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BIOLOGICAL AND CHEMICAL CONTROL OF STEM-CANKER AND BLACK-SCURF ON POTATO IN EGYPT

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ABSTRACT

Biological control of black-scurf and stem-canker caused by *Rhizoctonia solani* Kuhn was achieved by using three commercial bioagents, *i.e.*, Plant Guard, Promot and Rizo-N in pot and field experiments during two successive growing seasons. Data indicated that using any of the tested bioagents for treating segments of potato tubers before sowing caused significant reduction in the average percentages of dead plants (stem-canker) and infected tubers (black-scurf on the tubers) with significant increase in tuber yield.

Treating segments of potato tubers with any of the three tested fungicides, *i.e.*, Rovral, Sumisclex and Rizolex-10% before sowing caused significant reduction in the infection with stem-canker and black-scurf with significant increase in tuber yield in pot and field experiments. In addition, chemical control was more efficient either in reducing the disease or increasing tuber yield compared with biological control.

***Key words**: bioagents ,black-scurf, fungicides,Rhizoctonia solani, stem-canker.*

1. INTRODUCTION

Potato(*Solanum tuberosum* L.)is one of the most importan Solanaceous crops for local consumption and exportation. In Egypt potato is cultivated in three sowings , *i.e.*, fall season (from the

beginning of September to mid of October), early summer season (from the mid of October to the end of December) and normal summer season (from the beginning of December to the mid of February). The total cultivated area during the three sowings was about 200,000 feddans which produced about 2,000,000 tons with the average of 10 tons/feddan during 1999. (Annual Report of Agric. Statis. Dept., Min. of Agric., ARE, 2000).

Potato plants are liable to attack with vulnerable viral, bacterial and fungal diseases (Davis, 1973; Cother, 1983; Bicici and Erkilic, 1986; Ghanem, 1994 and Wahdan *et al.*, 1999). However, fungal diseases, especially black-scurf and stem-canker caused by *Rhizoctonia solani* Kuhn (the imperfect stage of *Thanatephorus cucumeris* (Frank) Donk) is one of the most important diseases that causes great reduction in both quality and quantity of tuber yield. In addition, no great attention has been given for this disease under Egyptian conditions, with exception of the studies carried out by Abdel-Halim (1972) and Wahdan *et al.* (1999).

The aim of this investigation was to study the role of biological and chemical control methods in reducing disease hazard.

2. MATERIALS AND METHODS

This study included pot experiments, using a virulent isolate of *R. solani* (Wahdan *et al.*, 1999) and field experiments under natural conditions of soil infestation.

2.1. Soil and pot disinfestation

Nile silt soil was disinfested with 5% formalin solution. Also, pots (25cm. in diameter) were rinsed in the previous solution and left to dry.

2.2. Inoculum preparation and soil infestation

One disk (5 mm. in diameter) bearing 7 day-old growth of *R. solani* was used to inoculate each glass bottle containing BSP medium (75 g. washed dried barley, 100 g. washed dried sand and 75 cc. potato decoction), autoclaved at 1.5 lbs. for 30 min. and incubated at 25°C. for two weeks.

Soil previously treated with formalin was thoroughly mixed with the inoculum of *R. solani* at the rate of 50 g. inoculum/kg. soil then distributed in the pots.

2.3. Field preparation for sowing

A piece of land, located at Dakahliya Governorate, has a back history of natural infestation with stem-canker and black-scurf disease (*R. solani*), due to frequent sowing of potato, was chosen for biological and chemical control of this disease during 1998/1999 and 1999/2000 growing seasons. The land was prepared for potato sowing as usual and divided into plots of $84m^2$. All the agricultural practices were carried out as recommend by Ministry of Agriculture for potato.

2.4. Biological control

2.4.1. Pot experiment

Three commercial bioagent products, *i.e.* Plant Guard (containing $30x10^6$ spore of *Trichoderma harzianum*), Promot (containing spores of both *T. harzianum* $30 x10^6$ and *T. koningii* at 6 $x10^6$) and Rizo-N (containing $30 x 10^6$ cell of *Bacillus subtilis*) were used for this purpose. Each of the commercial products was used, alone, for treating apparently healthy segments of potato tubers (cv. Dimont) just before sowing, at the rate of 10 ml. or grams plus 1 ml. sticker (super film)/kg seeds (tubers). Untreated fragments were sown as control treatment. Two fragments were seeded in each pot and ten pots were used for each treatment.

2.4.2. Field experiments

Apparently healthy fragments of potato tubers (cv. Dimont) were, treated with the tested bioagents as mentioned before then sown. Untreated fragments were used for sowing the control treatment. Five randomized replicate plots ($84m^2$.) were used for each treatment. The experiments were carried out during 1998/1999 and 1999/2000 growing seasons.

2.5. Chemical control

2.5.1. Pot experiments

Three commercial fungicides namely Rovral 50% (Iprodione),

Sum sclex 50% (Procymidone) and Rizolex 10% (Tolclfos-methyl) were used for tuber dressing at the rate of 10 g. plus one ml sticker (Super Film)/kg. seeds (tubers). Nile silt soil, previously treated with formalin and infested with *R. solani* (5% inoculum level), were distr buted in the pots. The treated, and untreated, fragments were sown in the pots. Two fragments were sown in each pot and ten pots were used for each treatment.

2.5.2. Field experiment

Apparently healthy fragments of potato tubers were treated with one of the three tested fungicides as well as untreated ones (control) and were sown in plots of $84m^2$. Five randomized plots were sown for each treatment. The experiment was carried out during 1998/1999 and was repeated during 1999/2000 growing seasons.

2.6. Disease assessments

Disease assessment was done by calculating the dead plants, due to the stem-canker, two months after planting. In addition, percentage of the infected tubers with black-scurf was estimated at the time of harvesting as a number of infected tubers in each plot then the average percentages (related to the total number of examined tubers) of infected tubers were recorded.

2.7. Statistical analysis

The obtained data were statistically analyzed using the split plot design (Snedecor, 1967). The averages were compared at 5% level of probability using L.S.D. (Fisher, 1948).

3. RESULTS

3.1. Biological control

3.1.1. Pot experiments

Data (Table, 1) show that all the three tested bioagents caused significant reduction in the percentage of both dead plants (stem-canker) and infected tubers (black-scurf) with significant increase in the tuber yield compared with control treatment. In this respect,

Table (1): Effect of treating potato tubers (cv. Dimont) with some commercial bioagents before sowing on the incidence of stem-canker and black-scurf and tuber yield under artificial inoculation with *R. solani* (pot experiment).

Bioagent	%, Dead plants (stem-canker)		$\bar{X}$	% Infected tubers (black-scurf)		$\bar{X}$	Tuber yield g /pot		$\bar{X}$
	Control soil	Infested soil		Control soil	Infested soil		Control soil	Infested soil	
Plant- Guard	**0.0**	**30**	**15.0**	**0.0**	**37.8**	**18.9**	**267.0**	**160.0**	**213.5**
Promot	**0.0**	**25**	**12.5**	**0.0**	**31.0**	**1.5**	**269.5**	**165.0**	**217.3**
Rizo-N	**0.0**	**25**	**12.5**	**0.0**	**32.3**	**16.2**	**268.5**	**164.0**	**216.3**
Control	**0.0**	**55**	**27.5**	**0.0**	**62.4**	**31.2**	**256.5**	**90.5**	**173.5**
$\bar{X}$	**0.0**	**33.8**	**-**	**0.0**	**40.9**	**-**	**265.4**	**144.9**	**-**

L.S.D. at 0.05 for:

Bioagents (T) =	**1.3**	**3.4**	**3.8**
Soil infestation (I) =	**2.4**	**2.8**	**3.3**
T x I =	**2.1**	**4.1**	**5.2**

16.5 a ıd 18.9% for infected tubers and 217.3, 216.3 and 213.5kg./plot (84 m^2.) for tuber yield. In addition, values of control treatment were 27.5, 31.2% and 173.5 kg., respectively. No dead plants and/or infecte d tubers were observed when plants were grown in the un-infested soil. In addition, the average weight of tuber yield of plants grown in un-infested soil was significantly increased than those grown in infested soil, being 265.4 and 144.9 kg./plot (84m^2.), respectively.

3.1.2. Field experiments

Biological control experiments (Table, 2) were carried out during 1998/1999 and 1999/2000 seasons. Data reveal that the three commercial bioagents caused significant reduction in both dead plants (stem-canker) and infected tubers (black-scurf) with significant increase in tuber yield compared with control treatment during both seasons.

Promot was the best bioagent in reducing dead plants followed by Plant Guard and Rizo-N. The respective averages were 6.5, 7.1 and 7.3%, respectively, without significant differences. In addition, application of any of the three tested bioagents resulted in reducing the infected tubers with black-scurf, being 3.8%.

In case of tuber yield, plants treated with Promot or Rizo-N gave the highest yield, being 181.5kg./plot (84m^2.) followed by Plant Guard, being 180.2kg./plot (84m^2.) without significant difference. Meanwhile, the averages of control treatment were 16.6% for stem canker, 12.5% for black scurf and 171.8 kg./ plot for tuber yield, respectively.

In all cases, no significant differences were detected in the averages of dead plants, infected tubers and tuber yield due to the effect of the growing season.

3.2. Chemical control

3.2.1. Pot experiment

Data presented in Table(3) indicate that the application of any of the three tested fungicides, *i.e.* Rovral 50%, Sumisclex 50% and Rizo ex 10% caused significant reduction in the average of natural infection with stem-canker (dead plants) and infected tubers (black-scurf) with significant increase in tuber yield. The respective averages

Table (2):Effect of treating potato tubers (cv. Dimont) with some commercial bioagents before sowing on the infection with stem-canker and black-scurf, as well as tuber yield, field experiment, 1998/1999 and 1999/2000 growing seasons.

Commercial bioagent	%, Dead plants (stem-canker) during		$\bar{X}$	%, Infected tubers (black-scurf) during		$\bar{X}$	Weight of tuber yield (Kg)/pot (84m^2)		$\bar{X}$
	1998/1999	1999/2000		1998/1999	1999/2000		1998/1999	1999/2000	
Plant- Guard	7.2	7.0	7.1	4.2	3.4	3.8	180.4	180.0	180.2
Promot	6.4	6.6	6.5	4.0	3.6	3.8	182.0	181.0	181.5
Rizo-N	7.4	7.2	7.3	4.0	3.6	3.8	181.0	180.0	181.5
Control	16.2	17.0	16.6	12.8	12.2	12.5	171.6	172.0	171.8
$\bar{X}$	9.3	9.5	-	6.3	5.8	-	178.8	178.3	-

L.S.D. at 0.05 for:

Bioagents (T) =	1.8	1.6	3.9
Seasons (S) =	n.s	n.s	n.s
T x S =	2.6	1.8	2.7

Table (3): Effect of treating potato tubers (cv. Dimont) with some fungicides before sowing on the infection with stem-canker and black-scurf as well as tuber yield under artificial inoculation with *R. solani* (pot experiment).

Fungicides	%, Dead plants (stem-canker)		$\bar{X}$	%, Infected tubers (black-scurf)		$\bar{X}$	Weight of tuber yield (g)/pot		$\bar{X}$
	Uninfested soil	Infested soil		Uninfested soil	Infested soil		Uninfested soil	Infested soil	
Rovral 50%	0.0	15	7.5	0.0	24.0	12.0	269.5	198.0	233.8
Sumisclex50%	0.0	15	7.5	0.0	24.0	12.0	270.5	198.0	234.3
Rizolex 10%	0.0	20	10.0	0.0	25.0	12.5	268.0	196.5	232.3
Control	0.0	55	27.5	0.0	62.4	31.2	256.5	90.5	173.5
$\bar{X}$	0.0	26.3	-	0.0	33.9	-	266.2	170.8	-

L.S.D. at 0.05 for:

Fungicides (T)	=	1.7	1.9	2.3
Soil infestation (I)	=	3.6	3.0	3.8
T x I	=	4.7	5.2	4.9

of dead plants for the three fungicides were 7.5, 7.5, 10.0 and 27.5%, while those of infected tubers were 12.0, 12.0, 12.5 and 31.2% and those of tuber yield (g. /pot)were 233.8, 234.3, 232.3 and 173.5g.

3.2.2. Field experiments

Results (Table 4)indicate that each of the three tested fungicides, *i.e.* Rovral 50%, Sumisclex 50% and Rizolex 10% caused significant reduction in the average of natural infection with stem-canker (dead plants) and infected tubers (black-scurf) caused by *R. solani* during both seasons, *i.e.*, 1998/1999 and 1999/2000 compared with control treatment. The respective averages of dead plants for the three fungicides were 4.2, 4.2, 5.1 and 16.6% and those of infected tubers were 2.9, 2.9, 3.3 and 12.5%, respectively. Moreover, application of fungicides caused significant increase in the tuber yield, being 193.4, 193.0, 189.8 and 171.8kg./plot ($84m^2$.).

No significant differences were detected in the averages of dead plants, infected tubers and tuber yield/plot due to the effect of the growing season.

4. DISCUSSION

Two trials for controlling stem-canker and black-scurf of potato caused by *R. solani*, *i.e.*, biological and chemical control were conducted under artificial (pot experiments) and natural infection (field experiments). Wahdan *et al.*, (1999) used three indirect methods for controlling these diseases, *i.e.*, kind of balady manure, the preceding crops and different amounts of NPK and obtained unsatisfactory results.

It has been found herein that using any of Plant Guard, Promot and Rizo-N (commercial products used as bioagents for controlling soil-borne diseases) caused significant reduction in the infection with stem-canker and black-scurf of potato either in soil artificially infested with *R. solani* (pot experiment) or in naturally infested soil (field experiments) with significant increase in the produced tuber yield. The use of bioagents in controlling soil borne diseases including stem-canker and black-scurf of potato has been investigated by several

Table (4): Effect of treating potato tubers (cv. Dimont) with some fungicides before sowing on the natural infection with stem-canker and black-scurf, caused by *R. solani*, as well as tuber yield, field experiment at Dakahliya governorate during 1998/1999 and 1999/2000 growing seasons.

Fungicides	%, Dead plants (stem-canker) during		$\bar{X}$	%, Infected tubers (black-scurf) during		$\bar{X}$	Weight tuber yield (kg)/pot (84m^2)		$\bar{X}$
	1998/1999	1999/2000		1998/1999	1999/2000		1998/1999	1999/2000	
Rovral 50%	4.3	4.0	4.2	2.8	2.9	2.9	194.3	192.4	193.4
Sumisclex50%	4.3	4.0	4.2	2.9	2.9	2.9	194.0	192.0	193.0
Rizolex 10%	5.0	5.2	5.1	3.4	3.2	3.3	190.0	189.6	189.8
Control	16.2	17.0	16.6	12.8	12.2	12.5	171.6	172.0	171.8
$\bar{X}$	7.5	7.6	-	5.5	5.3	-	187.5	186.5	-
L.S.D. at 0.05 for:									
Fungicides (T) =			1.3			0.9			2.7
Seasons (S) =			n.s			n.s			n.s
T x S =			2.9			3.2			4.1

authors (Chet, 1984; Booger *et al.*, 1990; Abada, 1994; Wicks *et al.*, 1995; Ashour, 1996 and Mostafa *et al.*, 1999). According to Denr is and Webster (1971) and Hutchinson and Crown (1972) anti-fungal metabolites may also play a role in antagonism. *Trichoderma* sp. as a biocontrol agent, may act as a mycoparasite which detects its hc st from some distances, binds itself to the pathogenic fungus by sugar lectin linkage and begins to excrete extra-cellular lytic enzymes such as B-1, 3 glucanse, chitinase, protease and/or lipase (Chet, 1984). Moreover, Loeffer *et al.* (1986) pointed out that the antagonistic effects of *B. subtilis* towards wide spectrum of pathogenic soil-borne fungi are due to dipeptide compounds namely bacilysin and fengymycin.In addition, Fiddaman and Rossal (1993) mentioned that *T. harzianum* and *Bacillus subtilis* may secret during their growth some antagonistic substances and/or lytic enzymes which probably suppress the growth of many soil-borne pathogenic fungi.

Results pertaining to chemical control of the disease under study by some fungicides, *i.e.* Rovral 50% Sumisclex 50% and Rizolex 10% indicated that using these fungicides caused significant reduction in the amount of the disease with significant increase in the produced tuber yield, either in pot or in field experiments. In addition, chemical control was more efficient in this regard compared with biological control. This may be due to that fungicides usually have quick suppressive lethal effect on the pathogenic fungi compared with the bioagents. Chemical control of soil-borne diseases including stem-canker and black-scurf of potato was applied by many investigators for controlling many plant diseases (El-Helaly *et al.*, 1971; Weindhold *et al.*, 1982; Fahim *et al.*, 1987; Satiga and Indra-Hooda, 1987; Att a and Abada, 1994; Abada, 1995 and 1996 and Abdel-Fattah, 2001).

In addition, it was noticed that the adherence material (Super Film) may partially play a role in increasing the efficiency of the tested commercial bioagents and fungicides, which may cause stability in the high density or concentration of the tested bioagents and fungicides.

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المقاومة البيولوجية والكيماوية لمرض تقرح الساق والقشرة السوداء فى البطاطس

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ملخص

تم إختبار ثلاثة مركبات حيوية تجارية وهى: بلانت جارد ، البروموت ، ريزو- ن لمدى قدرتها على المقاومة البيولوجية لمرض تقرح الساق والقشرة السوداء فى البطاطس المتسبب عن الفطر ريزوكتونيا سولانى سواء فى تجارب أصص أو تجارب حقلية على مدى عامين متتاليين.

أوضحت النتائج أن استخدام أى من هذه المركبات الحيوية فى معاملة أجزاء درنات البطاطس قبل زراعتها أدى إلى خفض معنوى فى متوسط النسب المئوية للنباتات الميتة (تقرح الساق) ، الدرنات المصابة (القشرة السوداء) مع إحداث زيادة معنوية فى محصول الدرنات.

أدت معاملة أجزاء درنات البطاطس بأى من المبيدات الفطرية روفرال ، سوميسكللكس ، ريزولكس ١٠% قبل زراعتها إلى انخفاض معنوى فى الإصابة بتقرح الساق والقشرة السوداء مع احداث زيادة معنوية فى محصول الدرنات سواء فى تجارب الأصص أو التجارب الحقلية. بالإضافة إلى ذلك فإن المقاومة الكيماوية كانت أكثر فعالية من استخدام المركبات الحيوية سواء فى خفض الإصابة بالمرض أو زيادة محصول الدرنات.

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