

Evaluation of chemical seed treatments for control of stripe rust in wheat under controlled conditions.

The study was conducted under controlled conditions in a greenhouse in Pullman, WA. Seed of winter wheat 'PS 279' and spring wheat 'Lemhi' were treated by chemical companies with various chemicals. Seed of the two susceptible cultivars without treatment were used as non-treated controls. Five seeds of the same treatment were planted in a 3 x 3 x 3 in. plastic pot filled with a potting mixture of 24 L peat moss, 8 L perlite, 12 L sand, 12 L commercial potting soil mix, 16 L vermiculite, and 250 g 14%-14%-14% (available N-P-K) Osmocote fertilizer (Scotts Miracle-Gro Company, Marysville, OH) for the seedling tests (shoot, early tillering, and late tillering stages). Plants were grown in a rust-free greenhouse prior to inoculation. For plants of PS 279 tested at early jointing to flowering stages, two-leaf seedlings of 10 days after planting were kept in a vernalization chamber at 2-4°C with 14 h light/10 h dark for 60 days. Five vernalized plants of the same treatment were transplanted into a 7 x 7 x 7 in. plastic pot filled with the potting mixture described above and grown in a rust free greenhouse. Plants of different growth stages or days after planting were inoculated with a mixture of fresh urediniospores of *Puccinia striiformis* f. sp. *tritici* PST-100, a predominant race identified throughout the U.S. in the recent years, and talc at a 1:20 ratio using a brush to uniformly cover the upper surface of two top leaves. Inoculated plants were kept in a dew chamber for 24 h at 10°C without light, and then moved into a growth chamber with a diurnal temperature cycle gradually changing from 4°C at 2:00am to 20°C at 2:00pm and a 16-h light/8-dark cycle for the seedling tests (GS1 - GS3 in the following tables), or with a 10°C to 30°C diurnal cycle and the same light/dark cycle for the later growth stages (GS4 – GS7 in the first table) of PS 279. For each growth stage experiment, a complete randomized block design was used with three pots as blocks and five plants per pot. Stripe rust infection type (IT) based on a 0-9 scale with ITs 8 and 9 combined as IT 8 and severity from 0 to 100% (percentage of inoculated leaf area infected) were recorded for each plant twice, 15 days and 20 days after inoculation. Disease index (DI) was calculated using the formula: $DI = (IT \times severity) / (8 \times 100) \times 100$. Area under disease progress curve (AUDPC) was calculated for each plant using the two sets of DI data. Relative AUDPC was calculated as percent of the non-treated control and were subjected to analysis of variance and means were separated by Fisher's protected LSD test.

In the winter wheat tests, all Valent Corporation seed treatments (TRT) significantly reduced stripe rust only at the early stages (GS1 and GS2) 10 and 15 days after planting, except for TRT1 (Nipsit Inside Insect 5.00 FS 1.000 fl oz/cwt). TRT3 [Metlock 3.70FS 0.090 floz/cwt + V10209 2.65FS 0.150 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt (Metconazole 2.5)], TRT4 [Dividend Extreme 0.96SS 3.000 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt (Difenocon-18 gai)], and TRT5 [Dividend Extreme 0.96SS 3.000 fl oz/cwt + Rancona 3.80FS 0.051 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt (Difenocon 18 gai + Iaconazole 1.5)] were better than the other treatments based on the test of 15 days after planting, reducing the relative AUDPC value by about 57% compared to the non-treated control (NTC). Similar results were obtained in the spring wheat tests of first two growth stages (GS1 and GS2). However, TRT1 did not reduce stripe rust in the tests of inoculations of 10 and 16 days after planting, but had significant lower rust AUDPC value than NTC in the test of inoculation 32 days after planting (GS3). All treatments had significantly lower rust than NTC in the test of inoculation 32 days after inoculation, except TRT4 (Dividend Extreme 0.96SS 3.000 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt (Difenocon-18 gai)). For the seed treatments from Chemtura AgroSolutions, only spring wheat Lemhi was used in the study. Compared to NTC, all treatments significantly reduced the relative AUDPC value, with three treatments [Rancona 3.8 fs (3.4 ml/100 kg) + Dividend Extreme (185 ml/100 kg), UBI 9292 (325 ml/100 kg), and UBI 9349 (65 ml/100 kg)] the best in the first stage test (GS1), 10 days after planting. In the test of inoculation 16 days after planting (GS2), only two treatments [Rancona 3.8 fs (3.4 ml/100 kg) + Dividend Extreme (185 ml/100 kg) and UBI 9292 (325 ml/100 kg)] still had significant effect on reducing stripe rust, but the reduction dropped from more than 96% to less than 30% compared with the GS1 test. In the test of 32 days after planting, none of the treatments had significantly lower rust than NTC. For stripe rust, which is a multi-cyclic disease caused by an airborne pathogen, all of the tested seed treatments appear not able to provide protection long enough to have significant value in the disease management, which was also shown in the field studies under natural infection conducted at Pullman, WA during the 2011-2012 wheat growth season.

Valent seed TRT ^z	Stripe rust relative AUDPC ^y of tests on different growth stages (GS ^x)									
	Winter wheat 'PS 279'							Spring wheat 'Lemhi'		
	GS1	GS2	GS3	GS4	GS5	GS6	GS7	GS1	GS2	GS3
NTC	100.0 b ^w	100.0 a	100.0 a	100.0 cd	100.0 a	100.0 a-c	100.0 bc	100.0 a	100.0 a	100.0 a
TRT1.....	113.7 a	85.7 ab	91.7 a	108.0 ab	111.8 a	76.9 c	102.1 bc	100.0 a	105.4a	55.2 c
TRT2.....	1.7 e	61.4 c	93.9 a	112.3 a	104.0 ab	94.7 bc	82.1 cd	7.9 cd	37.7 c	58.5 bc
TRT3.....	0.3 e	41.9 d	86.5 a	95.7 d	107.6 ab	113.9 ab	92.5 b-d	9.1 cd	66.6 b	39.7 c
TRT4.....	13.7 cd	42.2 d	107.1 a	104.0 bc	114.6 a	106.5 ab	68.9 d	10.7 cd	64.3 b	80.4 ab
TRT5.....	3.4 de	42.3 d	100.1 a	113.0 a	107.2 ab	104.4 ab	109.4 b	14.2 c	68.3 b	59.1 bc
TRT6.....	24.5 c	83.3 b	102.8 a	103.7 bc	104.7 ab	124.9 a	115.1 ab	78.6 b	66.9 b	57.7 bc
TRT7.....	21.1 c	74.1 bc	102.9 a	110.7 a	113.6 a	108.3 ab	137.0 a	3.6 d	63.3 b	57.2 c
LSD (P<0.05).	11.2	14.3	22.4	6.5	11.3	27.5	26.9	9.6	16.4	23.1

^z TRT= treatments from Valent Corporation:

NTC= Non-treated control

TRT1= Nipsit Inside Insect 5.00 FS 1.000 fl oz/cwt

TRT2= Metlock 3.70FS 0.052 fl oz/cwt + V10209 2.65FS 0.150 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt (Metconazole 1.5)

TRT3= Metlock 3.70FS 0.090 floz/cwt + V10209 2.65FS 0.150 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt (Metconazole 2.5)

TRT4= Dividend Extreme 0.96SS 3.000 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt (Difenocon-18 gai)

TRT5= Dividend Extreme 0.96SS 3.000 fl oz/cwt + Rancona 3.80FS 0.051 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt (Difenocon 18 gai + Iaconazole 1.5)

TRT6= Stamina F3 1.74FS 1.000 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt

TRT7= Proceed Concentrate 1.03FS 1.000 fl oz/cwt + Nipsit Inside Insect 5.00FS 1.000 fl oz/cwt

^y AUDPC is area under disease progress curve, = $\sum[\text{disease index (i)} + \text{disease index (i+1)}]/2 \times \text{days}$, where disease index = (infection type x severity)/(the highest infection type x 100) x 100. Relative AUDPC was calculated for each treatment as the percent of the AUDPC (as 100%) of the non-treated control.

^x For winter wheat 'PS 279':

GS1 (shoot stage, Feekes 1): 10 days after planting (DAP) (planted 5 Mar 12, inoculated 15 Mar 12, 1st reading 30 Mar 12, and 2nd reading 4 Apr 12).

GS2 (early tillering, Feekes 2): 15 DAP (planted 5 Mar 12, inoculated 20 Mar 12, 1st reading 4 Apr 12, and 2nd reading 10 Apr 12).

GS3 (late tillering, Feekes 4): 21 DAP (planted 5 Mar 12, inoculated 26 Mar 12, 1st reading 10 Apr 12, and 2nd reading 16 Apr 12).

GS4 (early jointing, Feekes 5): 100 DPP and 30 days after 60-day vernalization (DAV) (planted 6 Nov 11, vernalized 16 Nov 12 – 15 Jan 12, inoculated 14 Feb 12, 1st reading 29 Feb 12, and 2nd reading 5 Mar 12).

GS5 (late jointing Feekes 7): 119 DAP and 49 DAV (planted 6 Nov 11, vernalized 16 Nov 12 – 15 Jan 12, inoculated 5 Mar 12, 1st reading 20 Mar 12, and 2nd reading 27 Mar 12).

GS6 (boot, Feekes 10): 127 DAP and 57 DAV (planted 6 Nov 11, vernalized 16 Nov 11 – 15 Jan 12, inoculated 13 Mar 12, 1st reading 28 Mar 12, and 2nd reading 3 Apr 12).

GS7 (Flowering, Feekes 10.5): 141 DAP and 71 DAV (planted 6 Nov 11, vernalized 16 Nov 11 – 15 Jan 12, inoculated 27 Mar 12, 1st reading 11 Apr 12, and 2nd reading 4/18/2012).

For winter wheat 'Lemhi':

GS1 (shoot stage, Feekes 1): 10 DAP (planted 16 Apr 12, inoculated 26 Apr 12, 1st reading 11 May 12, and 2nd reading 17 May 12).

GS2 (late tillering, Feekes 3): 16 DAP (planted 16 Apr 12, inoculated 2 May 12, 1st reading 17 May 12, and 2nd reading 21 May 12).

GS3 (middle jointing, Feekes 6): 32 DAP (Planted 16 Apr 12, inoculated 18 May 12, 1st reading 1 Jun 12, and 2nd reading 8 Jun 12).

^w Column numbers followed by the same letter are not significantly different at $P = 0.05$ as determined by LSD test.

Chemtura AgroSolutions Product and rate/A	Stripe rust relative AUDPC ^z of tests on different growth stages (GS ^y) of spring wheat 'Lemhi'		
	GS1	GS2	GS3
Non-treated control	100.0 a ^x	100.0 ab	100.0 a
Rancona pinnacle (325 ml/100 kg).....	31.5 b	84.7 bed	77.7 a
Rancona pinnacle (433 ml/100 kg).....	18.5 c	103.5 a	92.3 a
Rancona pinnacle (540 ml/100 kg).....	14.2 c	93.6 ab	78.6 a
Rancona 3.8 fs (3.4 ml/100 kg) + Dividend Extreme (185 ml/100 kg).....	3.1 d	73.3 cd	78.0 a
Dividend Extreme (185 ml/100 kg).....	16.0 c	96.6 ab	93.3 a
C7) UBI 9292 (325 ml/100 kg).....	3.7 d	71.1 d	106.3 a
C8) UBI 9349 (65 ml/100 kg).....	4.5 d	88.8 abc	88.0 a
LSD ($P \leq 0.05$)	7.8	17.2	38.1

^z AUDPC is area under disease progress curve, = $\sum[\text{disease index (i)} + \text{disease index (i+1)}]/2 \times \text{days}$, where disease index = (infection type x severity)/(the highest infection type x 100) x 100. Relative AUDPC was calculated for each treatment as the percent of the AUDPC (as 100%) of the non-treated control.

^y For spring wheat 'Lemhi':

GS1 (shoot stage, Feekes 1): 10 DAP (planted 16 Apr 12, inoculated 26 Apr 12, 1st reading 11 May 12, and 2nd reading 17 May 12).

GS2 (late tillering, Feekes 3): 16 DAP (planted 16 Apr 12, inoculated 2 May 12, 1st reading 17 May 12, and 2nd reading 21 May 12).

GS3 (middle jointing, Feekes 6): 32 DAP (Planted 16 Apr 12, inoculated 18 May 12, 1st reading 1 Jun 12, and 2nd reading 8 Jun 12).

^x Column numbers followed by the same letter are not significantly different at $P = 0.05$ as determined by LSD test.