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Agronomy Section

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Seed Treatment Demonstration - Regent, ND 2001

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Summary

Nineteen 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 tended to produce plants with greater seminal and crown root counts compared to plants in the untreated check. Root mass and root color were significantly improved for selected seed treatments compared to the untreated check. Grain yield for the fumigated and three registered and experimental treatments was greater than the untreated check. Pathogens know to be present at this site were *Fusarium graminearum*, *Pythium* spp and *Rhizoctonia* spp. *Bipolaris sorokiniana* (syn. *Helminthosporium sativum* = Common root rot) was not detected in root and crown tissue samples submitted for analysis.

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 August and Perry Kirschmann Farm near Regent, ND, at a site that had been in spring wheat continuously since 1993. The soil was a Moreau silty clay loam (pH 5.9, O.M. 2.8%, N 109 lb/A, P 32 PPM, K 440 PPM, Cl 43 lb/A). Ammonium sulfate (21-0-0-24) was applied at the rate of 200 pounds per acre on 5 May 2001. Rainfall of over a quarter of an inch occurred shortly after application. Roundup (glyphosate) was applied 3 May 2001 preplant to control volunteer and emerged weeds. 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 no-till drill with double disk openers was used to seed the plot.

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 (50 g m^{-2}), on 30 April 2001. The fumigated plots remained covered for 48 hours after which time the plastic was removed.

Trenton hard red spring wheat was seeded on 8 May 2001 at a rate of 1.5 million seeds per acre. Post emergence weed control consisted of an application of a tank mix of 2/3 pint per acre Puma with 1 pint per acre Buctril, applied on 27 May 2001. A second post emergence herbicide application was required on 13 Jun 2001. One pint of Bronate was applied. In addition to the herbicide, two fluid ounces of Tilt fungicide was tank mixed with the Bronate for the control of early season tan spot.

Emergence counts and vigor ratings were made on 16 May and 23 May on six plots per treatment. 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.

Root and crown samples from four plots per treatment were evaluated twice during the growing season. The first evaluation occurred between the six- and seven-leaf stage on 12 June and the second evaluation occurred at soft dough stage on 31 July. 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. During the second evaluation, selected plants from the CHECK plots were placed in a cooler and shipped overnight to the Plant Pest Diagnostic Laboratory at NDSU, Fargo, ND. Agar plate cultures were conducted on these selected root samples to determine fungi present.

Soil samples were taken from a CHECK plot and a FUMIGATED plot at the one-leaf and soft dough stages, 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 31 October 2001 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 record with a Hobo H8 Pro Series temperature data logger. Rainfall was 25% below normal in May but nearly 200% above normal during June and July.

Prior to harvest, mature plant height and head densities were determined. The plots were harvested on 16 August 2001 with a Massy Ferguson 8XP combine, 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 were adjusted to a 12% moisture basis (Hellevang, 1986).

All data except where noted were statistically analyzed using SAS Statistical software version 8.01.

Results and Discussion

Emergence and Vigor

No significant differences in emergence counts (Table 2) were detected for the 23 May counts when it appeared that 100% emergence had occurred. However plant counts tended to be greater for plots treated with products registered for the control of soil-borne pathogens. Significant differences in plant vigor were detected in the 16 May evaluation between the CHECK and seed treatments registered for the control of root disease. However no significant differences were detected at the later evaluation on 23 May between seed treatments and the CHECK. Crop condition appeared to deteriorate between 16 May and 23 May due to dry weather and soil conditions. Rainfall was below normal in May but in June the plots received twice the amount of normal rainfall. Visible differences between treatments could be seen (Figure 1 and 2) by the time crop development had advanced to the sixth- to seventh-leaf stage.

Grain Yield and Test Weight

Grain yields (Table 3) for Raxil MD, Raxil MD Extra, and Charter Max were significantly greater than that of the untreated CHECK but were significantly less than the FUMIGATED treatment. Products labeled for the control of root pathogens tended to produce higher yields than the CHECK. Reducing the application rate of Raxil MD (Raxil MD-L) did not improve grain yield significantly over the untreated 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. However, producers should consider the use of insecticides in fields where wireworm infestations are thought to exist.

Test weight (Table 3) for a few of the experimental and registered products was significantly greater than the FUMIGATED treatment. These differences may have been due to the maturity of the plants in relation to moisture stress during grain fill. No significant differences in grain protein content were observed between the untreated CHECK and seed treatments.

Root Evaluations and Soil Propagule Counts

Seminal and crown root counts (Table 4) tended to be greater for seed treatments registered for the control of root diseases. Also plant length tended to be longer for seed treatments registered for the control of root pathogens. Fewer lesions were noted on thesubcrown internode, root mass was larger and roots were healthier than the CHECK for seed treatments registered for the control of root disease (Table 5).

Fusarium graminearum, *Pythium* spp., and *Rhizoctonia* spp. were isolated from tissue cultures of root and crown tissue taken from the CHECK plots. Ten of 19 fungicide seed treatments were found to significantly reduce subcrown internode lesion ratings compared with the CHECK at the soft dough stage. Of the ten seed treatments with fewer subcrown internode lesions, five treatments had significantly whiter roots than the CHECK. Of the five seed treatments with whiter roots, two treatments had significantly greater root mass than the CHECK. Symptoms found on the subcrown internodes were consistent with the type of lesions produced by *Bipolaris sorokiniana* L. (Common root rot) but no cultures of this disease from tissue samples submitted were found. Fungi propagule counts (Table 6) indicated that *Fusarium* spp levels were very high in non-fumigated soils (Natural) at the beginning of the growing season. *Fumigation also had an effect on Pythium and Rhizoctonia propagule counts early in the season. Fusarium* propagules were not identified to species so all Fusarium propagules detected in the soil using Komad's medium can not be attributed to disease producing *Fusarium* species. Two thirds of the root and crown samples submitted for tissue analysis contained *Fusarium*. *Pythium* propagule levels at the beginning of the season were approaching levels that are thought to cause economic losses and benefit from seed treatments that control *Pythium*. All of the tissue samples submitted for analysis for *Pythium* were found to have this pathogen. *Rhizoctonia* propagule levels were considered low and less likely to cause economic loss than Fusarium, although all nine of the root and crown samples submitted for tissue analysis provided positive readings for *Rhizoctonia*.

Not all products performed better than the CHECK in most agronomic characteristics measured. D B Green L tended to exhibit equal or poorer performance than the CHECK in 12 of 18 agronomic characteristics reported. However products such as Charter Max, Raxil MD, and Dividend XL tended to show better performance compared with the CHECK in 17, 15, and 14 agronomic characteristics measured respectively. Products registered for the control of root pathogens tended to exhibit better performance in most agronomic characteristics

measured.

Implications of Demonstration

Seed treatments do provide some protection against root pathogens that infect wheat as evidenced by root and yield data in this demonstration. Fungicidal seed treatments with activity against Fusarium, Pythium, and common root rot tended to promote healthier root systems. Soil fumigation reduces soil-born pathogens and may modify nutrient availability in soil, both of which affects yield.

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Tables & Figures

Figure 1. Seed treatment plots on the August and Perry Kirschmann farm, Regent, ND, 2001. The fumigated plot is on the left and the check plot is on the right. Plants growing in the fumigated soil treatment were at the 6.6 Haun stage and those grown in the check plot were at the 6.4 Haun stage when this photo was taken. Note the uneven growth in the check plot compared with the fumigated plot.

Figure 2. Check plot is on the left and Syngenta #9 seed treatment is on the right. Note bare ground and uneven growth in check plot compared with treated seed plot.

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]
Charter MAX	Not Registered in USA	Triticonazole 1.3 Metalaxyl 0.5	5.8 fl oz/cwt	NA[2]
Charter PB	Not Registered	Triticonazole 1.3 Thiram 13.0	5.5 fl oz/cwt	NA[2]

	in USA			
DB Green L	Registered	Maneb 25.6 Lindane 8.6	5 fl oz/cwt	Seedling Blight
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
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 - L	Registered	Tebuconazole 0.48 Metalaxyl 0.64	3 fl oz/cwt	Seedling Blight, Pythium, Common Root Rot, Loose Smut
Gus Trt #1	Not Registered	Tebuconazole 0.48 Metalaxyl 0.64 L0258-A2	5 fl oz/cwt 25 PPM PR	NA[2]
Dividend OX 1.67 FS	Registered	Difenoconazole 16.5 Mefenoxam 1.38	1 fl oz/cwt	Common Root Rot, Pythium, Seedling Blight, Loose Smut
Syn Trt #4	Not Registered	CGA307759 Apron XL	NA[2]	NA[2]
Syn Trt #5	Not Registered	CGA301940 Apron XL	NA[2]	NA[2]
Syn Trt #6	Not Registered	CGA301940 Apron XL	NA[2]	NA[2]
Syn Trt #7	Not Registered	CGA301940 Apron XL	NA[2]	NA[2]
Syn Trt #8	Not Registered	Hexaconazole Apron XL	NA[2]	NA[2]
Syn Trt #9	Not Registered	Dividend XL CGA301940	NA[2]	NA[2]
Syn Trt #10	Not Registered	Maxim XL CGA301940	NA[2]	NA[2]

[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. Emergence counts and vigor ratings for various seed treatments on May 16 and May 23, 2001, August and Perry Kirschmann Farm, Regent, ND.

	May 16	May 23		
Treatment	**Plant count**	**Vigor[1]**	**Plant count**	**Vigor[1]**
	no./ft2	***%***	***no./ft2***	***%***
Check	19.3	64	26.1	82
Fumigated	24.2	100	29.5	92
Raxil MD	22.9	93	30.3	79
Raxil MD + Gaucho	20.8	87	30.2	85
Raxil MD Extra	25.8	90	33.1	77
Gustafson Exp Trt #1	21.7	85	29.4	68
RTU Vitavax-Thiram	23.5	82	28.2	83
DB Green	19.3	65	25.9	82
DB Green + RR II	17.7	75	27.8	76
Charter PB	16.7	83	27.6	80
Charter MAX	24.6	85	30.4	84
Vitavax 200 + Flo-Pro IMZ	18.9	71	28.6	78
Dividend XL	20.5	90	29.1	80
Raxil MD - L[2]	19.4	82	30.7	80
Syngenta Exp Trt #4	15.2	86	24.5	87

Syngenta Exp Trt #5	16.5	73	28.2	80
Syngenta Exp Trt #6	13.5	70	25.9	78
Syngenta Exp Trt #7	14.9	78	28.2	76
Syngenta Exp Trt #8	19.0	85	27.4	81
Syngenta Exp Trt #9	16.4	80	23.6	77
Syngenta Exp Trt #10	19.4	81	27.2	81
Mean	19.5	81.2	28.2	80.2
CV%	28.8	8.2	15.2	10.6
$LSD_{.05}$	6.45	7.6	NS	9.7

[1] Vigor is a visual rating.

[2] Raxil MD - L is Raxil MD applied at a rate less than current labeled rate.

Table 3. Grain yield, test weight, protein, height and head density at harvest of Trenton hard red spring wheat grown under various seed treatments, August and Perry Kirschmann Farm, Regent, ND, 2001.

			---------- Grain[1] ----------		
Treatment	**Head density**	**Height**	**Yield**	**Test weight**	**Protein**
	no/yd2	***inches***	***bu/a***	***lb/bu***	***%***
CHECK	329.4	36.1	56.5	60.6	15.4
FUMIGATED	390.2	36.8	63.1	60.1	15.8
Raxil MD	329.6	36.9	59.0	60.4	15.5
Raxil MD + Gaucho	336.5	36.8	58.3	60.5	15.2
Raxil MD extra	325.5	37.1	59.1	60.4	15.5
Gus Trt #1	337.4	36.7	57.8	60.1	15.5
RTU Vitavax + Thiram	312.3	36.4	58.2	60.8	15.6

DB Green L	329.2	35.7	57.7	60.9	15.4
DB Green L + RR II	327.6	36.3	58.0	60.9	15.5
Charter PB	330.3	36.7	57.7	60.7	15.5
Charter Max	337.4	37.0	59.2	60.8	15.5
Vitavax 200 + Flo Pro IMZ	326.0	36.2	57.3	60.9	15.7
Dividend XL	318.4	37.0	58.2	60.7	15.3
Raxil MD - L[2]	322.1	36.3	57.2	60.4	15.6
Syn Trt #4	325.3	36.8	57.3	60.3	15.6
Syn Trt #5	348.2	36.6	57.0	60.7	15.5
Syn Trt #6	332.2	35.9	58.2	60.4	15.6
Syn Trt #7	333.8	36.1	58.0	60.9	15.5
Syn Trt #8	338.1	35.5	58.2	60.9	15.4
Syn Trt #9	326.4	36.1	58.3	61.1	15.6
Syn Trt #10	342.9	36.0	57.9	61.0	15.6
Mean	333.3	36.4	58.2	60.6	15.5
CV %	7.3	2.6	3.3	0.8	1.8
LSD $_{.05}$	27.7	NS	2.2	0.6	0.3

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

[2] Raxil MD - L is Raxil MD applied at a rate less than current labeled rate.

Table 4. Initial root and plant evaluations of Trenton hard red spring wheat with various seed treatments, August and Perry Kirschmann Farm, Regent, ND, 2001.

Treatment	Development stage	Length[1]	Tillers	Subcrown internode rating[2]	Seminal roots	Crown roots
	Haun	*mm*	*no./plant*		*no./plant*	*no./plant*

CHECK	6.4	385.1	2.9	1.45	4.9	9.9
FUMIGATED	6.6	431.2	3.6	1.33	5.6	14.1
Raxil MD	6.4	402.9	3.1	1.13	4.8	11.5
Raxil MD + Gaucho	6.3	400.3	2.6	1.00	5.0	9.4
Raxil MD extra	6.5	396.0	2.8	1.00	5.3	10.2
Gus Trt #1	6.3	399.2	2.9	1.25	5.3	10.3
RTU Vitavax - Thiram	6.4	404.1	2.6	1.10	5.5	10.3
DB Green L	6.3	373.0	3.1	1.00	4.9	8.9
DB Green L + RR II	6.2	384.3	3.0	1.03	5.6	10.7
Charter PB	6.2	388.4	3.2	1.03	5.6	9.4
Charter Max	6.3	393.4	3.4	1.00	5.0	10.1
Vitavax 200 + Flo Pro IMZ	6.1	370.3	3.5	1.45	5.3	8.9
Dividend XL	6.3	388.2	3.2	1.38	5.1	10.4
Raxil MD - L[3]	6.3	385.7	3.2	1.38	5.3	9.6
Syn Trt #4	6.2	380.8	3.1	1.18	5.3	9.6
Syn Trt #5	6.3	372.1	3.4	1.13	5.0	10.3
Syn Trt #6	6.1	365.8	3.3	1.10	5.3	9.0
Syn Trt #7	6.2	355.8	3.1	1.10	4.9	9.0
Syn Trt #8	6.1	376.2	3.1	1.20	4.5	10.0
Syn Trt #9	6.3	378.8	3.2	1.08	4.9	10.3
Syn Trt #10	6.3	395.2	3.2	1.10	5.2	11.2
Mean	6.3	387.0	3.1	1.16	5.1	10.1
CV%	2.3	4.4	16.7	20.4	8.4	11.7
LSD $_{.05}$	0.2	23.9	NS	NS	0.6	1.7

[1] Length measured from the crown to the tip of the last fully extended leaf of the plant.

[2] Subcrown internode rating, 1 to 4. 1 = less than 25% of the internode infected, 2 = 25 to 50% of the internode infected, 3 = 50 to 75% of

the internode infected, multiple lesions, and 4 = 75 to 100% of the internode infected, lesions coalesced.

[3] Raxil MD - L is Raxil MD applied at a rate less than the current labeled rate.

Table 5. Root evaluation at the soft dough stage, August and Perry Kirschmann Farm, Regent, ND, 2001.

Treatment	Subcrown internode rating[1]	Root color[2]	Root Mass[3]
CHECK	1.87	2.30	2.42
FUMIGATED	1.55	1.84	3.08
Raxil MD	1.41	2.09	2.63
Raxil MD + Gaucho	1.40	2.16	2.45
Raxil MD extra	1.37	2.12	2.52
Gus Trt #1	1.25	2.07	2.73
RTU Vitavax + Thiram	1.80	2.36	2.27
DB Green L	1.98	2.30	2.40
DG Green L + RR II	1.37	2.39	2.56
Charter PB	1.51	2.21	2.62
Charter Max	1.60	2.09	2.70
Vitavax 200 + Flo Pro IMZ	1.42	2.22	2.57
Dividend XL	1.40	2.06	2.59
Raxil MD - L[4]	1.80	2.28	2.24
Syn Trt #4	1.66	2.02	2.59
Syn Trt #5	1.65	2.12	2.71
Syn Trt #6	1.69	2.07	2.65
Syn Trt #7	1.83	2.19	2.52
Syn Trt #8	1.45	2.19	2.51

Syn Trt #9	1.44	2.08	2.66
Syn Trt #10	1.84	2.11	2.68
Mean	1.58	2.16	2.58
CV%	16.0	5.9	6.7
LSD $_{.05}$	0.36	0.18	0.25

[1] Subcrown internode rating, 1-4. 1 = less than 25% internode infected, 2 = 25 - 50% of internode infected, 3 = 51-75% infected, multiple lesions, and 4 = 75-100% of internode infected, lesions coalesced.

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

[3] Root mass 1 to 4. 1 = few roots and 4 = substantial root system.

[4] Raxil MD - L is Raxil MD applied at a rate less than current labeled rate.

Table 6. Soil-borne pathogen survey of the August and Perry Kirschmann site, Regent, ND, 2001.

	May 16		**August 5**	
Pathogen	**Fumigated**	**Natural**	**Fumigated**	**Natural**
	---------- Propagules g^{-1} soil ----------			
Fusarium	90 (VL)	1760 (VH)	110 (L)	1840 (VH)
Pythium	280 (L)	360 (M)	320 (M)	300 (M)
Rhizoctonia	0	10 (L)	0	10 (L)

(VL) = very low number of propagules of pathogen isolated per gram of soil sample tested; (L) = low numbers; (M) = moderate numbers; (H) = high numbers; (VH) = very high numbers of propagules isolated.