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تأثير المعاملة بالمبيدات الفطرية على أمراض أعفان جذور أصول الموالح

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الملخص العربي

تتسبب أمراض أعفان الجذور في موت شتلات أصول الموالح التجارية. وكانت الفطريات *Fusarium oxysporum, F. solani* and *Botryodiplodia theobromae* الأكثر قدرة على إحداث المرض بجانب انها كانت أكثر الفطريات تكراراً في العزل من شتلات أصول الموالح التي ظهرت عليها أعراض الإصابة.

أظهرت دراسة تأثير عشر مبيدات فطرية في المعمل بناءاً عن قيم LC_{50} إن مبيدات كاربندازيم، ثيوفانات الميثيل، فلوداي اوكسونيل كانت أعلى كفاءة ضد الفطريات الثلاثة في حين كانت مبيدات كاربوكسين، تولكوفوس ميثيل + ثيرام ، فلوتولانيل، ثيابندازول متوسطة التأثير على الفطريات الثلاثة المختبرة. بينما كانت مبيدات بروباموكارب هيدروكلوريد، كوبراوكسي كلوريد+ ميتالاكسيل، كوبر هيدركسيد اقل المبيدات فاعلية. عند اختبار هذا المبيدات كمعاملة للتربة تحت ظروف الصوبةعلى اربع اصول للموالح هى الليمون المخرفش وليمون الفولكامرينا والليمون المالح المصرى والنارنج كان أعلى تأثير لهذه المبيدات عندما تم تطبيقها في نفس وقت زراعة الشتلات في التربة المعداه بالفطريات يليها معاملة التربة بالمبيدات بعد ١٥ يوم من الزراعة ثم بعد ٣٠ يوم من الزراعة. وكانت مبيدات ، ثيوفانات الميثيل، كاربندازيم، فلوداي اوكسونيل أكثر المبيدات فاعلية بينم.ا مبيدي كوبر هيدركسيد، ، كوبراوكسي كلوريد + ميتالاكسيل اقل المبيدات فاعلية في مكافحة المرض.

EFFECT OF FUNGICIDE APPLICATIONS ON ROOT ROT DISEASES IN CITRUS ROOTSTOCKS.

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ABSTRACT: ***Root rots resulting in mass mortality of young seedlings of commercial citrus rootstocks. The most pathogenic as well as the most frequently isolated fungi from citrus rootstock seedlings suffer from root rot symptoms were Fusarium oxysporum, F. solani and Botryodiplodia theobromae. Studying the effect of ten fungicides on the in vitro experiment according to LC_{50} showed that Carbendazim, Thiophanate-methyl and Fludioxonil were high efficacies against the three fungi. Carboxin, Tolclofos-Methyl+ Thiram, Flutolanil and Thiabendazole exhibited moderate effect. While Propamocarb hydrochloride, Copper oxycholoride + Metalaxyl and Copper hydroxide were the least effective ones. The highest effect of the tested fungicides used as soil drench on four rootstocks namely rough lemon , Volkamer lemon, Egyptian lime and Sour orange when applied at the same time of transplanting in the infested soil followed by 15 and 30 days application after transplanting. Thiophanate-methyl, Carbendazim and Fludioxonil were the most effective fungicides while Copper hydroxide and Copper oxychloride + metalaxyl were the lowest effective ones.***

Key words*: root rot of citrus rootstocks, Fusarium spp., Botryodipodia theobromae, fungicides, in vitro and in vivo experiments.*

INTRODUCTION

Citrus is considered one of the most important fruit crops in the world and Egypt. In fact, citrus responds on the request of the local market and give off a surplus intended to the exportation. Recently, citrus crops have recognized a considerable development with a steady expansion of the surface and the number of farms, there by, strenuous efforts have always been exerted to increase its production through a better using of suitable rootstocks. Citrus rootstock seedlings are usually affected by soil borne fungi living in the regions of root system. Root rot diseases are common in the presence of *Fusarium oxysporum, F. solani* and *Botryodiplodia theobromae* (Suarez, 1990; Rondon, 1992; Radhouane, 2007; Mansour and El-Shimy, 2009 and Harender Sharma, 2010). Under natural infection root rot is also prevalent in all nurseries, manifest itself as wethering and drying of seedling from top to bottom and whole plant die up.

Initially rootnets became rooten and later the infested root system result in plant yellowing, wilting and/or mass mortality of young seedlings of commercial citrus rootstocks.

The chemical control of the disease is recorded as an active measure (Verma and Navtej Singh, 1999; El-Mohamedy, 2004 and Gade, 2009). The present work was carried out to study the causal pathogens of citrus rootstocks root rot diseases. The chemical control with different fungicides was also evaluated at different time of transplanting in infested soil with the tested fungi

MATERIALS AND METHODS

Isolation, Purification and Identification of the Causal pathogens:

Diseased citrus rootstock seedlings were collected from El-Qanater El-Khairya Horticultural Research Station, Agricultural Research Centre during 2007 and 2008 growing seasons. The roots of the diseased seedlings were washed carefully with tap water to remove the adhering soil particles, then cutted into small pieces (about 1 cm lenght), and surface sterilized by immersing them in 5% sodium hypochlorite solution for five minutes. The segments were rinsed several times in sterilized water then dried between folds of filter papers and aseptically transferred onto sterilized Petri dishes containing PDA. The dishes were incubated at 27-28 ^{o}C for 7 days. The colonies were counted, picked up and cultured on another Petri dishes containing PDA. Isolated fungi were purified using the hyphal tip and/or single spore techniques. Pure cultures were identified according to Gilman (1957), Booth (1971), Nelson *et al.* (1983) and Burnet and Hunter (1987).

Pathogenicity tests of the isolated fungi:

For preparing fungal inocula, the tested fungi were grown on autoclaved barely medium at 28 ^{o}C for two weeks. They were separately added to the potted soil at the rate of 5% (W/W), ten days before planting seedlings (six-month-old) which transplanting in pots (25 cm. diam), filled with infested or uninfested soil. Three seedlings were cultivated in each pot and four pots were used for each treatment. Disease incidence was recorded as percentage of infected plants, 30 and 60 days of transplanting

Chemical control:

In vitro sensitivity tests:

The efficiency of ten fungicides namely Vitavax (Carboxin), Ridomil Gold Plus (copper oxycholoride+ metalaxyl), Kema-Z (Carbendazim), Kocide 101 (Copper hydroxide), Topsin–M70 (Thiophanate-methyl), Rhizolex-T (Tolclofos-methyl+ Thiram), Tecto (Thiabendazole), Aracure (Propamocarb hydrochloride), Maxim (Fludioxonil) and Moncut (Flutolanil) were tested on

the *in vitro* linear growth of three fungi causing root rot diseases of citrus rootstocks, i.e. *Fusarium oxysporum, F. solani and Botryodiplodia theobromae.* Each fungicide at concentrations of 5.0, 10.0, 50.0, 100.0, 200.0, 300.0, 400.0, 500.0, 600.0, 800.0 and 1000.0 µg a.i/ml was added to PDA medium just before solidification. Discs of each fungus (5mm in diameter) were placed in the center of each plate. Four dishes were used for each concentration. All dishes were incubated at 28°C. The linear growth (mm) of each tested fungus was measured when mycelial growth completely covered the surface of the control treatment plate.

Activity of fungicides was determined by calculating LC50 values according to Finney (1971).

Effect of fungicides on incidence of citrus rootstocks root rots:

Efficiency of the tested fungicides as soil drench for controlling root rot diseases of four citrus rootstocks namely, rough lemon, volkamer lemon, Egytian lime and Sour orange was studied.

Pots (25 cm in diameter) containing clay loam were infested separately with one of the tested fungi, i.e. *Fusarium oxysporum F. solani Botryodiplodia theobromae* at the level of 5% w/w. Transplanting was carried out with three apparently healthy seedlings (six month-old) in each pot and four repelicates were used for each treatment. Seedlings were grown in infested soil free of fungicides served as control. The recommended dose of each fungicide was used as soil drench at the rate 250 ml/pot at the same time of transplanting and also after 15 and 30 days of transplanting. The percentage of all the infected plants was recorded after two months from transplanting.

RESULTS AND DISCUSSIONS

Isolation, Purification and Identification of the Causal pathogens:

Isolation from infected citrus rootstock seedlings yielded eight species representing six fungal genera (Table, 1). *Fusarium oxysporum* and *F. solani* were the highest frequency percentages on all rootstocks in two seasons (32.15% and 29.85%, respectively), followed by *Botryodiplodia theobromae* which recorded 15.14% while the other pathogens were less frequent.

Higher frequency percentages were recorded for *F. oxysporum* than *F. solani* and that was true on rough lemon than volkamer lemon and egyptian lime. On the other hand, *F. solani* was, more frequent than *F. oxysporum* on cleoptra mandarine and sour orange. In addition, these two rootstocks recorded the least frequent of isolation among all tested rootstocks and this was true for both seasons of isolation. All rootstocks recorded almost the same frequency percentages of *B. theobromae.*

The predominance of *F. oxysporum* and *F. solani* among fungi isolated from infected citrus rootstock seedlings are in agreement with those reported by (Radhouane, 2007; Mansour and El-Shimy, 2009 and Harender Sharma, 2010). However, *B. theobromae* was isolated either alone or with other fungi from diseased citrus rootstock roots (Suarez, 1990 and Rondon, 1992).

Pathogenicity tests of the isolated fungi:

Table (2) showed that the tested fungi were differed in their pathogenic capability. *Fusarium oxysporum* and *F. solani* were found to be highly pathogenic to citrus rootstock seedlings both after 30 and/or 60 days of transplanting, followed by *Botryodiplodia theobro*mae. On the other hand, F*. semitectium, Rhizoctonia solani, alternaria alternata* and *Phytophthora parasitica* caused the lowest percentages of infection. *Aspergillus* sp. didn't show any pathogenic effect.

For all fungi tested the disdease incidence was greater when determined 60 days after transplanting in the infested soil than 30 days. Results showed that F. *oxysporum* and *F. solani* were the main pathogens caused high percentages of citrus seedling mortality. The previous studies showed that seedlings showed a typical root rot with poor fibrous rot development, Garcia-Maccira et al., 2001; and Mansour and El-Shimy, 2009.

Chemical control:

***In vitro* effect of different fungicides on the radial growth of *Fusarium oxysporum, F. solani* and *Botryodiplodia theobromae* was studied.**

Results presented in table (3) showed that the three pathogenic fungi had the same trend in their sensitivity to different fungicides. Fungicides can be divided into three categories according to their LC_{50}. The highly active group included Carbendazim, Thiophanate-methyl and Fludioxonil. Thiabendazole, Tolclofos-methyl + Thiram and Carboxin were of moderate activity. The other fungicides *i.e.* Flutolanil, Propamocarb hydrochloride, Copper oxycholoride + Metalaxyl and Copper hydroxide were the least in their fungitoxicities.

The moderate fungitoxicity included also the effect of Tolclofos-methyl + Thiram against *F. oxysporum* and *B. theobromae* and the effect of Thiabendazole against *F. solani* and *B. theobromae*.

The variation obtained in the effect of the different fungicides on the fungal growth could be attributed to one or more of the following factors: (1) Degree of permeability of cell wall and/or plasmalemma of the fungus for the uptake and passage of fungicides into fungal cell. (Waard and Ragsdale, 1977). Giffin, (1981) found that, the majority of antifungal component act within the cell by inhibition of vital processes including biosynthesis and activity of enzymes, (2) Mode of action of specific fungicides against fungal cell (Watkins *et al*. (1977). And (3) Chemical composition of the fungicides (Carnegi *et al.,* 1990)

Table (2): Percentage of wilted volkamer lemon seedlings recorded after 30 and 60 days of transplanting.

Isolated fungi	Days after soil infestation	
	30	60
Aspergillus spp.	0.0	0.0
Fusarium semitectium	8.33	16.66
F. oxysporum	58.33	75.00
F. solani	50.00	66.66
Rhizoctonia solani	8.33	16.66
Botryodiplodia theobromae	25.00	41.66
Alternaria alternata	0.0	8.33
Phytophthora parasitica	0.0	8.33

Table (3): LC_{50} values (ug a.i/ml) of the tested fungicides against *Fusarium oxysporum, F. solani* and *B. theobromae*

Fungicides	*F. oxysporum*		*F. solani*		*B. theobromae*	
	LC_{50}	slop	LC_{50}	slop	LC_{50}	slop
Carboxin	25.42	1.17	44.74	1.28	78.19	1.47
Copper oxycholoride +Metalaxyl	193.51	1.40	152.78	1.10	79.92	0.98
Carbendazim	1.03	0.78	2.73	1.70	0.57	1.22
Copper hydroxide	388.87	1.90	528.86	2.10	182.50	3.08
Thiophanate-methyl	1.34	0.80	1.19	1.49	1.50	1.72
Tolclofos-methyl + Thiram	36.81	1.13	87.86	1.41	15.29	1.33
Thiabendazole	86.61	1.14	30.04	1.43	13.04	1.65
Propamocarb hydrochloride	102.24	1.27	37.72	1.24	134.49	1.58
Fludioxonil	5.81	1.36	9.83	1.17	7.00	1.52
Flutolanil	68.96	1.21	93.42	1.37	80.27	1.18

Effect of fungicides *in vivo* on root rot diseases:

Data presented in tables (4, 5, 6 and 7) showed the effect of different fungicides, applied as soil drench, on root rot disease caused by different fungi. The obtained results indicate that fungitoxicity differed according to the tested rootstocks, to the causal pathogens, the type of fungicide the time of fungicidal application.

Concerning the effect of tested fungicides on root rot diseases of rough lemon rootstock, results presented in Table (4) indicated that the highest effect of tested fungicides was recorded when applied at the same time of transplanting in the infected soil, followed by 15 and 30 days of transplanting. Carbendazim, Thiophanate-methyl and Fludioxonil were significantly the most effective fungicides against all three pathogens at the three time of application, followed by Tolclofos-methyl + Thiram, Carboxin, Flutolanil and Propamocarb hydrochloride. While Thiabendazole, Copper oxycholoride + Metalaxyl and Copper hydroxide were significantly the lowest effective ones. *B. theobromae* was the highest sensitive fungus to the tested

fungicides followed by *F. solani* and *F. oxysporum* but Tolclofos-methyl + Thiram gave better control to *F. oxysporum* than *F. solani*. Also, Thiabendazole which gave the lowest effect against *F. oxysporum* and *F. solani* was the most effective one against *B. theobromae*. This efficiency was similar to that of Carbendazim and higher with Thiophanate-methyl.

Table (4): Effect of the tested fungicides as soil drench on percentage of infection of rough lemon seedlings in soil infested with the tested fungi at three times of application.

Tested fungi / Fungicides	Time of application after transplanting in days									Mean
	F. oxysporum			*F. solani*			*B. theobromae*			
	0	15	30	0	15	30	0	15	30	
Carboxin	41.66	50.00	58.33	33.33	41.66	50.00	25.00	33.33	41.66	41.66
Copper oxycholoride +Metalaxyl	58.33	66.66	75.00	50.00	58.33	58.33	25.00	33.33	33.33	50.92
Carbendazim	33.33	33.33	41.66	25.00	33.33	33.33	16.66	25.00	25.00	29.62
Copper hydroxide	66.66	75.00	75.00	41.66	50.00	58.33	33.33	41.66	41.66	53.70
Thiophanate-methyl	33.33	41.66	41.66	25.00	33.33	41.66	16.66	25.00	33.33	32.40
Tolclofos-methyl + Thiram	33.33	41.66	50.00	41.66	50.00	50.00	25.00	33.33	33.33	39.81
Thiabendazole	66.66	75.00	75.00	50.00	58.33	58.33	16.66	16.66	25.00	49.07
Propamocarb hydrochloride	50.00	58.33	66.66	33.33	50.00	58.33	25.00	33.33	41.66	46.29
Fludioxonil	41.66	50.00	58.33	33.33	41.66	50.00	16.66	25.00	33.33	38.88
Flutolanil	41.66	58.33	66.66	41.66	50.00	50.00	25.00	33.33	41.66	45.36
Control 1	83.33			66.66			50.0			
Control 2	0.0			0.0			0.0			

Control(1) = seedling transplanted in infested soil
Control(2) = seedling transplanted non-in infested soil
L.S.D at 5% for
Fungicides (F) = 5.88 Pathogens (P)= 2.94
Time (T) = 2.94 FxP =10.19
FxT = 10.19 PxT = 5.09
FxPxT 17.65

The effect of tested fungicides on root rot disease of volkamer lemon are presented in Table (5) which clear that the tested fungicides were more effective when applied at the same time of transplanting than those applied after 15 days and 30 days of transplanting. Carbendazim, Thiophanate-methyl, Carboxin, Fludioxonil and Tolclofos-methyl + Thiram were the most effective fungicides against the three pathogens at different times of application, followed by Propamocarb hydrochloride, Flutolanil and Copper oxycholoride + Metalaxyl. While Thiabendazole and Copper hydroxide were

the least effective ones. *Botryodiplodia theobromae* was the most affected fungus by the tested fungicides at the three times of application, followed by *F. solani* and *F. oxysporum*, but *F. oxysporum* was more sensitive to Tolclofos-methyl +Thiram than *F. solani*. Although Thiabendazole was the least effective fungicide on *F. solani* and *F. oxysporum*, it was the most effective one against *B. theobromae*, this efficiency was similar to Carbendazim which was the most effective one.

Table (5): Effect of the tested fungicides as soil drench on the percentage of infection of volkamer lemon seedlings in soil infested with the tested fungi at three times of application.

Tested fungi / Fungicides	Time of application after transplanting in days									Mean
	F. oxysporum			*F. solani*			*B. theobromae*			
	0	15	30	0	15	30	0	15	30	
Carboxin	25.00	33.33	41.66	16.66	25.00	25.00	16.66	16.66	25.00	24.99
Copper oxycholoride +Metalaxyl	41.66	50.00	58.33	25.00	33.33	41.66	8.33	16.66	25.00	33.33
Carbendazim	16.66	33.33	33.33	16.66	25.00	25.00	8.33	16.66	16.66	21.29
Copper hydroxide	41.66	58.33	66.66	33.33	41.66	41.66	16.66	25.00	25.00	38.88
Thiophanate-methyl	16.66	33.33	41.66	16.66	25.00	25.00	16.66	25.00	25.00	24.99
Tolclofos-methyl + Thiram	16.66	25.00	33.33	25.00	33.33	33.33	16.66	25.00	25.00	25.92
Thiabendazole	50.00	58.33	66.66	25.00	33.33	41.66	8.33	16.66	16.66	35.18
Propamocarb hydrochloride	33.33	41.66	50.00	16.66	33.33	33.33	16.66	25.00	33.33	31.47
Fludioxonil	25.00	33.33	41.66	16.66	25.00	33.33	8.33	16.66	25.00	24.99
Flutolanil	33.33	41.66	50.00	25.00	33.33	41.66	16.66	25.00	33.33	33.33
Control 1	75.00			50.00			33.33			
Control 2	0.0			0.0			0.0			

Control(1) = seedling transplanted in infested soil
Control(2) = seedling transplanted non-in infested soil

L.S.D at 5% for

Fungicides (F)	**=6.21**	**Pathogens (P)**	**=3.10**
Time (T)	**=3.10**	**FxP**	**=10.77**
FxT	**=10.77**	**PxT**	**=5.38**
FxPxT	**=18.65**		

The comparison between time of fungicide application on egyptian lime (table 6) indicated that the highest effect of all tested fungicides was noticed when applied at the same time of transplanting in the infested soil, followed by 15 days of transplanting. While the least effect of tested fungicides was noticed when applied after 30 days of transplanting in the infested soil. Carbendazim, Thiophanate-methyl and Fludioxonil gave the highest effect against the three pathogens at the three times of application. Carboxin, Tolclofos-methyl + Thiram and Thiabendazole gave moderate effect. While Flutolanil, Propamocarb hydrochloride, copper oxycholoride + Metalaxyl

were the least effective ones. The same results revealed that, the lowest infection percentage was recorded on *B. theobromae*, followed by *F. solani* and *F. oxysporum*. Although Thiabendazole and Copper hydroxide were the least effective fungicides against *F. oxysporum* and *F. solani*, they were the most effective ones against *B. theobromae*.

Table (6): Effect of the tested fungicides as soil drench on percentage of infection of egyptian lime seedlings in soil infested with the tested fungi at three times of application.

Tested fungi / Fungicides	Time of application after transplanting in days									Mean
	F. oxysporum			*F. solani*			*B. theobromae*			
	0	15	30	0	15	30	0	15	30	
Carboxin	8.33	16.66	25.00	8.33	16.66	16.66	16.66	16.66	25.00	16.66
Copper oxycholoride +Metalaxyl	25.00	33.33	41.66	16.66	25.00	33.33	16.66	25.00	25.00	26.84
Carbendazim	8.33	16.66	16.66	8.33	8.33	16.66	8.33	8.33	16.66	12.03
Copper hydroxide	16.66	25.00	33.33	25.00	33.33	41.66	8.33	16.66	25.00	24.99
Thiophanate-methyl	8.33	16.66	16.66	8.33	8.33	16.66	8.33	16.66	25.00	13.88
Tolclofos-methyl + Thiram	8.33	16.66	25.00	8.33	16.66	16.66	16.66	25.00	25.00	17.58
Thiabendazole	16.66	25.00	33.33	8.33	16.66	25.00	8.33	8.33	16.66	17.58
Propamocarb hydrochloride	16.66	25.00	33.33	8.33	16.66	16.66	25.00	33.33	33.33	23.14
Fludioxonil	8.33	16.66	25.00	8.33	16.66	16.66	8.33	16.66	16.66	14.81
Flutolanil	16.66	25.00	25.00	8.33	16.66	25.00	16.66	25.00	33.33	21.29
Control 1	50.00			41.66			33.33			
Control 2	0.0			0.0			0.0			

Control(1) = seedling transplanted in infested soil
Control(2) = seedling transplanted non-in infested soil
L.S.D at 5% for
Fungicides (F) = 5.21 Pathogens (P) = 2.60
Time (T) = 2.60 FxP = 9.03
FxT =9.03 PxT = 4.51
FxPxT =15.64

The effect of time of fungicidal application on sour orange presented in Table (7) showed that the highest effect of tested fungicides was found at the same time of transplanting in infested soil with the tested fungi, followed by 15 and 30 days of transplanting. The comparison between different fungicides showed that Thiophanate-methyl, Carbendazim, Fludioxonil and Carboxin were the most effective fungicides against the tested fungi at all time of application. Tolclofos-methyl +Thiram, Thiabendazole and Flutolanil were moderate on their effect. While Propamocarb hydrochloride, Copper hydroxide and Copper oxycholoride + Metalaxyl were the least effective ones. Also, results indicated that *B. theobromae* was the most sensitive to fungicides, followed by *F. solani* and *F. oxysporum*, but the last was more

sensitive to Tolclofos-methyl + Thiram and Propamocarb hydrochloride than *f. solani*. Although Thiabendazole and Copper hydroxide were the least effective fungicides used against *F. oxysporum* and *F. solani*, they were the most effective ones for controlling on *B. theobromae.*

Table (7): Effect of the tested fungicides as soil drench on % infection of Sour Orange seedlings in soil infested with the tested fungi at three times of application.

Tested fungi / Fungicides	Time of application after transplanting in days									X
	F. oxysporum			*F. solani*			*B. theobromae*			
	0	15	30	0	15	30	0	15	30	
Carboxin	0.0	8.33	16.66	0.0	8.33	8.33	0.0	8.33	16.66	7.40
Copper oxycholoride +Metalaxyl	16.66	25.00	33.33	16.66	25.00	25.00	0.0	8.33	16.66	18.51
Carbendazim	0.0	8.33	8.33	0.0	8.33	8.33	0.0	0.0	8.33	4.62
Copper hydroxide	16.66	25.00	25.00	16.66	25.00	25.00	0.0	8.33	8.33	16.66
Thiophanate-methyl	0.0	8.33	8.33	0.0	0.0	8.33	0.0	0.0	8.33	3.70
Tolclofos-methyl + Thiram	0.0	8.33	8.33	0.0	8.33	16.66	8.33	16.66	16.66	9.25
Thiabendazole	8.33	16.66	25.00	8.33	25.00	25.00	0.0	0.0	8.33	12.96
Propamocarb hydrochloride	8.33	16.66	16.66	8.33	16.66	25.00	8.33	16.66	16.66	14.81
Fludioxonil	0.0	8.33	16.66	0.0	8.33	8.33	0.0	8.33	8.33	6.47
Flutolanil	8.33	16.66	16.66	0.0	8.33	16.66	8.33	16.66	25.00	12.95
Control 1	33.33			25.00			25.00			
Control 2	0.0			0.0			0.0			

Control(1) = seedling transplanted in infested soil
Control(2) = seedling transplanted non-in infested soil
L.S.D at 5% for

Fungicides (F)	**= 4.73**	**Pathogens (P)**	**=2.36**
Time (T)	**= 2.36**	**FxP**	**=8.19**
FxT	**=8.19**	**PxT**	**= 4.09**
FxPxT	**=14.20**		

Concerning the difference between the four citrus rootstocks, results in Tables (4,5,6 and 7) showed that all fungicides were the most effective on sour orange (the highly resistant rootstock whereas % infections in control treatment for *F. oxysporum, F. solani* and *B. theobromae* were 33.33, 25.00 and 25.00 %, respectively), followed by egyptian lime (% infections were 50.00, 41.66 and 33.33% for *F. oxysporum, F. solani* and *B. theobromae,* respectively). While all fungicides were the least effective on volkamer lemon and rough lemon (the highly susceptible rootstocks whereas % infection in control treatment were (75.00 and 83.33%), (50.00 and 66.66%) and (33.33 and 50.00%) for *F. oxysporum, F. solani* and *B. theobromae*, respectively.

Thiophanate-methyl, Carbendazim and Fludioxonil were the most effective fungicides against the three fungi on four rootstocks, followed, by Carboxin and Tolclofos-methyl +Thiram. While Flutolanil, Propamocarb hydrochloride, Thiabendazole, Copper hydroxide and Copper oxycholoride + Metalaxyl were the least effective ones. Thiabendazole gave the lowest effect against *F. oxysporum and F. solani* but it was the most effective fungicide against *B. theobromae* as Thiophanate-methyl. *Botryodiplodia theobromae* was the most sensitive to the tested fungicide in all rootstocks, followed by *F. solani and F. oxysporum*.

The obtained results could be explained by the presense of fungicides in the soil may cause certain abnormal mycelial forms on fungi or pushing them to dormant states, Rana, (1981) and El-Deeb *et al*., (1985).

On the other hand, it could be concluded that the action of effective fungicides *in vitro* studies was somewhat different than that recorded *in vivo* ones. This might be due to the different active ingredient of the tested fungicides, their mode of action and the effect of environmental condition during application on the reaction processes. When fungicides are used in suitable time and recommended dosage they are most effective and don't pollute the environment and keep human health.

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تأثير المعاملة بالمبيدات الفطرية على أمراض أعفان جذور أصول الموالح

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الملخص العربي

تتسبب أمراض أعفان الجذور في موت شتلات أصول الموالح التجارية. وكانت الفطريات *Fusarium oxysporum, F. solani* and *Botryodiplodia theobromae* الأكثر قدرة على إحداث المرض بجانب انها كانت أكثر الفطريات تكراراً في العزل من شتلات أصول الموالح التي ظهرت عليها أعراض الإصابة.

أظهرت دراسة تأثير عشر مبيدات فطرية في المعمل بناءاً عن قيم LC_{50} إن مبيدات كاربندازيم، ثيوفانات الميثيل، فلوداي اوكسونيل كانت أعلى كفاءة ضد الفطريات الثلاثة في حين كانت مبيدات كاربوكسين، تولكوفوس ميثيل + ثيرام ، فلوتولانيل، ثيابندازول متوسطة التأثير على الفطريات الثلاثة المختبرة. بينما كانت مبيدات بروباموكارب هيدروكلوريد، كوبراوكسي كلوريد+ ميتالاكسيل، كوبر هيدركسيد اقل المبيدات فاعلية. عند اختبار هذا المبيدات كمعاملة للتربة تحت ظروف الصوبةعلى اربع اصول للموالح هى الليمون المخرفش وليمون الفولكامرينا والليمون المالح المصرى والنارنج كان أعلى تأثير لهذه المبيدات عندما تم تطبيقها في نفس وقت زراعة الشتلات في التربة المعداه بالفطريات يليها معاملة التربة بالمبيدات بعد ١٥ يوم من الزراعة ثم بعد ٣٠ يوم من الزراعة. وكانت مبيدات ، ثيوفانات الميثيل، كاربندازيم، فلوداي اوكسونيل أكثر المبيدات فاعلية بينم.ا مبيدي كوبر هيدركسيد، ، كوبراوكسي كلوريد + ميتالاكسيل اقل المبيدات فاعلية في مكافحة المرض.

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Table (1): Frequency (%) of the isolated fungi from infected citrus rootstock seedlings during the two seasons 2007 and 2008.

Isolated fungi	Season 2007					Season 2008					Mean
	egyptian lime	Volkamer lemon	cleoptra mandarin	rough lemon	sour orange	egyptian lime	volkamer lemon	cleoptra mandari	rough lemon	Sour orange	
Aspergillus spp.	2.78	2.78	2.08	4.18	1.38	0.0	2.08	1.38	2.78	0.0	1.94
Fusarium semitectium	11.12	7.64	11.12	4.18	9.72	8.33	6.94	12.50	2.08	7.64	8.13
Fusarium oxysporum	31.95	34.03	28.48	37.49	29.86	32.63	32.63	29.86	35.43	29.16	32.15
Fusarium solani	27.07	27.77	31.24	30.56	30.56	29.86	29.16	30.56	31.24	30.56	29.85
Rhizoctonia solani	3.48	2.78	2.78	2.08	3.48	6.25	3.51	3.47	2.08	5.56	3.55
Botryodiplodia theobromae	15.27	14.59	15.97	13.19	15.97	15.97	16.66	14.59	15.27	13.88	15.14
Alternaria alternata	0.69	2.08	2.08	1.38	2.78	2.78	2.08	2.08	3.48	4.87	2.43
Phytophthora parasitica	7.64	8.33	6.25	6.94	6.25	4.18	6.94	5.56	7.64	8.33	6.81