Efficacy of Vitaflo 280 to Control Soil- and Seed-Borne Diseases of Pea and Lentil, and Compatibility with Rhizobium Inoculants

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Abstract

Lentil (*Lens culinaris* Medikus) and pea (*Pisum sativum* L.) have the ability to fix dinitrogen (N_2) from the atmosphere. Rhizobium inoculants are applied to the seed to ensure effective N_2 fixation. In addition, fungicidal seed treatments are recommended to control extremely aggressive diseases such as Ascochyta, Botrytis, Fusarium, and Rhizoctonia seedling blight. To determine the efficacy of Vitaflo 280 to control seedling blight of pea and lentil caused by *Botrytis cinerea, Mycosphaerella pinodes* (Ascochyta blight), *Rhizoctonia solani* and *Fusarium spp.* experiments were established at several locations and years in western Canada. To determine the effect of Crown, Allegiance FL, Vitaflo 280, and Apron Maxx on the ability of Rhizobium inoculants to nodulate and fix N_2 from the atmosphere experiments were established at two locations in Saskatchewan in 2002. Vitaflo 280 at the recommended rates effectively controls seedling blight of lentil caused by seed-borne *Botrytis cinerea* and soil-borne *Fusarium spp* and *Rhizoctonia solani.* Vitaflo 280 at the recommended rates effectively controls seedling blight of pea caused by seed-borne *Mycosphaerella pinodes* and soil-borne *Fusarium spp* and *Rhizoctonia solani.* In addition, Allegiance FL, Crown, Vitaflo 280, and Apron Maxx at the recommended rates have no effect on visual nodulation or the ability of the Rhizobium to fix N_2 from the atmosphere.

Introduction

Lentil (*Lens culinaris* Medikus) and pea (*Pisum sativum* L.) have the ability to fix dinitrogen (N_2) from the atmosphere. Rhizobium inoculants are applied to the seed to ensure effective N_2 fixation. In addition, fungicidal seed treatments are recommended to control extremely aggressive diseases such as Ascochyta, Botrytis, Fusarium, and Rhizoctonia seedling blight. The new Vitaflo 280 [Carbathiin (systemic) and Thiram (contact)] fungicide is a broad-spectrum disease control fungicide registered on wheat, barley, oat, rye, triticale, dry common beans, snap common beans, soybean, corn, lentil, flax including edible oil flax and pea. This product is a water based , low dusting, low odor, soft settle and easy to reconstitute flowable fungicide that is safer on Rhizobium than the old formulation. Also, it is easier to clean up due to a change from a dye to a pigment for the colorant. *Botrytis cinerea* and *Mycosphaerella pinodes* (Ascochyta blight) are seed–borne pathogens that cause seedling blight of lentil (Diseases of Field Crops in Canada, 2003a) and pea (Diseases of Field Crops in Canada, 2003b), respectively. *Rhizoctonia solani* and *Fusarium spp.* are soil-borne fungal agents that also cause seedling blight of lentil and pea in western Canada. The objectives of this study were: 1) to determine the efficacy of Vitaflo 280 to control seedling blight of pea and lentil caused by *Botrytis cinerea, Mycosphaerella pinodes* (Ascochyta blight), *Rhizoctonia solani* and *Fusarium spp.* 2) To determine the effect of Crown, Allegiance FL, Vitaflo 280, and Apron Maxx on the ability of Rhizobium inoculants to nodulate and fix N_2 from the atmosphere.

Materials and Methods

To determine the efficacy of Vitaflo 280 to control seedling blight of pea and lentil caused by *Botrytis cinerea, Mycosphaerella pinodes* (Ascochyta blight), *Rhizoctonia solani* and *Fusarium spp* pea and lentil were grown at several locations in western Canada. In Pea, Vitaflo 280 was applied at 260 mL 100 kg^{-1} of seed to control *Rhizoctonia solani* and *Fusarium spp* and 330 mL 100 kg^{-1} of seed to control Ascochyta blight. In lentil, Vitaflo 280 was applied at 330 mL 100 kg^{-1} of seed to control seedling blight caused by *Botrytis cinerea*, *Rhizoctonia solani*, and *Fusarium spp*. Soils were artificially inoculated with *Rhizoctonia solani* and *Fusarium spp.* at a rate of 40 g of death-infected wheat per 1m by 6m plot. Seed of pea and lentil infected with more than 10% *Botrytis* and *Ascochyta* was used. Data were collected on percent emergence, grain yield, visual nodulation, and percent N_2 derived from the atmosphere. Percent emergence was determined 21 to 28 days after planting from $1m^2$ at the center of each plot. At maturity, plots were machine harvested and the seed was cleaned and weighed.

To determine the effect of Crown and Vitaflo 280 on the ability of Rhizobium inoculants to nodulate and fix N_2 from the atmosphere in lentil cv. Laird and the effect of Allegiance FL (Metalaxyl), Vitaflo 280, and Apron Maxx on the ability of Rhizobium inoculants to nodulate and fix N_2 from the atmosphere in pea cv. CDC Mozart plots were established at Clavet and Langham, Saskatchewan in 2002. At these locations, pulse crops were never grown before. Soil type, soil available nitrogen, total precipitation, seeding date, and harvest date are given in Table 1. Lentil and pea were inoculated with *Rhizobium leguminosarum* bv. v*iceae* [N-Prove (Philom Bios) and SelfStick lentil and pea (Becker Underwood)]. Rhizobium inoculants were applied at the manufacturers recommended rate. The active ingredients and fungicide rates are given in Table 2. Treatments for lentil were: 1) Rhizobium inoculated, no fungicide, 2) Vitaflo 280, Rhizobium applied sequentially to fungicide, 3) Crown, Rhizobium applied sequentially to fungicide, 4) Vitaflo 280, Rhizobium applied simultaneously to fungicide, 5) Crown, Rhizobium applied simultaneously to fungicide, and 6) No Rhizobium, no fungicide. Treatments for pea were: 1) Rhizobium inoculated, no fungicide, 2) Vitaflo 280 plus Allegiance, Rhizobium applied sequentially to fungicides, 3) Vitaflo 280 plus Allegiance FL, Rhizobium applied simultaneously to fungicides, 4) Apron Maxx, Rhizobium applied sequentially to fungicide, and 5) No Rhizobium, no fungicide.

The percent Ndfa was determined by the ^{15}N natural abundance method (Bremer and van Kessel, 1990,) using flax as a reference crop. Plant samples were harvested at mid-flowering stage, dried to constant weight, and finely ground to talcum powder consistency. Isotopic composition ($\delta^{15}N$) was determined as described by Knight et al. (1994). Visual nodulation was measured at mid-flowering stage using a scale 0-4. A zero was assigned to plants with no nodulation and a four to plants with good nodulation. Visual nodulation was assessed by a combination of nodule count, size, and colour. Data were analysed using the General Lineal Model (SAS Institute Inc. 1996). Seeding was delayed at both locations due to dry soil conditions and low average precipitation during May and early June (Table 2). The combination of late maturity and grasshopper's damage did not allow biomass or grain yield data collection. The location by treatment interaction was not significant for any of these crops. Therefore, the means from the combined analysis of variance for visual nodulation and percent Ndfa are presented.

Results and Discussion

Efficacy of Vitaflo 280 to Control Seedling Blight of Lentil and Pea

Vitaflo 280 efficiently controls seedling blight of pea and lentil caused by seed- and soil-borne fungal pathogens. Vitaflo 280 significantly increased both percent emergence (12 station years) and grain yield (four station years) of lentil seed infected with *Botrytis cinerea* by 7% when compared with the untreated control (Table 3). Vitaflo 280 significantly increased percent emergence (ten station years) and grain yield (five station years) of pea seed infected with *Mycosphaerella pinodes* (Ascochyta seedling blight) by 26% and 16%, respectively, when compared with the untreated control (Table 4).

Vitaflo 280 significantly increased percent emergence of lentil (nine station years) and pea (12 station years) planted in soils infected with *Fusarium spp* by 18% and 24%, respectively, when compared with the untreated control (Table 5). Vitaflo 280 significantly increased percent emergence (12 station years) and grain yield (four station years) of lentil planted in soils infected with *Rhizoctonia solani* by 72% and 69%, respectively, when compared with the untreated control (Table 6). In addition, Vitaflo 280 significantly increased percent emergence (eight station years) and grain yield (16 station years) of pea planted in soils infected with *Rhizoctonia solani* by 22% and 7%, respectively, when compared with the untreated control (Table 7).

Vitaflo 280 Compatibility with Rhizobium Inoculants

Fungicidal seed treatments had no effect on visual nodulation and percent Ndfa of lentil (Table 8) and pea (Table 9). Visual nodulation and percent Ndfa of lentil and pea treated with fungicides and inoculated with Rhizobium was similar to that observed in these crops inoculated with Rhizobium and not treated with fungicides. Rhizobium inoculation of lentil and pea significantly increased visual nodulation and percent Ndfa when compared with the non inoculated control, suggesting that these soils may not have a native Rhizobium strain capable of efficiently nodulating these crops (Bremer et al., 1988).

Our results agree with other studies conducted under controlled environments and under field conditions. Thus, it has been reported that Metalaxyl has no effect on nodulation of lentil (Rennie et al., 1985) and pea (Rennie et al., 1985; Kutcher et al. 2002). Other reports indicate that Metalaxyl has no effect on the ability of Rhizobium to fix nitrogen from the atmosphere on alfalfa (Edmisten et al., 1988), chickpea (Kyei-Boahen et al., 2001), lentil (Rennie et al., 1985), and pea (Rennie et al., 1985). Similarly, Thiram has no effect on nodulation of chickpea (Welty et al., 1988), bean (Graham et al., 1980), lentil (Rennie et al., 1985), pea (Rennie et al., 1985; Fritz and Rosen, 1991; Dunfield et al., 2000; Kutcher et al., 2002), and soybean (Rennie and Dubetz, 1984). These reports support the finding of this study, that Metalaxyl and Thiram at the recommended rates are compatible with Rhizobium inoculants.

Others have shown that fungicides reduced nodulation or N_2 fixation (Bhattacharyya and Sengupta, 1980; Revellin et al., 1993; Kyei-Boahen et al., 2001). However, in those studies they applied a rate of fungicide that exceeded the recommended rate by two- to 35-fold and consequently their results must be viewed with caution. For example, Revellin et al. (1993) reported a negative effect of Metalaxyl on nodulation of bean. However, the Metalaxyl rate used by Revellin et al. (1993) was 35 fold higher than the recommended rate. Nodulation of chickpea was not affected by Thiram at recommended rate, but decreased significantly when applied at 4.6 fold the recommended rate (Bhattacharyya and Sengupta, 1980). Similarly, Thiram had no effect on soybean nodulation when applied at the recommended rate but decreased nodulation when applied at two fold the recommended rate (Rennie and Dubetz, 1984).

Conclusions

Vitaflo 280 at the recommended rates effectively controls seedling blight of lentil caused by seed-borne *Botrytis cinerea* and soil-borne *Fusarium spp* and *Rhizoctonia solani.* Vitaflo 280 at the recommended rates effectively controls seedling blight of pea caused by seed-borne *Mycosphaerella pinodes* and soil-borne *Fusarium spp* and *Rhizoctonia solani.* In addition, Allegiance FL, Crown, Vitaflo 280, and Apron Maxx at the recommended rates have no effect on visual nodulation or on the ability of the Rhizobium to fix N_2 from the atmosphere.

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Table 1. Soil type, soil available nitrogen (0-12 cm), total precipitation from May to August, and seeding date of pulse crops grown at two locations in Saskatchewan in 2002.

Location	Soil type	$N0_3$-N (Kg ha^{-1}) (0-12 cm)	Precipitation May to August (mm)	Seeding date	Harvest date
Clavet	Clay loam	30	150	June 14, 2002	No harvest
Langham	Sandy loam	21	180	June 13, 2002	No harvest

Table 2. Active ingredients and rates of fungicidal seed treatments used in lentil, and pea grown at two locations in Saskatchewan in 2002.

Crop	Crown	Allegiance FL	Vitaflo 280	Apron Maxx
Active ingredient	Carbathiin (Systemic activity) Thiabendazole (Contact and systemic activity)	Metalaxyl (Systemic activity)	Carbathiin (Systemic activity) Thiram (Contact activity)	Fludioxonil (Contact activity) Metalaxyl (Systemic activity)
Lentil	600-mL/100 kg of seed		330-mL/100 kg of seed	
Pea		16-mL/100 kg of seed	260 & 330 mL/100 kg of seed	325-mL/100 kg of seed

Table 3. Percent emergence and grain yield of lentil seed infected with *Botrytis Cinerea* treated with Vitaflo 280 and grown at several locations in western Canada.

Trait	**Untreated**	**Vitaflo 280**	**Increase over untreated (%)**
Emergence (%) (12)*	45b	60a	7
Grain yield (kg ha^{-1}) (4)*	2593b	2763a	7

*, Station years

Table 4. Percent emergence and grain yield of pea seed infected with *Mycosphaerella pinodes* (Ascochyta seedling blight) treated with Vitaflo 280 and grown at several locations in western Canada.

Trait	**Untreated**	**Vitaflo 280**	**Increase over untreated (%)**
Emergence (%) (10)*	62b	78a	26
Grain yield (kg ha^{-1}) (5)*	4844b	5633a	16

*, Station years

Table 5. Percent emergence of pea grown in soils infected with *Fusarium spp* treated with Vitaflo 280 and grown at several locations in western Canada.

	Emergence (%)		
Crop	**Untreated**	**Vitaflo 280**	**Increase over untreated**
Lentil (9)*	39b	46a	18
Pea (12)*	63b	78a	24

*, Station years

Table 6. Percent emergence and grain yield of lentil grown in soils infected with *Rhizoctonia solani* treated with Vitaflo 280 and grown at several locations in western Canada.

Trait	Untreated	Vitaflo 280	Increase over untreated (%)
Emergence (%) (12)*	36	62a	72
Grain yield (kg ha^{-1}) (4)*	345	582a	69

*, Station years

Table 7. Percent emergence and grain yield of pea grown in soils infected with *Rhizoctonia solani* treated with Vitaflo 280 and grown in western Canada.

Trait	Untreated	Vitaflo 280	Increase over untreated (%)
Emergence (%) (8)*	67b	82a	22
Grain yield (kg ha^{-1}) (16)*	3418b	3672a	7

*, Station years

Table 8. Visual nodulation (scale 0-4) and percent dinitrogen derived from the atmosphere (Ndfa) of lentil treated with fungicides, inoculated with two commercial Rhizobium inoculants, and grown at Clavet and Langham, Saskatchewan in 2002.

Treatment	Nodulation (0-4)	Ndfa (%)
Rhizobium, no fungicide	3.06a	45a
Vitaflo 280, Rhizobium applied Sequentially	3.00a	40a
Crown, Rhizobium applied Sequentially	2.67a	46a
Vitaflo 280, Rhizobium applied Simultaneously	2.57a	45a
Crown, Rhizobium applied Simultaneous	2.67a	41a
No Rhizobium, no fungicide	0.31b	22b
LSD (0.05)	0.50	12

Table 9. Visual nodulation (scale 0-4) and percent Nitrogen derived from the atmosphere (Ndfa) of pea treated with fungicides, inoculated with two commercial Rhizobium inoculants, and grown at Clavet and Langham, Saskatchewan in 2002.

Treatment	**Nodulation (0-4)**	**Ndfa (%)**
Rhizobium, no fungicide	3.06a	54a
Vitaflo 280+Allegiance FL, Rhizobium applied Sequentially	3.25a	45a
Vitaflo 280+Allegiance FL, Rhizobium applied Simultaneously	2.81a	44a
Apron Maxx, Rhizobium applied Sequentially	2.75a	47a
No Rhizobium, no fungicide	0.36b	27b
LSD (0.05)	1	11