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EFFECT OF INOCULATION WITH VESICULAR ARBUSCULAR MYCORRHIZA ON ROOT-ROT DISEASE INCIDENCE AND PLANT GROWTH OF TWO CULTIVARS OF BROAD BEAN

By

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ABSTRACT

Effects of soil infestation with vesicular arbuscular mycorrhizal (VAM) fungi, i.e. ***Glomus macrocarpum*** *and* ***G. australe*** *, each alone or in combination with the root-rot infecting fungi, i.e.* ***Fusarium solani (Mart.) Appel & Wollenew.*** *or* ***Rhizoctonia solani Kühn,*** *in sterilized and unsterilized soils, on percentage of survived plants, root-rot disease severity index (DSI) and some growth characters of broad bean (Vicia faba L.) cultivars Giza 2 and Ribaya -40 (R-40), were investigated under greenhouse conditions.*

Mycorrhizal plants grown in soils infested with ***F. solani*** *or* ***R. solani*** *showed significant increases in percentage of survived plants and reductions in root-rot disease incidence compared with the non-mycorrhizal plants grown with pathogens only. The VAM-fungus,* ***G. macrocarpum*** *was more effective, in this respect, than* ***G. australe*** *and broad bean cultivar R-40 responded better than Giza 2 one especially in unsterilized soil. Root-rot disease incited by* ***F. solani*** *on cv. Giza 2 and* ***R. solani*** *on cv. R-40 were slightly but significantly reduced by introducing* ***G. australe*** *into soils infested with these pathogens. However, double infestation of unsterilized soil with both* ***G. australe*** *and* ***R. solani*** *resulted in significant increase in DSI on cv. Giza 2 compared with* ***R. solani*** alone. ***Fusarium solani*** *caused considerable increase in colonization intensity of roots by the VAM-fungus* ***G. australe*** *but not* ***G. macrocarpum,*** *while* ***R. solani,*** *in general decreased colonization indexes of both VAM-fungi. Inversed relationships were detected between colonization index of* ***G. macrocarpum*** *only and DSI particularly of* ***F. solani.*** *The lowest values of DSI of* ***F. solani*** *or* ***R.***

*solani and highest colonization index of G. **macrocarpum** were associated with mycorrhizal plants of cv. R- 40 in unsterilized soil.*

*Soil infestation with G. **australe** and F. **solani** or R. **solani** showed significant higher plant height, root length, shoot and root dry weight than in case of pathogen only. Height and root length of F. **solani** infected plants , in both soil types were not significantly different from those inoculated with both G. **macrocarpum** and F. **solani**. Results of this investigation indicate that, soil infestation with VAM-fungi could be promising for controlling root-rot diseases and/or improved growth of broad bean plants.*

INTRODUCTION

Fusarium solani and ***R. solani*** caused severe damping-off and root-rot diseases and great reduction in growth characters of broad bean (*Vicia faba* L.) plants (**Sirry *et al.*, 1970 ; Nofal *et al.*, 1982**).

Several investigators reported that diseases caused by soil-borne pathogen can be influenced by the action of mycorrhizae inside the root system and /or its surrounded area (**Santoro and Casida, 1962; Harely and Smith, 1983 and Ahmed *et al.*, 1994**). In general, mycorrhizal plants suffer less damage due to root-pathogens (**Dehne, 1982, Saleh and Ahmed, 1988**). More recently, the vesicular-arbuscular mycorrhizal (VAM) fungi showed an important role in the biological control of tomato and sunflower bacterial crown gall disease (**Abd El-Sayed, 1992**) and root-rot of broad bean caused by ***R. solani*** (**Ahmed *et al.*,1994**). However, some reports indicate an increase in disease severity under the influence of VAM-fungi (**Ross, 1972 and Davis and Menge, 1980**). Mycorrhizal plants showed enhanced growth development especially under field condition, mainly, because improvement of nutrients uptake and may be due to providing further protection against soil-borne pathogen attacking their roots (**Garcïa-Garrido and Ocampo, 1987 and Ahmed *et al.*,1994**).

The present study was conducted under greenhouse conditions to investigate effects of two species of the VAM-fungi, i.e. *Glomus macrocarpum* and *G. australe* each alone or in combination with *F. solani* or *R. solani* on the disease incidence and growth characters of two cultivars of broad bean in sterilized and unsterilized soils. Relation between intensity of VAM-colonization and disease severity index was also investigated.

MATERIALS AND METHODS

Isolation of the causal organism(s):

The used cultures of root-rot infecting fungi, i.e. *F. solani and R. solani* were isolated from rotted roots of broad bean plants. Purification of the isolated fungi was carried out using hyphal tip and/or monosporic culture techniques, then identified according to **Nelson *et al.* (1983)** and **Parameter** and **Whitney (1970).**

Inoculum preparation and Pathogenicity test:-

The inocula were prepared by growing each of *Fusarium solani (Mart.) Appel & Wollenew.* and *R. solani* **(Kuhn.)** on sterilized sorghum grain medium in glass bottles for 2 weeks at 28 C. A clay loam soil with pH 7.5, unsterilized or sterilized by autoclaving at 15 lb/in^2 for two hours, was infested by the prepared inocula separately at rate of 5.0% of the soil weight. The infested soil was potted in plastic pots (ϕ 20 cm), each containing 1.5 kg infested soil. Pots were watered on alternate days and incubated under greenhouse conditions for 7 days to maintain equal distribution of the fungal inoculum. Sterilized, un-inoculated sorghum grain medium was used in control pots. Surface sterilized seeds (with 0.1% mercuric chloride solution for 2 min) of Giza 2 and Ribaya-40 (R-40) broad bean cvs., were planted at the rate of 6 seeds/pot. Four pots, were used for each particular treatment.

Disease Assessment:-

Percentage of pre-emergence damping-off was calculated 15 days from sowing. While, after 60 days from sowing, plants were carefully removed, washed currently with tap water, then examined for root-rot symptoms. Determination of the root-rot disease severity index (DSI) was carried out, based on a scale from 0 (non-visible damage) to 5 (completely destroyed roots) according to **Salt (1982).** Also, plant height, root length, fresh and dry weights of both shoots and roots were estimated at the same time.

Mycorrhizal Studies:-

These experiments were carried out under greenhouse conditions to investigate effects of adding vesicular-arbuscular mycorrhizae (VAM) to sterilized or unsterilized soil not infested or infested with ***F. solani*** or ***R. solani*** just before sowing on percentage of survived plants and root-rot disease incidence as well as on plant growth of two broad bean cultivars. All experimental necessities were accomplished as mentioned before.

Two different species of the VAM i.e. ***Glomus macrocarpum*** and ***G. australe*** were used in this study. Each of them was kindly provided by Dr. **Gendia, H.,** Dept. of Hort., Fac. of Agric., Moshtohor. The VAM-fungi were propagated, separately, on onion plants using the propagation technique described by **Al-Fassi *et al.* (1990).** After three months from onion cultivation, the mycorrhizal roots of onion bulbs together with its adjacent soil were collected and used for mycorrhizal infestation. Plastic pots (ϕ 20 cm), each containing 1.5 kg soil prepared as above described were used. The inocula of the VAM was added at rate of 10 g/pot (modified from Fares, 1986). Pots without mycorrhizal infestation were served as control. Root-rot disease severity index (DSI), percentage of survived plants, plant height, root length, dry weight

of shoots and roots were determined 60 days after sowing as mentioned before. This work was repeated for two seasons (1991 and 1992). All data obtained were statistically analyzed by calculating the least significant difference (L.S.D.) at the 5% level according to **Little and Hills (1975).**

Effect of root-rot pathogens on the VAM-colonization:-

Samples from root system of broad bean plants arised in the above experiment were collected and examined for VAM-colonization as described by **Phillips and Hayman (1970).** The roots were washed several times by tap water, cutted into small segments (1 cm long) and preserved in FAA solution (5% formaldehyde; 5% glacial acetic acid; 54% absolute alcohol and 36% distilled water). For microscopic preparation, the preserved roots of each treatment were washed several times by tap water to remove the preservative fluid. The roots were treated with 10% potassium hydroxide (KOH) in test tubes, then heated in water bath for 10 min. at 80-90 C . Root segments were then washed with tap water followed by 10% HCl. Trypan blue stain ($0.5g\ l^{-1}$) was added to the root portions and heated again at 80-90 C for 5 min. Some of treated root segments (up to 20 portions/treatment) chosen at random were picked up and placed on glass slides to which few drops of fresh lactic acid were added. Then examined microscopically for mycorrhizal infection. Intensity of VAM-colonization expressed as an average number of the mycorrhizal structures i.e. vesicles and arbuscules, per root segment was calculated. Relationship between colonization intensity and root-rot disease severity index was also investigated.

RESULTS AND DISCUSSION

The obtained data (not shown) proved that the isolated fungi, *Fusarium solani* and *Rhizoctonia solani,* could infect broad bean and cause pre-emergence damping-off and root-rot diseases. Damping-off was relatively higher in sterilized than unsterilized soil, and on cv. R-40 than cv. Giza 2. *R. solani,* mostly, was more virulent than *F. solani* . It caused the greatest reduction in plant height, root length, fresh and dry weights of shoots and roots of diseased plants of both tested cvs., especially in sterilized soil, compared with healthy plants in control treatments. These results are in agreement with these reported by **Sirry *et al.*(1970) and Nofal *et al.*(1982).** They stated that, *R. solani* and/or *F. solani* reduced seed germination, plant height, fresh and dry weights of shoots and roots of broad bean plants.

Effect of VA-mycorrhizal fungi on percentage of survival plants and root-rot disease severity:-

Data in **Table (1)** show clearly that, percentage of survived plants of cv. Giza 2 in unsterilized soil was significantly higher than cv. R-40. However, both cvs. survived better in sterilized soil without significant difference in between.

The lowest percentages of survived plants were obtained in soil inoculated with *R. solani* or *F. solani*. These figures were significantly raised by using VAM-pathogen combination. However, degree of improvement was depended on type of the combined partners. In this regard, percentage of survived plants in soil infested with *G. macrocarpum* and *R. solani* was significantly higher than the corresponding figure of *G. macrocarpum* and *F. solani* combination. Meanwhile, when *G. australe* was combined with these pathogens, it showed less effect. Soil infestation with *G. australe* and *F. solani* or *R. solani* resulted

in the highest and lowest significant increases in percentages of survived plants, respectively compared with those survived in soil infested by any of these pathogens alone.

Regarding root-rot-DSI, **Table (1)** proved that, DSI of *F. solani* and *R. solani* (averages) infections were reduced from 65% and 63% on non-mycorrhizal plants to 20.0% and 19.4%, when *G. macrocarpum* was combined with these root-rot infecting pathogens, respectively. However, *G. australe*, seems to be effective only against infection of *F. solani* as DSI were 48.1% and 60.7%, respectively. It is interest to state that DSI incited naturally (without artificial soil infestation) was significantly increased with *G. australe* (9.4%) as compared with *G. macrocarpum* or control treatments (6.3%).

Regardless of soil type, non-mycorrhizal plants of both tested cvs. were reacted similarly against *F. solani* infection , while, DSI of *R. solani* was significantly higher on cv. R-40 than cv. Giza 2. However, applying of *G. macrocarpum* in soils infested by *F. solani* or *R. solani* resulted in great reductions of DSI of these pathogens especially on R-40, the more susceptible cv., as compared with Giza 2, the less susceptible cv. The other VAM-fungus, *G. australe*, was slightly effective only against infections caused by *F. solani* on cv.Giza 2 and *R. solani* on cv. R-40 as compared with *G. macrocarpum*. Variations in effectivities of these VAM-fungi in controlling root-rot disease incidence may be correlated with the manner by which it could colonized roots of broad bean plants. In this regard, data in **Table (2)** proved that, colonization index in roots of mycorrhizal plants inoculated with *G. australe* together with a given pathogen especially *F. solani* was increased considerably compared with those inoculated with *G. australe* only. *R. solani*-infection, in general, caused slight reduction in *G. australe*-colonization except in case of cv. R-40 in

Table 1: Effect of soil infestation with the VAM-fungi, *G. macrocarpum* and *G. australe* on root-rot disease severity index (DSI) and percentage of survived plants of two cultivars of broad bean cultivated in sterilized and unsterilized, infested (with *F. solani* or *R. solani*) or uninfested soils after 60 days from sowing.

Soil Types		% Survival						% Root-rot DSI					
		Unsterilized Soil			Sterilized Soil			Unsterilized Soil			Sterilized Soil		
CV.	Treatment	Con-trol	*F. solani*	*R. solani*	Con-trol	*F. solani*	*R. solani*	Con-trol	*F. solani*	*R. solani*	Con-trol	*F. solani*	*R. solani*
Giza 2	Control	91.8	33.3	29.2	100	29.2	20.9	10.0	52.5	52.0	0.0	72.5	55.0
	G. macroca	3.37	50.0	62.5	100	58.4	58.4	10.0	25.0	15.0	0.0	22.5	32.5
	G. austarle	83.3	41.7	33.3	100	37.5	41.7	15.0	50.0	71.8	0.0	25.0	53.5
R-40	Control	83.3	29.2	33.3	100	20.9	16.7	15.0	52.5	65.0	0.0	82.5	80.0
	G. macroca	83.3	66.7	62.5	100	58.4	50.0	15.0	7.5	15.0	0.0	25.0	15.0
	G. austarle	66.7	20.9	45.8	100	62.5	37.5	22.5	60.0	60.0	0.0	57.5	55.0

L.S.D. at 5% for :	Survival	Root-rot DSI
Soil type (S)	N. S.	N. S.
Cultivar (C)	N. S.	N. S.
Treatment (T)	0.44	2.90
S × C	0.29	N. S.
S × T	N. S.	N. S.
C × T	N. S.	12.6
S × C × T	N. S.	N. S.

sterilized soil. These results are in agreement with **Zamblin and Schenck (1983)** working on *R. solani* of soybean and **Kiran *et al.*(1987)** on *Fusarium*-wilt of broad bean. In most cases DSI of a given pathogen on *G. australe*-mycorrhizal plants was affected proportionally with colonizing ability of *G. australe*. When the latter, VAM-fungus was introduced into sterilized soil, it could minimized infection of *F. solani* on cv. Giza 2 only up to 34.5% and its colonization index was increased up to 262.0%. The corresponding values, in unsterilized soil for the same cultivar and inoculation were 95.2% and 353.5% from those arised from *F. solani* and *G. australe* , each alone, respectively. As for cv. R-40 , similar trend was also observed. These results indicated that both DSI and VAM-colonization index may be affected by the interaction between pathogen and VAM-fungus. In this respect,

Table 2: Colonization intensity and colonization index* of the VAM-fungi *G. macrocarpum* and *G. australe* as affected by *F. solani* and *R. solani*, the root-rot pathogens on two broad bean cultivars.

Soil Type		Unsterilized Soil			Sterilized Soil		
CV.	Treatment	Control	*F. solani*	*R. solani*	Control	*F. solani*	*R. solani*
Giza 2	*G. macroc.*	63.2	34.8	29.3	62.5	48.7	28.6
	%	100.0	55.1	46.4	100.0	77.9	45.8
	G. australe	40.9	144.6	32.3	48.2	126.3	46.2
	%	100.0	353.5	79.0	100.0	262.0	95.9
R-40	*G. macroc.*	43.0	51.2	66.0	56.4	41.9	39.0
	%	100.0	119.1	153.5	100.0	74.3	69.1
	G. australe	51.9	160.7	41.5	42.2	94.2	46.6
	%	100.0	309.6	80.0	100.0	223.2	110.4

* colonization intensity in case of VAM-pathogen combination x 100/ colonization intensity in VAM alone.

Ross (1972) found that *Phytophthora* root-rot of disease-susceptible but not disease-tolerant soybeans was increased by VA-mycorrhiza. This may have been because the tested *Endogone spp.* produced large vesicles in root cortex which could have caused some splitting of tissues, thereby facilitating entry of the pathogen . The obtained results are in agreement also with those reported by **Zamblin and Schenck** (1983) and **Kiran** *et al.* (1987). In case of mycorrhizal plants inoculated with *G. macrocarpum* and *F. solani* or *R. solani*, inversed relationship between DSI and colonization index was observed. For example, DSI of *F. solani* was minimized up to 14.3 % on *G. macrocarpum*-mycorrhizal plants of cv. R-40 grown in unsterilized soil. For the same combination, colonization index of *G. macrocarpum* was maximized up to 119.1%. On the other side, mycorrhizal plants of cv. Giza 2 infected with *F. solani* in unsterilized soil showed the maximum DSI and minimum colonization index. These results are in accordance with **Al-Raddad** (1991) who stated that, all tested *Glomus spp.* (seven isolates) reduced percentage

of *Fusarium*-infection in tomato and pepper roots at different rates. In fact, mycorrhizal fungi may changed the natural reaction of plants against their pathogen or may have no effect. The final reaction seems to be depending on several factors including soil conditions, host, pathogen, and the particular nature of the interaction between the host and the pathogen. In this point, **Dehne (1982)** reported that, mycorrhizal fungi, in some cases, reduced the disease incident due to pathogens causing morphological or physiological changes in the plant. **Garcïa-Garrido and Ocampo (1987)** indicated also, that VA-mycorrhizae could protect the plant against pathogenic organisms such as nematodes, fungi, bacteria and viruses. On the other hand, several investigators reported that, the mycorrhizal plants suffered more from, *Verticillium*-wilt on cotton (**Davis *et al.*, 1979**), *Phytophthora*-root-rot on citrus (**Davis and Mange, 1980**). In addition, **Zamblin and Schenck (1983)** showed that, *Glomus mosseae*, the VAM-fungus, did not reduce significantly the disease index rating of ***R. solani*** on broad bean plants, but ***R. solani*** significantly reduced the percentage of root colonization by ***G. mosseae*** in autoclaved soil. The maintained successful in control of root-rot diseases by using VAM-fungi might be attributed to improved uptake of phosphorus, nitrogen and other mineral nutrients from soil as reported by **Ross (1971)** and **Kucey and Paul (1983)**. In general, mycorrhizal fungi may conceivably afford protection to the roots by, utilizing surplus carbohydrate, thus reducing attractiveness of the roots to the pathogens (**Zak, 1964**); increasing in lignification of the cell wall (**Dehne and Schonbeck, 1979**) secreting antibiotic substances (**Santoro and Casida, 1962**) or by favoring, along with the root, protective rhizosphere organisms (**Ahmed *et al.*, 1994**). Protection of the roots, against root-rot infection, by *G. macrocarpum* may not be limited to roots actually formed mycorrhizae. The protective substances which may be secreted by it

into root tissue during colonization process could be translocate to and benefit other root parts.

Effect of VAM-mycorrhizae on plant growth :

Data presented in **Table (3)** exhibited that, inoculation with both tested VAM-fungi increased plant height significantly compared with control treatment. Double inoculation with *G. ausrale* and *F. solani* resulted in the highest and significant increase in plant height compared with *G. australe* or *F. solani* alone. Similar increases in plant height was also obtained by combinations of *R. solani* with any of the tested VAM-fungi compared with *R. solani* alone. However, *G. macrocarpum* and *F. solani* combination has no significant effect on plant height compared with *F. solani* alone, but it was significantly decreased as compared with *G. macrocarpum* alone. Reduction was more pronounced on cv. R-40. These results were true in both sterilized and unsterilized soils. However, soil infestation with both *G. macrocarpum* and *F. solani,* in both types of soil, produced the highest reduction in plant height of cv. R-40. The same data proved that, root length was affected similarly as in plant height. However, *G. australe* combined with *F. solani* or *R. solani* produced significant improvement of root length of both tested cvs. in both soil types compared with the pathogen alone. These results could be supported by **Al-Raddad** and **El-Saket (1991)** who reported that, roots of good growth olive seedlings showed higher mycorrhizal structures, while week seedlings showed lower intensity of colonization. These are in agreement with the present work..

Data in **Table (4)** show that, dry weights of shoots and roots of both tested cvs., were clearly affected by the VAM-fungi and their combinations with root-pathogens. In most cases, *G. austarle* alone or combined with *F. solani* or *R. solani* gave the best results. However, *G. macrocarpum* combined with any of these pathogens produced the highest dry weight of shoots of R-40 cv. in unsterilized

Table 3: Effect of soil infestation with the VAM-fungi, *G. macrocarpum* and *G. australe* on plant height and root length of two cultivars of broad bean plants cultivated in sterilized and unsterilized, infested (with *F. solani* or *R. solani*) or uninfested soils after 60 days from sowing.

Soil Types		Plant height (cm)						Root length (cm)					
		Unsterilized Soil			Sterilized Soil			Unsterilized Soil			Sterilized Soil		
cv.	Treatment	Cont-rol	*F. solani*	*R. solani*	Cont-rol	*F. solani*	*R. solani*	Cont-rol	*F. solani*	*R. solani*	Cont-rol	*F. solani*	*R. solani*
Giza 2	*Control*	15.4	17.5	12.7	19.6	19.8	19.8	12.4	8.3	10.3	11.2	14.8	12.1
	G. macroc.	21.5	16.2	23.9	23.6	22.1	23.8	11.1	12.3	15.1	14.4	14.3	16.7
	G. australe	15.7	36.6	24.7	24.7	34.0	26.5	22.3	20.6	20.2	23.7	20.5	19.8
R-40	*Control*	22.8	15.7	18.2	20.5	19.6	17.9	10.9	12.1	14.2	13.4	10.0	13.7
	G. macroc.	25.7	13.8	19.8	24.2	16.4	23.1	12.6	13.3	13.2	15.2	10.4	15.4
	G. australe	30.4	27.0	27.7	24.1	24.1	23.2	22.3	20.8	20.4	19.3	21.4	19.5

L. S. D. at 5% for :	Plant height	Root length
Soil type (S)	N. S.	N. S.
Cultivar (C)	N. S.	N. S.
Treatment (T)	2.70	2.64
S × C	N. S.	N. S.
S × T	N. S.	N. S.
C × T	3.89	N. S.
S × C × T	5.28	5.28

soil only compared with its specific control. The same combinations on Giza 2 cv. in both types of soil and R-40 cv. in sterilized soil showed slight reduction in shoot dry weight compared with *G. macrocarpum* alone. As for root dry weight, the same data proved that it was affected similarly as in shoot dry weight. These results are supported by **Khan (1973); Graham *et al.* (1976)** and **Kucey and Paul (1983).** They reported that, their mycorrhizal plants grew much better and the dry matter of its shoots and roots were higher than the non-mycorrhizal plants. Also, **Al-Raddad (1991)** stated that, mycorrhizal tomato plants inoculated with *F. oxysporum* possessed a significantly higher root, shoot weight and plant height than those inoculated with *F. oxysporum* only. Pepper plants inoculated with *G. mosseae* showed higher fresh weight and

Table 4: Effect of soil infestation with the VAM-fungi, *G. macrocarpum* and *G. australe* on shoot and root dry weight of two cultivars of broad bean plants cultivated in sterilized and unsterilized, infested (with *F. solani* or *R. solani*) or uninfested soils after 60 days from sowing.

Soil Types		Shoot dry weight(g)						Root-dry weight(g)					
		Unsterilized Soil			Sterilized Soil			Unsterilized Soil			Sterilized Soil		
CV.	Treatment	Control	*F. solani*	*R. solani*	Control	*F. solani*	*R. solani*	Control	*F. solani*	*R. solani*	Control	*F. solani*	*R. solani*
Giza 2	Control	24.9	15.7	15.6	24.7	15.2	10.6	3.55	3.45	3.29	7.82	2.93	5.25
	G. macroc.	31.8	27.2	18.1	25.4	14.4	14.8	4.22	2.67	5.17	4.35	3.65	3.66
	G. australe	23.4	42.4	46.7	49.5	55.3	55.8	7.50	8.71	9.56	5.61	8.00	5.68
R-40	Control	24.8	16.5	14.9	24.0	19.3	11.8	4.10	3.36	3.32	5.86	3.55	3.82
	G. macroc.	31.1	62.5	56.6	21.8	13.6	17.4	5.04	2.24	5.10	5.09	4.43	3.34
	G. australe	53.9	54.6	47.7	67.7	51.5	55.0	7.43	7.51	6.97	7.45	6.15	9.10

height than the mycorrhizal plants inoculated with *F. oxysporum* and plants inoculated with *F. oxysporum* alone. He added that, growth of pepper plants inoculated with *F. oxysporum* was not significantly different from plants inoculated with both VAM-fungi and *F. oxysporum*. In fact, the VA-mycorrhizal plants could absorb greater amounts of phosphorus and other nutrients from soil **(Harley and Smith, 1983)** and have more healthy roots when grown in infested soil with the pathogen **(Davis and Menge, 1981)**, finally, this make them grew better than the non-mycorrhizal plants.

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تأثير الحقن بالميكورهيزا الحويصلية الشجيرية على النمو ودرجة الإصابة بأعفان الجذور في صنفين من الفول البلدي

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في هذه الدراسة جرى حقن التربة المعقمة أو غير المعقمة تحت ظروف الصوبة بأحد فطريات الميكورهيزا الداخلية *Glomus macrocarpum* منفردا أو مع أي من مسببات عفن الجذور *Fusarium* أو *Glomus australe*

solani أو *Rhizoctonia solani* بهدف التعرف على تأثير ذلك على حدوث الإصابة بأعفان الجذور وبعض صفات النمو في صنفي الفول البلدي جيزة ٢ وريباية ٤٠ وكذلك دراسة العلاقة بين شدة الإصابة بالمرض وكثافة إستعمار الجذور بفطريات الميكورهيزا المستخدمة وفيما يلي أهم النتائج التي تم التوصل إليها :-

- كانت الإصابة بالمرض في التربة المعقمة أعلى منها في غير المعقمة ، وعلى الصنف ريباية ٤٠ أكثر منها على الصنف جيزة ٢ ، وفي معظم القياسات كان الفطر ريزوكتونيا أشد تأثيرا من الفطر *Fusarium* حيث سبب فضلا عن تأثيره الممرض نقصا شديدا في أطوال الجذور ووزنها الغض والجاف في كلا الصنفين.
- تميزت النباتات النامية في تربة محقونة بأي من فطريات الميكورهيزا وأحد مسببات المرض بتحسن معنوي في كل من نسبة بقائها ودرجة مقاومتها للإصابة بأعفان الجذور مقارنة بتلك النامية في تربة محقونة بالمسبب المرضي فقط وفي هذا الخصوص كان الصنف ريباية ٤٠ أفضل في إستجابته من الصنف جيزة ٢ والفطر *G. macrocarpum* أفضل تأثيرا من *G. australe*. ولقد أدى الفطر الأخير إلى زيادة معنوية في شدة الإصابة بالفطر *Rhizoctonia* على الصنف جيزة ٢ في التربة غير المعقمة.
- أدى الفطر *F. solani* إلى زيادة كبيرة في كثافة إستعمار الميكورهيزا للجذور خاصة *G. australe* بينما سبب *R. solani* في معظم الأحيان تناقصا واضحا في كثافة الإستعمار بكل من فطري الميكورهيزا.
- لوحظت علاقة عكسية بين كل من معدل كثافة إستعمار الجذور بالفطر *G. macrocarpum* وبين شدة إصابة هذه الجذور بمسببات المرض خاصة *F. solani* ومثال ذلك الصنف ريباية ٤٠ النامي في تربة غير معقمة ومحقونة بالفطر *G. macrocarpum* مع أي من مسببات المرض تحت الدراسة والذي ظهر عليه أعلى معدل إستعمار ميكورهيزي مع أقل نسبة إصابة بالمرض مقارنة بنفس الصنف المحقون فقط بالمسببات المرضية .
- أدى إستخدام *G. australe* مع أي من المسببات المرضية المستخدمة إلى زيادة معنوية كبيرة في إرتفاع النبات وطول الجذور ، كذلك زيادة الوزن الجاف للجذور مقارنة بإستخدام تلك المسببات المرضية كل على إنفراد ، ومن ناحية أخرى لم تظهر هناك إختلافات معنوية في هذه القياسات عند إستخدام كل من *G. macrocarpum* و *F. solani* معا مقارنة بالأخير منفردا.