



# Field study of the relative susceptibility of eleven potato (*Solanum tuberosum* L.) varieties and the efficacy of two fungicides against *Rhizoctonia solani* attack

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## ABSTRACT

Rhizoctonia black scurf is an economically important disease of potatoes in Tunisia and around the world. It reduces the quality and yield of potatoes and has become an important impediment for export of potatoes, especially to Europe. The information on comparative susceptibility of potato cultivars will help the growers make informed decisions regarding the management of this disease. The eleven potato cultivars used in this study showed a range of susceptibility reactions to *Rhizoctonia solani* but none of these was completely resistant to the disease. The Spunta variety showed the least percentage of infection of progeny tubers by *R. solani* sclerotia at harvest, while the varieties Nicola, Santana, Labadia, Liseta and Tango showed a high percentage of infection of progeny tubers. Seed treatment using fungicides, presently registered in Tunisia, are not effective in controlling the disease to growers' satisfaction. Field experiments conducted to evaluate the efficacy of two newly introduced fungicides pencycuron (Monceren<sup>®</sup>) and azoxystrobin (Amistar<sup>®</sup>) showed that they were effective for the control of the disease. Seed potatoes treatment and in-furrow application of azoxystrobin consistently provided superior protection in two years of experimentation.

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## 1. Introduction

Potato is one of the strategic crops in Tunisia (Azzouz, 1996); it occupies about 16% of the area cultivated for vegetable crops. Despite this importance, the average of potato yield does not exceed 14 t per ha due to several factors, including fungal diseases. Black scurf disease caused by *Rhizoctonia solani*, is one of the most damaging pathogens worldwide (El Bakali and Martín, 2006). The attack by this fungus may lead to weak, spindly-looking or late-emerging potato plants. The first sprouts are often killed before they reach the surface, resulting in the emergence of a weaker secondary sprout. Dry, sunken, brownish lesions developing on the base of the stem below the soil line are evidence of the stem canker phase of this disease. The lesions may girdle the stem or large cankers may interfere with movement of nutrients from the leaves to the tubers. Cankers that form on stolons may prune off young developing tubers. This disease may lead to surface cracking of mature tubers and sometimes shallow, brown lesions will form around lenticels. At harvest, tubers are found to be covered with small brownish-black fungal bodies called sclerotia or 'black scurf'.

When introduced into soil, these structures can survive and germinate the following spring to attack young shoots, roots, stolons, and tubers of the new crop (Messiaen et al., 1991). The quantitative yield losses can reach 50% according to Keiser (2008) and tubers heavily covered with sclerotia cannot be traded. In Tunisia, *R. solani* reduces the quality and the yield of potatoes (Daami-Remadi et al., 2008a) and has become an important impediment for seed production and export, especially to Europe. In the last decade, southern of Tunisia has become an important area for potato production since it has a suitable climate for the production of this crop from January to March, during which the export of potatoes to European countries is exempt from taxes. Nevertheless, severe *R. solani* black scurf infections on potatoes were found in southern Tunisia in 2005 and 2006 (Tarhouni, 2007). As potato areas are limited, and rotation is often difficult to apply, the use of cultivars resistant to black scurf would obviously improve the control of the disease.

In Tunisia, all registered fungicides on potato crops showed little effect on *R. solani* attack under field conditions (Tarhouni, 2007). Therefore, Pencycuron (trade name Monceren<sup>®</sup>) a protective phenylurea fungicide originally developed for selective control of *Rhizoctonia* on rice and potato (Kuck et al., 1988; Roberts and Stephens, 1984) and Azoxystrobin (trade name Amistar<sup>®</sup>) a broad spectrum fungicide from the strobilurin group were introduced in

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Tunisia in 2007. These fungicides were tested in field conditions for the first time in this study in southern Tunisia for the control of *R. solani* black scurf on potato crops.

The objectives of this study were to determine under field conditions (i) the resistance level of eleven potato varieties to *R. solani* black scurf infection and (ii) the effectiveness of two fungicides, Pencycuron and Azoxystrobin for the control of this disease.

## 2. Material and methods

### 2.1. Potato culture

Small-size (3–5 cm of diameter) certified seed tubers were used (>3% of *R. solani* infection) and each tuber, ascertained as visibly free from black scurf. Tubers were planted by hand in a high naturally *R. solani* contaminated sandy soil in the region of Gafsa in the south west of Tunisia. The assessment of soil infestation was based on black scurf incidence on progeny of the previous potato crop, two years before set up of the experiments. The infection of harvested tubers with black scurf was greater than 40% in spring-season culture and greater than 15% in autumn-season culture with the tubers infected in moderate to high levels. Tubers were planted with a spacing of 0.3 m on the row and 0.9 m between the rows. Irrigation was by a drip irrigation system based on the needs of the crop. Fertilization was done according to plant development stage. The total quantities of fertilizers added per ha were 107 kg of nitrogen (N), 50 kg of phosphorus oxide (P<sub>2</sub>O<sub>5</sub>) and 180 kg of dipotassium hydroxide (K<sub>2</sub>O). Weeds in the crop were hand removed and insecticides were applied as and when required at standard recommended rates.

### 2.2. Variety testing assay

Eleven potato varieties were used for *R. solani* resistance experiments; Eden, Santana, Nicola, Spunta, Gourmandine, Atlas, Fabula, Global, Labadia, Liseta and Tango. These varieties were planted in the 2007 spring-season culture (planting in February) and harvested at several periods; 50, 75, 90 and 105 days after planting (dap) to follow the infection process of progeny tubers by *R. solani* sclerotia. No fungicide treatments were applied during cultivation of potato varieties in this assay.

### 2.3. Fungicide effectiveness assay

Two fungicides were used; Pencycuron (trade name Monceren<sup>®</sup> Bayer) recommended for potato seed treatment and Azoxystrobin (trade name Amistar<sup>®</sup> Syngenta) recommended for seed potato and soil treatments (Table 1). Five pre-planting fungicide applications were field tested in this study to fight against *R. solani* black scurf infection; treatment of seed potato with Pencycuron or Azoxystrobin, treatment of seed potato with Pencycuron combined to the application of Azoxystrobin in-furrow, applications of

Azoxystrobin on seed potato and in-furrow, application of Azoxystrobin in-furrow. Seed tuber and in-furrow treatments by fungicides were done 2 h before planting. Control plants did not receive any fungicides. The variety Nicola was used in this experiment because it is commonly cultivated in southern Tunisia for export and has been described by Tsror and Peretz-Alon (2005) to be susceptible to *R. solani* attack. This experiment was conducted twice in 2007 and 2008 autumn-season cultures (planting in September). Progeny tubers were harvested at 144 dap because Nicola is late maturing.

### 2.4. Disease assessment

The assessment of *R. solani* black scurf attack was made by measuring the percentage of infection of potato progeny tubers (PIPT) and by visual evaluation of the level of infection of potato progeny tubers (LIPT) according to the French scale, which includes 5 levels scored from 1 to 5 (Anon., 2009).

### 2.5. Experimental design and statistical analyses

For variety testing and fungicide efficacy experiments plots were 10 m long and three rows wide for a total of 100 seed potato tubers per plots. Ten consecutive plants per row were harvested for the assessment of black scurf infection on potato progeny tubers. The experiment was arranged in a randomized complete block design with five replicates per treatment.

Data were subjected to an analysis of variance (ANOVA) using the Statistica software version 5.1 ([www.statsoft.com](http://www.statsoft.com)) and the means were compared with the LSD test at  $p \leq 0.05$ . Correlations between measured parameters were estimated by computing the Pearson correlation coefficient ( $r$ ).

## 3. Results and discussion

### 3.1. Reaction of potato varieties to *R. solani* black scurf infection

All potato varieties tested showed typical *R. solani* cankers on the stem base. The percentage of infected stems varied between 80% and 100% at 90 dap (data not shown), indicating that all varieties were susceptible to *R. solani* infection, which is in agreement with the results of Daami-Remadi et al. (2008b).

The Analysis of variance showed that the harvest time, the variety and their interaction have very highly significant effects on the variability of PIPT of the potato varieties (Table 2). The harvest time has the highest effect on the variability of PIPT, contributing with 96.9% of the total variability observed (Table 2). Indeed, as shown in Fig. 1, as harvest is delayed the level of PIPT increased. In fact, this later parameter was doubled for all varieties between 90 and 105 dap. Therefore, it appears that early harvesting of the potato crop in Tunisia can avoid severe infestation of progeny tubers by sclerotia of *R. solani*, as previously observed by Spencer

**Table 1**

Fungicide treatments of potato seed and soil used to manage *Rhizoctonia solani* attack under field conditions.

Fungicide	Chemical name	Active ingredient (a.i.) (%)	Formulation	Trade name	Manufacture	Treated part	Dose of a.i. <sup>a</sup>
Pencycuron	N-[(4-chlorophenyl)-methyl]-N-cyclopentyl-N'-phenylurea (C.A.)	25	Suspension concentrate	Monceren	Bayer	Seed potato	15 g/100 kg
Azoxystrobin	Methyl (Z)-2-[2-[6-(2-cyanophenoxy)pyrimidin-4-yl]oxyphenyl]-3-methoxyprop-2-enoate	25	Suspension concentrate	Amistar	Syngenta	Seed potato In-furrow	25 g/100 kg 750 g/ha

<sup>a</sup> The fungicide products were applied at manufacture recommended use rate.

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