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CHEMICAL AND BIOLOGICAL CONTROL OF SOME SOIL-BORNE FUNGI INFECTING PEA ROOTS

BY

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ABSTRACT

Rhizoctonia solani Kühn, and *Fusarium solani* (Mart.) Apple & Wr. were the most frequently isolated fungi from diseased roots of pea plants (*Pisum sativum* L.). *R. solani* was more aggressive than *F. solani* in the pre-emergence damping-off phase. Littel Marvel cultivar was more sensitive to diseases infection than Perfection cv.

Soil infestation with *F. solani* and *R. solani* reduced the number of *Rhizobium leguminosarum* nodules on pea roots, than the non-infested soil. Monceren was the most effective fungicide increased root nodules number while, Benlate showed the lowest effect. Number of nodules formed on roots of Perfection cv. was more than that formed on Littel Marvel cv. in all treatments. The tested antagonistic fungi (*Chaetomium globosum, Gliocladium virens* and *Trichoderma harzianum*) and their combinations showed an increasing effect on root nodules number. Treatment with *Trichoderma harzianum* + *Gliocladium virens* was the best combination in increasing root nodules number specially in case of Perfection cv. Addition of *Rhizobium* with biocontrol agents to the infected soil caused high reduction in the disease incidence. All combinations including *T. harzianum* gave better disease control in both pea cultivars.

Combinations of *Rhizobium* with all antagonistic fungi caused high increase in all growth characters (*i.e.* plant length, as well as fresh and dry weight) of tested pea cultivars. Soil infested with pea rhizobia only or in combination with fungicides increased crop parameters. The best combination in this respect was Benlate + Rhizobium in both pea tested cultivars.

INTRODUCTION

Pea (*Pisum sativum* L.) is considered an economic legume crop for local consumption and exportation. This crop is grown in most governorates in Egypt due to its high protein content, balanced amino acids composition and good digestibility. The cultivated area reached about 63769 feddan which produced about 261453 tons.*

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* Agricultural Economic Reports (99/2000). Ministry of Agriculture, Dokki, Giza

Pea is susceptible to attack by many fungi causing serious diseases such as damping-off, root-rot, wilt, downy and powdery mildew and pod rot (Rush and Kraft, 1986). Damping-off and root-rot are considered the most important diseases limiting seed production (Hampton and Ford, 1964) as it ranged from 10 to 40% loss annually in North America (Kraft, 1991).

Many workers studied the relation between fungal infection and rhizobial inoculation on legume crops (Anbu and Sullia, 1990; Bhattacharyya and Mukherjee, 1990; Blum *et al.*, 1991 and Haque and Ghaffar, 1993). They reported that rhizobial inoculation used as seed dressers or soil drench reduced fungal infection with damping-off and root-rot.

Effect of fungicides on pathogenic fungi of legume crops was studied by many workers (Ho *et al.*, 1992; Ilyas *et al.*, 1992; Raffat, 1992 and Singh and Malhotra, 1993). Others researchers studied the effect of biological control on pathogenic fungi (El-Fahham, 1993; Abada, 1994; El-Garhy, 1994 and Saksirriat *et al.*, 1994). They reported that chemical and bioagents treatments reduced fungal infection as damping-off and root-rot diseases in leguminous crops.

The present work was carried out to study the interaction between damping-off fungal infection and/or rhizobial inoculation on the disease incidence. Also, biological and fungicidal control treatments on damping-off in some pea cultivars were studied.

MATERIALS AND METHODS

1- Isolation and identification of the causal organism(s):

Some fungi were isolated from naturally infected pea seedlings showing damping-off and root-rot, had been collected from different provinces in Egypt namely, Shebeen El-Kanater, and Tukh (Kalubiya), Belbeas (El-Sharkyia), El-Saff (Giza) and Abou-Khalefa. (Ismailyia).

Purification of the isolated fungi was carried out using the hyphal-tip and/or single-spore techniques (Brown, 1924 and Hawker, 1960).

Purified fungi were maintained on PDA slants and kept for further studies in a refrigerator. Identification of the isolated fungi was carried out according to cultural properties, morphological and microscopical characters described by Gilman (1957), Barnett (1960) and Singh (1982).

2- Pathogenicity tests:

Inocula were prepared in sterilized sand-corn medium (Whithehead, 1957). Formalin-sterilized pots (ϕ 20 cm) were filled with 4 kg autoclaved Nile silt, then inoculated with any of the isolated fungi at the rate of 5% of soil weight. The inoculum was thoroughly mixed with the soil and watered regularly for one week before planting to ensure the distribution and growth of the inoculum (Whithehead, 1957). Pots used for control were filled with the same soil and mixed with the same sterilized amount of autoclaved medium. Ten surface

sterilized pea seeds (Littel Marvel cv.) were sown in each pot and covered with a thin layer of the same soil (2 cm). Four replicates were prepared for each particular treatment and pots were completely randomized in the greenhouse. Pathogenicity was recorded as percentage of pre-emergence damping-off, two weeks after sowing, post-emergence damping-off after 21 days and survived plants were counted after 30 day from sowing.

3- Disease assessment:

1- Percentage of pre-emergence damping - off was determined after 15 days from sowing as:

$$\% \text{ Pre-emergence} = \frac{\text{No.of ungerminated seeds/pot}}{\text{No.of sown seeds/pot}} \times 100$$

2- Percentage of post-emergence damping-off was determined after 21 days from sowing as:

$$\% \text{ Post-emergence} = \frac{\text{No.of dead seedling/pot}}{\text{No.of sown seeds/pot}} \times 100$$

3- Percentage of survived plants was determined after 30 days from sowing as:
% Survived plants = 100-(% pre-emergence + % post-emergence).

3.1. Effect of causal organisms and their interactions on the incidence of pre- and post-emergence damping-off and survived plants of Littel Marvel and Perfection pea cultivars.

Infested rate of this experiment was determined according to the inoculum level experiments (gave 50% survived plants). Pots (ϕ 20 cm) were filled with 4 kg autoclaved Nile silt soil and divided into four treatments:

Group 1: infested with *R. solani* (isolate 2) at the rate of 3% of soil weight according to the inoculum level experiments.

Group 2: infested with *F. solani* (isolate 3) at the rate of 4% of soil weight according to the inoculum level experiments.

Group 3: infested with *R. solani* at the rate of 2% + *F. solani* at the rate of 1.5% of soil weight.

Group 4: Control treatment was mixed with sterilized corn medium.

Ten surface sterilized seeds from any cultivar (Littel Marvel and Perfection) were sown in each pot. Four replicates were used for each particular treatment. The percentages of pre- and post-emergence damping-off and survived plants were recorded after 15 and 30 days from sowing.

3.2. Interactions among the pathogenic fungi and *R. leguminosarum*:

R. leguminosarum used in this experiment was obtained from Dept. of Microbiology, Water and Soil Res. Inst., (ARC), Giza. Pots (ϕ 20 cm) were filled with 4 kg Nile silt soil infested with any of the pathogenic fungi separately or their mixture and/or *R. leguminosarum*. Soil infested or non-infested with *R. leguminosarum* served as controls. Two ml of *R. leguminosarum* inoculum grown on yeast extract mannitol liquid medium and adjusted to 50×10^8 cfu/ml (according to Gohar *et al.*, 1991) were added to each pot at sowing time. Eight surface-sterilized

seeds from each cultivar (Littel Marvel and Perfection) were sown in each pot, in 15th Oct. 1996. Four replicated pots were used for each treatment. The percentage of pre- and post-emergence damping-off disease and healthy plants were recorded as mentioned before.

4- Chemical Control:

Three fungicides, Benlate (benomyl), Methioal-2-(butyl carbomoyl) benzimidazol-2- ylacarbamate., Dupont); Rizolex-T (Tolclofos methyl + thiram), 20% (tolclofos-ethylum-o-dimethyl)-0-2, 6-dichloro-4-methyl-phenylphosphoro thiale 30% thiram (TMTD): bis (dimethyl- thiocarbamayl dusulphide) and Monceren (Pencycuron), (1-(4-chlorobenzyl)-1-cyclopenyl-lurea) were used in this experiment. Seeds of Littel Marvel and Perfection pea cultivars were dressed with any of the tested fungicides (2, 3 and 3 g/kg seed, respectively) in a closed glass container containing 4 ml arabic gum suspension which used as a sticker. At the same time, Nile silt soil in each pot was infested with any of the pathogenic fungi at the rate of 4% of soil weight of *F. solani* and 3% in case of *R. solani*. Two ml of Rhizobium inoculum were added to each pot at sowing time. Control treatment was either infested with Rhizobium only or non-infected, then ten seeds/pot from each pea cultivar was sown. A set of four pots was used for each particular treatment as replicates. The infested and non-infested pots were kept under greenhouse conditions at 23±2°C. Data were determined as the percentage of pre-, post- emergence damping-off and survived plants after 15, 21 and 30 days from sowing, respectively. After 60 days from sowing, 5 survived plants were picked up at random and carefully washed with tap water and the number of nodules was determined. At the same time, the length of plant shoots and roots (in cm), fresh and dry weights (in g) were estimated to study the effect of disease on plant growth.

5- Biological control:

Three different antagonistic fungi were kindly obtained as follows: *Trichoderma harzianum* from Biological and Bacterial Disease Res.Dept.; *Gliocladium virens,* Ornamental Disease Res. Dept., Agric. Res. Center, Giza; and *Chaetomium globosum*, Agric. Bot. Dept., Fungus and Plant Pathology Branch, Fac. Agric., Moshtohor. These fungi were tested to evaluate their effect, each alone or in mixture, on the pathogenic fungi and the number of nodules. Pots (ϕ 20 cm) were used to study the biological effect on the number of nodules, pre- and post-emergence damping-off disease incidence of Littel Marvel and Perfection pea cultivars. Formalin sterilized pots were filled with 4 kg/pot Nile silt soil. Different antagonists were grown on liquid Gliotoxin fermentation medium as adopted by Brain and Hemming (1945). Inoculum concentrations were prepared according the method of Harman *et al.* (1980) as follows, *T. harzianum* ($5x10^8$ spores/ml), *G. virens* ($1.2x10^6$ spores/ml) and *C. globosum* ($1x10^5$ spores/ml). After 9 days from incubation in dark at 25°C, different cultures blending with sodium alginate at the rate of 5g/L culture of the antagonistic fungi were used to prepare a viscous suspension. One hundred surface sterilized seeds (by immersing in 3.5% sodium hypochlorite solution for 3 min. then washed for several times in sterilized distilled water) were soaked in 50 ml suspension of the antagonistic fungi for 20 minutes, then air dried. Two ml of Rhizobium inoculum were mixed with the soil in pots underneath pea seeds after coating the

seeds with the antagonist suspension. The soil in each pot was infested with the growth of any of the pathogenic fungi at the rate of 4% of soil weight of *F. solani* and 3% in case of *R. solani*. Control treatment was infested with Rhizobium inoculum only. Ten antagonistic suspension treated seeds of each cultivar separately were sown in each pot. A set of four pots was used for each particular treatment as replicates. The percentage of pre- and post-emergence damping-off and survived plants were determined after 15, 21 and 30 days from sowing, respectively. After 60 days from sowing, 5 survived plants were picked up at random and carefully washed with tap water and the number of nodules was determined. At the same time, the length of plant shoots and roots (in cm), fresh and dry weights (in g) were estimated to study the effect of disease on plant growth.

6- Statistical analysis:

All experiments were performed in a complete randomized block, split plot and split split designs. All data in form of percentages were transformed into arcsin, then subjected to analysis of variance according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

1- Isolation and Identification of the Causal Organism(s):

The following fungi were isolated from roots of pea (***Pisum sativum***) plants collected from Shebeen El-Kanater and Tukh (Kalubyia), Belbeas (El-Sharkyia), El-Saff (Giza) and Abou-Khalefa (Ismailyia).

(1) *Fusarium solani* (Mart.) Apple & Wr. [5 isolates].
(2) *Macrophomina phaseolina* (Tassi) Goid. [1 isolate].
(3) *Rhizoctonia solani* Kühn [5 isolates].
(4) *Sclerotium rolfsii* Sacc. [1 isolate].

These fungi were also reported by other investigators as the causal agent of pre- and post-emergence damping-off and root-rot diseases in legume crops (Kraft, 1991; Abada *et al.*, 1992; Oyarzun *et al.* 1993 and Persson *et al.*, 1997).

2- Pathogenicity Test:

The different isolated fungi were examined after purification to insure their pathogenicity.

Data in Table (1) show that, all tested fungi infected pea plants caused pre- and post-emergence damping-off, but with different categories of infection. *Fusarium solani* (isolate 3) and *Rhizoctonia solani* (isolate 2) showed the highest percentage of pre- and post-emergence damping-off, followed by *Rhizoctonia solani* (3, 4 & 5), and *Sclerotium rolfsii*. However, *Macrophomina phaseolina* showed the lowest percentage. Thus, *Rhizoctonia solani* and *Fusarium solani* were more significantly aggressive than the other isolated fungi.

F. solani and *R. solani* showed the highest percentages of pre- and post-emergence damping-off, while *M. phaseolina* showed the lowest percentages.

These results were frequently reported by many investigators (Kirpicheva, 1990; Abada *et al.*, 1992; Persson *et al.*, 1997 and Ragab *et al.* , 1999).

Table (1): Percentage of pre- and post-emergence damping-off with the isolated fungi as well as healthy survived of pea plants Littel Marvel cv.

Tested Fungi*	Pre-emergence damping - off	Post-emergence damping-off	%Survived Plant
Fusarium solani (1)	50.0	25.0	25.0
Fusarium solani (2)	50.5	27.5	22.5
Fusarium solani (3)	72.5	17.5	10.0
Fusarium solani (4)	57.5	25.0	17.5
Fusarium solani (5)	50.0	20.0	30.0
Rhizoctonia solani (1)	62.5	15.0	22.5
Rhizoctonia solani (2)	77.5	22.5	00.0
Rhizoctonia solani (3)	65.0	15.0	20.0
Rhizoctonia solani (4)	57.5	22.5	20.0
Rhizoctonia solani (5)	55.0	25.0	20.0
Macrophomina phaseolina	25.0	27.5	47.5
Sclerotium rolfsii	40.0	40.0	20.0
Control	00.0	0.00	100
L.S.D. at 0.05 for:	6.143	6.445	4.834
0.01	8.205	8.608	6.456

*Inoculum potential 5% of soil weight.

3- Susceptibility of Littel Marvel and Perfection pea cultivars:

Data of the disease incidence of *F. solani* (isolate, 3) and *R. solani* (isolate, 2) and their mixture and survived plants of pea cultivars are shown in Table (2). *R. solani* was more aggressive than *F. solani* in the pre- emergence damping-off phase, while the opposite was found in the post- emergence damping-off phase. This was true for both cultivars under study.

Littel Marvel cv. was more susceptible to disease infection than Perfection cv., which showed higher percentages of pre- and post-emergence damping-off and lower percentage of survived plants. These results are in harmony with the results of Abada *et al.* (1992) who found that, *R. solani* and *F. solani* were more virulent than other pathogens and *R. solani* was more severe. Also, Littel Marvel cv. was more susceptible to the infection than Linkoln and Perfection cvs. The interaction between both pathogenic organisms resulted in a higher increase in the percentage of pre- and post-emergence damping-off phase and a lower percentage of survived plants than each pathogen alone. This was true for both cultivars under study. Also, Littel Marvel cv. was more sensitive in this respect than Perfection cv. The interaction effect of the pathogenic fungi might be due to their synergistic effect. These results are in agreement with the results of Abdou *et al.* (1970).

Table (2): Effect of the most pathogenic causal organisms and their interactions on pre-, post-emergence damping-off and survived plants of Littel Marvel (LM) and Perfection (P) pea cultivars.

Pathogenic fungi	% damping-off						% Survived plants		
	Pre-emergence			Post-emergence					
	P	LM	Mean	P	LM	Mean	P	LM	Mea
Fusarium solani (F.3)*	25.00	24.25	24.63	15.50	17.50	16.50	59.50	48.25	53.8
Rhizoctonia solani (R.2)**	28.25	32.50	30.38	12.50	15.50	14.00	59.25	42.00	50.6
F. + R.***	31.50	35.50	33.50	28.50	33.5	31.00	40.00	31.00	35.5
Control	0.00	0.00	0.00	0.00	0.00	0.00	100.0	100.0	100.
Mean	21.19	23.06	--	14.13	16.63	--	64.69	55.31	--

L.S.D. at	5%	1%	5%	1%	5%	1%
for Cultivar (C):	N.S	N.S	N.S	N.S	N.S	N.S
Pathogenic fungi (P):	5.71	7.36	1.26	1.47	5.14	5.79
C. x P.:	3.11	3.42	N.S	N.S	N.S	N.S

* Inoculum potential 4% of soil weight.
** Inoculum potential 3% of soil weight
*** Inoculum potential 2% and 1.5% of soil weight, respectively.

3.1. Interaction among the pathogenic fungi (*R. solani* and *F. solani*) and *R. leguminosarum*:

Data (Table 3) show that inoculation with *R. leguminosarum* caused highly significant reduction in the percentage of pre- and post-emergence damping-off disease incidence against the two pathogens and with the two cultivars. Inoculation with *Rhizobium* in the presence of the pathogens caused a significant reduction in disease incidence compared with each pathogen alone The lowest percentage of pre- and post-emergence damping-off and the highest percentage of healthy survived plants were recorded with the combination *F. solani* + *Rhizobium* followed by *R. solani* + *Rhizobium*. The same trend was found in both cultivars under study.

These results are in agreement with the results of Hilal *et al.* (1990); Blum *et al.* (1991), El-Fahham (1993) and Haque and Ghaffar (1993) who found that seed or soil application of Rhizobium increased survived plants.

4- Chemical control:

4.1. Effect of some fungicides and *R. leguminosarum* on number of nodules of pea cultivars (Littel Marvel and Perfection) in the presence of the pathogenic fungi (*F. solani* and *R. solani*):

Results of the effect of three fungicides, on number of nodules formed by *Rhizobium* in the presence of the two pathogenic fungi (*F. solani* isolate 2 and *R. solani* isolate. 3) are presented in Table (4).

Data show that soil infestation with *F. solani* and *R. solani* has significantly decreased nodules number/plant than in non-infested soil. The tested fungicides varied in their effect on pea nodulation. Monceren was the most efficient fungicide in increasing nodule numbers followed by Rizolex-T, *i.e.*

44.55 and 41.15 in soil infested with *F. solani* and 48.75 and 47.55 in soil infested with *R. solani*. While Benlate showed the lowest effect. It is clear that, number of nodules formed on roots of Perfection cultivar was significantly more than that formed on Littel Marvel cultivar and that all treatments including Rhizobium showed more nodules than in non-Rhizobium treatments. This was true for both fungi under study.

Table (3): Effect of the interactions among the causal organisms and *Rhizobium leguminosarum* (B) on the incidence of pre-, post-emergence damping-off and survived plants of 2 pea cultivars.

Pathogenic Fungi	% damping-off						% Survived plants		
	Pre-emergence			Post-emergence					
	P	LM	Mean	P	LM	Mean	P	LM	Mean
Fusarium solani (F.)	34.38	40.63	37.51	9.38	15.63	12.51	56.22	43.77	50.00
Rhizoctonia solani (R.)	28.25	37.50	32.88	12.50	15.63	14.07	59.25	46.87	53.06
F. + B.	15.50	18.75	17.13	12.50	12.50	12.50	72.00	68.75	70.38
R. + B.	21.88	21.88	21.88	12.50	9.38	10.94	65.62	68.72	67.17
B.	0.00	0.00	0.00	0.00	0.00	0.00	100.0	100.0	100.0
Control	0.00	0.00	0.00	0.00	0.00	0.00	100.0	100.0	100.0
Mean	16.67	19.79	18.23	7.81	8.86	8.33	75.52	71.35	73.44

L.S.D. at	5%	1%	5%	1%	5%	1%
for Cultivar (C).	N.S	N.S	N.S	N.S	N.S	N.S
Treatment (T):	6.14	8.39	1.70	1.05	5.88	7.92
C. x T.:	N.S	N.S	2.41	3.25	N.S	N.S

These results are in agreement with the results of Abd El-Moity and Hanna (1994) who found that, *Rhizoctonia* disease reduced the number of nodules in broad bean roots, also, coating seeds with Vitavax captan reduced both of *Rhizoctonia* disease and the number of nodules. Therefore, Agnihotri *et al.* (1973) mentioned that, distribution of biological balance by using hazardous toxic fungicides may led to harmful effects on the beneficial microorganisms in the soil. In the same trend Zaghloul and Abd El-Mageed (1996) found that, the lowest values of fresh and dry weight of root nodules were recorded when *R. solani* or bean common mosaic virus (BCMV) were inoculated with *R. leguminosarum* either solely or in combination on broad bean.

4.2. Effect of some fungicides on number of nodules/plant formed by Rhizobium on roots of pea cultivars Little Marvel (LM) and Perfection (P) in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*):

The effect of seed dressing with any of the 3 fungicides and *Rhizobium* on the percentage of pre- and post- emergence damping-off and survived plants of Perfection and Littel Marvel pea cultivars are presented in Table (5).

Data show that all fungicides under study, either alone or combined with Rhizobium, have significantly decreased the percentage of damping-off disease. Rizolex-T was the most effective fungicide in decreasing the percentage of pre-

Table (4): Effect of some fungicides on number of nodules/plant formed by *Rhizobium* on roots of pea cultivars Littel Marvel (LM) and Perfection (P) in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*).

Fungicides	Number of nodules/plant roots in soil infested with														
	F. solani							*R. solani*							
	Rhizobium			non-Rhizobium			Mean	Rhizobium			non-Rhizobium			Mean	Mean
	P	LM	Mean	P	LM	Mean		P	LM	Mean	P	LM	Mean		
Benlate	40.50	36.30	38.40	24.50	19.00	21.75	30.08	43.50	36.80	40.15	28.00	22.50	20.25	30.20	30.14
Rizolex-T	44.30	38.00	41.15	29.00	20.80	24.90	33.03	48.80	46.30	47.55	29.50	24.80	27.15	37.35	35.19
Monceren	48.80	40.30	44.55	31.50	26.30	28.90	36.73	50.00	47.50	48.75	33.80	26.00	29.90	39.33	38.03
Control* (1)	30.50	17.50	24.00	20.00	12.00	16.00	20.00	30.00	18.00	22.00	21 50	11.50	16.50	19.25	19.63
Control* (2)	64.50	57.00	60.75	40.50	32.00	36.25	48.09	64.50	57.00	60.75	40.50	32.00	36.25	48.53	48.51
Mean	49.40	42.00		32.10	25.80			51.60	47.10		32.80	26.10			

*Control (1): Fungicides free infected treatments, Control (2): fungi and fungicides free treatments.

L.S.D at	5%	1%
for Pathogenic fungi:	1.03	1.36
Rhizobium:	1.03	1.36
Cultivar:	1.03	1.36
Treatment:	1.64	2.17

Table (5): Effect of tested fungicides and/or *Rhizobium* on the incidence of pre-, post-emergence damping-off and survived plants of Perfection and Littel Marvel pea cultivars in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*).

Treatments	Perfection pea cv.									Little Marvel pea cv.								
	%Pre-emergence damping-off			%Post-emergence damping-off			%Survived plants			%Pre-emergence damping-off			%Post-emergence damping-off			%Survived plants		
	F. solani	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean
Benlate	10.50	12.50	11.50	6.30	9.40	7.85	81.12	78.10	79.61	12.50	12.50	12.50	10.00	12.50	11.25	77.50	75.00	76.25
Rizolex-T	9.40	3.10	6.25	9.40	6.30	7.85	81.12	90.60	85.86	10.00	5.00	7.50	12.50	10.00	11.25	77.50	85.00	81.25
Monceren	10.50	12.50	11.50	15.60	12.50	14.05	71.90	75.00	73.45	12.50	12.50	12.50	15.00	15.00	15.00	72.50	72.50	72.50
Benlate +R.	7.50	6.30	6.90	6.30	9.40	7.85	81.12	84.13	82.63	10.00	10.00	10.00	7.50	7.50	7.50	82.50	82.50	82.50
Rizolex+ R.	9.40	0.00	4.70	9.40	0.00	4.70	81.12	100.0	90.56	10.00	7.50	8.75	7.50	5.00	6.25	82.50	87.50	85.00
Monceren +R.	18.75	9.40	14.08	3.10	12.50	9.30	78.15	78.10	78.13	10.00	10.00	10.00	7.50	12.50	10.00	82.50	77.50	80.00
Rhizobium	17.75	21.90	19.83	12.50	12.50	12.50	68.75	65.60	67.18	18.50	22.50	20.50	15.00	15.00	15.00	66.50	62.50	64.50
Control*	30.50	31.50	31.00	15.30	12.50	13.90	54.50	56.10	55.30	32.50	25.00	28.75	22.50	20.00	21.25	45.50	55.00	50.25
Mean	14.29	12.15	--	9.738	9.388	--	74.72	78.45	--	14.50	13.13	--	12.19	12.19	--	73.38	74.69	--
L.S.D at 5%			5%	1%	5%	1%	5%	1%		5%	1%	5%	1%	5%	1%			
For Pathogenic (P)			2.558	3.416	N.S	N.S	3.202	4.277		N.S	N.S	N.S	N.S	N.S	N.S			
Treatment (T)			5.116	6.833	5.700	7.613	6.425	8.581		3.827	5.111	4.934	6.591	5.136	6.860			
P x T			N.S	N.S	N.S	N.S	9.063	N.S		5.438	N.S	N.S	N.S	N.S	N.S			

* Infected plants with pathogenic fungi free from fungicide and Rhizobium.

and post-emergence damping-off and increasing the survived plants followed by Benlate, while Monceren was the least effective.

In case of perfection pea cultivar, Rizolex-T was the most effective fungicide in reducing pre- and post-emergence damping-off due to soil infestation with *R. solani* being 3.10% and 6.30%, respectively.

Addition of *Rhizobium* also decreased the percentage of pre- and post-emergence damping-off disease and increased the healthy survived plants compared to the control. However, this reduction in disease incidence was much less than that of fungicides or fungicides + *Rhizobium* combinations. The best combination in reducing disease incidence was Rizolex-T + Rhizobium followed by Benlate + Rhizobium, while Monceren + Rhizobium was less effective. Similar results were obtained for both Perfetion and Littel Marvel pea cultivars.

Hilal *et al.* (1990) found that, the survived plants increased most following treatment with Bavistin, Sumisclex followed by Benlate. They added that, seed or soil application of Rhizobium also increased survived plants. All fungicides tested effectively reduced the incidence of *R. solani* and *F. moniliforme* on groundnut rots caused by various other pathogens.

4.3. Effect of some fungicides and/or *Rhizobium* on some crop characters of pea cultivars in the presence of pathogenic fungi:

The effect of the tested fungicides and *Rhizobium* on some crop characters of Perfection and Littel Marvel pea cultivars are presented in Tables (6-A and 6-B). Data show that all the tested fungicides each alone or combined with *Rhizobium* have significantly increased stem and root length, as well as fresh and dry weight of both pea plants of the two cultivars, compared with control. The best combination in increasing most of the studied characters was Benlate + Rhizobium and Rizolex-T + Rhizobium. This was true for both cultivars under study.

In regard to Perfection cv., stem lengths were 44.60 and 44.53 cm in the previous two treatments, respectively. While, length of roots were more longer (17.12 cm) in treatment of Rizolex-T + Rhizobium in comparison with control treatment 12.96 cm.

Regarding dry weight of stems and roots, there were little differences among all treatments. In addition, all treatments increased these parameters in comparison with the control.

On the other hand, all the calculated crop characters of Littel Marvel cv. were lower than that of Perfection cv.

These results are in agreement with those reported by Hwang and Chakravarty (1992), Benhamou and Chet (1993), Xu *et al.* (1993) and Abd El-Moity and Hanna (1994).

Table (6-A): Effect of some fungicides and/or Rhizobium on some crop characters of Perfection pea cultivar in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*).

Treatments	Stem length (cm)			Root length (cm)			Stem fresh weight (g)			Root fresh weight (g)			Stem dry weight (g)			Root dry weight (g)		
	F. solani	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean
Benlate	41.65	41.3	41.48	14.95	15.73	15.34	36.8	3.75	3.72	0.53	0.63	0.58	0.63	0.8	0.72	0.43	0.55	0.49
Rizolex-T	41.13	43.3	42.22	14.90	16.30	15.60	3.60	3.98	3.79	0.60	0.65	0.63	0.63	0.95	0.79	0.50	0.53	0.52
Monceren	41.40	41.93	41.67	15.40	15.35	15.38	3.65	4.05	3.85	0.58	0.63	0.61	0.63	0.93	0.78	0.48	0.55	0.52
Benlate+Rhizobium	45.55	43.65	44.60	16.80	16.98	16.89	4.23	3.65	3.94	0.70	0.68	0.69	0.75	1.15	0.95	0.58	0.58	0.58
Rizolex-T+Rhizobium	43.25	45.8	44.53	17.00	17.23	17.12	3.60	4.05	3.83	0.63	0.73	0.67	0.06	1.08	0.57	0.53	0.60	0.57
Monceren+Rhizobium	42.98	43.15	43.07	16.60	16.95	16.78	3.48	4.00	3.74	0.63	0.63	0.63	0.65	0.95	0.80	0.50	0.55	0.53
Rhizobium	42.30	43.55	42.93	16.00	16.98	16.49	3.55	3.65	3.60	0.65	0.70	0.68	0.73	0.80	0.77	0.53	0.53	0.53
Control*	35.48	33.63	34.56	13.03	12.88	12.96	2.70	2.80	2.75	0.45	0.53	0.49	0.48	0.63	0.56	0.33	0.33	0.33
Mean	41.72	42.04	--	15.59	16.05	--	7.70	3.74	--	0.6	0.65	--	0.64	0.91	--	0.49	0.53	--

* infected plants with pathogenic fungi free from fungicide and Rhizobium.

L.S.D. at	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%
Pathogenic fungi (P)=	0.101	0.135	0.040	0.054	0.032	0.043	0.020	0.027	0.024	0.032	0.020	0.027
Treatment (T)=	0.020	0.027	0.101	0.135	0.060	0.081	0.044	0.059	0.048	0.065	0.040	0.054
P x T =	0.282	0.377	0.141	0.188	0.081	0.108	N.S	N.S	0.070	0.094	N.S	N.S

Table (6-B): Effect of some fungicides and/or Rhizobium on some crop characters of Littel Marvel pea cultivar in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*).

Treatments	Stem length (cm)			Root length (cm)			Stem fresh weight (g)			Root fresh weight (g)			Stem dry weight (g)			Root dry weight (g)		
	F.solani	R. solani	Mean	F.solani	R. solani	Mean	F.solani	R. solani	Mean	F.solani	R. solani	Mean	F.solani	R. solani	Mean	F.solani	R. solani	Mean
Benlate	29.18	24.10	26.64	11.38	10.95	11.17	2.75	2.33	2.54	0.58	0.52	0.55	0.65	0.63	0.64	0.35	0.31	0.33
Rizolex-T	28.18	28.93	28.56	10.65	12.15	11.40	2.58	2.78	2.68	0.56	0.59	0.58	0.65	0.68	0.67	0.33	0.38	0.36
Monceren	28.85	29.65	29.25	110.5	11.05	11.05	2.83	2.75	2.79	0.58	0.56	0.58	0.63	0.68	0.66	0.34	0.35	0.35
Benlate+Rhizobium	33.60	28.83	31.22	12.53	11.65	12.09	3.13	2.95	3.04	0.61	0.61	0.61	0.90	0.80	0.85	0.39	0.41	0.40
Rizolex-T+Rhizobium	30.60	30.15	30.38	11.90	12.50	12.20	2.78	3.05	2.92	0.58	0.59	0.59	0.80	0.90	0.85	0.38	0.39	0.39
Monceren+Rhizobium	31.63	27.90	29.77	12.10	11.30	11.70	2.70	2.90	2.80	0.58	0.57	0.58	0.85	0.78	0.81	0.36	0.39	0.38
Rhizobium	30.78	30.90	30.84	11.98	12.05	12.30	2.95	2.85	2.90	0.61	0.58	0.60	0.85	0.80	0.83	0.32	0.40	0.36
Control	28.20	22.23	25.22	10.28	10.30	10.29	2.25	1.98	2.11	0.51	0.49	0.50	0.53	0.53	0.53	0.30	0.28	0.29
Mean	30.13	27.84	--	23.92	11.49	--	2.75	2.7	--	0.58	0.56	--	0.73	0.73	--	0.35	0.36	--

L.S.D at.	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%
for Pathogenic (A)=	0.226	0.301	N.S	N.S	0.026	0.035	0.007	0.009	N.S	N.S	0.002	0.003
Treatment (B)=	0.451	0.603	0.101	0.135	0.052	0.070	0.014	0.019	0.040	0.054	0.004	0.005
A x B =	0.644	0.861	0.135	0.180	0.075	0.100	0.020	0.027	0.060	0.081	0.006	0.008

Abd El-Moity and Hanna (1994) reported that Vitavax captan increased the fresh and dry weight of treated broad bean plant compared with the control treatment.

5- Biological Control:

5.1- Effect of the antagonistic fungi (*Trichoderma harzianum*, *Gliocladium virens* and *Chaetomium globosum*) and their combinations on the number of nodules formed by Rhizobium on pea cultivars (Little Marvel (LM) and Perfection (P) in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*):

Data (Table, 7) show that all the tested antagonists, *i.e. T. harzianum*, *C. globosum* and *G. virens* and their combinations caused significant increase in nodulation. The most effective treatment in this respect was *G. virens* followed *T. harzianum*, while *C. globosum* showed the lowest effect. This was clear in *R. solani*-infested soil than in case of *F. solani*. Mixture of antagonists has also improved nodulation rates of the 2 cultivars under study. The mixture of *T. harzianum* + *G. virens* was the best one in increasing the nodules number. It is remarkable that number of nodules formed on roots of cultivar Perfection was more than that formed on Littel Marvel cultivar. In addition, all treatments including Rhizobium infestation showed more nodules number than non-infested treatment. This was true in the presence of the 2 pathogenic fungi under study. These results are in agreement with the results of Abd El-Moity and Hanna (1994) who observed that Rhizoctonia disease reduced the number of nodules in broad bean roots. Adding certain isolates of *Trichoderma harzianum* or *Gliocladium penicilloids* increased the number of nodules, while the other *Trichoderma* spp. isolates showed slight or no respectable effect.

5.1- Effect of the antagonistic fungi (*Trichoderma harzianum*, *Gliocladium virens* and *Chaetomium globosum*) and their combinations with Rhizobium on the incidence of pea- and post-emergence damping-off as well as survived plants of Perfection and Little Marvel pea cultivars in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*):

Data (Table, 8) show that all tested antagonists could suppress both *R. solani* and *F. solani* and thus increased pea survived plants. *T. harzianum* showed the best result in this respect compared with the other antagonists. Addition of *Rhizobium* with any of the tested bioagents to the fungal infested soil caused highly significant reduction on pre- and post- emergence damping-off disease. It is remarkable that, all combinations including *T. harzianum* gave better control on the fungal disease compared with other combinations. In this respect, *T. harzianum* + *Rhizobium* gave the highest percentage of survived plants and the lowest percentages of pre- and post-emergence damping-off of Perfection cv. (90.0%, 7.5% and 2.5%, respectively) as shown in Table (8) and the same trend was clear in Littel Marvel cv. In this respect, many investigators demonstrated the efficiency of biocontrol treatments using *Trichoderma* spp. or *Gliocladium* sp. to control *R. solani* (Abd El-Moity *et al.*, 1990; Abd El-Moity and Hanna, 1994). Ragab *et al.* (1999) reported that among various bioagents tested, *Trichoderma harzianum* (EA) and *Bacillus subtilis* (I) showed the highest antagonistic ability against pea root-rot pathogens.

Table (7): Effect of the antagonistic fungi (*Trichoderma harzianum, Gliocladium virens* and *Chaetomium globosum*) and their combinations on the number of nodules formed by Rhizobium on pea cultivars [Littel Marvel (LM) and Perfection (P)] in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*).

Treatments	Number of nodules in soil infested with														
	F. solani							*R. solani*							Mean
	Rhizobium			non-Rhizobium			Mean	Rhizobium			non-Rhizobium			Mean	
	P	LM	Mean	P	LM	Mean		P	LM	Mean	P	LM	Mean		
T. harzianum	52.00	47.00	49.50	35.50	30.00	32.75	41.13	60.30	53.00	56.65	37.80	29.80	33.80	45.23	43.18
G. virens	55.50	49.50	52.50	38.00	30.50	34.25	43.37	61.00	54.50	57.75	36.00	29.30	32.65	45.20	44.29
C. globosum	49.80	41.30	45.55	33.30	28.00	30.65	38.10	56.00	55.80	55.90	34.80	29.00	31.90	43.90	41.00
T. + G.	54.00	47.50	50.75	36.00	30.80	33.40	42.08	51.80	50.30	51.05	36.00	28.50	32.25	41.65	41.87
T. + C.	50.50	41.00	45.75	34.50	28.50	31.50	38.63	50.80	48.50	49.65	33.00	28.00	30.50	40.08	39.35
G. + C.	49.50	43.30	46.40	32.00	27.00	29.50	37.95	52.50	49.80	51.15	30.50	25.50	28.00	39.58	38.76
T.+ C.+ G.[1]	52.80	45.80	49.30	30.80	25.00	27.90	38.60	50.00	47.80	48.90	32.30	26.00	29.15	39.03	38.81
Control(1)[2]	30.50	17.50	24.00	20.00	12.00	16.00	20.00	30.00	18.00	24.00	21.50	11.50	16.50	20.25	20.13
Control(2)[2]	64.50	57.00	60.75	40.50	32.00	36.00	48.38	64.50	57.00	60.75	40.50	32.00	36.25	48.50	48.44
Mean	51.01	43.32	--	33.40	27.09	--	--	52.99	48.30	--	33.60	26.62	--	--	--

1) – T.= *T. harzianum*, G.= *G. virens*, and C.= *C. globosum*.
2)- **Control (1)**: Pathogenic fungi, **Control (2)**: Without fungi and natural soil.

L.S.D at	5%	1%
for Pathogenic fungi:	1.45	1.91
Rhizobium:	1.45	1.91
Cultivar:	1.45	1.91
Treatment:	3.07	4.04

Table (8): Effect of the antagonistic fungi (*Trichoderma harzianum*, *Gliocladium virens* and *Chaetomium globosum*) and their combinations with Rhizobium on the incidence of pre- and post-emergence damping-off as well as survived plants of Perfection and Little Marvel pea cultivars in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*).

Treatments	Perfection pea cultivar									Little Marvel pea cultivar								
	%Pre-emergence damping-off			%Post-emergence damping-off			%Survived Plant			%Pre-emergence damping-off			%Post-emergence damping-off			%Survived Plant		
	F. solani	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean
T. harzianum (T.)	10.0	10.0	10.00	10.0	10.0	10.00	80.0	80.0	80.00	12.5	12.5	12.50	7.5	10.0	8.75	80.0	77.5	78.75
G. *virens* (G.)	7.5	7.5	7.50	12.5	15.0	13.75	80.0	77.5	78.75	15.0	10.0	12.50	15.0	12.5	13.75	70.0	77.5	73.75
C. *globosum* (C.)	10.0	7.5	8.75	12.5	12.5	12.50	77.5	80.0	78.75	15.0	12.5	13.75	15.0	10.0	12.50	70.0	77.5	73.75
T.+ G.	12.5	10.0	11.25	10.0	10.0	10.00	77.5	80.0	78.75	7.5	10.0	8.75	17.5	17.5	17.50	80.0	72.5	76.75
T.+ C.	12.5	10.0	11.25	10.0	12.5	11.25	77.5	77.5	77.50	12.5	15.0	13.75	10.0	15.0	12.50	77.5	72.5	75.00
G.+ C.	15.0	10.0	12.50	10.0	10.0	10.00	75.0	80.0	77.50	15.0	15.0	15.00	10.0	12.5	11.25	75.0	72.5	73.75
T.+ G. + C.	10.0	10.0	10.00	12.5	10.0	11.25	77.5	80.0	78.75	12.5	12.5	12.50	12.5	17.5	15.00	75.0	70.0	72.50
T.+ R.	7.5	7.5	7.50	2.5	2.5	2.50	90.0	90.0	90.00	5.0	5.0	5.00	7.5	12.5	10.00	87.5	87.5	87.50
G.+ R.	7.5	7.5	7.50	7.5	2.5	5.00	85.0	90.0	87.50	10.0	10.0	10.00	12.5	12.5	12.50	77.5	77.5	77.50
C.+ R.	2.5	5.0	3.75	17.5	5.0	11.25	80.0	90.0	85.00	12.5	12.5	12.50	10.0	10.0	10.00	77.5	77.5	77.50
T. + G. + R.	7.5	5.0	6.25	7.5	7.5	7.50	85.0	87.5	86.25	10.0	12.5	11.25	10.0	12.5	11.25	80.0	75.0	77.50
T. +C. + R.	5.0	5.0	5.00	7.5	5.0	6.25	87.5	90.0	88.25	7.5	7.5	7.50	15.0	12.5	13.75	77.5	80.0	78.75
C. + G. + R.	10.0	7.5	8.75	7.5	2.5	5.00	82.5	90.0	86.25	15.0	12.5	13.75	10.0	10.0	10.00	75.0	77.5	76.25
T.+ G.+C.+ R.	2.5	2.5	2.50	10.0	7.5	8.75	87.5	90.0	88.25	12.5	12.5	12.50	10.0	10.0	10.00	77.5	77.5	77.50
Rhizobium (R.)	17.5	22.5	20.00	12.5	12.5	12.50	70.0	65.0	67.50	18.5	21.5	20.00	15.0	15.0	15.00	66.5	62.5	64.50
Control	22.5	17.5	20.00	22.5	30.0	26.25	55.0	52.5	53.25	20.0	20.0	20.00	25.0	22.5	23.75	55.0	57.5	56.25
Mean	10.00	09.06	–	10.78	09.69	–	79.22	81.25	–	12.56	12.59	–	12.66	13.28	–	75.09	74.53	–
L.S.D at.	5%	1%		5%	1%		5%	1%		5%	1%		5%	1%		5%	1%	
for Pathogenic (P):	N.S	N.S		N.S	N.S		1.311	1.737		N.S	N.S		N.S	N.S		N.S	N.S	
Treatment (T.):	4.391	5.817		4.233	5.606		3.616	4.790		3.561	4.724		4.193	5.554		12.32	16.32	
P x T.:	N.S	N.S		5.981	7.922		N.S	N.S		5.047	6.685		N.S	N.S		N.S	N.S	

5.3. Effect of the antagonistic fungi and their combinations with *Rhizobium* on some crop characters of pea cultivars in the presence of (*F. solani* and *R. solani*):

The effect of *T. harzianum*, *C. globosum*, *G. virens* and *Rhizobium* on plant length, fresh and dry weight was studied under green house conditions and data are tabulated in Tables (9 & 10). Results showed that addition of biological agents to the infested soil increased all crop characters under study compared with soil infested with pathogenic fungi only. In this respect, *T. harzianum* was the best one in increasing all the crop characters compared to other antagonists. All combinations of *Rhizobium* and the antagonistic fungi caused highly significant increase in all crop character under study However, *T. harzianum* + *Rhizobium* showed the best effect in improving the studied characteristics. The same trend was found for both Perfection and Littel Marvel pea cultivars.

Regarding Perfection cv. all the assessed crop characters studied significantly increased when *T. harzianum* was combined with Rhizobium compared with the other treatments or control. In this respect, stem length was 47.63 mm, root length was 17.49 mm, fresh stem weight 4.80 g and dry stem and root weight were 1.59 and 0.91 g, respectively (Table, 9). Meanwhile, Littel Marvel cv. act in the same differences, where Rhizobium treatment alone increased stem and root lengths, being 42.90 and 16.49 mm, respectively and also increased fresh weight of stem and root (3.60 and 0.68, respectively) and stem and root dry weight (0.76 and 0.53, respectively), compared with the other treatments (Table, 10). This can be explained in the light of work of Chang *et al.* (1986) and Windham *et al.* (1986) who reported that treatment with *Trichoderma* spp. led to increased vigour due to increase a viability nutrient substances, control minor pathogens and also through production of some growth regulators, which affect positively on plant metabolism and appear as increase in the vigour of treatment.

Also, these results are in harmony with results reported by Konde *et al.* (1984) who found that seed germination and plumule length were increased when antagonistic organisms and soil borne pathogens were inoculated along with chickpea rhizobia. Also, Abd El-Moity and Hanna (1994) mentioned that, adding certain isolates of *Trichoderma harzianum* or *Gliocladium penicilloids* increased the fresh and dry weight of treated broad bean plants. Furthermore, Naseby *et al.* (2000) found that all the Trichoderma strains reduced the number of lesions caused by *Pythium ultimum* and increased the number of lateral roots and nodules, also, significantly increased the wet root weights in the presence of *P. ultimum* compared to the *P. ultimum* control.

Table (9): Effect of the antagonistic fungi (*Trichoderma harzianum*, *Gliocladium virens* and *Chaetomium globosum*) and their combinations with Rhizobium on some crop characters of Perfection pea cultivar in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*).

Treatments	Stem length (cm)			Root length (cm)			Stem fresh weight (g)			Root fresh weight (g)			Stem dry weight (g			Root dry weight (g)		
	F. solani	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean
T. harzianum	38.00	39.38	38.69	14.43	14.53	14.48	4.15	4.40	4.28	0.63	0.70	0.66	1.05	1.12	1.09	0.51	0.55	0.53
G. virens	36.30	38.50	37.40	13.68	13.90	13.78	3.93	4.15	4.04	0.59	0.62	0.61	1.02	1.50	1.26	0.45	0.55	0.50
C. globosum	36.80	37.45	37.13	13.15	13.40	13.26	3.85	3.83	3.84	0.6	0.59	0.60	1.00	1.02	1.01	0.43	0.46	0.44
T. + G.	37.18	39.18	38.18	14.20	14.00	14.10	3.75	4.10	3.93	0.65	0.64	0.64	0.93	1.00	0.96	0.50	0.50	0.50
T. + C.	38.73	39.35	39.04	14.23	14.00	14.11	3.98	4.08	4.03	0.64	0.64	0.64	1.03	1.04	1.03	0.49	0.48	0.48
G. + C.	36.78	38.40	37.59	13.83	13.08	13.45	3.70	3.93	3.81	0.61	0.62	0.61	0.93	0.99	0.96	0.47	0.48	0.47
T. + G. + C.	37.58	38.65	38.12	13.95	14.00	13.98	3.83	4.00	3.91	0.61	0.65	0.63	1.01	1.01	1.01	0.47	0.50	0.49
T. + R.	47.50	47.75	47.63	17.48	17.50	17.49	4.53	5.08	4.80	1.31	1.25	1.28	1.50	1.68	1.59	0.88	0.94	0.91
G. + R.	43.63	43.90	43.76	16.48	16.20	16.34	4.25	4.68	4.46	1.57	0.92	1.25	1.40	1.58	1.49	0.85	0.81	0.83
C. + R.	45.70	45.90	45.80	16.83	16.80	16.81	4.45	4.85	4.65	1.17	0.99	1.08	1.45	1.60	1.53	0.87	0.83	0.85
T. + G. + R.	45.43	44.23	44.83	16.98	16.80	16.89	4.40	1.11	2.89	0.96	1.04	1.06	1.38	1.58	1.48	0.86	0.84	0.85
T. + C. + R.	44.78	44.63	44.70	16.70	16.80	16.75	4.43	0.95	2.69	0.98	0.96	0.97	1.40	1.63	1.52	0.81	0.86	0.83
G. + C. + R.	[illegible]	45.[illegible]	44.66	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.58	[illegible]	[illegible]	[illegible]	[illegible]
T.+G.+C.+ R.	43.83	43.98	43.90	16.80	16.80	16.80	4.39	1.16	2.78	0.95	1.05	1.00	1.40	1.53	1.46	0.87	0.82	0.84
Rhizobium	42.30	43.55	42.93	16.00	16.98	16.49	3.55	3.65	3.60	0.65	0.70	0.68	0.73	0.80	0.76	0.53	0.53	0.53
Control	33.83	33.68	33.76	12.63	13.50	13.00	3.49	0.54	2.02	0.54	0.54	0.54	0.71	0.68	0.70	0.38	0.34	0.36
Mean	40.83	41.48	--	15.27	15.32	--	4.07	3.23	--	0.84	0.81	--	1.15	1.27	--	0.64	0.65	--
L.S.D. at		0.05	0.01		0.05	0.01		0.05	0.01		0.05	0.01		0.05	0.01		0.05	0.01
Pathogenic fungi (P)=		0.016	0.021		0.016	0.021		0.004	0.005		0.002	0.002		0.006	0.002		NS	NS
Treatment (T)=		0.040	0.053		0.040	0.060		0.010	0.013		0.004	0.005		0.004	0.005		0.008	0.011
P x T =		0.191	0.260		0.060	0.086		0.014	0.018		0.006	0.008		0.006	0.008		0.012	0.016

Table (10): Effect of the antagonistic fungi (*Trichoderma harzianum*, *Gliocladium virens* and *Chaetomium globosum*) and their combinations with Rhizobium on some crop characters of Littel Marvel pea cultivar in the presence of the pathogenic fungi (*Fusarium solani* and *Rhizoctonia solani*).

Treatments	Stem length (cm)			Root length (cm)			Stem fresh weight (g)			Root fresh weight (g)			Stem dry weight (g)			Root dry weight (g)		
	F. solani	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean	*F. solani*	*R. solani*	Mean
T. harzianum	30.05	27.9	28.98	11.73	11.38	11.55	2.93	2.53	2.73	0.61	0.56	0.58	0.74	0.61	0.67	0.46	0.41	0.43
G. virens	29.80	26.45	28.13	11.38	10.85	11.12	2.90	2.20	2.55	0.55	0.52	0.53	0.73	0.55	0.64	0.41	0.37	0.39
C. globosum	28.45	27.33	27.89	10.73	11.00	10.86	2.65	2.40	2.53	0.54	0.53	0.54	0.66	0.60	0.63	0.37	0.41	0.39
T.+G.	29.13	26.95	28.04	10.88	10.88	10.88	2.85	2.25	2.55	0.53	0.52	0.52	0.71	0.57	0.64	0.38	0.37	0.38
T.+C.	29.30	27.45	28.38	11.03	10.88	10.96	2.65	2.20	2.43	0.52	0.53	0.52	0.67	0.55	0.61	0.35	0.38	0.36
G.+C.	28.73	28.53	28.63	10.90	10.93	10.91	2.70	2.28	2.49	0.51	0.53	0.52	0.68	0.57	0.62	0.36	0.39	0.37
T.+G.+C.	29.75	28.38	29.06	10.90	11.05	10.98	2.90	2.20	2.55	0.52	0.53	0.53	0.72	0.55	0.64	0.38	0.39	0.38
T.+R.	34.80	32.40	33.60	13.00	12.05	12.53	3.13	2.88	3.00	0.63	0.59	0.61	1.05	0.93	0.99	0.52	0.47	0.49
G.+R.	33.65	30.65	32.15	12.45	11.63	12.04	3.00	2.70	2.85	0.61	0.57	0.59	1.03	0.90	0.96	0.49	0.45	0.47
C.+R.	33.33	28.85	31.09	12.45	11.38	11.92	3.00	2.88	2.94	0.58	0.57	0.58	0.99	0.93	0.96	0.47	0.46	0.46
T.+G.+R.	34.38	30.38	32.38	12.70	11.83	12.26	3.10	3.00	3.05	0.60	0.60	0.60	1.02	0.98	1.00	0.48	0.49	0.48
T.+C.+R.	31.68	31.95	31.82	11.73	11.53	11.63	2.93	2.75	2.84	0.54	0.59	0.56	0.97	0.90	0.93	0.41	0.43	0.42
G.+C.+R.	33.13	31.93	32.53	12.15	11.78	11.96	3.05	2.58	2.81	0.55	0.58	0.57	1.01	0.90	0.96	0.46	0.47	0.46
T.+G.+C.+R.	32.75	31.05	31.90	12.80	11.4	11.92	2.95	2.55	2.75	0.57	0.59	0.58	0.97	0.89	0.93	0.47	0.46	0.47
Rhizobium	42.30	43.55	42.90	16.00	16.98	16.49	3.55	3.65	3.60	0.65	0.70	0.68	0.73	0.80	0.76	0.53	0.53	0.53
Control	27.33	26.85	27.09	10.00	10.33	10.16	2.40	2.05	2.22	0.45	0.49	0.47	0.47	0.41	0.44	0.27	0.29	0.28
Mean	31.78	30.04	--	11.93	11.62	--	2.92	2.57	--	0.56	0.56	--	0.82	0.73	--	0.43	0.42	--
L.S.D. at	0.05	0.01		0.05	0.01		0.05	0.01		0.05	0.01		0.05	0.01		0.05	0.01	
Pathogenic fungi (P)=	0.040	0.053		0.016	0.021		0.016	0.021		N.S	N.S		0.010	0.008		0.001	0.01	
Treatment (T)=	0.099	0.132		0.040	0.053		0.040	0.053		0.004	0.005		0.017	0.023		0.002	0.02	
P x T =	0.159	0.211		0.060	0.079		0.060	0.079		N.S	N.S		0.024	0.032		0.002	0.03	

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المقاومة الكيميائية والبيولوجية لبعض فطريات التربة التي تصيب جذور البسلة

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فـرع الفطر وأمراض النبات – قسم النبات الزراعي – كلية الزراعة بمشتهر –جامعة الزقازيق/فرع بنها

كـانت فطريات ريزوكتونيا سولاني وفيوزاريوم سولاني هي أكثر الفطريات تكـرارا عند العزل من جذور نباتات البسلة المصابة ، وكان فطر ريزوكتونيا سولاني أكثر إحداثا لمرض موت البادرات قبل الظهور فوق سطح التربة عن الفطر فيوزاريوم سـولاني. وكان صنف البسلة لتل مارفيل أكثر حساسية للإصابة بالمرض عن صنف بيرفكشن.

أدت عـدوى الـتربة بفطريات ريزوكتونيا سولاني وفيوزاريوم سولاني إلى تقليل عدد العقد الجذرية عنها في التربة الغير مصابة.

كـان مـبيد المونسـرين أكـثر المبيدات الفطرية فعالية في زيادة عدد العقد البكتيرية ، بينما كان مبيد البنليت أقل المبيدات المختبرة فعالية في ذلك.

وقـد لوحظ أن عدد العقد البكتيرية المتكونة على الصنف بيرفيكشن أكثر من تلك المتكونة على جذور الصنف لتل مارفيل في جميع المعاملات.

أدت المعاملة بالفطريات المضادة كيتوميوم جلوبوسم و جلايكولديم فيرنس و ترايكودرما هارزيانم ومخاليطها إلى زيادة عدد العقد الجذرية ، وكانت المعاملة بخليط مـن ترايكودرما هارزيانم + جلايكولديم فيرنس أفضل المعاملات في زيادة عدد العقد الجذرية وخاصة على الصنف بيرفيكشن عن الصنف لتل مارفيل في كل المعاملات.

وجـد أن إضـافة الريزوبيوم مع الفطريات المضادة إلى التربة المصابة أدى إلى نقص كبير في حدوث المرض.

أظهرت جميع التوافقات التي احتوت على فطر ترايكودرما هارزيانم أظهرت مقاومة أفضل للمرض. بينما أدت جميع توافقات الريزوبيوم مع الفطريات المضادة إلى حـدوث زيادة كبيرة في جميع صفات النمو مثل طول النبات والوزن الرطب والجاف. وقد حدث ذلك في كلا صنفي البسلة المختبرة.

لوحـظ أن إضافة الريزوبيوم سواء بمفردها أو متوافقة مع المبيدات الفطرية إلى زيـادة صفات النمو (طول النبات والوزن الطازج والجاف) مقارنة بتأثير المبيدات بمفـردها. وفـي هـذا المجال كانت أفضل التوافقات بين البنليت + ريزوبيوم مع كلا صنفي البسلة تحت الاختبار.