

# Fungicide soil application efficiency for the control of black scurf (*Rhizoctonia solani*) on three potato cultivars

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## Abstract

In the 2004 and 2005 seasons, experiments were carried out at INTA Balcarce, Argentina on potato cultivars Kennebec, Innovator and Shepody, with different susceptibility to *Rhizoctonia solani* Kuehn. A randomized block design with four replications was created. Visual observations during the crop cycle were carried out in order to record the number of healthy and infected plants, with symptomatology of stem canker produced by *R. solani*. After harvest, the potatoes in each block were washed and weighted, the total yield recorded and the marketable and “seed” potatoes were classified into healthy, cracked or malformed tubers. The best results on the reduction of infected plants were obtained with the highest dose of fluazinam (as Frowncide 50SC) and pencycuron (as Monceren 25SC). Commercial and “seed” tuber yields in the Spunta cultivar showed no significant differences among treatments, but with the Shepody cultivar, when the severity of the disease was high (2004) both fungicide treatments surpassed the untreated check. When the severity of the disease was low (2005), all chemical treatments registered higher commercial and “seed” tubers yields than the untreated check. In Kennebec and Spunta cultivars, all the treatments – except the lowest dose of fluazinam – accomplished a higher quantity of healthy tubers and surpassed the untreated check; although only the highest doses showed the highest yield of healthy tubers, showing a positive relationship with respect to the applied dose. Only the highest doses of fluazinam considerably reduced diseased tuber incidence in comparison to the untreated check.

**Key words:** Potato, black scurf, control, Argentina, fluazinam, pencycuron

## Introduction

*Rhizoctonia solani* can manifest itself during various stages of the potato crop. The young shoots of planted tubers can become infected with the pathogen, which causes their death and thus diminishes the emergence plant stand. Once the plant has emerged, the roots, stolons and stalks can be infected, producing cankers and higher severity can cause death (Hide, 1981; Jeger and Velvis, 1994; Jeger *et al.*, 1996). In stalks, the cankers modify normal physiological functions of the plant, inducing lower growth, rolling, and red coloring in apical leaves. If the canker develops to the base of the stalk, the most aggressive symptom of the disease can be observed: inhibition of the movement of nutrients to the tubers, which impedes tuber development and leads to the formation of aerial tubers. The affected plants that complete their cycle produce smaller and malformed tubers due to cracking. In the surface of the tubers, the pathogen develops mycelium, which will later form sclerotes (Scholte, 1992; Schöber and Turkensteen, 1992). These are strongly fastened to the skin and cannot be removed by washing without causing damage. The pathogen also produces intense cracking of variable depth, where high concentration of sclerotes can be observed. If the cracks are deep and numerous, they cause commercial quality loss of the tuber (Simons and Gilligan, 1997).

Usage of seed free from *R. solani* is highly recommended to avoid the introduction of the pathogen as a source of infection in the crop (Carmona *et al.*, 2003). Deep plantation in cold and excessively humid or easily flooded soils should be avoided as rapid emergence of the cultivar helps prevent infection. Chemical control is an advisable practice that reduces the effects caused

by the disease (Eyherabide and Mantecón, 1981; Mantecón and Eyherabide, 1992). The fungicides can be applied to the seed tuber before planting (highly recommended when a seed with presence of the pathogen is used) and/or to the ground at plantation time (advisable when a seed free from the pathogen is used). Chemical treatment can reduce the disease symptoms by 70% in plants and 55% in tubers (Scholte, 1992). The use of integrated control is necessary to attenuate the incidence of the black scurf of the potato. Infected seed plantation in cold and wet soils, severely reduces the effectiveness of chemical control. The objective of this work was to evaluate the efficacy of fungicides applied on the planting row of cultivars with different behaviour in the face of the disease.

## Material and methods

In the 2004 and 2005 seasons, experiments were carried out at INTA Balcarce, Argentina. Kennebec, Spunta and Shepody cultivars with different susceptibility to *R. solani*, were used for the experiment. The cut potato seeds used during test trials were healthy and without any symptoms of the disease. Planting was carried out on the 11/01/04 and 11/30/05 by means of an experimental four-row planting machine and was hand harvested on the 04/21/05 and 06/19/06, respectively. A randomized block design with four repetitions was created. The plots consisted of four 4-m wide rows every 0.8 m. The distance between plants along the rows was 0.2 m. Fungicide was applied, to the ground of the row furrows, after mechanical planting of the cut potato seed. In order to inoculate with the pathogen each planted cut seed and rebuild the row furrows by means of a weeding machine and artificial inoculation was carried out through the superficial distribution of milled oat grains, which were previously sterilized

and colonized by a severely pathogenic strain of *R. solani* (AG3) which causes stem canker and black scurf of potato plants.

During the crop cycle, the trial was sprayed weekly with difenoconazole (as Bogard 25EC) with a dose of 0.25 L ha<sup>-1</sup> and fluazinam (as Frownicide 50SC) with a dose of 0.5 L ha<sup>-1</sup> to control early and late blight, *Alternaria solani* Jones & Grout and *Phytophthora infestans* De Bary, respectively. Visual observations during the crop cycle were carried out in order to register the number of healthy and infected plants, with symptomatology of stem canker produced by *R. solani*. After harvest, the yield of each block was washed and weighed, recording the total yield, in addition to the marketable and “seed” yield which were later classified into healthy, cracked or malformed tubers. In each case, the two external rows of each block were not taken into account. Data were statistically analyzed and significance between means was tested by LSD ( $P=0.05$ ).

## Results and discussion

During the two years of evaluations, climatic conditions were favorable for the development of both the crop and the disease. Artificially inoculated seeds, cultivar management and frequent watering allowed a significant development of the disease during test trial. In the Kennebec and Shepody cultivars, all chemicals showed a lower percentage of infected plant than untreated check; while with Spunta cultivar, the lowest dose of fluazinam did not reduce the percentage of disease plants (Table 1, 2, 3). The best results on the reduction of infected plants were obtained with the highest dose of fluazinam and the chemical check pencycuron. These treatments surpassed the untreated check, which, during the two years, showed disease average 62.5% with Kennebec; 42.5% with Spunta and 29.5% with Shepody plants at full tuberization. A clear and direct relationship between the dose of usage and reduction of the percentage of diseased plants could be observed. The lowest levels of diseased plants (%) were obtained with highest dose of fluazinam and with pencycuron. When the marketable commercial tubers yields were evaluated (Tables 1, 2, 3) it can be seen that fluazinam surpassed the untreated check with doses from 1000 to 1500 mL ha<sup>-1</sup> with the Kennebec cultivar.

The lower dose of 750 mL ha<sup>-1</sup> showed similar yield in commercial tubers to the untreated check. Differences between treatments was observed when the yield of “seed” tubers was analyzed. The largest quantity of diseased tubers was in untreated check, which was expected due to stress caused by the disease resulting into a smaller size of tubers.

With regards to commercial and “seed” tuber yield in the Spunta cultivar, there was no significant differences among treatments. However, with the Shepody cultivar, when the severity of the disease was high (2004), pencycuron and fluazinam had higher seed tuber yield than the untreated check at the highest, but not at the lowest evaluated dose. There was no noticeable difference in tuber “seed” yield. When the severity of the disease was low (2005), all chemical treatments registered higher commercial and “seed” tuber yield than the untreated check.

In the Kennebec and Spunta cultivars, all the treatments (except the lowest dose of fluazinam) accomplished higher quantity of healthy tubers than the untreated check and a positive relationship could be observed with respect to the applied dose. Only the highest doses of fluazinam considerably reduced the quantity of diseased tubers in comparison to the untreated check. With the Shepody cultivar, when the severity of the disease was high (2004), only pencycuron and the highest doses of fluazinam had better results than the untreated check, registering a larger number of healthy tubers. However, when the severity of the disease was low (2005), all chemical treatments registered higher commercial and “seed” tubers yields than the untreated check.

Efficacy to control the disease by pencycuron and fluazinam with the highest doses are good because they reduced its incidence and notably increased commercial and “seed” tuber yield than the untreated checks. With excellent climatic conditions for the development of the disease, high disease levels were registered and only the highest doses of fluazinam notably reduced it. When the incidence of the disease was low, generally all chemical treatments reduced it significantly. Chemical treatment efficacy in the control of the disease did not increase due to the use of a cultivar like Shepody, which presented the lowest susceptibility to the disease.

Table 1. Diseased plant percentage, marketable, diseased and healthy tubers registered in Kennebec cultivar

Treatments and dose (mL ha <sup>-1</sup> )	Diseased plants (%)		Yield (kg/plot)				
	45 days	70 days	Healthy tubers	Healthy tubers (%)	Diseased tubers	Marketable tubers	Seed tubers
Season 2004							
Check	32 a*	60 a	12.2 c	62.0 d	10.7 a	16.3 b	6.6 a
Fluazinam 500	20 b	28 b	17.1 b	68.7 cd	7.8 ab	20.4 ab	4.5 ab
Fluazinam 750	15 bc	22 b	19.0 ab	74.5 bc	6.5 bc	22.5 a	3.0 b
Fluazinam 1000	10 cd	10 c	21.6 a	87.1a	3.5 c	21.2 a	3.6 ab
Fluazinam 1500	8 d	8 c	21.5 a	84.2ab	4.4 bc	23.7 a	3.2 b
Pencycuron 2000	6 d	5 c	20.8 a	83.0ab	3.9 c	21.8 a	2.9 b
Season 2005							
Check	25.0 a	65.0 a	14.3 c	62.4 c	8.6 a	15.9 c	7.0 a
Fluazinam 500	12.0 b	32.0 b	17.5 bc	73.2 bc	6.4 ab	19.5 bc	4.4 b
Fluazinam 750	6.0 cd	8.5 cd	21.8ab	82.0 ab	4.8 b	22.0ab	4.6 b
Fluazinam 1000	4.0 cd	4.0 d	25.4a	82.2 a	5.5 b	24.5a	6.4ab
Fluazinam 1500	2.5 d	3.0 d	24.6a	83.1 a	5.0 b	25.0a	4.6 b
Pencycuron 2000	5.0 cd	8.0 cd	23.9a	83.6 a	4.7 b	23.2ab	5.4ab

Within a column, means followed by the same letter are not significantly different ( $P=0.05$ ).

Table 2. Diseased plant percentage, marketable, diseased and healthy tubers registered in Spunta cultivar

Treatments and dose (mL ha <sup>-1</sup> )	Diseased plants (%)		Yield (kg/plot)				
	45 days	70 days	Healthy tubers	Healthy tubers (%)	Diseased tubers	Marketable tubers	Seed tubers
Season 2004							
Check	29 a*	45 a	14.5 c	65.9 c	7.5 a	17.5 a	3.5 a
Fluazinam 500	25 a	40 a	16.1abc	73.5 bc	5.8 ab	18.1 a	3.7 a
Fluazinam 750	5 b	12 b	19.9ab	81.6 ab	4.5 ab	20.6 a	3.8 a
Fluazinam 1000	4 b	8 bc	20.2a	84.2 ab	3.9 b	21.0 a	3.1 a
Fluazinam 1500	5 b	8 bc	19.9ab	85.8 a	3.4 b	19.5 a	3.8 a
Pencycuron 2000	6 b	6 c	21.0a	87.5 a	3.0 b	20.9 a	3.1 a
Season 2005							
Check	22.0 a	40.0 a	11.5 c	59.0 c	8.0a	14.1 b	5.4 a
Fluazinam 500	5.5 b	9.5 bc	19.1ab	74.4 bc	6.5ab	21.4a	4.2 a
Fluazinam 750	0.0 c	5.5 c	22.2a	82.1 a	4.8 bc	22.6a	4.4 a
Fluazinam 1000	0.0 c	4.0 c	23.1a	87.3 a	3.4 c	21.5a	5.0 a
Fluazinam 1500	0.5 c	8.5 c	21.4a	79.9 ab	5.4 bc	22.5a	4.3 a
Pencycuron 2000	9.0 b	15.5 b	16.0 b	78.5 ab	5.4 bc	19.2a	4.2 a

\* Within a column, means followed by the same letter are not significantly different ( $P=0.05$ ).

Table 3. Diseased plant percentage, marketable, diseased and healthy tubers registered in Shepody cultivar

Treatments and dose (mL ha <sup>-1</sup> )	Diseased plants (%)		Yield (kg/plot)				
	45 days	70 days	Healthy tubers	Healthy tubers (%)	Diseased tubers	Marketable tubers	Seed tubers
Season 2004							
Check	32 a*	35 a	10.8 c	55.7 c	8.6 a	14.0 b	5.4 a
Fluazinam 500	22 b	28 ab	13.5 bc	62.8 bc	8.0 a	15.4 ab	6.1 a
Fluazinam 750	22 b	25 b	14.0 b	65.1 bc	7.5 ab	16.0 ab	5.5 a
Fluazinam 1000	12 c	14 c	17.1ab	79.5 ab	4.4 b	15.7 ab	5.8 a
Fluazinam 1500	10 c	10 c	19.1a	82.0 a	4.2 b	18.2 a	5.1 a
Pencycuron 2000	10 c	12 c	18.9a	82.5 a	4.0 b	18.0 a	4.9 a
Season 2005							
Check	10.5 a	24.0 a	14.4 b	70.4 b	8.6 a	13.0 b	7.5 a
Fluazinam 500	2.5 b	11.0 b	19.4 a	85.0 a	3.4 b	18.6a	4.2 b
Fluazinam 750	0.0 b	2.5 c	21.1 a	89.5 a	2.5 b	18.4a	3.6 b
Fluazinam 1000	0.0 b	3.5 c	20.0 a	91.0 a	2.0 b	18.6a	3.4 b
Fluazinam 1500	0.0 b	1.5 c	21.6 a	90.5 a	2.3 b	19.9a	4.0 b
Pencycuron 2000	1.5 b	1.5 c	21.3 a	92.0 a	1.9 b	18.8a	4.4 b

\* Within a column, means followed by the same letter are not significantly different ( $P=0.05$ ).

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