

Effects of fungicide application on control of stripe rust on winter wheat cultivars in 2014.

To determine the effects of fungicide application on control of stripe rust on individual winter wheat cultivars with various levels of resistance grown in the U.S. Pacific Northwest, this study was conducted in a field near Pullman, WA. Fertilizer (100N-20K-25S) was applied at 80 lb/A at the time of cultivation on 10 Oct 13. Winter wheat genotype 'PS 279' was used as a susceptible check and 23 cultivars were selected based on their acreage planted in the State of Washington in 2013 or new releases. These genotype and cultivars were seeded in rows spaced 14 in. apart at 60 lb/A (99% germination rate) with a drill planter on 10 Oct 13. The plots were 4.5 ft in width and 14.3 to 16.3 ft in length. Because a low level of stripe rust was predicted for the 2014 season, the field was inoculated with a mixture of locally predominant races PSTv-14 and PSTv-37 of *Puccinia striiformis* f. sp. *tritici* on 16 Apr 14 at late tillering stage (Feekes 3). Urea (46N-0P-0K) at 125 lb/A was applied on 28 Apr 14 at the early stage (Feekes 4) and herbicide (Allecto, 24 fl oz/A mixed with surfactant M-90, 14 fl oz/A) was applied on 12 May when wheat plants were at the early jointing stage (Feekes 5). Fungicide Quilt 1.66 SE was sprayed at the rate of 14.0 fl oz/A mixed with M-90 at the rate of 1% v/v in 16 gallon water/A on 29 May when most plants at boot-heading stage and stripe rust reached 10% severity on the susceptible check PS 279. A 601C backpack sprayer was used with a CO₂-pressurized spray boom at 18 psi having three operating ¼ in. nozzles spaced 19 in. apart. A randomized complete block design was employed with a split block based on spray or not spray and with four replications. Disease severity (percentage of diseased foliage per whole plot) was assessed from each plot on 27 May at boot stage, 10 Jun at flowering stage, and 24 Jun at soft dough stage or two days before the fungicide application and 12 and 26 days after application. Plots were harvested on 6 Aug when kernels had 3 to 5% kernel moisture and test weight of kernels was measured. Area under the disease progress curve (AUDPC) was calculated for each plot using the three sets of severity data. Relative AUDPC (rAUDPC) was calculated as percent of the non-treated control. rAUDPC, test weight, and yield data were subjected to analysis of variance and the effect of fungicide application on rAUDPC reduction and test weight and yield increases for each cultivar was determined by Fisher's protected LSD test.

Stripe rust was first observed in the field on May 7, three weeks after the inoculation. The disease was developing slowly due to the dry and hot weather conditions. The disease reached 10% severity on the susceptible check on 27 May, two days before the fungicide was applied and 90% on 10 Jun (flowering stage) and 100% on 24 Jun (soft dough stage) in the plots of the susceptible check without fungicide application. The one time application protected the wheat throughout the late growing season as no obvious re-development of stripe rust in the sprayed plots up to the soft dough stage was observed. The fungicide application significantly reduced rAUDPC for cultivars Eltan, Tubbs 06, ORCF-102, ARS-Amber, ARS-Crystal, Mary, Bauermeister, Stephens, Puma, and ORCF-103, as well as the susceptible check PS 279, but the reduction was not significant for the remaining 11 cultivars. For test weight, nine cultivars (PS 279, Eltan, Xerpha, Tubbs 06, ORCF-102, ARS-Crystal, Mary, Bauermeister, and ORCF-103) had significant increase in sprayed plots compared to the no-sprayed plots, and the significant increases ranged from 1.48 to 7.72 lb/bu. The fungicide application significantly increased grain yield for four of the commercially grown cultivars (Eltan, Xerpha, Tubbs 06, and ORCF-102) and the susceptible check. The significant increases ranged from 18.39 to 33.20 bu/A, or 25.60 to 126.43%. Based on the yield data of the no-sprayed and sprayed plots, stripe rust caused yield losses from -3.80 to 33.20 bu/A (-4.60 to 55.84%) with a mean of 7.10 bu/A (8.24%), and fungicide application increased yield by -4.40 to 126.43% with a mean of 8.98%. This study indicates that under the severe stripe rust epidemic created by artificial inoculation, resistance in most cultivars is adequate and only few cultivars need fungicide application. As stripe rust was generally low in commercial fields, fungicide application was not necessary in most winter wheat fields in the Pacific Northwest. These data can be used in the future to guide stripe rust management based on individual cultivars with different levels of resistance.

Wheat cultivar ^z	rAUDPC (%) ^y			Test weight (lb/bu) ^x			Yield (bu/A) ^x		
	No spray	Spray ^w	Reduction ^v	No spray	Spray ^w	Increase ^v	No spray	Spray ^w	Increase ^v
PS 279	100.00	21.12	78.88*^u	52.55	60.27	7.72*^u	26.26	59.46	33.20*^u
Eltan	14.91	3.02	11.89*	58.01	60.05	2.04*	62.01	80.40	18.39*
Xerpha	46.56	7.16	39.40*	57.13	59.84	2.71*	72.70	92.06	19.36*
Tubbs 06	50.26	8.19	42.07*	55.47	58.75	3.28*	69.46	87.90	18.44*
ORCF-102	40.17	7.50	32.67*	57.91	60.41	2.50*	71.87	90.27	18.40*
ARS-Amber	11.38	3.19	8.19*	58.47	58.82	0.35	79.14	89.66	10.52
ARS-Crystal	20.61	2.15	18.46*	57.17	59.77	2.60*	78.99	87.73	8.74
Mary	34.23	5.09	29.14*	58.01	60.02	2.01*	81.06	87.74	6.68
Bauermeister	25.43	5.87	19.56*	59.81	61.32	1.51*	72.88	78.46	5.58
Stephens	12.59	5.00	7.59*	58.29	59.35	1.06	79.50	84.83	5.33
Westbred 528	5.69	2.16	3.53	60.69	61.04	0.35	89.97	95.98	6.01
Puma	18.19	3.80	14.39*	57.94	58.75	0.81	79.71	84.95	5.24
Cara	3.45	1.64	1.81	57.37	57.91	0.54	85.91	91.55	5.64
AP700CL	4.05	2.07	1.98	59.59	59.49	-0.10	87.80	93.47	5.67
ORCF-103	19.39	6.81	12.58*	57.41	58.89	1.48*	73.99	77.48	3.49
Farnum	3.97	2.67	1.30	59.66	59.77	0.11	73.50	76.08	2.58
Chuckar	5.26	2.15	3.11	58.01	57.76	-0.25	89.81	91.33	1.52
Madsen	4.57	2.50	2.07	59.31	59.63	0.32	86.29	87.53	1.24
LCS-Artdeco	7.85	2.59	5.26	58.82	59.42	0.60	93.38	94.72	1.34
Bruehl	6.47	3.97	2.50	57.87	57.94	0.07	82.04	83.04	1.00
Otto	2.67	1.72	0.95	59.28	60.41	1.13	85.24	84.85	-0.39
Skiles	6.04	3.19	2.85	60.69	61.18	0.49	98.80	98.08	-0.72
ARS-Crescent	6.98	2.16	4.82	58.72	58.18	-0.54	91.10	88.00	-3.10
Norwest 553	3.79	2.67	1.12	61.25	61.25	0.00	86.33	82.53	-3.80
<i>R</i> ²	0.95			0.77			0.76		
CV	40.08			1.67			9.36		
<i>P</i> -value	<0.0001			<0.0001			<0.0001		
LSD (<i>P</i> ≤ 0.05)	6.57			1.38			10.81		

^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 2013, which were planted in 67% of the total winter wheat acreage in Washington in 2013 and were major cultivars planted in Idaho and Oregon.

^y AUDPC is area under disease progress curve, = $\sum[\text{rust severity (i)} + \text{rust severity (i+1)}]/2 \times \text{days}$, calculated using severity data recorded three times at flag-leaf stage (27 May), flowering stage (10 Jun), and soft dough stage (24 Jun). Stripe rust severity was recorded as percentage of whole plot leaf area with disease. 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 (lb/A) based on 3-5% kernel moisture.

^w Fungicide Quilt 1.66 SE was sprayed at the rate of 14.0 fl oz/A mixed with surfactant M-90 at the rate of 1% v/v on 29 May when the plants at boot stage (Feekes 10) and stripe rust reached to 10% severity on the susceptible check PS 279.

^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 increase 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 as the benefits of the fungicide application.

^u The “*” indicates that the value is significant at *P* = 0.05 as determined by LSD test.