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BIOLOGICAL CONTROL OF BEAN DAMPING-OFF DISEASE INCITED BY *Fusarium solani* (Mart) UNDER GREENHOUSE CONDITIONS.

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ABSTRACT: ***This investigation was carried out during 2003 season at Gemmeiza agricultural Research station under green house conditions. In vitro, antagonistic effect of some isolates of Trichoderma or Gliocladium spp on damping-off pathogen (Fusarium solani) revealed the presence of clear antagonistic action between them. The highest mean inhibition values were 79.78 and 75.73% with T.polykoningii or G.virens, respectively, while the lowest effect was observed with T.koningii (65.62%). Under green-house data proved that soil treatment was more effective than seed treatment against pre and post damping-off disease. T. polykoningii as soil treatment gave the highest protection against pre emergence damging-off (3.33 and 6.67%) in sterilized or unsterilized soil, respectively. On the other hand the lowest effect was noticed with T.koningii (13.33 and 20.0%) as compared to the control. G. virens, T. hamatum or T. polykoningii were the most effective against post emergence damping–off exhibited (0.00, 0.00, 3.33; 3.33, and 6.67%) of infection, respectively, while T. koningii, G.deliquescens exhibited (16.67, 3.33; 10.0, 10.0%) of infection. hese bioagents also improved fresh, dry weight (gm./plant) , plant hight (cm./ plant), green bods and seeds yield (gm./ plant). T. polykoningii, T. hamatum or G.virens were the highiest effect in increasing these parameters, while G.deliquescens or T. koningii were the latest rank with seed or soil treatment in sterilized soil. All bioagents gave persistent effect in reducing F. solani population up to 6 weeks of sowing, while topsin M70 was superior in its reduction up to 3 weeks, then the population started to increase up to 6 weeks. the siol treatment with T. polykoningii, G. virens, T. hamatum remarkabley reduced the populalion of F. solani in sterilized soil from 22.5 to 0.25 ; 22.75 to 0.50; 25.25 to 0.25 (cfu) ×106. /gm .soil respectively.***

Key words : ***Biological control – damping-off, F. solani, Trichoderma and Gliocladium spp.- seed and soil treatment .***

INTRODUCTION

Fusarium solani **is a widespread soil borne pathogen responsible for serious damage of many crops. Damping-off, root rot are among the most important diseases that lead to yield losses. At the last few years, many great efforts were done to save the environment from pollution (Boland 1990). Application of pesticides causes pollution to the environment and human**

health . It may induce the appearance of new and resistant isolates in the pathogen population . Pesticides are considered one of the most famous environmental pollutants (Polararapu, 2000). Thus, biological initiated and interests in biological control for plant diseases have grown due to the concerns about environment health and safety (Kerry, 2000). Certain bioagents that can act against various plant pathogens are repeatedly demonstrated to control the disease, such as using *Tirchoderma* spp. as seed dressing or soil treatment (Larkin&Farvel, 1998 and Aguilar *et al* , 2000).Over the past few years *Trichoderma* and *Gliocladium* spp. were reported as producer of plant growth regulators (Hutchinson, 1998). Furthermore, the protoplast fusion technique was used to cambium cells from different *Trichoderma* spp and *Gliocladium* spp. to produce a super strain , effective on wide range of crops and diseases . It also protects both seeds and roots from soilborne pathogens that can effect plant growth (Cook, 2000) . Mechanisms of biological control of *Fusarium* spp might include parasitism , competition for nutrients of infection sites on roots , production of antibiotics and inducing resistance . Many researches used *Trichoderma* and *Gliocladium* spp as bioagent to control *Fusarium* sp . (Papavizas 1985 , Howell 1987 , Hwang&Chakravarty 1993 , Kaushik Jcamel Singh1996 , Gupta and Sarkar 1997 , Fugaro *et al.* 1997 , Mondal *et al* . 1997 ,El-kafrawy2002, Mclean *etal* ,2004 and Lobna Saleh Nawer ,2007). The aim of the present study was to evaluate antagonistic effect of some *Trichoderma spp* . and *Gliocladium spp* .isolates applied either seed or soil treatment in reducing bean damping-off caused by *Fusarium solani*. As well as examined the population dynamics of *F. solani* with *Trichoderma* or *Gliocladium* spp application and its effect on both plant growth and the yield .

MATERIALS AND METHODS

***Fusarium solani* was isolated from bean roots and hypocotyls collected from damping-off or root roted plants at Gemmeiza Research Station.**

Identification

Pure culture of fungal isolate was identified using cultural and morphological feature with reference to (Gilman,1957, Burnett and hunter, 1972 and Nelson *etal*, 1983)

Antagonistic effect *in vitro* :

The antagonistic effect of *Trichoderma* spp and *Gliocladium* spp. against isolates of *F. solani In vitro* was examined on petri plates (9 cm. in diameter) containing Potato Dxtrose Agar (PDA) medium. A disc (6 cm) from a three day-old culture of each the antagonists was transferred to one side of Petri plates containg solidified PDA medium and the other side was inoculated with mycelia disc from edge of a three day-old culture of *F. solani.* Five plates were used for each particular antagonist , five plates were inoculated with the

pathogen only serving as control and the inoculated plates were incubated at 25± 2C ° for five days . The radial growth inhibited percentage of the pathogen was calculated using Abbott equation (Frolich,1979).

$$I..P\% = \frac{C - T}{C} \times 100$$

Where:

C = Radial growth of control .

T = Radial growth of treatment.

I.P = Inhibition%

Greenhouse experiment:

The soil used in this work was clay loam soil and it was divided into two parts , one was sterilized using formalin 40% [250 ml of / 100 L. water] and the other was unsterlized. The soil was infested at 7 days before the sowing with *F.solani* grown on sand wheat – bran medium (1 :3 v/v) at the rate of (3% w/w) . The antagonistic fungi was applied in two methods.

a) Seed treatment:

Spores of the antagonists were harvested from the surface of agar cultures after 7 days of inoculation by adding 10 ml of sterile distilled water to each plate and the spore along with mycelial fragments were collected by soft brush, blended and filtrated through a muslin cloth the filterate containing conidia was centrifuged at 3000 rpm for 10 minutes. The supernatent was discarded and the conidial pellet was resupended in 3 ml sterile distilled water . The spore suspention was adjusted to 5 $\times 10^9$ conidia / ml using a haemocytometer . Three ml of the conidial suspention were mixed with 2 ml of 0.1% carboxymethyl cellulose as a sticker to coat 10 gm of bean seeds , shade dried for 6 hours and sown in pathogen inoculated soil. Seeds with no treatments served as control .

b) Soil treatment

Inoculum of the antagonists was applied on sand wheat – bran medium and used for greenhouse experiment . It was mixed with the soil at the rate of 3% w/w at sowing time.

Seed treatment with fungicide

Topsin M 70 was used as seed dressing fungicide at the rate of 3 g/kg seeds . Seeds were treated with the fungicide 6 hours before sowing .Ten seeds of the susceptible cultivar (Giza 6) were sown in each pot (25 cm in diameter) and 4 pots were used for each particular treatment . The percentages of pre and post-emergence damping-off were recorded after 15

and 30 days from sowing , respectively , Plant height , dry and fresh weight and the yield / plant as green pods , dry seeds were also recorded .

Effect of seed and soil treatment with antagonists on the soil population of *F.solani*

F.solani **population were determined in pots infested with** ***Trichoderma*** **spp and** ***Glioclaium*** **spp .applied either seed or soil treatment, to compare the effect of antagonists on the soil population of** ***F.solani*****. Serial dilutions using dilution plate technique were used where 5 gm of soil samples were collected from each particular treatment after 3 and 6 weeks of sowing and 0.1 ml of each dilution was spread over the surface of PDA plates containing 33 mg . rose Bengal to check bacterial contamination . The seeded plates were inocubated at 25+- 2c˚ for 5 days . The population of** ***F.solani*** **was expressed as colony forming units (cfu)/g.soil.**

Disease assessment:

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

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

Percentage of post- emergence damping off was determined after 60 days:

$$\% \text{ post-emergence} = \frac{\text{No. of died seedings / pot}}{\text{No. of survival plants / pot}} \times 100$$

Statistical analysis:

All data were subjected to completely block randomize desing (Gomes and Gomes 1984).

RESULTS AND DISCUSSION

The antagonistic effects on the fungal isolates were measured by dual culture technique using PDA medium in (Table 1) . Generally , all the antagonists inhibited the growth of ***F.solani*** **significantly , compared to the control .** ***Trichoderma*** **spp grew over the mycelium of** ***F.solani*** **. The inhibition zones were observed between** ***Gliocladium*** **spp and** ***F.solani*** **. The radial growth of** ***F.solani*** **was inhibited by** ***T. polykoningii*** **to 1.80cm ,*G.virens* (2.16) ,** ***T.viride*** **(2.42) ,** ***G.deliquescen*****s (2.52) and** ***T.harzianum*** **(2.67 cm) and these value equal to 79.8, 75.7, 72.8, 71.7 and 70.0 inhibition percentage, respectively**

These results are in line with that reported by Kaushik Jcamel Singh, (1996) and El-kafrawy *et al* , (2002).

Table (1) Effect of antagonists on the radial growth of *F.solani in Vitro*

Antagonists	Radial growth (cm)	Inhibition (%)
T . viride	2.42	72.81
T .harzianum	2.67	70.00
T . hamatum	2.88	67.64
T . poly koningii	1.80	79.78
T . koningii	3.06	65.62
G . deliquescens	2.52	71.69
G . virens	2.16	75.73
Control	8.90	00.00
1.02	L.S.D at 5%	---

T . = Trichoderma G. = Gliocladium

Greenhouse experiment

Effect of some antagonistic fungi on bean damping-off

Data presented in Table (2) indicate that , soil treatment with the tested antagonists , generally gave higher protection against bean damping-off than seed treatment in both sterilized and unsterilized soil prior to infestation. This can be attributed to the fact that the antagonist is colonizing larger volume of the soil, consequently reaching more propaguls of the pathogen (Whipps and Lumsden, 2001; Mclean *et al*, 2004). Moreover, adding *Trichoderma polykoningi*i , *T.hamatum* and *T.viride* to the soil gave lowest percentage of pre- emergence damping-off in either sterilized or unsterilized soil (3.33¸ 6.67¸and 6.67%;6,67¸ 10,0 and 10.0% , respectively). Also, *Gliocladium virens*, *T.hamatum* followed by *T.polykoningii* were the highest effect in checking post emergence damping–off (0.00,0.00 and 3.33%; 3.33, 3.33 and 6.67%) in sterilized or unsterilized soil, respectively. Whereas *T. koningii* and

G. deliquescens **were the lowest in reducing pre and post emergence damping–off (13.33, 13.33% and 20.0, 16.67%; 16.67, 6.67% and 10.00, 10.00%), respectively as compared to the control (20.0, 46.67% and 20.0, 13.33%) respectively . However, the survivals were always lower in the unsterilized soil. This can probably be attributed to the presence of additional inoculum and the natural flora could have interfered with the antagonists . These results are in the accordance with those obtained by fugaro *et al* , (1997), Gupta & Sarkar (1997) and Tha & Singh(1997) they found that soil application of wheat bran culture of antagonists were significantly more effective than seed dressing with Topsin M70 in reducing disease incidence caused by *F.solani* of bean under field condition. And , also Lobna Saleh Nawar (2007) found that soil treatment with *T.harzianum* was more effective than seed coating in reducing squash pre and post damping-off caused by *F.solani* (12.5,20.40% with soil treatment and 20.00,20.00,25.00% with seed coating, respectively).**

Effect of soil and seed treatment with some antagonists on the soil population of *F.solani*

Data presented in Table (3) showed that, treating the soil with antagonistic fungi signficantly decreased the population of *F. solani* by time and was comparable to seed treatment with antagonists in both sterilized and unsterilized soil. Reduction in *F. solani* population was noticed when *T. polykongii, G. virens, T. hamatum* and *T. viride* were added to the soil. These bioagents reduced the population of *F. solani* from 22.50 to 0.25;22.75 to 0.50; 25.25 to 0.75 and 27.75 to 2.00 (cfu) $\times 10^6$ gm . soil after 6 weeks of sowing respectively , while *G. deliquenscens* and *T. koningii* were the least in reducing that population (26.75 to 4.25; 28.25 to 3.75), respectively. Topsin M70 was superior in its reduction up to 3 weeks from sowing , then started to increase upto 6 weeks, while the population was increased by time in the untreated control (from 28.75 to 39.75) after 6weeks from sowing , (cfu) $\times 10^6$ /gm. soil. The mechanism of biocontrol agents could be categorized under five general categories, parasitism, antibiosis, competition, induced resistance and lysis. Howell, (1987) who added that *T.harzianum, T.hamatum* and G.virens significantly reduced the population of Fusarium spp,in soil. Joseph & Sivapasad (1997) and El-Kafrawy (2002) also found that *T. viride*,*T. hamatum, T. harzianum, T. viride* and *G. virens* significantly reduced the population of *Pythium* spp and *Rhizoctonia solani*, respectively. Results reported here indicate that, the feasitity of the integrated management program dealing with damling with damping– off of bean .

Effect of some antagonistic fungi on fresh , dry weight (gm/plant) and plant height (cm/ plant).

The effect of antagonists on plant growth is presented in Table (4) . Soil treatment with the antagonists increased the fresh ,dry weight and plant height of bean plants more than seed treatment of both sterilized and unsterilized soil. Data also revealed that treating the sterilized and unsterilized soil with *T. polykoningii*, *T. hamatum* and *G. virens* were the most effective one in improving fresh, dry weight and plant hight from 9.459 to 23463, 22.264 and 21.643gm./ planthight, respectively; 2.859 to 8.152, 7.674 and 39.30cm./plant, respectively. *T. koningii* and *G. deliquescens* were the least effective in this respect, while the other antagonists fall in between . The improvement of these parameters could be due to the control of the pathogen on one hand, or the possible change in the hormonal behavior of the plant itself and the possible production of growth promoting substances. Result obtained with sterilized soil is similar to those of unsterilized soil . These results are in agreement with those obtained by Fugro *et al* . (1997); Gupta & Sark (1997) , and El-Kafrawy (2002) thjea found that *Trichderma* spp . and *Gliocladium* spp. showed bioagents produced substances in host plants such as hormones and vitamins which led to increase seed germination , shoot and root length.

Effect of some fungal antagonists on the yield as green pods and dry seeds (gm/plant).

Data presented in Table (5) indicate that, soil treatment with the antagonists gave the maximum yield as green pods and dry seeds compared with seed treatment in both sterilized and unsterilized soil . Treating soil with *T.polykoningii, T.hamatum* and *G.virens* increased the yield as green pods from 12.958 to 23.642, 23.146 and 23.023gm./plant, respectively and dry seeds from 3.989 to 8.760, 8.348 and 8.057gm/plant,respectively. In this respect, *T.koningii* and *G.deliquescens* gave the minimum yield, whereas other antagonists fall in between . This is probably a reflection of the better plant growth parameters as a result of disease control and the possible direct effect of metabolites(Davison,1998 and Dubelkovsky et al,1993). There are not much differences between the results obtained with sterilized soil of those of unsterilized soil

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المقاومة الحيوية لمرض موت البادرات في الفاصوليا المتسبب عن فطر فيوزاريوم سولانى تحت ظروف الصوبة

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الملخص العربى

نفذ هذا البحث فى موسم ٢٠٠٣ بمحطة بحوث الجميزة تحت ظروف الصوبة ويمكن تلخيص نتائج هذا البحث فيما يلى :

- **لقد أثبتت بعض عزلات من فطر الترايكوديرما والجليوكلاديوم تضادا واضحا بينها وبين فطر الفيوزاريوم سولانى المسبب لمرض موت بادرات الفاصوليا ، وذلك فى المعمل .**
- **وكان أعلى تثبيط ٧٩,٧٩ , ٧٥,٧٣% مع فطريات الترايكوديرما بولى كوننجى وفطر الجليوكلاديوم فيرنس , على الترتيب. بينما كان أقل تثبيط مع فطر التريكوديرما كوننجى ٦٥,٦٢%.**
- **وقد أثبتت تجارب الصوبة ان معاملة التربة بفطريات التضاد الحيوى أكثر كفاءة فى تثبيط المرض عن معاملة البذرة بهذه الفطريات تحت ظروف التربة المعقمة والغير المعقمة .**
- **وكانت أعلى نسبة تثبيط للموت ما قبل الانبثاق مع فطريات الترايكوديرما بولى كوننجى وفيردى كمعاملة تربة [(٣,٣٣ , ٦,٦٧%) ,(٦٧, ٦, ١٠,٠%)] تحت ظروف التربة المعقمة والغير المعقمة على الترتيب وكان أقل كفأءة تحت نفس الظروف هى الترايكوديرما كوننجى والجليوكلاديوم ديلكوسنس [(١٣,٣٣, ١٣,٣٣%) , (٢٠, ٦٧, ١٦%)] .**
- **وكانت أعلى نسبة تثبيط للموت البادارات مع فطريات الجليوكلاديوم فيرنس , التريكوديرما هاماتم والبولى كوننجى كمعاملة تربة تحت نفس الظروف [صفر , صفر, ٣,٣٣%), (٣,٣٣, ٣,٣٣ , ٦,٦٧%)] . وكان أقلها كفأءة فطريات التريكوديرما كوننجى , الجليوكلاديوم ديليكوسس [(١٦,٦٧, ٣,٣٣%),"(١٠, ١٠%)] .**

- وقد حسنت هذة الفطريات من وزن النبات الطازج والجاف وكذلك طولة كما حسنت وزن القرون ومحصول البذرة , حيث كانت فطريات الترايكوديرما بولى كوننجى والهاماتم والجليوكلاديوم فيرنس هى الأكثر كفاءة , بينما كان فطريات الجليوكلاديوم ديلكوسنس والترايكوديرما كوننجى الأقل تأثيرا وذلك كمعاملة للبذرة أو التربة تحت ظروف التربة المعقمة وغير المعقمة .
- وكانت كل الفطريات المقاومة حيويا لها تأثير فى خفض أعداد فطر الفيوزاريوم سولانى بعد ٦ أسابيع من الزراعة , بينما المعاملة بالمبيد التوبسين ام٧٠ أدت إلى خفض اعداد الفطر حتى ٣ أسابيع من الزراعة ثم زادت أعداد المسبب للمرض بعد ٦ أسابيع من الزراعة .
- وكان خفض أعداد الفيوزاريوم سولانى واضحا بمعاملة التربة بفطريات الترايكوديرما هاماتم , حيث كان النقص فى التربة المعقمة من [(٢٢,٥ الى ٢٥,) , (٢٢,٧٥إلى ٥٠,) , (٢٥,٢٥الى ٧٥,)] (cuf)×١٠٦/جم تربة على الترتيب.

Table (2) Effect of seed and soil treatment with *Trichoderma* spp. and *Gliocladium* spp and the recommended fungicide Topsin M70 on bean damping-off caused by *Fusarium solani* in sterilized and unsterilized soil under green house conditions.

Antagonists	Seed treatments						Soil treatments					
	Sterilized soil			Unsterilized soil			Sterilized soil			Unsterilized soil		
	Damping-off infection %											
	Pre-emerg.	Post-emerg.	Survival	Pre-emerg.	Post-emerg.	Survival	Pre-emerg.	Post-emerg.	Survival	Pre-emerg.	Post-emerg.	Survival
T.viride	16.67	10.00	73.33	20.00	10.00	70.00	6.67	3.33	90.00	10.00	6.67	83.33
T.harzianum	20.00	10.00	70.00	20.00	13.33	66.67	10.00	3.35	86.67	13.33	6.67	80.00
T.hamatum	16.67	6.67	76.66	16.67	10.00	73.33	6.67	0.00	93.33	10.00	3.33	86.67
T.polykonigii	13.33	6.67	80.00	13.33	10.00	76.67	3.33	3.33	93.34	6.67	6.67	86.68
T.koningii	23.33	13.33	63.34	16.67	16.67	66.66	13.33	6.67	80.00	20.00	10.00	70.00
G.deliquescens	20.00	13.33	66.67	26.67	10.00	63.33	13.67	6.33	80.00	16.67	10.00	73.33
G.virens	16.67	6.66	76.67	20.00	10.00	70.00	10.00	0.00	90.00	13.33	3.33	83.33
Topsin M70	10.00	3.33	86.67	13.33	6.67	80.00	10.00	0.00	90.00	13.33	0.00	86.67
Untreated control	36.67	20.00	43.33	43.33	16.67	40.00	30.00	20.00	50.00	46.67	13.33	40.00
L.S.D at 5%	6.58	4.15	9.78	5.26	5.93	11.15	6.57	3.12	6.21	8.05	8.05	11.34

T. = Trichoderma G .= Gliocladium

Table (3) Effect of seed and soil treatment with *Trichoderma* spp . and *Gliocladium* spp and the recommended fungicide TopsinM70 on *F. solani* population (cfu x 10^6 gm/soil)at different intervals week .

Antagonists	F.solani population (cfu) x 10^6 /gm soil											
	Seed treatments						Soil treatments					
	Sterilized soil			Unsterilized soil			Sterilized soil			Unsterilized soil		
	0	3W	6W	0	3W	6W	0	3W	6W	0	3W	6W
T.viride	28.50	22.25	18.25	23.25	17.25	7.25	27.75	13.25	2.00	15.75	6.25	0.12
T.harzianum	26.00	20.75	14.00	21.50	16.00	8.50	26.50	14.75	2.75	16.50	6.75	0.50
T.hamatum	24.25	18.75	13.50	19.50	11.50	4.00	25.25	11.75	0.75	17.75	5.50	.08
T.polykoningii	29.00	20.50	12.00	22.75	12.00	3.25	22.50	10.50	0.25	16.00	7.75	0.05
T.koningii	21.5	17.50	14.75	18.50	14.75	19.75	28.25	13.00	3.75	17.25	7.50	1.75
G.deliquescens	25.5	21.00	16.50	20.25	15.50	10.50	26.75	14.25	4.25	18.50	8.25	2.00
G.virens	26.25	20.75	12.25	21.75	13.25	4.75	22.75	10.75	0.50	15.25	5.50	0.09
Topsin M70	27.75	15.25	17.50	22.50	8.50	11.00	24.50	9.25	13.25	18.00	6.25	9.25
Untreated control	26.50	34.50	42.25	24.75	30.25	45.75	28.75	34.50	39.75	20.25	26.00	32.75
L.S.D at 5%	2.78	3.20	4.22	2.34	3.96	4.16	2.43	3.00	2.96	1.95	2.00	2.29

T. = Trichoderma G .= Gliocladium W = week

Table (4): Effect of seed and soil treatment with fungal antagonists and the recommended fungicide (Topsin M70) on the fresh, dry weight(gm / plant) and plant hight (cm / plant)of bean plants as affected by *F.solani* in sterilized and unsterilized soil .

Antagonists	Seed treatments						Soil treatments					
	Sterilized soil			Unsterilized soil			Sterilized soil			Unsterilized soil		
	Fresh weight	Dry weight	Plant height	Fresh weight	Dry weight	Plant height	Fresh weight	Dry weight	Plant height	Fresh weight	Dry weight	Plant height
T.viride	15.649	4.556	33.50	15.048	4.185	31.80	20.359	6.842	38.50	18.485	5.732	35.40
T.harzianum	15.188	4.319	32.90	14.986	4.050	32.10	19.785	6.217	37.90	17.842	5.111	34.80
T.hamatum	16.316	5.245	36.40	16.194	5.140	35.10	22.264	7.674	40.20	20.997	6.783	38.10
T.polykonigii	17.420	5.868	37.50	16.995	5.675	36.40	23.463	8.152	41.50	21.693	7.689	39.20
T.koningii	14.036	3.556	29.50	13.729	3.195	27.30	17.954	5.895	36.20	15.076	4.610	32.90
G.deliquescens	13.892	3.280	26.00	13.567	3.015	25.10	16.896	5.231	35.80	14.124	4.123	32.20
G.virens	16.124	5.027	35.90	15.973	4.890	34.80	21.643	7.196	39.30	19.989	6.998	37.10
Topsin M70	19.653	6.114	38.10	19.484	5.995	37.20	20.987	7.034	38.90	19.234	6.106	36.80
Untreated control	8.468	2.586	20.60	7.995	2.220	18.80	9.459	2.859	21.20	7.024	1.893	18.10
L.S.D at 5%	2.18	0.96	3.62	3.24	1.58	4.18	3.89	1.98	3.16	3.09	1.37	8.54

T. = Trichoderma G .= Gliocladium

Table (5) Effect of seed and soil treatment with *Trichoderma* spp. and *Gliocladium* and the recommended fungicide Topsin M70 on yield of bean as green pods and dry seeds (gm / plant) in sterilized and unsterilized soil infested by *F.solani*.

Antagonists	Yield of bean gm/ plant			
	Seed treatments		Soil treatments	
	Sterilized soil	Unsterilized soil	Sterilized soil	Unsterilized soil

	Green pods	Dry seeds	Green pods	Dry seeds	Green pods	Dry pods	Green pods	Dry pods
T.viride	**16.896**	**5.984**	**14.767**	**5.567**	**22.285**	**7.465**	**20.118**	**6.815**
T.harzianum	**15.389**	**5.246**	**13.896**	**4.985**	**21.854**	**7.123**	**19.659**	**6.469**
T.hamatum	**19.656**	**6.546**	**17.213**	**6.125**	**23.146**	**8.348**	**21.654**	**8.018**
T.polykoningii	**20.014**	**6.965**	**18.986**	**6.364**	**23.642**	**8.760**	**21.989**	**8.337**
T.koningii	**14.678**	**4.998**	**13.012**	**4.238**	**20.426**	**6.896**	**18.018**	**6.175**
G.deliquescens	**14.023**	**4.587**	**12.654**	**3.879**	**19.820**	**6.234**	**17.210**	**5.869**
G.virens	**18.989**	**6.078**	**18.214**	**5.896**	**23.023**	**8.057**	**21.126**	**7.564**
Topsin M70	**21.574**	**7.335**	**20.643**	**6.948**	**22.014**	**8.169**	**21.657**	**7.896**
Untreated control	**11.595**	**3.246**	**9.899**	**2.980**	**12.958**	**3.989**	**11.065**	**3.298**
L.S.D at 5%	**4.19**	**1.62**	**3.26**	**1.09**	**1.13**	**1.20**	**2.19**	**1.42**

T.= Trichoderma **G.= Gliocladium**