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Seed Treatment Demonstration - Regent 2000

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Summary

Sixteen 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. Trenton) by comparing disease, growth, and yield parameters of treated plots to those in untreated check and fumigated plots in southwest North Dakota. Seed treatments with known activity against root rot resulted in significantly greater seminal and crown root counts than the untreated check. Significant grain yield increases over the untreated check were noted for the fumigated check. Pathogens known to be present at this site were *Bipolaris sorokiniana* (syn. *Helminthosporium sativum* = Common root rot), *Fusarium* spp., and *Pythium* spp.

Introduction

Rotation to non-host crops for two years 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 more wide 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. The inclusion of a fumigated check plot provided the opportunity to evaluate the yield potential as fumigation reduces root pathogens to a low level. 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 located on the August and Perry Kirschmann Farm near Regent, ND, at a site that had been in spring wheat continuously since 1993. Anhydrous ammonia was applied at a rate of 85 pounds per acre (70lbs/acre actual N) in October 1999. No tillage beyond the application of anhydrous ammonia was done. Roundup (glyphosate) was applied post plant but prior to crop emergence to control emerging weeds. Soil tests indicated that adequate N, P, K, and sulfur were present to obtain maximum yield. Trenton hard red spring wheat was treated with various seed treatment fungicides prior to planting (Table 1). Seed that was planted in the fumigated-check (FUMIGATED) and the check (CHECK) plot were untreated.

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 a 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 ft^2 (50g m^{-2}), on April 21, 2000. Fumigated plots remained covered for 48 hours after which time the plastic was removed.

Trenton hard red spring wheat was seeded on May 2, 2000 at a rate of 1,200,000 seeds per acre. Weed control consisted of an application of a tank mix of 2/3 pint per acre of Puma with 1 [illegible] pints per acre of Buctril, applied on May 24, 2000.

Root and crown samples from four plots per treatment were evaluated twice during the growing season. The first evaluation occurred between the sixth and seventh leaf stage, and the second evaluation occurred at soft dough stage. For the first evaluation, 15 plants were carefully dug from each plot and excess soil gently shaken from the roots. Samples were stored with 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 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. During the second evaluation, selected plants were placed in a cooler and shipped via overnight mail to the Plant Pest Diagnostic Laboratory at NDSU, Fargo, ND. Agar plate cultures were conducted on these selected root samples to determine fungi present.

A soil sample was taken from a check plot at soft dough stage and submitted to Riberio Plant Lab Inc., Bainbridge Island, Washington, to determine the level of soil propagules per gram of soil for two species of fungi. *Pythium* presence and levels were determined using a modification of the PARPH medium published by Jeffers and Martin (1986); and Fusarium presence and levels were determined using Komada's medium (Komada, 1975).

Rainfall was recorded on site using a RainWise electronic self-tipping bucket and a Hobo event logger (Figure 1).

Prior to harvest, mature plant height and head densities were determined. The plots were harvested on August 10, 2000 with a Massy Ferguson 8XP combine (Figure 2) which measured grain 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 was adjusted to a 12% moisture basis (Hellevang, 1986).

All data were statistically analyzed using SAS Statistical software version 6.12 (SAS Institute Inc., 1996).

Results and Discussion

Yield and Quality

No significant difference was detected in yield between seed treatments for wheat and the CHECK (Table 2). However, grain yield of the FUMIGATED was 7.8 bushel per acre greater than the CHECK. Products labeled for the control of root pathogens tended to produce higher yields than the CHECK. Treatments that contained an insecticide such as lindane or thiamethoxam yielded no more than registered treatments without the insecticide. Wireworms were not found at this site and therefore a response to insecticide would not be expected.

No significant differences in test weight were detected between the CHECK and seed treatments. However protein was significantly higher for the FUMIGATED, Charter PB, and L0120-A1 + Allegiance treatments compared to the CHECK.

No significant differences were found in stand establishment counts at 20 days after planting (Table 3). However head density at harvest was greater for the FUMIGATED, Charter Max, Charter PB, DB Green L, DB Green L + RR, Dividend XL, L0120-A1 + Allegiance, Novartis 1, Novartis 2, Raxil MD + Lindane 30, and Raxil XT treatments compared to the CHECK treatment (Table 2). Tiller counts done during the initial root evaluation were greater for all seed treatments except Charter Max, L0267-A1, and Raxil MD + Lindane 30 in comparison to the CHECK (Table 4).

Root Evaluations

Initial Root and Plant Evaluation

A significant increase in seminal root numbers was noted for FUMIGATED and all seed treatments except for DB Green L + RR when compared to the CHECK (Table 4). Crown root counts for the FUMIGATED and seed treatments 4496, DB Green L + RR, L0120-A1 + Allegiance, Novartis 1, RTU Vitavax + Thiram, Raxil MD, Raxil MD + L0120-A1-H, and Raxil XT were greater than the CHECK plot.

Plant length and crop development for the FUMIGATED treatment was significantly different than the CHECK. Plant length and crop development was not significantly different between the CHECK and any of the seed treatments.

Root Evaluation at Soft Dough

FUMIGATED, Charter Max, Charter PB, DB Green L + RR, L0267-A1, Novartis 1, Raxil MD, and Raxil MD + Lindane 30 had significantly fewer lesions than the CHECK. Root mass was only greater for the FUMIGATED treatment compared to the CHECK. No significant differences in root color were detected. Root tissue samples analyzed indicated that *Pythium* and *Fusarium* were present. Symptoms found on the subcrown internodes were consistent with the type of lesions produced by *Bipolaris sorokiniana* L. (syn. *Helmenthosporium sativum*). The soil fungus assay for *Fusarium* and *Pythium* in the untreated CHECK at the soft dough stage indicated that there were 1680 and 390 propagules per gram of soil, respectively. *Fusarium* propagules were not identified to species so all *Fusarium* propagules detected in the soil using Komada's medium can not be attributed to disease producing *Fusarium* species.

Soil environment has been shown to affect development and severity of root disease (Cook and Veseth, 1991). Rainfall (Table 6) from seeding to two weeks prior to harvest was 6.26 inches. Soil moisture at planting time was estimated to be about 5.5 inches at seeding time. It is thought that this site received less precipitation in May and June than the Regent site did in 1999. *Fusarium* and *Pythium* though present may not have caused the injury on the crop in the 2000 season that they would have under moister conditions. Systemic seed treatments move mainly upward in the plant rather than down into the root system (Stack, 1991). Seed treatments may modify the soil immediately surrounding the seed, eliminating some pathogenic fungi directly and in other cases eliminating soil microorganisms that compete with other soil organisms that are antagonistic to disease causing fungi. These effects may be longer-lived than the fungicide itself (Watson, 1966).

Implications of Demonstration

Seed treatments do provide some protection against root pathogens that infect wheat as evidenced by 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 demonstrated only in the FUMIGATED treatment. Soil fumigation reduces soil-borne pathogens and may modify nutrient availability in soil, both of which affects yield.

A seed treatment demonstration on hard red spring wheat is scheduled for the 2001 at the August and Perry Kirschmann farm near Regent.

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Figure 1. RainWise self-tipping bucket rain gauge and Hobo event logger.

Figure 2. Harvesting Regent seed treatment plots on August 10, 2000.

Table 1. Active ingredients of seed treatments used at Regent, ND, 2000.

Treatment	Status	Active ingredient and percent concentration in product	Product application rate	Active on disease[1]
4496	Experimental	NA[2]	9 fl oz/cwt	NA[2]
Charter MAX	Not Registered in USA	Triticonazole 1.3 Metalaxyl 0.5	5.8 fl oz/cwt	NA[2]
Charter PB	Not Registered in USA	Triticonazole 1.3 Thiram 13.0	5.5 fl oz/cwt	NA[2]
DB Green L	Registered	Maneb 25.6	5 fl oz/cwt	Seedling Blight

		Lindane 8.6		
DB Green L + RR	Registered	Maneb 25.6 Imazalil 10.0 Lindane 8.6	5.6 fl oz/cwt	Seedling Blight, Common Root Rot
Dividend XL 1.6 FS	Registered	Difenoconazole 16.5 Mefenoxam 1.38	1 fl oz/cwt	Common Root Rot, *Pythium*, Seedling Blight, Loose Smut
L0120-A1 + Allegiance	Experimental	NA[2]	5 fl oz/cwt	NA[2]
L0267-A1	Experimental	NA[2]	5 fl oz/cwt	NA[2]
Novartis 1	Experimental	NA[2]	0.95 fl oz/cwt	NA[2]
Novartis 2	Experimental	NA[2]	0.55 fl oz/cwt	NA[2]
RTU Vitavax + Thiram	Registered	Carboxin 10.0 Thiram 10.0	6.0 fl oz/cwt	Seedling Blight, Loose Smut
Raxil MD	Registered	Tebuconazole 0.48 Metalaxyl 0.64	5 fl oz/cwt	Seedling Blight, *Pythium*, Common Root Rot, Loose Smut
Raxil MD + L0120-A1-H	Registered	Tebuconazole 0.43 Metalaxyl 0.58 NA[2]	5 fl oz/cwt + 25 ppm pr	NA[2]
Raxil MD + L0120-A1	Experimental	Tebuconazole 0.48 Metalaxyl 0.64 NA[2]	5 fl oz/cwt + 15 ppm pr	NA[2]
Raxil MD+ Lindane 30	Registered	Tebuconazole 0.48 Metalaxyl 0.64 Lindane[3] 30.0	5 fl oz/cwt + 1 fl oz/cwt	Seedling Blight, *Pythium*, Common Root Rot, Loose Smut
Raxil XT	Registered	Tebuconazole 15.0 Metalaxyl 20.0	0.16 oz wt/cwt	Seedling Blight, *Pythium*, Common Root Rot, Loose Smut

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

[2] NA = Not Available.

[3] Lindane and Adage are insecticides.

Table 2. Grain yield, test weight, height, and head density at harvest of Trenton hard red spring wheat grown under various seed treatments, August and Perry Kirschmann Farm, Regent, ND, 2000.

Treatment	Head density	Height	Yield[1]	Test weight[1]	Protein[1]
	no./yd^2	inches	bu/a	lb/bu	%
FUMIGATED	387.8	34.6	44.8	59.3	16.6
4496	282.2	33.1	39.0	58.5	15.9
Charter MAX	308.2	33.9	39.6	59.2	15.8
Charter PB	306.6	33.7	36.9	58.8	16.2
DB Green L	295.6	34.0	37.7	58.5	15.9
DB Green L + RR	317.4	33.6	39.0	59.0	15.8
Dividend XL	311.4	33.7	39.4	58.6	16.1
L0120-A1 + Allegiance	309.8	33.6	38.2	58.2	16.3
L0267-A1	273.9	33.1	37.0	58.7	15.8
Novartis 1	301.6	33.7	37.5	58.9	16.1
Novartis 2	301.4	33.3	38.4	57.8	16.1
RTU Vitavax + Thiram	288.1	33.2	38.0	58.7	15.6
Raxil MD	280.6	32.7	37.5	59.4	15.5
Raxil MD + L0120-A1-H	286.3	34.0	36.4	58.7	16.1
Raxil MD + L0120-A1	279.9	33.6	37.1	58.8	15.8
Raxil MD + Lindane 30	299.1	33.4	37.5	59.0	15.9
Raxil XT	305.2	34.0	39.2	57.8	16.0
CHECK	259.5	33.4	37.0	59.9	15.6
Mean	299.7	33.6	38.3	58.8	15.9
CV%	9.6	2.8	6.6	2.8	2.7
LSD $_{.05}$	33.1	NS	2.9	NS	0.5

[1] All yields, test weights, and proteins are adjusted to 12% moisture basis.

Table 3. Emergence counts on May 22 for various seed treatments, August and Perry Kirschmann Farm, Regent, ND, 2000.

Treatment	Emergence count[1]
	no./ft^2
FUMIGATED	25.8
4496	24.3
Charter MAX	21.8
Charter PB	23.6
DB Green L	23.0
DB Green L + RR	23.8
Dividend XL	24.5
L0120-A1 + Allegiance	22.6
L0267 - A1	23.8
Novartis 1	25.9
Novartis 2	24.1
RTU Vitavax + Thiram	22.1
Raxil MD	23.2
Raxil MD + L0120-A1-H	23.7
Raxil MD + L0120-A1	23.2
Raxil MD + Lindane 30	22.9
Raxil XT	24.6
CHECK	23.8
Mean	23.7
CV%	11.5
LSD $_{.05}$	NS

[1] Emergence count at 100% emergence.

Table 4. Initial root and plant evaluations of Trenton hard red spring wheat with various seed treatments, August and Perry Kirschmann Farm, Regent, ND, 2000.

Treatment	Development Stage	Length[1]	Tillers	Subcrown internode rating[2]	Seminal roots	Crown roots
	Haun	inches	no./plant		no./plant	no./plant
FUMIGATED	6.7	16.2	2.5	0.2	4.7	11.0
4496	6.3	15.5	2.2	0.1	5.1	8.4
Charter MAX	6.2	15.0	1.8	0.1	5.0	7.9
Charter PB	6.3	15.0	1.9	0.2	4.7	7.8
DB Green L	6.3	14.2	2.1	0.4	4.6	7.8
DB Green L + RR	6.1	14.2	1.9	0.4	4.4	8.4
Dividend XL	6.1	13.7	1.9	0.3	4.6	8.2
L0120-A1 + Allegiance	6.4	15.2	1.9	0.6	4.9	8.7
L0267 - A1	6.0	14.7	1.8	0.0	4.6	6.7
Novartis 1	6.4	15.1	2.3	0.1	4.9	9.0
Novartis 2	6.3	15.0	2.0	0.0	5.0	7.5
RTU Vitavax + Thiram	6.3	14.6	2.0	0.3	4.6	8.5
Raxil MD	6.2	14.1	2.0	0.4	4.9	8.9
Raxil MD L0120-A1-H	6.3	14.8	2.1	0.0	4.9	8.1
Raxil MD + L0120-A1	6.3	15.2	2.1	0.3	5.0	8.6
Raxil MD + Lindane 30	6.1	14.6	1.8	0.3	4.9	6.9
Raxil XT	6.3	14.5	2.2	0.2	4.8	9.2
CHECK	6.2	14.4	1.3	0.9	4.0	6.8
Mean	6.3	14.8	2.0	0.3	4.8	8.2
CV%	2.4	5.5	17.0	105.0	6.4	12.8
LSD $_{.05}$	0.2	1.2	0.5	0.4	0.4	1.5

[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 internode infected, multiple lesions, and 4 = 75-100% of internode infected, lesions coalesced.

Table 5. Root evaluation at the soft dough stage, August and Perry Kirschmann Farm, Regent, ND, 2000.

Treatment	Subcrown internode rating[1]	Root color[2]	Root mass[3]
FUMIGATED	0.6	1.5	3.1
4496	1.4	1.7	2.1
Charter MAX	1.2	1.9	1.9
Charter PB	1.2	1.8	1.9
DB Green L	1.6	1.9	2.1
DB Green L + RR	1.1	1.8	2.4
Dividend XL	1.7	2.1	2.3
L0120-A1 + Allegiance	1.7	1.9	2.1
L0267 - A1	0.5	1.7	1.9
Novartis 1	1.0	1.7	2.2
Novartis 2	1.5	2.2	2.4
RTU Vitavax + Thiram	1.6	2.2	2.4
Raxil MD	1.1	1.6	2.0
Raxil MD L0120-A1-H	1.5	1.8	2.1
Raxil MD + L0120-A1	1.5	1.8	2.2
Raxil MD + Lindane 30	1.2	1.8	1.9
Raxil XT	1.8	1.9	1.9
CHECK	2.1	2.0	2.0
Mean	1.3	1.8	2.2
CV%	40.9	15.5	14.6

LSD $_{.05}$	0.8	NS	0.4

[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 to 4. 1 = few roots and 4 = substantial root system.

[3] Root color index, 1 to 4. 1 = white and 4 = dark brown

Table 6. Precipitation record at the seed treatment demonstration site, August and Perry Krischmann Farm, Regent, ND, 2000.

Day	May	June	July	August
	---------- inches ----------			
1		0.04	0.10	0.17
2			0.01	0.07
3	Installed[1]	0.48	0.18	
4			0.01	
5			0.82	0.09
6			0.11	
7				
8				
9		0.02	0.05	
10		0.02	0.04	0.01
11	0.17		0.40	
12	0.01	0.45		
13		0.56		
14			0.16	
15	0.08	0.11	0.01	0.03
16		0.32		Removed[2]
17		0.17	0.04	

18		0.01	0.06	
19	0.05		0.02	
20			0.01	
21			0.02	
22			0.02	
23		0.01		
24			0.03	
25		0.06		
26	0.96			
27			0.01	
28	0.01			
29	0.07			
30				
31	0.39			
Total	1.74	2.25	2.10	0.37

[1] Installed = date Rainwise self tipping bucket rain gauge with Hobo event logger installed.
[2] Removed = date when rain gauge was removed from site.

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