Factors affecting peanut pod rot severity under field conditions

II-Chemical, biological and integrated control methods

By

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ABSTRACT

Using some antagonists in controlling peanut pod rot infection in Beheira and Sharkya governorates during two growing seasons 2002 and 2003 revealed the superiority of *Trichoderma harzianum* followed by *Chaetomium bostrycoides* and *Giliocladium penicilloides* than each of the other tested commercial products *i.e.* Rhizo-N, Plantguard and Multi-VAM (mycorrhiza) in reducing peanut pod rot infection. Also, all the tested antagonists i.e. *Trichoderma*, *Chaetomium* and *Gliocladium* or those in commercial formula (Rhizo-N, Plantguard and Multi-VAM) increased the yield of pods in the two governorates. Meanwhile, all tested fungicides reduced peanut pod rot infection to percentages much lower than those of un-treated ones during the two seasons. The fungicides, Vitavax-T, Sumisclex and Rizolex-T were the best, followed by Benlate, Balear, Noplit, Daconil and Clorocip which had a moderate action while, Daconil was the least tested fungicide in reducing peanut pod rot infection during the two growing seasons in Beheira and Sharkya governorates. In addition, Rizolex-T was the best followed by Vitavax-T and Sumisclex in increasing peanut pod yield in most cases of treating during the two seasons. On the other hand, the integration between fungicides and fertilizers (NPK) at certain sowing time controlled effectively the pod rot infection and increased the total peanut pods more than any individual treatment whether in South-Tahrir or in Abou-Hammad.

Key words: biological control**,** chemical control, Integrated control, peanut pod rot.

INTRODUCTION

Peanut is considered one of the most important export crops in Egypt. Peanut pod rot is a serious worldwide disease attacking fruits below the ground. The pods are subjected to attack with numerous soil borne pathogens such as *Fusarium* spp., *Sclerotium* sp., *Rhizoctonia solani Aspergillus* spp. *etc*. which causing different symptoms of pod rots (**Marei, 2000)**.

As for biological control, **Yehia *et al.* (1983)** reported that coating broad bean seeds with *Trichoderma viride* or *Bacillus subtilis* gave good control of *Fusarium* root-rot disease and increased both fresh and dry weight of the shoots, roots and nodules under both greenhouse and field conditions. **Lashin *et al.* (1989)** reported that soil treatment with *T. harzianum* greatly reduced the growth of 3 isolates of *Aspergillus niger* (the causal agent of crown rot of groundnut), resulted in higher numbers of pods and increased pod weight/plant. The best control was obtained when the seeds were treated with 10^7 *T. harzianum* spores/ml. **Turner and Backman (1991)** found that treatment of peanut seeds with *Bacillus subtilis* reduced levels of root cankers caused by *R. solani* (AG.4), improved seed germination, increased root growth and nodulation. **Sabet *et al*. (1992)** tested *Pseudomonas lindbergii* and *Coniothyrium minitans*, as biocontrol seed treatments against groundnut damping-off and pod-rot organisms (*Rhizoctonia solani*, *Fusarium oxysporum* and *Sclerotium rolfsii [Corticium rolfsii]). P. lindbergii* was more effective in preventing pre- and post emergence damping-off. While, *C. minitans*, not effective against seedling infection, but showed noticeable activity against pod-rot causal organisms. **Sailaja *et al.* (1998)** found that treating groundnut seeds with *B. subtilis*-AF1 alone or in combination with *A. niger,* increased seedling emergence. *B. subtilis* treated seedlings were more vigorous than controls. **Abdalla and Abdel-Fattah (2000)** investigated the interaction between the arbuscular mycorrhizal fungus (*Glomus mosseae*) and the two pod rot pathogens (*Fusarium solani* and *Rhizoctonia solani*) and subsequent effects on growth and yield of peanut plants in a greenhouse over a 5-month period. They found that the growth response and biomass of peanut plants inoculated with *G. mosseae* was significantly higher than that of non-mycorrhizal plants, either in the presence and absence of the pathogens. Plants inoculated with *G. mosseae* had a lower incidence of root rot, decayed pods, and death than non-mycorrhizal treated ones. **El-Deeb *et al*. (2002)** found that Plantguard (a formula of *Trichoderma harzianum*), Rhizo-N (a formula of *Bacillus subtilis*) reduced the percentage of root and pod rots (*Aspergillus* spp., *Fusarium oxysporum, F. solani, F. moniliforme, Macrophomina phaseolina*, *Sclerotium rolfsii* and *Penicillium* spp.) of groundnut cv. Giza-5 under greenhouse and field conditions. Also, all treatments increased pod yield compared to the non-treated control. **Varadharajan *et al.* (2006)** found that *Trichoderma viride* inhibited the mycelial growth of *Sclerotium rolfsii* (Sacc.), the causal agent of stem rot of groundnut followed by *P. fluorescens* and they were the most effective bio-agents in suppressing sclerotial formation.

Yehia *et al*. (1979) found that treating seeds of peanut with fungicides (Benlate, Vitavax-Thiram and Vitavax-Captan) reduced the percentage of pre-and post-emergence damping off and root-rot diseases in the field. **Kannaiyan *et al.* (1989)** demonstrated that treating groundnut seeds with Benlate (benomyl) or Labilite (thiophanate-methyl) at 3g/kg seeds controlled infection with *Aspergillus flavus*. **Hilal *el al.* (1990)** found that Bavistin and Sumisclex were the most effective fungicides for controlling soil borne groundnut diseases where they reduced the incidence of brown rot (*Rhizoctonia solani*), pink discoloration (*Fusarium moniliform*) and break-down caused by various other pathogens. **Marei (2000)** evaluated 4 fungicides as seed treatment (Benlate, Rizolex –T, Sumisclex and Topsin-M) and 3 fungicides as soil treatments (Chlorothalonil, Sumisclex and Ronilan). Soil treatment resulted in significant reduction of disease incidence and the percentage of fungi isolated from both shells and seed; however, Sumisclex was the most effective one. **El-Deeb *et al*. (2002)** found that treating groundnut seeds cv. Giza-5 with the fungicides Vitavax-T [carboxin]-thiram, Rizolex-T [tolclofos-methyl] thiram and Topsin-M70 [thiophanate-methyl] reduced the percentage of root and pod rots (*Aspergillus* spp., *Fusarium oxysporum*, *F. solani*, *F. moniliform* [*Gibberella fujikuroi*], *Macrophomina phaseolina*, *Sclerotium rolfsii*, *Penicillium* spp.) in both the greenhouse and the field. In addition, all treatments increased pod yield compared to the non-treated check.

The study aimed at expressing the effect of chemical, biological and integrated control in controlling peanut pod rot diseases under field conditions

MATERIALS & METHODS

1- Biological control:

In this study, the peanut seeds were soaked for 2 hrs in suspension containing propagules of the following antagonistic fungi and biocides as well as Multi-VAM. Three antagonists i.e *Trichoderma harzianum, Gliocladium penicilloides* and *Chaetomium bostrycoides*, 2 commercial biocides i.e. Plantguard and Rizo-N as well as Multi-VAM (vesicular-arbuscular mycorrhizal "VAM"fungi formulation) were used as soil treatments to evaluate their efficacy against peanut pod rots infection. All biological materials tested were kindly obtained from Onion, and Oil Crop Diseases Res. Division and Mycology and Plant Survey Diseases Res. Division, Plant Pathol. Res. Inst., (ARC) Giza.

The above mentioned three antagonistic fungi were grown separately in conical flasks containing PDA liquid medium at 26°C. After 15 days from incubation, the liquid cultures of each fungus were mixed together and filtered through double layers of sterilized cheese cloth. Number of conidial spores in the resultant spore suspensions was counted and adjusted to about $8x10^5$ conidia/ml for *T. harzianum* and *G. penicilloides* and $1x10^6$ conidia/ml *Ch. bostrycoides* (**Harman *et al.*, 1980**). Plantguard (one ml contains about $30x10^6$ spores of *Trichoderma* spp.) and Rizo-N (one gram contains about $30x10^6$ cfu *Bacillus subtilis*) were used as 0.05% suspension of these antagonists and biocides while, Multi-VAM (30-50 VAM spores/g) were used as soil treatment at rates of 10g/hill (0.5kg/plot) as recommended by **Ferguson and Woodhead (1984)**. Untreated peanut seeds were served as a check treatment.

This experiment was accomplished in a complete randomized block design with four replicates for each treatment. All the required farm practices were applied as usual. At harvest (120 days post sowing) pod rot diseases were assessed and calculated as mentioned before.

2- Chemical control:

In this study, nine fungicides (**Table, 1**) were tested as seed treatments at the recommended doses for their effects on peanut pod rots infection and pod yield. The peanut seeds were mixed with the different tested fungicides individually at the recommended dose as clear in **Table (1)** for each fungicide in presence of a little amount of Tween-20 as surfactant material and then shaked to cover the whole seeds before sowing directly. The tested fungicidal treatments were arranged in a complete randomized block design with four replicates for each treatment. Untreated peanut seeds were served as check treatment. All the other farm practices were applied as usual. At harvest (120 days post sowing) pod rot diseases were investigated and calculated as mentioned before.

3- Integrated control of peanut pod rots:

This study was carried out in season 2004 at two mentioned locations to investigate effect of combination between 2 sowing dates (15th April and 1st May), 2 treatments of fertilization ($N_2P_2K_2$ and $N_2P_2K_3$) and fungicides (Rizolex-T or Vitavax-T) as integrated disease management (IDM) for controlling the natural infection with pod rot diseases. Treatments tested for each factor were selected because they exhibited the best results in the above experiments carried out for fertilization, fungicides and sowing date. Fertilization and fungicidal treatments were performed as described above. Unfertilized plots ($N_1P_1K_1$) and untreated peanut seeds (without fungicides) were served as check for fertilization and fungicidal treatments, respectively.

This experiment was conducted in a split split-plot design with three replicates in which sowing times were arranged in the main plot meanwhile fertilization and fungicidal treatments were arranged in the sub and sub-sub plots, respectively. Spray (sprinkle) irrigation system was used in this study as recommended for this method normally. Disease and yield assessment were recorded.

Statistical analysis:

Statistical analysis was done according to procedures of ANOVA reported by **Snedecor and Cochran (1989).**

Table (1): List of tested fungicides as seed dressing**.**

Commercial name	Common name Concentration	Chemical name	Dose /kg seeds
Rizolex-T	Tolclofos-methyl 20% + Thiram 30%WP	O-(2,6-dichloro-p-tolyl) O,O-dimethyl phosphorothioate (IUPAC). 20% Tetramethylthiuram disulfide (IUPAC).30%	3g
Amconil	Chlorothalonil 75% WP	Tetrachloroisophthalonitrile (IUPAC).	5g
Daconil	Chlorothalonil 75% WP	Tetrachloroisophthalonitrile (IUPAC).	5g
Benlate	Benomyl 50% WP	Methyl-a1-(butylcarbamoyl)benzimidazol-2-ylcarbamate (IUPAC).	1.5g
Balear	Chlorothalonil 50% SC	Tetrachloroisophthalonitrile (IUPAC).	3ml
Chlorothit	Chlorothalonil 75%	Tetrachloroisophthalonitrile (IUPAC).	5g
Sumisclex	Procymidone 50% WP	N-(3,5-dichlorophenyl)-1,2-dimethylcyclopropane-1,2-dicarboximide.	1g
Vitavax-T	Carboxin 37.5% + Thiram 37.5% WP	5,6-dihydro-2-methyl-N-phenyl-1,4-oxathiin-3-carboxamide (CAS). tetramethylthiuram disulfide (IUPAC).	3g
Noblight	Thiram 50% WP	tetramethylthiuram disulfide (IUPAC)	3g

RESULTS

1 - Effect of antagonists

Data in **Table (2)** indicate efficacy of some antagonists in controlling peanut pod rot infections and improving pod yield in Beheira and Sharkyia governorates during growing seasons 2002 and 2003. All tested bioagents treatments (*Trichoderma harzianum*, *Chaetomium bostrycoides*, *Giliocladium penicilloides*, Rhizo-N, Plantguard and Muli-VAM,) significantly reduced peanut pod rots (break down, brown and pink rots) and increased the yield of pods comparing with the untreated check. In this respect, *Trichoderma harzianum* was the superior bioagent as seed treatment whereas Multi-VAM was the inferior one during both seasons.

Incidence of total pod rots and brown rot in the first season and pink and breakdown rots in both seasons were significantly affected by the interaction between locations and bioagent treatments. While, pod yield was not affected significantly by location or by the interaction between locations and bioagent treatments. In Beheira, *T. harzianum* recorded the lowest total rots (13.67 & 14.1%) and highest pod yield (1.122 & 1.122 ton/fed.) during the two seasons, respectively. In Sharkyia, *T. harzianum* still the best in both season as it reduced total rots to 14.4 & 15.3% and increased yield to 1.127 & 1.117 ton/fed., respectively.

Table (2): Effect of different antagonists on pod rot infections % and peanut yield during 2002 and 2003 growing seasons.

Seasons	Locations	Antagonists	Total infection %	% Infection with: Brown rot %	Pink rot %	Break-Down %	Yield (ton/fed.)
2002 season	Beheira	***T. harzianum***	13.67	6.00	1.20	6.47	1.122
		Ch. bostrycoides	15.75	7.00	1.25	7.50	1.115
		G. penicilloides	19.53	6.03	2.10	11.40	1.077
		Rhizo-N	20.48	7.72	1.43	11.33	1.073
		Plant-Guard	26.34	9.17	1.83	15.34	1.042
		Multi-VAM	28.58	10.80	3.10	14.68	1.027
		Check	32.40	13.13	4.20	15.07	0.850
	Sharkyia	***T. harzianum***	14.40	5.70	1.00	7.70	1.127
		Ch. bostrycoides	17.08	6.33	1.33	9.42	1.110
		G. penicilloides	18.67	7.67	2.00	9.00	1.100
		Rhizo-N	25.46	8.67	2.06	14.73	1.043
		Plant-Guard	27.49	11.05	3.07	13.37	1.038
		Multi-VAM	30.18	10.75	3.00	16.43	1.002
		Check	42.94	17.77	5.07	20.10	0.762
2003 season	Beheira	***T. harzianum***	14.10	5.70	1.07	7.33	1.122
		Ch. bostrycoides	15.63	6.47	1.43	7.73	1.075
		G. penicilloides	20.17	8.07	2.00	10.10	1.108
		Rhizo-N	22.33	9.00	3.00	10.33	1.077
		Plant-Guard	27.42	10.67	3.05	13.70	1.040
		Multi-VAM	30.03	12.03	3.00	15.00	1.015
		Check	39.63	14.10	4.20	21.33	0.840
	Sharkyia	***T. harzianum***	15.30	5.33	2.10	7.87	1.117
		Ch. bostrycoides	17.20	7.10	2.00	8.10	1.108
		G. penicilloides	20.17	8.07	2.70	9.40	1.077
		Rhizo-N	24.82	8.79	3.00	13.03	1.067
		Plant-Guard	28.35	9.33	3.02	16.00	1.037
		Multi-VAM	32.00	11.00	4.00	17.00	0.965
		Check	43.10	14.00	4.33	24.77	0.790

LSD at 5% for						
	Location	0.191	0.084	0.030	0.144	NS
2002 season	Bio-agents	0.667	0.295	0.105	0.504	0.046
	Interaction	1.334	0.591	0.211	1.007	NS
	Location	0.135	NS	0.030	0.101	NS
2003 season	Bio-agents	0.473	0.273	0.105	0.353	0.047
	Interaction	NS	NS	0.209	0.706	NS

2 - Effect of fungicides:

Results in **Table (3a &b)** reveal effects of some fungicides on peanut pod rot infections and pod yield in two locations (governorates) during two growing seasons (2002 and 2003). All determined criteria (different types of pod rots & yield) were significantly affected by tested fungicides in the first season as well as by the interaction between both locations during both seasons. Also, the pink and breakdown rots in seasons 2002 & 2003, respectively and yields of peanut pods in both seasons were significantly affected by location and the interaction between location and fungicides. The different pod rots determined were responded differently against tested fungicides. Regardless location, the highest significant decreases in percentages of brown rot of recorded by Sumisclex (2.39%) and Vitavax-T (2.56%) during 2002 and 2003 seasons, respectively. While, the lowest incidence of pink rot in season 2002 was recorded by Vitavax-T (0.35%) and Rhizolex-T (0.367%) in 2002 season while, Benlate (0.5%) and Blair (0.6%) were the best in 2003 season without significant difference between each pair of fungicides. As for incidence of the breakdown rot, the lowest significant infection was induced by the fungicides Noplit (4.033%) and Blair (4.217%) in 2002 season and Noplit (4.167%), Rhizolex-T (4.197%) and Blair (4.212%) in 2003 season without significant differences in between. In general, the lowest averages of total pod rots (brown, pink and breakdown) was recorded by the fungicide Vitavax-T (8.56%) followed by Rhizolex-T (9.34%) and Sumisclex (9.47%) in 2002 season whereas, Vitavax-T (8.58%) and Rhizolex-T (8.88%) were the best of all followed by Sumisclex (9.32%) in 2003 season. Among all tested fungicides, Amconil, in general, was the least effective in controlling infections with different types of pod rots particularly in 2002 season comparing with the untreated controls.

Table (3a): Effect of different fungicidal treatments on percentages of pod rot infection and peanut yield during 2002 growing season.

Location	Fungicides	Total infection %	% Infection with			Yield (ton/fed.)
			Brown rot %	Pink rot %	Break-Down %	
Beheira	Rhizolex-T	9.70	3.93	0.33	5.43	1.299
	Amconil	20.03	11.33	1.00	7.70	1.072
	Daconil	13.54	4.83	0.33	8.38	1.099
	Benlate	11.50	5.67	0.50	5.33	1.114
	Balear	12.14	7.37	0.33	4.43	1.133
	Chlorocip	14.06	7.00	0.39	6.67	1.072
	Sumisclex	9.15	2.01	0.33	6.80	1.238
	Vitavax-200	8.05	2.72	0.33	5.00	1.262
	Noplit	12.39	7.35	1.00	4.03	1.155
	Check	42.14	18.81	6.00	17.33	0.737
Sharkeia	Rhizolex-T	8.98	4.20	0.40	4.38	1.371
	Amconil	21.11	9.67	0.71	10.73	1.106
	Daconil	12.74	6.03	1.02	5.70	1.168
	Benlate	10.04	4.67	0.67	4.71	1.139
	Balear	12.81	8.07	0.73	4.00	1.172
	Chlorocip	13.55	7.00	0.80	5.75	1.113
	Sumisclex	9.80	2.77	1.00	6.03	1.294
	Vitavax-200	9.06	3.00	0.37	5.69	1.235
	Noplit	13.27	8.43	0.80	4.03	1.234
	Check	40.16	19.39	2.07	18.70	1.164

LSD at 5% for

Location	NS	NS	0.013	NS	0.007
Fungicides	0.577	0.438	0.065	0.425	0.033
Interaction	NS	NS	0.130	0.849	0.066

Also, average yield of peanut pods (ton/fed.) was responded differently against tested fungicides. In this regard, Rhizolex-T was best of all during seasons 2002 (1.335) and 2003 (1.378) followed by Sumisclex (1.266) and Vitavax-T (1.249) without significant difference on between in the first season and Vitavax-T (1.304) followed by Sumisclex (1.260) in the second season. On the contrary, the lowest significant increase in the average yield of pods was recorded by the fungicides

Chlorocip (1.092 & 1.102) and Amconil (1.089 & 1.083) comparing with the untreated controls (0.951 & 0.998) for both seasons, resoectively

The present results proved also that, only incidence of pink rot in 2002 season and breakdown rot and pod yield in 2003 season was significantly affected by locations. Average infection with pink rot in 2002 season was significantly lower in Sharkyia (0.856%) than Beheira governorate (1.056%) while, the breakdown rot infection in 2003 season was significantly higher in Sharkyia (7.602%) than Beheira governorate (7.158%). However, yield of pods was significantly higher in Shrkyia (aver. 1.214 ton/fed.) than Beheira governorate (aver. 1.136 ton/fecd).

Table (3b): Effect of different fungicidal treatments on percentages of pod rot infections and peanut yield during 2003 growing season.

Location	Fungicides	Total infection %	% Infection with Brown rot %	Pink rot %	Break-Down %	Yield (ton/fed.)
Beheira	Rhizolex-T	9.73	4.00	1.33	4.39	1.419
	Amconil	18.84	9.04	1.07	8.73	1.069
	Daconil	13.29	4.83	0.40	8.06	1.070
	Benlate	12.17	5.50	0.83	5.84	1.102
	Balear	11.56	6.83	0.67	4.06	1.125
	Chlorocip	15.69	8.22	0.33	7.13	1.065
	Sumisclex	7.94	2.70	0.67	4.57	1.248
	Vitavax-200	7.24	2.40	0.50	4.34	1.304
	Noplit	13.14	8.33	0.47	4.33	1.171
	Check	44.13	21.00	3.00	20.13	0.788
Sharkyia	Rhizolex-T	8.02	3.67	0.36	4.00	1.336
	Amconil	22.39	10.72	0.33	11.33	1.135
	Daconil	13.62	4.43	1.00	8.18	1.204
	Benlate	9.76	5.06	0.37	4.33	1.183
	Balear	12.39	7.69	0.33	4.37	1.181
	Chlorocip	13.10	6.06	1.03	6.00	1.101
	Sumisclex	10.71	3.37	1.33	6.00	1.273
	Vitavax-200	9.92	2.72	1.07	6.13	1.305
	Noplit	13.35	8.33	1.02	4.00	1.209
	Check	44.73	20.33	2.73	21.67	1.208
LSD at 5% for						
	Location	NS	NS	NS	0.059	0.007
	Fungicides	0.442	0.388	0.102	0.293	0.037
	Interaction	0.884	0.776	0.205	0.587	0.073

The obtained results proved also that, incidence of pink and breakdown pod rots and pod yield in 2002 season in addition to brown and total pod rots in 2003 season were significantly affected by the interaction between fungicides and locations. The lowest significant decrease in percentage of pink rot was produced by Chlorocip and Daconil (0.33-0.4%) in season 2002 and Balear, Noplit, Vitavax-T, Rhizolex-T and Sumisclex (4.06-4.57%) in season 2003 comparing with their respective untreated controls. In general, Vitavax-T and Sumisclex induced the lowest incidence of brown rot (2.4-2.7%) and total rots (7.24-7.94%) comparing with the other fungicides without significant differences between all.

In season 2003, the fungicides Vitavax-T, Sunisclex and Amconil were more effective in controlling total pod rots in Beheira governorate than in Sharkyia one while Rizolex-T, Benlate and Chlorocip exhibited the opposite trend. However, the fungicides Blair and Noplit were significantly equal when applied at the two locations. The same trends were approximately observed concerning brown, pink and breakdown pod rots.

The obtained results indicated also that the pod yield of control (untreated) was significantly higher in Sharkyia (1.208 ton/fed) than in Beheira (0.788 ton/fed.) whereas, the fungicide Rizolex-T increase pod yield significantly more in Beheira (1.419 ton/fed) than in Sharkyia (1.336 ton/fed.). These results revealed that efficacy of a known fungicide might be significantly varied according to location in which it was applied.

3 - Integrated management of peanut pod rots under field conditions

This study was performed at tow different localities (South-Tahrir "Beheira" and Abou-Hammad "Sharkyia") to investigate effects of combination between two fungicides and two NPK fertilization treatment applied at two different sowing dates on the total pod rots (break down, brown and pink rots) as well on the total yield of peanut pods.

Table (4a): Effect of using the integrated control on pod rot percentages and peanut yield (Ton/feddan) in South-Tahrir.

Integrated treatments			Pod rot type %			Total pod rots %	Yield (Ton/fed.)
Sowing time	Fungicides	Fertilizers	Brown rot %	Pink rot %	Break down rot %		
15^{th} April	Vitavax	N2 P2 K2	1.60	0.40	2.20	4.20	1.303
		N2 P2 K3	1.93	0.60	2.20	4.73	1.322
		N1 P1 K1	3.17	0.90	5.47	9.53	1.281
	Rizolex-T	N2 P2 K2	1.70	0.47	2.43	4.60	1.313
		N2 P2 K3	2.27	0.67	2.40	5.33	1.330
		N1 P1 K1	3.57	1.03	7.87	12.47	1.294
	Check	N2 P2 K2	2.53	0.77	4.43	7.73	1.264
		N2 P2 K3	3.60	0.97	4.30	8.87	1.271
		N1 P1 K1	13.90	3.00	11.47	28.37	1.082
1^{st} May	Vitavax	N2 P2 K2	1.87	0.53	1.87	4.27	1.327
		N2 P2 K3	2.10	0.70	2.57	5.37	1.359
		N1 P1 K1	5.00	1.13	8.07	14.20	1.131
	Rizolex-T	N2 P2 K2	2.27	0.50	2.00	4.77	1.354
		N2 P2 K3	2.33	0.60	2.70	5.63	1.363
		N1 P1 K1	5.23	1.27	7.87	14.37	1.167
	Check	N2 P2 K2	4.17	0.83	4.37	9.37	1.261
		N2 P2 K3	4.53	0.93	5.20	10.67	1.280
		N1 P1 K1	11.97	2.47	15.07	29.50	1.074

L.S.D. at 5% for:					
Dates (D)	0.051	NS	NS	NS	NS
Fertilization (Fe)	0.032	0.034	0.259	0.244	0.009
D x Fe	0.063	0.067	NS	NS	NS
Fungicides (Fu)	0.040	0.035	0.247	0.245	0.009
D x Fu	0.080	NS	NS	NS	0.018
Fe x Fu	0.121	0.105	0.740	0.734	NS
D x Fe x Fu	0.241	NS	NS	NS	NS

The obtained results are tabulated in **Tables (4a & 4b)**. These results indicate that, sowing date had significant effects of the brown, pink and breakdown pod rots in locality of South-Tahrir and brown rot only in Abou-Hammad locality. The pink rot in Abou-Hammad, was significantly lower when peanut sown at 15th April (aver. 1.281%) than at 1st May (aver. 1.374%) while breakdown rot exhibited the opposite trend. It was significantly higher in sowing at 15th April (6.19%) than sowing at 1st May (aver. 5.85%) at the last locality. Average percentage of total pod rots at both South-Tahrir and Abou-Hammad localities, however, was significantly lower when peanut sown at 15th April (9.54 & 11.79%) in comparison with sowing at 1st May (10.9 & 12.35%) for both localities, respectively. The yield of peanut pods in both localities was not affected significantly by the tow sowing dates tested.

The same results prove that all determined pod rot criteria as well as yield of pods were significantly affected by fertilization treatments. Comparing with the unfertilized control (N1P1K1), the tow fertilization treatments namely N2P2K2 and N2P2K3 significantly decreased infection with brown rot in both South-Tahrir and Abou-Hammad localities and pink rot in South-Tahrir locality without significant difference in between. While in Abou-Hammad locality, N2P2K2 treatment was significantly better for controlling infection with pink rot (aver. 1.017%) than N2P2K3 (average 1.083%) compared with the unfertilized control (aver. 1.883%).

Table (4b): Effect of using the integrated control on pod rot percentages and peanut yield (Ton/feddan) in Abou-Hammad.

Integrated treatments			Pod rot type %			Total pod rots %	Yield (Ton/fed.)
Sowing time	Fungicides	Fertilizers	Brown rot %	Pink rot %	Break down rot %		
15th April	Vitavax	N2 P2 K2	1.97	0.60	2.27	4.83	1.367
		N2 P2 K3	2.20	0.73	2.43	5.37	1.373
		N1 P1 K1	3.80	1.13	8.77	13.70	1.302
	Rizolex-T	N2 P2 K2	1.87	0.70	2.53	5.10	1.387
		N2 P2 K3	2.20	0.80	2.53	5.53	1.397
		N1 P1 K1	4.43	1.40	8.40	14.23	1.298
	Check	N2 P2 K2	2.97	1.03	4.30	8.30	1.276
		N2 P2 K3	4.00	1.27	4.37	9.63	1.286
		N1 P1 K1	15.40	3.87	20.10	39.37	1.105
1st May	Vitavax	N2 P2 K2	2.00	0.80	2.23	5.03	1.379
		N2 P2 K3	2.40	0.90	2.80	6.10	1.402
		N1 P1 K1	6.17	1.93	8.63	16.73	1.190
	Rizolex-T	N2 P2 K2	2.50	0.67	2.40	5.57	1.401
		N2 P2 K3	2.50	0.83	2.97	6.30	1.415
		N1 P1 K1	6.53	2.10	8.90	17.53	1.164
	Check	N2 P2 K2	5.60	1.03	5.70	12.33	1.255
		N2 P2 K3	5.87	1.20	5.27	12.33	1.276
		N1 P1 K1	12.57	2.90	13.77	29.23	1.108

L.S.D. at 5% for:

Dates (D)	0.048	NS	0.012	0.061	NS
Fertilization (Fe)	0.044	0.030	0.045	0.085	0.014
D x Fe	0.087	0.059	0.089	0.169	NS
Fungicides (Fu)	0.030	0.028	0.045	0.070	0.006
D x Fu	0.060	NS	0.090	0.141	0.011
Fe x Fu	0.090	0.083	0.135	0.211	NS
D x Fe x Fu	0.180	0.167	0.270	0.422	0.034

From point of significance view, the N2P2K2 fertilization treatment also was significantly better than N2P2K3 for controlling infection with breakdown rot as well as the total pod rots in both localities. As for pod yield (ton/fed.), N2P2K3 produced significant higher yield in South-Tahrir (aver. 1.304) than N2P2K2 (aver. 1.287) comparing with the unfertilized control (aver. 1.205), while the tow treatments were significantly equal (aver. 1.344 & 1.335) and better than the unfertilized control (aver. 1.218) in Abou-Hammad locality.

The interaction between sowing dates and fertilization treatments significantly affected all determined pod rot criteria in Abou-Hammad locality and brown rot and total pod rots only in South-Tahrir locality. The highest significant decreases in these disease criteria were induced by applying N2P2K2 or N2P2K3 fertilization treatments each combined with sowing at 15th April. The yield of peanut pods in both localities , however, was not significantly affected by this type of interaction.

The different types of pod rots (brown, pink and breakdown) as well as total pod rots and yield of peanut pods were significantly affected by the fungicidal treatments. The two tested fungicides Vitavax-T and Rizolex-T were significantly equal in controlling pink rot at South-Tahrir locality while the first fungicide was significantly better than the second one in controlling the other types of pod rots as well as total pod rots at the two localities South-Tahrir and Abou-Hammad. On the contrary, the fungicide Rizolex-T significantly improved yield of pods (ton/fed.) in both localities (aver. 1.321 & 1.358) more than Vitacax-T (aver. 1.304 & 1.344) in comparison with the untreated controls of both localities (aver. 1.171 & 1.195), respectively.

The interaction between sowing dates and fungicides had significant effect on total pod rots and yield of pods at both localities in addition to pink and breakdown pod rots at Abou-Hammad only. In this respect, Vitavax-T combined with sowing at 15th April was the most effective interaction and significantly better than Rizolex-T at same sowing date for decreasing infection with pink rot at Abou-Hammad locality and total pod rots at both localities while, both fungicides applied at same sowing date were significantly equal in controlling infection with breakdown rot at Abou-Hammad locality. Rizolex-T combined with sowing at 1st May resulted in the highest significant increase in average yield of pods (ton/fed.) at both localities i.e. South-Tahrir (1.334) and Abou-Hammad (1.364) in comparison with the untreated control of same sowing date (1.124 & 1.154) at both localities, respectively.

With regarding interaction between fertilization and fungicides, the present results reveal that, N2P2K2 fertilization treatment combined with fungicide Vitavax-T was the most effective at both localities for suppressing infection with brown pod rot (aver. 1.73 & 1.98%) and total pod rots (aver. 4.23 & 4.93%) in comparison with any other interaction. Incidence of pink rot at the two localities, however, responded differently against this interaction. All tested interactions between the two factors (fungicides and fertilization) as well as each alone were significantly equal for decreasing infection with pink rot (aver. 0.47-1.15%) comparing with the untreated unfertilized control (aver. 2.73%) at South-Tahrir locality while the interactions between the two factors were significantly better (0.683-0.817%) comparing with the untreated (1.033-1.233%) and unfertilized (aver. 1.533 & 1.75%) of both factors, respectively. It is interest to state the yield of pods at both localities was not significantly affected by this type of interaction.

Total rots only at South-Tahrir locality and all determined criteria (total rots, brown, pink and breakdown rots as well as yield) at Abou-Hammad locality were significantly affected by the total interaction (sowing date x fertilization x fungicide). The fungicides Vitavax-T and Rizolex-T in combination with N2P2K2 fertilization treatment caused the lowest incidence of total pod rots at South-Tahrir, (1.6 & 1.7%)

and Abou-Hammad (1.97 & 1.87) comparing with the untreated unfertilized control at sowing date 15th April i.e. 13.9 and 15.4%, for both localities, respectively. However, at sowing date 1st May the lowest incidence of total pod rots at the first locality was caused by Vitavax-T combined with N2P2K2 (1.87%) or N2P2K3 (2.1%) and Vitavax-T combined with N2P2K2 at the latter locality in comparison with the untreated unfertilized control of both localities i.e. 11.97 & 12.57%, respectively. As for yield, the following fungicide-fertilization-date interactions produced the highest significant increase in yield of pods (ton/fed.) without significant differences between the: Rizolex T- N2P2K3-1st May (1.415), Vitavax T- N2P2K3-1st May (1.402), Rizolex T- N2P2K2 -1st May (1.401), Rizolex T- N2P2K3-15th April (1.397) and Rizolex T- N2P2K2-15th April (1.387) comparing with untreated unfertilized control of both sowing dates i.e. 15th April (1.105) and 1st May (1.108), respectively

Finally, the integration between fungicides and fertilizers (NPK) at certain sowing time controlled effectively the pod rot infection and increased the total peanut pods more than any individual treatment whether in South-Tahrir or in Abou-Hammad.

DISCUSSION

The results of using some antagonists in controlling peanut pod rot infection in Beheira and Sharkya governorates during two growing seasons 2002 and 2003 revealed the superiority of *Trichoderma harzianum* followed by *Chaetomium bostrycoides* and *Giliocladium penicilloides* than each of the other tested commercial products *i.e.* Rhizo-N, Plantguard and Multi-VAM (mycorrhiza) in reducing peanut pod rot infection. On the other hand, all of tested antagonists whether the free or those in commercial formula reduced peanut pod rot infection more than the un-treated one (control). Also, using all of tested antagonists whether, the free (*Trichoderma*, *Chaetomium* and *Gliocladium*) or those in commercial formula (Rhizo-N, Plantguard and Multi-VAM) increased the yield of pods in the two governorates comparing with un-treated ones with significant differences between the treatment and without significance between Beheira and Sharkya governorates during the two seasons. These obtained results could be interpret in light the findings of **Abdalla and Abdel-Fattah (2000), El-Deeb, *et al*. (2002)** and **Varadharajan *et al.* (2006)** who found that Plantguard (a formula of *Trichoderma harzianum*), Rhizo-N (a formula of *Bacillus subtilis*) and the synthetic Saponin reduced the percentage of root and pod rots (*Aspergillus* spp., *Fusarium oxysporum, F. solani, F. moniliforme*, *Macrophomina phaseolina*, *Sclerotium rolfsii* and *Penicillium* spp.) of groundnut cv. Giza-5 under greenhouse and field conditions. On the other hand, efficacy of *T. harzianum* (Plantguard) in controlling disease may be due to its action, *i.e.* inhibitory substances **(Turner, 1971);** mycoparsitsm (**Callan *et al*., 1990)** or colonizing the court infection and preventing fungi for reaching susceptible plant tissues **(Cook & Backer, 1983)** or regulating the fungus population **(Gabriel & Cook, 1990)**, while, the antagonistic activities of the commercial bio-product *B. subtilis* (Rhizo-N) may attributed to di-peptide compounds namely Bacilysin and Fengymeicn and to extremely tolerant to environmental stresses, including seed-treatment, pesticides, soil and seed pH, host plant effects, edaphic factors and long-term storage as bio-product (**Brannen and Kenney, 1997)**. Also, all treatments increased pod yield compared to the non-treated control. The interactions between mycorrhizal fungi was only relative and based on a modification of disease development **(Baltruschat, 1975)**.The mechanisms of the protective effect of the mycorrhizal fungi may be due to improved nutrition and plant development **(Dehne, 1982). Schnôbeck (1987)** suggested that, mycorrhizal fungi protect the plant by eliminating pathogens or reducing their effectiveness and improving host resistant through plant metabolism **Sundaresan *et al*. (1993)** suggested that, the production of phytoalexin compounds in mycorrhizal plants could be one of the mechanisms for plant protection.

Results about using fungicides in controlling peanut pod rot infections in two governorates during two growing seasons (2002 and 2003) revealed that all tested fungicides reduced peanut pod rot infection to percentages much lower than those of un-treated ones during the two seasons. The fungicides, Vitavax-T, Sumisclex and Rizolex-T were the best, followed by Benlate, Balear, Noplit, Daconil and Clorocip which had a moderate action while, Daconil was the least tested fungicide in reducing peanut pod rot infection during the two growing seasons in Beheira and Sharkya governorates. In addition, using fungicides increased peanut pod yield in most cases of treating during the two seasons but Rizolex-T was the best followed by Vitavax-T and Sumisclex in this respect. These results are in agreement with the obtained results of **Yehia *et al.* (1979), Sumner and Littrell (1989), Hilal *el al.* (1990), Marei (2000)** and **El-Deeb *et al*. (2002)** where all of them verified the efficacy of tested fungicides in controlling peanut pod rot and increasing pod yield with superiority of some fungicides over others in this field.

The integration between the best previously tested fungicides (Vitavax-T or Rizolex**)** with different levels of fertilizers (NPK) at two sowing times (15th April or 1st May) in two localities (South-Tahrir and Abou-Hammad) reduced greatly the total pod rot infections and consequently their pod rot infections with break down, brown and pink rots as well as increased the total yield of peanut pods. In this respect, the Vitava-T with $N_2P_2K_2$ fertilizers at sowing date 15th. April was the best treatment followed by Rizolex-T with $N_2P_2K_2$ at the same sowing time. Moreover, the results indicate that using the integrated control with Vitavax-T and Rizolex-T in combination with $N_2P_2K_2$ and $N_2P_2K_3$ was better at 15th April than those used at 1st May. Generally, the integration between fungicides and fertilizers (NPK) at certain sowing time controlled effectively the pod rot infection and increased the total peanut pods more than the individual treatment with any of them whether in South-Tahrir or in Abou-Hammad. These obtained results could be interpret in light the findings of **Chen, (1991), Abdalla and Abdel-Fattah (2000), El-Garhy, (2000), Marei (2000)** and **El-Deeb *et al***. **(2002)**.

REFERENCES

Abdalla, M.E. and G.M. Abdel-Fattah (2000): Influence of the endomycorrhizal fungus *Glomus mosseae* on the development of peanut pod rot disease in Egypt. Mycorrhiza, **10:** 29-35.

Baltruschat, H. (1975): Untersuchungen fiber den Einfluss der endotrophen Mycorhiza auf den Befall dutch pathogene plize, insbesondere von *Nicotiana tabacum* dutch *Thielaviopsis basicola*. Diss. Bonn, W. Germany. 137 PP.

Brannen, P.M. and D.S. Kenney (1997): Kodiak® a successful biological control product for suppression of soil-borne plant pathogens of cotton. J. Industrial Microbial & Biotechnol. (USA), **19**:169-171. (c.f. Rev. Pl. Pathol., **77**: 460, 1998).

Callan, N.W.; D.E. Mather and J.B. Miller (1990) Biopriming seed treatment for biological control of *Pythium ultimum* pre-emergence damping-off in sweet corn. Plant Dis., **74:** 368-372.

Cook, R.J. and K.F. Backer (1983): The nature and practice of biological control of plant pathogens. Amer. Phytopathol. Soc., St. Paul, Mn, USA, 359 pp.

Chen, S.S. (1991): Classification of peanut pod rot disease and its relation with soil characteristics. Journal of Agriculture and Forestry. **40:** 65-75.

Dehne, H.W. (1982): Interaction between Vesicular-Arbuscular-Mycorrhizal fungi and plant pathogen. Phytopathology, **72**:1115-1119.

El-Deeb-A.A.; S.M. Abdel-Momen and A.A. Hanafi (2002): Effect of some fungicides and alternative compounds on root and pod rots in peanut. Egyptian-Journal-of-Agricultural-Research. **80:** 71-82;

El-Garhy, A.M.M. (2000): Pathological studies on fungal rot diseases of Lentil. Ph. D. Thesis Fac. of Agric, AL-Azhar Univ.

Ferguson, J.J. and S.H. Woodhead (1984): Production of endomycorrhizal inoculum. A-Increase and Maintenance of Vescular Arbuscular Mycorrhizal Fungi. Methods and Principles of Mycorrhizal Research, Florida Univ. USA.

Gabriel, C.J. and R.J. Cook (1990). Developing appropriate IPM technology for the traditional small-scale farmer in tropical Africa. FAO Plant Prot. Bull., **38**: 95-99.

Harman, G.E.; I. Chet and R. Baker (1980): *Trichoderma hamatum* effects on seed and seedling disease in radish and pea by *Pythium* spp. or *Rhizoctonia solani*. Phytopathology, **70**: 1167-1172.

Hilal, A.A.; M. I. Elian; A.H. Metwally and A.A. El-Deeb (1990): Peanut diseases in Egypt. II- Factors affecting healthy survival plants, pod rots and yield. Annals of Agricultural Science, Moshtohor, **28:**1557-1567.

Kannaiyan, J., R.S. Sandilu and A.L. Phiri (1989): Aflatoxin and *Aspergillus flavus* contamination problems of groundnuts in Zambia. Aflatoxin contamination of groundnut: Proceedings of the International Workshop, 6-9 Oct. 1987, ICRISAT Centre, India (edited by McDonald, D. and V.1K. Mehan), 1989, 65 -70.

Lashin, S.M.; H.I.S. E1-Nasr; M.A.A. El-Nagar and M.A. Nofal (1989): Biological control of *Aspergillus niger* the causal organism of peanut rot by *Trichoderma harzianum.* Annals of Agric. Sci., **34**: 795-803.

Marei, T.A. (2000): Studies on pod rots of peanut. Ph.D. Thesis, Faculty of Agric. Zagazig Univ. 143 pp.

Sabet, K.K; M.A. Mostafa; O.H.I. El-Bana and M. El-Sherif (Ebtisam) (1992): *Pseudomonas lindbergii* and *Coniothyrium minitans* as biocontrol agents effective against some soil fungi pathogenic to peanut. Egyptian Journal of Agricultural Research, **70**: 403-414.

Sailaja, P.R; A.R. Podile and P. Reddanna (1998): Biocontrol strain of *Bacillus subtilis* AF 1 rapidly induces lipoxygenase in groundnut *(Arachis hypogaea* L.) compared to crown rot pathogen *Aspergillus niger*. European J. of Pl. Path., **104**:125-132.

Schnôbeck, F. (1987): Mycorrhiza and plant health. A contribution to biological protection of plants. Angenwandte Botaink, **61**:9. (c.f. Rev. Plant Path., **66**: 4093).

Snedecor, G.W. and W.G. Cochran (1989): Statistical Methods 8th ed. The Iowa State Univ. Press, Ames, USA.

Sumner, D.R. and R.H. Littrell (1989): Effects of fumigation with chlorothalonil and diniconazole on soil fungi and pod, peg and stem disease of peanut. Plant Disease, **73**: 642 -646.

Sundaresan, P.; N.U. Raja and N.U. Gumaskaran (1993): Induction and accumulation of phytotoxins in cowpea roots infected with a mycorrhizal fungi *Glomus fasiculatus* and their resistance to *Fusarium* wilt disease. J. of Biosciences, **18**: 219-301.

Turner, J.T. and P.A. Backman (1991): Factors relating to peanut yield increases after seed treatment with *Bacillus subtilis.* Plant Disease, **75**: 347-352.

Turner, W.B. (1971): Fungal Metabolites. Academic Press, London, N.Y. 446 pp.

Varadharajan, K.; S. Ambalavanan and N. Sevugaperumal (2006): Biological control of groundnut stem rot caused by *Sclerotium rolfsii* (Sacc.). Archives of Phytopathology and Plant Protection, 39:239-246.

Yehia, A.H.; S.A. El-Hassan and A.H. El-Baghdadi (1983): Biological seed treatment to control Fusarium root rot of broad bean. Egypt. Journal of Phytopathology, **14**: 59-66.

Yehia, A.H; H.M. El-Said; A.A. Ali and A.A. El-Deeb (1979): Fungicidal control of damping-off and root rot disease of peanut with special reference to varietal resistance in ARE. Agric. Res. Rev. 57- 62.

العوامل المؤثرة على إصابة الفول السودانى بأمراض عفن القرون تحت ظروف الحقل

1- تأثير مسمدات الــ NPK والرى وميعاد الزراعة على عفن قرون الفول السودانى تحت ظروف الحقل

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الملخص العربى

أظهر إســتخدام بعض عوامل التضاد الحيوى فى مقاومة الإصابة بعفن قرون الفول السودانى تحت ظروف الحقل فى محافظتى البحيرة والشرقية خلال موسمى 2002/ 2003 إلى تفوق فطر الترايكودرما هارزيانم متبوعا بفطر كاتوميم بوستريكويدس ثم فطر جليوكلاديوم بنسيلويدس على باقى المستحضرات التجارية الأخرى المختبرة مثل الريزو-ن والبلانتاجارد والمالتى-فام (مستحضر الميكورهيزا) فى مقاومة المرض. كما زودت أيضا كل عوامل التضاد الحيوى المختبرة فى صورة حرة مثل الترايكودرما و الكاتوميم و الجليوكلاديوم أو المختبرة فى الصورة التجارية مثل مثل الريزو-ن والبلانتاجارد والمالتى-فام محصول القرون المنتج فى المحافظتين. وفى نفس الوقت فقد خفضت كل المبيدات المختبرة الإصابة بعفن قرون الفول السودانى حيث كانت المبيدات فيتافاكس-ت و سوميسكلكس والريزولكس-ت هى الأفضل متبوعة بالمبيدات بنليت ، بالير ، نوبليت ، داكونيل ، كلوروسيب والتى كان لها تأثير متوسط فى خفض الإصابة بعفن قرون الفول السودانى خلال موسمى النمو فى محافظتى البحيرة والشرقية. بالإضافة إلى ذلك فقد كان المبيد ريزولكس-ت هو الأفضل متبوعا بمبيدات فيتافاكس-ت و سوميسكلكس فى زيادة محصول قرون الفول السودانى فى معظم حالات المعاملة خلال موسمى النمو. وعلى الجانب الآخر فقد كان للتكامل بين بعض المبيدات والأسمدة (ن- ب- ك) عند مواعيد زراعة محددة تأثير فعال فى خفض الإصابة بعفن قرون الفول السودانى وزيادة المحصول مقارنة بالمعاملات الفردية لأيهم سواء فى جنوب التحرير أو فى أبو حماد.