Crop Rotation, Prosaro Fungicide and Cultivar as Management Tools to Control Disease on Durum Wheat, Langdon, 2011

Halley, S.*, Crop Protection Scientist and Arens, A., Research Technician.

Corresponding author* North Dakota State University-Langdon Research Extension Center Langdon, ND 58249. PH: (701) 256-2582, E-mail: Scott.Halley@ndsu.edu.

Efforts have been initiated and funded by the U.S. Wheat and Barley Scab Initiative to communicate some of the research progress made in developing and identifying strategies that will reduce or minimize the negative effect on small grains from the disease Fusarium head blight (FHB) or head scab. One of these efforts is reported here that compares using crop rotation, a foliar fungicide treatment and durum cultivar resistance or tolerance to FHB. The study utilized a common regional crop rotation, durum after canola, as a comparison to a small grain rotation, durum after hard red spring wheat. The theory behind this is that the quantity of inoculum would be reduced when the previous crop was not susceptible to FHB. The second strategy researched was an application of Prosaro fungicide timed at Feekes growth stage 10.51 (anthesis) to minimize the effects of FHB. The third strategy researched was the selection of a durum cultivar with less susceptibility to FHB.

MATERIALS AND METHODS

These studies were initiated in 2010 by planting randomized strips of hard red spring wheat (HRSW) and canola in six replicates and data collected in 2011 at the North Dakota State University Langdon Research Extension Center. The trial design was a randomized complete block with a split split plot arrangement. Whole plot factor (WP) was previous crop of canola or HRSW, split plot factor (SP) was Prosaro fungicide applied at anthesis or non-treated and split split plot factor was one of six durum cultivars with different levels of resistance to FHB. In 2011 six durum cultivars, DG Star, Dilse, Divide, Grenora, Lebsock and Monroe, were planted at seeding rate of 1.5 million pls $acre^{-1}$ determined by blotter paper germination in vitro. Durum is very susceptible to FHB. The cultivar Divide would have slightly greater tolerance than the other cultivars. All the cultivars are from the North Dakota State University durum breeding program except DG Star which is from the Dakota Growers Pasta breeding program. 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, respectively, not enough data, moderately susceptible (MS), moderately resistant, MS, MS and very susceptible. 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.

Liquid nitrogen fertilizer (28-0-0) was fall applied by broadcast method at rate to achieve a yield goal of 60 bu./acre. 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 prepare a seed bed. An Almaco double-disk drill was used to seed the plots on 19 May. The plots were seven rows wide six-inch row spacing and measured 20 feet long. A border plot was seeded between each block to minimize the negative effects of spray drift. A solution of Prosaro fungicide and Induce adjuvant (Helena Chemical Co.) was applied at rate of 6.5 fl. oz. /acre and 0.125%v/v. Prosaro fungicide (421 SC 3.57 lb./gal. formulation of prothioconazole/tebuconazole, 19% +19% w/w, manufactured by Bayer CropScience), applied at Feekes growth stage 10.51, is recommended to reduce the effects of FHB in small grains. Fungicide treatments were applied 18 July at 8:15 a.m. with a CO_2-pressurized backpack sprayer (no wind and air temperature 75°F). 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 on a six-nozzle boom 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(number of FHB infected kernels per head divided by total kernels). FHB index is the summation of the incidence times the severity. Ten leaves were also sampled at this time and the necrotic area on the leaf determined visually. The plots were harvested with an Almaco plot combine, 24 Aug and the sample processed to determine yield and test weight. A sub sample of the grain was ground and sent to North Dakota State University NDSU Veterinary Diagnostic lab to determine the accumulation of the toxin deoxynivalenol (DON) in the seed. North Dakota State University Extension recommended production practices for durum wheat for Northeast North Dakota were followed. After the plots were harvested. Data was analyzed with the general linear model (GLM) in SAS. Fisher's protected least significant differences (LSD) were used to compare means at the 5% probability level (Table 1).

RESULTS

Previous Crop

The only differences determined for previous crop was an increase in yield and seed weight for durum planted on HRSW previous crop, Table 2. An interaction for previous crop by cultivar for yield was also determined, Table 4. Yield of DG Star increased almost 11 bu. when planting on HRSW previous crop. Only Grenora yield was not increased by planting on HRSW previous crop. Test weight also had interaction for previous crop by cultivar with cultivar Dilse's test weight negatively affected by planting into previous crop HRSW. These results contrast reports from previous similar studies conducted at Langdon where planting on canola previous crop had a positive effect. 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 significant differences in yield and seed weights between the two previous crop systems.

Fungicide Treatment

The application of Prosaro fungicide positively affected all the measured parameters except for Fusarium damaged kernels (FDK), Table 2. As one would expect, fungicide treatment provided measurable control of FHB and reduced incidence, severity and index. Foliar disease was also reduced by fungicide treatment and overall deoxynivalenol accumulation in the seed (DON) was reduced by two-thirds. An interaction was determined for DON for fungicide treatment by cultivar, Table 3. All cultivars not treated with fungicide had greater DON. The most severely affected cultivars were Monroe > Lebsock = Grenora = Dilse > DG Star and Divide. This may be one of the first reported comparisons indicating DG Star = to Divide in DON accumulation. Yield was increased by almost eight bushels and both test weight and seed weight significantly increased, Table 2. Perhaps the only disappointment by the fungicide treatment is that the DON levels were still great enough that a price discount may still be applied by the grain buyer.

Cultivar

Differences were determined among cultivars for all parameter except FHB incidence, Table 2. As previously reported Monroe was the most susceptible cultivar and the same as DG Star for FHB severity. All other cultivars had less FHB severity than Monroe. Monroe had slightly greater FHB index than all other cultivars. Dilse had less susceptibility than DG Star determined by FHB index. In contrast Grenora had greatest FDK compared to all other cultivars except Dilse. Divide had less FDK than all cultivars except DG Star. Grenora was the least effected cultivar when measuring foliar disease severity. The DON levels were smallest in DG Star and Divide and greatest in Monroe followed by Dilse. DG Star cultivar yield the greatest and Dilse the least. Test weight was greatest on Lebsock > Monroe and DG Star > Divide > Grenora > Dilse. DG Star and Monroe seed weight > Grenora = Lebsock > Dilse = Divide. A three way interaction occurred for seed weight (previous crop * fungicide treatment * cultivar), Table 4. Seed weight for DG Star, Grenora, Lebsock and Monroe were the same when treated with fungicide and planted on previous crop canola. When no fungicide was applied to previous crop canola all cultivars except DG Star had reduced seed weight. DG Star and Monroe had greater seed weight when treated with Prosaro and planted on previous crop HRSW compared to previous crop canola. In contrast Grenora, Dilse, Divide and Lebsock were not different compared to the previous crop canola Prosaro treated. Divide cultivar had smaller seed weight when not treated with fungicide and planted on previous crop HRSW.

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

Source of	Fusarium head blight				Foliar			Test	Seed
Variation	Incidence	Severity	Index	FDK	Disease	DON	Yield	Weight	Weight
Rep	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0148	<0.0001	<0.0001	0.0283
WP	0.4515	0.2027	0.2571	0.3742	0.1918	0.6311	0.0004	0.2417	0.0030
Rep*WP	0.0322	0.0014	<0.0001	0.8515	0.0004	0.0261	0.5484	0.0201	0.2207
SP	0.0013	<0.0001	<0.0001	0.1552	0.0140	<0.0001	0.0003	0.0012	<0.0001
WP*SP	0.7199	0.9243	0.7690	0.6437	0.3385	0.8262	0.6094	0.9074	0.5823
Rep*SP(WP)	0.0051	0.3780	0.1142	0.6355	<0.0001	0.0046	0.0003	<0.0001	0.1770
SSP	0.1899	0.0003	0.0003	0.0004	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
WP*SPP	0.3094	0.0817	0.0627	0.5023	0.6140	0.2495	0.0220	0.0428	0.3662
SP*SSP	0.2461	0.1231	0.1375	0.2951	0.3819	<0.0001	0.5469	0.1078	0.2294
WP*SP*SPP	0.8545	0.3708	0.5148	0.5968	0.1802	0.2647	0.8410	0.3552	0.0071
% C.V.	11.3	26.6	38.0	63.3	33.7	34.9	10.7	0.9	3.2

Table 2. Fusarium head blight disease incidence, severity, index and Fusarium damaged kernels (FDK), foliar disease, deoxynivalenol accumulation in seed (DON), yield, test weight and seed weight by previous crop averaged across fungicide treatments and durum cultivars, fungicide treatment averaged across previous crops and durum cultivars and durum cultivars averaged across previous crops and fungicide treatments Langdon, 2011.

	Fusarium head blight				Foliar			Test	Seed
	Incidence	Severity	Index	FDK	Disease	DON	Yield	Weight	Weight
	(%)	(%)	(0-100)	(g/100)	(%)	(ppm)	(bu. /acre)	(lb. /bu.)	(g/1000)
Previous Crop									
Canola	86.8	17.9	14.8	3.6	39.3	1.9	39.6	61.2	42.0
HRSW	84.7	15.7	12.1	3.3	32.5	2.0	45.2	61.0	43.5
$LSD_{(0.05)}$	NS	NS	NS	NS	NS	NS	1.8	NS	0.7
Fungicide Treatment									
Prosaro	79.8	13.8	9.6	3.2	29.3	1.0	46.3	61.6	43.9
Non-treated	91.7	19.8	17.2	3.7	42.4	3.0	38.4	60.5	41.6
$LSD_{(0.05)}$	5.9	1.7	2.4	NS	9.8	0.4	3.2	0.6	0.6
Cultivar									
DG Star	85.9	17.5	14.1	2.5	39.7	1.1	46.2	61.6	44.7
Dilse	82.1	14.7	10.9	3.8	35.3	2.5	38.1	59.8	41.0
Divide	85.7	15.4	12.1	2.2	37.8	1.1	41.2	60.7	40.9
Grenora	85.6	16.6	13.2	5.0	23.3	2.1	43.0	60.3	43.2
Lebsock	85.4	16.1	12.8	3.7	39.1	1.9	42.3	62.3	42.6
Monroe	89.7	20.6	17.7	3.6	40.2	3.2	43.4	61.7	44.3
$LSD_{(0.05)}$	NS	2.6	2.9	1.3	6.9	0.4	2.6	0.3	0.8

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

Previous Crop	Cultivar	Yield	Test Weight	Fungicide Treatment	Cultivar	Deoxynivalenol Accumulation (ppm)
Canola	DG Star	40.8	61.6	Prosaro	DG Star	0.5
	Dilse	35.4	60.2		Dilse	1.6
	Divide	38.9	60.8		Divide	0.5
	Grenora	42.4	60.5		Grenora	1.0
	Lebsock	39.2	62.3		Lebsock	0.8
	Monroe	40.6	61.7		Monroe	1.5
HRSW	DG Star	51.6	61.6	Non-treated	DG Star	1.7
	Dilse	40.8	59.4		Dilse	3.5
	Divide	43.6	60.7		Divide	1.6
	Grenora	43.6	60.1		Grenora	3.2
	Lebsock	45.4	62.3		Lebsock	3.0
	Monroe	46.2	61.7		Monroe	4.9
$LSD_{(0.05)}$		3.7 or 3.8	0.5 or 0.6			0.6 or 0.7

To compare a_0c_0 vs. a_0c_1 LSD = 3.69 and to compare a_0c_0 vs. a_1c_0 LSD = 3.78 for previous crop by cultivar for yield.

To compare a_0c_0 vs. a_0c_1 LSD = 0.45 and to compare a_0c_0 vs. a_1c_0 LSD = 0.57 for previous crop by cultivar for test weight.

To compare b_0c_0 vs. b_0c_1 LSD = 0.56 and to compare a_0c_0 vs. b_1c_0 LSD = 0.66 for fungicide treatment by cultivar for deoxynivalenol accumulation.

Table 4. Durum seed weight by previous crop, fungicide treatment and cultivar, Langdon 2011

Previous Crop	Fungicide Treatment	Cultivar	Seed Weight (g/1000)
Canola	Prosaro	DG Star	44.5
		Dilse	41.1
		Divide	41.5
		Grenora	44.1
		Lebsock	43.4
		Monroe	44.1
	Non-treated	DG Star	43.0
		Dilse	38.7
		Divide	39.6
		Grenora	41.4
		Lebsock	40.5
		Monroe	42.7
HRSW	Prosaro	DG Star	47.4
		Dilse	42.0
		Divide	42.4
		Grenora	44.8
		Lebsock	44.4
		Monroe	47.3
	Non-treated	DG Star	43.6
		Dilse	42.2
		Divide	40.0
		Grenora	42.7
		Lebsock	42.1
		Monroe	42.9
$LSD_{(0.05)}$			1.6 , 1.7 or 1.3

To compare $a_0b_0c_0$ vs. $a_0b_0c_2$ LSD = 1.6; to compare $a_0b_0c_0$ vs. $a_0b_1c_0$ LSD = 1.7; and to compare $a_0b_0c_0$ vs. $a_1b_0c_1$ LSD = 1.3.