Utilizing an Integrated Management Strategy for Reducing the Negative Effect of Fusarium Head Blight in 6-row Spring Barley.

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Efforts have been initiated and funded by the U.S. Wheat and Barley Scab Initiative to identify management practices that when used together minimize the negative effects caused by Fusarium head blight (FHB) in small grains. Part of this effort has been an ongoing set of trials in different environments evaluating different small grain classes evaluating management options using this integrated approach.

MATERIALS AND METHODS

In 2011 a study was conducted at the North Dakota State University Langdon Research Extension Center. The study was designed as a randomized complete block with a split split plot arrangement and six replicates. The whole plot factor (WP) was previous crop of either canola or hard red spring wheat (HRSW). The split plot factor (SP) was fungicide treatment; Prosaro fungicide or non-treated. The split split factor (SSP) was six-row type spring barley cultivar with differing levels of resistance to FHB. For the 2011 study six barley cultivars were evaluated including Celebration (Bush Agricultural Resources, Inc.), NDSU Experimental a. (NDSU barley breeding program), NDSU Experimental b. (NDSU), Quest (University of Minnesota), Robust (U. of Minnesota) and Tradition (Bush Ag.) NDSU Experimental a. is about 4-5 inches shorter than Tradition, has similar yield potential, would be well suited for irrigation and possible straight combining, has deoxynivalenol accumulation (DON) similar to Stellar-ND and still has not been ruled out by the brewers as suitable for use in their industry. North Dakota Experimental b. has resistance to DON about 50% greater than Robust, is a little taller but has better resistance to lodging, has less stem breakage and similar yield and test weight potential. The cultivars were selected because they were planted on significant acreages of grower's fields in North Dakota or fit a range of susceptibility to FHB. For the split plot factor Prosaro fungicide + Induce adjuvant (6.5 fl. oz. / acre + .0125% v/v) was applied to half the plots and compared to a non-treated. The previous crops for the WP factor were established in 2010 and were canola and HRSW.

The two previous crop treatments were managed by rotary mowing twice (Fall 2010) the canola after pod establishment and HRSW at milk dough growth stage to reduce the amount of viable seed deposited on the ground and minimize contamination by crop class for the 2011 study. The site was tilled with a spring tooth chisel plow with attached harrows once in the fall 2010. In the spring the area was tilled once with a spring tooth cultivator with attached harrows to incorporate the fertilizer and prepare a seed bed. Nitrogen liquid fertilizer, 28-0-0, was fall and spring applied by broadcast method to achieve a target yield goal of 100 bushel /acre. Seed was planted at 1.25 million pure live seeds per acre, determined by blotter paper germination in vitro. The planted plots were seven rows wide six-inch row spacing and measured 20 feet long. An Almaco double-disk drill was used to seed the plots on 19 May. Border plots were planted between treatment rows to minimize negative effects from spray drift. Prosaro fungicide (421 SC 3.57 lb. /gal. formulation of prothioconazole/tebuconazole, 19% +19% w/w, manufactured by Bayer

CropScience)was applied at Feekes growth stage 10.5 (head fully extended), and is recommended to reduce the effects of FHB in small grains. Fungicide treatments were applied with a CO_2-pressurzed backpack sprayer. The boom was equipped with two Spraying Systems Co. TeeJet XR8001 nozzles mounted on a double swivel. The swivels were spaced on 20-inch centers and oriented to spray 30 degrees downward from horizontal and forward and backward. The spray volume was 18.4 GPA obtained by pressurizing the boom at 40 psi. Twenty days after the fungicide application (soft dough growth stage, Feekes 11.2) 20 heads were removed and evaluated to determine FHB incidence (number of spikes infected) and severity of the infected heads (numbers of FHB infected kernels per head divided by total kernels). FHB index is the summation of the individual head incidence times the severity. The plots were harvested with an Almaco plot combine and the sample processed to determine yield, test weight and plump on the barley. Plots were harvested, 24 Aug. A sub sample of the grain was ground and sent to North Dakota State University Barley Quality Lab to determine the presence of the toxin deoxynivalenol (DON). North Dakota State University Extension recommended production practices for barley for Northeast North Dakota were followed. Data were analyzed with the general linear model (GLM) in SAS. Fischer's protected least significant differences (LSD) were used to compare means at the 5% probability level (Table 1).

RESULTS

Previous Crop

The effect of previous crop was measured for Fusarium head blight severity and index and plump. Fusarium severity and index levels were less than 10% and 10 of possible 100, respectively, Table 2. The previous crop HRSW had smaller disease levels than previous crop canola. In previous studies when previous crop canola had greater levels than HRSW we explained differences due to increased density in the canopy including a microclimate more conducive to the development of FHB. In the 2011 trial this was not likely the cause. The site selected for the 2011 trial had a soil profile that was near saturated with water. Since the canola in 2010 matured earlier than the HRSW, the soil had more time to accumulate soil water. The author feels this additional soil water may be partial cause of the small but significant differences in disease levels. A similar advantage was determined for plump although plumps on both previous crops were excellent. An interaction was also determined for DON for previous crop by cultivar, Table 3. The interaction was mostly a magnitude difference with the DON levels for NDSU Experimental line a have greater DON on previous crop canola compared to previous crop HRSW.

Fungicide Treatment

A single application of Prosaro fungicide at early flowering growth stage reduced both head severity and foliar disease levels, Table 2. Deoxynivalenol accumulation was also reduced by 80% with the application. On average yield was increased by 5.2 bu. / acre and test weight increased by 0.7 lb. /bushel. An interaction was also determined for DON for fungicide treatment by cultivar. Most differences by fungicide treatment were magnitude and not significant, Table 3. However, the application of Prosaro to NDSU Experimental a was very effective in reducing DON from 4 ppm on the untreated to 0.6 ppm after fungicide application.

Cultivar

As is often the case differences exist in the cultivar genetics and this study was not different, Table 2. For visual FHB symptoms Quest and Robust had smaller incidence, severity and index. Celebration and NDSU Experimental b had similar FHB severity to Tradition. Foliar disease levels were not high at the growth stage when means were compared. However NDSU Experimental b. had less disease present than Celebration or NDSU Experimental a. Quest and Tradition were statistically significantly different in foliar disease levels from NDSU Experimental a. The ranking of cultivars for DON was as follows NDSU Experimental a > Robust > Tradition = NDSU Experimental b and Quest = Celebration in this study. Yield differences were as follows: Quest = Tradition = Robust and NDSU Experiment b, both of which were equal to Celebration. Differences were also determined for test weight. Robust had greatest test weight followed by Tradition > Celebration which was equal to the other three cultivars. Plump ranking was as follows; NDSU Experimental a > Celebration > Robust and Experimental b both of which were greater than the last two cultivars.

While performance of barley in general was likely affected by site and the microclimate of the season level of performance was very acceptable and comparison among factors should help producers make future decision on strategies for managing FHB.

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Table 1. Confidence intervals for Fusarium head blight incidence, severity, index, foliar disease, deoxynivalenol accumulation in the seed, yield test weight and plump by source of variation, Langdon 2011.

Source of	Fusarium head blight			Foliar			Test	
Variation	Incidence	Severity	Index	Disease	DON	Yield	Weight	Plump
Rep	0.0221	<0.0001	<0.0001	<0.0001	0.0057	<0.0001	0.0006	0.0609
WP	0.4807	0.0335	0.0381	0.0902	0.0603	0.6038	0.8409	0.0037
Rep*WP	0.0692	0.2484	0.2842	0.0340	0.4825	0.0681	0.0712	0.2581
SP	0.8871	0.0429	0.0634	0.0176	<0.0001	0.0383	<0.0001	0.5534
WP*SP	0.3865	0.3674	0.3659	0.6819	0.0866	0.4345	0.0530	0.4821
Rep*SP(WP)	0.3536	0.0889	0.0529	0.0305	0.1050	<0.0001	0.3011	<0.0001
SSP	<0.0001	<0.0001	<0.0001	0.0448	<0.0001	0.0027	<0.0001	<0.0001
WP*SPP	0.1577	0.9873	0.9534	0.7943	0.0103	0.7606	0.0820	0.2564
SP*SSP	0.1500	0.9663	0.8079	0.9880	<0.0001	0.3030	0.6562	0.2287
WP*SP*SPP	0.6903	0.9576	0.9842	0.9480	0.1120	0.5926	0.2588	0.6387
% C.V.	5.4	18.3	21.0	59.1	47.4	8.6	1.0	0.7

Table 2. Fusarium head blight disease incidence, severity and index, foliar disease, deoxynivalenol accumulation in seed, yield, test weight and plump by previous crop averaged across fungicide treatments and 6-row spring barley cultivars, fungicide treatment averaged across previous crops and 6-row spring barley cultivars and 6-row spring barley cultivars averaged across previous crops and fungicide treatments Langdon, 2011.

	Fusarium head blight			Foliar			Test	
	Incidence	Severity	Index	Disease	DON	Yield	Weight	Plump
	(%)	(%)	(0-100)	(%)	(ppm)	(bu. /acre)	(lb. /bu.)	(%)
Previous Crop								
Canola	97.4	9.8	9.4	23.3	1.0	70.6	46.9	95.9
HRSW	96.4	8.8	8.4	16.7	0.8	71.4	46.8	96.5
LSD $_{(0.05)}$	NS	0.9	0.9	NS	NS	NS	NS	0.3
Fungicide Treatment								
Prosaro	97.0	8.9	8.5	16.0	0.3	73.8	47.2	96.3
Non-treated	96.9	9.7	9.4	24.1	1.5	68.2	46.5	96.1
LSD $_{(0.05)}$	NS	0.8	NS	6.4	0.2	5.2	0.2	NS
Cultivar								
Celebration	98.5	10.1	9.9	24.1	0.4	68.2	46.8	97.1
NDSU Expt. a	98.8	11.1	10.9	25.2	2.3	71.5	46.3	98.1
NDSU Expt. b	98.1	9.7	9.4	16.4	0.6	69.4	46.3	96.2
Quest	93.5	6.9	6.2	18.4	0.6	74.9	46.2	93.3
Robust	92.9	7.3	6.4	18.6	1.0	69.4	48.0	96.2
Tradition	99.8	10.8	10.8	17.4	0.7	72.5	47.4	93.3
LSD $_{(0.05)}$	3.0	1.0	1.1	6.8	0.3	3.5	0.3	0.4

Table 3. Deoxynivalenol accumulation in seed by previous crop and cultivar and fungicide treatment and cultivar, Langdon 2011.

Previous Crop	Cultivar	Deoxynivalenol Accumulation (ppm)	Fungicide Treatment	Cultivar	Deoxynivalenol Accumulation (ppm)
Canola	Celebration	0.4	Prosaro	Celebration	0.2
	NDSU Expt. a	2.7		NDSU Expt. a	0.6
	NDSU Expt. b	0.6		NDSU Expt. b	0.2
	Quest	0.7		Quest	0.2
	Robust	1.0		Robust	0.5
	Tradition	0.6		Tradition	0.3
HRSW	Celebration	0.4	Non-treated	Celebration	0.7
	NDSU Expt. a	1.9		NDSU Expt. a	4.0
	NDSU Expt. b	0.5		NDSU Expt. b	1.0
	Quest	0.6		Quest	1.1
	Robust	0.9		Robust	1.4
	Tradition	0.8		Tradition	1.0
$LSD_{(0.05)}$		0.36 or 0.59			0.36 or 0.39

To compare a_0c_0 vs. a_0c_1 LSD = 0.36 and to compare a_0c_0 vs. a_1c_0 LSD = 0.59 for previous crop by cultivar.
To compare b_0c_0 vs. b_0c_1 LSD = 0.36 and to compare a_0c_0 vs. b_1c_0 for fungicide treatment by cultivar.