Kansas Agricultural Experiment Station Research Reports

Volume 7
Issue 5 *Kansas Field Research*

Article 28

2021

Winter Wheat Variety Response to Timing and Number of Fungicide Applications During the 2019–2020 Growing Season in Kansas

G. Cruppe
Kansas State University, gicruppe@ksu.edu

B. R. Jaenisch
Kansas State University, bjaenisch5@ksu.edu

B. Valent
Kansas State University, bvalent@k-state.edu

See next page for additional authors

Recommended Citation

Cruppe, G.; Jaenisch, B. R.; Valent, B.; and Lollato, R. P. (2021) "Winter Wheat Variety Response to Timing and Number of Fungicide Applications During the 2019–2020 Growing Season in Kansas," *Kansas Agricultural Experiment Station Research Reports*: Vol. 7: Iss. 5. https://doi.org/10.4148/2378-5977.8098

Winter Wheat Variety Response to Timing and Number of Fungicide Applications During the 2019–2020 Growing Season in Kansas

Abstract

The objective of this project was to evaluate the yield response of different winter wheat varieties to different fungicide management treatments during the 2019–2020 growing season in Kansas. Fourteen varieties were evaluated under four fungicide treatments (no fungicide, application either at jointing, heading, or at both stages) in five 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 late in the season. Late-season diseases had a greater effect on grain yield when compared to early-season diseases. While varieties responded differently to fungicide management, there was an overall yield increase of 1.8 bushels per acre resulting from the jointing fungicide application; 3.3 bu/a from the heading fungicide; and 4.3 bu/a from the combination of both applications. Overall, susceptible varieties had a greater response to fungicide management compared to varieties with intermediate or high levels of genetic resistance. Late-season drought and heat stress affected three out of five locations (Belleville, Conway Springs, and Hutchinson planted late), resulting in less effect of fungicide management than in the other two locations (Ashland Bottoms and Hutchinson planted in the optimal timing). Although there were some similarities, the ranking of the highest yielding varieties was not uniform across locations. 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 and on the variety.

Keywords

wheat, foliar fungicide, genotype, environment

Authors

G. Cruppe, B. R. Jaenisch, B. Valent, and R. P. Lollato

Winter Wheat Variety Response to Timing and Number of Fungicide Applications During the 2019–2020 Growing Season in Kansas

G. Cruppe,[1] B.R. Jaenisch, B. Valent,[1] and R.P. Lollato

Summary

The objective of this project was to evaluate the yield response of different winter wheat varieties to different fungicide management treatments during the 2019–2020 growing season in Kansas. Fourteen varieties were evaluated under four fungicide treatments (no fungicide, application either at jointing, heading, or at both stages) in five 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 late in the season. Late-season diseases had a greater effect on grain yield when compared to early-season diseases. While varieties responded differently to fungicide management, there was an overall yield increase of 1.8 bushels per acre resulting from the jointing fungicide application; 3.3 bu/a from the heading fungicide; and 4.3 bu/a from the combination of both applications. Overall, susceptible varieties had a greater response to fungicide management compared to varieties with intermediate or high levels of genetic resistance. Late-season drought and heat stress affected three out of five locations (Belleville, Conway Springs, and Hutchinson planted late), resulting in less effect of fungicide management than in the other two locations (Ashland Bottoms and Hutchinson planted in the optimal timing). Although there were some similarities, the ranking of the highest yielding varieties was not uniform across locations. 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 and on the variety.

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; de Oliveira Silva et al., 2020; Munaro et al., 2020), although the response to fungicides depends on environmental conditions (Cruppe et al., 2017). Fungal diseases have been among the leading causes of yield losses in Kansas; still, only about 22% of the wheat grown in the region

[1] Department of Plant Pathology, College of Agriculture, Kansas State University.

is protected by foliar fungicides (USDA-NASS, 2020). Foliar fungicide often provides control of the most common leaf fungal diseases (especially with susceptible genotypes or under high yielding environments). But the economic return and yield gain of foliar fungicides are inconsistent, partially explaining 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

Five rainfed field experiments were established during the 2019–2020 winter wheat growing season in different Kansas locations: Ashland Bottoms, Belleville, Conway Springs, and Hutchinson. Two experiments, sown 18 days apart, were established in Hutchinson to create distinct yield and disease environments. Four experiments were sown using no-tillage practices and following a previous soybean crop, while one experiment was established under conventional tillage practices following a previous winter canola crop (Hutchinson sown at the optimum time). Experiments were sown using a commercial no-till drill (Great Plains 606-NT drill) at a seeding rate of 2.5 million seeds/a. 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 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) using the PDIFF statement for comparisons between least square means. The effect of environment, variety, fungicide management, and their interaction were treated as fixed effects, and the 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 average maximum temperature during the 2019–2020 wheat growing season ranged from 57.7°F in Belleville to 61.9°F in Conway Springs, while the average minimum temperature ranged from 33.7°F to 39.4°F for the same locations. Ashland Bottoms had the highest precipitation rate during the season (24.2 in.) and the experiment planted after soybeans in Hutchinson had the lowest precipitation amount (13.6 in.) (Table 1). Table 1 also shows the ratio between water supply (WS) and water demand (WD), which indicates how much of the reference water evapotranspiration was supplied by precipitation. This ratio ranged from 0.4 to 0.8, indicating either that the wheat crop received enough water during the season or experienced potential drought stress (i.e. ratio closer to 1 indicates good water supply).

We grouped the occurrence of the diseases into early (i.e., present 20 d after the jointing fungicide application) and late-season diseases (i.e., present 20 d after the heading fungicide application). Septoria blotch and tan spot were the most prevalent early-season diseases and negatively affected yield in one out of the five locations. Stripe rust, leaf rust, and tan spot were the most prevalent late-season diseases and reduced yields in three out of five locations.

Variety × Fungicide Management × Environment Interactions

There was a significant interaction between variety and fungicide management, environment and fungicide management, and variety and environment. While varieties responded differently to fungicide management and there was a wide yield range within and between environments, mean yield (across varieties and environments) ranged from 55.6 bu/a with no fungicide application to 59.7 bu/a with the dual fungicide application. With a few exceptions, varieties with intermediate to high levels of genetic resistance to the most prevalent diseases present at the studies' sites (e.g. LCS Chrome, WB4269, and DoubleStop CL Plus) had little or no yield benefit from the fungicide application. On the other hand, the fungicide application either at heading or at both stages (jointing and heading) had greater beneficial effects on the yield of susceptible varieties (e.g. WB-Grainfield, WB4458, and WB4303) (Table 2).

The response to fungicide management across genotypes was greater in Ashland Bottoms and Hutchinson planted in the optimum timing, which reflects the weather conditions experienced in these two locations. Specifically, there was a yield difference of 10.6 bu/a from the dual application, 9.1 bu/a from the heading application, and 2.7 bu/a from the jointing application (not statistically different) when compared to the control in Ashland Bottoms. The same pattern was observed in Hutchinson optimum, but the magnitude of the yield benefit was smaller. On the other hand, the combination of drought and heat stress late in the season in Belleville, Conway Springs, and Hutchinson planted late might have limited the benefits of the fungicide application (Table 3).

The ranking of the highest yielding varieties was not uniform across locations. In three out of five locations, a single variety outyielded the others (LCS Chrome in Ashland Bottoms, WB-Grainfield in Belleville, and WB4269 in Hutchinson optimum). Both in Ashland Bottoms and Hutchinson optimum, the top yielding varieties also had the lowest disease ratings. Seven varieties encompassed the highest yielding group in

Conway Springs (e.g. Tatanka, Bob Dole, WB-Grainfield, SY Monument, WB4303, Larry, and DoubleStop CL Plus) and three varieties were part of the top group in Hutchinson planted late (WB4269, Bentley, and Tatanka) (Table 4).

Preliminary Conclusions

The effect of foliar fungicide was neither uniform across environments nor across varieties. However, our data suggest that the application of fungicide usually out-yielded the non-fungicide control, but the degree of this benefit was dependent upon the environment (high vs. low yielding environment) and on the varieties evaluated (resistant vs. susceptible varieties). Additionally, late-season diseases had a greater impact on wheat grain yield compared to early-season diseases, which reflects the greater variety response to treatments that include the late fungicide application (i.e. at heading or the dual application).

References

Bockus, W. W., Su, Z., Garrett, K. A., Gill, B. S., Stack, J. P., Fritz, A. K., Roozeboom, K. L. & Martin, T. J. (2007). Number of experiments needed to determine wheat disease phenotypes for four wheat diseases. Plant disease, 91(1), 103-108.

Cruppe, G., Edwards, J.T. and Lollato, R.P., 2017. In-season canopy reflectance can aid fungicide and late-season nitrogen decisions on winter wheat. Agronomy Journal, 109(5), pp. 2072-2086.

de Oliveira Silva, A., Slafer, G.A., Fritz, A.K. and Lollato, R.P., 2020. Physiological basis of genotypic response to management in dryland wheat. Frontiers in plant science, 10, p. 1644.

Jaenisch, B.R., de Oliveira Silva, A., DeWolf, E., Ruiz-Diaz, D.A. and Lollato, R.P., 2019. Plant population and fungicide economically reduced winter wheat yield gap in Kansas. Agronomy Journal, 111(2), pp. 650-665.

Lollato, R. P., Edwards, J. T., Ochsner, T. E. (2017). Meteorological limits to winter wheat productivity in the U.S. southern Great Plains. Field Crops Res. 203, 212–226. doi: 10.1016/j.fcr.2016.12.014.

Lollato, R. P., Ruiz Diaz, D. A., DeWolf, E., Knapp, M., Peterson, D. E., Fritz, A. K. (2019b). Agronomic practices for reducing wheat yield gaps: a quantitative appraisal of progressive producers. Crop Sci. 59, 333–350. doi: 10.2135/cropsci2018.04.0249.

Munaro, L.B., Hefley, T.J., DeWolf, E., Haley, S., Fritz, A.K., Zhang, G., Haag, L.A., Schlegel, A.J., Edwards, J.T., Marburger, D. and Alderman, P., and R.P. Lollato. 2020. Exploring long-term variety performance trials to improve environment-specific genotype × management recommendations: A case-study for winter wheat. Field Crops Research, 255, p. 107848.

USDA-NASS. (2020). 2019 Agricultural chemical use survey wheat. 2018-5, 1–2. Available at: *https://bit.ly/3r309oC*.

Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Average maximum (Tmax) and minimum (Tmin) temperatures, precipitation, grass evapotranspiration (ETo), and ratio between water supply (WS) and water demand (WD) during the 2019–2020 wheat growing season for the five studied sites in Kansas

Location	Tmax	Tmin	Precip.	ETo	WS:WD
	°F		inches		
Ashland Bottoms	59.3	37.0	24.2	30.3	0.80
Belleville	57.7	33.7	12.5	31.0	0.40
Conway Springs	61.9	39.4	16.4	35.9	0.46
Hutchinson (opt.)	61.7	37.2	16.8	34.5	0.49
Hutchinson (late)	59.4	34.6	13.6	30.8	0.44
Average	60.0	36.4	16.7	32.5	0.52
Max	61.9	39.4	24.2	35.9	0.80
Min	57.7	33.7	12.5	30.3	0.40

Table 2. Wheat grain yield as affected by fungicide management and variety across the five different environments in Kansas during the winter wheat season of 2019–2020. Numbers highlighted in bold indicate the highest yield within each fungicide treatment ($P < 0.05$).

	Fungicide management			
Variety	Control	Jointing application	Heading application	Dual application
	Grain yield (bu/a)			
Bentley	56.0	57.3	**62.7**	62.9
Bob Dole	57.4	55.6	59.2	57.7
DoubleStop	57.6	59.1	59.4	58.1
Everest	52.0	55.5	53.5	56.8
Green Hammer	56.3	54.0	54.8	53.9
Larry	56.0	59.4	60.2	**63.0**
LCS Chrome	**59.1**	**60.4**	57.9	60.5
SY Monument	55.5	56.7	60.3	61.4
Tatanka	57.0	58.8	58.1	60.0
WB-Grainfield	55.9	59.1	**62.1**	**65.3**
WB4269	**60.7**	**62.0**	**62.4**	**63.7**
WB4303	52.6	54.9	57.1	58.6
WB4458	48.5	50.9	54.4	57.1
Zenda	54.0	56.7	57.0	56.5

Table 3. Wheat grain yield as affected by fungicide management and the different environments during the winter wheat season of 2019–2020. Numbers highlighted in bold indicate the highest yield within each environment ($P < 0.05$).

	Environment				
Fungicide	**Ashland Bottoms**	**Belleville**	**Conway Springs**	**Hutchinson opt.**	**Hutchinson late**
	------------------------------ Grain yield (bu/a) ------------------------------				
Control	57.1	51.2	**55.0**	64.3	50.6
Jointing application	59.8	51.1	**54.8**	**68.8**	51.4
Heading application	**66.2**	50.1	52.3	**69.9**	**54.1**
Dual application	**67.7**	52.6	**54.0**	**71.1**	**53.0**

Table 4. Wheat grain yield as affected by variety and the different environments during the winter wheat season of 2019–2020. Numbers highlighted in bold indicate the highest yield within each environment ($P < 0.05$).

	Environment				
Variety	**Ashland Bottoms**	**Belleville**	**Conway Springs**	**Hutchison opt.**	**Hutchinson late**
	-------------------------------- Grain yield (bu/a) --------------------------------				
Bentley	63.4	51.8	55.0	71.3	**57.1**
Bob Dole	64.2	50.0	**57.0**	61.5	54.7
DoubleStop	65.5	49.6	**55.5**	71.4	50.6
Everest	57.7	46.6	48.8	67.4	51.7
Green Hammer	64.1	46.2	52.2	64.4	46.9
Larry	63.3	52.3	**57.1**	71.7	53.7
LCS Chrome	**71.1**	53.9	53.9	68.4	50.2
SY Monument	58.2	54.9	**55.7**	70.7	52.9
Tatanka	59.2	51.7	**58.0**	68.3	**55.2**
WB-Grainfield	65.8	**60.8**	**55.9**	67.7	53.0
WB4269	64.5	54.2	55.2	**79.8**	**57.3**
WB4303	58.2	50.0	**55.7**	64.2	50.9
WB4458	58.3	50.3	45.2	63.3	46.7
Zenda	64.1	45.1	50.6	69.1	51.2