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CONTROLLING SOME SOIL-BORNE FUNGAL DISEASES INFESTING SUGAR BEET.

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ABSTRACT

Four species of Trichoderma were tested either singly or in mixture to control damping off and root rot diseases of sugar beet.

A synergistic effect on these diseases was obtained by using mixture of *Trichoderma spp.* Combination of *Trichoderma spp.* Improved their efficiency to control damping-off and root rot diseases. These biocontrol agents reduced the growth of following soil borne pathogens: *Sclerotium rolfsii, Rhizoctonia solani, Macrophomena phaseolina* and *Fusarium oxysporum.*

INTRODUCTION

Sugar beet (*Beta vulgaris,* L.) is liable to be attacked by many soil borne fungal pathogens at all stages of growth causing damping – off and root – rot diseases (Yorganci and Turhan, 1988). There are many reports on antogonism of *Trichoderma spp.* against soil borne pathogenic fungi (Wells *et al.*, 1972; Backman and Rodriguze-Kabana, 1975; Elad *et al.*, 1980; Abd El-Moity and Shatla, 1981 and Abd El-Moity *et al.*, 1982).

Sclerotium rolfsii, was the most destructive pathogens (Abada, 1980; Fahim *et al.,* 1981; Coe and Neil, 1983; El-Kholi, 1984 and Ciccarese *et al.,* 1990 and 1992).

The objectives of this study were to:

1- Assess the efficacy of using different of bioagent fungi in single or mixed forms.
2- Control some important root diseases by combinations of Trichoderma species.
3- Study the effect of establishing of *Trichoderma spp* in soil against pathogen and disease incidence.
4- To determine the role of biological control against some soil borne patterns.

Sugar beet is also susceptible to *R. solani* and *F. oxysporum* (Ashour *et al.,* 1967; El-Sheshtawi and Dawood, 1988, Martyn *et al.,* 1989 and El-Sheshtawi *et al.,* 1994).

Trichoderma spp were successfully used as a bioagents against some pathogens in several crops including sugar beet, under laboratory, greenhouse and field conditions (Wells *et al.,* 1972; Elad *et al.,* 1980; Khalifa, 1991 and 1993 and Ibrahim, 1999).

MATERIALS AND METHODS

I. Laboratory experiments:

Four *Trichoderma spp.* (*T. harzianum, T. album, T. viridi* and *T. hamatum*) were isolated from sugar beet rhizosphere in Tag El-Ezz Agricultural Research Station farm and Bilqas region by dilution plate technique on pepton-dextrose rose-bengal agar medium (Martin, 1950). *Trichoderma spp.* were identified at plant Pathology Research Institute.

Pathogens which cause damping-off and root-rot as *Sclerotium rolfsii, Rhizoctonia solani, Macrophomina phaseolina* and *Fusarium oxysporum* were isolated from root-rotted sugar beet. To study the antagonism between fungal bioagents and soil borne pathogens. An agar block 6 mm in diameter with mycelium from advanced zone of mycelium of 3 days – old culture of *Trichoderma spp.* were transferred to Petridishes containing 5 ml P.D.A at one side, the other side of Petri-dishes were inoculated with a similar disk from culture of the main pathogens, we used.

Three replicates were incubated at 30°C and observed daily. Inhibition zones were measured and recorded according Martyn (1987).

II. Greenhouse experiments:

Inoculum of *Trichoderma spp.* was prepared on sterilized wheat bran in 250 ml glass bottle. While inocula of the pathogenic fungi were prepared individually on barley grain. Fifteen-days-old cultures of each pathogens were used for infestation of sterilized soil 7 days before sowing.

Inoculum of each pathogen was applied at the rate of 2 % of soil weight then the inoculum of the bio control agent was added. The inoculum ratios of *Trichoderma spp.* and pathogens were 1:1, 2:1, 3:1, 1:2 and 1:3 (w/w).

Soil infested with pathogen only were used as control treatments.

Fifteen sugar beet seeds (cultivar Top) were sown in each pot (25 cm in diameter) and watered. Pots were kept under greenhouse conditions. Pre and post-emergence damping-off were recorded two and four weeks after sowing respectively. Sugar beet plants were uprooted 60 days after sowing and the root-rot incidance was recorded.

III. Field experiments:

The used of *Trichoderma spp.* were grown on wheat bran preparation. Root-rot of sugar beet was studied under field condition in naturally infested soil during two successive seasons (1998/99 and 1999/2000) at two farms in Dakahlia governorate. Trial was laid out in a randomized block dosing with three replicates and a plot size of 10.5 m^2. Inocula of *Trichoderma spp.* were prepared described, before. 7 days before sowing inocula of *Trichoderma spp.* were applied as 300 gm/plot of wheat bran preparation non-infested plots with Trichoderma were used as control.

Each treatment was replicated three times. Damping – off data was recorded pre and post emergence, but root – rot was recorded during harvesting time (about 180 days after sowing). Plants were uprooted and

examined for disease symptoms. Percentages of root – rot incidence and disease severity were recorded as described before.

RESULTS

A. Laboratory experiments:

The growth of all biocontrol agents was faster than all tested pathogenic fungi especially *T. harzianum*. In Table (1) we can see that *T. harzianum* was the most effective against all soil borne fungal pathogens under study. The biocontrol agents grew faster than each of the pathogenic fungi. The radial growth of the four soil borne pathoginic fungi on the (PDA) was recorded. The growth of *F. oxysporum* was more unhibited than *S. rolfsii* or *R. solani, M. phaseolina.* Also when we use mixtures of the four bioagents was used to study the antagonism between these biocontrol agents and four of soil borne pathogenic fungi we found that: All the petri dishes of *T. harzianum* with others of *T. spp.* gave the lowest radial growth for all pathogenic fungi especially with *F. oxysporum* while at case of *S. rolfsii* we found that *S. rolfsii* gave more of tolerate ability of all bioagents. Results in Table (1a) showed that the application of mixture of bio control agent gave more controlling to the fungal pathogen than of using every specie single.

B. Greenhouse experiments:

Table (2) showed that *Trichoderma spp.* reduced the incidence of damping – off diseases especially *T. harzianum.* The ratio of bioagent /pathogens (3:1) application gave the lowest infection of pre and post emergence damping-off disease for all pathogenic fungi i.e. *S. rolfsii* was able to tolerate the bio control agents (Table 2). We used (0:1) bio control agent to 1 pathogenic fungi application as control which gave the highest infection values at pre and post emergence for all tested pathogens, while the use of mixtures of the three bio control agents at all treatments gave reduction in pre and post emergence damping-off disease (Table 2a).

C. Field experiments:

Data in Table (3 & 3a) indicate that all *Trichoderma spp.* at all inoculum levels tested significantly reduced on all sugar beet damping-off and root rot diseases under field conditions when each *Trichoderma spp.* was used alone. Root rot was effectively controlled when the field soil was infested with 300 g/plot wheat bran preparation of *T. harzianum* while 200 g/plot was less effective but 100 g/plot was the least effective inoculum level tested in this concern. Also at the case of damping-off disease of the highest inoculum level preparation of wheat bran 300 g/plot of *Trichoderm spp* gave the lowest infection either in pre or post emergence damping-off.

Table (1): Plant growth measuring antagonistic effect between four pathogenic fungi and one single species of (*Trichoderma spp.*) under laboratory conditions.

Bio control agent	*T. harzianum*		*T. viride*		*T. album*		*T. hamatum*		***Control	
	Radial Growth in cm and Inhibition %									
Pathogenic fungi	*P.R.G	**Inh. %	P.R.G	Inh. %	P.R.G	Inh. %	P.R.G	Inh. %	P.R.G	Inh. %
S. rolfsii	6.0	53.33	8.0	46.66	7.0	53.33	6.0	53.33	15.0	0.0
R. solani	9.0	40.00	10.0	33.33	8.0	46.66	7.0	53.33	15.0	0.0
M. phaseolina	11.0	26.66	10.0	33.33	10.0	33.33	7.0	53.33	15.0	0.0
F. oxysporum	12.0	20.00	9.0	40.0	10.0	33.33	8.0	46.66	15.0	0.0
L.S.D. (0.05)	**1.7**	**2.3**	**1.0**	**3.1**	**0.0**	**0.0**	**1.0**	**3.2**	**0.0**	**0.0**

* P.R.G = Pathogen Radial Growth in cm.
** Inh. % = Inhibition in pathogen growth caused by the antagonist compare with control %.
*** Control = without Bio control agent

Table (1a): Plant growth measuring antagonistic effect between four pathogenic fungi and one mixture of species of (*Trichoderma spp.*) under laboratory conditions.

Bio control agent	*T. harzianum* + *T. album* (1:1)		*T. harzianum* + *T. viride* (1:1)		*T. harzianum* + *T. hamatum* (1:1)		***Control	
	Radial Growth in cm and Inhibition zone %							
Pathogenic fungi	*P.R.G	**Inh. %	P.R.G	Inh. %	P.R.G	Inh. %	P.R.G	Inh. %
S. rolfsii	6.3	58.0	5.7	62.00	5.7	62.0	15.0	0.0
R. solani	6.0	53.3	5.6	62.66	6.3	58.0	15.0	0.0
M. phaseolina	5.2	65.3	6.0	53.33	6.2	52.0	15.0	0.0
F. oxysporum	4.3	71.33	4.0	73.33	4.0	73.33	15.0	0.0
L.D.D. (0.05)	**2.0**	**3.4**	**2.7**	**3.0**	**2.9**	**3.0**	**0.0**	**0.0**

* P.R.G = Pathogen Radial Growth in cm.
** Inh. % = Inhibition in pathogen growth caused by the antagonist compare with control %.
*** Control = without Bio control agent

Table (2): Antagonistic effect of (*Trichoderma spp.*) against some soil borne pathogenic fungi under greenhouse conditions.

Bio control agent (single)	Bio-agent: Pathogen ratio	The soil borne Pathogenic Fungi							
		S. rolfsii		*R. solani*		*M. phadeolina*		*F. oxysporum*	
		% Pre em*	% Post em**	% Pre em	% Post em	% Pre em	% Post em	% Pre em	% Post em
T. harzianum	1 : 1	55.25	15.80	33.16	5.70	35.80	3.80	15.90	2.40
	2 : 1	8.92	6.00	5.70	2.30	7.16	2.70	2.30	0.00
	3 : 1	3.10	0.00	1.30	0.0	4.22	0.27	0.00	0.00
	1 : 2	47.40	9.80	45.80	3.19	40.80	7.11	7.00	1.18
	1 : 3	65.20	17.30	52.17	4.60	49.12	8.60	15.00	3.70
Control	**0 : 1**	**75.22**	**22.00**	**58.64**	**7.12**	**52.40**	**7.75**	**20.00**	**6.30**
L.S.D. (0.05)		**5.3**	**3.0**	**4.2**	**3.1**	**3.9**	**3.0**	**2.4**	**2.0**
T. viride	1 : 1	59.60	13.60	32.11	4.10	36.10	4.60	15.80	3.12
	2 : 1	7.00	6.40	6.70	3.20	8.62	2.80	2.00	0.0
	3 : 1	2.90	0.00	2.30	0.00	5.11	0.36	0.00	0.0
	1 : 2	45.30	8.70	42.80	4.22	39.15	6.92	6.00	2.0
	1 : 3	68.00	18.11	53.10	5.11	50.16	7.11	16.0	4.15
Control	**0 : 1**	**69.20**	**24.12**	**60.70**	**7.75**	**55.10**	**8.10**	**27.00**	**8.20**
L.S.D. (0.05)		**5.6**	**3.0**	**3.7**	**3.5**	**3.0**	**3.0**	**3.2**	**2.4**
T. album	1 : 1	50.60	16.20	32.66	4.66	39.11	2.85	16.10	3.10
	2 : 1	7.30	5.00	5.00	2.11	7.13	3.20	2.40	0.00
	3 : 1	2.90	0.00	2.10	0.00	5.11	0.18	0.00	0.00
	1 : 2	53.17	8.75	48.30	2.16	43.12	8.60	7.40	2.00
	1 : 3	56.20	16.21	57.12	5.24	5.00	9.33	18.11	3.77
Control	**0 : 1**	**70.00**	**25.33**	**57.55**	**8.77**	**61.15**	**9.30**	**22.10**	**7.33**
L.S.D. (0.05)		**5.0**	**3.6**	**3.1**	**4.0**	**3.2**	**3.3**	**2.7**	**3.0**
T. hamatum	1 : 1	53.70	14.30	35.16	3.99	33.15	2.33	16.15	3.12
	2 : 1	7.40	7.50	4.48	2.17	8.11	3.44	2.16	0.00
	3 : 1	3.00	0.00	2.17	0.00	6.22	0.19	0.00	0.00
	1 : 2	59.11	7.18	45.11	2.48	44.90	8.80	80.00	2.90
	1 : 3	69.75	18.18	55.00	4.11	56.11	6.22	17.10	3.20
Control	**0 : 1**	**45.00**	**27.60**	**60.33**	**7.12**	**50.45**	**8.72**	**23.12**	**5.9**
L.S.D. (0.05)		**4.33**	**3.2**	**3.3**	**4.6**	**4.2**	**3.7**	**2.5**	**3.10**

%* Pre em = Pre emergence damping-off , % ** Post em = Post emergence damping-off

Table (2a): Antagonistic effect of the mixtures of (*Trichoderma spp.*) against some soil borne pathogenic fungi under greenhouse conditions.

Mixture of Bio control agents	Bio-agent: Pathogen ratio	The soil borne Pathogenic Fungi							
		S. rolfsii		*R. solani*		*M. phadeolina*		*F. oxysporum*	
		% Pre em*	% Post em**	% Pre em*	% Post em**	% Pre em*	% Post em**	% Pre em*	% Post em**
T. harzianum + *T. viride*	1 : 1	40.0	13.00	30.00	9.0	28.33	25.11	17.6	8.0
	2 : 1	7.00	6.00	4.0	0.0	3.6	0.0	0.0	0.0
	3 : 1	3.00	0.00	3.0	0.0	3.1	0.0	0.0	0.0
	1 : 2	39.50	7.30	32.0	5.0	4.0	3.0	1.0	0.7
	1 : 3	55.00	16.33	49.0	13.0	13.8	19.0	21.0	18.0
Control	0 : 1	72.40	20.22	70.0	33.0	80.6	35.3	67.0	29.6
L.S.D. (0.05)		4.2	3.0	4.1	3.0	3.7	3.1	2.4	2.0
T. harzianum + *T. album*	1 : 1	50.6	15.66	47.33	11.0	33.12	24.11	22.10	7.0
	2 : 1	8.3	7.00	4.12	0.0	3.0	2.6	2.0	1.0
	3 : 1	4.0	0.00	3.60	0.0	3.12	2.6	3.0	1.0
	1 : 2	40.6	11.60	38.10	3.0	28.18	25.11	27.3	22.6
	1 : 3	59.0	17.0	50.33	13.7	49.22	45.0	43.0	40.0
Control	0 : 1	70.0	22.10	75.33	36.11	73.0	28.0	80.0	16.0
L.S.D. (0.05)		4.2	3.0	3.7	3.6	3.0	3.2	3.1	2.6
T. harzianum +*T.hamatum*	1 : 1	45.00	15.20	50.70	13.0	30.65	10.33	19.66	7.0
	2 : 1	9.00	7.33	5.66	0.0	6.0	2.10	6.33	0.0
	3 : 1	6.30	5.00	7.60	0.0	8.0	2.12	6.18	0.0
	1 : 2	45.30	13.60	44.00	4.0	45.0	11.0	34.3	7.0
	1 : 3	59.60	17.33	55.00	17.0	55.0	14.0	58.0	16.0
Control	0 : 1	73.40	22.00	78.16	37.30	75.0	15.10	80.0	33.0
L.S.D. (0.05)		4.33	3.7	3.3	4.5	4.0	3.2	2.3	3.1

%* Pre em = Pre emergence damping-off , % ** Post em = Post emergence damping-off

Table (3): Effect of the four species of Trichoderma on controlling some important diseases of sugar beet (*Beta vulgaris*, L.) under field conditions during 1998/ 99 and 1999/2000 seasons.

	Diseases	1998/99 season				1999/2000 season			
		Damping-off %		Root-rot		Damping-off %		Root-rot	
Trichoderma spp.	*Wheat-bran Preparation g/plot	Pre em.	Post em.	**Prec. %	***D.S.I	Pre em.	Post em.	Prec.%	D.S.I
T. harzianum	100	28.16	9.12	8.11	1.17	30.10	8.10	6.66	2.00
	200	13.00	6.00	7.60	1.20	15.60	6.00	5.50	2.50
	300	8.00	4.00	3.40	0.75	5.75	2.00	2.50	0.60
	0 cont.	35.12	17.00	16.00	3.25	45.00	19.20	17.21	4.20
L.S.D. (0.05)		**2.6**	**2.0**	**2.0**	**3.10**	**2.11**	**3.42**	**2.0**	**2.6**
T. viride	100	33.15	10.15	10.33	2.00	33.16	9.33	8.80	3.30
	200	17.33	5.30	6.00	1.50	18.00	5.06	4.16	2.75
	300	11.00	6.00	3.33	1.00	9.00	3.66	3.99	1.50
	0 cont.	50.00	20.18	26.00	4.00	55.10	17.10	19.00	6.00
L.S.D. (0.05)		**3.7**	**4.0**	**2.66**	**3.0**	**3.3**	**3.0**	**1.12**	**2.15**
T. album	100	36.33	10.00	12.66	3.00	36.90	10.22	9.20	3.75
	200	20.15	7.00	7.30	3.00	16.00	6.00	4.00	2.00
	300	15.12	7.10	4.12	2.00	7.04	4.65	2.06	1.00
	0 cont.	55.70	20.15	30.00	5.00	52.00	19.33	17.00	7.12
L.S.D. (0.05)	0 : 1	**3.6**	**3.3**	**3.11**	**2.17**	**2.20**	**3.42**	**2.33**	**3.17**
T. hamatum	100	45.00	12.15	12.75	4.00	39.10	13.90	10.00	4.00
	200	27.18	9.00	8.16	3.00	17.60	7.02	5.66	2.12
	300	20.33	8.00	5.50	2.5	6.50	3.00	3.44	1.00
	0 cont.	47.00	24.00	35.12	8.4	56.00	22.25	19.60	8.44
L.S.D. (0.05)		**4.6**	**3.1**	**2.00**	**3.0**	**3.6**	**2.32**	**3.0**	**3.25**

*Wheat bran preparation of *Trichoderma* g/plot, Plot=1/400 feddan=10.5 m^2, **perc.= Percentage of disease, ***D.S.I.= Disease severity index

Table (3a): Effect of mixture species of Trichoderma on controlling some important diseases of sugar beet (*Beta vulgaris*, L.) under field conditions during 1998/ 99 and 1999/2000 seasons.

Diseases		1998/99 season				1999/2000 season			
		Damping-off %		Root-rot		Damping-off %		Root-rot	
Trichoderma spp	Wheat-bran Preparation g/plot	*Pre em.	**Post em.	***Prec. %	****D.S.I	Pre em.	Post em.	Prec.%	D.S.I
T. harzianum + *T. viride*	100	20.32	8.00	90.00	2.00	18.33	7.00	12.45	2.70
	200	10.00	7.00	6.00	1.00	10.50	8.00	7.30	1.30
	300	6.33	2.60	2.30	1.00	8.44	3.12	3.00	1.70
	0 cont.	45.0	20.30	14.66	3.00	40.66	18.00	15.00	3.24
L.S.D. (0.05)		2.3	2.0	2.0	3.2	3.4	2.0	3.0	3.6
T. harzianum + *T. album*	100	25.50	6.00	10.50	2.60	20.66	6.00	10.44	2.33
	200	12.33	6.18	6.44	1.70	10.16	6.00	7.33	1.60
	300	9.00	1.00	5.50	1.00	8.18	2.00	3.16	1.80
	0 cont.	48.00	23.70	16.55	3.40	52.22	27.00	21.77	3.70
L.S.D. (0.05)		2.1	2.0	2.4	3.5	3.1	2.4	3.0	3.7
T.harzianum +*T. hamatum*	100	30.18	10.80	12.00	2.00	25.44	12.02	14.08	2.70
	200	9.00	7.66	7.12	1.00	10.11	9.33	9.11	2.30
	300	9.66	6.60	6.00	1.30	6.00	2.66	6.20	1.40
	0 cont.	53.09	32.00	27.00	4.33	50.00	57.75	30.33	4.40
L.S.D. (0.05)	0 : 1	2.0	2.0	2.1	3.1	3.0	2.1	3.2	3.1

* Pre em = Pre emergence damping-off, ** Post em = Post emergence damping-off
***perc. = Percentage of disease , ****D.S.I.= Disease severity index

Data in Table (3) indicate that the effect of using two or more of *Trichoderma spp* gave the highest of controlling to the pathogens under study with the same ratio of application (100, 200 and 300 g/plot) of wheat-bran preparation per plot.

DISCUSSIONS

Application of fungicides in controlling pathogenic fungi is expensive and causes environmental pollution. Therefore, effective and safe method have been considered in the last few years. Biological control is one important methods in this respect.

Trichoderma spp. were effectively used as fungal biocontrol agent against soil borne causal organisms which cause many soil borne diseases of sugar beet *(Beta vulgaris,* L.*)* especially *S. rolfsii* (Mathur and Sarbhoy, 1978; Upadhyay and Mukhopadthay, 1985 and Grondona *et al.,* 1993).

Trichoderma spp specially *T. harzianum* suppressed the linear growth of *S. rolfsii, R. solani, F. oxysporum* and *M. phaseolina.* The inhibition of these pathogens which cause these diseases of sugar beet under tested (Top variety) may be attributed to the rapid growth of Trichoderma and to antibiotics which produced and inhibit the growth several fungi (Dennis and Webster, 1971a). Some of *Trichoderma spp.* were able to produce acetaldhyde or other acidic volatittes (Dennis and Webster, 1971b) also were able to parasitise many soil borne pathogens (Upadhyay and Mukhopadhyay, 1986).

Damping-off and root-rot diseases of sugar beet and several crops caused by many soil borne pathogens were effectively controlled by biocontrol agents in both greenhouse and field conditions (Wells *et al.,* 1972; Backman and Rodriguez Kabana, 1975; Mathur and Sarbhoy, 1978; Grinstein *et al.*. 1979; Elad *et al.,* 1980 and Yehia *et al.,* 1994). The degree of disease control of damping-off, root-rot was related to the type of *Trichoderma spp.* and the ratio of inoculum. The results in the case of using single bio control agent are different in the ability of antagonism to the four pathogenic fungi under study specially while we used *T. harzianum* which may be able to parasites many soil-borne pathogens (Dennis and Webster, 1971c and Upadthay and Mukhopadhay, 1986).

Also*T. Harzianum* can produce inhibitory substances retarding the growth of the pathogenic fungi (Dennis and Webster, 1971a,b and Wu, 1980).

To use the biological control methods we need more studies specially for the economic delivery of the bio control agent under the field conditions in large scale.

In the case of using mixture of two species or more of *Trichoderma spp.* (Table 3b) we can see that the effect of antagonism in laboratory, greenhouse and the field conditions was more than in the case of single bioagent.

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تأثير استخدام بعض أنواع فطريات التضاد من الترايكودرما مفردة أومختلطة فـــى مقاومة مسببات بعض أمراض بنجر السكر الهامة المحمولة فى التربة

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لوحظ أن استخدام أربعة أنواع من فطر الترايكودرما وهى ترايكودرمـــا هارزيـــانم و ترايكودرما فيردى و ترايكودرما ألبم و ترايكودرما هاماتم كل منها منفردا أ ومختلطا مع غيره من باقى الأنواع فى مقاومة بعض فطريات التربة التى تحدث أمراضا هامة لبنجر السكر ، مثل مـــوت اليادرات وعفن الجذور يؤدى إلى نتيجة مبشرة خصوصا فى المعمل والصوبة وأيضا الحقل.

وكان للنوع ترايكودرما هارزيانم دورا كبيرا وواضحا فى احـــداث التضـــاد لبعـــض فطريات التربة الممرضة فى المعمل وفى الصوبة. وكانت لكمية اللقاح من هذا المقـــاوم الحيـــوى دورا واضحا فى مقاومة الفطر الممرض.. فقد نلاحظ ان النوع الأول والأكثر فاعلية فى المقاومـــة كان ترايكودرما هارزيانم يليه ترايكودرما فيردى ثم ترايكودرما ألبم ثم ترايكودرما هاماتم وظـــهر ذلك من نسبة موت اليادرات قبل وبعد الإنبات نسبة وشدة الإصابة فى حالة عفن الجذور.

أما فى الحقل فلقد أظهرت المعاملات بوضوح أن زيادة كمية اللقاح من عجينه القمـــح النامى عليها الفطر ترايكودرما أدت إلى قلة الإصابة فى حالة مرض موت البادرات سواء فى حالة ما قبل أو بعد الإنبات. وسواء كان الفطر المستخدم كمقاوم حيوى منفردا أو مشتركا مع غيره.

وعن رد فعل المسببات المرضية لمرض عفن الجذور فقد أبدى الفطـــر (سكليروشـــيم رولفسياى) تحملا واضحا لفطر الترايكودرما منفردا أو مختلطا رغم أن النسبة المئويـــة للإصابـــة وشدة المرض قد قلت بزيادة كمية اللقاح المضاف للتربة من الترايكودرما.

وفى حالة الكنترول (حيث لا يضاف ترايكودرما على الإطلاق) فقد زاد معدل وشـــدة المرض فى كل الحالات وفى حالة استخدام الفطر ترايكودرما فى صورة مخلوط لنوعين أو أكـــثر فقد زادت المقاومة طالما كان أحد النوعين (ترايكودرما هاريزيانم) موجودا فى الخليط .

ويمكن اعتبار هذه النتائج مؤشر على امكانية المقاومة البيولوجية باستخدام بعض الكائنات الحية الدقيقة من فطريات التضاد بدلا من استخدام المبيدات الكيماوية التى تؤدى إلى تلـــوث التربـــة والبيئة .