Fungicide Seed Treatment Effects on Disease and Nodulation of Field Pea in North Dakota

Bob Henson, Carl Bradley, Scott Halley, Bryan Hanson, Kent McKay, and Mark Halvorson

Introduction

Dry pea (*Pisum sativum*) production in North Dakota has grown from approximately 64,000 acres planted in 1999 to 160,000 acres planted in 2003. In North Dakota, dry pea is generally planted in the early spring when soil temperatures tend to be cold. Early spring rain showers, along with cold soil temperatures, provide a good environment for seed and seedling diseases caused by *Pythium* spp. With the abundance of broadleaf crops that are grown in North Dakota, field inoculum levels of the root rot pathogens *Rhizoctonia solani* and *Fusarium* spp. can be moderately high, increasing the potential for stand and yield reductions depending on weather patterns. Fungicide seed treatments are management tools that can be used to protect pea seeds and seedlings against diseases, but little information is available on their performance against diseases and their effect on nodulation under North Dakota conditions. In addition, little is known about the occurrence and distribution of specific field pea root rot pathogens in North Dakota soils. Proper disease identification is crucial to developing management strategies.

Objectives

The objectives of this study were: to determine the effects of field pea fungicide seed treatments labeled for use in North Dakota on stand, disease, nodulation, and yield under three North Dakota field environments; to study the compatibility of these seed treatments with *Rhizobium* inoculant; and to identify field pea root pathogens present in North Dakota soils.

Materials and Methods

Fungicide seed treatments and an untreated control were evaluated at the North Dakota State University Carrington, Langdon, and North Central (Minot) Research Extension Centers in 2003 and 2004. In 2003, the treatments consisted of Apron XL LS (mefenoxam, Syngenta, Greensboro, NC) at 0.64 fl oz/cwt, ApronMaxx RTA (mefenoxam + fludioxonil, Syngenta) at 5 fl oz/cwt, Captan 400 (captan, Gustafson, Plano, TX) at 2.5 fl oz/cwt, Kodiak concentrate (*Bacillus subtilus* GBO3, Gustafson) at 0.125 oz/cwt, Kodiak concentrate + Allegiance LS (metalaxyl, Gustafson) at 0.125 oz/cwt + 1.2 fl oz/cwt, and an untreated control. In 2004, an additional treatment was evaluated which was ApronMaxx RTA + Dynasty (azoxystrobin, Syngenta) at 5 fl oz/cwt + 0.765 fl oz/cwt. Fungicide seed treatments were applied as slurries to dry pea cv. 'Integra'. The *Rhizobium* inoculant CellTech-C (Nitragin, Inc., Brookfield, WI) was applied to the seeds either just prior to planting or three days prior to planting. A universal control treatment (no fungicide, no inoculant) was also included to bring the total number of treatments to 13 and 15 in 2003 and 2004, respectively. Data collected consisted of stand, nodulation, root length, root rot lesion length, and yield. Isolations from diseased roots were made by surface disinfesting root tissue with a 10% Clorox solution for one minute, rinsing with sterile distilled water for one minute, and placing tissue on potato dextrose agar amended with streptomycin sulfate (200 mg/L).

Results and Discussion

Carrington 2003. No significant ($P \leq 0.05$) differences among any of the treatments for any of the measured parameters occurred (Table 1). *Rhizoctonia solani* and *Fusarium* spp. were isolated from diseased roots.

Table 1. Effect of fungicide seed treatments and timing of *Rhizobium* inoculant on plant stand, nodulation, root length, root disease, and yield at Carrington in 2003.

Fungicide seed treatment	Inoculant timing (days before planting)	Stand (plants/A)	Nodulation (1-9)[a]	Root length (mm)	Root rot lesions (mm)	Yield (bu/A)
None	0	227,000	3.8	69	2	59
Apron XL	3	239,000	3.5	86	6	58
ApronMaxx	3	243,000	4.8	82	1	58
Kodiak	0	271,000	4.0	85	3	55
Kodiak	3	243,000	3.5	78	4	55
Apron XL	0	259,000	3.5	76	4	55
ApronMaxx	0	267,000	4.3	68	3	55
Captan 400	3	251,000	3.8	85	4	55
None	3	239,000	3.5	78	5	54
Kodiak + Allegiance	3	247,000	3.5	84	5	52
Captan 400	0	255,000	5.3	84	4	52
Kodiak + Allegiance	0	255,000	4.0	84	3	51
None	No inoculant	251,000	4.0	84	4	49
LSD 0.05	-	ns[b]	ns	ns	ns	ns
CV%	-	10.2	25.2	14.5	86.4	13.6

[a] Nodulation was measured using a 1 to 9 scale in which 1 = profuse nodulation and 9 = no nodules present.
[b] Not significant at $P = 0.05$.

Langdon 2003. No significant differences among treatments occurred for plant stand, nodulation, root rot, or yield, but did occur for root length (Table 2). The treatments Kodiak + Allegiance inoculated 3 days prior to planting (67 mm), Kodiak inoculated three days prior to planting (67 mm), Apron XL inoculated three days prior to planting (67 mm), Captan 400 inoculated three days prior to planting (66 mm), and ApronMaxx inoculated at planting (65 mm) had the largest root lengths, which were significantly greater than the treatments Captan 400 inoculated at planting (51 mm), Apron XL inoculated at planting (50 mm), and no fungicide inoculated three days prior to planting (50 mm). *Fusarium* spp. were isolated from diseased roots at Langdon in 2003.

Table 2. Effect of fungicide seed treatments and timing of *Rhizobium* inoculant on plant stand, nodulation, root length, root disease, and yield at Langdon, ND, in 2003.

Fungicide seed treatment	Inoculant timing (days before planting)	Stand (plants/A)	Nodulation (no./plant)	Root length (mm)	Root rot lesions (mm)	Yield (bu/A)
None	3	312,000	38	50	6	51
Kodiak	0	259,000	39	64	4	51
ApronMaxx	0	287,000	29	65	3	50
None	No inoculant	324,000	30	62	4	49
Kodiak + Allegiance	0	279,000	24	62	5	49
Apron XL	0	271,000	23	50	4	49
ApronMaxx	3	324,000	38	56	8	49
Captan 400	0	356,000	18	51	4	48
None	0	259,000	35	56	8	47
Kodiak	3	291,000	38	67	7	46

Kodiak + Allegiance	3	267,000	27	67	5	46
Apron XL	3	267,000	29	67	4	46
Captan 400	3	295,000	40	66	2	46
LSD 0.05	-	ns[a]	ns	14	ns	ns
CV%	-	22.5	54.3	19.7	77.0	10.5

[a] Not significant at $P = 0.05$

Minot 2003. No significant differences among treatments occurred for any of the measured parameters (Table 3). *Fusarium* spp. were isolated from diseased roots.

Table 3. Effect of fungicide seed treatments and timing of *Rhizobium* inoculant on plant stand, root length, root disease, and yield at Minot, ND, in 2003.

Fungicide seed treatment	Inoculant timing (days before planting)	Stand (plants/A)	Root rot lesions (mm)	Yield (bu/ha)
Kodiak + Allegiance	0	243,000	6	37
None	3	202,000	8	36
Kodiak	0	239,000	5	36
ApronMaxx	0	251,000	9	35
None	0	267,000	6	34
Kodiak	3	214,000	9	34
Apron XL	0	267,000	8	34
ApronMaxx	3	235,000	6	33
Captan 400	0	255,000	7	33
Captan 400	3	291,000	7	33
None	No inoculant	247,000	6	32
Kodiak + Allegiance	3	219,000	7	32
Apron XL	3	235,000	6	32
LSD 0.05	-	ns[a]	ns	ns
CV%	-	15.6	48.8	8.6

[a] Not significant at $P = 0.05$

Carrington 2004. No significant differences among treatments occurred for any of the measured parameters (Table 4). *Rhizoctonia solani* and *Fusarium* spp. were isolated from diseased roots.

Table 4. Effect of fungicide seed treatments and timing of *Rhizobium* inoculant on plant stand, nodulation, root length, root disease, and yield at Carrington in 2004.

Fungicide seed treatment	Inoculant timing (days before planting)	Stand (plants/A)	Nodulation (1-9)[a]	Root length (mm)	Root rot lesions (mm)	Yield (bu/A)
Untreated	0	246,000	3.3	107	16	69
Untreated	3	251,000	3.0	112	7	65
ApronMaxx	0	223,000	4.0	108	9	65
ApronMaxx + Dynasty	0	252,000	3.5	117	4	65
Apron XL	0	243,000	4.5	116	8	65

ApronMaxx + Dynasty	3	221,000	4.0	106	7	64
Kodiak	0	256,000	3.3	110	7	63
Captan 400	3	214,000	5.0	111	6	62
Untreated	No inoculant	262,000	3.8	118	4	61
ApronMaxx	3	230,000	3.5	105	4	61
Kodiak	3	237,000	4.0	102	6	61
Kodiak + Allegiance	3	209,000	3.3	108	6	61
Kodiak + Allegiance	0	227,000	4.0	120	3	57
Apron XL	3	230,000	4.3	104	10	56
Captan 400	0	233,000	4.5	101	7	56
LSD 0.05	-	ns[b]	ns	ns	ns	ns
CV%	-	11	22	16.9	96.1	9.7

[a] Nodulation was measured using a 1 to 9 scale in which 1 = profuse nodulation and 9 = no nodules present.
[b] Not significant at $P = 0.05$.

Langdon 2004. No significant differences among treatments occurred for any of the measured parameters (Table 5). *Fusarium* spp. were isolated from diseased roots.

Table 5. Effect of fungicide seed treatments and timing of *Rhizobium* inoculant on plant stand, nodulation, root length, root disease, and yield at Langdon, ND, in 2004.

Fungicide seed treatment	Inoculant timing (days before planting)	Stand (plants/A)	Nodulation (no./plant)	Root length (mm)	Root rot lesions (mm)	Yield (bu/A)
Apron XL	0	284,000	32	145	6	62
Kodiak	0	256,000	48	125	12	59
Captan 400	3	293,000	25	128	6	59
Untreated	0	281,000	70	122	7	57

Table 5. Effect of fungicide seed treatments and timing of *Rhizobium* inoculant on plant stand, nodulation, root length, root disease, and yield at Langdon, ND, in 2004. (cont.)

Fungicide seed treatment	Inoculant timing (days before planting)	Stand (plants/A)	Nodulation (no./plant)	Root length (mm)	Root rot lesions (mm)	Yield (bu/A)
Kodiak + Allegiance	0	312,000	21	131	7	56
Kodiak	3	281,000	37	142	5	56
ApronMaxx + Dynasty	3	185,000	42	160	7	56
ApronMaxx	3	259,000	45	118	6	55
Captan 400	0	256,000	36	121	4	55
Untreated	3	290,000	69	139	7	55
Untreated	No inoculant	278,000	25	143	6	55
Kodiak + Allegiance	3	265,000	34	119	8	53
Apron XL	3	259,000	38	124	4	53

ApronMaxx + Dynasty	0	265,000	57	116	4	51
ApronMaxx	0	284,000	57	130	8	47
LSD 0.05	-	ns[a]	ns	ns	ns	ns
CV%	-	18.3	55.4	17.3	77.9	14.1

[a] Not significant at $P = 0.05$

Minot 2004. No significant differences among treatments occurred for any of the measured parameters (Table 6). *Fusarium* spp. were isolated from diseased roots.

Table 6. Effect of fungicide seed treatments and timing of *Rhizobium* inoculant on plant stand, root length, root disease, and yield at Minot, ND, in 2004.

Fungicide seed treatment	Inoculant timing (days before planting)	Stand (plants/A)	Root length (mm)	Root rot lesions (mm)	Yield (bu/A)
Kodiak	0	181,000	99	10	35
Kodiak + Allegiance	3	173,000	90	12	35
Kodiak + Allegiance	0	171,000	108	11	35
Apron XL	0	169,000	88	7	33
ApronMaxx	3	180,000	78	10	33
Kodiak	3	168,000	111	8	33
Untreated	No inoculant	194,000	88	10	32
Captan 400	3	169,000	102	13	32
Untreated	3	153,000	105	8	30
Untreated	0	166,000	100	9	30
ApronMaxx	0	173,000	95	11	29
Captan 400	0	190,000	89	9	28
Apron XL	3	183,000	105	7	28

Table 6. Effect of fungicide seed treatments and timing of *Rhizobium* inoculant on plant stand, root length, root disease, and yield at Minot, ND, in 2004. (cont.)

Fungicide seed treatment	Inoculant timing (days before planting)	Stand (plants/A)	Root length (mm)	Root rot lesions (mm)	Yield (bu/A)
ApronMaxx + Dynasty	3	191,000	107	9	28
ApronMaxx + Dynasty	0	171,000	110	12	28
LSD 0.05	-	ns[a]	ns	ns	ns
CV%	-	18.2	18.7	38.6	16.6

[a] Not significant at $P = 0.05$

In general, fungicide seed treatments did not significantly improve plant stand or yield, and did not decrease measured root diseases at any of the locations in any of the years in which this experiment was conducted. Two factors that drive disease severity of soil borne root rot diseases are weather and amount of disease inoculum in a particular field. Although 2004 was generally cool and wet immediately after planting, which is ideal for some root rot diseases, the level of disease inoculum at the research sites could have been low. Growers should still consider fungicide seed treatments if planting into sites with a history of poor dry pea stand establishment.

Some fungicide seed treatments have been reported to reduce the effectiveness of *Rhizobia* inoculants in dry pea and chickpea (Kyei-Boahen et al., 2001; Rennie et al., 1985; Thomas and Vyas, 1984; Welty et al., 1988). However, nodulation did not appear to be affected by any of the fungicide seed treatments at any of the sites where nodulation was measured in our experiments. In our studies, the fungicide seed treatments were allowed to dry before inoculants were added to the seeds. This may have helped prevent any antagonism between inoculants and fungicide seed treatments. Growers are still encouraged to allow fungicide seed treatments to completely dry before applying inoculants. Also, the experimental areas at Carrington and Minot had a history of field pea production and the established population of *Rhizobium* may have masked problems of incompatibility.

Rhizoctonia solani was isolated only from the Carrington site in both years. *Fusarium* spp. were isolated from all sites in all years. The *Fusarium* isolates are currently being identified to species. Preliminary observations suggest that some of the *Fusarium* isolates are *F. avenaceum* and *F. solani*, which are both known pathogens of pea.

Aphanomyces euteiches, which can cause a devastating root rot to pea, was not isolated from roots at any of the locations. *Aphanomyces* spp. can be difficult to isolate from roots even if using *Aphanomyces* semi-selective media. Soil-baiting assays are a better way of recovering *Aphanomyces* spp. Research is currently being conducted to determine the spectrum of soil borne pathogens in pea in North Dakota using root isolations as well as soil-baiting assays.

Literature Cited

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