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EFFECT OF MYCORRHIZAL INOCULATION AND PHOSPHATIC FERTILIZATION ON DAMPING-OFF AND ROOT-ROT DISEASES OF SOUR ORANGE.
I- THE EFFECT ON DISEASE SEVERITY, MICROBIAL COUNTS, PHENOLS AND CARBOHYDRATES CONTENT

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ABSTRACT: This research was carried out to study the effect of mycorrhizal inoculation and/or phosphatic fertilization on damping-off and root-rot diseases in sour orange. Obtained data showed that *Fusarium oxysporum* was the most destructive soil pathogen causing damping-off and root-rot of sour orange. Percentage of disease severity increased by the increasing of inoculum potential. Soil infestation with *F. oxysporum* alone caused the highest percentage of pre- & post-emergence damping-off and root-rot diseases. Mycorrhizal inoculation significantly decreased the percentage of disease severity caused by *F. oxysporum*.

Moreover, the highest counts of total microbial flora were obtained from mycorrhizal inoculation alone. While, the highest counts of actinomycetes were resulted from mycorrhizal inoculation in combination with super-P. On the other hand, the lowest counts of total microbial flora and actinomycetes were resulted from soil infestation with *F. oxysporum* either alone or in combination with super-P. Soil inoculation with *Glomus macrocarpum* + *F. oxysporum* in combination with super-P led to decrease the populations of soil fungi.

Also, data showed that the treatment including *G. macrocarpum* + *F. oxysporum* gave the highest value of total phenols and lowest value of free phenols. The highest values of total carbohydrates were obtained from mycorrhizal inoculation combined with *F. oxysporum* whereas, the lowest ones were observed in the treatments including *F. oxysporum* either alone or in combination with super-P.

INTRODUCTION

Sour orange (*Citrus auruntium*) is a distinctive, readily recognized species of citrus with numerous variants. Also, sour orange induces maximum cold hardiness, it is tolerant of *Phytophthora* foot rot, but less so to fibrous root damage by this fungus. It tolerates exocortis and xyloporosis viroid, but it is extremely sensitive to citrus tristeza virus (Castle *et al.*, 1993). *Fusarium solani* and *Fusarium oxysporum* were isolated from rough lemon and sweet orange seedling roots (Labuschagne *et al.* 1987). Whereas, Wehner *et al.* (1987) isolated fungi root pathogens *F. solani* and *F. oxysporum*, *Pythium* spp. and *Phytophthora* spp. from citrus seedlings root-rot in nurseries. Marx (1973) showed that plants with mycorrhizae do not exhibit reduction in top growth,

chlorosis, restricted root development and eventual death, and are therefore more restricted to feeder root diseases than non-mycorrhizal plants. Obviously, with an increasing degree of mycorrhizal development there is a proportionate reduction in the amount of feeder roots susceptible to pathogen attack. Also, mycorrhizal fungi might be produced antifungal, antibacterial and antiviral or metabolites produced by symbiotically infected host cortical cells might also function as inhibitors to infection and spread of pathogens in mycorrhizal roots. Moreover, Stack and Sinclair (1975) reported that the addition of basidiospores of *Laccaria laccata* to nursery soil containing *F. oxysporum* reduced damping-off (mortality) of Douglas fire seedlings during the first growing season by nearly 100%. The protective influence of *L. laccata* occurred before mycorrhizal formation. In addition, Many studies were carried out on the role of mycorrhizal fungi and phosphatic fertilization on growth and minerals content of fruit seedlings (Menge *et al.*, 1980; Gendiah, 1987 and Gendiah *et al.*, 1991).

This work planning in pot experiment under greenhouse conditions to study the effect of mycorrhizal fungi (*Glomus macrocarpum*) and phosphatic fertilization on damping-off and root-rot diseases caused by *Fusarium oxysporum* in sour orange.

MATERIALS AND METHODS

Isolation and identification of damping-off and root-rot causal fungi:

Naturally infected seedlings of sour orange were collected from different growing fields in Qalubia Governorate. The isolation procedures are carried out as described by Strobel and Mathre (1970). Purification of the isolated fungi was carried out using hyphal-tip and/or monosporic culture techniques described by Hildebrand (1938), then identified according to Parameter and Whitney (1970) as well as Nelson *et al.* (1983). The identification were confermed by Department of Taxonomy, Plant Pathology Inst., Agric. Res. Cent., Giza, Egypt. The isolated fungi were maintained on PDA slants and kept in refrigerator at 5°C for further study.

The effect of inoculum potential of the isolated fungi on disease severity index. The inoculum of the isolated fungi was grown on sterilized sand sorghum grain medium (Whithead, 1975). Pots of 20 cm. in diameter were properly sterilized using 5% formalin solution. Loamy-clay soil was autoclaved at 15 lb/in.^{2} for 3 hours then infested with different amount of inoculum i.e., 0.5, 1.0, 3.0, 5.0 and 8.0% of soil weight. Pots were filled with infested soil and watered on alternate days and incubated under greenhouse conditions for 7 days to activate of fungi and maintain equal distribution of fungal inoculum. Seven wet seeds of sour orange were sown in each pot with four replicates. Pre- and post-emergence damping-off were recorded after 15 to 45 days of germination, respectively. Sixty days old seedlings of sour orange carefully removed, currently washed with tap water and examined for root-rot symptoms. Determination of the root-rot disease severity index (DSI) was carried out based on a scale from 0 (non-visible damage) to 5 (completely destroyed roots) according to Salt (1982). The aggressive fungus isolate (*F. oxysporum* I) and suitable inoculum rate (3% of soil weight) were chosen according to

obtained results and were subjected in further study.

Effect of inoculation with combined treatment of mycorrhizae and phosphatic fertilization on disease assessment, rhizospheric microbial counts and biochemical contents.

A pot experiment was carried out under greenhouse conditions to study the effect of mycorrhizal inoculation and phosphatic fertilization on damping-off and root-rot diseases caused by *F. oxysporum* and microbial counts in the rhizosphere of sour orange.

This research was carried out during 1995 and 1996 seasons at Faculty of Agriculture, Moshtohor, Zagazig University. In early March during two seasons, ten sour orange seedlings were sown in pots 20 cm. in diameter, which filled with autoclaved loamy clay soil (2 kg/pot) and the following treatments were undertaken:

1- Control
2- Calcium superphosphate (super-P)
3- Mycorrhizal inoculation (*G. macrocarpum*)*
4- *Fusarium oxysporum* fungus isolate I
5- *G. macrocarpum* + super-P
6- *G. macrocarpum* + *F. oxysporum*
7- *F. oxysporum* + super-P
8- *G. macrocarpum* + *F. oxysporum* + super-P

Six pots were used as replicates for each particular treatment in a randomized complete block design.

Phosphatic fertilizer was added at a rate of 2 g P_2O_5/pot at sowing time. Mycorrhiza fungus (*G. macrocarpum*) was added according to Menge *et al.* (1977) method. While, *F. oxysporum* was added to the soil at a rate of 3% of soil weight one week before cultivation.

Generally, each pot under study received 6.0 g N in the form of ammonium nitrate, also potassium fertilizer was added for soil at a rate of 2 g K_2O/pot in the form of potassium sulphate.

Two months after seed germination, pots contents were entirely transported into other pots (30 cm in diameter) containing non-sterilized loamy clay soil. Each treatment under study was replicated 6 times (2 plantlet/pot).

Determinations:

A- Disease assessment:

Percentages of pre- and post-emergence damping-off were estimated at 15 to 45 days after seed germination. While, root-rot seedlings were estimated at the end of the experiment as mentioned before.

B- Microbiological assay:

Rhizospheric soil samples of the developed plantlets were taken monthly and microbiologically analyzed for total microbial flora, actinomycetes and total fungal counts. These determination were periodically detected for 180 days after plantlets were transported in non-sterilized soil.

The soil yeast extract agar medium was used for counting of total microbial flora (Skinner *et al.*, 1952). Jensen medium was used for actinomycetes count and prepared as described by Allen (1950), while Martin's medium (1950) was used for

* *Glomus macrocarpum*, soil Goettinge strain was obtained from Tropical Institute, Goerringen Univ., Federal Republic Germany, by El-Deepah, (1981).

counting the fungi. The plates count method was used for the three determinations.

C-Chemical analysis :

Total carbohydrates content was determined in dry matter of leaves by the phenol sulphuric acid method described by Michel *et al.* (1956) and calculated as mg glucose/g fresh weight. Also, total and free phenolic compounds were determined in an ethanolic extract according to Snell and Snell (1953) and calculated as mg catechol per 10 g of the fresh weight.

D- Statistical analysis:

All data obtained from disease assessment were transferred into angles to be statistically analyzed (Steel and Torrie, 1960). The Duncan's multiple range test (Duncan, 1955) was used to differentiate among means.

RESULTS AND DISCUSSION

Two isolates of *Fusarium oxysporum* Schlecht., (I, II) as well as one isolate of *Fusarium tricinactum* (Corda)Sacc. *Fusarium poae* (Peck) Wollenweber were frequently isolated from damping-off and root rotted seedlings of sour orange.

Data in **Table (1)** clearly indicate that the isolates of *Fusarium oxysporum* (I and II) were found to be the most destructive soil pathogen causing damping-off and root-rot diseases severity of sour orange as compared with *Fusarium poae* and *Fusarium tricinactum*. *F. oxysporum* isolate I was more aggressive than isolate II. Also, data cleared that, the percentage of pre- & post-emergence damping-off and root-rot increased with the increasing of inoculum potential of tested fungi. In this respect Timmer (1982), Morgan and Timmer (1983) and Tatum *et al.* (1987) found that *Fusarium oxysporum* causes a serious wilt and dieback in more than one of *Citrus* spp. as Mexican lime (*Citrus aurantifolia*), Milam (*Citrus jambhiri variant*), *Citrus volkameriana* and *Citrus amblycarpa*. Also, this result is in agreement with the findings of Morgan and Timmer (1984) who found that the percent infection of *F. oxysporum* and mean disease severity rating on Mexican lime increased with increasing inoculum density of the pathogen.

Interaction effect between mycorrhizal inoculation and phosphatic fertilization on *F. oxysporum* disease severity in sour orange rootstock:

Data in **Table (2)** show that *F. oxysporum* when infested alone in sterilized soil caused the highest percentage of pre- & post-emergence damping-off and root-rot disease severity followed by natural soil (control 2) compared with other investigated treatments in the two seasons. These results are in agreement with the findings of Morgan and Timmer (1984) who recorded that *Fusarium oxysporum* f.sp. *citri* caused wilting and dieback of Mexican lime (*Citrus aurantifolia*) under greenhouse conditions and on various *Citrus* spp. However, Gaumann *et al.* (1960) recorded that Orchids infected with mycorrhizal fungi produced a phytoalexin (Orchinal), which might protect the plant against pathogens. Phosphatic fertilization treatment significantly decreased the percentage of diseases severity of *F. oxysporum* compared with combination treatment included *G. macrocarpum* + super-P + *F. oxysporum*, while, the lowest percentage

Table (1): Effect of inoculum potential of isolated fungi on the percentage of disease severity in sour orange.

Inoculum potential	*F. oxysporum (I)*			*F. oxysporum (II)*			*F. poea*			*F. tricinactum*		
	Pre	Post	R. rot	Pre	Post	R. rot	Pre	Post	R. rot	Pre	Post	R. rot
8.0%	53.6 a	82.5 a	86.5 a	32.1 a	65.5 a	58.3 a	48.2 a	32.5 a	34.3 a	44.6 a	55.5 a	42.4 a
5.0%	39.3 b	76.7 a	73.3 b	25.0 b	52.6 b	45.4 b	33.0 b	23.6 b	26.4 b	30.4 b	34.5 b	36.6 b
3.0%	21.4 c	52.2 b	65.4 c	17.9 c	32.8 c	28.5 c	25.0 c	18.3 c	15.5 c	20.5 c	20.5 c	18.6 c
1.0%	17.9 d	34.5 c	42.8 d	7.1 d	21.6 d	15.9 d	17.9 d	9.7 d	8.8 d	9.8 d	9.6 d	12.8 d
0.5%	10.7 e	21.7 d	25.6 e	00.0 e	16.8 e	9.8 e	8.3 e	5.9 e	6.7 d	5.4 e	5.8 e	9.0 d
(Control)	00.0 f	00.0 e	00.0 f	00.0 e	00.0 f	00.0 f	00.0 f	00.0 f	00.0 e	00.0 f	00.0 f	00.0 e

Means followed by the same letter(s), within each column, are not significantly different from each other at 1% level. R. rot = Root-rot

Table (2): Effect of mycorrhizal inoculation and phosphatic fertilization on *Fusarium oxysporum* disease severity in sour orange root in two successive seasons.

Treatments	1995			1996		
	Pre-emergence (%)	Post-emergence (%)	Root-rot (%)	Pre-emergence (%)	Post-emergence (%)	Root-rot (%)
Autoclaved soil (Control)	0.0 e	0.0 e	0.0 f	0.0 f	0.0 e	0.0 f
G. macrocarpum	0.0 e	0.0 e	0.0 f	0.0 f	0.0 e	0.0 f
Super-P	0.0 e	0.0 e	0.0 f	0.0 f	0.0 e	0.0 f
Fusarium oxysporum	20.0 a	54.18 a	62.48 a	22.5 a	58.53 a	62.68 a
G. macrocarpum + Super-P	0.0 e	0.0 e	0.0 f	0.0 f	0.0 e	0.0 f
G. macrocarpum + *F. oxysporum*	10.0 d	17.38 d	20.58 e	7.5 e	19.63 d	22.98 e
Fusarium oxysporum + Super-P	15.0 b	22.46 c	36.71 c	17.5 b	22.98 c	37.46 c
G. mac. + Super-P + *F. oxysporum*	12.5 c	24.46 c	33.81 d	12.5 d	23.01 c	35.39 d
Natural soil (Control 2)	12.5 c	27.72 b	41.89 b	15.00 c	26.23 b	42.19 b

Means followed by the same letter(s), within each column, are not significantly different from each other at 1% level.

of damping-off and root-rot diseases were resulted by mycorrhizal inoculation treatment alone, the same trend was observed in the two seasons. In this respect, many investigators reported that vescular arbuscular mycorrhiza (VAM) inoculation decrease or inhibit soil-borne fungal disease and the percentage of fungal infection such as Wingfield (1968), Zamblin and Schenck (1983), Garcia and Ocampo (1987) and Abd El-Mageed and Zaghloul (1997). On the other hand, Fahim *et al.* (1971) found that the addition of potassium sulphate or calcium superphosphate or both to the soil reduced of Fusarium wilting on cotton plant. Also, Mahdy (1981) reported that phosphorus application in low or high concentration with *F. oxysporum* f.sp. *vasinfectum* increased cotton seed germination and suppressed disease index of seedlings.

Microbiological analysis:

Periodical changes in total microbial flora in rhizosphere of sour orange:

Data presented in **Table (3)** show that total microbial counts showed fluctuation during growth period. This fluctuation was most probably due to the temperature changes occurring in the greenhouse. Counts of total microbial flora gradually increased with the increasing of growth period to reach their maximum values at 90 to 120 days then decreased thereafter. These results were true in all treatments and in both growing seasons. The highest counts of total microbial flora were obtained by mycorrhizal inoculation alone. This result likely to be due to the mycorrhizal fungi which produce growth promoting substances as well as increased the availability of most nutrient elements specially phosphorus and micro-nutrients which consequently reflected on the bacterial proliferation in soil Azazy *et al.* (1988) and Bellone and De Bellone (1993). Also, Abdel-Mageed and Zaghloul (1997) found that mycorrhizal inoculation increased the viable counts of total microbial flora in rhizosphere of bean plants.

In contrast, the lowest counts of total microbial flora resulted from soil infestation with *F. oxysporum* alone. This result might be due to the antagonistic effect of *F. oxysporum* on different soil bacteria. Compared with the control, obtained data emphasize that soil fertilized with super-P showed an increase in total microbial flora in the rhizoshpere of sour orange.

Mycorrhizal inoculation in combination with either super-P or *F. oxysporum* led to an increase of total microbial counts compared with soil treated with either super-P or *F. oxysporum* each one alone.

Periodical changes in actinomycetes counts in rhizosphere of sour orange:

Data in **Table (4)** clearly show that the counts of actinomycetes were differed by different treatments and growth periods. The counts of actinomycetes in rhizosphere of sour orange showed fluctuation during growing season and this was true in all treatments. This fluctuation could be attributed to the temperature changes occurring in the greenhouse.

Moreover, actinomycetes populations gradually increased with the increasing of growth period to reach their maximum values at the period ranged between 120 to 150 days. The highest populations of actinomycetes were resulted from mycorrhizal inoculation in

Table (3): Periodical changes in total microbial counts ($x10^6$/g dry weight of soil) in the rhizosphere of sour orange.

Period (days) / Treatments	Initial		30		60		90		120		150		180	
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
Control	48	40	62	60	75	68	90	84	97	91	78	60	64	56
G. macrocarpum	86	78	160	171	188	180	200	160	215	195	180	156	110	95
Super-P	76	66	132	124	160	148	181	175	150	130	126	103	86	72
Fusarium oxysporum	32	26	45	36	58	54	62	42	30	28	20	16	12.5	10.8
G. macrocarpum + Super-P	94	90	190	180	220	200	240	220	265	260	220	200	140	132
G. macrocarpum + *F. oxysporum*	56	52	72	66	86	82	120	112	128	118	90	84	78	70
F. oxysporum + Super-P	36	30	48	44	60	56	65	56	40	35	28	22	16	12
G. mac. + *F. oxysporum* + Super-P	80	76	120	105	140	136	161	152	130	120	98	92	86	80

Table (4): Periodical changes in actinomycetes counts ($x10^6$/g dry weight of soil) in the rhizosphere of sour orange.

Period (days)	Initial		30		60		90		120		150		180	
Treatments	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
Control	28	25	36	30	53	48	48	36	60	55	56	48	42	34
G. macrocarpum	43	40	56	48	76	72	90	86	84	78	98	92	74	62
Super-P	33	30	42	40	60	56	88	80	92	86	84	76	66	52
Fusarium oxysporum	20	14	18	16	14	10	16	12	15	11	17	13	12	10
G. macrocarpum + Super-P	65	60	74	68	90	86	105	110	130	124	140	132	82	78
G. macrocarpum + *F. oxysporum*	40	32	44	38	58	50	66	54	78	72	52	40	40	32
F. oxysporum + Super-P	25	20	32	24	33	28	30	26	34	31	22	16	12	8
G. mac. + *F. oxysporum* + Super-P	52	46	60	54	71	65	76	68	88	82	58	45	61	56

combination with super-P. This trend of results was observed at all growth periods as well as in both growing seasons. Increasing of actinomycetes population in case of *G. macrocarpum* + super-P is likely to be due to the beneficial effect of mycorrhizal fungi as a result of P-supply increase by these fungi from insoluble phosphorus. El-Ghandour (1992) and Abdel-Mageed and Zaghloul (1997) found that VA-Mycorrhizal inoculation had favourably effects on bacterial proliferation in rhizosphere of mycorrhizal-inoculated plants compared with non-inoculated one.

Data in **Table (4)** also show that the lowest counts of actinomycetes were resulted from soil infested with *F. oxysporum* either alone or in combination with super-P and this was true in both growing seasons.

On the other hand, obtained data revealed that actinomycetes populations were increased when mycorrhizal fungus was inoculated either alone or in combination with *F. oxysporum* as well as in the treatment included *G. macrocarpum* + *F. oxysporum* + super-P. Also, it is important to notice that the actinomycetes populations were higher in the 1st season than in the 2nd season. This might be due to the difference in meteorological factors (climatic conditions).

Periodical changes in fungi counts in rhizosphere of sour orange:

Data presented in **Table (5)** clearly indicate that the counts of fungi in the rhizosphere of sour orange gradually decreased with the increasing of growth period. Mycorrhizal inoculation either alone or in combination with super-P led to sharp decrease in the populations of fungi. These results are in agreement with those obtained by Eisa *et al.* (1994) and Abdel-Mageed and Zaghloul (1997) who reported that mycorrhizal fungi decrease or inhibit soil borne fungal diseases.

The highest counts of fungi in rhizosphere of sour orange were observed in the treatments of soil infested with either *F. oxysporum* alone or in combination with super-P.

Also, it is interested to notice that soil inoculated with *G. macrocarpum* + *F. oxysporum* in combination with super-P led to decrease the populations of soil fungi in the rhizosphere of sour orange.

Effect of mycorrhizal inoculation, phosphatic fertilization and *F. oxysporum* infection on phenolic compounds and total carbohydrates.

Data in **Table (6)** show that total phenols in sour orange roots were higher in all treatments than control (1) in sterilized soil. Also, the same trend of results was observed in case of free phenols except the treatment included *G. macrocarpum* + *F. oxysporum* that gave the highest value of total phenols and lowest value of free phenols. It is important to mention that the treatment including *G. macrocarpum* + *F. oxysporum* gave the lowest disease severity, (Table, 2).

Gaumann *et al.* (1960) reported that orchids inoculated with mycorrhizal fungi producing a phytoalexin (orchinal), which might protect the plant against pathogens.

Table (5): Periodical changes in total fungi counts ($x10^3$/g dry weight of soil) in the rhizosphere of sour orange.

Period (days) / Treatments	Initial		30		60		90		120		150		180	
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
Control	50	62	30	46	20	28	32	48	24	20	36	30	20	18
G. macrocarpum	12	10	8.5	6.2	4.6	3.1	6.5	2.8	5.0	3.5	6	4	0	2
Super-P	42	38	50	45	71	62	60	48	40	30	46	34	38	32
Fusarium oxysporum	96	82	76	72	65	60	60	52	40	34	32	25	28	21
G. macrocarpum + Super-P	4.3	3.6	1.2	1.0	1.6	0.0	7.0	0.0	3.3	4.0	2.4	2.0	0.0	1.0
G. macrocarpum + *F. oxysporum*	60	48	45	20	2.8	4.8	3.1	11	6.2	3.0	4.0	6.0	2.8	2.5
F. oxysporum + Super-P	160	140	146	130	120	140	100	120	60	80	42	40	34	30
G. mac. + *F. oxysporum* + Super-P	48	36	40	32	20	18	12	18	5.6	3.0	4.2	2.8	2.0	0.0

Table (6): Effect of mycorrhizal inoculation and phosphatic fertilization as well as *F. oxysporum* infection on phenolic compounds and total carbohydrates in sour orange.

Treatments	Phenolic compounds (mg/g fresh weight)				Total carbohydrates (mg/g fresh weight of leaves)	
	Free	Total	Free	Total		
	1995	1995	1996	1996	1995	1996
Control (1) sterilized soil	0.195	0.272	0.189	0.269	130.0	132.5
G. macrocarpum	0.226	0.368	0.228	0.371	146.3	141.2
Super-P	0.232	0.327	0.238	0.324	126.7	128.8
Fusarium oxysporum	0.232	0.354	0.242	0.359	125.2	128.7
G. macrocarpum + Super-P	0.201	0.341	0.210	0.348	145.0	148.0
G. macrocarpum + *F. oxysporum*	0.143	0.417	0.148	0.422	155.4	162.8
F. oxysporum + Super-P	0.202	0.368	0.212	0.372	126.9	122.3
G. mac. + *F. oxysporum* + Super-P	0.240	0.380	0.248	0.397	152.7	158.4
Control (2) non-strilized soil	0.213	0.338	0.219	0.341	119.4	116.8

On the other hand, soil infestated with *F. oxysporum* combined with *G. macrocarpum* gave higher values of total phenols than soil infested with *F. oxysporum* combined with super-P. The combination treatment *G. macrocarpum* + *F. oxysporum* + super-P causing an increase of either total or free phenols as compared with using each one alone. These results are in agreement with the findings of Mahdy and Eid (1989) who found that the fungal infection greatly increased the amounts of total and free phenols in cultivated plants.

Data in **Table (6)** also emphasize that the total carbohydrates were higher in all treatments as compared with the control (2). The highest values of total carbohydrates were resulted from mycorrhizal inoculation in combination with *F. oxysporum* and this was true in both seasons. Also, mycorrhizal inoculation either alone or in combination with super-P showed an increase in total carbohydrates content. This result is in accordance with Abdel-Mageed and Zaghloul (1997) who found that mycorrhizal inoculation increased total carbohydrates in bean plants.

In contrast, soil infestation with *F. oxysporum* either alone or in combination with super-P decreased total carbohydrates content. This result is in agreement with those obtained by Amer *et al.* (1983) and Abdel-Mageed and Zaghloul (1997) who reported that fungal infection decreased the total carbohydrates content.

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تأثير التلقيح بفطريات الميكورهيزا والتسميد الفوسفاتي على أمراض موت البادرات وعفن الجذور في النارنج

١- التأثير على حدة المرض ، محتوى التربة من الميكروبات ومحتوى النبات من الفينولات والكربوهيدرات

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تم إجراء هذا البحث لدراسة تأثير التلقيح بالميكورهيزا والتسميد الفوسفاتي على أمراض موت البادرات وعفن الجذور في النارنج.

أوضحت النتائج المتحصل عليها أن فطر (*Fusarium oxysporum*) من بين الفطريات المختبرة كان أكثر قدرة مرضية حيث أدى إلى إحداث أعلى نسبة من مرضي موت البادرات وعفن الجذور للنارنج. ولقد زادت نسبة الإصابة بهذه الأمراض بزيادة كمية اللقاح. وقد وجد أيضاً أنه عند عدوى التربة بفطر *F. oxysporum* بمفرده أدى ذلك إلى حدوث أعلى نسبة لموت البادرات وعفن الجذور للنارنج. كما أدى التلقيح بفطر الميكورهيزا *G. macrocarpum* مع عدوى التربة بفطر *F. oxysporum* إلى نقص معنوي في نسبة الإصابة بكلا من المرضين.

تم الحصول على أعلى أعداد للميكروبات الكلية في منطقة الريزوسفير عند التلقيح بفطر الميكورهيزا بمفرده ، بينما كانت أعلى أعداد للأكتينوميسيتات عندما تم التلقيح بالميكورهيزا مع إضافة السوبر فوسفات. كما أثبتت النتائج أيضاً أنه عند عدوى التربة بفطر *F. oxysporum* بمفرده أو مع إضافة السوبرفوسفات أدى ذلك إلى الحصول على أقل الأعداد من الميكروبات الكلية و الأكتينوميسيتات. كما وجد أنه عند تلقيح التربة بفطر *F. oxysporum + G. macrocarpum* مع إضافة السوبر فوسفات أدى ذلك إلى الحصول على أقل الأعداد من فطريات التربة.

كذلك وجد أن التلقيح بفطر الميكورهيزا + فطر الفيوزاريوم أدى إلى الحصول على أعلى تركيز للفينولات الكلية وأقل تركيز من الفينولات الحرة. كما أدى التلقيح بفطر الميكورهيزا مختلطاً مع فطر الفيوزاريوم إلى الحصول على أعلى قيمة للكربوهيدرات الكلية ، بينما تم الحصول على أقل قيمة للكربوهيدرات الكلية عند عدوى التربة بفطر *F. oxysporum* سواء بمفرده أو مع إضافة السوبر فوسفات.