Spring Barley Seed Treatment Trial, Hettinger County, North Dakota, 2005

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Summary

Four experimental seed applied fungicides were compared to two registered seed applied fungicides on barley (*Hordeum vulgare* L.) in two separate trials at one location near Mott, ND. One trial specifically screened products for the control of loose smut (*Ustilago nuda*) and the other trial was designed to specifically screen products for the control of root and crown rots though differences in loose smut control were observed. Significant differences were observed in the control of seed-borne as well as soil-borne diseases as well as grain yield.

Introduction

Seeds may be treated with fungicides for various reasons. These reasons include: 1) prevention of disease development because 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 that cause root and crown rots. A number of protectant or systemic seed treatments are registered for barley 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. The purpose of this study was to demonstrate the ability of fungicide seed treatments to control the seed-borne disease loose smut (*Ustilago nuda*) in disease containing seed and root and crown pathogens such as Foot rot (*Fusarium* spp.), common root rot (*Bipolaris sorokiniana*), *Pythium* spp., *Rhizoctonia* spp in a continuous or intense cereal rotations.

Methods

Two experiments were conducted in a field located near Mott, ND (46.59728 N, 102.28103 W). One experiment was specifically designed to compare two experimental fungicides (KNF 2834 and KNF 2827) at various application rates with two registered fungicides (Raxil MD and Dividend XL) used at labeled rates for the control of loose smut. Barley seed with a known *Ustilago nuda* infection rate of 6% was treated with various fungicide treatments prior to planting. Prior to seeding a germination test was performed for each treatment. On 26 Apr, seed was planted at the rate of 197.6 seed m^{-2} using no-till methods into wheat residue after gylphosate was applied to control volunteer wheat and weeds. A herbicide application of 0.4 oz of Harmony GT XP + 0.66 pt of Puma + 0.75 pt MCP ester per acre was applied on 28 May when the crop was at Haun stage 2 to 2.5. Plant counts were made on 19 May and on 26 May. Loose smut head evaluation was done on 9 Jul by counting the number of smutted heads per 50 heads and the results recorded.

The second experiment was designed to compare two experimental fungicides (KNF 4330 and KNF 4331) at various rates with two registered fungicides (Raxil MD and Dividend XL) used at labeled rates for the control of soil-borne root diseases, primarily *Fusarium* spp., *Pythium* spp., *Rhizoctonia* spp., and Common root rot (*Bipolaris sorokiniana*). In addition the testing of these fungicides on soil-borne pathogens, the products were also examined for the control of loose smut. The previous crop was winter wheat. Soil samples taken on 14 Apr, submitted to Ribeiro Plant Lab, Inc., Bainbridge Island, WA for analysis of Pythium, Fusarium, and Rhizoctonia propagules. 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 (Sneth, 1991). Propagule counts for *Bipolaris sorokiniana*, the cause of common root rot, were not done.

Fertilizer, post emergent weed control, and other management practice used with this trial were the same as in the loose smut trial. Plant counts were made on 19 May and on 26 May.

Initial plant evaluations were made on 21 Jun and the root and crown evaluation at soft dough was done on 22 Jul. Soil samples taken at soft dough and analyzed for soil-borne disease propagules of *Fusarium* spp. *Pythium* spp. and *Rhizoctonia* spp. Plants in these treatments were also examined for loose smut on 9 July.

Root and crown samples from four plots per treatment were evaluated twice during the growing season. The first evaluation occurred between Haun stage 4.5 and 5.5 (tillering) and the second evaluation occurred at Haun stage 14.5 to 15.0 (soft dough). 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 (Ledingham et al 1973).

Harvest was with a Massy Ferguson 8XP combine on 22 Aug. Grain yield and test weight were adjusted to 12% moisture basis (Helevang 1986). All data was statistically analyzed using SAS Statistical software version 9.1.

Results and Discussion

Loose smut treatments

Germination, Emergence and Vigor

As treatment rates increased for the experimental seed applied fungicides germination rates tended to decrease compared to the same fungicides applied at the lowest rates (Table 1). However, no significant differences in germination or emergence were noted for the experimental or labeled fungicide treatments compared to the untreated check. Vigor was significantly improved over the check during early emergence and tended to be improved but not significantly during the final evaluation of vigor.

Smutted Heads

Significant reductions in the number of smutted heads observed were noted for all seed treatments compared to the check (Table 2). Dividend XL controlled about only 50% of the loose smut and had significantly less control compared to the remaining fungicide seed treatments used in this trial. In most instances when application rates increased for the experimental fungicide treatments the percent of smutted heads tended to decrease. Treatment KNF 2827 at 2 g of active ingredient per 100 Kg of seed was the only treatment in the trial where no smutted heads were observed.

Head Density, Plant Height, Grain Yield and Test Weight

No significant differences were noted in head density, plant height, grain yield or test weight (Table 2). Grain yields for all seed treatments in this trial tended to be greater than the check except Dividend XL. Seed treatments did not affect head density or plant height.

Root Rot

Germination, Emergence and Vigor

No significant differences were noted in germination and emergence for these seed applied fungicides and the check (Table 3). As application rate increased for KNF 4330 germination rate tended to decrease but not significantly. Seed treatments significantly improved vigor at the time of the first evaluation and tended to improve vigor at the time of the final evaluation on 25 May.

Root Evaluations and Soil-borne Disease Propagule Counts

The initial evaluation indicated KNF 4331 tended to delay development and seminal root development though not significantly (Table 4). None of the treatments provided significant improvement in plant performance during the initial evaluation.

The subcrown internode rating and root color was significantly improved and root mass

tended to be larger when compared to the check during the second evaluation.

Propagule counts (Ribeiro 2005a) at the beginning of the season were 200 propagules (Low) of Fusarium per gram of soil, 340 propagules (Moderate) of Pythium per gram of soil and no Rhizoctonia propagules were detected for the 14 April sampling date. However, Propagule counts were 1220 propagules (High) of Fusarium per gram of soil, 240 propagules (Moderate) of Pythium per gram of soil, and 30 propagule (Moderate) of Rhizoctonia per gram of soil for the sample taken on 9 July (Ribeiro 2005b).

The higher disease propagule counts at soft dough may explain the significant differences detected during the root evaluation at soft dough stage found at this location. During the first evaluation disease pressure was low but developed to significant levels by the time the second evaluation occurred.

Loose smut

As in the previous trial discussed in this report, Dividend XL provided significantly less control of loose smut than all of the remaining fungicide seed treatments (Table 5). KNF 4331 at 2 g of active ingredient per 100 Kg of seed was the most effective product in this trial for the control of loose smut.

Grain Yield and Test Weight

KNF 4330 at 1.50 g A/100Kg of seed, KNF 4331 at 1.75 g A/100 Kg of seed, and KNF 4331 at 2.0 g A/100 Kg of seed produced grain yields significantly greater than the check(Table 5). Grain yields for all other treatments tended to be higher than the check yield.

Implications of Demonstration

Loose Smut

All of the seed applied fungicide treatments except Dividend XL provided loose smut control equivalent to Raxil MD a registered seed treatment currently labeled for the control of loose smut in barley. Dividend XL controlled only about one-half KNF 2728 at 2.0 grams of active ingredient per acre provided the highest control rating of loose smut of any of the treatments examined in this trial while maintaining a high degree of safety to seed germination, emergence, and vigor.

Root Rot

Seed treated with KNF 4331 at 2.0 grams of active ingredient per 100 Kg of seed produced the highest yields in this root rot trial and nearly the lowest percentage of smutted heads. In addition to few smutted heads this treatment also produced the greatest number of crown roots per plant and highest number of tillers of any of the treatments in this trial. The ability of this treatment to improve subcrown internode and root color ratings over the check should be of interest to producers.

Cooperating Producer and Financial Support

The authors wish to thank Francis and Darwyn Mayer for providing the use of their land to these trials. In addition, the authors wish to extend a thank you to Crompton Uniroyal Chemical Company for their financial support of this trial.

The following individuals assisted with collecting the data: Joshua Seekins, Wesley Messer, Michael Carr and Nevin Ringwall.

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Table 1. Germination and stand counts for Drummond barley with various seed treatments for loose smut (*Ustilago nuda*), Mott, ND, 2005.

Treatment	Rate[3]	Seed Germination	Initial[1] Stand count	Initial[1] Vigor	Second[2] Stand count	Second[2] Vigor
	g A 100Kg^{-1}	%	m^{-2}		m^{-2}	
Check	NA	91.3	60.6	5.0	117.9	5.8
KNF2834	1.00	93.3	67.1	8.3	122.9	7.5
KNF2834	1.25	93.3	59.1	7.3	118.8	7.5
KNF2834	1.50	90.7	56.6	8.0	116.9	6.8
KNF2834	2.00	88.7	60.2	6.3	109.0	7.8
KNF2827	1.00	96.7	64.1	6.8	114.7	7.8
KNF2827	1.50	94.0	60.8	7.5	119.9	7.0
KNF2827	2.00	92.0	55.6	8.3	117.4	7.8
Raxil MD	3.50	95.3	54.1	7.3	116.4	7.5
Dividend XL	1.30	94.7	55.9	7.3	119.2	7.0
Mean		93.0	59.4	7.2	117.3	7.2
CV%		4.2	18.1	12.0	9.7	15.3
LSD .05		6.7	15.6	1.2	16.5	1.6
SE		2.3	5.4	0.4	5.7	0.5
Trt F Prob		0.4036	0.8091	0.0003	0.9176	0.2833
Rep F Prob		0.1767	0.0050	0.1492	0.0039	0.6766

[1] Initial count performed on 19 May.
[2] Second count performed on 26 May.
[3] Rates for products used in treatment are grams of active ingredient per 100 Kg of seed.

Table 2. Smutted heads, grain yield, test weight, height, and head density of Drummond barley grown with various seed treatments for the control of loose smut (*Ustilago nuda*), Mott, ND, 2005.

Treatment	Rate[2]	Smutted heads	Head density	Plant height[3]	Grain[1] Yield	Grain[1] Test weight
	g A 100Kg^{-1}	%	m^{-1}	mm	bu/a	lb/bu
Check	NA	19.0	211.3	648.8	51.4	44.3
KNF2834	1.00	3.5	199.3	653.8	55.6	43.6
KNF2834	1.25	5.0	211.3	660.0	55.2	43.6
KNF2834	1.50	3.0	216.8	650.0	55.1	43.7
KNF2834	2.00	1.0	216.2	667.5	54.8	43.5
KNF2827	1.00	3.0	187.0	652.5	54.3	43.7
KNF2827	1.50	1.5	211.3	666.6	57.1	44.0
KNF2827	2.00	0.0	222.0	652.5	54.5	43.9
Raxil MD	3.50	1.0	212.8	645.0	53.0	44.1
Dividend XL	1.30	10.0	198.7	620.0	50.0	43.5
Mean		4.7	208.6	651.7	54.1	43.8
CV%		86.7	7.8	5.2	5.4	1.2
LSD .05		5.9	23.8	48.7	4.2	0.7606
SE		2.0	8.2	16.8	1.5	0.3
Trt F Prob		<.0001	0.1501	0.7580	0.0709	0.4314
Rep F Prob		0.8753	0.0001	0.0008	0.0001	0.3233

[1] Grain yield, test weight, and protein were adjusted to a 12% moisture basis.
[2] Rates for products used in treatment are grams of active ingredient per 100 Kg of seed.
[3] Plant height is measured from base of plant at soil surface to the tip of the head excluding awns.

Table 3. Germination and stand counts for Drummond barley with various seed treatments, Mott, ND, 2005.

Treatment	Rate[3]	Germination	-------- Initial[1] --------		--- Second[2] ---	
			Stand count	Vigor	Stand count	Vigor
	g A 100Kg^{-1}	%	m^{-2}		m^{-2}	
Check	NA	91.3	77.0	5.0	138.4	5.3
KNF4330	1.50	94.7	79.2	6.5	137.0	6.8
KNF4330	1.75	92.0	83.4	7.0	136.5	6.3
KNF4330	2.00	88.7	77.5	5.3	130.4	7.5
KNF4331	1.50	92.7	81.0	7.3	140.5	6.3
KNF4331	1.75	96.0	75.7	6.8	124.9	7.0
KNF4331	2.00	95.3	80.2	6.3	129.9	7.0
Raxil MD	3.50	92.7	73.3	6.8	133.4	6.5
Dividend XL	1.30	96.7	78.2	6.5	141.2	7.0
Mean		93.3	78.3	6.4	134.7	6.6
CV%		4.8	18.0	11.9	12.1	13.8
LSD .05		7.7	20.6	1.1	23.9	1.3
SE		2.9	7.1	0.4	8.2	0.5
Trt F Prob		0.4832	0.9916	0.0035	0.8834	0.0856
Rep F Prob		0.9358	0.3174	0.9854	0.0020	0.1409

[1] Initial count performed on 19 May.
[2] Second count performed on 25 May.
[3] Rates for products used in treatment are grams of active ingredient per 100 Kg of seed.

Table 4. Initial root/plant and soft dough evaluations of Drummond barley with various seed treatments, Mott, ND, 2005.

Treatment	Rate[3]	---------- Initial evaluation[1] ----------						- Soft dough evaluation[2] -		
		Plant length	Stage	Tiller	SCI[4]	Seminal root	Crown root	SCI[4]	Root color[5]	Root mass[6]
	g A 100Kg^{-1}	mm	Haun	no plant^{-1}		no plant^{-1}	no plant^{-1}			
Check	NA	303.2	5.1	1.9	1.2	1.1	13.3	1.7	2.2	2.0
KNF4330	1.50	269.0	5.0	2.0	1.0	1.5	11.1	1.3	1.8	2.5
KNF4330	1.75	259.6	5.1	2.1	1.1	1.3	13.3	1.3	1.7	2.4
KNF4330	2.00	259.8	5.0	2.0	1.1	1.1	12.0	1.3	1.9	2.4
KNF4331	1.50	274.7	5.0	1.8	1.1	0.8	13.7	1.2	1.8	2.3
KNF4331	1.75	282.9	4.7	2.0	1.1	0.7	13.8	1.2	1.8	2.2
KNF4331	2.00	297.7	4.8	2.2	1.0	1.0	14.2	1.3	1.9	2.1
Raxil MD	3.50	261.7	5.1	2.1	1.1	1.2	12.7	1.3	1.9	2.3
Dividend XL	1.30	277.2	5.2	2.0	1.1	1.0	13.6	1.5	1.9	2.5
Mean		276.2	5.0	2.0	1.1	1.2	13.1	1.3	1.9	2.3
CV%		9.4	7.4	17.8	9.1	62.8	11.2	10.5	6.6	11.0
LSD .05		37.7	0.5	0.5	0.1	1.0	2.1	0.2	0.2	0.4
SE		12.9	0.2	0.2	0.05	0.3	0.7	0.07	0.06	0.13
Trt F Prob		0.1971	0.7477	0.9596	0.4969	0.7702	0.1196	0.0014	0.0040	0.0699
Rep F Prob		0.0001	0.0004	0.1473	0.6646	0.1657	0.0001	0.4340	0.0004	0.6014

[1] Initial evaluation performed 1 Jun 2005.
[2] Soft dough evaluation performed on 14 Jul 2005.
[3] Rates for products used in treatment are grams of active ingredient per 100 Kg of seed.
[4] Subcrown internode rating, 1-4. 1 = less than 25% internode infected, 2 = 25-50% internode infected, 3 = 50 – 75% internode infected, multiple lesions, and 4 = 75-100% internode infected, lesions coalesced.
[5] Root color rating, 1-4. 1 = white roots, 4 = dark roots.
[6] Root mass rating, 1-4. 1= few roots, 4 = many roots.

Table 5. Grain yield, test weight, protein, height, and head density of Drummond barley grown under various seed treatments, Mott, ND, 2005.

Treatment	Rate[2]	Smutted heads	Head density	Plant height	Grain[1] Yield	Grain[1] Test weight
	g A $100Kg^{-1}$	%	no m^{-1}	mm	bu/a	lb/bu
Check	NA	22.5	218.6	661.3	51.8	43.8
KNF4330	1.50	3.5	223.3	633.8	56.0	44.1
KNF4330	1.75	3.0	225.4	668.8	54.6	44.0
KNF4330	2.00	0.5	219.9	638.8	54.7	44.0
KNF4331	1.50	3.0	207.0	652.5	53.1	43.2
KNF4331	1.75	2.5	211.0	632.5	56.4	44.2
KNF4331	2.00	1.0	223.3	680.0	58.7	44.0
Raxil MD	3.50	3.0	234.6	690.0	52.9	44.0
Dividend XL	1.30	7.5	222.6	651.3	55.1	44.1
Mean		5.2	220.6	656.5	54.8	43.9
CV%		25.0	12.2	3.5	4.9	1.2
LSD .05		3.9	39.3	33.4	3.9	0.8
SE		1.3	13.5	11.5	1.3	0.3
Trt F Prob		0.0001	0.9319	0.0141	0.0471	0.3987
Rep F Prob		0.3215	0.3138	0.0027	0.4249	0.0076

[1] Grain yield, test weight, and protein were adjusted to a 12% moisture basis.
[2] Rates for products used in treatment are grams of active ingredient per 100 Kg of seed.