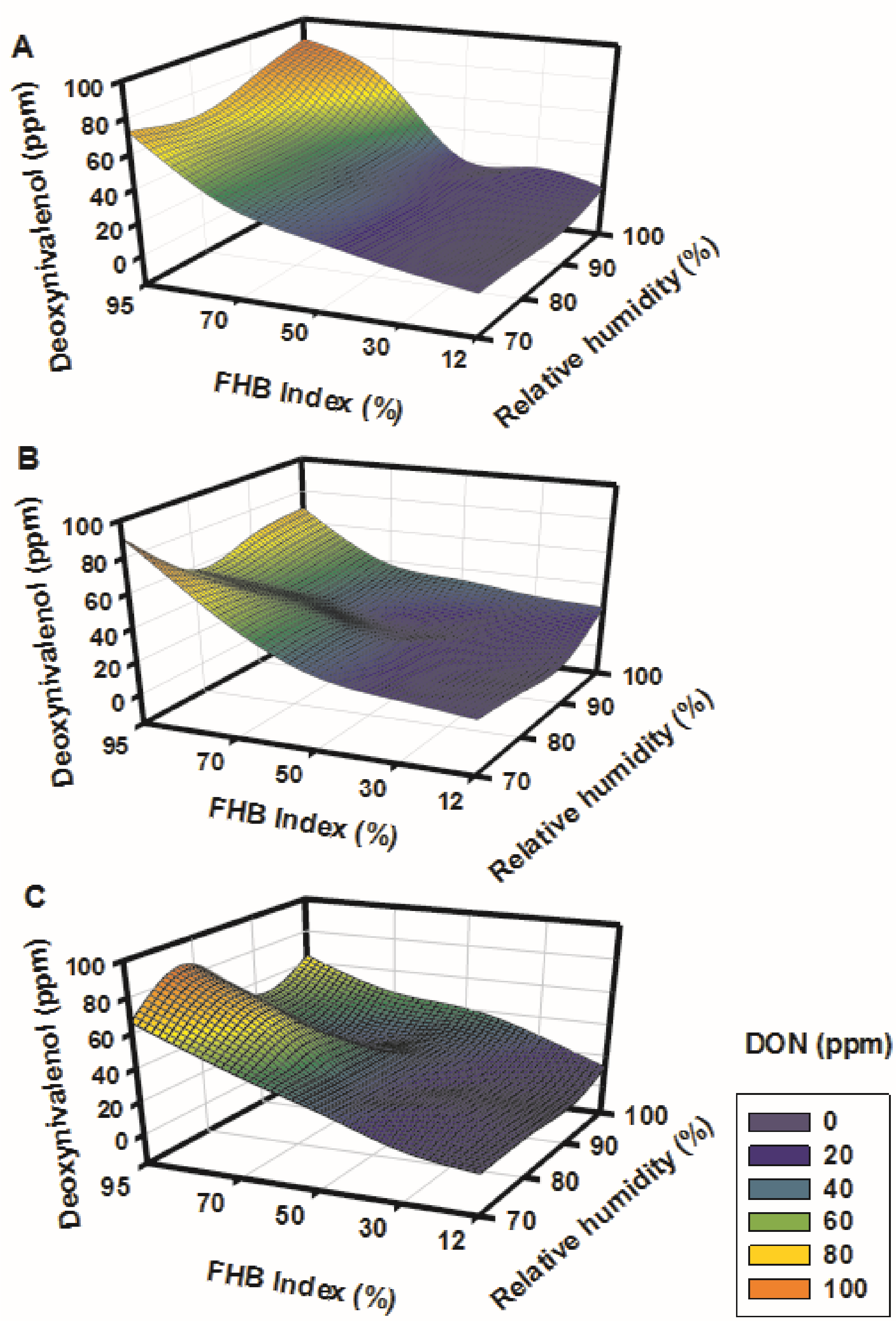

Figure 2. Response surfaces for deoxynivalenol (DON) as a function of Fusarium head blight (FHB) index and relative humidity. Detached diseased spikes of Bravo were subjected to 70 to 100% relative humidity at 20º (A), 25º (B) and 30°C (C) for 30 days. Plots were generated using values from the five repetitions.

2014 AND 2015 FIELD PLOT TRIALS FOR BIOLOGICAL CONTROL OF FUSARIUM HEAD BLIGHT IN SOUTH DAKOTA USING *BACILLUS AMYLOLIQUEFACIENS* STRAINS

N.K.S. Murthy[1], B.H. Bleakley[1,2*], D.N. Yabwalo[2] and E. Byamukama[2]

[1]Biology and Microbiology Department, and [2]Plant Science Department,
South Dakota State University, Brookings, South Dakota 57007
[*]Corresponding Author: PH: 605-688-5498; Email: bruce.bleakley@sdstate.edu

ABSTRACT

Fusarium graminearium (*Gibberella zeae*) is primarily responsible for Fusarium head blight (FHB) in Wheat and Barley. Economic losses due to FHB can be significant. Yield losses can be controlled or reduced through the use of fungicides alone or in combination with biological control agents (BCA). Field plot trials were conducted in 2015 in Brookings, South Dakota to analyze the efficacy of *Bacillus amyloliquefaciens* strains 1BA and 1D3 in biological control of FHB. Spray applications of *Bacillus* BCAs alone or in combination with Prosaro® (fungicide) and/or Induce NIS (non-ionic surfactant) and/ or colloidal chitin were done on Samson spring wheat heads at Feekes 10.5.1. Similar trials were conducted previously in 2014 using Briggs spring wheat.

Although multiple treatments had decreased DON (deoxynivalenol) and FDK (*Fusarium*-damaged kernels) levels in the 2014 field plot trials with Briggs spring wheat, statistically significant treatment differences (P=0.05) were not observed. Some treatments exhibited statistically significant treatment differences (P=0.05) for protein in comparison to the untreated control. Only the DON, FDK and protein results from 2014 plots are presented in this abstract, as the other results were presented at the 2014 FHB Forum.

In the 2015 field plot trials with Samson spring wheat, significant treatment differences (*P=0.05*) were observed for FHB incidence, disease severity and FHB index, in comparison to the untreated control. Statistically significant treatment differences were not observed for test weight and protein content, in comparison to the untreated control. Some 2015 treatments with *Bacillus* 1BA and/or 1D3 in combination with Prosaro, with/without colloidal chitin exhibited better results for FHB incidence, disease severity and FHB index than a single application of Prosaro alone. Significant differences (P=0.05) were observed with some BCA treatments for yield in comparison to untreated control. The combination of 1BA, 1D3, colloidal chitin, and Prosaro increased the yield to 54.49 bu/ac, which was 1.4 times more yield than the untreated control (38.67 bu/ac). Prosaro alone increased the yield to 43.93 bu/ac. The treatment combination of 1D3 amended with colloidal chitin and Prosaro increased the yield to 54.64 bu/ac; and the treatment combination of 1BA with colloidal chitin and Prosaro increased the yield to 54.54 bu/ac. The results for DON and FDK are pending and not yet available. These trials demonstrated that *Bacillus* strains 1BA or 1D3 in combination with Prosaro and/or colloidal chitin can not only reduce FHB in wheat, but can statistically increase the yield as well, compared to a single application of Prosaro alone.

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No. 59-0206-9-050. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

COMPARATIVE CONTROL OF *FUSARIUM VERTICILLIOIDES* INFESTING MAIZE USING *HYPTIS SUAVEOLENS* AND SYNTHETIC INSECTICIDE

Olotuah, O.F.* and Adeyefa, B.G.

Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba-Akoko, Ondo State, NIGERIA
*Corresponding Author: PH: 348054582550; Email: olanrewaju.olotuah@aaua.edu.ng, lanrose2002@yahoo.com

ABSTRACT

Pathological study on *Fusarium verticillioides* (Sacc.) infesting Maize, Zea mays, was investigated in a field trial. Comparative protection using a plant extract obtained via vaccum filtration using cold method and a synthetic fungicide was evaluated against *Fusarium verticillioides* (Sacc.) Nirenberg, causing great loss in maize production. Healthy maize plants were sprayed with botanical extract of *Hyptis suaveolens* and *Fusarium verticilliodes* prepared on the demonstration field of the Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria. The maize plants were inoculated with *Fusarium verticilliodes* inoculums at 5 weeks after planting. Subsequently on different maize plots, treatment of the maize plants was carried out using *Hyptis suaveolens* extract and synthetic fungicide (Redforce) separately in order to determine the efficacy of each treatment in the control of the disease. Remarkable control was established after the treatment of the infected maize with *Hyptis suaveolens* extract and synthetic fungicide as such, basis for comparison was subsequently recorded as there was no significant difference ($P < 0.05$) in the 1, 2, 3 and 4 weeks after planting before the inoculation. At 2, 3, 4 and 5 weeks after inoculation a significant difference ($P < 0.05$) was observed and at 7, 8, 9 and 10 weeks after planting, higher mean and standard error values were recorded for the parameters, stem girth, number of leaves and internodes under study in plants treated with *Hyptis suaveolens* extract while synthetic fungicide treated maize plants had lower mean and standard error values.

ROBUST MANAGEMENT PROGRAMS TO MINIMIZE LOSSES DUE TO FHB AND DON: A MULTI-STATE COORDINATED PROJECT

J.D. Salgado[1], K. Ames[2], G. Bergstrom[3], C. Bradley[2,7], E. Byamukama[5], J. Cummings[3], V. Chapara[4], M. Chilvers[10], R. Dill-Macky[12], A. Friskop[4], P. Gautam[14], N. Kleczewski[6], L.V. Madden[1], E. Milus[9], M. Nagelkirk[10], J. Ransom[4], K. Ruden[13], J. Stevens[11], S. Wegulo[11], K. Wise[8], D. Yabwalo[5] and P.A. Paul[1*]

[1]The Ohio State University/OARDC, Wooster, OH 44691; [2]University of Illinois, Urbana, IL 61801; [3]Cornell University, Ithaca, NY 14853; [4]North Dakota State University, Fargo, ND 58102; [5]South Dakota State University, Brookings, SD 57007; [6]The University of Delaware, Newark, DE 19719; [7]University of Kentucky, Lexington, KY 40506; [8]Purdue University, West Lafayette, IN 47907; [9]University of Arkansas, Fayetteville, AR, 72701; [10]Michigan State University Extension, Sandusky, MI 48471; [11]University of Nebraska-Lincoln, NE 68588; [12]University of Minnesota, St. Paul, MN 55108; [13]Bayer CropScience, Bruce, SD 57220; and [14]Bayer CropScience, Beavercreek, NE 68313
[*]Corresponding Author: PH: 330-263-3842; Email: paul.661@osu.edu

OBJECTIVE

Evaluate the integrated effects of fungicide and genetic resistance on FHB and DON in all major grain classes, with emphasis on different application timings and new genotypes to develop more robust "*best-management practices*" for FHB and DON.

INTRODUCTION

FHB management programs that integrate multiple in-field, harvesting and post-harvesting strategies have been shown to be the most effective for minimizing FHB-associated grain yield and quality losses in wheat and barley (Wegulo et al., 2011; Willyerd et al., 2012; McMullen et al., 2012; Salgado et al., 2014). For instance, Willyerd et al (2012) demonstrated that the application of the DMI fungicide Prosaro® at anthesis combined with a moderately resistant cultivar resulted in more than 70% control of both FHB index and DON. However, weather and field conditions often prevent fungicides from being sprayed at the recommended anthesis growth stage. For instance, wet, soggy field conditions may prevent ground applications, and even if such applications are made, research shows the rainfall during or shortly after treatment may reduce fungicide efficacy (Andersen et al., 2014). Moreover, several other factors such as uneven crop development and variable anthesis window affect the ability of producers and crop advisors to correctly determine the anthesis growth stage when making a fungicide application to manage FHB and DON. To address these limitations, one of the primary goals of the USWBSI management action plan is to develop integrated management strategies for FHB and mycotoxins that are robust to conditions experienced in production fields.

MATERIALS AND METHODS

Field experiments were established in 12 US wheat-growing states (AR, DE, IL, IN, MD, MI, MN, ND, NE, NY, OH and SD) to investigate the effects of cultivar resistance and fungicide application timing on FHB and DON. Plots were established following host or non-host crops of *F. graminearum*, according to standard agronomic practices for each location. At least three commercial wheat cultivars, classified as susceptible (S), moderately susceptible (MS), or moderately resistant (MR), were planted in most trials. However, some trials only included one or two of these resistance categories. Plots were planted in four to six replicate blocks. The standard experimental design was a randomized complete block, with a split-plot arrangement of cultivar as whole-plot and fungicide (Prosaro, 6.5 fl.oz./A + NIS) application timing as sub-plot (untreated or treated at anthesis [A] or 2 to 7 days post-anthesis [A+2 … A+7, respectively]). All plots were artificially inoculated with either *F. graminearum*-colonized corn kernels spread on the soil surface or spray-inoculated with a spore suspension of the fungus approximately 24-36 hours following the anthesis fungicide treatment. FHB index (plot severity) was assessed during the soft dough stage of grain development. Milled grain samples were sent to a USWBSI-supported laboratory for toxin analysis. For the purpose of this report, percent control of FHB index and DON was estimated for each cultivar x fungicide application timing combination relative to the untreated susceptible or very susceptible check (the reference treatment) for each trial/environment. However, in NY the untreated MS cultivar was used as the reference when estimating percent control.

RESULTS AND DISCUSSION

FHB index and DON results from 27 environments, representing 15 soft red winter, two soft white winter, three hard red winter, and seven hard red spring wheat classes were summarized. Estimated means and percent controls for FHB index and DON for S/VS, MS and MR cultivars treated with Prosaro at or after anthesis are shown in Table 1, 2 and 3, respectively. In some environments, FHB did not develop due to unfavorable weather conditions. In addition, DON data were not available for some trials at the time of this report, therefore trials with missing data or nominal disease and mycotoxin levels (< 3% index and < 1 ppm DON) in the untreated susceptible reference (S/VS/MS) were not used. Overall, mean FHB index and DON in the untreated susceptible check ranged from 3 to 54% and from 1.9 to 33 ppm, respectively. Relative to the untreated susceptible or very susceptible check, fungicide alone reduced FHB index by 1 to 97% and DON by 5 to 54% (Table 1). However, combinations of the fungicide treatment with a moderately susceptible (Table 2) or a moderately resistant (Table 3) cultivar were consistently more effective than fungicide alone at reducing FHB and DON in most trials, with percent control ranging from 4 to 99% for index and 11 to 89% for DON on the MS cultivars and from 42 to 99% for Index and 32 to 93% for DON on MR cultivars. Post-anthesis treatments were as effective as or more effective than anthesis treatments, particularly on MR cultivars. Based on these results, there is evidence suggesting that applying fungicides post-anthesis may be as efficacious against FHB and DON as treatments applied at anthesis in all wheat classes and environments.

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No. 59-0206-4-018. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

REFERENCES

Andersen, K. F., Morris, L., Derksen, R.C., Madden, L.V., and Paul, P. A. 2014. Rainfastness of prothioconazole+tebuconazole for Fusarium head blight and deoxynivalenol management in soft red winter wheat. Plant Dis. 98:1396-1406.

McMullen, M., Bergstrom, G., De Wolf, E., Dill-Macky, R., Hershman, D., Shaner, G., and Van Sanford, D. 2012. A Unified Effort to Fight an Enemy of Wheat and Barley: Fusarium Head Blight. Plant Dis. 96:1712-1728.

Salgado, J. D., Madden, L. V., and Paul, P. A. 2014. Efficacy and economics of integrating in-field and harvesting strategies to manage Fusarium head blight of wheat. Plant Dis. 98:1407-1421.

Wegulo, S.N., Bockus, W. W., Nopsa, J.H., De Wolf, E.D., Eskridge, K.M., Peiris, K.H.S., and Dowell, F.E. 2011. Effects of integrating cultivar resistance and fungicide application on Fusarium head blight and deoxynivalenol in winter wheat. Plant Dis. 95:554-560.

Willyerd, K. T., Li, C., Madden, L. V., Bradley, C. A., Bergstrom, G. C., Sweets, L. E., McMullen, M.,Ransom, J. K., Grybauskas, A., Osborne, L., Wegulo, S. N., Hershman, D. E., Wise, K., Bockus, W. W.,Groth, D., Dill-Macky, R., Milus, E., Esker, P. D., Waxman, K. D., Adee, E. A., Ebelhar, S. E., Young,B. G., and Paul, P. A. 2012. Efficacy and stability of integrating fungicide and cultivar resistance to manage Fusarium head blight and deoxynivalenol in wheat. Plant Dis. 96:957-967.

Table 1. Mean FHB index, DON, and percent control for different fungicide programs on FHB susceptible cultivars in 20 environments (ENV) representing different wheat classes (TYPE = SRW, SWW, HRW and HRS). Results are organized by fungicide treatment (untreated [UT] or treated at anthesis [A] or 2, 4, 5, 6 or 7 days post-anthesis [A+2…A+7, respectively]). Percent controls were estimated relative to the untreated susceptible or very susceptible (S_UT).

			Fungicide timing of application [a]							% Control Compared to Susceptible reference (S/VS[b])					
STATE	TYPE	ENV	S_UT	A	A+2	A+4	A+5	A+6	A+7	A	A+2	A+4	A+5	A+6	A+7
			FHB Index (%)= mean proportion of disease spikelets per spike												
IL	SRW	1	7.3	8.5	3.8	0.7	--	1.1	--	-17.2	48.3	91.0	--	84.4	--
IL	SRW	2	12.5	7.0	3.0	8.3	--	7.5	--	44.0	76.0	34.0	--	40.0	--
IL	SRW	3[b]	31.3	17.8	16.8	8.8	--	16.8	--	43.2	46.4	72.0	--	46.4	--
IL	SRW	4[b]	22.0	5.4	6.1	7.6	--	2.4	--	75.5	72.1	65.3	--	89.2	--
IN	SRW	5	4.4	2.3	1.8	2.8	--	1.7	--	48.3	58.1	36.4	--	62.2	--
IN	SRW	6	29.5	16.8	8.2	22.1	--	18.4	--	42.9	72.3	25.0	--	37.4	--
OH	SRW	7	12.6	10.3	4.1	7.2	--	12.2	--	18.3	67.5	42.9	--	3.2	--
OH	SRW	8	40.6	22.1	23.5	30.2	--	26.2	--	45.6	42.1	25.6	--	35.5	--
MI	SWW	11[b]	8.7	2.3	1.3	1.5	--	2.9	--	74.0	85.6	83.3	--	67.1	--
DE	SRW	14	7.0	4.9	--	4.1	--	3.3	--	30.3	--	40.9	--	53.2	--
MD	SRW	15	13.2	12.4	--	12.0	--	10.5	--	5.9	--	8.5	--	20.2	--
DE	SRW	16	3.2	1.1	--	0.3	--	1.3	--	65.8	--	89.3	--	58.6	--
NE	HRW	17	3.6	6.0	--	--	2.4	--	2.0	-69.6	--	--	31.6	--	43.4
NE	HRW	18	27.5	11.6	--	--	--	--	16.9	57.9	--	--	--	--	38.7
SD	HRW	19	19.0	8.5	10.9	14.9	--	15.4	--	55.5	42.7	21.6	--	18.9	--
SD	HRS	20	48.8	37.8	38.4	33.3	--	50.6	--	22.5	21.2	31.7	--	-3.8	--
SD	HRS	21	21.1	13.2	13.0	12.3	--	15.6	--	37.6	38.5	41.9	--	26.2	--
SD	HRS	22	53.6	29.5	34.0	32.9	--	35.9	--	44.9	36.5	38.5	--	32.9	--
ND	HRS	25	10.1	4.5	--	--	2.1	--	--	54.9	--	--	79.1	--	--
ND	HRS	27	21.4	4.2	--	0.6	--	--	--	80.5	--	97.0	--	--	--
			DON = Deoxynivalenol content of harvested grain in ppm												
IL	SRW	1	4.0	7.9	3.0	2.4	--	3.0	--	-97.2	25.1	38.9	--	25.1	--
IL	SRW	2	7.6	5.7	5.1	4.4	--	4.5	--	24.8	33.1	42.4	--	40.4	--
IN	SRW	5	7.1	7.3	4.5	4.1	--	4.1	--	-2.8	36.7	42.1	--	42.8	--
IN	SRW	6	7.2	4.9	4.9	4.7	--	4.5	--	31.5	32.2	35.0	--	36.6	--
OH	SRW	7	15.6	9.0	7.3	9.1	--	9.2	--	42.3	53.2	41.7	--	41.0	--
MI	SW/SR	10	2.4	1.6	1.1	1.5	--	1.4	--	35.4	54.2	37.5	--	43.8	--
DE	SRW	14	2.0	1.2	--	1.2	--	1.2	--	41.5	--	40.5	--	42.0	--
MD	SRW	15	1.9	1.6	--	1.1	--	0.9	--	13.7	--	42.6	--	51.6	--
NE	HRW	18	33.3	26.7	--	--	--	--	24.9	19.7	--	--	--	--	25.3
SD	HRW	19	6.9	5.4	5.4	5.0	--	5.3	--	21.9	21.2	27.0	--	23.7	--
SD	HRS	20	9.3	8.8	8.0	6.2	--	6.6	--	5.4	14.2	33.5	--	29.0	--
SD	HRS	21	9.6	7.7	7.2	6.3	--	7.6	--	20.3	25.3	35.2	--	21.2	--
ND	HRS	25	7.4	5.6	--	--	4.0	--	--	24.5	--	--	45.2	--	--

[a] Fungicide application = Prosaro applied at 6.5 fl. oz./A + NIS at or after anthesis

[b] Environments (ENV) where very susceptible cultivars (VS) were planted

Table 2. Mean FHB index, DON, and percent control for different fungicide programs on moderately susceptible cultivars in 15 environments (ENV) representing different wheat classes (TYPE = SRW, SWW, HRW and HRS). Results are organized by fungicide treatment (untreated [UT] or treated at anthesis [A] or 2, 4, 5, 6 or 7 days post-anthesis [A+2…A+7, respectively]). Percent controls were estimated relative to the untreated susceptible or moderately susceptible (S_UT or MS_UT).

			Fungicide timing of application [a]							% Control Compared to Susceptible reference (S/VS[b]/MS[c])						
STATE	TYPE	ENV	MS_UT	A	A+2	A+4	A+5	A+6	A+7	MS_UT	A	A+2	A+4	A+5	A+6	A+7
FHB Index (%)= mean proportion of disease spikelets per spike																
IL	SRW	3[b]	6.5	2.8	5.8	3.3	--	5.3	--	79.2	91.2	81.6	89.6	--	83.2	--
IL	SRW	4[b]	8.3	3.5	2.1	2.8	--	1.8	--	62.5	84.1	90.3	87.5	--	92.0	--
IN	SRW	5	0.5	0.4	0.4	0.4	--	0.2	--	88.4	90.4	90.7	90.0	--	95.4	--
IN	SRW	6	14.4	7.1	6.4	9.2	--	15.2	--	51.2	75.9	78.3	68.6	--	48.4	--
OH	SRW	7	8.4	6.5	3.3	4.6	--	7.8	--	33.3	48.4	73.8	63.5	--	38.1	--
OH	SRW	8	16.7	8.8	8.8	9.7	--	8.1	--	58.9	78.3	78.3	76.1	--	80.0	--
MI	SWW	11[b]	3.1	1.6	1.0	0.9	--	0.6	--	64.6	81.5	88.8	89.6	--	93.1	--
NY	SRW	12[c]	4.2	1.8	--	--	--	--	0.5	N/A	57.4	--	--	--	--	87.9
NY	SRW	13[c]	8.5	2.0	--	--	2.7	--	--	N/A	76.3	--	--	68.4	--	--
SD	HRW	19	30.6	11.3	10.4	15.9	--	18.3	--	-60.8	40.8	45.3	16.6	--	3.9	--
SD	HRS	20	11.3	9.8	13.5	9.2	--	14.1	--	76.9	79.9	72.3	81.2	--	71.0	--
SD	HRS	21	3.7	2.3	1.6	3.0	--	1.4	--	82.7	89.2	92.5	86.0	--	93.2	--
SD	HRS	22	31.4	22.3	16.7	19.3	--	24.5	--	41.5	58.3	68.9	64.0	--	54.3	--
ND	HRS	25	0.5	0.2	--	--	0.1	--	--	95.1	97.9	--	--	98.6	--	--
ND	HRS	27	1.3	0.4	--	0.1	--	--	--	93.9	97.9	--	99.4	--	--	--
DON = Deoxynivalenol content of harvested grain in ppm																
IN	SRW	5	2.4	2.3	2.1	2.0	--	1.8	--	65.7	67.5	70.3	71.3	--	74.9	--
IN	SRW	6	3.8	2.9	2.8	2.6	--	3.0	--	47.1	59.4	61.1	63.6	--	58.3	--
OH	SRW	7	6.1	5.3	4.6	4.4	--	5.0	--	60.9	66.0	70.5	71.8	--	67.9	--
MI	SW/SR	10	0.6	0.4	0.3	0.4	--	0.3	--	75.8	83.3	86.3	84.2	--	86.3	--
NY	SRW	12	3.2	1.3	--	--	--	--	0.7	N/A	59.1	--	--	--	--	76.7
NY	SRW	13	2.3	1.3	--	--	1.3	--	--	N/A	44.5	--	--	43.2	--	--
SD	HRW	19	7.4	5.9	5.9	6.1	--	4.5	--	-7.6	14.5	14.7	11.0	--	34.3	--
SD	HRS	20	3.6	2.6	2.5	2.6	--	3.2	--	61.5	71.7	73.7	72.0	--	65.8	--
SD	HRS	21	2.4	1.6	1.7	1.5	--	1.9	--	75.2	83.6	82.6	84.4	--	80.0	--
ND	HRS	25	1.0	0.8	--	--	1.0	--	--	86.4	88.7	--	--	87.1	--	--

[a] Fungicide application = Prosaro applied at 6.5 fl. oz./A + NIS at or after anthesis
[b] Environments (ENV) where very susceptible cultivars (VS) were planted
[c] Percent Control was estimated relative to moderately susceptible.

Table 3. Mean FHB index, DON, and percent control for different fungicide programs on moderately resistant cultivars from 22 environments (ENV) representing different wheat classes (TYPE = SRW, SWW, HRW and HRS). Results are organized by fungicide treatment (untreated [UT] or treated at anthesis [A] or 2, 4, 5, 6 or 7 days post-anthesis [A+2…A+7, respectively]). Percent controls were estimated relative to the untreated susceptible or moderately susceptible (S_UT or MS_UT).

			Fungicide timing of application [a]							% Control Compared to Susceptible reference (S/VS[b]/MS[c])						
STATE	TYPE	ENV	MR_UT	A	A+2	A+4	A+5	A+6	A+7	MR_UT	A	A+2	A+4	A+5	A+6	A+7
						FHB Index (%)= mean proportion of disease spikelets per spike										
IL	SRW	1	1.8	2.4	1.5	1.1	--	0.8	--	74.8	67.2	79.3	84.4	--	88.6	--
IL	SRW	2	4.7	2.1	2.8	2.8	--	3.7	--	62.6	83.4	78.0	77.4	--	70.6	--
IL	SRW	3[b]	5.4	1.4	2.0	0.4	--	1.1	--	82.8	95.6	93.6	98.8	--	96.4	--
IL	SRW	4[b]	1.3	1.3	0.8	1.0	--	0.8	--	94.3	94.0	96.6	95.5	--	96.6	--
IN	SRW	5	0.4	0.2	0.2	0.2	--	0.5	--	90.0	94.5	96.6	96.1	--	87.9	--
IN	SRW	6	4.8	1.6	1.6	1.0	--	1.8	--	83.6	94.6	94.6	96.6	--	93.9	--
OH	SRW	7	4.1	3.2	1.3	2.5	--	3.4	--	67.5	74.6	89.7	80.2	--	73.0	--
OH	SRW	8	10.6	4.6	3.7	7.0	--	4.5	--	73.9	88.7	90.9	82.8	--	88.9	--
MI	SWW	11[b]	0.6	0.4	0.2	0.3	--	0.4	--	92.7	96.0	97.7	97.0	--	95.5	--
NY	SRW	12[c]	1.0	0.8	--	--	--	--	0.3	76.0	81.9	--	--	--	--	94.0
NY	SRW	13[c]	8.8	2.9	--	--	1.5	--	--	-3.9	66.2	--	--	82.6	--	--
DE	SRW	14	0.4	0.2	--	0.7	--	0.3	--	94.3	97.9	--	90.4	--	96.1	--
MD	SRW	15	5.2	0.8	--	3.7	--	2.4	--	60.8	93.6	--	71.6	--	81.5	--
DE	SRW	16	0.8	0.4	--	0.2	--	0.6	--	74.6	89.0	--	94.0	--	80.3	--
NE	HRW	17	1.8	1.2	--	--	1.5	--	0.8	49.4	65.3	--	--	57.3	--	78.7
NE	HRW	18	9.9	4.9	--	--	--	--	12.2	64.1	82.1	--	--	--	--	55.6
SD	HRW	19	7.2	1.8	3.0	4.2	--	3.9	--	62.4	90.4	84.1	78.2	--	79.5	--
SD	HRS	20	28.9	27.7	19.8	22.4	--	28.4	--	40.7	43.2	59.3	54.1	--	41.8	--
SD	HRS	21	2.9	1.4	1.9	2.0	--	1.6	--	86.5	93.6	91.1	90.6	--	92.3	--
SD	HRS	22	15.5	12.2	9.8	7.9	--	13.1	--	71.0	77.3	81.8	85.2	--	75.6	--
ND	HRS	25	2.8	0.9	--	--	3.1	--	--	71.9	91.3	--	--	69.7	--	--
ND	HRS	27	1.5	0.2	--	0.0	--	--	--	93.2	99.1	--	99.9	--	--	--
						DON = Deoxynivalenol content of harvested grain in ppm										
IL	SRW	1	1.1	2.5	1.1	0.8	--	1.5	--	73.6	37.4	71.9	79.4	--	63.1	--
IL	SRW	2	2.2	2.4	2.1	2.5	--	2.1	--	70.3	68.5	71.9	66.6	--	72.7	--
IN	SRW	5	3.9	2.6	3.0	2.5	--	2.1	--	44.4	63.7	57.9	64.7	--	69.8	--
IN	SRW	6	3.9	3.0	3.3	2.8	--	2.8	--	45.0	57.5	54.0	61.0	--	60.4	--
OH	SRW	7	4.2	3.5	2.1	2.5	--	2.4	--	73.1	77.6	86.5	84.0	--	84.6	--
MI	SW/SR	10	0.4	0.3	0.2	0.2	--	0.2	--	85.4	89.2	92.1	91.3	--	91.3	--
NY	SRW	12	1.3	0.5	--	--	--	--	0.2	59.4	83.3	--	--	--	--	93.4
NY	SRW	13	1.5	1.2	--	--	0.7	--	--	34.9	47.2	--	--	68.6	--	--
DE	SRW	14	0.3	0.3	--	0.2	--	0.2	--	83.5	86.0	--	90.5	--	88.0	--
MD	SRW	15	0.6	0.5	--	0.4	--	0.4	--	67.4	73.7	--	77.9	--	81.6	--
NE	HRW	18	13.3	12.9	--	--	--	--	10.1	60.1	61.2	--	--	--	--	69.6
SD	HRW	19	4.8	4.7	3.6	3.8	--	2.6	--	30.2	31.7	48.4	44.3	--	62.2	--
SD	HRS	20	3.1	2.4	2.6	2.4	--	2.6	--	67.2	74.4	72.0	74.4	--	71.7	--
SD	HRS	21	2.3	1.4	1.4	1.2	--	1.5	--	76.7	86.0	86.0	87.2	--	84.6	--
ND	HRS	25	2.1	1.6	--	--	1.4	--	--	71.4	78.2	--	--	80.5	--	--

[a] Fungicide application = Prosaro applied at 6.5 fl. oz./A + NIS at or after anthesis
[b] Environments (ENV) where very susceptible cultivars (VS) were planted
[c] Percent Control was estimated relative to moderately susceptible.

A FUNCTIONAL EXPLORATION OF TEMPERATURE AS A PREDICTOR OF FUSARIUM HEAD BLIGHT EPIDEMICS

D.A. Shah[1*], E.D. De Wolf[1], P.A. Paul[2] and L.V. Madden[2]

[1]Dept. of Plant Pathology, Kansas State University, Manhattan KS; and
[2]Dept. of Plant Pathology, The Ohio State University, Wooster OH
[*]Corresponding Author: PH: (716) 998-5112; Email: dashah81@ksu.edu

ABSTRACT

Our focus is on weather-driven predictive models for Fusarium head blight (FHB) epidemics in the U.S. An epidemic was defined as having occurred when the FHB index ≥ 10%. The current FHB observational data matrix contains 865 observations representing site-years from 1982 to 2014. FHB epidemics were represented by 236 observations. Each observation was linked to a weather time series matrix consisting of daily estimates of temperature for the given location from which the FHB observation was collected. We looked at daily temperatures beginning 120 days pre-anthesis to 20 days post-anthesis. The raw daily temperature time series were then represented by smooth curves built from cubic B-spline basis functions with a roughness penalization. The mean smooth curves for epidemics and non-epidemics were estimated, along with their first and second derivatives, and the differences in these curves between epidemics and non-epidemics. The functional representations of the temperature time series indicated three potential periods where the separation between epidemic and non-epidemic temperature profiles may be greatest: 84 to 72 days pre-anthesis, 42 to 23 days pre-anthesis, and 7 days pre-anthesis to 10 days post-anthesis. We calculated (for each observation) the mean temperatures (T_m) estimated from the raw daily values within these three periods, and then looked at the distribution of T_m (for epidemics and non-epidemics) with histograms, density plots and empirical cumulative distributions. The plots showed some separation between epidemics and non-epidemics, and much overlap. Choosing T_m = 11 °C as a cut-point for classifying epidemics and non-epidemics gave an overall correct classification rate of 72%. Non-epidemics were correctly classified 88% of the time, but epidemics were correctly classified only 29% of the time. Therefore, the functional representation of the temperature time series was useful in identifying periods during which epidemics may be potentially discriminated from non-epidemics. Identified time periods (e.g. 84 to 72 days pre-anthesis) were much earlier than we had given thought to before (15 days pre-anthesis to anthesis) when formulating predictors of FHB epidemics. However, the mean temperature differences between the smooth curves for epidemics and non-epidemics was on the order of 1 °C, which was indicative of the difficulty of using temperature alone to separate the two classes. Current research is focusing on a functional analysis of moisture variables, such as mean relative humidity, a variable previously identified for its high discriminatory ability.

AKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No. 59-0206-2-087 (Kansas State University) and 59-0206-4-018 (The Ohio State University). This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

THE EFFECT OF FUSARIUM HEAD BLIGHT AND STRIPE RUST ON GRAIN YIELD OF HARD WINTER WHEAT IN LINCOLN NE

Javed Sidiqi[1], P.S. Baenziger[1*] and S.N. Wegulo[2]

[1]Dept. of Agronomy and Horticulture, and [2]Dept. of Plant pathology,
University of Nebraska-Lincoln, Lincoln, Ne 68583-0915
[*]Corresponding Author: PH: 402-472-1538; Email: pbaenziger1@unl.edu

ABSTRACT

To determine the effect of fungal plant pathogens on grain yield in eastern NE, we initiated a study in 2015 to compare fungicide treated and untreated plots using our elite nursery. While it is well documented that diseases reduce grain yield and fungicide use is becoming more common, growers still debate the cost and value of using fungicides. The purpose of this experiment was to provide growers with information on the value of fungicides so they can make informed decisions and also learn about our advanced breeding lines and how they respond to fungicides in the presence of disease. The Nebraska elite nursery contains 60 lines (two historic check cultivars, 6 cultivars, and 52 unreleased elite lines). Two fungicide regimens, treated vs. untreated, were utilized. In the treated plots, Cruiser Max® was used to treat the seed before planting. Then at early spring green-up the plots were sprayed with Priaxor®. At flag leaf, the plots were sprayed with Twinline® followed by Caramba® at flowering. Seed treatments and fungicides were not applied to the untreated plots. Each fungicide treatment (treated and untreated) had 60 genotypes replicated twice in an alpha lattice design with an incomplete block size of 5 entries. Grain yield was harvested using a small plot combine and the grain was weighed after drying in the seed house. Eastern Nebraska receives on average 65 to 75 cm of rainfall annually. In 2015, the Lincoln research station received 42 cm of precipitation from 1 May to 15 June. The average flowering date for winter wheat in our elite trial was 24 May with a range from 20 May to 29 May. Hence the conditions were ideal for Fusarium head blight (FHB, incited by *Fusarium graminearum*.). The other major disease present was stripe rust (incited by *Puccinia striiformis* f. sp. *tritici*). Other diseases that are favored by cool moist conditions were present, but not to the extent of FHB and stripe rust. Average FHB index in the untreated plots was 56% (range 4% to 96%) compared to 10% in the treated plots (an 82% reduction in index; range 0% to 68%). Yield in the treated plots averaged 3460 kg/ha (range 4860 kg/ha to 1360 kg/ha) compared to 1940 kg/ha (a 44% reduction in yield; range 3500 kg/ha to 340 kg/ha). On average the diseases caused a 44% reduction in yield (excluding the two historic check cultivars which actually yielded higher in the untreated plots; yield loss due to disease ranged from 15% to 86%). There was a significant negative correlation between FHB index and yield in the untreated plots ($R = -0.38$; $P = 0.0034$) indicating that some lines had good FHB resistance whereas others were susceptible. In contrast, there was no correlation between FHB index and yield in the treated plots ($R = 0.04$; $P = 0.7454$), indicating the effectiveness of Caramba applied at flowering in suppressing FHB. The stripe rust reactions varied among lines from highly resistant to highly susceptible. In looking at those lines which had infection scores of 1-3 (on a 1= resistant to 9= susceptible scale) for stripe rust, the grain yield loss averaged 30% presumably due to FHB. In looking at those lines with infection scores of 7-9 for stripe rust, the grain yield loss averaged 50%. In

both the resistant and susceptible to stripe rust groups, lines varied in their response to FHB with the best lines having only a 15% or 27% yield loss, respectively. Though not measured, the effects on grain volume weight and seed germination were obvious in preparing and planting seed this fall. This experiment will be repeated to provide multi-year disease loss information and to ensure having high quality seed for planting. Growers in eastern Nebraska were warned of the scab epidemic and many decided to use fungicides despite the low price of wheat. Clearly this year fungicides were economically beneficial, especially when coupled with cultivars that also had some tolerance or resistance to FHB and stripe rust.

ACKNOWLEDGEMENT AND DISCLAIMER

Javed Sidiqi is supported by a scholarship awarded by The Fulbright Scholar Program. This research is based upon work supported by BASF and in part by the U.S. Department of Agriculture, under Agreement Nos. 59-0206-4-011 and 59-0206-2-085. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

UNIFORM FUNGICIDE TRIAL RESULTS FOR MANAGEMENT OF FHB AND DON, 2015

M.J. Smith[1*], A. Friskop[2], A. Arends[2], V. Chapara[2], S. Meyer[2], B. Schatz[3], G.C. Bergstrom[4], J.A. Cummings[4], E. Byamukama[5], D. Yabwalo[5], B. Bleakley[5] N. Murthy[5] K. Ruden[6], C.A. Bradley[7], K. Ames[8], J. Pike[8] and R. Bellm[8]

[1]University of Minnesota Northwest Research and Outreach Center; Crookston, MN 56716; [2]North Dakota State University, Fargo, ND, 58105; [3]North Dakota State University Carrington Research and Extension Center, ND 58421; [4]Cornell University, Ithaca, NY, 14853; [5]South Dakota State University, Brookings, SD, 57007; [6]Bayer CropScience LP, 307 First St., PO Box 425, Bruce, SD 57220; [7]University of Kentucky Research and Education Center, Princeton, KY, 42445; and [8]University of Illinois, 1102 S. Goodwin Ave., Urbana, IL 61801
[*]Corresponding Author: PH: 218-281-8691; Email: smit7273@umn.edu

ABSTRACT

Data from prior USWBSI-funded uniform fungicide trials have shown that DMI fungicides, Caramba® 90 SL and Prosaro® 421 SC, were two of the most effective products against FHB and DON. However, for the grower these products can be relatively expensive. Tebuconazole fungicide is now off-patent, and several "generic" formulations are available at relatively low costs (some reports of less than $3 per acre). In years where the risk of scab is predicted as low, and growers have fields planted to moderately FHB resistant varieties, many are making the economic decision to use generic tebuconazole products. The aim of this project was to compare generic formulations of tebuconzole products to evaluate any differences in efficacy and to examine biocontrol formulations for the suppression of FHB. Trials were conducted at multiple locations across five states (Illinois, North Dakota, South Dakota, Minnesota and New York) in 2015. All sites were inoculated with *Fusarium graminearum* infested corn spawn, infested residue, or spray inoculation with spores at flowering. In several locations, mist irrigation was used to promote disease development. Eleven common fungicide treatments were evaluated across locations; Prosaro, Caramba, Monsoon, Muscle, Onset, Orius, Tebustar, Toledo, Aproach, Aproach Prima and the biological control Taegro in combination with Prosaro. Additional rates of Caramba and/or Prosaro were tested. All treatments were applied at Feekes 10.5.1 (early anthesis). Preliminary analysis of the data revealed that all treatments helped reduce the incidence of FHB in comparison with plots that received no fungicide application. The fungicides Caramba and Prosaro appeared to provide the best control of FHB, yield increase and reduction in DON for the locations where DON was measured. Two new, products designated MAD1 and MAD2 also showed good FHB control at some locations.

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture, under Agreement Nos. 59-0206-4-038, 59-0206-4-012, 59-0206-4-006, 59-0206-4-005, 59-0206-4-024 and 59-0206-4-030. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

SPRING WHEAT CULTIVAR PERFORMANCE AGAINST FUSARIUM HEAD BLIGHT IN NATURAL INFESTATION

D. Yabwalo[1], K. Ruden[2], S. Ali[1], R. Geppert[1], K. Glover[1], B. Bleakley[1] and E. Byamukama[1*]

[1]Plant Science Department, South Dakota State University, Box 2140C, Brookings, SD 57007-2141; and [2]Bayer CropScience LP, 307 First St., PO Box 425, Bruce, SD 57220-0425
[*]Corresponding Author: PH: 605-688-4521; Email: emmanuel.byamukama@sdstate.edu

ABSTRACT

Fusarium head blight (FHB) or scab, mainly caused by *Fusarium graminearum*, remains one of the most destructive fungal diseases affecting wheat and barley. The disease is responsible for economic losses stemming from reduced yield due to shriveled kernels and poor quality kernels as a result of mycotoxin accumulation. The minimum acceptable levels of mycotoxins, especially deoxynivalenol (DON), in finished wheat products for human consumption is 1ppm. Therefore, the market value of wheat kernels with high mycotoxin levels declines significantly. Use of resistant cultivars is the most cost effective approach to managing FHB. This study evaluated the performance of 19 released and popular cultivars under natural infestation. The trial was planted at the South Dakota State University (SDSU) Northeast research farm, near South Shore. Plot size was 6 m^2 and cultivars were replicated four times and were laid out in a randomized complete block design. Variables assessed included FHB incidence, FHB severity, FHB disease index (DI), yield, and test weight (TW). Significant differences ($p=0.05$) were observed in all assessed variables except for FHB severity. Amongst the top three cultivars for each assessed variable, at least one cultivar appeared in the top three of four out of five variables. Forefront, Brick and Sabin had the lowest FHB incidence and FHB index, while Brick, SY Ingmar and Norden had the lowest FHB severity. The cultivars which had low FHB index did not necessarily yield the highest. Norden, Sabin and SY Soren were the top yielding cultivars. Negative associations between FHB against TW and yield were observed although, in general, the magnitudes were higher for TW than for yield suggesting that TW was affected more by FHB than yield.