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Winter Wheat Variety Response to Timing and Number of Fungicide Applications During the 2020–2021 Growing Season in Kansas

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Abstract

The objective of this project was to evaluate the yield response of different winter wheat varieties to different fungicide management treatments during the 2020–2021 growing season in Kansas. Fourteen varieties were evaluated under four fungicide treatments (no fungicide, application either at jointing, heading, or at both stages) in four locations across Kansas in a split-plot design. Disease incidence was assessed approximately 20 d after each fungicide application. Septoria blotch and tan spot were the most prevalent early-season diseases at the studied fields, while stripe rust, leaf rust, and tan spot prevailed later in the season. While varieties responded differently to fungicide management and there was a range in yield response across locations, there was an overall yield increase of 4.2 bushels per acre resulting from the jointing fungicide application; 10.3 bu/a from the heading fungicide; and 9.9 bu/a from the combination of both applications. Although there were some similarities, the ranking of the highest yielding varieties was not uniform across locations. While different reactions occurred regarding the response of the varieties to fungicide management, overall susceptible varieties had a greater response to fungicide management compared to varieties with intermediate or high levels of genetic resistance. Our preliminary data suggest that the application of fungicide to winter wheat in Kansas might be advantageous, but the degree of this benefit will depend upon the environment, variety, and level of disease incidence.

Keywords

wheat, fungicide, timing, jointing, flag leaf, cultivars, variety

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Summary

The objective of this project was to evaluate the yield response of different winter wheat varieties to different fungicide management treatments during the 2020–2021 growing season in Kansas. Fourteen varieties were evaluated under four fungicide treatments (no fungicide, application either at jointing, heading, or at both stages) in four locations across Kansas in a split-plot design. Disease incidence was assessed approximately 20 d after each fungicide application. Septoria blotch and tan spot were the most prevalent early-season diseases at the studied fields, while stripe rust, leaf rust, and tan spot prevailed later in the season. While varieties responded differently to fungicide management and there was a range in yield response across locations, there was an overall yield increase of 4.2 bushels per acre resulting from the jointing fungicide application; 10.3 bu/a from the heading fungicide; and 9.9 bu/a from the combination of both applications. Although there were some similarities, the ranking of the highest yielding varieties was not uniform across locations. While different reactions occurred regarding the response of the varieties to fungicide management, overall susceptible varieties had a greater response to fungicide management compared to varieties with intermediate or high levels of genetic resistance. Our preliminary data suggest that the application of fungicide to winter wheat in Kansas might be advantageous, but the degree of this benefit will depend upon the environment, variety, and level of disease incidence.

Introduction

Average wheat yields in Kansas have been relatively low (~45–50 bu/a) and well below the long-term dryland yield potential of ~70–75 bu/a in the region (Lollato et al., 2017, 2019). Recent studies indicated that nitrogen and fungicide management are the two main factors contributing to the difference between the current and potential dryland winter wheat yields in this region (Jaenisch et al., 2019, 2021, 2022; de Oliveira Silva et al., 2020; Munaro et al., 2020), although the response to fungicides depends on environmental conditions (Cruppe et al., 2017, 2021). Fungal diseases have been among the leading causes of yield losses in Kansas; still, only about 22% of the wheat grown in the region is protected by foliar fungicides (USDA-NASS, 2020). Foliar fungicide often provides control of the most common leaf fungal diseases (especially with susceptible

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genotypes or under high yielding environments). But the economic return and yield gain of foliar fungicides are inconsistent, depending on environmental conditions. The environment for winter wheat in Kansas is often characterized by re-occurring heat and drought stresses (Couedel et al., 2021; Lollato et al., 2020; Sciarresi et al., 2019), which partially explains the conservative behavior of Kansas wheat producers. Given the importance of fungicides in protecting the yield potential of the crop, our objectives were to evaluate the yield response of different winter wheat varieties to fungicide timing and the number of applications in a range of environmental conditions.

Procedures

Four rainfed field experiments were established during the 2020–2021 winter wheat growing season in different locations in Kansas: Two experiments were established in Ashland Bottoms sown under different soil conditions (Ashland Bottoms A = Belvue silt loam and Ashland Bottoms B = Bismarckgrove silt loam), one experiment was established near Belleville, and another near Hutchinson. All experiments were sown using no-tillage practices and following a previous soybean crop. Experiments were sown using a commercial no-till drill (Great Plains 606-NT drill) at a seeding rate of 2.5 million seeds per acre. Initial soil fertilizer was applied according to soil fertility analyses, and spring nitrogen management was adjusted according to a yield goal of 75 bu/a at all locations. Weeds and insects were controlled as needed.

Treatments, Experimental Design, and Disease Evaluation

Fourteen commercially available varieties were evaluated under four different fungicide management strategies. Fungicide treatments consisted of (1) a no fungicide control, or 5 ounces per acre of Topguard [1-(2-fluorophenyl)-1-(4-fluorophenyl)-2-(1H-1,2,4-triazol-1-yl) ethanol] applied at (2) jointing (Feekes GS6), (3) heading (Feekes GS10), and (4) both GS6 and GS10. Varieties were selected based on their different levels of genetic resistance to the most common fungal diseases in Kansas. Treatments were arranged in a split-plot design with fungicide treatment assigned to the main plots and varieties to the subplots. Main plots were arranged in a randomized complete block design with three to four replications. Disease incidence and severity of the major diseases that occurred naturally were individually assessed approximately 20 d after each fungicide application based on a 1 to 9 scale, where 1 is highly resistant and 9 is highly susceptible (Bockus et al., 2007). Grain weight and moisture content were measured at harvest maturity using a Massey Ferguson 8XP self-propelled small-plot combine and yields were corrected to 13% moisture.

Statistical Analyses

Disease and yield data were analyzed through a three-way analysis of variance (ANOVA) using the GLIMMIX procedure on SAS v. 9.4 (SAS Institute Inc., Cary, NC) and the PDIFF statement for comparisons between least square means. The effects of environment, variety, fungicide management, and their interaction were treated as fixed effects, and block nested within environment and its interaction with fungicide management were treated as random effects.

Results

Weather Conditions and Prevalent Diseases in the Studied Fields

The 2020–2021 wheat growing season was characterized by adequate precipitation amounts and distribution which, combined with colder temperatures during spring, contributed to satisfactory wheat yields in most locations. The average maximum and minimum temperatures were similar for Ashland Bottoms (average Tmax = 59.4°F and Tmin = 37.4°F) and Hutchinson (average Tmax = 59.9°F and Tmin = 37.8°F), but were lower in Belleville (average Tmax = 57.3°F and Tmin = 33.5°F) (Table 1). The same pattern occurred for precipitation, where Ashland Bottoms and Hutchinson had 17.9 and 17.5 inches of rain, respectively, and Belleville had the lowest precipitation amount (10.9 inches) (Table 1).

Disease incidence was grouped into early (i.e. disease assessment conducted 20 d after the jointing fungicide application) and late season diseases (i.e. disease assessment conducted 20 d after the heading fungicide application). Belleville and Ashland A (Belvue silt loam) had the lowest averages for early season disease incidence, while Ashland B (Bismarckgrove silt loam) and Hutchinson had intermediate levels of disease incidence. In the first assessment, septoria tritici blotch (STB) was the most prevalent disease in all four locations, followed by stripe rust in three and tan spot in one location. Hutchinson, Belleville, and Ashland A had similar levels of late season disease incidence, while levels were significant lower in Ashland B, with stripe rust being the most prevalent disease in three out four locations, and leaf rust in one location (Ashland B).

Variety × Fungicide × Environment Interactions

There was a significant interaction between variety, fungicide management, and environment, indicating that variety response to fungicide management depended on environment. In Ashland Bottoms A (Table 2) and in Hutchinson (Table 3), there was an increase in yield benefit when comparing the dual and the single application (either at heading or jointing) to the control, with greater differences with applications later in the season. Specifically, there was a yield difference of 12.1 bu/a from the dual application, 9.1 bu/a from the heading application, and 6.9 bu/a from the jointing application when compared to the control in Ashland Bottoms A. These differences were 14.4 bu/a, 13.2 bu/a, and 3.2 bu/a when doing the same comparisons in Hutchinson. In Ashland A and in Hutchinson, the majority of the grain yields falling into the highest yielding group were varieties that received either fungicide at heading or the dual fungicide treatment. In Belleville (Table 2), the greatest response was when the foliar fungicide was applied at jointing (4.5 bu/a difference), followed by the dual application (2.6 bu/a). In Ashland Bottoms B (Table 2), the greatest yield benefit was derived from the heading application (17.4 bu/a), followed by the dual application (10.5 bu/a). Bob Dole was the highest yielding variety in all locations. Larry, WB4303, and WB-Grainfield were in the highest yielding group in Belleville at different fungicide management strategies. Tatanka, WB4269, WB4303, and WB-Grainfield were in the highest yielding group in Ashland B. In Hutchinson, virtually all varieties were in the highest yielding group when a fungicide was applied at heading or as dual fungicide.

Different reactions were observed regarding the response of the varieties to fungicide management. The ranking of varieties with the greatest response to the dual and to the heading application was similar in both experiments in Ashland Bottoms (WB-Grainfield, WB4458, WB4303, and SY Monument) (Table 2). The same pattern was observed for the varieties with the lowest response to fungicide management in these experiments (Bob Dole, Zenda, LCS Chrome, Green Hammer, and Double Stop). No patterns were observed for Belleville or Hutchinson (Table 3). With a few exceptions, varieties with low levels of resistance to the most prevalent diseases had the greatest yield benefit from either one or the dual fungicide application.

Preliminary Conclusions

The effect of foliar fungicide was neither uniform across environments nor across varieties. However, our data suggest that wheat with the application of fungicide usually out-yielded the non-fungicide control, but the degree of this benefit was dependent upon the environment, on the varieties evaluated (resistant vs. susceptible varieties), and the level of disease incidence in the field.

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Table 1. Average maximum (Tmax) and minimum (Tmin) temperatures and precipitation during the 2020–2021 wheat growing season for the four studied sites in Kansas

Location	Tmax	Tmin	Precipitation
	-------------------------- °F	--------------------------	in.
Ashland Bottoms*	59.4	37.4	17.9
Belleville	57.3	33.5	10.9
Hutchinson	59.9	37.8	17.5
Average	58.9	36.3	15.4
Max	59.9	37.8	17.9
Min	57.3	33.5	10.9

*There were two field experiments conducted near Ashland Bottoms.

Table 2. Wheat grain yield as affected by fungicide management and variety in the two experiments conducted in Ashland Bottoms (A = Belvue silt loam and B = Bismarckgrove silt loam) in Kansas during the winter wheat season of 2020–2021

	Ashland Bottoms A				Ashland Bottoms B			
Variety	Control	Jointing	Heading	Dual	Control	Jointing	Heading	Dual
	----------	----------	----------	---------- Grain yield (bu/a) ----------	----------	----------	----------	----------
Bentley	53.6	60.1	73.0	**79.1***	49.2	49.9	68.3	60.0
Bob Dole	73.3	**80.2**	**79.0**	**78.8**	62.0	60.9	**77.2**	65.1
DoubleStop	70.7	70.6	66.1	67.4	58.8	58.9	67.2	61.4
Everest	51.8	62.2	61.2	70.4	50.9	53.1	65.5	58.5
Green Hammer	72.0	**74.6**	71.6	72.5	55.5	57.7	55.7	58.4
Larry	71.9	**77.8**	79.2	**80.8**	56.0	57.3	67.0	65.8
LCS Chrome	63.4	67.4	67.4	68.2	59.0	60.4	**69.8**	62.7
SY Monument	48.7	58.3	70.1	69.5	46.7	48.8	68.9	64.3
Tatanka	69.0	**78.1**	**79.9**	**78.7**	59.4	63.3	**77.2**	**69.3**
WB4269	62.6	70.8	71.9	**74.7**	52.4	57.1	**75.8**	65.9
WB4303	55.7	67.1	70.5	**75.4**	48.2	54.9	**73.9**	**69.5**
WB4458	55.5	62.7	67.8	**75.5**	43.6	45.3	61.3	63.0
WB-Grainfield	57.2	66.2	68.8	**78.2**	52.1	56.1	**74.2**	**69.6**
Zenda	63.5	69.1	69.3	68.9	54.6	54.7	69.1	61.9

*Values in bold belong to the highest yielding group.

Table 3. Wheat grain yield as affected by fungicide management and variety in Belleville and Hutchinson in Kansas during the winter wheat season of 2020–2021

	Belleville				Hutchinson			
Variety	Control	Jointing	Heading	Dual	Control	Jointing	Heading	Dual
	----------	----------	----------	---------- Grain yield (bu/a) ----------	----------	----------	----------	----------
Bentley	69.4	71.6	70.5	72	56.3	61	**76.4**	**74.7**
Bob Dole	71.8	**73.7**	71.7	68.7	70.2	70.2	**81.5**	**82.4**
DoubleStop	61.3	65.3	58.3	61.6	70	68.4	70.3	**76.6**
Everest	61	69.4	62.7	65.1	58.2	61.6	**73.9**	**77.2**
Green Hammer	66.7	69.4	62.6	67.1	65.5	63.8	**72.3**	**72**
Larry	69.7	**73.7**	**72.4**	**74.1**	60.6	67.6	**71.3**	**77.7**
LCS Chrome	65.6	67.5	63.6	65.6	58.4	63.2	70.2	**71.4**
SY Monument	64.5	71.3	70.4	67.8	57.7	63.9	**72.1**	66.3
Tatanka	69.2	68	71.7	71.4	63.9	**71.4**	**75.4**	**80.6**
WB4269	64.3	71	68.1	64.2	61	66.6	**74.8**	**76**
WB4303	65.6	**74**	71.1	**79.1**	61.8	65.7	**80.1**	**82**
WB4458	59.6	64.5	63.4	63.8	57.1	56.1	77	**75.9**
WB-Grainfield	65.9	**74.2**	**74.1**	72.1	54.4	59.9	**76**	**74.7**
Zenda	58.3	62.2	55.8	56.9	63.4	64	**71.7**	**72.6**

*Values in bold belong to the highest yielding group.