Spring Wheat Seed Treatment Demonstration – Taylor, ND 2002

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Summary

Fourteen registered and experimental seed treatments were evaluated for the control of fungal root and crown diseases on hard red spring wheat (*Triticum aestivum* L. c.v. Parshall) by comparing disease, growth, and yield parameters of treated plots to those in untreated check and fumigated plots in southwest North Dakota. Significant improvement in the rate of emergence and vigor were noted for most fungicide seed treatments evaluated in this study. However, plant characteristics examined along with yield and quality were affected by heat and dry conditions and no significant differences were detected between seed treatments and the check. Parshall was found to be sensitive to the methyl bromide soil fumigation treatment.

Introduction

Rotation to non-host crops for two years or more provides time for natural processes to degrade root pathogens of wheat, durum (*Triticum turgidum* L Durum Group) and barley (*Hordeum vulgare* L.) (Cook and Veseth, 1991). Some long-lived residual herbicides that producers have used in the past may prevent rotation to non-host crops, or producers have limited themselves to continuous wheat or wheat-fallow rotations. One tool that may be of use to producers is seed treatment.

Seeds may be treated with fungicides for various reasons. These reasons include: 1) prevention of disease development as a result of seed-borne infection by pathogenic microorganisms; 2) protecting seeds and seedlings from invasion by soil-borne seedling invaders; and 3) protecting the plant from specific soil-borne pathogens which cause root and crown rots. A number of protectant or systemic seed treatments are registered for wheat seed treatment. Some are specific for certain seed- or soil-borne fungi; others are wider spectrum. Often several products are used in combination or are formulated to provide control of a wider spectrum of diseases.

Soil-borne fungi and seed treatments are affected by individual or local soil environments so field demonstrations under local conditions are prudent. Knowing the yield potential of a system allows an individual to optimize the inputs of a system. Inclusion of a fumigated check plot provides the opportunity to evaluate the yield potential as fumigation reduces root pathogen populations. The purpose of this study was to demonstrate the ability of fungicide seed treatments to control root and crown pathogens in a continuous hard red spring wheat rotation.

Methods

The demonstration was conducted on the Jay Elkin Farm near Taylor, ND at a site that had been in spring wheat continuously since 1999. The soil was a Morton-Chama silt loam (pH 6.7, O.M. 2.7%, N 95 lbs/acre, P 15 ppm, K 240 ppm, S 41 lbs/acre, Cl 34 lbs/acre). Ammonium sulfate was broadcast applied at the rate of 240 lbs/acre on 30 Apr. Roundup Ultra Max (glyphosate) at the rate of 1.5 pts/acre and ActaMaster Spray Adjuvant at the rate of 1 qt/acre were applied on 6 May 2002 preplant to control volunteer and emerged weeds. Parshall hard red spring wheat was treated with various fungicide seed treatments prior to planting (Table 1). Seed treatments with an "(S)" were treated by Syngenta and treatments listed with a "(G)" were treated by Gustafson. The DB Green L + RR treatment was applied by staff at the Dickinson Research Extension Center. Seed that was planted in the fumigated-check (FUMIGATED) and the check (CHECK) plot were untreated. A Hege no-till double-disc plot drill was used to seed the plots.

A randomized complete block design with six replications was used in this demonstration. Plots were 10 feet wide by 45 feet long with a four foot buffer strip of winter wheat seeded between each plot. Plots to be fumigated were covered with six-mil clear plastic sheet, edges buried in trenches four to six inches deep to seal the covered area, and methyl bromide was metered through plastic hoses at the rate of one pound per 100 ft2 (50 g m-2), on 3 May 2002. The fumigated plots remained covered for 48 hours after which time the plastic was removed.

Parshall hard red spring wheat was seeded on 15 May 2002 at the rate of 1.5 million seeds per acre. Post emergence weed control and foliar disease control consisted of an application of a tank mix of

0.4 oz/acre Harmony Extra, 0.66 pt/acre of Puma, and 2 fl oz/acre of Tilt, applied 14 June 2002.

Emergence counts and vissual vigor ratings (Figure 1) were made on six plots per treatment on 27 May and on four plots per treatment on 12 June. Plant counts in two eight foot sections of row were collected and plants per square foot calculated. Vigor ratings were a subjective rating where the evaluator compared the appearance of plant density and leaf width of the treatment with the CHECK plot.

Army cutworms (Euxoa auxiliaris) were found to infest particularly the first two replications in this trial when seedling emergence was about 50%. An application of Warrior (lambda cyhalothrin) at the rate of 3.2 fl oz/acre was made on 28 May 2002.

Root and crown samples from four plots per treatment were evaluated twice during the growing season. The first evaluation occurred between the five- and seven-leaf stage on 27 Jun and the second evaluation occurred at soft dough stage on 3 Aug. For the first evaluation, 15 plants were carefully dug from each plot and excess soil gently shaken from the roots. Samples were stored with the soil still on the roots in plastic bags and refrigerated until washed and analyzed. Plants selected for the first evaluation were evaluated for stage of development, length of the plant measured from the crown to the tip of the last fully extended leaf, extent of lesions on the subcrown internode, and counts of both seminal and crown roots. Twenty-five plants for the second evaluation were carefully dug and excess soil gently shaken from the roots. The samples were stored with the soil still on the roots and refrigerated until the roots were washed and evaluated. For the second evaluation, subcrown internode, root color, and root mass were examined. Mature crown and root samples were sampled 19 November and shipped overnight to the Plant Pest Diagnostic Laboratory at NDSU, Fargo, ND. Agar plate cultures were conducted on these selected root and crown samples to determine fungi present.

Soil samples were taken from the CHECK plots prior to fumigation, stored in a refrigerator at a temperature between 40^{o} and 45^{o}F until they were submitted to Riberio Plant Lab Inc., Bainbridge Island, Washington, on 5 November to determine the level of propagules per gram of soil for three species of fungi. Pythium presence and levels were determined using a modification of the PARPH medium published by Jeffers and Martin (1986); Fusarium presence and levels were determined using Komada's medium (Komada, 1975) and Rhizoctonia presence and levels were determined using MKH at 1:1000 dilution (Sneh, 1991). No statistical analysis was performed on this data.

Rainfall was recorded on site using a RainWise Electronic self-tipping bucket and a Hobo event logger. Air and soil temperatures were recorded with a Hobo H8 Pro Series temperature data logger.

Prior to harvest, mature plant height and head densities were determined. The plots were harvested on 23 August 2002 with a Massy Ferguson 8XP combine, which measured grain weight harvested percent moisture of harvested grain, and test weight harvested, percent moisture of harvested grain, and test weight. Harvested area was measured and yields calculated. Protein was determined at Southwest Grain, Inc., Dickinson, ND. Grain yield, test weight, and protein were adjusted to 12% moisture basis (Hellevang, 1986).

All data except where noted were statistically analyzed using SAS Statistical software version 8.2.

Results and Discussion

Army Cutworms caused significant damage to plots in two of the replications in this trial. These replications were not included in the analysis. Wireworms were also detected during the initial root and plant evaluation but ratings were not done to determine the extent of the damage.

Emergence and Vigor

Emergence was faster for DB Green L + RR, Dividend XL 1.67FS, Dividend Extreme, Dividend Extreme + Crusier 400CS, and Gus Trt #4 + Allegiance and Gus Trt #5 + Allegiance compared to the untreated CHECK for the 27 May count (Table 2). However, no significant differences were detected between seed treatments and the CHECK after complete emergence. Treated seed plots all exhibited higher vigor than the CHECK plot.

Grain Yield, Test Weight, Protein, Head Density, and Mature Plant Height

No significant differences in grain yields were detected between seed treatments and the CHECK in this trial. However treated seed plot yields tended to be higher than the CHECK grain yield. Highest yields were those treatments that contained an insecticide. Parshall appears to be sensitive to methyl bromide. Though early in the season wheat in the FUMIGATED plots appeared to be initially resistant

to methyl bromide and its metabolites by the time grain had begun to head, toxicity symptoms of yellow streaking on the leaves had developed and the plants were significantly shorter than the CHECK and many of the seed treated plots.

Root Evaluations and Propagule Counts

Development stage of wheat plants (Table 4) was more advanced for DB Green L + RR, Dividend XL 1.67FS, Raxil XT, Raxil MD, Raxil MD Extra, and the experimental treatment Gus Trt#6 compared to the CHECK plots. Root and crown disease is known to delay development and maturity (Cook and Veseth, 1991). However, no differences were detected in plant length, tillers or subcrown internode rating.

The number of seminal roots (Table 4) per plant was greater for Raxil MD, Raxil MD + Gaucho 480, Raxil MD and XT, as well as Dividend XL1.67FS and Dividend Extreme compared to the CHECK. However, only higher numbers of crown roots were found in the FUMIGATED, DB Green L + RR, and Raxil XT 35WP + Gaucho treatments compared to the CHECK.

Raxil XT 35WP+Gaucho 480FS seed treatment and the FUMIGATED soil treatment had significantly lighter colored roots than the CHECK (Table 5). DB Green L + RR had roots that were darker in color than the CHECK. Maneb has little or no control on root rotting soil-borne fungal diseases.

Propagule counts (Ribeiro, 2002) indicated high levels of Pythium (440 ppg), high levels of Fusarium (1120 ppg) and very high levels of Rhizoctonia (80 ppg) at planting time. Volunteer spring wheat was prevalent throughout the plot area prior to an application of glyphosate. These volunteer plants may have provided a "green bridge" for soil-borne disease to the newly seeded spring wheat crop and should have been controlled at least two to three weeks prior to seeding (Smiley, Ogg, and Cook, 1992).

Implications of Demonstration

Seed treatments do provide some protection against root pathogens that infect wheat as evidenced by emergence, vigor, and root data in this demonstration. Fungicidal seed treatments with activity against common root rot, Pythium, and Fusarium tended to promote healthier root systems although a significant improvement in grain yield over the CHECK was not demonstrated. Insecticides in seed treatments are useful in controlling damage from wireworms. Though not significant in this test, fungicide seed treatments in combination with insecticides produced the highest yields.

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Table 1. Active ingrediants of seed treatments used at Talyor, ND, 2002.

Treatment[1]	Registration status	Active ingredient and (perecent concentration in product)	Product application rate	Active on disease[2]
DB Green L + RR	Registered	Maneb (25.6) Imazalil (10.0) Lindane (8.6)	5.6 fl oz/cwt	Seeding Blight, Common Root Rot
Dividend XL 1.67FS (S1)	Registered	Difenoconazole (16.5) Mefenoxam (1.38)	1.6 fl oz/cwt	Common Root Rot, Pythium, Seedling Blight, Loose Smut
Dividend Extreme (S2)	Registered	Difenoconazole (7.73) Mefenoxam (1.87)	3.3 fl oz/cwt	Loose smut, Pythium, Fusarium seed scab, seed-borne Septoria, Penicillium, Aspergillus seed rots, Common Root Rot, Rhizoctonia
Raxil XT 35WP (S3)	Registered	Tebuconazole (15.0) Metalaxyl (20.0)	0.16 oz/cwt	Seedling Blight, Pythium, Common Root Rot, Loose Smut
Raxil MD (S4)	Registered	Tebuconazole (0.48) Metalaxyl (0.64)	5.0 fl oz/cwt	Seedling Blight, Pythium, Common Root Rot, Loose Smut
Raxil XT 35WP + Gaucho[4] 480 FS (S5)	Registered	Tebuconazole (15.0) Metalaxyl (20.0) Imidacloprid (40.7)	0.16 oz/cwt + 2.2 fl oz/cwt	Seedling Blight, Pythium, Common Root Rot, Loose Smut
Dividend Extreme + Cruiser 400 CS (S6)	Registered	Difenoconazole (7.73) Mefenoxam (1.87) Thiamethoxam (47.6)	3.3 fl oz/cwt + 1.0 fl oz/cwt	(See active on disease above for Dividend Extreme)
Dividend Extreme + CGA301940 (S7)	Not Registered in USA	Difenoconazole (7.73) Mefenoxam (1.87) CGA301940	3.3 fl oz/cwt + 2.5 g/100Kg	(See active on disease above for Dividend Extreme)
Raxil MD (G1)	Registered	Tebuconazole (0.48) Metalaxyl (0.64)	5.0 fl oz/cwt	Seedling Blight, Pythium, Common Root Rot, Loose Smut
Raxil MD Extra + Gaucho[4] 480 (G2)	Registered	Tebuconazole (0.48) Metalaxyl (0.58) Imazalil (1.0) Imidacloprid (40.7)	5.0 fl oz/cwt + 0.16 fl oz/cwt	Seedling Blight, Pythium, Common Root Rot, Loose Smut
Raxil MD Extra (G3)	Registered	Tebuconazole (0.48) Metalaxyl (0.58) Imazalil (1.0)	5.0 fl oz/cwt	Seedling Blight, Pythium, Common Root Rot, Loose Smut
Gus Trt #4 + Allegiance (G4)	Not Registered	L0121-A1 Metalaxyl (28.35)	75 ppm AE + 0.1 fl oz/cwt	NA[3]
Gus Trt #5 + Allegiance (G5)	Not Registered	L0115-A1 Metalaxyl (28.35)	50 ppm AE + 0.1 fl oz/cwt	NA[3]
Gus Trt #6 + Allegiance (G6)	Not Registered	L1194-A1 Metalaxyl (28.35)	25 ppm AE + 0.1 fl oz/cwt	NA[3]

[1] Treatment listed as with an (S) were provided by Syngenta. Treatments listed with a (G) were provided by Gustafson.

[2] Registered seed treatment for wheat has activity on seed-borne and/or soil-borne pathogens that causes these diseases.

[3] NA = Not Available

[4] Gaucho 480FS and Cruiser 400CS are insecticides.

Table 2. Stand counts for Parshall hard red spring wheat with various seed treatments, Jay Elkin Farm, Taylor, ND, 2002.

Treatment	--- 27 May --- Count	Vigor[1]	--- 12 Jun --- Count	Vigor[1]
	plants ft^{-2}		plants m^{-2}	
CHECK	16.8	1.5	33.4	5.0
FUMIGATED	26.7	7.5	40.5	9.8
DB Green L + RR	23.4	3.5	35.6	7.8
Dividend XL 1.67FS (S1)	25.4	3.8	34.5	7.8
Dividend Extreme (S2)	24.1	4.3	35.5	7.0
Raxil XT 35WP (S3)	20.2	4.0	33.3	7.3
Raxil MD (S4)	22.4	4.3	35.4	8.0
Raxil XT 35WP + Gaucho 480FS[2] (S5)	19.9	4.0	35.9	7.5
Dividend Extreme + Crusier 400CS[2] (S6)	26.1	4.0	37.2	7.8
Syn Trt #7 (S7)	16.6	3.2	35.3	7.8
Raxil MD (G1)	15.8	3.5	36.7	7.3
Raxil MD Extra + Gaucho 480FS[2] (G2)	16.8	2.8	32.2	7.3
Raxil MD Extra (G3)	20.2	4.2	34.4	7.5
Gus Trt #4 (G4)	25.9	5.3	34.1	7.8
Gus Trt #5 (G5)	23.5	5.0	36.0	7.5
Gus Trt #6 (G6)	20.4	4.3	35.9	7.0
Mean	21.6	4.1	35.3	7.5
CV%	22.8	30.5	7.8	8.6
$LSD_{.05}$	5.7	1.4	NS	0.9
Reps	4	4	4	4

[1] Vigor 1-10. 1 = poor vigor exhibited; 10 = high vigor exhibited.
[2] Gaucho 480FS and Crusier 400CS are insecticides.

Table 3. Grain yield, test weight, protein, height, and head density at harvest of Parshall hard red spring wheat grown under various seed treatments, Jay Elkin Farm, Taylor, ND, 2002.

			Grain[1]		
Treatment	Head density	Height	Yield	Test weight	Protein
	no/yd2	inches	bu/a	lb/bu	%
CHECK	308.3	25.4	44.9	62.8	15.5
FUMIGATED	317.2	23.7	39.6	61.7	15.9
DB Green L + RR	317.5	25.7	43.4	61.9	16.3
Dividend XL 1.67FS (S1)	292.1	24.8	45.1	62.2	15.5
Dividend Extreme (S2)	329.6	25.5	46.0	62.2	15.1
Raxil XT 35WP (S3)	310.1	25.6	44.2	61.4	15.8
Raxil MD (S4)	306.0	25.9	45.0	62.0	16.0
Raxil XT 35WP + Gaucho 480FS[2] (S5)	321.8	26.0	48.6	63.0	15.4
Dividend Extreme + Cruiser 400CS[2] #6 (S6)	290.3	25.4	46.9	62.5	15.8
Syn Trt #7 (S7)	308.5	25.4	44.9	62.4	16.1
Raxil MD (G1)	318.8	26.0	43.2	62.5	15.7
Raxil MD Extra + Gaucho 480FS[2] (G2)	322.0	25.6	48.6	62.3	15.7
Raxil MD Extra (G3)	307.2	24.7	42.7	61.4	15.8
Gus Trt #4 (G4)	314.0	24.8	44.8	62.3	15.3
Gus Trt #5 (G5)	313.6	25.2	45.1	62.1	15.9
Gus Trt #6 (G6)	324.5	25.1	45.3	62.0	15.8
Mean	314.4	25.3	44.9	62.2	15.7
CV%	8.8	4.5	5.9	1.3	4.2
LSD .05	NS	1.2	3.8	1.2	NS
Reps	4	4	4	4	4

[1] All grain yields, test weights, and proteins are adjusted to 12% moisture basis.
[2] Gaucho 480FS and Cruiser 400CS are insecticides.

Table 4. Initial root and plant evaluations of Parshall hard red spring wheat with various seed treatments, Jay Elkin Farm, Taylor, ND, 2002.

Treatment	Development stage	Length[1]	Tillers	Subcrown internode rating[2]	Seminal roots	Crown roots
	Haun	mm	no plant^{-1}		no plant^{-1}	no plant^{-1}
CHECK	5.7	399	2.6	1.2	3.1	7.2
FUMIGATED	6.4	446	3.5	1.1	4.6	10.8
DB Green L + RR	6.2	436	2.8	1.0	3.8	9.5
Dividend XL 1.67FS (S1)	6.0	411	3.2	1.0	3.9	8.6
Dividend Extreme (S2)	5.9	440	3.1	1.0	3.3	8.6
Raxil XT 35WP (S3)	6.0	408	3.0	1.1	3.6	7.9
Raxil MD (S4)	6.0	414	2.8	1.0	3.8	7.6
Raxil XT 35WP + Gaucho 480FS[3] (S5)	5.9	423	3.2	1.0	4.0	9.0
Dividend Extreme + Crusier 400CS[3] (S6)	5.9	397	3.2	1.0	3.8	7.8
Syn Trt #7 (S7)	6.1	431	3.3	1.0	4.0	8.9
Raxil MD (G1)	6.1	434	2.9	1.0	3.6	8.1
Raxil MD Extra + Gaucho 480FS[3] (G2)	5.8	418	2.4	1.0	3.4	6.8
Raxil MD Extra (G3)	6.0	401	2.9	1.0	3.6	8.2
Gus Trt #4 (G4)	5.8	415	2.6	1.1	3.3	6.9
Gus Trt #5 (G5)	6.0	441	3.1	1.1	3.5	8.6
Gus Trt #6 (G6)	5.9	413	3.0	1.0	3.2	7.1
Mean	6.0	420	3.0	1.0	3.7	8.2
CV%	3.4	6.2	16.1	8.8	10.1	15.0
LSD .05	0.3	NS	NS	NS	0.5	1.8
Reps	4	4	4	4	4	4

[1] Length measured from the crown to the tip of the last fully extended leaf of the plant.
[2] Subcrown internode rating, 0-4. 0=no infection, 1=less than 25% of the internode infected, 2 = 25-50 of the internode infected, 3 =51-75% of the internode infected, multiple lesions, and 4=75-100% of internode infected lesions coalesced.
[3] Gaucho 480FS and Crusier 400CS are insecticides.

Table 5. Root evaluation at soft dough of Parshall hard red spring wheat treated with various seed treatments, Jay Elkin Farm, Taylor, ND, 2002.

Treatment	Subcrown internode rating[1]	Root mass[2]	Root color[3]
CHECK	1.5	2.0	2.0
FUMIGATED	1.4	2.6	1.6
DB Green L + RR	1.5	2.0	2.2
Dividend XL 1.67FS (S1)	1.4	2.1	2.0
Dividend Extreme (S2)	1.6	2.1	1.9
Raxil XT 35WP (S3)	1.3	2.3	1.9
Raxil MD (S4)	1.3	2.1	1.8
Raxil XT 35WP + Gaucho 480FS[4] (S5)	1.2	2.2	2.0
Dividend Extreme + Crusier 400CS[4] (S6)	1.3	2.3	1.9
Syn Trt #7 (S7)	1.3	2.2	2.0
Raxil MD (G1)	1.3	2.2	1.9
Raxil MD Extra + Gaucho 480FS[4] (G2)	1.3	2.2	1.9
Raxil MD Extra (G3)	1.4	2.2	1.9
Gus Trt #4 (G4)	1.6	2.2	2.0
Gus Trt #5 (G5)	1.6	2.2	1.9
Gus Trt #6 (G6)	1.1	2.2	1.9
Mean	1.4	2.2	1.9
CV%	18.2	8.7	7.3
LSD .05	NS	NS	0.2
Reps	4	4	4

[1] Subcrown internode rating, 0-4. 0=no infection, 1=less than 25% internode infected, 2=25-50% of internode infected, 3=51-75% of internode infected, multiple lesions, and 4=75-100% of internode infected, lesions coalesced.
[2] Root mass rating, 1-4. 1=few roots and 4= substantial root system.
[3] Root color index, 1-4. 1=white, 4=dark.
[4] Gaucho 480FS and Crusier 400CS are insecticides.

Figure 1. The photograph on top is of the plot that was planted with seed treated with Raxil XT 35WP and the photograph below is of the CHECK plot on 12 Jun 2002. Raxil XT 35WP was rate 7.3 while the CHECK was rated as a 5.0.