WHEAT (*Triticum aestivum*)
Stripe rust; *Puccinia striiformis* f. sp. *tritici*

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Evaluation of Pacific Northwest winter wheat cultivars to fungicide application for control of stripe rust in 2020.

This study was conducted in a field near Pullman, WA to evaluate the control of stripe rust with fungicide applications on major winter wheat cultivars grown in the U.S. Pacific Northwest and assess yield loss caused by the disease. Winter wheat genotype 'PS 279' was used as a susceptible check, and 23 cultivars were selected based on their high acreage planted in the state of Washington in 2019. The 24 entries were arranged in a randomized split block design based on fungicide application, with four replications. They were seeded in rows spaced 14-in. apart at 60 lb/A (99% germination rate) with a drill planter on 31 Oct 19. The plots were 4.5-ft in width and 14.8 to 16.5-ft in length. Ammonium nitrogen fertilizer was applied at 100 lb/A at the time of planting and again on 22 Apr 20 at the same rate when plants were at late tillering stage (Feekes 3). Herbicides (Huskie 15.0 fl oz/A + Axial XL 16.4 fl oz/A + Starane Flex 13.5 fl oz/A + M-90 10.4 fl oz/A) were applied on 8 May when wheat plants were at the early jointing stage (Feekes 5-6). On 28 May when most plants were at the late jointing stage (Feekes 8) and stripe rust was just 1% severity in the susceptible check plots, Quilt Xcel 2.2SE was sprayed at the rate of 14.0 fl oz/A mixed with 0.25% v/v M-90 in 16-gallon water/A and sprayed again at the same rate on 11 Jun when plants were at the heading stage (Feekes 10.1) and stripe rust in the non-sprayed PS 279 plots reached 10-15% severity. A 601C backpack sprayer was used with a CO_2-pressurized spray boom at 18 psi having three operating ¼ in. nozzles spaced 19-in. apart. Disease severity (percentage of stripe rust infected foliage per whole plot) was assessed from each plot on 27 May at the late jointing stage (Feekes 8-9), 10 Jun at the heading stage (Feekes 10.2), 24 Jun at the late flowering stage (Feekes 10.54), and 30 Jun at the milk stage (Feekes 11.1) or 1 day before and 13, 27, and 33 days after the first time of the fungicide application. Plots were harvested on 13 Aug when kernels had 13 to 15% kernel moisture and test weight of kernels was measured. Area under the disease progress curve (AUDPC) was calculated for each plot using the four sets of severity data. Relative AUDPC (rAUDPC) was calculated as percent of the non-treated susceptible check. rAUDPC, test weight, and yield data were subjected to analysis of variance, and the effect of fungicide application on rAUDPC, test weight, and yield was determined in comparison with non-sprayed plots for each cultivar by Fisher's protected LSD test.

A natural infection of the stripe rust pathogen was first observed on PS 279 plants in the nursery on 5 May 20. Stripe rust reached 100% severity by 24 Jun at the late flowering stage (Feekes 10.54) in the non-sprayed susceptible check plots. The two applications of Quilt Xcel at 14 fl oz/A reduced rAUDPC by 95.6% in the susceptible check (PS 279) plots. The fungicide applications also significantly reduced rAUDPC of eleven commercial cultivars (UI Magic, Eltan, LCS Jet, Mela CL+, WB 528, Otto, ARS-Crescent, Curiosity CL+, Puma, SY Clearstone 2CL, and Kelding), and the reduction ranged from 8.5 to 78.8%. The fungicide applications significantly protected grain test weight of the susceptible check (PS 279) by 16.2 lb/bu and thirteen commercial cultivars (UI Magic, Eltan, LCS Jet, ORCF-102, Mela CL+, WB 528, Jasper, Curiosity CL+, LCS Artdeco, Puma, SY Clearstone 2CL, Keldin, and SY Ovation) by 1.3 to 6.7 lb/bu. The fungicide applications made significant yield differences for the susceptible check (62.4 bu/A more in the sprayed plots) and twelve commercial cultivars (UI Magic, Eltan, LCS Jet, ORCF-102, Mela CL+, WB 528, Jasper, Otto, ARS-Crescent, Curiosity CL+, Northwest Duet, and Bruehl) with 14.2 to 52.4 bu/A more grain in the sprayed plots. The remaining eleven commercial cultivars (Northwest Tandem, WB1529, LCS Artdeco, Puma, SY Clearstone 2CL, Skiles, Keldin, Madsen, SY Ovation, LCS Drive, and Bobtail) showed no significant yield differences between the no-spray and spray treatments. These data indicated that stripe rust caused yield loss of 62.4 bu/A (48.6%) on the susceptible check and 17.4 bu/A (11.6%) yield loss on average across the commercially grown cultivars under the severe disease pressure in the experimental field.

Winter wheat cultivar [z]	rAUDPC (%)[y]			Test weight (lb/bu) [x]			Yield (bu/A) [x]		
	No spray	Spray [w]	Reduction [v]	No spray	Spray [w]	Protected [v]	No spray	Spray [w]	Protected [v]
PS 279	100.0	4.4	95.6*[u]	44.3	60.5	16.2*[u]	65.9	128.3	62.4*[u]
UI Magic	82.0	3.2	78.8*	54.9	61.6	6.7*	94.5	146.9	52.4*
Eltan	55.3	3.2	52.1*	54.8	58.8	4.0*	104.4	145.2	40.8*
LCS Jet	59.6	3.2	56.4*	59.9	61.6	1.7*	122.7	158.6	35.9*
ORCF-102	14.2	7.2	7.0	58.2	60.5	2.3*	126.9	154.6	27.7*
Mela CL+	38.2	3.2	35.0*	55.8	58.1	2.3*	127.4	152.9	25.5*
WB 528	55.0	4.1	50.9*	57.7	61.7	4.0*	116.9	141.3	24.4*
Jasper	4.3	3.2	1.1	57.3	59.1	1.8*	142.9	165.7	22.8*
Otto	21.6	3.0	18.6*	56.7	57.7	1.0	123.0	144.2	21.2*
ARS-Crescent	12.4	3.9	8.5*	57.1	58.3	1.2	132.1	151.5	19.4*
Curiosity CL+	35.4	3.4	32.0*	55.8	58.3	2.5*	116.7	135.0	18.3*
Northwest Duet	5.6	3.2	2.4	60.3	60.8	0.5	155.4	169.8	14.4*
Bruehl	3.8	3.5	0.3	56.1	57.2	1.1	130.7	144.9	14.2*
Northwest Tandem	7.6	5.1	2.5	60.1	60.7	0.6	149.6	160.9	11.3
WB1529	4.0	3.9	0.1	62.5	63.2	0.7	135.3	146.1	10.8
LCS Artdeco	9.6	4.7	4.9	57.9	60.3	2.4*	151.5	161.9	10.4
Puma	18.6	3.6	15.0*	58.9	60.5	1.6*	143.2	153.3	10.1
SY Clearstone 2CL	22.6	8.8	13.8*	60.8	62.1	1.3*	125.6	134.5	8.9
Skiles	7.1	6.5	0.6	60.2	60.4	0.2	133.8	142.6	8.8
Keldin	23.3	6.4	16.9*	62.3	63.9	1.6*	124.9	133.4	8.5
Madsen	2.3	3.0	-0.7	59.7	60.6	0.9	145.3	151.3	6.0
SY Ovation	4.9	3.0	1.9	59.4	60.8	1.4*	151.8	156.2	4.4
LCS Drive	2.3	2.8	-0.5	58.3	59.4	1.1	153.5	155.5	2.0
Bobtail	3.3	3.2	0.1	56.8	57.2	0.4	164.9	166.1	1.2
Mean (excl. PS 279)	21.4	4.1	17.3	58.3	60.1	1.8*	133.6	151.0	17.4*
R^2			1.0			0.9			0.8
CV			39.4			1.6			7.2
P-value			<0.0001			<0.0001			<0.0001
LSD ($P \leq 0.05$)			7.9			1.3			14.2

[z] Wheat genotype PS 279 was used as a susceptible check, and the remaining 23 cultivars were selected based on their planted acreage in the State of Washington in 2019, which were also major cultivars planted in Idaho and Oregon.

[y] AUDPC is area under disease progress curve, =∑[rust severity (i) + rust severity (i+1)]/2*days, calculated using severity data recorded four times at Feekes 8-9 (27 May), Feekes 10.2 (10 Jun), Feekes 10.54 (24 Jun), and Feekes 11.1 (30 Jun). Stripe rust severity was recorded as percentage of whole plot leaf area with stripe rust infection. Relative AUDPC (rAUDPC) was calculated for each treatment as the percent of the AUDPC (as 100%) of the susceptible check without fungicide application.

[x] Test weight (lb/bu) and yield (bu/A) based on 13 to 15% kernel moisture.

[w] Fungicide, Quilt Xcel 2.2 SE, was sprayed at the rate of 14.0 fl oz/A mixed with surfactant M-90 0.25% v/v on 28 May when the plants were at the late jointing stage (Feekes 8) and stripe rust severity was 1% in the susceptible check (PS 279) plots, and on 11 Jun when plants were at the heading stage (Feekes 10.1) and no-sprayed PS 279 plots had 10-15% stripe rust severity.

[v] The reduction value of rAUDPC (%) was calculated by subtracting the mean of the sprayed plots from the mean of the non-sprayed plots for each cultivar, and the protected or increased value of test weight (lb/bu) or yield (bu/A) was calculated by subtracting the mean of non-sprayed plots from the mean of the sprayed plots for each cultivar.

[u] The '*' indicates that the value is significant at $P = 0.05$ as determined by Fischer's Protected LSD test.