FHB MANAGEMENT

INTEGRATED FHB MANAGEMENT OF SPRING WHEAT IN IDAHO

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OBJECTIVE

Evaluate the integrated effects of fungicide application and wheat resistance on Fusarium head blight (FHB) and deoxynivalenol (DON) in Idaho.

INTRODUCTION

FHB damage in spring wheat has substantially increased in southern Idaho over the last ten years. Many spring wheat fields in the area tested at 1-7 ppm DON even after appropriate fungicide treatments. Since the majority of the wheat varieties available to growers in the area are susceptible to FHB, it is crucial to develop integrated management strategies of FHB and DON specific to irrigated, high-desert production conditions in Idaho. Participation in the USWBSI FHB management coordinated project will not only provide a framework to educate local growers but also add a unique location to the national coordinated research program for meta-analysis.

MATERIALS AND METHODS

The coordinated study was conducted at the University of Idaho Aberdeen Research and Extension Center in Aberdeen, ID with four wheat varieties, Diva (moderately susceptible), IDO1202S (moderately susceptible) IDO851 (moderately resistant), and Klasic (susceptible) on 20 April 2016. Varieties were selected based on 2015 FHB screening data. The experimental design was compete randomized block with a split plot arrangement in 6 replications, with cultivars as main plots and treatments as sub-plots. Fungicide applications were at anthesis (Feekes growth stage 10.5.1) and anthesis + 4 days post-anthesis (A+4). Fungicide treatments were Prosaro® (6.5 fl. oz /A) at anthesis, Prosaro + Caramba® (6.5 + 14 fl. oz/A) at A+4, Caramba + Folicur® (14 + 4 fl. oz/A) at A+4 and Proline® + Folicur (5.7 + 4 fl. oz/A) at A+4. Fungicides were applied with a CO_2 sprayer using 8001 VS nozzles at a rate of 10 gallons per acre. Conidial suspensions (100,000 macroconidia/L) were sprayed a day following the anthesis fungicide application with a CO_2 backpack sprayer with Teejet 8003 VS nozzles at a ground speed of 1 second per foot at 40 psi. Severity (percent blighted spikelets per head) of 100 heads per plot was arbitrarily rated at soft dough (FGS 11.2) specifically 23-24 days after anthesis. FHB severity was used to calculate FHB incidence (incidence= number of blighted heads/100 sampled heads) and FHB index (FHB Index= Severity x Incidence / 100). Plots were harvested on 7 September using a Harvestmaster plot combine. *Fusarium*-damaged kernels (FDK) were assessed as a percentage of harvested kernels visibly affected by FHB out of the harvested grain from each plot. Data were analyzed using the generalized linear mixed model procedure (PROC GLIMMIX) in SAS (version 9.4). Subsamples were sent to Dr. Yanhong Dong of University of Minnesota for DON analysis and data will be provided on a later date.

RESULTS AND DISCUSSION

Significant differences in FHB ratings, yield and test weight were found among varieties (Table 1). IDO851 had the lowest FHB ratings and highest yield. Only FHB severity and test weight were significantly different between Diva and IDO1202S. Klasic also had lower FHB than Diva and IDO1202S but had the highest FDK, and lowest yield and test weight among varieties. Klasic reached anthesis one week earlier than other varieties, which resulted to earlier and possibly lower FHB ratings.

Despite the moderately low disease pressure, fungicide applications significantly reduced FHB ratings and FDK as well as significantly increased yield and test weight compared to the untreated checks (Table 2). Inoculated and non-inoculated untreated checks significantly differ in test weight only. Although treatments with post-anthesis fungicide applications significantly reduced FHB severity and FDK, no significant differences in FHB index and yield were detected among fungicide treatments. The effectiveness of additional post-anthesis fungicide applications cannot be determined in this trial but may be effective in environments with highly conducive conditions.

Overall, FHB index ranged from 2 to 32 % (Table 3). Moderately susceptible varieties Diva and IDO1202S with fungicide treatments had significant FHB reduction but yields did not differ. However, test weights of fungicide-treated IDO1202S plots were significantly higher than the untreated checks. When treated with fungicides, the susceptible variety Klasic had significantly increased yield and test weight. Only Prosaro application at anthesis resulted to significantly higher yield and test weight of the moderately resistant ID0851. The 2016 growing season was very dry and under these conditions, split fungicide applications did not improve disease control compared to one application. Current recommendation of one fungicide application at anthesis remains the most cost effective method to reduce FHB under irrigation in southern Idaho.

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Table 1. Main effect of varieties on FHB, yield, test weight and FDK at Aberdeen, ID in 2016.

Variety	Severity (%)	Incidence (%)	FHB Index	Yield (bu/A)	Test weight (g)	FDK (%)
Diva	16.4 a	27.4 a	6.1 a	133.3 ab	60.1 b	1.1 ab
IDO1202S	12.3 b	27.2 a	4.8 a	131.5 b	61.3 a	1.0 b
IDO851	2.4 c	9.3 b	0.3 b	144.4 a	59.7 b	0.4 c
Klasic	4.2 c	13.7 b	0.9 b	103.2 c	58.5 c	1.5 a
P=0.05	<.0001	0.0007	0.0013	0.0002	0.0005	0.003

Table 2. Main effect of fungicide on FHB, yield, test weight and FDK at Aberdeen, ID in 2016.

Treatment	Severity (%)	Incidence (%)	FHB Index	Yield (bu/A)	Test weight (g)	FDK (%)
Untreated check	16.5 a	29.2 a	6.8 a	117.9 b	58.5 c	1.8 a
Prosaro Anthesis	8.0 b	18.8 b	2.1 b	133.5 a	60.2 a	0.81 b
Prosaro + Caramba Anthesis + 4 days	2.1 c	8.4 d	0.2 b	132.7 a	60.6 a	0.45 c
Caramba + Folicur Anthesis + 4 days	3.2 c	12.9 cd	0.6 b	131.7 a	60.4 a	0.58 c
Proline + Folicur Anthesis + 4 days	7.0 b	16.0 bc	1.7 b	130.9 a	60.3 a	0.61 bc
Untreated non-inoculated check	16.2 a	31.0 a	6.7 a	121.8 b	59.2 b	1.6 a
P=0.05	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Table 3. Effect of variety and fungicide treatments on FHB, yield, test weight and FDK at Aberdeen, ID in 2016.

Variety	Treatment	Severity (%)		Incidence (%)		FHB Index		Yield (bu/A)		Test weight (g)		FDK (%)	
	Untreated inoculated	31.6	a	43.3	a	14.2	a	128.2	f	59.3	def	1.9	a
	Prosaro	15.2	c	27.5	b	4.9	b	132.1	c-f	59.9	c-f	1.1	a
Diva	Prosaro + Caramba	4.7	f-i	11.5	def	0.6	c	134.8	b-f	60.2	cde	0.6	a
	Caramba + Folicur	7.1	d-h	20.0	bcd	1.6	bc	135.8	b-f	60.6	bc	0.6	a
	Proline + Folicur	11.9	cd	21.8	bc	3.3	bc	137.8	b-f	60.4	c	0.9	a
	Untreated non-inoculated	28.2	ab	40.3	a	12.1	a	131.4	ef	60.1	c-f	1.7	a
	Untreated inoculated	23.9	b	44.5	a	11.2	a	120.9	h	59.8	c-f	1.9	a
	Prosaro	9.1	def	24.3	b	2.3	bc	130.4	ef	61.7	ab	0.8	a
IDO1202S	Prosaro + Caramba	1.9	i	9.8	ef	0.2	c	145.8	bcd	62.1	a	0.4	a
	Caramba + Folicur	3.5	ghi	14.3	c-e	0.6	c	132.0	c-f	62.0	a	0.6	a
	Proline + Folicur	10.9	cde	24.0	b	2.7	bc	133.6	c-f	62.0	a	0.4	a
	Untreated non-inoculated	24.2	b	46.3	a	12.0	a	126.0	f	60.1	c-f	1.7	a
	Untreated inoculated	3.8	f-i	11.0	def	0.5	c	135.7	b-f	59.1	ef	1.0	a
	Prosaro	2.6	ghi	10.8	def	0.4	c	160.6	a	60.3	cd	0.2	a
IDO851	Prosaro + Caramba	0.8	i	5.8	f	0.1	c	143.5	b-e	60.1	c-f	0.1	a
	Caramba + Folicur	0.9	i	7.3	f	0.1	c	148.6	b	59.9	c-f	0.1	a
	Proline + Folicur	2.4	ghi	8.8	ef	0.4	c	146.3	bc	59.8	c-f	0.0	a
	Untreated non-inoculated	4.0	f-i	12.5	c-e	0.5	c	131.7	def	59.0	f	0.8	a
	Untreated inoculated	6.6	d-i	18.0	b-e	1.3	bc	87.0	k	55.9	h	2.6	a
	Prosaro	5.3	e-i	12.8	c-e	1.0	c	110.9	hi	59.2	ef	1.2	a
Klasic	Prosaro + Caramba	1.1	i	6.8	f	0.1	c	106.6	hij	60.1	c-f	0.8	a
	Proline + Folicur	2.7	ghi	9.5	ef	0.3	c	106.1	ij	59.1	ef	1.2	a
	Caramba + Folicur	1.4	i	10.0	ef	0.1	c	110.6	hi	59.1	ef	1.1	a
	Untreated non-inoculated	8.4	d-g	25.0	b	2.5	bc	98.0	j	57.8	g	2.3	a
	$P = 0.05$	<.0001		<.0001		<.0001		0.0136		0.0006		0.2909	

2016 FIELD PLOT TRIALS FOR BIOLOGICAL CONTROL OF FUSARIUM HEAD BLIGHT ON WINTER WHEAT IN SOUTH DAKOTA USING *BACILLUS AMYLOLIQUEFACIENS* STRAINS

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ABSTRACT

Fusarium graminearum is mostly responsible for Fusarium head blight (FHB) in wheat and barley, which can cause significant economic losses. Yield losses can be controlled or reduced through using fungicides alone or in combination with biological control agents (BCAs). We have previously investigated the efficacy of *Bacillus amyloliquefaciens* strains 1BA and 1D3 in biological control of FHB on spring wheat cultivars. In the present study we assayed the ability of these bacteria to control FHB on winter wheat cultivars, to see if similar beneficial effects of BCA application would be observed. Field plot trials were conducted in 2016 in Brookings, South Dakota to analyze the efficacy of the *B. amyloliquefaciens* strains 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 chitin were done on winter wheat cultivars Lyman and Redfield at Feekes 10.51.

Significant treatment differences (P=0.1) were observed for FHB Incidence, percentage disease, and test weight in the Lyman cultivar, compared to the untreated control; with the Prosaro alone (single application), and Prosaro plus BCAs/chitin treatments having the same percentage incidence (3.0%). Although not statistically significant, final yield (48.79 bu/ac), 1000 kernel weight (25.41), and protein percentage (14.88) were highest for the Prosaro plus BCAs/chitin treatment.

In the Redfield winter wheat treatments, significant treatment differences (P = 0.1) were observed for final yield, 1000 kernel weight, and percent *Fusarium* damaged kernels, compared to the untreated control. Although not statistically significant, the Prosaro plus BCAs/chitin treatment had the lowest percentage incidence (5.0%), and highest test weight (54.59 lb/bu). For both winter wheat cultivars, the results for DON are pending and not yet available.

These trials suggested that treatment with the *Bacillus* BCA strains in combination with Prosaro can help increase yield in some situations, and reduce some measures of FHB on these winter wheat cultivars. Further trials of these BCAs on winter wheat would help clarify the benefits of foliar BCA application in increasing yield and reducing FHB.

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EFFECTS OF CULTIVAR RESISTANCE, FUNGICIDE APPLICATION TIMING, AND FUNGICIDE CHEMICAL CLASS ON FHB AND DON IN WINTER WHEAT

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ABSTRACT

The frequency and severity of Fusarium head blight (FHB), caused by *Fusarium graminearum*, 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 from 2007 to 2016. *F. graminearum* produces the mycotoxin deoxynivalenol (DON). Losses to the grower include decreased yield and grain volume weight and 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 anthesis. The narrow window (anthesis) 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. During 2015 and 2016, two field trials (dryland and irrigated) were conducted to accomplish the following objectives: 1) determine the effect of fungicide application timing at anthesis, as well as at 6 and 12 days post anthesis (dpa) on FHB and DON in a susceptible and a moderately resistant cultivar, and 2) compare the effects of Prosaro® (prothioconazole + tebuconazole, triazole) and Headline® (pyraclostrobin, strobilurin) on FHB and DON when applied at different timings in the cultivars Overley (susceptible) and Overland (moderately resistant). Data from the 2015 growing season, in which severe FHB and high DON levels occurred, have been presented (Bolanos-Carriel et al., 2015). In 2016, FHB and DON levels were very low. In the dryland trial, few differences were detected among treatments (cultivars and application timings). In Overley, FHB index was similar between fungicides (Prosaro and Headline) and application timings (range 14-33%; 38% in the unsprayed check) and the same was true for DON (range, 0.1-1 ppm; 1.4 ppm in the unsprayed check). In Overland, FHB index (range 2-13%; 14% in unsprayed the check) and DON (range 0.1-0.2 ppm; 0.1 ppm in the unsprayed check) were lower than in Overley. In the irrigated trial in Overley sprayed with Prosaro, FHB index was 28, 35, and 51% at anthesis, 6 dpa, and 12 dpa, respectively compared to 74% in the unsprayed check. The corresponding DON values were 2.9, 2.6, and 3.7 ppm, respectively compared to 4 ppm in the unsprayed check. In the same trial in Overley sprayed with Headline, FHB index was 23, 45, and 67% at anthesis, 6 dpa, and 12 dpa, respectively compared to 74% in the unsprayed check and the corresponding DON values were 4.1, 3.1, and 4 ppm, respectively compared to 4 ppm in the unsprayed check. In the irrigated trial in Overland, FHB index was similar between Prosaro and Headline (range 13 to 37% compared to 39% in the unsprayed check). Prosaro DON values were 0.6, 1.1, and 0.8 ppm, at anthesis, 6 dpa, and 12 dpa, respectively compared to 1.1 ppm in the unsprayed check and the corresponding Headline DON values were 0.6, 0.9, and 1.2 ppm, respectively compared to 1.1 ppm

in the unsprayed check. Results from 2015 (Bolanos-Carriel et al., 2015) and 2016 (this report) allow us to conclude that: 1) the window of fungicide application to control FHB and DON can be widened from anthesis to 6 days later without loss of efficacy in suppressing FHB and DON, and 2) moderate resistance coupled with fungicide application can significantly reduce DON in grain.

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EFFECTS OF FUNGICIDES, TIME, AND GRAIN MOISTURE CONTENT ON POSTHARVEST ACCUMULATION OF DON IN WINTER WHEAT

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ABSTRACT

Fusarium Head Blight (FHB), caused by *Fusarium graminearum*, is one of the most destructive diseases of wheat and other small grain cereals. *F. graminearum* produces the mycotoxin deoxynivalenol (DON). Losses to the grower are manifested as decreased yield and grain volume weight and discounts at the elevator if DON levels in grain exceed 2 ppm. DON toxicity has direct repercussions for human and animal health. During storage, the most critical factors for grain quality are moisture and temperature, parameters which are directly related to spoilage. The objective of this study was to determine the effect of time and grain moisture content on DON in stored winter wheat grain from field plots treated with the fungicides Headline® (pyraclostrobin, strobilurin) and Prosaro® (prothioconazole + tebuconazole, triazole) at anthesis. In 2015, plots of winter wheat cultivar Overland (moderately resistant to FHB), under rainfed environmental conditions, were treated with Prosaro (rate 6.5 fl oz/Acre (0.475 L/ha)) and Headline (rate 9 fl oz/Acre (0.658 L/ha)) at anthesis. After harvest, *Fusarium*-damaged kernels (FDK) were removed through a sorting process. Removal of FDK was necessary because during the growing season in 2015, conditions were highly favorable to disease development, leading to high levels of FHB and DON, which masked treatment differences in preliminary DON analysis. A mass of 300 g of clean grain from each of four replications per treatment was soaked, placed in a sterile micro-propagation container, and stored in a seed cooler under dark conditions at 50°F (10°C) and 40% relative humidity (RH). The conditions inside the containers were monitored using temperature and RH recorders. Moisture content was kept constant at 16% which corresponded to a water activity (Aw) value of 0.60 and at 20% which corresponded to an Aw value of 0.75. Sampling of each of the experimental units was made at 0, 30, 60, 90 and 120 days after soaking (DAS) and subsamples were subjected to DON analysis using Gas chromatography–mass spectrometry (GC-MS). Results showed that DON accumulation was higher in grain from plots treated with Headline (4.37 µg/g) than in grain from non-sprayed check plots (3.61 µg/g) (LSD, $P = 0.05$). Grain from plots treated with Prosaro, had the lowest DON (2.68 µg/g) which differed from the Headline and check treatments (LSD, $P = 0.05$). Following soaking, DON concentration declined during the first 30 days by an average (over the two moisture levels) of 24, 34, and 36% in the Headline, check, and Prosaro treatments, respectively. Then over the next 30 days, DON levels increased by an average of 23, 27, and 40% over the 30-day levels in the Headline, check, and Prosaro treatments, respectively. Thereafter, DON levels in all treatments stabilized with slight fluctuations. Averaged over time treatments, DON was slightly higher, similar,

and lower at 20% moisture compared to 16% moisture in the Headline, check, and Prosaro treatments, respectively. However, these differences were not significant at P = 0.05, indicating that grain moisture (16% or 20%) did not have an effect on DON during grain storage for 120 days. There was a consistent trend in DON levels over time in grain from plots treated with Headline, Prosaro, as well as in grain from the non-sprayed checks. The results clearly showed elevated DON (above the non-sprayed check) in the Headline treatment and reduced DON (below the non-sprayed check) in the Prosaro treatment. Overall, DON declined over time from 0 DAS to 120 DAS. However, DON in grain from plots treated with Headline was not different at 0 DAS versus 120 DAS (4.37 ppm vs 4.08 ppn; P = 0.1161) whereas significant differences were detected in DON at 0 DAS versus 120 DAS in grain from plots treated with Prosaro (2.68 ppm vs 2.24 ppm; P = 0.0142) as well as in grain from the non-sprayed checks (3.61 ppm vs 2.98 ppm; P=0.0005). The results from this study indicated that 1) Headline sprayed at anthesis elevated DON in wheat grain and therefore should not be used to control FHB and DON and 2) at a room temperature of 50^{o}F (10^{o}C) and 40% RH, DON decreased over time (120 days) in stored wheat grain from plots treated with Prosaro at anthesis and grain from non-sprayed plots, but not in grain from plots treated with Headline at anthesis.

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INTEGRATED MANAGEMENT OF FUSARIUM HEAD BLIGHT OF WHEAT IN CENTRAL ALABAMA

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ABSTRACT

Fusarium head blight (FHB), caused by *Fusarium graminearum*, is a disease of wheat that has sporadically but substantially impacted Alabama's wheat crop. Moderate epidemics occurred in 2015 and 2016 in the southern third of the state, and varying levels of the disease have occurred in other regions of the state in recent years. In addition to yield reduction, *F. graminearum* produces the mycotoxin deoxynivalenol (DON) which can reduce the price that growers receive for their grain and its value as livestock feed. Fungicide applications to control FHB must be carefully timed to protect the flower since infections occur during this growth stage. However, even with appropriately timed fungicide applications, disease can be severe when weather favors FHB. In addition, while no wheat cultivars have complete resistance to FHB, cultivars do differ in their susceptibility. It is important to understand how the use of differences in susceptibility plus fungicide application can impact FHB and subsequent DON levels. Thus, the objectives of this research were to: 1) evaluate the integrated effects of fungicide and soft red winter wheat cultivar differences FHB and DON in AL; and 2) evaluate late and multiple tebuconazole applications for control of FHB.

In December 2015, a field trial in central Alabama (32.500352, -85.891843) was planted to four wheat cultivars. The cultivars were Jamestown (moderately resistant, medium maturity), Pioneer 26R41 (moderately resistant, late maturity), AGS 2035 (moderately susceptible, medium maturity) and SS 8641 (moderately susceptible, medium maturity). Four blocks of a split-plot arrangement of treatments were included, with cultivars as main plots; sub-plots were fungicide and inoculation treatments. Treatments were: i) non-inoculated, non-treated; ii) inoculated, non-treated; iii) Prosaro® at FS10.51; iv) Prosaro at FS10.51 followed 3 to 5 days later with (fb) Caramba®; v) Caramba at FS10.51 fb Folicur®; and vi) Proline® at FS 10.51 fb Folicur; all treatments were inoculated. A mist irrigation system was placed in the plots and ran at hourly intervals for 10 minutes from 7 p.m. to 10 a.m. from 1 Apr to 12 May. Inoculation consisted of *F. graminearum* infested corn spread on plots at full flag leaf stage. Fungicides were applied on different dates based on cultivars reaching FS 10.51 (early flower), from 10 Apr to 1 May. Approximately 3 weeks after FS 10.51 for each cultivar, 20 heads were collected for determining FHB incidence and severity index. Plots were combined for yield calculations and samples were assayed for DON determination.

Cultivar did not have a significant effect on scab incidence or severity index; however, Jamestown had numerically lower values for both of these variables. SS 8641 and Pioneer 26R41 had higher ($P < 0.01$) DON content than AGS 2035, which also had higher ($P < 0.01$) DON content than Jamestown. Fungicide and inoculation significantly affected incidence and severity index, with both non-treated treatments having higher incidence than the Prosaro fb Caramba or the Proline fb Folicur treatments. The non-treated, inoculated treatment had a significantly ($P < 0.01$) higher FHB severity index than either Prosaro treatment or the Proline fb Folicur. The non-treated, inoculated treatment also had the highest ($P < 0.01$) DON content among treatments; lowest DON levels were found in the Prosaro fb

Caramba and Caramba fb Folicur treatments. Yields and test weights were improved with each of the fungicide treatments compared to the non-treated, inoculated treatment.

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INTEGRATED MANAGEMENT OF FUSARIUM HEAD BLIGHT OF WHEAT IN SOUTH ALABAMA

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ABSTRACT

Severe intensities of Fusarium head blight (FHB), caused by *Fusarium graminearum*, were noted in a wheat variety trial in southern Alabama (30^0 32' 5 N, -87^0 53' 7 W) in spring of 2015. In a nearby trial, with fungicide applications made at FS 10.5 (inflorescence complete), FHB intensities were noted at scores of 4 to 8 on a 0 to 10 scale where 10 = all heads and kernels affected by disease. These results demonstrated that even with fungicide applications aimed at protecting the flower, FHB can be problematic. Thus, in 2016, we sought to evaluate multiple fungicide applications and their effectiveness for managing FHB.

Two cultivars (Jamestown (moderately resistant) and AGS 2035 (moderately susceptible)) were planted in early December 2015 as main plots in a split plot arrangement with fungicide treatments as sub-plots. Four blocks of treatments were established. Fungicide treatments included applications made at FS10.51 or 4 days after FS10.51 (delayed); treatments also included two applications at both of these timings. Fungicides that were evaluated were Prosaro® (at FS10.51 and delayed), Prosaro (FS10.51) followed by Caramba® (delayed), Caramba (FS 10.51) followed by Folicur® (delayed), Proline® (FS10.51) followed by Folicur (delayed), Folicur at FS 6, and Folicur at FS6 followed by a delayed Folicur application, as well as a non-treated control treatment. Ten head samples were collected randomly from each plot for determination of Fusarium head blight (FHB) incidence and severity index. Plots were harvested at maturity and test weights determined. Samples were taken from combined samples and assayed for deoxynivalenol (DON) content. Data were subjected to generalized mixed model analysis followed by mean separation using Fisher's (protected) least significant difference (FLSD) with P=0.05.

No measured variables differed due to cultivar; however, Jamestown had a numerically lower FHB incidence, severity index and DON content, and higher yield than AGS 2035. All three fungicide programs that involved two applications during flower reduced FHB severity index ($P < 0.01$) compared to Folicur at FS6 and delayed Prosaro. Two treatments (Prosaro followed by Caramba, and Proline followed by Folicur) had lower FHB severity indices ($P < 0.01$) than the non-treated control. Yields were higher ($P < 0.01$) and DON was lower with the two (FS10.51 and delayed) application fungicide programs than other treatments.

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No. 59-0206-6-008. 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 and do not necessarily reflect the view of the U.S. Department of Agriculture.

EFFECTS OF FUNGICIDE AND FERTILITY ON DISEASE DEVELOPMENT AND YIELD IN WINTER WHEAT

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ABSTRACT

Nitrogen fertilization in winter wheat is increasingly popular, as growers try to increase yields and profitability. However, nitrogen can also contribute to increased disease and lodging. Fungicide and growth regulator products may help mitigate these negative consequences. The objective of this study is to examine the interactions of fungicide, nitrogen, and growth regulators and their effects on disease and ultimately, yield. In 2015 and 2016, field trials were conducted in East Lansing, MI to evaluate leaf disease, Fusarium head blight (FHB), lodging, deoxynivalenol (DON) production, and yield in response to factorial combinations of the fungicides Stratego YLD® (Feekes 6) and Prosaro® (Feekes 10.5.1), and growth regulator Palisade (Feekes 6) under low (90 lbs N/A at green up) or high (additional 50 lbs N/A at Feekes 6) fertilization. In 2015, the highest yielding treatments were the low nitrogen treatments containing Prosaro, which were significantly higher than all of the high fertility treatments except those with both Stratego YLD and Prosaro. DON levels were greatest in the high fertility Feekes 6 application of Stratego YLD. Low nitrogen fertility treatments with Prosaro had the lowest DON values, and FHB disease index ratings followed the same trends. In 2016, there was very little FHB disease development due to dry conditions during flowering. No visible symptoms were apparent across plots, so no disease severity or incidence was measured. *Fusarium* damaged kernels (FDK) were assessed, but no significant differences were found. DON levels were extremely low across all treatments; all but two samples tested negative (below the detectable limit of 0.05 ppm). However, stripe rust (*Puccinia striiformis*) pressure was extremely high in 2016, which could explain the differences in yields compared to 2015. The highest yielding treatment was high nitrogen with both a Stratego YLD and Prosaro application, however this was not significantly different than the five treatments containing either one or both of Stratego YLD or Prosaro. This suggests the early Stratego YLD application can be important in protecting against reduced yield from stripe rust, but perhaps high nitrogen with Prosaro can also compensate for that loss of yield from stripe rust.

ACKNOWLEDGEMENT AND DISCLAIMER

This study is supported by funding from the Michigan Wheat Program. We thank Gary Zehr, Lee Siler and Eric Olson for assistance with planting and harvesting.

FUNGICIDE TIMING AND VARIETY RESISTANCE TO MANAGE FUSARIUM HEAD BLIGHT IN MID-ATLANTIC WINTER BARLEY CROPS

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ABSTRACT

The mycotoxins resulting from barley Fusarium head blight (FHB) can render grain unsuitable for human or animal consumption, and there is a zero tolerance for deoxynivalenol (DON) in malting barley. At the same time, interest in barley production has increased in the mid-Atlantic U.S. because of the upsurge in craft malt and the demand for local grain. A three-year field experiment is underway to help mid-Atlantic barley producers select FHB-resistant varieties, judge the potential benefit from a fungicide, and choose the optimal timing for a fungicide application should FHB threaten. The split-plot experiment is taking place in a misted, inoculated nursery in Raleigh, NC, using main plots of three commonly planted six-row barley cultivars (Atlantic, Nomini, and Thoroughbred) and one two-row cultivar (Endeavor). Both Endeavor and Thoroughbred are used for malting. As sub-plots, three fungicide treatments are applied: Prosaro® at 100% spike emergence, Prosaro 6 days later, or no fungicide.

So far, two years of data have been obtained. FHB intensity was higher in 2015 than in 2016, with the mean levels of DON in the two years being 4.5 ppm and 1.5 ppm, respectively. There was no difference in DON for treatment*variety; i.e., the relative efficacy of fungicide timings did not depend on the variety to which they were applied. Spray efficacy in reducing DON did depend on year, however. In 2015, the higher-scab year, the two spray timings resulted in the same amount of DON (3.7 vs. 4.0 ppm for early and late, $P = 0.74$), and both produced less DON ($P \leq 0.0005$) than the unsprayed check (5.8 ppm). In 2016, the lower-scab year, neither spray timing was significantly less DON than the unsprayed check (1.6 vs 1.1 for early vs. late, and 1.9 for unsprayed; $P \geq 0.14$). The year*variety interaction for DON was significant ($P = 0.005$), although varieties maintained the same ranks by DON level in both years, with Endeavor consistently the lowest and Atlantic consistently the highest for DON. In 2015, the higher-scab year, Endeavor and Thoroughbred had the lowest DON, while Nomini was significantly higher and Atlantic was the highest, averaging across fungicide timings. In 2016, the lower-scab year, DON levels did not differ among varieties when averaged across fungicide treatments.

There was no significant effect of fungicide treatment on test weight in 2015 ($P = 0.44$). In 2016, however, the unsprayed treatment had slightly lower test weight than the mean of the sprayed treatments (47.4 vs. 48.5 lb/bu, respectively, $P = 0.01$).

So far, this experiment has shown that in a high-scab year, applying Prosaro at 100% spike emergence or 6 days later resulted in the same DON levels, and provided an approximately 34% reduction in DON relative to the unsprayed check when averaging across the two fungicide timings. Variety resistance also provided a significant reduction in DON in that year, with the average of the two MR varieties (Endeavor and Thoroughbred) providing a 68% DON reduction when compared to Atlantic (S) and a 56% DON reduction when compared to Nomini (MS). The experiment is being repeated for a third year.

EVALUATION OF INTEGRATED METHODS FOR MANAGING FHB AND DON IN WINTER WHEAT IN NEW YORK IN 2016

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OBJECTIVE

To evaluate the individual and interactive effects of moderately resistant cultivars and application timings and combinations of the fungicides Prosaro® and Caramba® on yield, Fusarium head blight (FHB), and deoxynivalenol (DON) on soft red winter wheat 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 2016, we evaluated the disease and yield impact of cultivar susceptibility, inoculation with *Fusarium graminearum*, and treatment with Prosaro and Caramba fungicides alone or sequentially.

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, 'Erie' (moderately susceptible to Fusarium head blight (FHB)), 'Otsego' (susceptible to FHB), 'Pioneer Brand 25R25' (moderately resistant to FHB), and 'Pioneer Brand 25R46' (moderately resistant to FHB), following soybean harvest on 6 Oct 2015. 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 10 Apr (120 lb/A of urea, providing an additional 55 lb/A of nitrogen). The first Prosaro (6.5 fl. oz./A) or Caramba (17 fl. oz./A) application was at anthesis (Feekes growth stage, FGS 10.51) on 31 May 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 Caramba (17 fl. oz./A) application occurred seven days after anthesis on 7 Jun including the surfactant Induce at 0.125% V/V, and plants were 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 21 Jun and used to calculate FHB Index, where FHB index = (FHB severity * FHB incidence)/100. Foliar diseases were rated on 21 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 12 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 in the mycotoxin analysis laboratory at the University of Minnesota, St. Paul, MN. Treatment means were calculated, subjected to analysis of variance, and separated by Tukey-Kramer HSD test ($P = 0.05$).

RESULTS AND DISCUSSION

The 2016 growing season was the driest in NY in more than 20 years. Severely dry conditions during the season were not conducive for the development of FHB, and incidence was < 1% throughout the trial despite inoculation with *F. graminearum*. In the virtual absence of FHB development, DON measurements were < 0.04 ppm in all plots, regardless of cultivar or treatment. The only significant difference observed in DON results occurred when the results of all treatments were combined and Otsego had significantly higher DON than all other varieties, though only at a very low mean of 0.02 ppm. Therefore, based on the extreme drought conditions of this trial, no strong conclusions or recommendations could be made for FHB and DON management regarding the cultivars or treatments evaluated.

However, there was measurable leaf and stripe rust observed throughout the trial. This was the first significant stripe rust epidemic observed in New York State. Significant responses among cultivars and treatments were observed for both leaf and stripe rust. When the results of all treatments were combined, Otsego had significantly higher leaf rust and Pioneer Brand 25R46 had significantly higher stripe rust than all other cultivars. However, when each of these cultivars were analyzed individually, all three fungicide treatments effectively eliminated both rusts. When the results of all cultivars were combined, all three fungicide treatments were equally effective at significantly reducing both leaf and stripe rusts as compared to non-fungicide treated plots. These results support our recommendations for NY growers to apply triazole fungicides for management of leaf and stripe rust during years of significant rust disease pressure. The results also indicate that although Pioneer Brand 25R46 has been shown in years past to be moderately resistant to FHB, it has notable susceptibility to stripe rust.

Also, despite the drought, we observed measurable Septoria and Stagonospora leaf blotches throughout the trial, though at fairly low levels ranging from 0.1 to 2.5% severity on the flag leaves. When the results of all treatments were combined, Pioneer Brand 25R25 had significantly higher leaf blotch than all other cultivars. When the results of all cultivars were combined, the non-fungicide treated plots had the highest levels of leaf blotches, though not significantly so in all cases. These results indicate that the triazole fungicide treatments evaluated under the conditions of this study may not provide effective control of leaf blotches even at fairly low levels of disease severity.

Surprisingly, the drought resulted in only slightly lower than average yields across the trial. When results of all the cultivars were combined or analyzed separately, none of the treatments had any significant effect on yield. This supports previous research and recommendations that fungicide applications in the absence of significant disease may not be cost effective. On the other hand, when the results of all the treatments were combined, Pioneer Brand 25R25 yielded significantly higher than all other varieties. Pioneer Brand 25R25 is a new release by Pioneer. In previous similar studies, we have found Pioneer Brand 25R46 to yield consistently higher than all other varieties. Perhaps the higher stripe rust susceptibility of Pioneer Brand 25R46 negatively impacted the yield of this variety, and the lack of stripe or leaf rust on Pioneer Brand 25R25 conveyed a yield advantage. These results indicate that cultivar selection for rust resistance may have a larger impact on yield than fungicide applications in the absence of significant FHB disease pressure.

ACKNOWLEDGEMENT AND DISCLAIMER

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Table 1. Main effect of treatment on leaf rust, stripe rust, leaf blotch, deoxynivalenol and grain yield at Aurora, NY in 2016.

Treatment	Leaf rust (%)	Stripe rust (%)	Leaf blotch (%)	DON (ppm)	Yield (Bu/A)
Non-sprayed, non-inoculated control	0.1 b	2.9 ab	0.9 ab	0.01	73.3
Inoculated FGS 10.51, and inoculated 7 days later	0.5 a	4.0 a	1.3 a	0.02	71.3
Prosaro SC (6.5 fl oz) and inoculated FGS 10.51, then inoculated 7 days later	0.0 b	0.0 b	0.8 ab	0.01	73.2
Caramba (17 fl oz) and inoculated FGS 10.51, then inoculated 7 days later	0.0 b	0.0 b	0.5 b	0.01	73.9
Prosaro SC (6.5 fl oz) and inoculated FGS 10.51, then Caramba (17fl oz) and inoculated 7 days later	0.0 b	0.0 b	0.8 ab	0.01	71.3
HSD (*P*=0.05)	0.30	2.99	0.66	NS	NS
CV (%)	339.1	290.7	105.9	100.0	9.9

Table 2. Main effect of cultivar on leaf rust, stripe rust, leaf blotch, deoxynivalenol and grain yield at Aurora, NY in 2016.

Cultivar	Leaf rust (%)	Stripe rust (%)	Leaf blotch (%)	DON (ppm)	Yield (bu/A
Erie	0.1 b	0.1 b	0.4 b	0.01 b	72.3 b
Otsego	0.3 a	0.6 b	0.5 b	0.02 a	68.9 b
Pioneer Brand 25R25	0.1 b	0.1 b	1.6 a	0.01 b	77.8 a
Pioneer Brand 25R46	0.0 b	4.7 a	0.9 b	0.01 b	71.3 b
HSD (*P*=0.05)	0.26	2.43	0.48	0.25	3.69
CV (%)	339.1	290.7	105.9	154.9	9.9

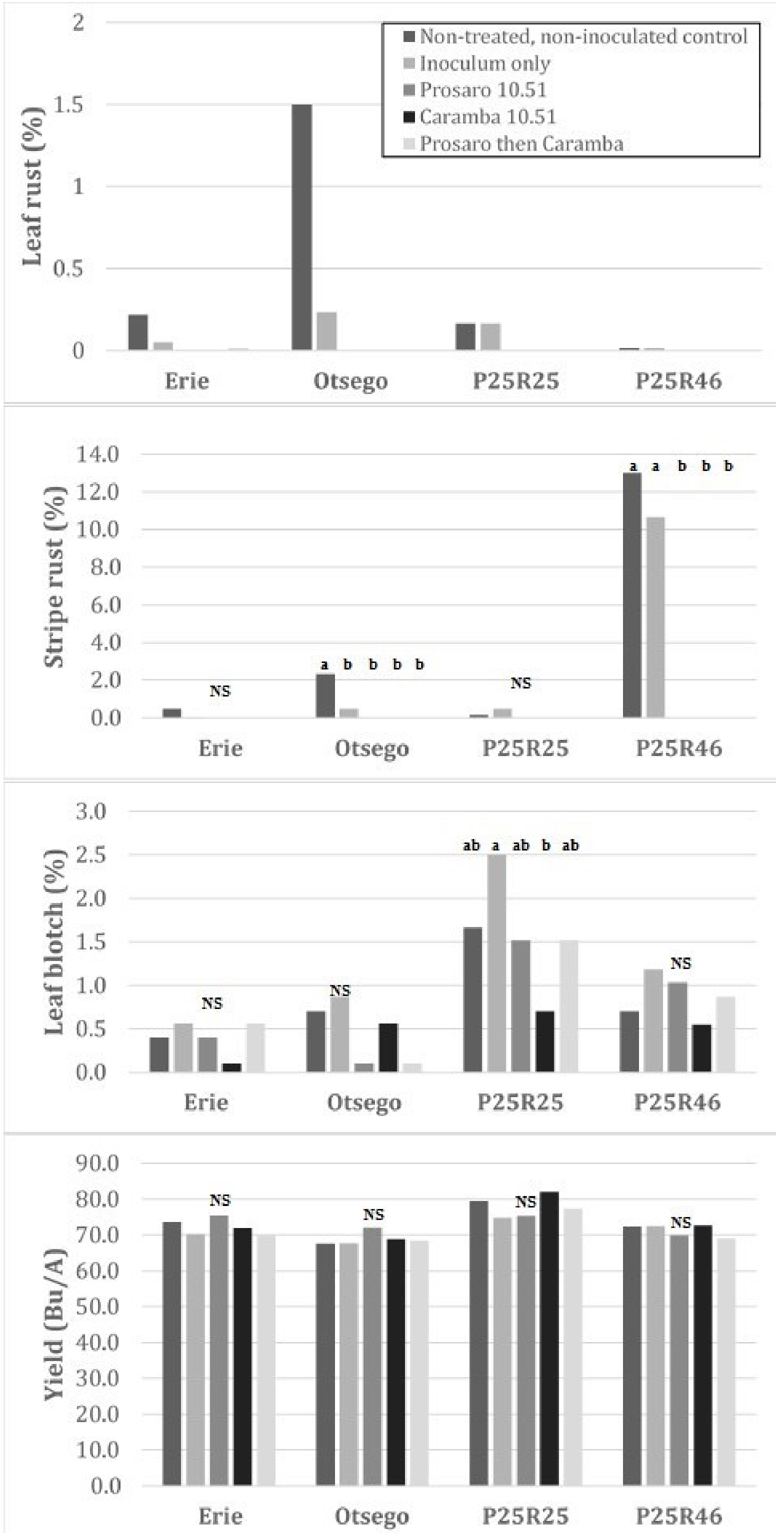

Figure 1. Effect of Prosaro® and Caramba® fungicide applications and *F. graminearum* inoculation on leaf rust, stripe rust, leaf blotches and yield of four winter wheat cultivars in Aurora, NY in 2016.

EVALUATION OF FUNGICIDE APPLICATIONS PLUS CULTIVAR RESISTANCE TO REDUCE FHB AND DON INFECTION OF BARLEY IN NEW ENGLAND

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OBJECTIVE

To evaluate the individual and interactive effects of moderately resistant cultivars and application timings of fungicides on barley yield and the integrated management of Fusarium head blight (FHB) and deoxynivalenol (DON) in Vermont.

INTRODUCTION

Public interest in sourcing local foods has extended into beverages. This had led to a rapid expansion of the northeast malting industry and has given farmers new markets. However these farmers are struggling to produce barley that is not infected with FHB and DON. Hence integrated management strategies are essential for reducing yield and quality losses from FHB. Most of these farmers have experienced significant crop loss from FHB and some farmers have already stopped growing barley. At present few farmers are specifically selecting varieties for resistance to FHB and even fewer are combining host resistance with fungicide applications. The use of a well-timed fungicide is an important management tool when suppressing FHB in barley production. In Vermont during 2016, we observed the disease and yield impact of cultivar susceptibility, inoculation with *Fusarium graminearum*, and treatment with fungicides at two timings.

MATERIALS AND METHODS

The trial was conducted at the Borderview Research Farm in Alburgh, VT in a Benson silt loam soil planted with two spring barley varieties, 'Robust' (susceptible to Fusarium head blight, FHB), 'Conlon' (moderately resistant to FHB) on 19 April 2016. The experiment was set up as a completely randomized block design with a split-plot arrangement, with cultivar as the main plot and the fungicide treatments as subplots, randomized in four replicated blocks. Fungicide treatments are shown in table 1. Main plots were sown with barley at 125 lb/A with a 5 ft wide Great Plains grain drill. Subplots were 5 x 20 ft including 7 rows with 7-in. row spacing. The first fungicide application was at heading (Feekes growth stage, FGS 10.1) on 17 June 2016 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 fungicide application occurred four days after heading on 21 June 2016 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 CO_2 backpack sprayer with paired TJ-60 8003vs nozzles mounted at an angle (30° 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 15 July and used to calculate FHB index, where FHB index = (FHB severity * FHB incidence)/100 (data not shown). Grain was harvested from a 5 x 20 ft area in each subplot using an Almaco plot combine on 27 July 2016. Grain moisture, plot yield, and test weight were recorded. Yield and test weight were adjusted to bu/A at 13.5% moisture. Analysis of deoxynivalenol (DON) content in grain was conducted at the University of Vermont Cereal Grain Testing Laboratory located in Burlington, VT. Treatment means were calculated, subjected to analysis of variance, and separated by Fisher's protected LSD test (P = 0.05).

RESULTS AND DISCUSSION

Weather conditions in Vermont during the 2016 growing season can be characterized as having below average precipitation and above average temperatures. The incidence of *F. graminearum* even with inoculation was less than 1% in all treatments (data not shown).

The impact of supplemental inoculation with *F. graminearum* was determined by comparing the non-inoculated and inoculum only treatment. Overall, inoculation did not significantly impact DON concentrations or yield as compared with the non-inoculated plots (Table 2).

There was no significant cultivar by fungicide treatment interactions for DON or yield. This indicates that under low disease pressure the varieties responded similarly to the fungicide treatments (data not shown).

When results were combined across cultivars, the fungicide treatments did not significantly impact DON concentrations (Table 2). Barley yields did respond differently to the fungicide treatments (Table 2). The Prosaro® SC application at heading had significantly higher yields than all other treatments except the Prosaro SC applied 4 days after heading. A positive yield increase from Prosaro SC application has been shown in previous year's work as well.

Under low disease pressure, there were no significant differences detected in DON concentrations or yield among cultivars (Table 3).

Overall low disease pressure led to lack of treatment differences during the 2016 growing season. This underscores the necessity to conduct these types of experiments over numerous years and environments.

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Table 1. Fungicide treatments, active ingredietns and rates applied.

Fungicide treatments	Company	Fungicide active ingredient	Application rates
Control			Water
Fusarium graminearum			40,000 spores/ml
Prosaro SC®	Bayer CropScience	Prothioconazole + tebuconazole	6.5 fl oz ac^{-1} + Induce at 0.125% V/V
Caramba®	BASF Ag Products	Metconazole	14 fl oz ac^{-1} + Induce at 0.125% V/V
Champ ION^{++}	NuFarm	Copper hydroxide	1.5 lbs ac^{-1}
Actinovate®	novozymes	Streptomyces lydicus WYEC	6 fl oz ac^{-1}
Sonata®	Bayer CropScience	Bacillus Pumllus strain 108	2 qt ac^{-1}

Table 2. Main effect treatment on deoxynivalenol (DON) contamination and grain yield at Alburgh, VT 2016.

Fungicide treatment	**DON**	**Yield**
	ppm	bu ac^{-1}
Non-sprayed, non-inoculated control	0.19	65.7
Inoculated FGS 10.1	0.28	61.4
Actinovate (6 fl oz) at heading	0.23	67.4
Actinovate (6 fl oz) 4 days after heading	0.29	67.3
Caramba (14 fl oz) at heading	0.20	73.1
Caramba (14 fl oz) 4 days after heading	0.35	68.0
ChampION (1.5 lbs) at heading	0.28	65.0
ChampION (1.5lbs) 4 days after heading	0.24	72.0
Prosaro SC (6.5 fl oz) at heading	0.19	82.5
Prosaro SC (6.5 fl oz) 4 days after heading	0.19	78.0
Sonota (2 qt) at heading	0.35	71.6
Sonota (2 qt) 4 days after heading	0.31	67.8
LSD (P=0.05)	NS	9.41

Table 3. Main effect of cultivar on deoxynivalenol (DON) contamination and grain yield at Alburgh, VT 2016.

Cultivar treatment	DON	Yield
	ppm	lbs ac^{-1}
Conlon	0.24	72.3
Robust	0.28	70.2
LSD (P=0.05)	NS	NS

THE USE OF INTEGRATED MANAGEMENT STRATEGIES TO LOWER FUSARIUM HEAD BLIGHT AND DEOXYNIVALENOL IN SPRING BARLEY

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ABSTRACT

Barley is an important crop in North Dakota and in most years Fusarium head blight (FHB) is the most devastating disease. Spring barley integrated FHB management trials were established at five locations in North Dakota: Fargo, Langdon, Carrington, Williston and Prosper. The trials evaluated the effect of fungicide treatment(s) and varietal resistance on the reduction of deoxynivalenol (DON) and protection of yield and test weight. Trials were designed in a randomized complete block with a split-plot arrangement with four replications at all locations. Barley varieties (at least two per location) differing in susceptibility to FHB served as whole plots. Fungicide treatments were the subplots and included prothioconazole+tebuconazole at heading, prothioconazole+tebuconazole at heading + metconazole 4-7 days later, metconazole at heading + tebuconazole 4-7 days later, prothioconazole at heading + tebuconazole 4 days later. Corn spawn served as the inoculum source at Langdon and Williston, ND. *Fusarium* spores were used at Fargo and *Fusarium* infected residue was used at Carrington and Prosper, ND. Inoculum was applied to all treatments except for the non-treated, non-inoculated check. The level of FHB severity was evaluated around the Feekes 11.2 growth stage (soft to mid dough) and DON, yield and test weight were obtained after harvest. Data were analyzed using Proc GLM and means were separated with LSD(P=0.05). Disease did not develop at Williston and Prosper and were excluded in the statistical analysis. Results indicated that, prothioconazole+tebuconazole at heading + metconazole 4-7 days later, had significantly lower DON levels when compared to the non-treated checks and the application of prothioconazole+tebuconazole at full head. Numerically, fungicides that were applied at two different times throughout the heading process had lower DON levels than a single application at full head. DON levels were lower in the resistant varieties when compared to the susceptible varieties. Both yield and test weight were significantly higher for treatments that included a fungicide application when compared to the non-treated inoculated check. Results from this study will help strengthen FHB fungicide recommendations for spring barley production.

ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No.59-0206-4-012. 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.

MONITORING THE SPLASH DISPERSAL OF SPORES OF *FUSARIUM GRAMINEARUM* FROM WHEAT PLANTS USING HIGH SPEED VIDEO

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ABSTRACT

Fusarium graminearum, causal agent of Fusarium Head Blight (FHB), produces macroconidia (asexual spores) and ascospores (sexual spores). Though both spore types may cause disease, they may be dispersed by different mechanisms; macroconidia may be dispersed by rainsplash, and ascospores may be forcibly discharged into the atmosphere from perithecia. Little is known about the dynamics of spore dispersal within and among wheat plants during rain events. We used high speed videos to study the dynamics of rain splash of macroconidia of *F.graminearum* on above-ground surfaces (leaves and spikes) of wheat plants grown under controlled environmental conditions. Different sizes of water droplets containing dye were released from different heights above healthy and infected wheat plants to simulate rainfall. The resulting splash events following impact with different surfaces of wheat plants were monitored with high speed photography, and the splashed droplets were captured on absorptive paper placed at the soil level surface around the treated plants. The splash traces were excised from the absorptive paper and plated on agar medium to confirm spores were associated with the observed dispersal patterns. Resulting knowledge could be used to inform FHB risk models, which may provide additional disease management information to growers of small grains in the U.S.

VARIETY AND FUNGICIDE APPLICATIONS ON FHB AND DON IN DELAWARE: A COLLABORATIVE OUTREACH STUDY

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ABSTRACT

Growers in Delaware and Maryland have been negatively impacted by Fusarium Head Blight (FHB) as recently as 2013. After the 2013 outbreak, it was determined that growers in the region required additional information, experience, and training with the use of moderately resistant (MR) wheat varieties and properly timed, FHB labelled fungicides for suppressing FHB and associated DON. In 2016, an on farm survey was conducted to show growers the value on integrating variety and fungicides for FHB management. A total of 21 fields were assessed 18-21 days after flower for rating visual FHB symptoms. Immediately prior to harvest, wheat heads were randomly collected from all wheat fields and processed for DON. Information on varieties was collected and each variety placed into a resistance category based on misted nursery results from the mid-Atlantic. MR varieties reduced visual symptoms by more than 91% and DON by more than 60% compared to susceptible varieties. Fungicide treatments reduced visual symptoms by 76% and DON by 72%. All MR varieties, even if untreated, had DON levels below 2ppm. DON levels in untreated fields or strips ranged from 2.0 ppm to 8.8 ppm. Growers participating in the studies indicated that the value of this project to them ranged from $30-80 /A and indicated that they will utilize USWBSI supported misted nurseries to help guide wheat variety selection.

DEVELOPING A SMART PHONE APP TO ESTIMATE *FUSARIUM* DAMAGED KERNELS OF WHEAT BASED ON COMPUTER VISION

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ABSTRACT

Fusarium head blight (FHB) is one of the most important diseases of wheat and barley. FHB affects grain yield and quality by reducing grain fill, leading to shriveled and lightweight kernels. Percent *Fusarium*-damaged kernels (FDK) is often estimated as one of the main ways of quantifying the effect of FHB on grain quality. This is commonly done by visually examining the grain and estimating percent damage based on grain color, size, and integrity. This is a time-consuming, inefficient, and often subjective process. In this study, we are developing a smartphone application to mimic the FDK quantification process using computer vision. Percent FDK is estimated by processing captured images and using FDK features such as whitish and reddish-pink discoloration to distinguish between healthy and scabby kernels. Kernels of soft red winter wheat cultivar Hopewell were spread out in a single layer on a black background and clear images were captured using a smartphone camera. Arithmetic algorithms, such as addition and subtraction, were implemented to clear the background of the image, and then edge detection was used to locate and separate each individual kernel from the background. Once the edges were detected, healthy and damaged kernels were counted by the program. To detect and count scabby kernels, histograms of FDK pixels were analyzed and HSV (Hue, Saturation and Value) and RGB (Red, Green and Blue) color spectra were used in combination to distinguish diseased from healthy kernels. The optimum threshold for distinguishing diseased from healthy kernels was determined through maximization of interclass variance. For each sample analyzed using the app, FDK was also visually estimated by counting the number of healthy and diseased kernels. Visual estimates were used as references (true values) against which the accuracy and precision of app estimates were compared based on concordance correlation coefficients. Preliminary results showed a strong concordance between true and app estimates of FDK, with 98.58% precision and 98.28% accuracy. The app successfully identified and distinguished between diseased and healthy kernels of Hopewell, with low false positive and false negative rates. However, when validated on a different set of cultivars, the results varied. It performed better on Cooper and Hopewell than on Malabar and Pioneer 25R47. Research continues to evaluate the app across cultivars and to determine the effects of light and image quality on it performance.

INFLUENCE OF RAINFALL PATTERNS ON DEOXYNIVALENOL ACCUMULATION IN WHEAT AFTER FUSARIUM HEAD BLIGHT SYMPTOM DEVELOPMENT

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ABSTRACT

Although there is often a positive correlation between visual symptoms of Fusarium head blight (FHB) and deoxynivalenol (DON) content in wheat, under certain conditions, DON levels may be higher than one would expect based on visual symptoms. A field experiment was conducted during the 2016 growing season to investigate the effects of intermittent rainfall patterns during the 22-day window between FHB visual symptom development and harvest on DON in wheat grains. The experimental design was a randomized complete block, with a split-plot arrangement of cultivar (moderately resistant and susceptible) as whole-plot, post-FHB symptom development simulated rainfall patterns (six levels) as sub-plot, and inoculum density (5 x 10^4, 1 x 10^5, and 2 x 10^5 spores.mL^{-1}) as sub-sub-plot. The six simulated rainfall treatments were initiated 24 days after visual symptoms developed and consisted of: 1) rainfall every day (Rain_1); 2) rainfall every other day (Rain_2); 3) two days of rainfall following by two days without rainfall (Rain_3); 4) three days of rainfall following by three days without rainfall (Rain_4); 5) four days of rainfall following by five days without rainfall (Rain_5); and 6) check (no supplemental rainfall). The combination of cultivar resistance and inoculation treatment resulted in a range of baseline FHB index levels under which the rainfall treatment effects were evaluated. Mean FHB index was 5.4, 11.4, and 12.8% for the moderately resistant cultivar, and 16.8, 23.2, 28.7% for the susceptible cultivar at low, medium, and high inoculum densities, respectively. As expected, plots with the highest levels of FHB index (high inoculum density) had the highest mean levels of DON, and plots of the moderately resistant cultivar had lower mean index and DON than plots of the susceptible cultivar, averaged across rainfall treatments. Plots that received simulated rain every day had higher mean DON levels than plots subjected to the other rainfall treatments, at all baseline index levels. Rain_3, Rain_4, Rain_5, and Rain_6 consistently resulted in higher mean DON levels than the check (no simulated rainfall) for the moderately resistant cultivar, and Rain_3 and Rain_5 resulted in higher mean DON than Rain_4 and Rain_6. However, Rain_3, Rain_4, Rain_5, and Rain_6 trended to have similar mean DON levels to that of the check for the susceptible at all baseline FHB index levels. Formal analyses will be conducted to quantify the effects of the aforementioned rainfall patterns on 1) FDK, after adjusting for baseline index, as a measure of their effects on grain colonization after visual symptom expression; 2) DON, after adjusting for FDK; and 3) DON-3-Glucoside, after adjusting for DON, as a measure of their effect on DON conjugation.

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EFFECT OF CLEANING AND FUNGICIDE SEED TREATMENT ON STAND ESTABLISHMENT IN SCABBY SEED LOTS IN THE SOUTHERN U.S.

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ABSTRACT

Six scabby wheat seed lots from the 2014-2015 season were either cleaned or not, and were treated with Raxil (0.1 oz/cwt), Stamina (0.8 oz/cwt), Vibrance (0.16 oz/cwt), or left non-treated. Seed were planted in five locations in Louisiana, Mississippi, and Georgia in randomized complete block designs with a total of four replicates per location. Plots were evaluated for stand, tillering, scab severity, and yield, and all four of these parameters varied with cultivar and location. Cleaning seed did not have a significant effect on any of these four parameters. The seed treatment, Stamina, significantly improved stand in two Louisiana locations, and no seed treatments improved stand in the Mississippi location. Fungicides did not have a significant effect on tillering, scab severity, or yield at any measured location. Based on these results, cleaning scabby seed lots may not be economically justifiable. Because of seed unavailability, this study was not repeatable, and more research is needed to confirm these results.

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DEVELOPMENT OF FUSARIUM HEAD BLIGHT IN HARD RED WINTER WHEAT DURING THE 2016 SEASON IN SOUTH DAKOTA

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ABSTRACT

Fusarium head blight (FHB) caused by *Fusarium graminearum* is a major disease of wheat in South Dakota. Infected plants produce chalky shriveled kernels. In addition, F. *graminearum* produces the mycotoxin, deoxynevalenol (DON) that is harmful to livestock and humans. Infection of wheat by *F. graminearum* is promoted by rainfall and warm weather when wheat is at flowering stage. During the 2016 growing season, FHB development was monitored in three hard red winter wheat cultivars with varying resistance to FHB at two locations: South Dakota State University (SDSU) Volga Research Farm and SDSU Northeast Research Farm, South Shore, near Watertown. The cultivars were either treated with Fungicide or not treated. For treated plots, Prosaro® (6.5 fl oz/ac) was applied at flowering using a backpack CO_2 sprayer. A randomized complete block design with a split plot arrangement was used with cultivar as the main plot and fungicide or no fungicide as the subplot. Plots were assessed for FHB 21 days after fungicide application. At harvest, grain yield, thousand kernel weight, *Fusarium* damaged kernels and test weight were determined for each plot. At the Volga location, FHB index was very low (5%). The South Shore location had negligible FHB levels. No significant FHB index differences were observed between fungicide treated and non-treated at both locations and this is attributed to very low FHB pressure. Similarly, no significant grain yield increase was observed between fungicide treated and non-treated. However, grain yield was significantly different between cultivars at the South Shore location with Overland out yielding Wesley and Expedition. Low FHB pressure is attributed to very low rainfall and cooler temperatures when winter wheat was at flowering at both locations. The South Shore location had only 0.24″of rainfall throughout June and the average temperature was 70^{o} F at this location. These results demonstrate the role of weather in the FHB development. There was no benefit of applying a fungicide for managing FHB in winter wheat at the two locations and generally in most of South Dakota for the 2016 winter wheat growing season. Use of resistant cultivars, monitoring conducive weather for FHB, and applying a triazole fungicide at flowering when moderate to high FHB risk is predicted, remain the most effective integrated management of FHB.

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