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EFFECT OF INOCULATION WITH RHIZOBIUM AND VA-MYCORRHIZAE ON PEANUT ROOT ROT DISEASES UNDER DIFFERENT SOURCES OF PHOSPHORUS FERTILIZER

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ABSTRACT

Greenhouse and field studies were conducted in 2006 and 2007 to study the effect of peanut inoculation with rhizobium and/or VA-mycorrhizae on peanut root rot diseases under different sources of phosphorus (P-rock and P-super). Application of rhizobium and/or mycorrhizae as a biofertilizer gave significant reduction in the incidence of damping-off and peanut root rot diseases and consequently increasing percentage of healthy survival plants and total peanut pod yield under greenhouse experiments and field studies during seasons 2006 and 2007. The effect of mycorrhizae was more effective than rhizobium on reduction of the studied diseases when used singly. Combination of both biofertilizers with phosphorus treatment recorded the highest reduction of damping-off and peanut root rot incidence and integration of P-rock, rhizobium and mycorrhizae gave the maximum diseases reductions compared with other treatments in greenhouse experiments and field studies during the two seasons. Using both of rhizobium and mycorrhizae together increased nodule number and dry weight and also increase of mycorrhizae infection percent and their spore numbers as well as using of them singly or together led to increasing the percentage of P in the soil whereas total or available P and also increased P and N contents in peanut plants. Generally, P-rock as a source of phosphorus was more effective than P-super in all previous parameters in greenhouse experiments and field studies during the two growing seasons 2006 and 2007.

Key words: Peanut, Rhizobium, VA-mycorrhizae, *Fusarium solani*, *Macrophomina phaseolina*, *Rhizoctonia solani*, *Sclerotium rolfsii*, Damping-off, Root rots, P-sources.

INTRODUCTION

Damping – off and root rot diseases are among the most destructive diseases attacking peanut in Egypt (Hussin, 2005 and Metwally *et al.*, 2006). These diseases also affect plant stand in the field, plant growth and seed yield (Hilal *et al.*, 1990 and Hussin, 2005).

Peanut, like most other herbaceous plants, is commonly infested with vesicular-arbuscular mycorrhizal fungi (Porter *et al.*, 1990 and Allen *et al.*, 2003). Species of *Glomus, Gigaspora, Acaulospora*, and *Sclerocystis* are the most commonly observed VAM associated with peanut (Porter *et al.*, 1990 and Kulkarm *et al.*, 1997). The vesicular arbuscular mycorrhizal (VAM fungi) and their associated interactions with plants can reduce the damage caused by plant pathogens by forming symbiotic relationship with their host by colonizing the cortical region of feeder roots both inter- and intracellularly (Siddiqui *et al.*, 2008). They benefit the host plant primarily by increasing the capability of the root system to absorb and translocate phosphorus and microelements through an extensive network of hyphae external to the root (Carling *et al.*, 1996 and Siddiqui *et al.*, 2008). These fungi act as biocontrol agents against root and soil borne pathogens (Abd-El-Sattar *et al.*, 2002, Khalifa, 2003 and Harrier and Watson, 2004).

In peanut, there is an antagonistic effect between mycorrhizal infections and colonized peanut roots with *R. solani, F. oxysporum, S. rolfsii* and *Pythium myriotylum* (Lynd and Ansman, 1989 and Kulkarm *et al.*, 1997). Moreover, it was found that the interaction between the arbuscular mycorrhizal fungus *Glomus mosseae* and the peanut pod rot pathogens *F. solani, S. rolfsii* and *R. solani* and subsequent effect on growth and yield. (Abdalla and Abdel-Fattah, 2000 and Mahmoud, 2004).

Because peanut is a legume, its root system must be exposed to the proper strain of *Bradyrhizoium* bacteria (nitrogen-fixing bacteria), which are generally can assimilate or fix atmospheric nitrogen in a symbiotic relationship with peanut plants (Hassan and Frederick, 1995 and Mahmoud, 2004).In the study of correlation between bacterized roots and peanut infections with soil borne pathogenic fungi, rhizobium have inhibited *M. phaseolina*, when they were inoculation together without any adverse effect on nodulation and growth of peanut (Gangawane and Salve, 1987). Rhizobium can also reduce the population of soil borne fungi and increase peanut yield (Bhattacharryya and Mukherjee, 1990 and Salui and Bhattacharryya, 1998). In field trials, inoculated peanut seeds with rhizobium with different levels of nitrogen, phosphorus and potassium decreased damping-off, root rot and pod rot diseases as well as increasing pod yield and N content of plants (EL-Deeb and Ibrahim, 1998, Hasan *et al.*, 2002 and Mahmoud, 2004).

The aim of this work is an attempt to study the role of rhizobium and mycorrhizae for controlling damping-off, and peanut root rots when inoculated under different sources of phosphorus.

MATERIALS AND METHODS

1. Isolation of the causal organisms:

Fungal isolates used throughout this study were previously isolated by the authors from diseased peanut plants and their pathogenic capabilities were also proved (Mahmoud, *et al.*, 2006).

2. Preparation of fungal inoculum and soil infestation:

Inocula of *Fusarium solani, Macrophomina phaseolina, Rhizoctonia solani* and *Sclerotium rolfsii* were prepared using sorghum - coarse sand - water (2:1:2 v/v/v) medium. Glass bottles containing autoclaved medium were inoculated by a given fungus using agar discs taken from the periphery of 5 day-old cultures, incubated at 26 °C for two weeks. The inocula were used, in a mixture at the rate of 2% soil weight, to infest sterilized potted soil, mixed thoroughly and watered and left for one week before sowing

3. Disease assessment

(A) Disease assessment was measured as percentage of pre- and post-emergence damping-off after 15 and 30 days from sowing, respectively. Percentages of pre- and post-emergence damping-off were calculated using the following formula:

$$\% \text{ Pre- emergence} = \frac{\text{Number of non germinated seeds}}{\text{Number of sown seeds}} \times 100$$

$$\% \text{ Post- emergence} = \frac{\text{Number of dead seedlings}}{\text{Number of sown seeds}} \times 100$$

(B) Percentages of infected plants by root-rot and survived healthy plants were estimated after uprooting (120 days from sowing) as follows:

$$\% \text{ Root rot} = \frac{\text{Number of plants with root - rot}}{\text{Number of sown seeds}} \times 100$$

$$\% \text{ Healthy plants} = \frac{\text{Number of survived healthy plants}}{\text{Number of sown seeds}} \times 100$$

4. Supply of P fertilizers:

Phosphorus was applied as single superphosphate (16.48 % P_2O_5) or fine rock phosphate (26.79 % P), at the rate of 7.5 g./pot and 150 kg/fed before sowing.

5. Bio-fertilizations incula used:

The effectiveness of two biofertilizer's treatment *i.e.* mycorrhizae and/or rhizobium to reduce root rot of peanut were studied. Mixture of two species of the vesicular arbuscular-mycorrhizal (VAM), *Glomus macrocarpum* and *G. australe* (obtained from onion, garlic and oil crops Dept., Plant Path. Res. Inst., Giza) were used in this study. Inocula of these VAM fungi were produced naturally on faba bean and maize grown in pots in the greenhouse. VAM (3000-5000 VAM spores/ 100g soil) were used for soil infestation, where 50 g. inoculm was added to each pot and 10g. inoculum was added to each hill, during sowing according to Ferguson and Woodhead (1984). Meantime, peanut seeds were treated as recommended directly before sowing with rhizobium (*Rhizobium lupine*), obtained from Agricultural Research Center. Both bio-fertilizers were applied singly or in combinations.

6. Greenhouse experiments:

The experiments were carried out at Agriculture Research Center, Giza. Peanut seeds, cv. Giza 6, were used for sowing in 50 cm-diameter pots containing soil previously infested with a mixture of *R. solani*, *F. solani*, *S. rolfsii* and *M. Phaseolina* (2% w/w). Ten seeds were sown per each pot. Treatments were replicated for five times. Treatments were applied and disease assessment as previously mentioned.

7. Field experiments:

These experiments were carried in 2006 and 2007 growing seasons, in Ismaillia Experimental Station of Agricultural Research Center (ARC). The selected fields were known to have natural infestation with root rot pathogens. The soil type was sandy loam (Table a). Peanut cv. Giza 6 seeds were sown on the first week of May. The experiment was arranged in a split-plot design with sources of phosphorus in the main plots and bio fertilizer treatments in the subplots (four replicates, 1/400 fed.; 3 X 3.5 m for each replicate). Irrigation was carried out as required using sprinkle system Plants in individual plots were harvested based on an optimum maturity index. Pods were threshed, air-dried for three days and weighted for pod yield. Treatments were applied and disease assessment as mentioned before.

Table (a): Properties of Ismailia station soils

Soil properties	Sand	Silt	Clay	pH	EC	O.M	Total N	P_2O_5	K_2O
Percentage (%)	77	11	12	7.9	7.2	0.73	0.08	009	0.06

8. Determinations of N and P in soil and plant:

Total nitrogen was determined by using Kjeldahl digestion method according to Black *et al.* (1965). Total phosphorus was determined according to Jackson (1958), while available phosphorus was extracted and determined according to Olsen *et al.* (1954).

9. Determinations of rhizobium and VAM mycorrhizae:

After 45 days from sowing peanut plant were taken and roots were washed several times with tap water to remove adhering soil particles and the number and dry weight of detached nodules were recorded. Percentage of mycorrhizal plants infections and mycorrhizal spores in soil were determined according to Gerdemann and Nicolson (1963).

10. Statistical analysis:

The data were statistically analyzed by analysis of variance (ANOVA) using Statistical Analysis System (SAS Institute, Inc, 1996). Means were separated by least significant difference (L.S.D.) Test at $P \leq 0.05$ levels.

RESULTS

1. Effect of peanut inoculations with rhizobium and mycorrhizae with different sources of P under greenhouse conditions:

1.1. On peanut root rot diseases:

Data presented in Table (1) indicate that, application of rhizobium and/or mycorrhizae as a biofertilizer gave a significant reduction in incidence of damping-off and peanut root rot diseases and consequently increasing percentage of healthy survival plants. The effect of mycorrhizae was more effective than rhizobium in reducing the diseases when used singly. Phosphorus addition to biofertilizer treatments was more effective in reducing damping-off and peanut root rot incidence. In this respect, P-rock was better than P-super in their effect on diseases. However, combination of both biofertilizers with phosphorus treatment recorded the highest reduction in damping-off and peanut root rot incidence and integration of P-rock, rhizobium and mycorrhizae gave the maximum reduction compared with other treatments.

1.2. On peanut yield, nodule performance, mycorrhizal infection percent and spore numbers:

Using both of rhizobium and mycorrhizae as a biofertilizer whether separately or together gave a significant increase of peanut yield compared to untreated (Table 2). Treated phosphorous with biofertilizer was give more effective in increasing total peanut yield. In this respect, P-rock showed more efficacies on yield increasing than P-super. Moreover integration of P-rock, rhizobium and mycorrhizae gave the maximum yield of peanut.

Table (1): Effect of peanut inoculations with rhizobium and mycorrhizae with different sources of P on peanut root rot diseases under artificial inoculation.

Bio-fertilizer	Sources of (P)	Damping -off		Root rot	Healthy
		Pre-emergence	Post-emergence		
Rhizobium	0.0	22	12	6	60
	Super	20	10	6	64
	Rock	20	8	4	68
Mycorrhiza	0.0	18	12	6	64
	Super	18	10	4	68
	Rock	16	8	4	72
Rhizobium + Mycorrhiza	0.0	18	8	4	70
	Super	16	6	4	74
	Rock	14	6	2	78
Control	0.0	30	18	10	42
	Super	24	14	8	54
	Rock	26	16	8	50
L.S.D. 5%	a) Bio-fertilizer	2.25	1.95	1.37	2.63
	b) Sources of (P)	1.95	1.69	1.19	2.28
	(a) X (b)	3.88	3.36	2.37	4.04

Regard to nodule performance, mycorrhizal infection percent and spore numbers data in Table (2) showed that, there is an increasing of nodules number and dry weight, mycorrhizal infection percent and spore numbers when inoculated together.

Data also showed that, treatment with phosphorus application gave a significant effect on increasing of nodule performance, mycorrhiza infection percent and spore numbers as well as P-rock gave more effective than P-super. However, integration of P-rock, rhizobium and mycorrhizae gave the maximum performance of nodule and mycorrhizal infection percent and number of their spores.

Table (2): Effect of peanut inoculations with rhizobium and mycorrhizae with different sources of P on peanut yield, nodule performance, mycorrhiza infection percent and spore numbers under artificial inoculation.

Bio-fertilizer	Source of (P)	Nodules		Mycorrhizae		Yield (g/plant)
		No./plant	D.W. (g)	infection (%)	No. spores (100 g/soil)	
Rhizobium	0.0	48	0.65	0	0	20.5
	Super	52	0.70	0	0	23.2
	Rock	59	0.74	0	0	27.2
Mycorrhiza	0.0	0	0	79	254.1	21.1
	Super	0	0	82	303.4	25.0
	Rock	0	0	88	330.0	28.2
Rhizobium + Mycorrhiza	0.0	61	0.75	65	399.0	30.3
	Super	72	0.81	72	422.4	33.1
	Rock	81	0.85	78	581.4	37.9
Control	0.0	0	0	0	0	15.1
	Super	0	0	0	0	17.7
	Rock	0	0	0	0	19.9
L.S.D. 5%	a) Bio-fertilizer	2.53	0.029	2.29	7.29	2.26
	b) Sources of (P)	2.19	0.026	1.99	6.32	1.96
	(a) X (b)	4.36	0.051	3.97	12.61	3.02

1.3. On percentage of P and N content:

In general, P-rock gives the highest percentage of total or available P in soil compared to P-super either was separate or when addition to biofertilizer (Table 3). Data also show that, mycorrhizal fungi give the best ability in increasing available P in soil under the two sources of P.

The rhizobium had increased both P and N content in plant comparable to unioncculated under the two P sources (Table 3). Also, mycorrhizal plant derived more of P and N than the nonmycorrhizal plant. Integration of P-rock, rhizobium and mycorrhizae gave the maximum content of P and N in plant compared to other treatments.

Table (3): Effect of peanut inoculations with rhizobium and mycorrhiza with different sources of P on percentage of P and N content under greenhouse conditions.

Bio-fertilizer	Source of (P)	Soil		Plant (shoot)	
		Total P %	Available P %	P content %	N content %
Rhizobium	0.0	0.056	0.013	0.140	4.246
	Super	0.065	0.018	0.160	4.439
	Rock	0.073	0.021	0.172	4.612
Mycorrhiza	0.0	0.058	0.016	0.149	3.867
	Super	0.069	0.020	0.169	3.922
	Rock	0.079	0.025	0.180	4.022
Rhizobium + Mycorrhiza	0.0	0.067	0.019	0.157	4.339
	Super	0.057	0.025	0.183	4.615
	Rock	0.083	0.028	0.198	4.799
Control	0.0	0.017	0.009	0.095	3.131
	Super	0.022	0.015	0.137	3.242
	Rock	0.029	0.017	0.142	3.525
L.S.D. 5%	a) Bio-fertilizer	0.0021	0.0018	0.0221	0.375
	b) Sources of (P)	0.0018	0.0016	0.0191	0.273
	(a) X (b)	0.0036	0.0021	0.0381	0.645

2. Effect of peanut inoculations with rhizobium and mycorrhizae with different sources of P under field conditions:

2.1. On peanut root rot diseases:

Data presented in Table (4) showed that, using of the applied two biofertilizers gave a significant effect for controlling incidence of damping-off and peanut root rot diseases under two sources of P during the two growing seasons 2006 and 2007. The effect of mycorrhizae was better than rhizobium on reduced of root diseases especially in case of root rot, but they work together better than singly in reductions of damping-off and peanut root rots diseases.

P-rock was better than P-supper in their effect on studied diseases. When any of P sources were applied with biofertilizer treatments it was more effective on reduction of damping-off and peanut root rot incidence during the two growing seasons. Integration of P-rock, rhizobium and mycorrhiza gave the maximum disease reduction compared with other treatments in both seasons.

Table (4): Effect of peanut inoculations with rhizobium and mycorrhizae with different sources of P on peanut root rot diseases under field conditions during seasons 2006 and 2007.

Seasons		2006				2007			
Bio-fertilizer	Sources of (P)	Damping –off (%) Pre-emergence	Damping –off (%) Post-emergence	Root rot (%)	Healthy (%)	Damping –off %) Pre-emergence	Damping –off %) Post-emergence	Root rot (%)	Healthy (%)
Rhizobium	0	11.00	8.12	7.97	72.91	10.00	8.41	6.17	75.42
	Super	10.30	8.48	6.13	75.09	9.00	7.71	6.09	77.29
	Rock	9.84	7.90	5.86	76.40	9.21	6.50	5.33	78.96
Mycorrhiza	0	10.01	7.02	5.86	77.11	9.00	6.21	5.80	78.99
	Super	9.40	5.46	5.33	79.81	8.01	5.00	5.08	81.91
	Rock	8.11	5.15	5.12	81.62	6.97	4.86	4.46	83.71
Rhizobium + Mycorrhiza	0	8.99	6.78	5.93	78.30	7.23	6.41	6.06	80.30
	Super	7.44	4.89	3.58	84.09	5.70	4.01	4.07	86.22
	Rock	6.30	4.26	3.09	86.35	4.21	3.11	2.77	89.91
Control	0	17.20	12.50	9.70	60.60	16.46	11.50	9.45	62.59
	Super	14.01	9.49	8.01	68.49	13.07	8.23	7.38	71.32
	Rock	13.00	8.98	7.00	70.02	11.39	8.20	7.01	73.40
L.S.D. 5%	a) Bio-fertilizer	1.83	1.27	0.88	1.24	1.97	1.32	0.78	1.70
	b) Sources of (P)	1.59	1.10	0.77	1.08	1.72	1.21	0.67	1.48
	(a) X (b)	3.17	2.21	1.03	2.15	3.22	2.41	0.98	2.39

2.2. On peanut yield, nodule performance, mycorrhizal infection percent and spore number:

Data in Table (5) showed that, soil treatment with mycorrhizae was more effective than rhizobium in increasing peanut yield whether singly or with P fertilizer in the two seasons 2006 and 2007. However, the combination of biofertilizers with P fertilizer treatments gave more effect in increasing pod yield. Therefore, integration of P-rock, rhizobium and mycorrhiza gave the maximum pod yield compared with other treatments in the two growing seasons.

Using both rhizobium and mycorrhizae together led to increasing of nodules number and dry weight and increasing of mycorrhizal infection percent and spore numbers during the two seasons (Table 5). Regard to the effect of P sources data also show that, generally supplying of phosphorus gave a significant effect on increasing nodule performance, mycorrhizal infection percent and spore numbers however, P- rock was more effective than P-super. Moreover integration of P-rock, rhizobium and mycorrhizae gave the maximum performance of nodule and mycorrhizal infection percent and number of their spores during the both seasons.

1.3. On percentage of P and N content:

Total and available P in the soil were affected by the source of P, in this respect P-rock was better than P- supper (Table 6). Data also showed that, the addition of bio-fertilizer perform to increase the percentage of total or available P in the two seasons 2006 and 2007. Results were obtained from Table (6) clearly shown the role of biofertilizer on available P which more benefit to peanut plants.

Moreover mycorrhizae gave the best ability in increasing available P in soil under the two sources of P during the two successive seasons. The content of P and N in peanut plants also was affected by biofertilizer treatments (Table 6). The rhizobium had more effect in increasing of N content in plants while, mycorrhizal plant had more of P content under the two P sources.

Table (5): Effect of peanut inoculations with rhizobium and mycorrhizae with different sources of P on peanut root rot diseases under field conditions during seasons 2006 and 2007.

Seasons		2006				
Bio-fertilizer	Source of (P)	Nodule		Mycorrhiza		Yield (Ton/Fed)
		No./plant	D.W. (gm)	infiction (%)	No. spores (100 gm soil)	
Rhizobium	0	130	0.78	12.3	87.3	1.120
	Super	137	0.80	15.5	132.4	1.198
	Rock	140	0.81	17.2	153.5	1.288
Mycorrhiza	0	80	0.62	75.5	412.2	1.144
	Super	91	0.65	77.9	525.6	1.200
	Rock	96	0.67	79.4	613.8	1.328
Rhizobium + Mycorrhiza	0	145	0.81	80.2	708.1	1.342
	Super	161	0.88	82.3	820.5	1.524
	Rock	179	0.91	86.9	925.8	1.616
Control	0	110	0.69	15.4	111.3	0.972
	Super	120	0.70	19.5	162.5	1.008
	Rock	125	0.75	21.2	171.5	1.096
L.S.D. 5%	a) Bio-fertilizer	3.11	0.049	1.47	16.38	0.034
	b) Sources of (P)	2.69	0.043	1.28	14.18	0.028
	(a) X (b)	3.37	0.084	2.55	28.31	0.058
		2007				
Rhizobium	0	141	0.80	10.2	154.5	1.141
	Super	148	0.82	16.5	184.6	1.194
	Rock	152	0.85	18.0	211.6	1.292
Mycorrhiza	0	91	0.60	52.8	766.3	1.166
	Super	99	0.65	63.5	785.3	1.200
	Rock	108	0.68	69.9	803.4	1.334
Rhizobium + Mycorrhiza	0	161	0.85	78.3	857.6	1.423
	Super	172	0.90	93.4	873.6	1.540
	Rock	183	0.98	98.9	908.7	1.742
Control	0	117	0.72	13.9	173.5	0.998
	Super	121	0.74	19.3	231.7	1.073
	Rock	126	0.77	21.4	254.8	1.116
L.S.D. 5%	a) Bio-fertilizer	2.67	0.046	1.38	13.14	0.048
	b) Sources of (P)	2.32	0.039	1.19	11.38	0.039
	(a) X (b)	4.63	0.077	2.38	22.71	0.073

Table (6): Effect of peanut inoculations with rhizobium and mycorrhiza with different sources of P on peanut root rot diseases under field conditions during seasons 2006 and 2007.

Seasons		2006				2008			
		Soil		Plant		Soil		Plant	
Bio-fertilizer	Source of (P)	Total P (%)	Available P (%)	P content (%)	N content (%)	Total P (%)	Available P (%)	P content (%)	N content (%)
Rhizobium	0	0.068	0.021	0.156	5.120	0.072	0.027	0.169	5.314
	Super	0.072	0.025	0.160	5.230	0.080	0.028	0.177	5.411
	Rock	0.079	0.029	0.163	5.512	0.083	0.030	0.181	5.561
Mycorrhiza	0	0.075	0.027	0.168	4.560	0.080	0.030	0.191	4.773
	Super	0.083	0.030	0.178	4.612	0.087	0.035	0.200	4.922
	Rock	0.088	0.032	0.189	5.011	0.091	0.037	0.208	5.135
Rhizobium + Mycorrhiza	0	0.078	0.029	0.187	5.239	0.085	0.032	0.209	5.513
	Super	0.091	0.035	0.190	5.640	0.096	0.040	0.212	5.800
	Rock	0.098	0.039	0.199	5.877	0.099	0.044	0.219	5.982
Control	0	0.051	0.014	0.144	4.089	0.078	0.017	0.149	4.484
	Super	0.071	0.024	0.147	4.222	0.060	0.027	0.155	4.289
	Rock	0.074	0.027	0.154	4.325	0.075	0.029	0.167	4.540
L.S.D. 5%									
a) Bio-fertilizer		0.006	0.003	0.009	0.218	0.003	0.004	0.003	0.189
b) Sources of (P)		0.005	0.003	0.008	0.195	0.003	0.003	0.002	0.158
(a) X (b)		0.010	0.005	0.017	0.310	0.006	0.006	0.006	0.327

However, integration of P-rock, rhizobium and mycorrhiza gave the maximum content of P and N in peanut plants compared to other treatments during the two successive seasons.

DISCUSSION

The results of this study provide that mycorrhiza when used either singly or with rhizobium gave a significant reduction in the incidence of damping-off and peanut root rot diseases and consequently increasing the percentage of healthy survival plants. This is in agreement with Kulkarm *et al.* (1997), Abdalla and Abdel-Fattah (2000) and Mahmoud, (2004). The role of vesicular arbuscular mycorrhizal fungi for controlling plant diseases has been demonstrated to include the enhancement of plant development and increasing plant vigor, especially under field conditions by enhancing plant nutrition which may led to diseases escape or higher tolerance towards soil borne pathogens (Carling *et al.*, 1996, Allen *et al.*, 2003 and Siddiqui *et al.*, 2008). It's also protecting the plants by eliminating pathogens or reducing their effectiveness by interacting directly with soil borne pathogens, or indirectly by stimulating other natural antagonists (Filion *et al.* 1999; Mohan 2000). Moreover, it's improving host resistance by the stimulation of plants to produce phytoalexins (Sundaresan *et al.* 1993).

With regard to, the effects of rhizobium as biofertilizer treatments data show that, there was a significant effect in the reducing damping-off and peanut root rot diseases. This is in agreement with EL-Deeb and Ibrahim, (1998); Shahaby *et al.* (2000), and Mahmoud, (2004).

Such effects could be explained by competition between the symbiont and the pathogen or by a possible inhibitory action of the symbiont on the pathogen (Bhattacharryya and Mukherjee, 1990 and Salui and Bhattacharryya, 1998). Moreover, the role of rhizobium in enhancing plant production by

N_2-fixation and producing plant phytohormones mainly indol acetic acid, gibberellins and cytekinins (Shahaby *et al.*, 2000).

Results also indicated that, the efficiency of mycorrhizae and rhizobium in reducing damping-off and peanut root rot incidence was increased by the addition of phosphorus. This is in agreement with Baker, and Cook, (1982) and Hassan and Frederick, (1995), who stated that, host susceptibility to infection by pathogens was influenced by the nutritional status of the host and fertility status of the soil.

Data also showed that, soil treatment with mycorrhizae and rhizobium more increased peanut yield whether singly or with P fertilizer. Addition of P fertilizer treatments gave more effect in increasing pod yield. This is due to the role of biofertilizers in dissolving the minerals in the soil and making it more available to plants. Moreover, the role of rhizobium in enhancing plant production due to N_2-fixation as proved by Shahaby *et al.* (2000), Allen *et al.* (2003) and Siddiqui *et al.* (2008).This hold true in the present study in the role of both mycorrhiza and rhizobium in increasing P content whether total or available in soil and contents of P and N in peanut plants.

Using the both of rhizobium and mycorrhizae together led to increase of nodules number and dry weight and also increasing of mycorrhiza infection and spore numbers. This is in agreement with El-Ghandour *et. al.* (1997) and Dar *et. al.* (1997) who stated that, rhizobium in association with mycorrhizae, caused the maximum increase in of nodules number and dry weight while, a vital role of mycorrhiza was more in the presence of rhizobium.

With regard to the effect of P sources data also show that, P-rock was more effective than P-super in all studied parameters. This is may be due to P-rock had more content of P and other minerals which benefit for plants. Moreover, the high ability of mycorrhizae and rhizobium to solubilize P-rock and that explain the increase of P content in soil and plant in case of addition biofertilizer to P-rock than P-super (Abd-Alla, 1994 and El-Ghandour *et. al.* 1997).

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تأثير تلقيح الفول السوداني بالريزوبيا والميكروهيزا علي أمراض أعفان الجذور في ظل تواجد مصادر مختلفة من التسميد الفوسفاتي

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أجريت هذه الدراسة تحت تأثير ظروف العدوى الصناعية بالصوبة والعـدوى الطبيعيـة بالحقـل خلال موسمي ٢٠٠٦ و٢٠٠٧ لتقدير مدي تأثير تلقيح الفول السوداني بالريزوبيا وفطريـات الميكروهيـزا علي أمراض أعفان الجذور في ظل تواجد مصادر مختلفة من التسميد الفوسفاتي (سوبر فوسفات وصـخر الفوسفات). هذا وقد أعطي التلقيح بكلاً من الريزوبيا والميكروهيزا كتسميد حيوي معنوية كبيرة في خفـض نسبة الإصابة بموت البادرات وأعفان جذور الفول السوداني وكذلك زيادة نسبة النباتـات السـليمة وزيـادة محصول قرون الفول السوداني في تجارب الصوبة والحقل خلال موسمي ٢٠٠٦ و٢٠٠٧. عندما تم تلقيـح الميكروهيزا بمفردها كان تأثيرها أعلي من تأثير الريزوبيا بمفرده في خفض نسب الإصابة. وأدي الجمـع بين التسميد الحيوي والمعاملة بالفوسفور إلي تسجيل أعلي خفض في نسب الإصابة بموت البادرات وأعفان جذور الفول السوداني وكانت المعاملة بالفوسفات الصخري إلـي جانـب التلقـيح بكـلاً مـن الريزوبيـا والميكروهيزا معاً هي الأفضل حيث أعطت أعلي نسبة خفض في الإصابة بموت البادرات وأعفان جـذور الفول السوداني بالمقارنة بالمعاملات الأخري في تجارب الصوبة والحقل خلال موسـمي ٢٠٠٦ و٢٠٠٧. أدي التلقيح بكلاً من الريزوبيا والميكروهيزا معاً إلي زيادة عدد العقد البكتيرية ووزنها الجاف إلـي جانـب زيادة في نجاح ارتباط الميكروهيزا بالجذور وكذلك زيادة عدد جراثيمها فـي التربـة. كمـا أن اسـتخدام الريزوبيا والميكروهيزا سواء بمفردهم أوفي حالة التلقيح المزدوج أدي إلي زيادة نسـبة الفوسـفور الكلـي والميسر في التربة وزيادة محتوي نباتات الفول السوداني من الفوسفور والنيتروجين إلي جانب ذلك بصـفة عامة أظهر الفوسفات الصخري كمصدر للفوسفور تفوق علي السوبر فوسفات في كـل القياسـات السـابق ذكرها في تجارب الصوبة والحقل خلال موسمي ٢٠٠٦ و٢٠٠٧.