Report: 2012 Uniform FHB Integrated Management Trials

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OBJECTIVE. To evaluate the integrated effects of fungicide and genetic resistance on FHB and DON in small grain crops in different environments.

INTRODUCTION. From 2009 to 2011, coordinated, uniform trials were conducted in multiple states to evaluate the effects of grain class, crop rotation, cultivar resistance, and fungicide application on management of FHB and DON. Results from over 40 wheat trials demonstrated using fungicide or moderate resistance alone resulted in approximately 53 and 54% control in FHB index, respectively; and 39 and 51% control in DON, respectively. Combining moderate resistance (in hexaploid wheat) and fungicide resulted in 76 and 71% control of index and DON; furthermore, the efficacy of this integrated approach was stable across different environments and cropping systems. However, more research is required to evaluate these effects under higher disease pressure and in other small grain classes such as barley and durum wheat. In a given year of this coordinated effort, 20 to 54% of trials were eliminated from analysis due to little to no FHB and/or DON in the susceptible, untreated check, as low disease in the reference makes calculating the effects of treatment impossible. This report summarizes results from trials conducted during the 2012 season, including trials with the factor of artificial inoculum, which was hypothesized to increase the amount of "useable" data (that is, trials with significant disease in the check).

MATERIALS AND METHODS. Trials were established in fields following a host or non-host crop of *F. graminearum*. At least three commercial small grain cultivars, classified as susceptible (S), moderately susceptible (MS) or moderately resistant (MR), were planted in three to six replicate blocks in each trial. The standard experimental design was a randomized complete block, with a split-split-plot arrangement of cultivar (whole-plot), inoculation (sub-plot) and fungicide treatment (sub-sub-plot; UT, untreated and TR, treated). Some trials used fungicide as whole-plot and cultivar as sub-sub-plot; while others did not include inoculation as a factor. Fungicide (Prosaro, 6.5 fl. oz/A + NIS) was applied at anthesis, using CO_2 powered sprayers, equipped with Twinjet XR8002 or paired XR8001 nozzles, mounted at a 30 or 60^o angle, forward or backward. For trials with artificial inoculations, either *F. graminearum*-colonized corn kernels were spread on the soil surface of plots prior to anthesis or plots were spray-inoculated with a spore suspension of the fungus approximately 24 hours following fungicide treatments. FHB index (plot severity) was assessed during the dough stages of grain development. Milled grain samples were sent to a USWBSI-supported laboratory for toxin analysis. Proc GLIMMIX of SAS was used to evaluate the effects of fungicide, cultivar, (and inoculation, when appropriate) and their interactions on index and DON (assuming a significance level $\alpha = 0.05$). Percent control was calculated to compare the effect of cultivar resistance and fungicide treatment combinations (S_TR, MS_UT, MS_TR, MR_UT and MR_TR) on index and DON to the susceptible, untreated check (S_UT).

RESULTS AND DISCUSSION. At the time of this summary, data were collected from 22 trials, conducted in 7 states (IL, IN, MO, ND, NY, OH and SD) (Table 1). These included 9 soft red winter wheat (SRWW), 4 hard red winter wheat (HRWW), 4 six-row barley, 3 hard red spring wheat (HRSW) and 2 two-row barley trials. FHB index and DON accumulation varied among locations and grain classes (Table 1). Overall, mean FHB was 0% in many locations (environments 1, 2, 3, 7, 8, 9, 10 and 11), and as a result, DON accumulation was also low or samples were simply not sent for toxin analysis (Table 1). Only environments with > 5% mean index (4, 5, 6, 12, 13, 21 and 22) and/or >1 ppm mean DON (4, 5 and 6) in the susceptible, untreated check were included in this analysis (Table 1). Means for cultivar resistance class x fungicide treatment combinations and percent control of index and DON, relative to the untreated susceptible check (S_UT), are found in Table 2.

Illinois. Six soft red winter wheat cultivars were planted into host residues in two trials that included artificial inoculation as a factor. Despite the presence of FHB in both trials, DON levels were well below 1 ppm perhaps due to rapid grain maturation and relatively early harvest in 2012. **Monmouth (ENV 21).** Index, DON and yield observations ranged from 0 to 100%; 0 to 0.2 ppm and 75.7 to 106.7 bu/A, respectively. Neither cultivar, fungicide treatment (Table 3) nor inoculation (data not shown) had significant effects on index. In this environment the MS_TR combination resulted in the greatest control in index (97%), followed by MS_UT and MR_TR (both approximately 70%, Table 2). **Urbana (ENV 22).** Index, DON and yield observations ranged from 0 to 18%; 0 to 0.4 ppm and 52.8 to 94.4 bu/A, respectively. Both cultivar and fungicide had significant effects on index and DON (Table 3). Inoculation did not have a significant effect on either response (data not shown). All management combinations resulted in <3% FHB index and reduced index by over 60% compared to the S_UT check (Table 2)

Missouri. Five soft red winter wheat cultivars were planted into host and non-host crop residues near Columbia, MO. These two trials relied on ambient inoculum. Overall, mean FHB index, DON and yield were greater in the non-host (soybean) environment compared to that of the trial planted following corn, despite the same planting and treatment dates. **Host residues (ENV 4).** Index, DON and yield observations ranged from 6.7 to 32%; 0 to 4 ppm and 45.7 to 90.0 bu/A, respectively. Both cultivar and fungicide treatment had significant effects on index and DON (Table 3). Generally, index and DON decreased with improved resistance and fungicide treatment application, however, S_TR showed improved DON control compared to MS_UT (Table 2). The MR_TR combination resulted in the greatest control in index and DON (57 and 89%, respectively) compared to the S_UT check. **Non-host residues (ENV 5).** Index, DON and yield observations ranged from 7.3 to 39.1%; 0 to 12.5 ppm and 52.2 to 95.5 bu/A, respectively. The cultivar x fungicide interaction had significant effects on DON only (Table 3). Similar to the host residue environment, S_TR showed improved DON control compared to MS_UT and MR_TR had the greatest DON control (89%, Table 2). Both cultivar and fungicide treatment had significant effects on index (Table 3). Mean index decreased with improved resistance level and treatment. MR_TR resulted in the greatest control of index (66%, Table 2).

North Dakota **(ENV 6).** Six hard red winter wheat cultivars were planted into non-host residue near Carrington, ND. This trial was inoculated with colonized corn spawn followed by supplemental misting. Index and DON observations ranged from 0.05 to 62% and 2.1 to 14.9 ppm, respectively. Yield data were not available for this environment. Cultivar and fungicide factors each had significant effects on index and DON (Table 3). Within each resistance class, fungicide treatment increased control of both index and DON, with MR_TR resulting in approximately 95 and 55% control of index and DON, respectively (Table 2).

South Dakota. Three trials, with three small grain cultivars each, were planted near Volga, SD. **HRSW (ENV 12).** This trial was established in non-host residue and was not artificially inoculated. Index, DON and yield observations ranged from 0 to 21.9%; 0 to 0.8 ppm and 34.9 to 55 bu/A, respectively. Only cultivar had significant effects on index (Table 3) and only the MR cultivar had significantly less index than that of S or MS cultivars (data not shown). The MR_TR combination had the greatest control of index (59%) compared to the S_UT. **6-Row Barley (ENV 13).** This trial was also established in non-host residue and was not artificially inoculated. An MS cultivar was not included in this trial. Index, DON and yield observations ranged from 8.6 to 17.9%; 0 to 1.2 ppm and 32 to 69.2 bu/A, respectively. Neither cultivar nor treatment had significant effects on index in this trial (Table 3). In general, the MR cultivar only provided between 4-5% control of index compared to the S_UT (Table 2). **HRWW (ENV 14).** This trial was established in host residue and artificial inoculation with colonized corn spawn was included as a third factor. Index, DON and yield observations ranged from 0 to 50%; 0 to 1.1 ppm and 36.2 to 61.6 bu/A, respectively. While the S_UT had index <5% and DON <1 ppm, the overall trial means exceeded these values, which is why this trial was included in the analysis. Neither cultivar nor treatment had significant effects on index in this trial (Table 3). Inoculation also did not have a significant effect on index ($F = 0.16$, $P = 0.69$; data not shown). Interestingly, the S cultivar had the lowest levels of mean index and DON out of all resistance classes. This may be explained, in part, by differences in flowering date among the cultivars. Reportedly, rain events occurred during flowering of the MS and MR cultivars, but the S cultivar may have “escaped”, reaching peak flowering during a dry period.

CONCLUSIONS. In most trials, the use of an MR cultivar reduced both index and DON, relative to the untreated, susceptible check. The effect of fungicide was slightly more variable across trials, potentially due to interactions between fungicide efficacy and environmental conditions. In general, fungicide application increased percent control of index and DON within each resistance category. However, there were some exceptions to this, observed within the MS cultivar this year. Most frequently, the combination of MR_TR resulted in the greatest level of control across trials. The degree of this control was dependent on each environment's unique cultivars and cropping system. Several trials incorporated artificial inoculations this year in an effort to provide more useable data (>5% index and >1 ppm DON in the S_UT); however, unless supplemental misting accompanied inoculations (as done in corn spawn-inoculated trials), the dry conditions prevalent in many small grain growing regions this year likely thwarted potential infections and disease development.

Table 1. Study descriptions, trial-wide mean index, DON and yield (across all treatments and reps) and mean index and DON for the susceptible, untreated (S_UT) check from 22 coordinated integrated management trials (ENV, environments) in 2012.

					Trial-wide means			**S_UT Check**	
			PREVIOUS		**Index**	**DON**	**Yield**	**Index**	**DON**
ENV	**LOCATION**	**CLASS**	**CROP**	**INOC?**	**%**	**ppm**	**bu/A**	**%**	**ppm**
1	IN	SRWW	host	Y	0.00	.	62.40	0.00	.
2	Aurora, NY	SRWW	host	Y	0.00	0.06	93.08	0.00	0.06
3	Aurora, NY	SRWW	non-host	Y	0.00	0.02	125.83	0.00	0.04
4	Bradford, MO	SRWW	host	N	13.62	1.25	66.98	24.27	3.07
5	Bradford, MO	SRWW	non-host	N	16.71	2.85	75.05	32.40	9.45
6	Carrington, ND	HRWW	non-host	Y	8.61	7.17	.	23.85	10.00
7	Forman, ND	HRWW	host	N	0.00	0.00	75.72	0.00	0.00
8	Forman, ND	HRSW	non-host	N	0.00	0.00	63.89	0.00	0.00
9	Prosper, ND	HRWW	host	N	0.00	0.00	79.06	0.00	0.00
10	Finley, ND	HRSW	non-host	N	0.00	0.00	71.71	0.00	0.00
11	Finley, ND	6rowBARLEY	non-host	N	0.00	0.05	67.56	0.00	0.05
12	Volga, SD	HRSW	non-host	N	11.48	0.12	46.72	17.75	0.12
13	Volga, SD	6rowBARLEY	non-host	N	12.87	0.51	44.95	12.96	0.51
14	Volga, SD	HRWW	host	Y	6.40	0.09	50.64	3.31	0.09
15	Wooster, OH	SRWW	non-host	Y	2.34	0.11	93.45	4.24	0.21
16	Fargo, ND	2rowBARLEY	host	N	0.389	.	41.87	0.54	.
17	Fargo, ND	2rowBARLEY	non-host	N	0.184	.	17.95	0.18	.
18	Fargo, ND	6rowBARLEY	non-host	N	0.229	.	20.58	0.39	.
19	Fargo, ND	6rowBARLEY	host	N	0.159	.	49.32	0.24	.
20	Dixon Springs, IL	SRWW	host	Y	4.64	0.04	51.41	4.06	0.15
21	Monmouth, IL	SRWW	host	Y	17	0.02	88.46	39.11	0.08
22	Urbana, IL	SRWW	host	Y	11.96	0.06	74.81	34.48	0.18

Table 2. Mean FHB index and DON and percent control for each management combination, relative to the untreated, susceptible check (from trials (ENV) with >5% index and/or >1 ppm DON in the check).

		Resistance x Treatment Combination*						% Control Compared to S_UT				
Response	**ENV**	**S_UT**	**S_TR**	**MS_UT**	**MS_TR**	**MR_UT**	**MR_TR**	**S_TR**	**MS_UT**	**MS_TR**	**MR_UT**	**MR_TR**
Index (%)	4	24.27	19.47	14.32	12.65	11.33	10.49	19.79	41.01	47.88	53.33	56.76
	5	32.40	26.78	19.52	16.70	12.80	11.08	17.34	39.76	48.46	60.49	65.79
	6	23.85	5.54	9.14	2.73	9.40	1.01	76.78	61.68	88.57	60.59	95.75
	12	17.75	11.13	11.86	12.48	8.40	7.28	37.28	33.16	29.68	52.68	59.00
	13	12.96	13.29	.	.	12.35	12.40	-2.51	.	.	4.69	4.35
	14	3.31	3.50	5.83	11.25	10.42	4.08	-5.74	-76.23	-239.88	-214.70	-23.36
	21	39.11	27.19	11.25	1.25	19.35	11.95	30.48	71.23	96.80	50.53	69.44
	22	7.19	2.13	1.31	1.13	2.61	0.00	70.45	81.75	84.35	63.71	100.00
DON (ppm)	4	3.07	1.70	2.60	1.62	0.82	0.34	44.63	15.31	47.34	73.22	88.78
	5	9.45	4.43	5.10	3.27	1.32	0.49	53.09	46.03	65.43	86.07	94.78
	6	10.00	10.05	7.59	5.73	5.09	4.55	-0.50	24.13	42.75	49.13	54.50

*Resistance x treatment combinations included: susceptible, untreated check (S_UT); susceptible, treated (S_TR); moderately susceptible, untreated (MS_UT); moderately susceptible, treated (MS_TR); moderately resistant, untreated (MR_UT); moderately resistant, treated (MR_TR).

Table 3. Effects of cultivar, fungicide and their interactions on FHB index and DON for those coordinated management trials with greater than 5% index and/or 1 ppm DON in the check.

		Cultivar Resistance		Fungicide Treatment		Cultivar x Treatment Interaction	
Response	**ENV**	***F Statistic***	***P-value***	***F Statistic***	***P-value***	***F Statistic***	***P-value***
Index (%)	4	77.31	<0.01	6.90	0.01	2.54	0.09
	5	52.52	<0.01	4.91	0.03	0.64	0.53
	6	4.37	0.02	14.33	<0.01	1.60	0.21
	12	6.50	0.02	3.62	0.08	3.06	0.08
	13	0.87	0.36	0.05	0.82	0.03	0.86
	14	0.63	0.54	0.00	0.95	0.76	0.48
	21	3.99	0.10	3.08	0.08	0.08	0.93
	22	6.25	<0.01	9.07	<0.01	1.96	0.15
DON (ppm)	4	61.41	<0.01	31.37	<0.01	3.01	0.06
	5	60.24	<0.01	25.58	<0.01	6.42	<0.01
	6	19.22	<0.01	0.49	0.53	0.66	0.52