Improving Wheat and Durum Seedling Stands and Vigor by Fungicide Seed Treatments

M.P. McMullen and **R.W. Stack**

Good quality, disease-free seed is the first requirement for producing a successful small grain crop. Healthy, plump seed results in increased stand and vigor and ultimately, increased yields. When wheat seeds that contain fungal infections are planted, reduced germination and seedling blight generally occur (6).

Seedling blight in wheat and durum is caused by several fungi; important among these in North Dakota are *Fusarium graminearum* and *Helminthosporium sativum* (4). Both of these fungi can survive in soil and debris and attack a healthy seed to cause seedling blight, but they also may infect the heads, resulting in diseased seed. The head infection by *F. graminearum* results in a seed disease called scab, and head infection by *H. sativum* results in a seed disease called black point. Planting scabby or black pointed seed will result in seedling blight.

Spring wheat and durum crops in much of eastern North Dakota and western Minnesota were severely damaged in 1986 by late season fungal infections of the head and kernels. Frequent rains during flowering and into maturity allowed for severe infections of head scab and black point. Harvested grain was shriveled and low in test weight. Test weights of hard red spring wheats and durums recorded from experiment station trials at Fargo and Langdon were 4 to 10 pounds lighter than test weights for the same cultivars at Williston and Dickinson experiment stations, whereas in most years test weights in the east are similar to or higher than those at the western locations (2).

Seed treatment fungicides are available to control seedling blights (3). However, many of the registered fungicides are considered contact fungicides, with activity primarily against fungi on the seed surface. Fusarium infections have been shown to be internal in the endosperm, as well as on the surface and in the seed coat (1). Because of the very high incidence of fungal infections in 1986 seed lots examined, and because of the high level of scab infections, a seed treatment study, testing registered and non-registered contact and systemic fungicides, was done. The purpose of this study was to see if these seed treatments could improve stand and vigor of these seed lots.

McMullen is plant pathologist, Cooperative Extension Service; Stack is professor, Department of Plant Pathology. *The authors thank Tracey Christianson and Marjorie Olson for their technical assistance. This study was partially supported by grants from: AGSCO, Inc., Grand Forks, ND; Janssen Pharmaceutica, Piscataway, New Jersey; KenoGard, Stockholm, Sweden; and MSDAGVET, Rathway, New Jersey.*

MATERIALS AND METHODS

Two hard red spring wheat cultivars, Marshall and Wheaton, and two durum cultivars, Lloyd and Cando, were used for seed treatment studies. All four seed lots were from 1986 harvested grain, the hard red spring wheats from the Red River Valley and the durums from the Langdon area. These seed lots were not screened to remove the smallest, lightest kernels. Seeds were tested at random, regardless of size or appearance.

Fusarium graminearum is the principal cause of head scab in North Dakota (5). It was recovered from up to 66 percent of the non-surface disinfested seed plated on artificial media and from up to 44 percent of surface disinfested seed. The black point fungus, *H. sativum*, was recovered from 31-74 percent of the seeds plated, depending on seed lot. All seeds plated had some fungal infection present, and scab and black point fungi were dominant.

Each experiment tested 12 seed treatment fungicide combinations against two untreated controls (Table 1). Seed treatment fungicides included registered and non-registered compounds (Table 1). Of the fungicides tested, thiabendazole, carboxin, and imazalil are considered to have systemic activity.

In each experiment, 50g of seed of each cultivar was treated with the appropriate amount of fungicide. Treated seeds of each cultivar were planted in soil beds in the greenhouse. There were eight replications of 12 seeds each per cultivar. All treatments were arranged in a randomized complete block design.

In the first experiment, treated seeds of Marshall, Wheaton, and Lloyd were planted in beds of sterilized soil on October 23, 1986. Final stand counts on this seeding date were taken on November 17, 1986. Average soil temperature in these beds during the experiment was 16°C (61°F).

In the second experiment Lloyd and Wheaton were planted in separate, sterilized soil beds on November 19, 1986. Average soil temperature in these beds was 11°C (52°F). Cando and Marshall were planted in sterilized soil beds on December 1, 1986. Soil temperature in these beds was 13°C (55°F). Final stands were determine on December 22, 1986.

Biomass measurements were made on plants of Experiment 2 to determine seedling vigor. All above-ground plant tissue was harvested on January 7, 1987, then dried and weighed.

Table 1. Seed treatment fungicides, rates of application and source.

No.	Common name	Trade name	Rate of application[a]	Source
	Treatment			
1.	Control			
2.	Thiabendazole	Mertect LSP	0.5 fl oz/cwt	MSD Agvet
3.	Thiabendazole	Mertect LSP	1.0 fl oz/cwt	MSD Agvet
4.	Thiabendazole	Mertect LSP	2.0 fl oz/cwt	MSD Agvet
5.	Guazatine	Panoctine[b]	2 ml/kg	KenoGard
6.	Guazatine + Imazalil	Panoctine Plus[b]	2 ml/kg	KenoGard
7.	Maneb + Lindane	DB Green L	5 fl oz/cwt	Agsco
8.	None	Ceresan M[c]	0.5 oz/bu	—
9.	Carboxin + Thiram	Vitavax 200	3 fl oz/cwt	Gustafson
10.	Imazalil FL	Imazalil FL[d]	0.42 fl oz/cwt	Janssen
11.	Imazalil ME	Imazalil ME[d]	1.5 fl oz/cwt	Janssen
12.	Maneb + Lindane + Imazalil	DB Green L + RR	5 fl oz/cwt + 0.8 fl oz/cwt	Agsco
13.	Thiram	Thiram 30-F	10.1 fl oz/cwt	Gustafson
14.	Control			

[a]All rates given are formulation rates of the product.
[b]Seed treatment products registered in Europe, not yet registered in the United States.
[c]Ceresan M = ethyl mercury p-toluine sulfonanalide. Mercury containing seed treatments are not registered for use in the United States. This compound is included for comparison only.
[d]New formulations of imazalil; not yet available to the consumer.

RESULTS AND DISCUSSIONS

In experiment 1 (soil temp. 16C), seed treatments improved plant stands above the untreated controls as much as 17 percent (Table 2). Ten seed treatments significantly improved germination over the average stand counts of the two untreated controls. Ceresan M, a product no longer on the market, gave the best improvement in stand. As this product is no longer registered, it only was included as a standard against which other products could be measured. The second best treatments in this experiment were the 2 fluid ounce rate of thiabendazole and the carboxin plus thiram treatment. These two fungicides have systemic activity.

In experiment 2 (soil temp. 11°C or 13°C), seed treatments also significantly improved plant stands above the untreated controls, with a maximum of 13 percent improvement in stand (Table 3). In these colder soils, Ceresan M treatment again increased plant stands the most, followed by maneb in combination with imazalil, thiabendazole at the 1.0 fl oz rate, and maneb alone. Ten of the 12 treatments improved plant stand significantly over the average plant stand of the two controls. Thiabendazole at the 2.0 fluid ounce rate appeared to inhibit germination under colder soil conditions, while under warmer soil temperatures (experiment 1) it was one of the best treatments.

Biomass measurements showed significant improvement in plant vigor with the Ceresan M and maneb treatments (Table 4). All other seed treatments, except for thiabendazole at the 2.0 fluid ounce rate, also improved biomass measurements, but not significantly so. Thiabendazole at the high rate of 2 fluid ounce per hundredweight resulted in lower seedling vigor than the untreated controls, while the 1.0 fluid ounce and 0.5 fluid ounce per hundredweight rates improved vigor, indicating an inhibition of plant growth at the high rate and at colder temperatures that was not evident under warmer soil temperatures (Table 2).

Table 2. Seed treatment effects on plant stands (soil temp. 16°C). Values given are the means over three cultivars (Percent stand of 288 seeds).

	Treatment	Percent stand
1	Control	68.75
14	Control	74.00
7	Maneb[a]	76.42
2	Thiabendazole, 0.5 fl oz[b]	77.10
13	Thiram	79.92
6	Guazatine + Imazalil	80.06
10	Imazalil FL	80.09
12	Maneb + Imazalil[a]	81.16
5	Guazatine	81.17
11	Imazalil ME	81.92
3	Thiabendazole, 1.0 fl oz[b]	82.67
9	Carboxin + Thiram	83.00
4	Thiabendazole, 2.0 fl oz[b]	83.00
8	Ceresan M	86.17

LSD (0.05) = 7.58
[a]Maneb products tested also contain lindane for wireworm control. Wireworms not present in this experiment.
[b]Rate given is formulation rate.

Table 3. Seed treatment effects on plant stand (soil temp. 11°C and 13°C). Values given are the means over four cultivars (Percent stand of 384 seeds).

	Treatment	Percent stand
1	Control	72.00
14	Control	76.25
10	Imazalil FL	77.75
4	Thiabendazole, 2.0 fl oz[b]	78.25
2	Thiabendazole, 0.5 fl oz[b]	80.50
9	Carboxin + Thiram	80.75
6	Guazatine + Imazalil	81.50
5	Guazatine	81.50
13	Thiram	81.75
11	Imazalil ME	81.75
7	Maneb[a]	82.00
3	Thiabendazole, 1.0 fl oz[b]	82.50
12	Maneb + Imazalil[a]	84.50
8	Ceresan M	85.25

LSD (0.05) = 6.02
[a]Maneb products tested also contain lindane for wireworm control.
[b]Rate given is formulation rate.

Table 4. Seed treatment effects on seedling vigor (soil temp. 11°C and 13°C). Vigor was measured as total dry weight/cultivar/treatment. Values given are the means over four cultivars.

	Treatment	Dry Weight (grams)
4	Thiabendazole, 2.0 fl oz[b]	0.87
14	Control	0.93
1	Control	0.94
3	Thiabendazole, 1.0 fl oz[b]	0.98
13	Thiram	0.99
11	Imazalil ME	1.01
10	Imazalil FL	1.04
6	Guazatine + Imazalil	1.04
9	Carboxin + Thiram	1.04
2	Thiabendazole, 0.5 fl oz[b]	1.05
12	Maneb + Imazalil[a]	1.05
5	Guazatine	1.07
7	Maneb[a]	1.13
8	Ceresan M	1.16

LSD (0.05) = 0.15
[a]Maneb products tested also contain lindane for control of wireworms. Wireworms not present in this experiment.
[b]Rate given is the formulation rate.

CONCLUSIONS

Seed treatment fungicides significantly improved stands and vigor of spring wheat and durum seed lots containing high levels of scabby and black-pointed seed. The majority of the seed treatments in this study significantly improved stand over the untreated controls. However, the differences among individual seed treatments in stand improvement generally were not statistically significant. Seed treatment fungicides differed in their ability to improve stand under varying seed bed temperatures. Experiment 2, with the cooler soil temperatures, may have been closer to natural field conditions than the warmer soil beds of Experiment 1.

Although seed treatments cannot rejuvenate dead seed, or improve germination from 50 percent to 100 percent, these results indicate that with diseased seed, appropriate seed treatment can result in substantial improvement in germination and seedling vigor. In addition to seed treatment, rigorous seed conditioning, with removal of seeds low in kernel weight, will provide additional improvement in stands and crop quality.

LITERATURE CITED

1. Bechtel, D.B., L.A. Kaleikau, R.L. Gaines, and L.M. Seitz. 1985. The effects of *Fusarium graminearum* infection on wheat kernels. Cereal Chem. 62:191-197.
2. Crop Production Guide. 1987. North Dakota Agricultural Association. 394p.
3. Lamey, H.A. and Marcia P. McMullen. 1986. 1987 Field Crop Fungicide Guide. North Dakota Cooperative Extension Circular PP-622 (Revised). 16p.
4. Sprague, R. 1944. Rootrots of cereals and grasses in North Dakota. N.D. Agric. Exp. Sta. Tech. Bul. 332. 35pp.
5. Stack, Robert W. and Marcia P. McMullen. 1985. Head blighting potential of *Fusarium* species associated with spring wheat heads. Can. J. Plant Path. 7:79-82.
6. Weise, M.V. 1977. Compendium of Wheat Diseases. American Phytopathology Society Press, St. Paul. pp. 11-17.