Winter Wheat Seed Treatment Demonstration – Dickinson, ND 2003

R.O. Ashley, M.P. McMullen, E. Eriksmoen, and G. Martin

Summary

Seven registered and experimental seed treatments were evaluated for the control of fungal root and crown diseases on hard red winter wheat (*Triticum aestivum* L. c.v. CDC Falcon) by comparing disease, growth, and yield parameters of treated plots to those in untreated check and fumigated soil plots in southwest North Dakota. Significant improvement in the rate of plant emergence was noted in three of the seed treatments compared to the check when emergence was complete in the spring. Head density, height, and yield of the seed treatments tended to be greater than the check but not significantly.

Introduction

Winter wheat is commonly no-till seeded into standing spring wheat stubble in southwest North Dakota for protection against temperature extremes that often occur during winter and early spring. In addition to the stress on plants produced by these extreme conditions, soil-borne pathogens may affect the ability of hard red winter wheat to survive the dormant period into the following spring (Cook and Veseth, 1991). A number of protectant or systemic seed treatments are registered for wheat seed treatment. Some are specific for certain seed or soil-borne disease while others are wide spectrum. Often several products are combined or formulated to provide control of a wider spectrum of disease.

Soil-borne fungi and seed treatments are affected by individual or local soil environments (Piccinni, Shriver, and Rush, 2001) 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 yield potential, as fumigation reduces root pathogen populations. The purpose of this study was to demonstrate the ability of fungicide seed treatments to improve emergence under weather stressed conditions, control root and crown pathogens in winter wheat grown after durum wheat.

Methods

The demonstration was conducted on the Ryan Kadrmas Farm near Dickinson, ND, at a site that had been durum wheat in 2002, sunflower in 2001, and in continuous wheat for previous six years. The soil is a Moreau silty clay loam. The soil was sampled on 13 Sep 2002 and analyzed at the NDSU Soil Testing Laboratory. The soil analysis indicated the soil contained 38 lbs/acre NO_3-N, 27 ppm P, 545 ppm K, 101 lbs/acre SO_4-S and 29 lbs/acre Cl. Organic mater content at the site was 3.6% and pH was 6.9. Nitrogen at the rate of 150 lbs/acre was broadcast applied on 11 Apr 2003 in the form of ammonium nitrate.

One quart of Roundup UltraMax (glyphosate) and one quart per acre of ActaMaster Spray Adjuvant (ammonium sulfate) was applied on 4 Sep 2002 preplant to control volunteer and emerged weeds.

CDC Falcon hard red winter wheat was treated with various seed treatment fungicides and insecticides prior to planting (Table 1). Seed planted in the fumigated soil check (FUMIGATED) and the check (CHECK) plots were untreated. A no-till drill with double disc 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 Roughrider 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 cans of methyl bromide in trays was released under the plastic sheet at the rate of one pound per 100 ft^2 (50 g m^{-2}), on 16 September 2003. The fumigated plots remained covered for 48 hours after which time the plastic was removed.

CDC Falcon hard red winter wheat was seeded on 23 September 2002 at the rate of 1,200,000 seeds per acre. Post emergence weed control consisted of an application of a tank mix of Harmony Extra, Buctril, and Puma applied on 22 May 2003. Folicur 3.6F foliar fungicide was

applied with an air mist sprayer at the rate of 4 fl oz/acre at head emergence on 28 Jun 2003.

Dry soil conditions in the seed zone immediately after seeding delayed germination. Precipitation was not received until 16 Oct 2002. Air temperature in October 2002 averaged 8.8°F cooler than the long-term average temperature for the area. Emergence did no occur until the spring of 2003. Emergence counts were made on 22 March and 10 April on six plots per treatment. Plant counts in two eight-foot sections of row were collected and plants per square meter calculated.

Root and crown samples from six plots per treatment were evaluated at Zadoks 30 (stem elongation) growth stage and three plots per treatment were evaluated at Zadoks 85 (soft dough) growth stage. For the first evaluation, 15 plants were carefully dug from each plot and excess soil gently shaken from the roots on 27 May 2003. 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 the seminal and crown roots. Twenty-five plants for the second evaluation were carefully dug on 10 Jul 2003 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.

Soil samples were taken from a CHECK plot at harvest, stored in a refrigerator at a temperature between 40° and 45°F until they were submitted to Riberio Plant Lab Inc., Bainbridge Island, Washington, on 20 August 2003 to determine propagule levels in the soil for three species of fungi. Pythium levels were determined using a modification of 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. Rainfall was 75% of normal from April through July.

Prior to harvest, mature plant height and head densities were determined. The plots were harvested on 6 Aug 2003 with a Massy Ferguson 8XP combine, which measured grain weight harvested, percent moisture of harvested grain, and test weight. Harvested area was measured and yield 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).

Results and Discussion

Emergence

Sufficient number of winter wheat plants did not emerge until early spring 2003 due to dry surface conditions and cooler than normal temperatures after seeding. Significant differences in plant counts were observed in five of the seven seed treatments when compared to the untreated CHECK for the 22 Mar 2003 plant counts (Table 2). When emergence was complete three of the seed treatments show significant improvement in plant stands compared to the CHECK. All seed treatments produced plant stands that were greater than the CHECK plot but less than the FUMIGATED soil plot. Weed counts were not done but wild oat and some broadleaf populations appeared to be greater in the CHECK plot than in the seed treated plots (Figure 1). Establishment of vigorous, competitive stands is important in controlling weeds even when herbicides are used.

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

Seed treated plot grain yields (Table 3) were not significantly greater when compared to the CHECK plot. Treatments of Dividend XL 1.67FS, A12532 + CrusierFS, and A12532 + CGA301940 produced grain yields that were greater than the CHECK plots but less than the FUMIGATED soil plots. Grain yield was significantly improved in the FUMIGATED soil plots. Seed treatments that contained an insecticide were not significantly better than the seed treatments without an insecticide. Wireworms were not found during field inspections or during root and crown

evaluations. However, producers should consider the use of insecticides in fields where wireworm infestations are thought to exist.

Head density and mature plant height (Table 3) showed no significant improvement between seed treatments and the CHECK plots, though there was a significant difference between the FUMIGATED soil plots and the CHECK plots. Head density and mature plant height tended to be less for the treatment, A12532+Maxium4FS+CGA301940, than the CHECK. Raxil XT had head densities tended to be lower than the CHECK in this trial. All other seed treatments in this trial had head densities that were greater than the CHECK but less than the FUMIGATED soil plots.

No significant differences were detected between FUMIGATED soil, the untreated CHECK, or seed treatment plots in this trial.

Root Evaluations and Propagule Counts

None of the seed treatments tested in this trial significantly delayed plant development (Table 4). Plant development was significantly faster in FUMIGATED soil plots than the CHECK plots. Plant development was significantly faster than the CHECK plot in the FUMIGATED soil plots. Plant length for the Raxil XT seed treatment was significantly longer than plants from the CHECK plots. The remainder of the seed treatments examined in this study did not significantly lengthen or stunt plant length although all seed treatments tended to produced plants with greater length than the CHECK plots but shorter than the FUMIGATED soil plots.

No significant differences were detected in root numbers or tiller numbers produced in this trial during the initial evaluation.

No significant differences in root color and root mass were noted among seed treatments, FUMIGATED soil, and the CHECK plots during the root and crown evaluation made of plants in the soft dough stage (Table 5). This may be the result of only moderate propagule numbers for Pythium (210 g-1 soil) and high numbers of Fusarium (1600 g-1 soil) (Ribeiro, 2003). Fusarium propagules were not identified to species so all Fusarium propagules detected in the soil using Komad's medium cannot be attributed to disease producing Fusarium species.

No significant differences were detected for the subcrown internode rating (Table 5). No soil-borne propagule test was used to detect *Bipolaris sorokiniana* L.

Implications of Demonstration

Cold stress as well as soil-borne pathogens may increase the difficulty in establishing winter wheat plant stands. Fungicidal seed treatments with activity against Fusarium and Pythium tended to promote improved establishment of winter wheat after delayed emergence by initially dry soil conditions followed by cool wet conditions in late fall, into winter and early spring. Stand establishment is essential in providing enough winter wheat plots to be competitive with weeds an yield well. Soil fumigation reduces soil-borne pathogens and may modify nutrient availability in soil, both of which affects yield.

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Table 1. Active ingredients of seed treatments used on CDC Falcon hard red winter wheat , Dickinson, ND, 2003.

Treatment	Status	Active ingredient and (percent concentration in product)	Product AI Rate	Active on disease[1]
			g/100 kg seed	
Dividend XL 1.67 FS	Registered	Difenoconazole (16.5) Mefenoxam (1.38)	9.75	Common Root Rot, Pythium, Seedling Blight, Loose Smut
A12532	Experimental	NA[2]	11.25	NA[2]
Raxil XT 35 WP	Registered	Tebuconazole (15.0) Metalaxyl (20.0)	3.5	Seedling Blight, Pythium, Common Root Rot, Loose Smut
A12532 +	Experimental	NA[2]	6.0	NA[2]
Maxim 4FS +	Registered	Fludioxonil (40.3)	1.25	Fusarium, Rhizoctonia, Helminthosporium, Aspergillus, Penicillium
CGA301940	Experimental	NA[2]	2.5	NA
Raxil XT 35 WP +	Registered	Tebuconazole (15.0) Metalaxyl (20.0)	3.5	Seedling Blight, Pythium, Common Root Rot, Loose
Gaucho 480FS	Registered	Imidacloprid[3] (40.7)	5.0	Smut
A12532 +	Experimental	NA[2]	11.25	NA[2]
Cruiser 5FS	Registered	Thiamethoxam[3] (47.6)	7.5	
A12532 +	Experimental	NA[2]	11.25	NA[2]
CGA301940	Experimental	NA[2]	2.5	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] Gaucho 480FS and Cruiser 5FS are insecticides.

Table 2. Stand counts for CDC Falcon hard red winter wheat with various seed treatments, Ryan Kadrmas Farm, Dickinson, ND, 2003.

Treatment	22 March 2003	10 Apr 2003
	plants m^{-2}	plants m^{-2}
CHECK	73.6	159.6
FUMIGATED	123.4	290.9
Dividend XL 1.67FS	87.3	183.5
A12532	95.8	184.8
Raxil MD	101.2	199.2
A12532 + Maxim + CGA3019	95.8	166.7
Raxil XT + Gaucho 480	106.8	200.0
A12532 + CGA30194	88.3	176.9
Mean	97.1	193.5
CV %	17.5	15.4
$LSD_{.05}$	19.8	34.9
Reps	6	6

Table 3. Winter wheat (cv. CDC Falcon) seed treatment on the Ryan Kadrmas Farm, Dickinson, ND, 2003.

			---------- Grain[1] ----------		
Treatment	Head density	Height	Yield	Test weight	Protein
	m^{-2}	mm	bu/A	lb/bu	%
CHECK	510.1	670.8	63.5	55.8	14.1
FUMIGATED	688.1	718.6	74.1	56.3	14.4
Dividend XL 1.67FS	547.0	689.2	65.6	56.0	13.9
A12532 115FS	528.0	679.8	60.5	55.3	14.3
Raxil XT	499.5	675.1	62.3	55.2	13.9
A12532 + Maxium4FS + CGA301940	463.0	666.8	63.0	56.2	14.0
Raxil XT + Gaucho 480[2]	575.3	674.9	63.4	55.8	14.2
A12532 + Crusier FS[2]	540.0	672.2	64.1	56.0	14.2
A12532 + CGA301940	549.6	681.4	64.6	55.9	13.8
Mean	544.5	681.0	64.6	55.8	14.1
CV%	14.9	2.9	9.8	3.1	10.7
LSD .05	94.9	23.0	7.4	NS	NS
Reps	6	6	6	6	6

[1] All grain yields, test weights, and proteins are adjusted to a 12% moisture basis.
[2] Guacho 480 and Crusier FS are insecticides.

Table 4. Initial root and plant evaluations of CDC Falcon hard red winter wheat for various seed treatments, Ryan Kadrmas Farm, Dickinson, ND, 2003.

Treatment	Development stage	Length[1]	Tillers	Subcrown internode rating[2]	Seminal roots	Crown roots
	Zadoks	mm	no plant^{-1}		no plant^{-1}	no plant^{-1}
CHECK	30.3	341.2	5.8	1.0	3.5	13.5
FUMIGATED	31.6	438.3	6.3	1.0	3.9	17.8
Dividend XL 1.67 FS	29.9	344.4	5.8	1.0	3.4	13.6
A12532	29.7	346.9	5.1	1.0	3.4	13.4
Raxil XT WP	31.0	382.9	6.2	1.0	3.6	16.3
A12532 + Maxim + CGA3019	30.2	371.2	6.2	1.0	3.4	15.3
Raxil XT WP + Gaucho 480[3]	30.3	362.5	5.8	1.0	3.4	14.7
A12532 + Cruiser FS[3]	29.9	349.2	5.6	1.0	3.3	13.6
A12532 + CGA30194	31.0	373.6	5.9	1.0	3.7	15.2
Mean	30.4	367.8	5.8	1.0	3.5	14.8
CV %	3.3	7.6	26.4	-	12.8	18.1
LSD $_{.05}$	1.2	32.7	NS	-	NS	NS
Reps	6	6	6	6	6	6

[1] Length is measured from the crown to the tip of the last fully extended leaf of the plant.
[2] Subcrown internode rating, 1 – 4. 1 = less than 25% of the internode infected, 2 = 25 – 50% of the internode infected, 3 = 50 to 75% of the internode infected, multiple lesions, and 4 = 75 – 100% of the internode infected, lesions coalesced.
[3] Gaucho 480 and Cruiser FS are insecticides.

Table 5. Root evaluation at the soft dough stage, CDC Falcon hard red winter wheat, Ryan Kadrmas Farm, Dickinson, ND, 2003.

Treatment	Subcrown internode rating[1]	Root mass[2]	Root color[3]
CHECK	1.4	2.2	2.3
FUMIGATED	1.3	2.2	1.9
Dividend XL 1.67FS	1.4	2.5	1.9
A12532	1.1	2.5	2.0
Raxil XT WP	1.3	2.3	1.8
A12532 + Maxim + CGA3019	1.2	2.3	1.7
Raxil XT WP + Gaucho 480[4]	1.2	2.2	2.0
A12532 + Cruiser FS[4]	1.2	2.0	2.0
A12532 + CGA30194	1.1	2.5	1.9
Mean	1.1	2.3	2.0
CV %	16.2	11.2	11.6
$LSD_{.05}$	NS	NS	NS
Reps	3	3	3

[1] Subcrown internode rating, 1 – 4. 1 = less than 25% internode infected, 2 = 25 – 50% internode infected, 3 = 51 – 75% 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, 4 = dark brown.

[4] Gaucho 480 and Cruiser are insecticides.

Figure 1. Plot on left was planted with a Dividend XL 1.67FS fungicide seed treatment while the plot on the right was seeded with untreated seed (CHECK). Immediately behind the CHECK plot is a FUMIGATED soil plot. The plot immediately behind the Dividend XL 1.67FS fungicide seed treatment plot is another CHECK plot. Note the difference in the wild oat infestation between the CHECK, FUMIGATED, and the fungicide seed treatment plot.