

2021 First Stripe Rust Forecast and 2020 Variety Yield Loss and Fungicide and Tests

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Xianming Chen

A. The 2021 first forecast of stripe rust for the eastern Pacific Northwest

Based on the weather conditions in November and December 2020, stripe rust in the 2021 wheat growing season is forecasted to be in the upper range of moderate epidemic level (20-40% yield loss on susceptible varieties). Using forecast models based on the 2020 November and December weather data, yield loss of highly susceptible winter wheat varieties in the 2021 crop season is forecasted to be in the range of 27 to 46% with an average of **39%**. This number is lower than the forecast (44%) made last January for the 2020 crop season due to the relatively cold weather of December in 2020 compared to 2019. Currently grown varieties are forecasted to be **0** to **29%** yield losses depending upon the level of resistance or susceptibility of individual varieties. Based on the forecast, fields grown with moderate susceptible or susceptible winter wheat varieties (stripe rust ratings 5 to 9) may need the early fungicide application at the time of herbicide application. The early prediction made in January is often close to the real situation, but usually not better than the prediction in March based on the entire winter weather. Therefore, we will make another prediction in early March. However, stripe rust resistant or moderately resistant spring wheat varieties (stripe rust ratings 1 to 4 in the Seed Buying Guide) are recommended for planting.

B. Yield losses caused by stripe rust and increases by fungicide application on wheat varieties tested in 2020

The data of stripe rust and yield differences in non-sprayed and fungicide-sprayed plots in our experimental fields near Pullman in 2020 under natural infection are shown in **Table 1** for winter wheat and **Table 2** for spring wheat.

Of the 24 winter wheat varieties tested, including 23 commercially grown varieties and a susceptible check ('PS 279'), 12 varieties (PS 279, UI Magic, Eltan, LCS Jet, Mela CL+, WB 528, Otto, ARS-Crescent, Curiosity CL+, Puma, SY Clearstone 2CL, and Keldin) had significant differences in stripe rust severity, presented as relative area under the disease progress curve (rAUDPC), between their non-sprayed and sprayed treatments (**Table 1**). The percentage of severity reduction by fungicide application in these varieties ranged from 8.5% (ARS-Crescent) to 95.6% (PS 279). Fourteen varieties (PS 279, UI Magic, Eltan, LCS Jet, ORCL-102, Mela CL+, WB 528, Jasper, Curiosity CL+, LCS Artdeco, Puma, SY Clearstone 2CL, Keldin, and SY Ovation) had significant differences in grain test weight with increases of 1.3 lb/bu (SY Clearstone 2CL) to 16.2 lb/bu (PS 279) by fungicide spray. Significant yield differences, ranging from 14.2 bu/A (Bruehl) to 62.4% (PS 279) were observed for 13 varieties (PS 279, UI Magic, Eltan, LCS Jet, ORCL-102, Mela CL+, WB 528, Jasper, Otto, ARS-Crescent, Curiosity CL+, Northwest Duet, and Bruehl). Stripe rust caused 48.6% yield loss on the susceptible check (PS 279) and from 0.7 to 52.4% yield losses (average 11.6%) on commercially grown varieties.

Fungicide application increased grain yield by 0.7 to 55.4% (average 14.3%) on commercial varieties. Among the 23 commercially grown varieties, UI Magic was the most susceptible, losing 35.7% yield without fungicide application. Under the severe stripe rust epidemic, 7 commercial varieties (UI Magic, Eltan, LCS Jet, ORCL-102, Mela CL+, WB 528, and Jasper) received fungicide application ratings 2 or higher (need fungicide application). Twelve varieties (Otto, ARS-Crescent, Curiosity CL+, Northwest Duet, Bruehl, Northwest Tandem, WB1529, LCS Artdeco, Puma, SY Clearstone 2CL, Skiles, and Keldin) were rated 1 (may or may not need fungicide application). The remaining four varieties (Madsen, SY Ovation, LCS Drive, and Bobtail) received fungicide application rating 0 (no need fungicide application).

Of the 24 spring wheat varieties tested including 23 commercial varieties and one susceptible check ('AvS'), 15 varieties (AvS, WB-1035CL+, Kelse, Whit, Solano, Diva, Louise, Net CL+, Chet, Alum, Ryan, Glee, AP Renegade, SY Selway, and SY Gunsight) had significant differences and 9 varieties (Tekoa, Melba, Seahawk, Espresso, WB9668, WB9662, WB6121, WB7202CLP, and JD) had no significant differences in stripe rust severity (presented as rAUDPC) (**Table 2**). The significant differences ranged from 4.7% to 97.1% rAUDPC. Eleven varieties (AvS, WB-1035CL+, Kelse, Whit, Solano, Diva, Louise, Tekoa, Net CL+, Alum, and Glee) had significant differences in grain test weight, and the significant differences ranged from 1.1 lb/A (Diva) to 7.9 lb/A (AvS). Grain yield losses of sprayed and non-sprayed plots were significantly different for 15 commercial varieties (WB-1035CL+, Kelse, Whit, Solano, Diva, Louise, Tekoa, Net CL+, Chet, Alum, Ryan, Melba, Glee, AP Renegade, and SY Selway) in addition to the susceptible check (AvS). Stripe rust caused 83.8% yield loss on the susceptible check and from 0 to 57.7% (average 10.7%) yield losses on commercial varieties. Fungicide application increased grain yields by 0 to 136.5% (average 13.1%) on commercial varieties. Based on the percentage of yield loss, 13 commercial varieties (WB-1035CL+, Kelse, Whit, Solano, Diva, Louise, Tekoa, Net CL+, Chet, Alum, Ryan, Melba, and Glee) received fungicide application ratings 2 to 9 (need fungicide application, 5 varieties (AP Renegade, SY Selway, Seahawk, SY Gunsight, and Espresso) rating 1 (may or may not need fungicide application), and the remaining 5 commercial varieties (WB9668, WB9662, WB6121, WB7202CLP, and JD) received rating 0 (no need fungicide application) under the severe epidemic level in 2020. The most susceptible commercial variety of spring wheat was WB-1035CL+, which had 7.8 lb/bu test weight reduction and 57.7% yield loss in non-sprayed plots.

These data can be used to select stripe rust resistant varieties to plant and to determine if fungicide application is needed for a variety based on its relative yield loss and potential epidemic level. Based on the current forecasted epidemic level (39% yield loss on susceptible varieties) for 2021 (see above), fungicide application may be needed for the varieties with a fungicide application rating 2 or higher, or stripe rust ratings 5-9 as mentioned above. Varieties with fungicide application ratings 0 and 1, or stripe rust ratings 1 to 4 in the Seed Buying Guide, may not need fungicide application in 2021.

C. Fungicide tests in 2020

In 2020, 19 fungicide treatments, plus a non-treated check, were evaluated for stripe rust control efficacy on both winter wheat and spring wheat in fields near Pullman, Washington under natural

infection of the stripe rust pathogen. The data can be used to select fungicides for control stripe rust when needed.

In the winter wheat field, stripe rust was observed as 1-2% severity in all plots on 27 May, one day before the first fungicide application, and reached 100% severity at the milk stage in the non-treated check plots by 30 Jun. The rAUDPC values of all fungicide treatments were significantly less than the non-treated check, and six treatments (3, 8, 15-18) provided the best control of stripe rust (**Table 3**). All treatments had higher test weight than the non-treated check. All treatments produced yield higher than the non-treated check with nine treatments (2, 3, 8, 9, 12, 14-16, and 18) producing the highest yields. The significant yield responses ranged from 21.8 bu/A (42.1%) by treatment 4 (Lucento 5.5 fl oz/A at Feekes 10.1) to 59.7 bu/A (115.3%) by treatment 16 (Trivapro 13.7 fl oz/A at Feekes 8 followed by Trivapro 13.7 fl oz/A at Feekes 10.1).

In the spring wheat field, stripe rust was observed as 2% severity in all plots on 17 Jun, one day before the first fungicide application, and reached a mean of 97.5% severity at the milk stage in the non-treated check plots by 22 Jul. The rAUDPC values of all fungicide treatments were significantly less than the non-treated check (**Table 4**). All 15 treatments (2-4, 7-18) with applications at both Feekes 5-6 and Feekes 10.2 provided equally better control of stripe rust than the four treatments (5, 6, 19, and 20) with only one application at Feekes 10.2. All treatments had higher test weight than the non-treated check. All treatments produced yield higher than the non-treated check, and treatments with two applications generally produced higher yields than those with only one application at Feekes 10.2. The significant yield responses ranged from 34.4 bu/A (68.4%) by treatment 5 (Topguard EQ 7.0 fl oz/A at Feekes 10.2) to 51.0 bu/A (101.4%) by treatment 10 (Proline 5.0 fl oz/A at Feekes 5-6 followed by Proline 5.0 fl oz/A at Feekes 10.2).

Table 1. Differences in stripe rust severity (as rAUDPC), test weight, and yield in non-sprayed and fungicide-sprayed plots of winter wheat varieties tested under natural infection of the stripe rust pathogen near Pullman, WA in 2020

Variety	rAUDPC (%)			Test Weight (LB/BU)			Yield (BU/A)			Yield loss (%)	Yield Inc. (%)	Relative	Rating ^b
	No spray	Spray ^a	Reduction	No spray	Spray ^a	Increase	No spray	Spray ^a	Difference	by stripe rust	by fungicide	yield loss (%)	
PS 279	100.0	4.4	95.6 *	44.3	60.5	16.2 *	65.9	128.3	62.4 *	48.6	94.7	100.0	4
UI Magic	82.0	3.2	78.8 *	54.9	61.6	6.7 *	94.5	146.9	52.4 *	35.7	55.4	73.3	4
Eltan	55.3	3.2	52.1 *	54.8	58.8	4.0 *	104.4	145.2	40.8 *	28.1	39.1	57.8	3
LCS Jet	59.6	3.2	56.4 *	59.9	61.6	1.7 *	122.7	158.6	35.9 *	22.6	29.3	46.5	3
ORCF-102	14.2	7.2	7.0	58.2	60.5	2.3 *	126.9	154.6	27.7 *	17.9	21.8	36.8	2
Mela CL+	38.2	3.2	35.0 *	55.8	58.1	2.3 *	127.4	152.9	25.5 *	16.7	20.0	34.3	2
WB 528	55.0	4.1	50.9 *	57.7	61.7	4.0 *	116.9	141.3	24.4 *	17.3	20.9	35.5	2
Jasper	4.3	3.2	1.1	57.3	59.1	1.8 *	142.9	165.7	22.8 *	13.8	16.0	28.3	2
Otto	21.6	3.0	18.6 *	56.7	57.7	1.0	123.0	144.2	21.2 *	14.7	17.2	30.2	1
ARS-Crescent	12.4	3.9	8.5 *	57.1	58.3	1.2	132.1	151.5	19.4 *	12.8	14.7	26.3	1
Curiosity CL+	35.4	3.4	32.0 *	55.8	58.3	2.5 *	116.7	135.0	18.3 *	13.6	15.7	27.9	1
Northwest Duet	5.6	3.2	2.4	60.3	60.8	0.5	155.4	169.8	14.4 *	8.5	9.3	17.4	1
Bruehl	3.8	3.5	0.3	56.1	57.2	1.1	130.7	144.9	14.2 *	9.8	10.9	20.1	1
Northwest Tandem	7.6	5.1	2.5	60.1	60.7	0.6	149.6	160.9	11.3	7.0	7.6	14.4	1
WB1529	4.0	3.9	0.1	62.5	63.2	0.7	135.3	146.1	10.8	7.4	8.0	15.2	1
LCS Artdeco	9.6	4.7	4.9	57.9	60.3	2.4 *	151.5	161.9	10.4	6.4	6.9	13.2	1
Puma	18.6	3.6	15.0 *	58.9	60.5	1.6 *	143.2	153.3	10.1	6.6	7.1	13.5	1
SY Clearstone 2CL	22.6	8.8	13.8 *	60.8	62.1	1.3 *	125.6	134.5	8.9	6.6	7.1	13.6	1
Skiles	7.1	6.5	0.6	60.2	60.4	0.2	133.8	142.6	8.8	6.2	6.6	12.7	1
Keldin	23.3	6.4	16.9 *	62.3	63.9	1.6 *	124.9	133.4	8.5	6.4	6.8	13.1	1
Madsen	2.3	3.0	-0.7	59.7	60.6	0.9	145.3	151.3	6.0	4.0	4.1	8.2	0
SY Ovation	4.9	3.0	1.9	59.4	60.8	1.4 *	151.8	156.2	4.4	2.8	2.9	5.8	0
LCS Drive	2.3	2.8	-0.5	58.3	59.4	1.1	153.5	155.5	2.0	1.3	1.3	2.6	0
Bobtail	3.3	3.2	0.1	56.8	57.2	0.4	164.9	166.1	1.2	0.7	0.7	1.5	0
Mean	24.7	4.2	20.6 *	57.7	60.1	2.4 *	130.8	150.0	19.2 *	12.8	14.7	26.4	
Mean (excl. PS279)	21.4	4.1	17.3 *	58.3	60.1	1.8 *	133.6	151.0	17.4 *	11.6	14.3	23.8	
R ²	1.0			0.9			0.8						
CV	39.4			1.6			7.2						
p-value	<0.0001			<0.0001			<0.0001						
LSD (P = 0.05)	7.9			1.3			14.2						

^a Quilt Xcel at 14.0 fl oz/A was sprayed twice, at late jointing stage (Feekes 8) on May 28 when stripe rust was 1% in susceptible check plots, and sprayed second time on June 11 when plants were at the heading stage (Feekes 10.1) and the non-first spray PS279 plots had 10-15% rust severity.

^b Rating = the single digit number of yield difference/LSD. Varieties with rating 0 does not need fungicide application, those with rating 1 may or may not need fungicide application, and those with rating 2 or higher need application.

* The difference between the non-sprayed check and fungicide spray plots is significant at $P \leq 0.05$.

Table 2. Differences in stripe rust severity (as rAUDPC), test weight, and yield in non-sprayed and fungicide sprayed plots of spring wheat varieties tested under natural infection of the stripe rust pathogen near Pullman, WA in 2020

Variety	rAUDPC (%)			Test Weight (LB/BU)			Yield (BU/A)			Yield loss (%) by stripe rust	Yield Inc. (%) by fungicide	Relative yield loss (%)	Rating ^b
	No spray	Spray ^a	Reduction	No spray	Spray ^a	Increase	No spray	Spray ^a	Difference				
AvS	100.0	2.9	97.1 *	52.7	60.6	7.9 *	18.1	112.0	93.9 *	83.8	518.8	100.0	14
WB-1035CL+	90.5	3.8	86.7 *	52.8	60.6	7.8 *	46.0	108.8	62.8 *	57.7	136.5	68.8	9
Kelse	53.5	4.5	49.0 *	56.5	60.9	4.4 *	72.4	108.1	35.7 *	33.0	49.3	39.4	5
Whit	46.2	4.6	41.6 *	57.5	60.0	2.5 *	90.5	117.3	26.8 *	22.8	29.6	27.3	4
Solano	43.3	5.6	37.7 *	57.6	59.5	1.9 *	86.4	111.4	25.0 *	22.4	28.9	26.8	4
Div a	16.4	3.0	13.4 *	58.7	59.8	1.1 *	81.5	99.3	17.8 *	17.9	21.8	21.4	3
Louise	25.8	3.4	22.4 *	57.3	58.6	1.3 *	78.9	93.3	14.4 *	15.4	18.3	18.4	2
Tekoa	5.6	2.8	2.8	59.7	61.1	1.4 *	103.9	122.6	18.7 *	15.3	18.0	18.2	3
Net CL+	19.8	3.6	16.2 *	60.3	61.5	1.2 *	93.6	109.9	16.3 *	14.8	17.4	17.7	2
Chet	16.5	3.4	13.1 *	61.5	62.2	0.7	87.1	102.1	15.0 *	14.7	17.2	17.5	2
Alum	18.0	3.8	14.2 *	59.6	60.8	1.2 *	92.0	105.7	13.7 *	13.0	14.9	15.5	2
Ryan	12.9	3.4	9.5 *	59.1	60.1	1.0	114.4	127.3	12.9 *	10.1	11.3	12.1	2
Melba	4.9	2.3	2.6	60.8	61.0	0.2	102.1	112.9	10.8 *	9.6	10.6	11.4	2
Glee	22.1	4.3	17.8 *	59.4	60.6	1.2 *	103.7	113.8	10.1 *	8.9	9.7	10.6	2
AP Renegade	10.4	3.0	7.4 *	59.0	59.6	0.6	104.1	113.8	9.7 *	8.5	9.3	10.2	1
SY Selw ay	18.8	4.1	14.7 *	59.2	60.0	0.8	104.4	112.8	8.4 *	7.4	8.0	8.9	1
Seahaw k	2.6	2.6	0.0	60.0	60.2	0.2	109.4	115.4	6.0	5.2	5.5	6.2	1
SY Gunsight	7.0	2.3	4.7 *	59.9	60.7	0.8	109.0	114.3	5.3	4.6	4.9	5.5	1
Expresso	4.8	2.6	2.2	60.4	60.7	0.3	103.3	107.6	4.3	4.0	4.2	4.8	1
WB9668	2.8	3.3	-0.5	61.2	61.5	0.3	110.5	113.8	3.3	2.9	3.0	3.5	0
WB9662	3.1	2.4	0.7	60.3	60.2	-0.1	103.8	106.7	2.9	2.7	2.8	3.2	0
WB6121	3.2	2.8	0.4	61.2	61.9	0.7	112.9	115.8	2.9	2.5	2.6	3.0	0
WB7202CLP	3.3	2.8	0.5	60.7	61.2	0.5	118.5	121.3	2.8	2.3	2.4	2.8	0
JD	3.6	2.6	1.0	61.6	61.0	-0.6	91.1	89.4	-1.7	-1.9	-1.9	-2.3	0
Mean	22.3	3.3	19.0 *	59.0	60.6	1.6 *	93.2	110.6	17.4 *	15.7	39.3	18.8	
Mean (excl. AvS)	15.7	3.3	12.3 *	59.6	60.6	1.0	98.8	110.7	11.9 *	10.7	13.1	12.8	
R ²	1.0			0.9			1.0						
CV	20.5			1.4			4.7						
p-value	<0.0001			<0.0001			<0.0001						
LSD (P = 0.05)	3.7			1.1			6.6						

^a Quilt Xcel at 14.0 fl oz/A was applied at jointing stage (Feekes 6) on June 18 when stripe rust was 1-2% severity in susceptible variety plots.

^b Rating = the single digit number of yield difference/LSD. Varieties with rating 0 do not need fungicide application, those with rating 1 may or may not need fungicide application, and those with rating 2 or higher need application.

* The difference between the non-sprayed check and fungicide spray plots is significant at $P \leq 0.05$.

Table 3. Stripe rust severities and relative area under the disease progress curve (AUDPC), test weight, and yield in susceptible winter wheat ('PS 279') field plots not sprayed (No fungicide) or sprayed with various fungicide treatments under natural infection of the stripe rust pathogen near Pullman, WA in 2020

Treatment		Stripe rust severity (%) ^c						Test weight ^c (lb/bu)	Yield	
		27 May	10 Jun	24 Jun	30 Jun	Relative			Mean ^c (bu/A)	Increase %
No.	Fungicide, rate, timing ^{a,b}	L. jointing	Heading	Flowering	Milk	AUDPC				
1	No fungicide	1.0 A	10.0 A	98.8 A	100.0 A	100.0 A	52.7 G	51.8 G	0.0	
2	Alto 4.0 fl oz/A at Fks 8; Trivapro 13.7 fl oz/A at Fks 10.1	1.3 A	2.3 G-I	13.8 DE	15.0 FG	15.5 EF	61.8 A-C	105.7 A-C	104.1	
3	Trivapro 9.4 fl oz/A at Fks 8; Trivapro 13.7 fl oz/A at Fks 10.1	1.3 A	1.3 I	3.3 G	4.5 J	5.1 H	61.8 A-C	110.4 A	113.1	
4	Lucento 5.5 fl oz/A at Fks 10.1	1.0 A	10.0 A	78.8 B	88.8 B	83.7 B	57.5 F	73.6 F	42.1	
5	Topguard EQ 7.0 fl oz/A at Fks 10.1	1.0 A	8.8 AB	73.8 BC	76.3 D	76.4 CD	59.6 E	85.2 E	64.5	
6	Lucento 5.5 fl oz/A at Fks 8; Lucento 5.5 fl oz/A at Fks 10.1	1.0 A	4.0 E-H	12.5 D-F	26.3 E	18.6 E	61.5 A-C	97.4 D	88.0	
7	Topguard EQ 7.0 fl oz/A at Fks 8; Topguard EQ 7.0 fl oz/A at Fks 10.1	1.3 A	2.3 G-I	7.5 FG	11.3 G-I	10.4 F-G	61.3 A-C	101.5 B-D	95.9	
8	Topguard EQ 7.0 fl oz/A at Fks 8; Lucento 5.5 fl oz/A at Fks 10.1	1.0 A	2.3 G-I	3.8 G	11.3 G-I	7.6 H	60.4 C-E	106.2 A-C	105.0	
9	Lucento 5.5 fl oz/A at Fks 8; Topguard EQ 7.0 fl oz/A at Fks 10.1	1.0 A	3.3 E-I	16.3 D	20.0 F	19.2 E	61.3 A-C	105.4 A-C	103.5	
10	Proline 480 SC 5.0 fl oz/A at Fks 8; Proline 480 SC 5.0 fl oz/A at Fks 10.1	1.5 A	4.8 D-G	8.8 E-G	11.3 G-I	13.8 E-G	61.1 A-C	103.5 B-D	99.8	
11	ADA 77901 9.5 fl oz/A at Fks 8; ADA 77901 9.5 fl oz/A at Fks 10.1	1.3 A	7.3 B-D	7.5 FG	12.5 GH	15.5 EF	61.4 A-C	100.0 CD	93.1	
12	ADA 77906 - L 22.8 fl oz/A at Fks 8; ADA 77906 - L 22.8 fl oz/A at Fks 10.1	1.0 A	5.0 D-F	4.3 G	6.3 IJ	9.6 F-G	61.8 A-C	107.5 AB	107.5	
13	ADA 77906 - M 24.7 fl oz/A at Fks 8; ADA 77906 - M 24.7 fl oz/A at Fks 10.1	1.0 A	8.0 A-C	8.0 E-G	12.5 GH	16.5 E	62.3 A	101.9 B-D	96.7	
14	ADA 77906 - H 26.6 fl oz/A at Fks 8; ADA 77906 - H 26.6 fl oz/A at Fks 10.1	1.0 A	5.5 C-E	4.3 G	5.0 J	9.9 F-G	61.8 A-C	107.4 AB	107.3	
15	QUILT XCEL 14.0 fl oz/A at Fks 8; QUILT XCEL 14.0 fl oz/A at Fks 10.1	1.5 A	2.5 F-I	4.0 G	5.0 J	7.0 H	61.8 A-C	110.6 A	113.5	
16	Trivapro 13.7 fl oz/A at Fks 8; Trivapro 13.7 fl oz/A at Fks 10.1	1.0 A	1.5 HI	3.0 G	3.3 J	4.8 H	61.9 AB	111.5 A	115.3	
17	Tilt 4.0 fl oz/A at Fks 8; QUILT XCEL 14.0 fl oz/A at Fks 10.1	1.3 A	2.3 G-I	5.0 G	5.0 J	7.4 H	62.3 A	103.0 B-D	98.8	
18	Tilt 4.0 fl oz/A at Fks 8; Tilt 4.0 fl oz/A at Fks 10.1	1.0 A	2.5 F-I	5.5 G	8.8 H-J	8.6 HG	61.0 A-D	105.6 A-C	103.9	
19	Tilt 4.0 fl oz/A at Fks 10.1	1.0 A	10.0 A	78.8 B	82.5 C	82.4 BC	59.6 DE	80.6 E	55.6	
20	QUILT XCEL 14.0 fl oz/A at Fks 10.1	1.0 A	9.8 AB	71.3 C	76.3 D	75.6 D	60.5 B-E	82.2 E	58.7	
	R²	0.2	0.8	1.0	1.0	1.0	0.9	0.9		
	CV	32.3	35.1	17.0	13.7	14.6	1.7	4.7		
	p-value	0.6	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		
	LSD (P ≤ 0.05)	0.5	2.60	6.10	5.60	6.10	1.40	6.40		

^a The application at Feekes 8 (late jointing) was done on 28 May, and at Feekes 10.1 (boot-heading) on 11 June, 2020.
^b The field was under natural infection of the wheat stripe rust pathogen.
^c Means sharing one or more letters are not significantly different at P = 0.05.

Table 4. Stripe rust severities and relative area under the disease progress curve (AUDPC), test weight, and yield in susceptible spring wheat ('AvS') field plots not sprayed (No fungicide) or sprayed with various fungicide treatments under natural infection of the stripe rust pathogen near Pullman, WA in 2020

Treatment		Stripe rust severity (%) ^c					Test weight ^c (lb/bu)	Yield	
		17 Jun	1 Jul	15 Jul	22 Jul	Relative		Mean ^c (bu/A)	Increase %
No.	Fungicide, rate, timing ^{a,b}	Jointing	Heading	Flowering	Milk	AUDPC			
1	No fungicide	2.0 A	10.0 A	91.3 A	97.5 A	100.0 A	56.9 D	50.3 G	0.0
2	Alto 4.0 fl oz/A at Fks 5-6; Trivapro 13.7 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	60.4 A	96.9 A-E	92.6
3	Trivapro 9.4 fl oz/A at Fks 5-6; Trivapro 13.7 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	59.3 BC	92.8 C-E	84.5
4	Lucento 5.5 fl oz/A at Fks 10.2	2.0 A	5.8 BC	15.0 C	22.5 B	22.8 B	59.5 A-C	84.8 F	68.6
5	Topguard EQ 7.0 fl oz/A at Fks 10.2	2.0 A	6.3 B	18.8 B	17.5 C	24.8 B	59.9 A-C	84.7 F	68.4
6	Lucento 5.5 fl oz/A at Fks 5-6; Lucento 5.5 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.3 D	2.3 E	5.1 E	59.6 A-C	93.3 B-E	85.5
7	Topguard EQ 7.0 fl oz/A at Fks 5-6; Topguard EQ 7.0 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	60.3 A-C	96.9 A-E	92.6
8	Topguard EQ 7.0 fl oz/A at Fks 5-6; Lucento 5.5 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	59.9 A-C	95.3 A-E	89.5
9	Lucento 5.5 fl oz/A at Fks 5-6; Topguard EQ 7.0 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.3 D	2.3 E	5.1 E	60.4 AB	94.0 B-E	86.9
10	Proline 480 SC 5.0 fl oz/A at Fks 5-6; Proline 480 SC 5.0 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	60.4 AB	101.3 A	101.4
11	ADA 77901 9.5 fl oz/A at Fks 5-6; ADA 77901 9.5 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	60.3 A-C	97.0 A-E	92.8
12	ADA 77906 - L 22.8 fl oz/A at Fks 5-6; ADA 77906 - L 22.8 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	60.5 A	100.0 AB	98.8
13	ADA 77906 - M 24.7 fl oz/A at Fks 5-6; ADA 77906 - M 24.7 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	60.2 A-C	93.7 B-E	86.3
14	ADA 77906 - H 26.6 fl oz/A at Fks 5-6; ADA 77906 - H 26.6 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	60.5 A	99.2 A-C	97.2
15	QUILT XCEL 14.0 fl oz/A at Fks 5-6; QUILT XCEL 14.0 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	60.0 A-C	97.4 A-D	93.6
16	Trivapro 13.7 fl oz/A at Fks 5-6; Trivapro 13.7 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.3 D	2.3 E	5.1 E	60.4 AB	90.6 D-F	80.1
17	Tilt 4.0 fl oz/A at Fks 5-6; QUILT XCEL 14.0 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.0 D	2.0 E	4.8 E	60.2 A-C	95.0 A-E	88.9
18	Tilt 4.0 fl oz/A at Fks 5-6; Tilt 4.0 fl oz/A at Fks 10.2	2.0 A	2.0 D	2.3 D	2.3 E	5.1 E	60.1 A-C	92.2 C-E	83.3
19	Tilt 4.0 fl oz/A at Fks 10.2	2.0 A	5.0 BC	12.5 C	12.5 D	17.8 C	59.2 C	92.0 DE	82.9
20	QUILT XCEL 14.0 fl oz/A at Fks 10.2	2.0 A	4.5 C	4.5 D	8.8 D	10.7 D	60.0 A-C	90.2 EF	79.3
	R²	0.0	0.9	1.0	1.0	1.0	0.6	0.9	
	CV	0.0	29.2	22.1	31.1	20.4	1.3	5.4	
	p-value	.	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
	LSD (P ≤ 0.05)	0.0	1.27	2.70	4.17	3.59	1.12	7.01	

^a The application at Feekes 5-6 (Jointing) was done on 18 June, and at Feekes 10.2 (Heading) on 2 July, 2020.

^b The field was under natural infection of the wheat stripe rust pathogen.

^c Means sharing one or more letters are not significantly different at P = 0.05.