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EFFECT OF SOME PLANT EXTRACTS AND ESSENTIAL OILS OF MEDICINAL AND AROMATIC PLANTS ON THE INCIDENCE OF PELARGONIUM ROOT ROT

BY

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ABSTRACT

Pelargonium (*Pelargonium graveolens* L.) is one of the most important medicinal and aromatic crops in many parts of the world as well as in Egypt. The complex disease, root-rot is considered one of the most destructive soil borne diseases attacking this crop. The most effective inoculum level of the tested fungi was 5 % V/V. The combinations between *Fusarium oxysporum* + *Rhizoctonia solani* and *Macrophomina phaseolina* + *R. solani* resulted in the highest synergistic effect, recording the highest incidence of pelargonium root rot under greenhouse conditions. Under Laboratory conditions, garlic and onion extracts, and essential oils of basil, clove and thyme significantly decreased the mycelial growth of the tested fungi. Greenhouse studies proved that the essential oils of basil and clove significantly decreased the incidence of pelargonium root rot. Field experiment proved the same trend. The essential oil of clove resulted in the lowest infection percentage and disease severity, while it resulted in the highest yield of herb and oil percentage compared with the essential oil of basil and control treatments.

Key word: Pelargonium root rot, Plant extracts. Essential oils. Medicinal and aromatic plants.

INTRODUCTION

Many investigators reported that the incidence of many soil borne diseases caused by *R. solani*, *Pythium* spp., *F. oxysporum lycopersici*, *F.oxysporum melonis* and others, was increased with the increase of the inoculum's level in the soil (Bohra *et al.* 1998; Landa *et al.* 2001; Raju *et al.* 2001; Elmer, 2002; Shubha *et al.* 2003 and Sinha *et al.* 2003).

Ahmed and Sultan (1984) found that the mycelial growth of *Macrophomina phaseolina*, the causal pathogen of jute damping-off was significantly inhibited *in vitro* as affected by garlic bulb extracts and the infection of jute seedlings with the same pathogen was also decreased by treating jute seeds by garlic paste. El-Shami *et al.* (1986) reported that the spore germination and mycelial growth of *Fusarium oxysporum* f.sp. *niveum*, the causal pathogen of watermelon wilt were significantly inhibited as affected by garlic extract. They

also reported that wilt of watermelon seedlings was reduced by treating the seeds by garlic extract. Assadi and Behroozin (1987) found that the mycelial growth of *F. solani, F. oxysoporum* and *F. acuminatam*, the causal pathogens of root and basal rots of onion and garlic was significantly inhibited *in vitro* as affected by garlic and onion extracts. Also, they found that garlic extract was more effective than onion one on the mentioned fungi. Tariq and Magee (1990) found that microconidia germination and hyphal growth of *F. oxysoporum* f.sp. *lycopersici*, the causal pathogen of tomato wilt were inhibited by garlic bulb extract. Dubey and Dwivedi (1991) reported that the mycelial growth of *M. phaseolina*, the causal pathogen of soybean charcoal root-rot was inhibited by the extracts of leaves and bulbs of fresh onion and garlic. Shalaby (1993) found that spore germination and mycelial growth of *F. oxysporum* f.sp. *melonis*, the causal pathogen of muskmelon wilt were significantly inhibited by garlic, onion and leek extracts. The extracts of many plants proved to be of antagonistic effects against serious pathogenic fungi (Shalaby, 1993; Osman *et al.* 1996; Bianchi *et al.* 1997 and Ahmed *et al.* 2000). They reported that plant extract of garlic and onion proved an inhibition effect for the mycelial growth of several soil borne pathogenic fungi; i.e. *M.phaseolina, R. solani, F. oxysporum* and *F. solani.*

Fahmy (1994) noticed the antifungal activity of the essential oils of caraway, cumin, coriander and fennel on the mycelial growth of *R. solni, F. oxysoporum* and *Sclerotium rolfsii*. Coriander's oil completely inhibited the mycelial growth of the above mentioned fungi. Bang and Sigvald (1995) found that vapor oils of garlic, caraway, thyme and peppermint reduced infection of potato by *Rhizoctonia solani* and *Fusarium oxysporum*. Zambonelli *et al.* (1996) found that the essential oils of thyme, lavandula and mint inhibited the mycelial growth of *Pythium* spp., *F. solani, R. solani* and *Colletotrichum* sp. *in vitro* and the most effective oil was that of thyme. It was proved that the oils caused degeneration of the fungal hypha, causing a significant decrease of their cytoplasm. Bravo-Luna *et al.* (1998) found that essential oils of basil, mint and thyme inhibited the mycelial growth and sporulatioon of *F. moniliforme*. Rai *et al.* (1999) found that the essential oils of eucalyptus and basil inhibited the mycelial growth of *F. oxysporum, F. solani, F. pallidoroseum* and *F. chlamydosporum*. Deferera *et al.* (2000) reported that essential oils of thyme and basil gave fungi toxicity against *Penicillium digitatum*. Assawah (2002) reported that oils of onion, eucalyptus and basil significantly decreased the mycelial growth of *F. oxysporum* f.sp. *fabae*, the causal of Fusarium wilt of broad bean. El-Habaa *et al.* (2002) reported that thyme extract was the most effective against the mycelial growth of *M. phaseolina* and other pathogenic fungi infecting sesame. El-Sherbieny *et al.* (2002) found that oils of thyme, cumin and mint caused the highest antifungal effect against *Macrophomina phaseolina, Sclerotium rolfsii, F. solani, R. solani* and *Pythium* sp. Giamperi *et al.* (2002) found that the oils of thyme and peppermint were the most effective essential oils against *Pytophthora* sp., *Pyrenochoeta lycopersici* and *Verticilium dahliae*. Ibrahim and Al-Mihanna (2002) found that essential oils of carnation, eucalyptus, onion, garlic, sesame and castor combined with antagonistic bacteria reduced the incidence of damping-off caused by *R. solani* and these oils reduced the mycelial growth of *R. solani*. Daferera *et al.* (2003) found that essential oils of thyme,

marjoram, rosemary and sage decreased the mycelial growth of *Botrytis cinerea, F.* spp. and *F. solani*. Zambonelli *et al.* (2004) showed that oils of thyme rich in thymol inhibited the mycelial growth of *F. solani, R. solani* and *Colletotrichum lindemuthianum.*

MATERIALS AND METHODS

Material used:

The tested fungi causing pelargonium root rot; i.e. *Fusarium moniliforme*, *F. oxysporum*, *Rhizoctonia solani* and *Macrophomina phaseolina that* used in this investigation were isolated and identified in a previous work (Shalaby *et al.* 2005).

Pelargonium terminal cuttings, cultivar geranium, 15 cm length and 60 day-old were kindly obtained from Beni-Sueif Station of Agriculture, Ministry of Agriculture and Land reclamation.

Laboratory Studies:

1- Effect of garlic and onion extracts on the mycelial growth of the tested fungi:

This experiment aimed to study the effect of garlic and onion extracts on the mycelial growth of the tested fungi, causing pelargonium root rot disease.

Sterilized extracts of the above-mentioned materials were obtained by crushing in blender, then squeezed twice through eight layers of cheese cloth and filtrated by using Seitz filter (Shalaby, 1993). Flasks (250 ml) contained 100 ml of sterilized PDA medium were melted, cooled and 25, 50, 75, 100 ml of each plant extract were separately added to them, mixed and poured in sterilized Petri-dishes (9 ml / plate). Plates were inoculated with equal disks (4 mm in diameter) of the tested fungi, taken from 7 day-old cultures. Four replicates were used for each treatment. The control was carried out without addition of any plant extract. The plates were incubated at 25 ± 2 ^{0} C. until the fungal growth covered the plate surface of the control treatment. Diameter of fungal growth in all treatments was determined, and then the percentage of reduction in mycelial growth was calculated using the following formula:

$$\% \text{ Growth reduction} = \frac{\text{Growth in control} - \text{growth in treatment}}{\text{Growth in control}} \times 100$$

2- Effect of essential oils of some medicinal and aromatic plants on the mycelial growth of the tested fungi:

Essential oils of seven medicinal and aromatic plants; i.e. pelargonium, basil, clove, coriander, thyme, fenugreek and eucalyptus (Table 1) were tested *in vitro* for their effect on the mycelial growth of the tested fungi. Plant extraction of any of the tested medicinal and aromatic plants was obtained by soaking 20 g of the dried plant materials in 100 ml solvent (1:5 W/V) over night. The water extracts were prepared by placing the mixture in water bath for 3 hours. Plant extracts were filtered through cheese cloth and the solvents were evaporated at 30°C in a vacuum incubator. The different dilutions from dried plant extracts

were prepared by adding one g of the dried crude extract to 5 ml of distilled water (1: 5 W/V) and few drops of tween 80 were added as an emulsifier to obtain homogenous emulsion (Perrucci *et al.* 1994). One ml oil of the emulsion of the desired medicinal and/or aromatic plants were separately added to 30 ml distilled water containing 0.15 g sodium phosphate tri-basic as emulsifying agent (Pieter and Robert, 1974).

The antifungal activity of the tested essential oils was assayed according to the method described by (Chkhikvishvili and Gogiya, 1995). Five amounts of oil's emulsion of the tested medicinal and/or aromatic plants; i.e. 1, 2, 3, 4 and 5 ml were added to the plates, separately just before pouring the PDA medium. Four replicates were used for each treatment and the plates were inoculated with equal disks (4 mm in diameter) of the tested fungi. Control treatment was PDA plates provided with distilled water containing 0.19 mg sodium phosphate tribasic and inoculated with the tested fungi. The plates were incubated at 25 ±2°C. Inhibition percentage (In P) was calculated according to the following equation:

$$\text{In P} = \frac{\text{Fungal growth of control} - \text{Fungal growth of treatment}}{\text{Fungal growth of control}} \times 100$$

Greenhouse Studies:

The effect of three different inoculum levels of the tested fungi and different combinations between them on the incidence of pelargonium root-rot were investigated under greenhouse conditions. Pots (25 cm in diameter) and soil were sterilized as usual by formalin, 5% and pelargonium terminal cuttings (geranium cultivar) 15 cm long, and 60 day-old) were used. Four pelargonium cuttings were transplanted per pot and each treatment was replicated ten times. Infection percentage (IP) and disease severity (DS) were recorded 60 days after transplanting.

Table (1): Common name and nomenclature of the tested medicinal and aromatic plants.

Common name	Scientific name	The used material	Family
French basil	*Ocimum basilicum*	Leaves and Oil	*Labiatae*
Geranium	*Pelargonium graveolens*	Leaves and Oil	*Geraniaceae*
Coriander	*Coriandrum sativium*	Fruits and Oil	*Apiaceae*
Clove	*Euginea maritime*	Flowers and Buds	*Myrtaceae*
Thyme	*Thymus vulgaris*	Leaves	*Compositae*
Fenugreek	*Trigonilla foenum greacum*	Seeds	*Fabaceae*
Eucalyptus	*Eucalyptus cicrodora*	Leaves and Oil	*Myrtaceae*

The infection percentage (IP) and Disease severity (DS) of pelargonium root- rot were estimated following the linear scale from 1-9 described by Bhatti and Kraft, 1992 as shown in Table (2).

The infection percentage (IP) and disease severity (DS) were estimated using the following formulae:

$$IP = \frac{\text{No. of diseased plants}}{\text{No of Total examined plants}} \times 100$$

$$DS = \frac{\sum n\, v \times 100}{NV}$$

Where, n = number of diseased plants, v = disease category, N = total plants and V = the highest disease category.

1- Effect of Inoculum level of the tested fungi:

Three different inoculum levels; i.e. 3, 4 and 5 % of soil weight (V/V) were prepared by mixing the tested fungi growing on sorghum sandy water medium (SSW) with the disinfested soil in pots separately and four cuttings of pelargonium were transplanted in each pot. The control's pots were filled with soil containing SSW without any of the tested fungi. Data were recorded as infection percentage (IP) and disease severity (DS), 60 days after transplanting.

Table (2): Disease severity rating scale.

Rating*	Root rot
1	No visible symptoms
3	Small lesions on taproot or secondary roots: less than 10% of root and hypocotyls tissue covered with lesions.
5	Moderate discoloration of crown or taproot: approximately 11-25 % of root and hypocotyls tissue covered with lesions.
7	Lesions coals to form large lesion; approximately 26-50 % of root and hypocotyls tissue covered with lesions; considerable soften and rotting of root system.
9	Approximately 51-100 of crown and root tissue discolored; rotting and reduction of root rot.

* Numbers 2, 4, 6 and 8 were assigned to plants showing symptoms between the appropriate old number ratings.

2- Interactions between the tested fungi:

The interaction between the different tested fungi, causing pelargonium root-rot was investigated under the greenhouse conditions. The inocula of the tested fungi, i.e. *Fusarium oxysporum, F. moniliforme, Macrophomina phaseolina* and *Rhizoctonia solani* were prepared as usual by growing on SSW medium. The inocula of the tested fungi were added to the disinfested soil at the rate of 5 % (V/V), separately as well as in pairs' combination. The control consisted of pots provided with SSW without any pathogen. All the pots were transplanted as mentioned before and the infection percentage and disease severity were determined 60 days after transplanting.

Field Experiments:

Effect of essential oils of basil and clove:

Field experiments were carried out during two successive seasons (2002 –2003) and (2003- 2004) in the two farms of the Faculty of Agriculture, Fayoum University; Dar El-Ramad and Demo farms (loamy clay and saline sandy soil, respectively), Fayoum Governorate, Egypt.

These experiments aimed to study the effect of essential oils of basil and clove, as they proved a significant effect under both Lab. and greenhouse conditions, on the incidence of pelargonium root rot under field conditions. In these experiments, terminal cuttings of pelargonium, 15 cm in diameter and 60 day-old were used and transplanted on 15th November.

The spilt-spilt or randomized complete block design was followed using field plot of (2.5 X 1.5 m.) and each plot contained 4 rows (60 cm apart). Each row contained 6 hills spaced with 20 cm. Each treatment was replicated three times and the usual practices and fertilization were followed.

Pelargonium cuttings were soaked, separately in the oils' emulsion of basil and clove (5%, as it caused the highest inhibition percentage for the mycelial growth of the tested fungi under lab. condition) for 6 hrs. In the control treatment, pelargonium cuttings were soaked in sterilized distilled water. The treated/untreated pelargonium cuttings were transplanted in the plots as usual. The infection percentage (IP) and disease severity (DS) were recorded 90 days after transplanting. At harvesting time the obtained yield of the herb and oil percentage as shoot fresh weight g/plot and ml/100 g herb, respectively were estimated.

Distillation of pelargonium oil:

The distillation of pelargonium oil was carried out according to Abo-Zeid, 2000. Hundred gram of pelargonium fresh herb were immersed in water and boiled. The steam and oil vapor was condensed and the oil was separated from the water and distilled by distillation with water. In order to obtaining oil free from any moisture or water content, one gram of dehydrated sodium sulphate was added for each bottle containing 5 ml oil.

Statistical analysis:

The obtained results were statistically analyzed using ANOVA Table and New L.S.D test to verify the difference between the treatments as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Results:

Laboratory Studies:

A- Effect of garlic and onion extracts on the mycelial growth of the tested fungi:

Data in Table (3) show that all of the tested concentrations of onion completely inhibited the mycelial growth of the tested fungi. The reduction percentage of the tested concentrations of onion was 100 %. Regarding garlic, the mean average of the mycelial growth and reduction percentage recorded with 25 % concentration was 2.1 cm and 0.76 % reduction percentage, respectively. Meanwhile the other concentrations of garlic; 50 and 75 % completely inhibited the mycelial growth of the tested fungi. From the present data, it is clear that

onion is more effective than garlic since all of its concentrations completely inhibited the tested fungi. Figure 1 (A and B) confirm the obtained results.

B- Effect of some essential oils on the mycelial growth of the tested fungi:

The effect of essential oils of seven medicinal and aromatic plants was tested *in vitro* for their effect on the mycelial growth of the tested fungi. Data recoded after 7 days incubation at 26 ^{0} C are presented in Table (4) and illustrated in Fig (2).

The three oils; i.e. basil, clove and thyme completely inhibited the mycelial growth of the tested fungi at all concentrations used. On the other hand, pelargonium oil exhibited the moderate effect in decreasing (inhibition) the mycelial growth of the tested fungi. Meanwhile, oils of coriander, fenugreek and eucalyptus had no effect on the mycelial growth of the tested fungi. According to such results, the oils of basil and clove were investigated under field conditions.

Table (3): Effect of different concentrations of garlic and onion extracts on the mycelial growth and inhibition percentage of the tested fungi causing pelargonium root-rot under laboratory conditions.

Treatment	Conc (%)	Mycelial growth and reduction percentage of the tested fungui								Mean	
		F.oxysporum		*R.solani*		*F.moniliforme*		*M.phaseolina*			
		MG	RP	MG	RP	MG	RP	MG	RP	MG	RP
Onion extract	25	0.00	100.0	0.0	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	50	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	75	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
Garlic extract	25	4.20	0.53	0.00	100.0	2.00	0.77	2.20	0.75	2.10	0.76
	50	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	75	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	000	100.0
Control		9.0	0.00	9.0	0.00	9.00	0.00	9.00	0.000	9.00	0.00
Mean		1.90	71.50	1.30	85.70	1.60	71.5	1.60	71.5		
L.S.D. 5%		Concentration (c) = 0.02				Extract (E)= 0.02				CxE = 0.04	

MG= mycelial growth, **RP** = reduction percentage

Greenhouse Studies:

1- Effect of inoculum's level of the tested fungi:

Data presented in Table (5) show that the inoculum level 5% resulted in the highest values of infection percentage (IP) and disease severity (DS) while the inoculum level 3% recorded the lowest ones. Values of IP recorded with the inoculum level 5 % were 25.0, 17.74, 20.80 and 15.70 % for *Fusarium oxysporum, Rhizoctonia solani, Macrophomina phaseolina,* and *F. moniliforme*, respectively. Values of DS recorded with the same inoculum were 40.0, 16.0, 21.60, and 15.50 % for the tested fungi in the same respect as mentioned above. The lowest IP and DS values were recorded with the inoculum level 3%, being 4.5, 4.2, 3.8, and 2.5 % (IP) and 16.0, 12.2, 10.1, and 4.0% (DS) for the tested fungi in the same respect as mentioned before.

2 – Effect of the combinations between the tested fungi:

Pathogenicity of *Fusarium oxysporum, F. moniliforme, Rhizoctonia solani* and *Macrophomina phaseolina* singly or combined in pairs, was investigated. Percentages of infection and disease severity were recorded every 15 days after transplanting.

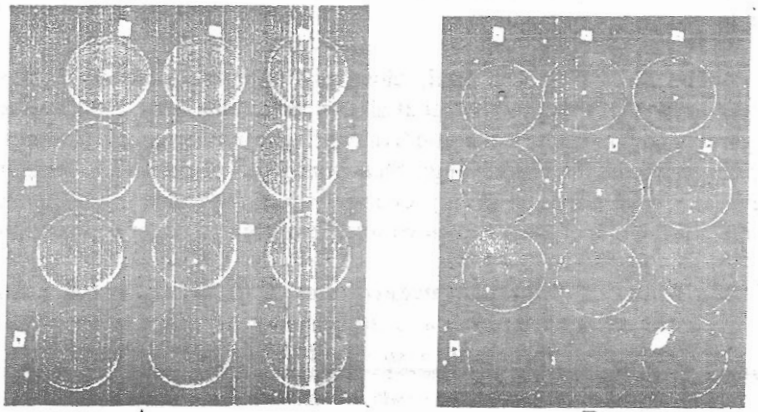

Fig (1): Effect of Onion (A) and Garlic (B) extracts on the mycelial growth of the tested fungi.

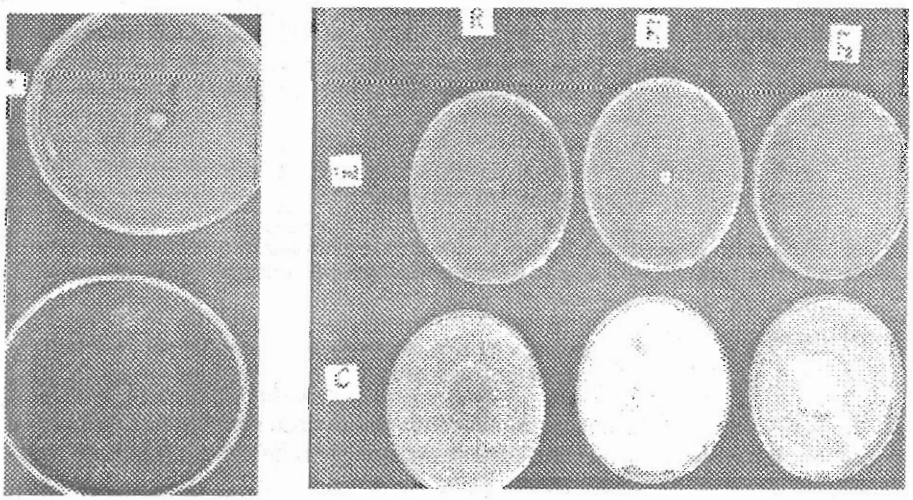

Fig (2): Effect of essential oils of clove (1ml.) on the mycelial growth of *Macrophomina phaseolina* (A) and *Rhizoctonia solani* (R); *F. oxysporum* (F1) and *F. moniliforme* (F2) (B), C = Control treatments

Table (4): Effect of essential oils of some medicinal and aromatic plants on the mycelial growth (MG) and Reduction percentage (% R) after 7 days incubation at 25 ± 2 °C).

Treatments	ml	*F.ox.f.sp.redolens*		*F.moniliforme*		*R.solani*		*M.phasolina*	
	1	MG	%R	MG	%R	MG	%R	MG	%R
	2	000	100.0	0.00	100.0	0.00	100.0	0.00	100.0
Basil oil	3	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	4	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	5	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	1	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	2	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
Clove oil	3	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	4	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	5	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	1	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	2	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
Thyme oil	3	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	4	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	5	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0
	1	2.0	77.7	2.00	77.7	2.60	71.10	3.00	66.70
	2	1.6	82.2	1.60	82.2	2.00	77.80	3.00	66.70
Pelargonium oil	3	1.0	88.9	1.00	88.9	1.50	83.30	2.00	77.80
	4	0.2	97.7	0.20	97.7	1.00	88.90	1.10	87.80
	5	0.00	100.0	0.00	100.0	0.00	100.0	1.00	88.90
	1	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	2	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
Eucalyptus oil	3	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	4	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	5	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	1	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	2	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
Coerander oil	3	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	4	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	5	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	1	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	2	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
Fenugreek oil	3	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	4	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
	5	9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00
Control		9.00	0.00	9.00	0.00	9.00	0.00	9.00	0.00

Data presented in Table (6) reveal that the incidence of pelargonium root- rot was increased with the increase in plant age till 60 days.

Table (5): Effect of different inoculum levels of the tested fungi on the incidence of pelargonium root-rot under greenhouse conditions.

Inoculum level (%)	Tested fungi	Infection percentage %	Disease severity %
3	*F. oxysporum*	4.50	16.00
	F. moniliforme	2.50	4.00
	R. solani	4.20	12.20
	M. phaseolina	3.80	10.10
4	*F. oxysporum*	16.70	18.40
	F. moniliforme	16.70	6.50
	R. solani	18.80	14.00
	M. phaseolina.	13.93	12.00
5	*F. oxysporum*	25.00	40.00
	F. moniliforme	17.74	16.00
	R. solani	20.80	21.60
	M. phaseolina	15.70	15.50
Control		0.00	0.00
L.S.D 0.0 5%	Inoculum level (I) = 5.40	Pathogenic fungi (P)= .98	Interaction (IxP)= 6.75

Table (6): Effect of the combinations between the tested fungi on the incidence of pelargonium root rot, 15, 30, 45 and 60 days after transplanting under greenhouse condition.

Treatments	Infection percentage and disease severity after								MEAN	
	15 days		30 days		45 days		60 days			
	IP *	DS**	IP	DS	IP	DS	IP	DS	IP	DS
F. oxysporum	7.26	9.5	9.38	7.6	7.81	11.4	7.81	17.9	8.06	11.60
F. moniliforme	0.0	0.0	3.13	2.5	3.13	3.3	6.25	7.6	3.12	3.35
R. solani	6.25	7.6	7.81	11.4	6.25	7.6	7.81	7.6	7.03	8.55
M. phaseolina	4.69	7.1	7.26	7.1	7.81	7.1	7.81	7.1	6.89	7.10
F. oxysporum + M.phaseolina	6.25	12.6	6.25	12.6	6.25	12.6	9.38	17.9	7.03	13.92
F. oxysporum +F.monilifore	4.69	8.9	4.69	8.9	7.81	8.9	9.38	11.4	6.64	9.52
F. oxysporum + R. solani	14.06	28.4	17.81	37.5	14.06	37.5	14.06	37.5	14.99	35.22
M. phaseolina +F.moniliforme	7.81	11.4	17.19	11.4	9.38	11.4	9.38	18.9	10.94	13.27
M. phaseolina + R. solani	14.06	27.4	14.06	28.4	12.50	28.4	18.75	28.4	14.84	28.15
F. moniliforme + R. solani	12.50	25.3	12.50	25.3	17.19	25.3	12.50	25.3	13.67	25.3
Control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

L.S.D. 0.05%	15 days	30 days	45 days	60 days
IP (infection percentage)	4.93	6.25	5.04	4.39
DS (disease severity)	19.50	24.69	22.87	19.00

Data presented in Table (6) show that *Fusarium oxysporum* resulted in the highest values of IP and DS, being 8.06 and 11.60, respectively as investigated singly. *R. solani* occupied the second category, recording 7.03 and 8.55 % IP and DS, respectively. Meanwhile *F. moniliforme* resulted in the lowest values, being 3.12 and 3.35 IP and DS, respectively. As in pairs, *F. oxysporum* + *R. solani* resulted in the highest values, being 14.99 and 35.22 % IP and DS, respectively. Meanwhile the combinations between *F. moniliforme* + *R. solani* resulted in the lowest values, being 13.67 and 25.3 % IP and DS, respectively.

Field experiments:

Effect of the essential oils of basil and clove on the incidence of pelargonium root-rot as well as the yield under field conditions:

Data in Table (7) represent the effect of essential oil of basil and clove on the incidence of pelargonium root rot as well as on the obtained yield of the herb fresh weight and oil percentage under field conditions.

Data in Table (7) show that both of clove's and basil's oils significantly reduced the incidence of pelargonium root rot under field conditions. On the other hand, the tested oils significantly increased the obtained yield of the herb fresh weight and oil percentage.

Table (7): Effect of essential oil of basil and clove on the incidence of pelargonium root-rot and the obtained yield in two different soils during 2002/2003 and 2003/2004 seasons underr field conditions.

Treatment	2002/2003						2003/2004					
	Loamy clay		Saline sandy soil		Mean		Loamy clay		Saline sandy soil		Mean	
	IP	DS	IP	DS	IP	DS	IP	DS	IP	DS	IP	DE
Basil oil	6.00	1.11	5.07	11.11	5.53	1.11	8.17	3.80	7.07	2.9	7.62	8.35
Clove oil	4.10	1.11	4.00	1.11	4.05	1.11	7.00	1.30	6.90	4.4	6.95	3.85
Control	11.10	11.1	10.00	5.83	10.55	8.46	13.50	13.79	12.1	11.56	12.83	12.67
Mean	7.22	4.44	6.37	2.68			9.50	14.8	8.71	15.0		
The obtained yield												
Treatment	HFW	Oil	HFW	OIL	HFW	Oil	HFW	Oil	HFW	OIL	HFW	Oil
Basil oil	1248.3	0.94	1022.0	0.73	1135.15	0.84	1218.3	0.53	1058.7	0.37	1138.1	0.45
Clove oil	1340.0	0.97	1270.0	0.77	1305.00	0.87	1350.0	0.67	1190.0	0.47	1274.0	0.57
Control	855.00	0.83	765.3	0.63	810.15	0.73	951.0	0.47	792.0	0.37	871.50	0.42
Mean	1147.7	0.91	1019.1	0.71			1173.1	0.56	1013.3	0.40		

L.S.D.0.05%	2002/2003				2003/2004			
Treatment (T)	IP	DS	HFW	Oil	IP	DS	HFW	Oil
	0.22	1.26	65.66	0.09	0.19	2.44	76.98	0.10
Soil type (ST)	0.55	n.s.	138.11	0.01	n.s.	n.s.	n.s.	n.s.
Tx ST	0.32	n.s.	n.s.	n.s.	0.27	n.s.	n.s.	n.s.

Clove's oil surpassed basil's one in decreasing the incidence of pelargonium root rot and the obtained yield of herb fresh weight and oil percentage. Values recorded with clove's oil were 4.05 and 1.11; and 6.95 and 3.85% IP and DS, in the two desired seasons, respectively. The considered values

recorded with basil's oil were 5.53 and 1.11; 7.62 and 8.35 % IP and DS, in the same respect as mentioned above.

The obtained yield of the herb fresh weight recorded with clove's oil was 1305.00 and 1274.0 g/plot in the two seasons, respectively. Oil percentage's values recorded with clove's oil were 0.87 and 0.5 % for the two seasons in the same respect.

As shown in Table (7), loamy clay soil surpassed the saline sandy soil in the obtained yield of herb fresh weight and oil percentage. It resulted 1147.7 and 1173.1 g/plot in the two seasons, respectively. Meanwhile oil percentage recorded with loamy clay soil was 0.91 and 0.56 % in the two seasons, respectively.

DISCUSSION

Pelargonium (*Pelargonium graveolens* L.) is subjected to root-rot the most widely distributed disease under Fayoum conditions. This disease causes severe reduction in the herb and oil yield.

Extracts of different concentrations of garlic and onion were tested against the tested fungi *in vitro*. The obtained results proved significant effect of those materials causing significant reduction in the mycelial growth of the tested fungi. Such extracts may be produced as root exudates in soil planted with the concerned crop. Therefore, the obtained results may explain the reason of the reduction in the incidence of pelargonium root rot when is grown after any of such crops.

The essential oils of basil, clove and thyme showed an inhibitory effect for the mycelial growth of the tested fungi, while the effect of pelargonium oil showed the lowest percentage of inhibition. On the other hand, oils of coriander, fenugreek and eucalyptus had no effect on the mycelial growth of the tested fungi. Such results are in agreement with Crisan *et al.* 1978; Dubey *et al.* (1991); Baiuomy (1997); and Daferera *et al* (2000). They reported the inhibition effect of the volatie substances on the mycelial growth of the pathogenic fungi. Singh *et al.* (1979) attributed this inhibitory effect as malformation in the mycelial growth, stunting, granulation, swelling and lyses of hyphae and these changes in the fungal characters were microscopically confirmed by Baioumy (1997). This action may be attributed to the effect of the oil on osmotic of the cell wall equilibrium and division of the fungal cells.

Under field conditions, treating pelargonium cuttings with basil or clove oils significantly reduced the incidence of pelargonium root rot compared with the control. Also, these treatments increased the herb fresh weight in the two seasons in two different soils. Clove oil surpassed basil oil in reducing the incidence of pelargonium root rot and in increasing the obtained yield of herb fresh weight and oil percentage.

The inoculum level 5% proved the most effective inoculum level in the incidence of pelargonium root rot compared with the other inoculum levels and control treatments. Similar results were obtained by Shalaby (1993), who recommended that the difference in susceptibility could be detected at 5 % inoculum level.

The infection percentage (IP) and disease severity (DS) of the most effective fungi were tested singly or in pairs, and it was found that combination of *Rhizoctonia solani* with each of *Fusarium oxysporum*, or *M. phaseolina* resulted in synergistic action since the IP and DS were significantly increased than in each fungus treatment alone. Similar results were obtained by Hilal (1985).

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تأثير المستخلصات النباتية والزيوت الأساسية لبعض النباتات الطبية والعطرية على أعفان الجذورفى العتر

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يعتبر العتر واحدا من أهم النباتات الطبية والعطرية فى كثير من مناطق العالم وفى مصر .ويعتبر المرض المركب أعفان الجذور من أخطر أمراض التربة التى تصيب هذا المحصول .كان تركيز اللقاح 5%هو أكثر تركيزات اللقاح فى إحداث أعلى نسبة وشدة إصابة .أسفرت التوليفات بين كل من الفطريات فيوزاريوم أوكسيسبورم ، ورايزوكتونيا فاسيولينا ، أو ماكروفومينا فاسيولينا وريزوكتونيا سولانى عن أعلى فعل تشجيعى فى إحداث أعفان الجذور فى العتر .تحت ظروف المعمل أدى كل من مستخلص البصل والثوم ، والزيوت الأساسية لكل من الريحان والقرنفل والزعتر إلى حدوث نقص معنوى للنمو الميسليومى لكل من الفطريات موضع الاختبار .تحت ظروف الحقل تحقق نفس الاتجاه ، حيث أدى غمر عقل العتر فىالزيوت الأساسية للقرنفل والريحان إلى حدوث أقل نسبة وشدة إصابة بأعفان الجذور فى العتر .وفى نفس الوقت أدت هذه المعاملة إلى الحصول على أعلى محصول من العشب والزيت .وكذلك أدى استخدام زيت القرنفل إلى حدوث أقل نسبة وشدة إصابة بأعفان جذور العتر ، وفى نفس الوقت أدت هذه المعاملة إلى زيادة معنوية للمحصول الناتج من العشب ونسبة الزيت مقارنة مع زيت الريحان ومعاملة الكونترول