Efficacy Testing of Onion Seed Treatments in the Greenhouse and Field

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Abstract

Fungicide seed treatments can protect onion seedlings from damping-off, caused by *Pythium* spp. and onion smut, caused by *Urocystis cepulae* Frost. The standard seed treatment in Canada has been PRO-GRO, a combination of carboxin and thiram. However, under high disease pressure, this treatment appeared to be losing effectiveness and growers began adding mancozeb in the seed furrow. Greenhouse efficacy tests were conducted to identify new effective fungicides and rates, in order to reduce the number of treatments evaluated in the field and increase the number of times a trial could be repeated. Trials were conducted in the greenhouse and field in 2000 and 2001. In the greenhouse, 200 cell black plastic trays were filled with field soil (60% organic matter, pH 6.4), naturally infested with the pathogens. Onion, cv. Gazette was seeded, one seed per cell, with four replicate trays per treatment. Trays were held in the dark at 13-16°C until seedling emergence and then placed in a greenhouse. Emergence and the incidence of damping-off and onion smut were recorded. Treatments with Charter (triticonazole 2.4%, 1 mg/100 g seed) or Vortex (LO258, 5, 10, 25, 50, 100 or 200 mg/100 g seed), in combination with Raxil (tebuconazole 28.3% at 100, 200 or 400 mg), and Allegiance (metalaxyl 28%, 30 mg), were compared to the standard, PRO-GRO (30% carboxin, 50% thiram, 2000 mg), and an untreated check. Treatments were applied with film coat. Field trials, with the best treatments determined in the greenhouse tests, consisted of cv. Gazette seeded 46 seeds/m, in 5 m rows, in early May each year. A treatment of 6.6 kg ai/ha of mancozeb, applied in the seed furrow, was included. Incidence of onion smut on untreated checks was 24-63% in the greenhouse and 19-51% in the field. The incidence of damping-off was low in the greenhouse (3%) and was not observed in the field. Charter was less effective than Raxil in greenhouse trials. PRO-GRO was less effective in field trials than in the greenhouse. In field trials, Raxil (100 or 200 mg ai/100 g seed) plus Allegiance, plus or minus Vortex (5 or 50 mg ai/100 g seed) seed treatments were as effective as the current standard treatments of PRO-GRO plus a furrow application of mancozeb (6.6 kg ai/ha).

INTRODUCTION

Fungicide seed treatments are used to protect onion (*Allium cepa* L.) seedlings from damping-off, caused by *Pythium* spp. and onion smut, caused by *Urocystis cepulae* Frost (Stienstra and Lacy, 1970; Tartier et al., 1976). If onion seed and seedlings are not protected by fungicide, infection levels can reach 50 to 80% or higher on onions grown on organic (muck) soils in temperate regions (Tartier et al., 1976; Hoepting et al., 2000). *Urocystis cepulae* is a soil borne plant pathogen that can persist in the soil for many years (Anderson, 1921). The emerging cotyledon becomes infected before it reaches the soil surface. By the time the cotyledon emerges it is no longer susceptible to infection.

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Infected plants may die at any stage in their life cycle or survive until harvest, but will be unmarketable (Walker and Wellman, 1926). The optimum temperature for infection and the colonization of the onion was found to be 13-25°C (Walker and Wellman, 1926) and 16-20°C in soils with high inoculm densities (Steinstra and Lacy, 1972).

Field evaluation trials for new fungicides are essential before recommendations to the growers are made. Such trials are difficult to conduct because of variable weather conditions and presence of other pests, such as onion maggot (*Delia antigua* Meigen) (Stienstra and Lacy, 1970; Hoepting et al., 2000). Thus, we attempted to closely approximate field conditions in the greenhouse to allow more trials to be conducted each year and to reduce the variability that occurs in the field.

The objectives of this study were to: a) identify fungicide seed treatments that will provide improved control of onion smut and good control of damping-off and b) determine if greenhouse trials could compliment field trials for screening fungicides for these diseases on onions.

MATERIALS AND METHODS

Greenhouse Trials

Onion, cv. Gazette, was seeded, 1 seed per cell, in 200 cell trays filled with naturally-infested field soil in 2000 and 2001. Trays were placed in a cool, dark room (13-16°C) until seedling emergence and then placed in a greenhouse for approximately eight weeks. Incidence of onion smut was assessed at the first true leaf stage (first assessment) in both 2000 and 2001 and the third true-leaf stage, when the cotyledons had senesced (second assessment, 2000). All seed treatments were applied with film coat (Opandry AG 0.75%) (Taylor, 2003). Treatments in 2000 were: Charter (triticonazole 2.4%), or an new product, Vortex (LO258) both applied at 5, 10, 25, 50, 100 or 200 mg a.i./100 g seed, in combination with Raxil (tebuconazole 28.3%) at 100, 200 or 400 mg a.i./100 g seed, and Allegiance (metalaxyl 28%), 30 mg a.i./100 g seed, compared to the standard of PRO-GRO (30% carboxin, 50% thiram, 2000 mg a.i./100 g seed), or Thiram alone (thiram, 125 mg a.i./100 g seed) and an untreated check with only film coat.

Field Trials

Onion, cv. Gazette, was direct seeded, 46 seeds/m, in 5 m rows, on 3 May, 2000 and 4 May, 2001. Treatments (Tables 3 and 4) were chosen based on greenhouse performance. A treatment of 6.6 kg a.i./ha of mancozeb, applied in the seed furrow, in combination with PRO-GRO treated seed, was included as the commercial standard. Stand counts were taken after emergence and percent onion smut was assessed at the first true leaf stage. Yield and percent of onions with symptoms of onion smut were recorded at harvest.

RESULTS

Greenhouse Trials

A high incidence of onion smut infection occurred in the untreated checks at first assessment in 2000 (62.5%, Table 1) with a moderate level of disease in 2001 (24.4 %, Table 2). In the 2000 trial, several of the fungicide treatments reduced the incidence of smut, with the exception of Charter at 5, 10, 25 and 50 mg ai/100 g seed and Raxil at 5 mg ai/100 g seed. At the second smut assessment (third true leaf stage) fewer fungicide treatments were effective. PRO-GRO was the most effective treatment in both assessments (Table 1) and only the higher rates of Raxil (50 and 100 mg ai/100 g seed) and Charter at 10 g ai/100 g seed were as effective as PRO-GRO. Under the lower incidence of smut in 2001, all treatments were as effective as PRO-GRO, except Vortex at 10 mg ai/100 g seed (Table 2). When Raxil was applied alone (Table 1) or in combination with Vortex and Allegiance (Table 2), there was a significant decrease in the incidence of onion smut with increasing rate of fungicide (r^2 = 0.58 and 0.45, 2000 and

2001, Tables 1 and 2). Charter was less effective; only the rate of 100 mg ai/100 g seed reduced the incidence of smut in comparison to the check at the first assessment (Table 1).

Levels of damping-off were low in this trial. None of the treatments reduced damping-off compared to the untreated check, but the combination of Vortex (10 mg ai) and Allegiance (30 mg ai) increased the incidence of damping-off (Table 2).

Field Trials

High levels of onion smut also developed in the field plots (51.1% in 2000 and 49.9% in 2001, Tables 3 and 4, respectively). All fungicide treatments reduced the incidence of onion smut, except the Thiram and Allegiance combination in 2000 (Table 3). PRO-GRO was as effective as the other fungicides in the 2000 trial, but was not as effective as the treatments that contained Vortex or Raxil in 2001 (Table 4). The new fungicide combinations tested in 2001 were as effective as the standard of PRO-GRO on the seed plus Dithane DG in the seed furrow (Tables 3 and 4) or Dithane DG alone (Table 4).

Seed treatments that included Raxil resulted in higher yields than the untreated check in both years (Tables 3 and 4). The treatment consisting of Raxil (200 mg ai/100 g seed, and Vortex (5 mg ai/100 g seed) plus Allegiance also had higher yields than the Dithane treatments in 2001 (Table 4). In both field trials, higher yields were related to lower levels of onion smut at the first assessment (r^2 = 0.09 and 0.25, 2000 and 2001, Tables 3 and 4).

DISCUSSION

Onion seed treatment with fungicides Raxil (100 or 200 mg ai/100 g seed), Allegiance (30 mg/100g seed), and Vortex (5 or 50 mg ai/100 g seed) provided good control of onion smut and high yields. This combination can potentially replace the currently used seed treatment with PRO-GRO and the seed furrow application of Dithane DG.

Increasing the rate of Raxil reduced the incidence of onion smut in greenhouse trials. Treatments that included Raxil also resulted in the highest yield in field trials. High yields were correlated to low levels of onion smut at the first assessment (first true leaf stage). This is consistent with the report of Tartier et al. (1976), who also found that low yields were related to high levels of onion smut at 6 weeks after seeding. The low values for the coefficient of regression suggest that other factors are involved in the determination of yield, although the incidence of onion smut was a significant factor in reducing yield. Onions appear to be able to partially compensate for early season loss of stand. Most likely the onions that are left grow larger as a result of reduced interplant competition.

Greenhouse screening was useful for identifying effective treatments for the control of onion smut in onion, and indicating those that were not effective, such as Charter. The exception was PRO-GRO, which was more effective in the greenhouse than in the field. Therefore, greenhouse trials should be considered pre-screening and the treatments that are most effective should be field tested before recommended for use.

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Tables

Table 1. Evaluation of different rates of Charter and Raxil on the incidence of onion smut on onions grown in the greenhouse, 2000.

Treatment	Rate (mg ai/ 100 g of seed)	1st assessment Incidence of Smut (%)	2nd assessment Incidence of Smut (%)
Film Coating	0.75%	62.5 e[1]	35.6 d
PRO GRO	2000	1.6 a	17.7 a
CHARTER	5.0	52.3 de	34.0 cd
CHARTER	10.0	42.7 cd	21.9 ab
CHARTER	25.0	54.9 de	32.6 cd
CHARTER	50.0	50.5 de	31.2 cd
CHARTER	100.0	37.7 c	35.4 d
RAXIL	5.0	58.7 e	31.6 cd
RAXIL	10.0	32.6 c	32.0 cd
RAXIL	25.0	16.8 b	26.9 bcd
RAXIL	50.0	7.6 ab	26.6 bc
RAXIL	100.0	6.4 ab	19.3 ab

[1] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

Linear regression:
1st Assessment:
% Incidence of smut = 55.201 – 0.1609 * rate Charter. P = 0.0228, r^2 = 0.2141.
% Incidence of smut = 46.949 – 0.5169 * rate Raxil. P = 0.0001, r^2 = 0.5775.

2nd Assessment:
Charter – Not Significant at P = 0.05.
% Incidence of smut = 33.219 – 0.1436 * rate Raxil. P = 0.0050, r^2 = 0.3067.

Table 2. Evaluation of efficacy of different rates of Vortex and Raxil on the incidence of onion smut and damping-off on onions grown in the greenhouse, 2001.

Treatments	Rate (mg ai/ 100 g of seed)	% Damped-off	% Onion Smut
Check	-----	3.3 ab	24.4 c
PRO-GRO	2000	1.1 a	3.5 a
VORTEX + ALLEGIANCE	5.0 + 30	4.9 abc	3.6 a
VORTEX + ALLEGIANCE + RAXIL	5.0 + 30 + 100	4.9 abc	1.2 a
VORTEX + ALLEGIANCE + RAXIL	5.0 + 30 + 200	8.6 bc	1.7 a
VORTEX + ALLEGIANCE + RAXIL	5.0 + 30 + 400	5.6 abc	0.0 a
VORTEX + ALLEGIANCE	10 + 30	9.7 c	11.0 b
VORTEX + ALLEGIANCE	25 + 30	8.8 bc	1.5 a
VORTEX + ALLEGIANCE	50 + 30	4.8 abc	4.3 a
VORTEX + ALLEGIANCE	100 + 30	3.3 ab	2.5 a
VORTEX + ALLEGIANCE	200 + 30	3.5 ab	0.7 a

[1] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

Linear regression:
Incidence of smut = 15.49 – 0.0494 * rate of Raxil. P = 0.0042, r^2 = 0.45.
Incidence of smut = 13.494 – 0.0801 * rate of Vortex. P = 0.0003, r^2 = 0.41.

Table 3. Evaluation of fungicides in film coat on the seed or in the seed furrow for the control of onion smut in the field, 2000.

Treatments	Rate (mg ai/ 100 g seed)	Incidence of Smut % First Assessment	Incidence of Smut % Harvest Assessment	Yield (t/ha)
Check	-----	51.1 c[1]	19 bc	35.2 cd
PRO-GRO	2000	21.8 ab	12.7 abc	24.0 d
THIRAM + ALLEGIANCE	125 + 30	48.3 c	22.2 c	58.5 ab
THIRAM + ALLEGIANCE + CHARTER	125 + 30 + 10.0	19.7 ab	8.6 a	50.1 bc
THIRAM + ALLEGIANCE + RAXIL	125 + 30 + 10.0	17.9 a	5.9 a	63.6 a
PRO-GRO pellet + DITHANE DG	6.6 kg/ha	10.0 a	0.0 a	54.8 abc

[1] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

Linear regression:
Yield = 6.97 – 0.043 * incidence of smut at first assessment. P = 0.04, r^2 = 0.09.
Yield and incidence of smut at harvest: not significant at P = 0.05.

Table 4. Evaluation of film coating and furrow fungicides for the control of onion smut in the field, 2001.

Treatments	Rate (mg ai/ 100 g seed)	Incidence of Smut % First Assessment	Incidence of Smut % Harvest Assessment	Yield (t/ha)
Check	-----	49.9 d[1]	37.3 c	19.4 d
PRO-GRO	2000	24.9 c	33.8 c	34.6 cd
ALLEGIANCE + VORTEX + RAXIL	30 + 5 + 200	0.2 a	8.6 a	67.9 a
ALLEGIANCE + VORTEX + RAXIL	30 + 50 + 100	2.5 ab	16.1 a	53.8 ab
ALLEGIANCE + RAXIL	30 + 100	11.2 abc	29.3 bc	47.2 bc
DITHANE DG	6.6 kg/ha	13.1 abc	9.6 a	49.8 bc
PRO-GRO + DITHANE DG	2000 + 6.6 kg/ha	11.6 abc	8.9 a	44.9 bc

[1] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

Linear regression:
Yield = 56.8 – 0.2635 * incidence of smut at first assessment. P = 0.004, r^2 = 0.25.
Yield and incidence of smut at harvest: not significant at P = 0.05.