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Seed Treatment Demonstration - Regent 1999

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Summary

Thirteen 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 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 root counts and earlier flowering than the seed treatments not registered for the control of root pathogens and also the untreated check. Significant grain yield increases over the untreated check were noted for the fumigated check and one experimental seed treatment. Pathogens know 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.). 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, after planting 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 is necessary in order to optimize the yield potential-related inputs of a system. The inclusion of a fumigated check plot provided the opportunity to "know" the yield potential by reducing 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 experiment was located on the August and Perry Kirschmann Farm, 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 April 1999. No tillage beyond the application of anhydrous ammonia was done. 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 and a biological seed treatment 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 four replications was used in this demonstration. 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 mg^{-2}), on April 29, 1999. Fumigated plots remained covered for 48 hours after which time the plastic was removed.

Trenton hard red spring wheat was seeded on May 19, 1999 at the 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] pins per acre of Buctril, applied on June 16, 1999.

Root and crown samples from three replicated plots per treatment were evaluated twice during the growing season. The first evaluation occurred at flag to early boot 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. After washing, samples were placed in a plastic bag, placed in a plastic cooler and shipped via overnight mail to the Plant Pathology Department at NDSU, Fargo, ND. Subcrown internodes, root color and root mass were rated. Agar plate cultures were conducted on selected root samples to determine fungi present.

A soil sample was taken from a check plot at soft dough stage and submitted to Eden Bioscience Corporation, Bothell, Washington, to determine the level of soil propagules per gram of soil for three species of fungi. Pythium presence and levels were determined using a modification of J. Michell[illegible]s selective antibiotic medium (1981); Fusarium presence and levels were determined using Komada[illegible]s medium (Komada, 1975); and Rhizoctonia presence and levels were determined using a MKH at 1:1000 dilution (Sneh, 1991).

Flower completion was estimated on July 13 by selecting 10 heads in each plot at random and visually determining the percent of florets that had expressed anthers in each of the ten heads.

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

All data was 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 currently registered seed treatments for wheat and the CHECK (Table 2). However, grain yield of the FUMIGATED and the experimental seed treatment, LS207 + LS176, was 9.9 and 4.8 bushel per acre, respectively, greater than the CHECK. Treatments that contained an insecticide such as imidacloprid or lindane 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.

Grain yield differences may have been greater if foliar disease had been absent. Septoria and tan spot infections occurred throughout the season at this location. Test weight for all treatments was less than 60 pounds per bushel, possibly as a result of these infections. No significant difference in protein occurred among treatments.

No significant differences were found in stand establishment counts at 16 days after planting (data not shown). However head density at harvest was greater for the FUMIGATED treatment compared to the CHECK treatment (Table 2). Tiller counts done during the initial root evaluation were not significantly different, but there was a tendency for tiller counts and head density counts to be greater for seed treatments in comparison to the CHECK.

Root Evaluations

Initial Root and Plant Evaluation

A significant increase in seminal root numbers was noted for FUMIGATED and some of the registered and experimental treatments (Table 3). Though crown root counts were not statistically significant, the FUMIGATED as well as treated seed plots tended to have more crown roots than the CHECK. Treatments that contained imazalil, a product active against the common root rot fungus, tended to have crown root counts between 22 and 23 roots per plant. A seed treatment that contained fungicides that are active on both common root rot and *Pythium* tended to have crown root counts of 26 to 27 crown roots per plant.

Plant length for the FUMIGATED treatment was significantly longer than the CHECK, but not significantly longer than most seed treatments. Plant length for most seed treatments tended to be longer than the CHECK.

Root Evaluation at Soft Dough

No significant differences were detected in the subcrown internode, root mass, and root color ratings at this site (Table 4) although seed treatments tended to have larger root mass and whiter root systems. Root tissue samples analyzed indicated that *Pythium* and *Bipolaris sorokiniana (*syn*. Helminthosporium sativum)* were present. The fungus soil assay for Fusarium in the untreated check at the soft dough stage indicated that there were 145 propagules per gram of soil.

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).

Flowering

Root and crown disease is known to delay development and maturity (Cook and Veseth, 1991). Flowering differences were noted between treatments (Table 5). Products know to contain fungicides that are active against pathogens which attack the crown and roots of wheat had a greater percentage of the heads flowered at the time of evaluation than the CHECK and maneb + lindane treatment. Maneb, a fungicide used primarily to control fungi that cause seedling blight or seed rot, is not registered for root rot control and has little affect on fungi that cause root rot.

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 one experimental seed treatment, LS 207 + LS 176 and the FUMIGATED treatment.

A seed treatment demonstration on hard red spring wheat is scheduled for the 2000 at the August and Perry Kirschmann farm near Regent.

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Table 1. Active ingredients of seed treatments used at Regent, ND, 1999.

Treatment	Status	Active ingredient[1]	Active on disease[2]
LS207	Experimental	NA[2]	NA
LS207 + LS176	Experimental	NA[2]	NA
4492	Experimental	NA[2]	NA
L324	Experimental	Biological agent	NA
DB Green L	Registered	Maneb + Lindane	Seedling Blight
DB Green L + RR	Registered	Maneb + Imazalil + Lindane	Seedling Blight, Common Root Rot
Dividend XL	Registered	Difenoconazole + Mefenoxam	Common Root Rot, Pythium, Seedling Blight, Loose Smut
Maxim	Registered	Fludioxonil	Seedling Blight
Raxil MD	Registered	Tebuconazole + Metalaxyl	Seedling Blight, Pythium, Common Root Rot
Raxil MD + Flo Pro IMZ	Registered	Tebuconazole + Metalaxyl + Imazalil	Seedling Blight, Pythium, Common Root Rot, Loose Smut
Raxil MD + Gaucho	Registered	Tebuconazole + Metalaxyl + Imidacloprid	Seedling Blight, Pythium, Common Root Rot, Loose Smut
Raxil MD + Kodiak	Registered	Tebuconazole + Metalaxyl + Biological agent	Seedling Blight, Pythium, Common Root Rot, Loose Smut
RTU Vitavax + Thiram	Registered	Carboxin + Thiram	Seedling Blight, Loose Smut

1Lindane and Imidacloprid are insecticides.
[2]Registered seed treatment for wheat has activity on seed-borne and/or soil-borne pathogen that cause these diseases.

[3]NA = Not Available.

Table 2. Grain yield, protein, test weight, height, head density, and grain moisture at harvest of Trenton hard red spring wheat grown under various seed treatments, August and Perry Kirschmann Farm, Regent, ND, 1999.

Treatment	Head density	Height	Yield[1]	Test weight[1]	Protein[1]	Moisture[2]
	no./yd²	*inches*	*bu/a*	*lb/bu*	*%*	*%*
Fumigated	422.5	39.0	46.8	58.0	16.9	10.9
LS 207 + LS 176	337.7	38.0	41.7	57.9	16.5	11.3
Dividend XL	300.7	37.6	40.1	58.6	16.4	12.3
Raxil MD + Gaucho	287.9	38.9	39.6	59.1	16.0	12.7
Raxil MD + Kodiak	298.0	37.2	39.6	57.9	16.7	12.4
RTU Vitavax + Thiram	306.1	37.5	39.2	57.7	16.6	12.3
Raxil MD	283.2	36.7	39.2	58.5	16.2	14.2
Raxil + Flo Pro IMZ	285.9	36.5	39.1	58.4	16.6	12.7
DB Green L + RR	302.7	37.2	39.0	58.6	16.2	12.1
DB Green L	297.4	37.5	38.7	58.7	16.4	12.6
LS 207	312.8	38.0	38.4	57.6	16.8	11.3
4492	312.2	36.9	37.6	57.9	16.6	14.1
L 324	271.1	37.6	37.2	58.6	16.1	12.5
Maxim	287.9	37.1	37.2	58.5	16.4	13.3
Check	279.2	36.2	36.9	58.3	16.4	12.4
Mean	305.7	37.5	39.4	58.3	16.4	12.5
CV%	12.9	3.7	8.0	1.7	3.2	11.0
$LSD_{0.05}$	56.2	NS	4.5	NS	NS	NS

[1] Value adjusted to 12% moisture.
[2] Percent moisture in grain at the time of harvest.

Table 3. Initial root and plant evaluations of Trenton hard red spring wheat with various seed treatments, August and Perry Kirschmann Farm, Regent, 1999.

Treatment	Development stage	Length[1]	Tillers	Subcrown rating[2]	Seminal roots	Crown roots
	Haun	*inches*	*no./plant*		*no./plant*	*no./plant*
Fumigated	9.7	27.6	3.9	0.4	5.7	27.0
LS 207 + LS 176	9.2	25.3	3.8	0.2	5.4	26.1
Dividend XL	9.3	25.0	3.5	0.2	6.0	26.7
Raxil MD + Gaucho	9.1	23.3	2.5	0.6	5.7	17.8
Raxil MD + Kodiak	9.1	24.6	3.1	0.4	5.4	20.9
RTU Vitavax + Thiram	8.8	21.6	2.6	0.9	4.7	15.9
Raxil MD	9.2	21.3	3.1	0.3	4.4	15.7
Raxil MD + Flo Pro IMZ	8.9	22.4	3.6	0.5	5.3	22.8
DB Green L + RR	9.3	23.4	2.6	0.4	5.9	22.5
DB Green L	8.9	21.7	2.5	0.5	4.4	20.4
LS 207	8.9	23.7	2.7	0.5	5.6	21.5
4492	9.0	22.9	2.4	0.6	4.7	17.7
L324	8.9	23.5	2.3	0.5	5.1	24.3
Maxim	9.1	22.9	2.3	0.8	4.8	18.3
Check	8.7	22.1	2.5	0.7	4.6	14.7
Mean	9.1	23.4	2.9	0.5	5.2	20.3
CV%	5.8	6.1	28.6	63.0	11.0	28.1
LSD $_{0.05}$	NS	5.2	NS	NS	1.0	NS

[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 internode infected, 3= 51-75% of internode infected, multiple lesions, and 4= 75-100% of internode infected, lesions coalesced.

Table 4. Root evaluation at the soft dough stage, August and Perry Kirschmann Farm, Regent, ND, 1999.

Treatment	Subcrown internode rating[1]	Root mass[2]	Root color[3]

Fumigated	2.37	2.67	2.33
LS 207 + LS 176	2.46	3.00	1.67
Dividend XL	2.48	3.00	2.50
Raxil MD + Gaucho	2.47	2.67	3.00
Raxil MD + Kodiak	2.59	3.00	2.33
RTU Vitavax + Thiram	2.75	2.33	2.67
Raxil MD	2.49	2.67	2.33
Raxil MD + Flo Pro IMZ	2.89	2.33	3.33
DB Green L + RR	2.12	3.00	2.00
DB Green L	2.40	3.00	2.33
LS 207	2.46	2.67	2.67
4492	2.84	2.67	2.67
L 324	2.09	2.67	2.00
Maxim	2.41	2.67	2.67
Check	2.67	2.00	3.00
Mean	2.50	2.69	2.50
CV%	15.2	22.3	24.0
$LSD_{0.05}$	NS	NS	NS

[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, mulitiple lesions, and 4= 75 to 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, 4 = dark brown.

Table 5. Percent flowering of Trenton hard red spring wheat grown under various seed treatments, August and Perry Kirschmann Farm, Regent, ND, July 13, 1999.

Treatment	**Flower**
	%
Fumigated	100.0

LS 207 + LS 176	40.0
Dividend XL	22.5
Raxil MD + Gaucho	25.0
Raxil MD + Kodiak	25.0
RTU Vitavax + Thiram	25.0
Raxil MD	20.0
Raxil MD + Flo Pro IMZ	22.5
DB Green L + RR	20.0
DB Green L	0.0
LS 207	15.0
4492	17.5
L 324	22.5
Maxim	17.5
Check	0.0
Mean	24.8
CV%	40.0
LSD $_{0.05}$	13.5