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Highlights:

- Results are from only one location and year. Study was carried out with artificial inoculation of *Fusarium graminearum* by spreading corn inoculum to promote disease. No artificial inoculation was done for tan spot.
- All treatments which included Prosoaro 421SC, significantly reduced FHB disease incidence and severity than the untreated.
- Fungicide Stratego at tillering stage with herbicide and/or insecticide was not effective in controlling tan spot, and did not result in increased yield unless it was followed by Prosoaro 421SC at flowering stage.
- Yield was significantly higher by 6.4 bu/A in the treatment where Stratego and Wolverine was applied at tillering followed by Prosoaro 421SC at flowering compared to the untreated.
- Except treatments Wolverine (A)+Prosoaro 421SC (B) and Stratego (A)+ Wolverine (A) + Prosoaro 421SC (B), yield was numerically lower in other treatments by 11.19 - 16.15 bu/A compared to the untreated.
- None of the treatments resulted in statistically higher or lower test weight and DON compared to the untreated.

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OBJECTIVE

Objectives of this study was to evaluate efficacy of foliar fungicides to control tan spot caused by *Pyrenophora tritici-repentis* and Fusarium head blight caused by *Fusarium graminearum* in spring wheat.

METHODS

Location: NDSU Langdon Research Extension Center.

Experimental Design: Randomized complete block with four replications.

Previous crop: Hard red spring wheat.

Cultivars: FHB susceptible cultivar 'Samson' was used.

Planting: 1.2 million pure live seed/A was planted on May 24, 2013. A border plot was planted between treated plots to minimize interference from spray drift.

Plot size: Seven rows at six inch spacing. Individual plot was 5 x 20 sq. ft., mowed back to 5 x 15 sq. ft.

Inoculation: Plots were inoculated with *Fusarium graminearum* by spreading corn spawn inoculum at around boot stage (Feekes 9-10) at the rate of 286 g/plot. Plots were naturally infected for tan spot.

Fungicide treatments: Fungicide treatments, their chemistry, application rates and time are listed in Table 1. Fungicides were applied, with CO₂-pressurized backpack sprayer with three nozzle boom (XR8001), at the water volume of 10 GPA. Fungicides were applied at Feekes' growth stage 3.3 on June 18 (wind westerly, speed five MPH, temperature 69 °F at 10:00 AM). Flowering time fungicide application was made at Feekes 10.51 on July 15 (wind westerly, speed three MPH, temperature 67 °F at 9:00 AM).

Disease Assessment: Tan spot severity was rated twice. First rating was done at around Feekes 10.54 (watery ripe stage, July 19) and second on at around Feekes 11.1 (late milk stage, August 02). Tan spot severity was determined as percent leaf area symptomatic on arbitrary ten top three leaves (three of each of flag and flag-1 leaves, and four of flag-2 leaves) excluding outer rows. Disease incidence was calculated by counting numbers of symptomatic leaves out of 10 leaves that were rated for severity.

Fusarium head blight severity (FHB SEV) was rated twenty days after flowering time fungicide application (August 05). FHB head severity was rated using 0-100% scale on arbitrary 25 heads, excluding two outer rows. FHB incidence (FHB INC) was calculated by counting numbers of heads showing FHB symptoms out of 25 heads that were rated for severity. FHB index (FHB I) was calculated using formula $FHB I = (SEV * INC) / 100$.

Harvest: Plots were harvested 05 September (104 days after planting) with a small plot combine and the yield and test weight determined. Deoxynivalenol (DON) was tested on 50 g sub-sample at Veterinary Diagnostic Laboratory, NDSU.

Data Analysis: Data on leaf disease severity first rating and yield were squared root and log transformed, respectively, to achieve homoscedasticity. Other variables were analyzed untransformed. Data were analyzed using the general linear model (GLM) in SAS. Fisher's least significant difference (LSD) were used to compare means at $P \leq 0.05$. Actual means are presented in table for simplicity of understanding.

Table 1. Chemical treatments, their chemistry and FRAC/WSSA/IRAC group, and rate of application.

TRT#	Treatments [†]	Chemistry (FRAC/WSSA/IRAC group)	App. rate
1	Untreated		
2	Stratego (A) Wolverine (A) [‡]	Trifloxystrobin (11) + Propiconazole (3) FOPS (1) + Bromoxynil (6)+ Pyrasulfotole (27)	4 oz/A 27.4 oz/A
3	Stratego (A) Baythroid XL (A) [§] Wolverine (A)	Trifloxystrobin (11) + Propiconazole (3) β-cyfluthrin (3) FOPS (1) + Bromoxynil (6)+ Pyrasulfotole (27)	1 oz/A 1.6 oz/A 27.4 oz/A
4	Wolverine (A) Prosoaro 421 SC (B) [¶]	FOPS (1) + Bromoxynil (6)+ Pyrasulfotole (27) Prothioconazole (3)+Tebuconazole (3)	27.4 oz/A 6.5 oz/A
5	Stratego (A) Wolverine (A) Prosoaro 421 SC (B)	Trifloxystrobin (11) + Propiconazole (3) FOPS (1) + Bromoxynil (6)+ Pyrasulfotole (27) Prothioconazole (3)+Tebuconazole (3)	4 oz/A 27.4 oz/A 6.5 oz/A
6	Stratego (A) Wolverine (A) Prosoaro 421 SC (B) Baythroid (B)	Trifloxystrobin (11) + Propiconazole (3) FOPS (1) + Bromoxynil (6)+ Pyrasulfotole (27) Prothioconazole (3)+Tebuconazole (3) β-cyfluthrin (3)	4 oz/A 27.4 oz/A 6.5 oz/A 1.6 oz/A

Notes: [†] A = herbicide timing, B = flowering timing
[‡] Wolverine is a herbicide
[§] Baythroid is an insecticide
[¶] Prosoaro 421SC was applied with NIS @ 0.125% v/v.

RESULTS

Results are presented in Table 2. Tan spot was the major disease observed.

Tan Spot Incidence: Tan spot incidence on the first rating was significantly lower by more than half in treatments which included Prosoaro 421SC compared to that of untreated. No treatment resulted in statistically lower leaf disease compared to the untreated in second rating. However, the incidence was significantly lower in treatments Wolverine (A) +Prosoaro (B) and Stratego (A)+Wolverine (A).

Tan Spot Severity: Tan spot severity on the first rating was significantly lower in treatments which included Prosoaro 421SC compared to the untreated. However, in second rating none of the treatments resulted in significantly lower severity than untreated.

FHB Incidence: Similar to leaf disease incidence, treatments which included Prosoaro 421SC significantly lowered FHB incidence than the untreated. Treatment which included Stratego and Wolverine at tillering followed by Prosoaro 421SC and Bathroid at flowering stage resulted in the least FHB incidence.

FHB Severity: The trend of FHB incidence was also true for FHB severity with treatments which included Prosoaro 421SC resulted in significantly lower than the untreated.

FHB Index: The trend of significantly reduced FHB disease compared to the untreated was also observed for FHB Index in treatments which included Prosoaro 421SC.

Deoxynivalenol: None of the treatments significantly reduced DON levels compared to the untreated. However, the treatment Wolverine at tillering followed by Prosoaro 421SC at flowering resulted in the least amount of DON (3.18 ppm).

Yield: Yield was significantly higher by 6.4 bu/A in the treatment where Stratego and Wolverine was applied at tillering followed by Prosoaro at flowering compared to the untreated. Other treatments resulted in statistically similar yield to that of the untreated. However, except treatment Wolverine (A)+Prosoaro 421SC (B), yield was numerically lower in other treatments by 11.19 - 16.15 bu/A compared to the untreated.

Test Weight: None of the treatments resulted in statistically higher or lower test weight compared to the untreated. However, test weight in Stratego (A)+Baythroid XL (A)+ Wolverine (A) had significantly lower test weight than in treatments Wolverine (A)+ Prosoaro 421SC (B) and Stratego (A)+ Wolverine (A)+ Prosoaro 421SC (B).

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Table 2. Mean comparison of treatments for first and second rating of Leaf disease incidence (%) and severity (%), FHB head severity (%), FHB incidence (%), FHB index, yield (bu/A), test weight (lb/bu), and DON (ppm).

TRT#	Treatments ^a	LD 1 INC ^c (%)	LD 1 SEV ^b (%)	LD 2 INC ^c (%)	LD 2 SEV ^b (%)	FHB INC ^c (%)	FHB SEV ^b (%)	FHB I ^d	Yield (bu/A)	Test Weight (lb/bu)	DON (ppm)
1	Untreated	75.0 a ^e	3.13 b ^e	62.5 ab ^e	12.65 a ^e	70.67 a ^e	11.66 a ^e	8.34 a ^e	85.99 ab ^e	61.34 ab ^e	4.43 a ^e
2	Stratego (A) Wolverine (A)	87.5 a	5.28 ab	72.5 a	11.33 a	71.00 a	12.52 a	9.15 a	74.23 ab	61.31 ab	-
3	Stratego (A) Baythroid XL (A) Wolverine (A)	82.5 a	7.55 a	62.5 ab	14.73 a	68.00 a	11.63 a	7.95 a	74.80 ab	60.38 b	-
4	Wolverine (A) Prosoaro 421SC (B) ^y	37.5 b	1.18 c	57.5 b	7.68 a	42.00 b	5.22 b	2.35 b	86.40 ab	61.78 a	3.18 a
5	Stratego (A) Wolverine (A) Prosoaro 421SC (B)	37.5 b	0.98 c	52.5 b	8.08 a	46.00 b	5.19 b	2.48 b	92.39 a	61.68 a	3.23 a
6	Stratego (A) Wolverine (A) Prosoaro 421SC (B) Baythroid XL (B)	30.0 b	1.28 c	65.0 ab	9.05 a	32.00 b	2.59 b	0.97 b	69.84 b	61.17 ab	3.50 a
Mean		58.33	3.23	62.08	10.19	54.94	8.13	5.21	80.61	61.28	3.59
% CV		27.99	26.17	15.54	62.14	19.27	37.61	48.43	3.69	1.40	36.26
Max		87.5	7.55	72.5	14.73	71.00	12.52	9.15	92.39	61.78	4.43
Min		30.00	0.98	52.5	7.68	32.00	2.59	0.97	69.84	60.38	3.18

^a A: Feekes 2 (tillering/herbicide) application, B: Feekes 10.5 (flowering application)

^e Means with same letter within individual variable (within column) are not significantly different at 5% level of significance.

^c LD1 INC: Leaf disease incidence first rating

^b LD 1 SEV: Leaf disease severity first rating

^c LD2 INC: Leaf disease incidence second rating

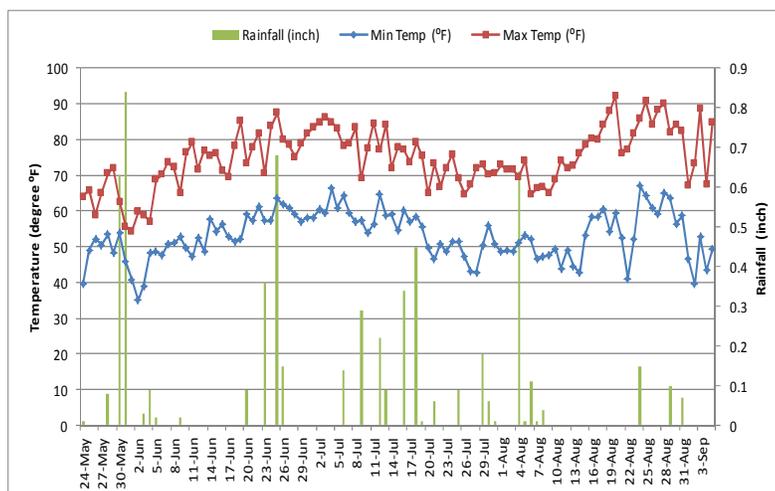
^b LD 2 SEV: Leaf disease severity second rating

^b FHB SEV: Fusarium head blight head severity

^c FHB INC: FHB incidence

^d FHB I: FHB index

^y Prosoaro was applied with non-ionic surfactant at the rate of 0.125% v/v



Daily minimum and maximum temperature, and rainfall recorded in Langdon, ND during planting to harvest of hard red spring wheat in this study.