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Management of Crown and Root Rot Diseases in Strawberry Commercial Fields in Egypt

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ABSTRACT

Surveyed strawberry fields at three different districts (Abo Swar, EL-Kassasin and El-Manayef) in Ismailia Governorate during 2014 -2016 growing seasons showed that 13 fungal species belonging to 13 genera were isolated from infected roots, runners and crowns segments of strawberry plants. The most frequent isolated fungi were; *Macrophomina phaseolina* (53.33%) and *Colletotrichum acutatum* (33.33%). These two pathogenic fungi were used in this study. Biological and chemical control experiments were conducted and significant differences in diseases incidence (DI%) and disease severity (DS%) were found among treatments of bioagents and chemical fungicides compared with control treatments. DI and DS percentages reached 0% when Bacillus *subtilis* or Rizolex were applied in plots of artificial infested soil with *M. phaseolina* and *C. acutatum*. *Trichoderma harzianum* occupied the second rank after *B. subtilis*, Rizolex (15 and 7.4% for DI) for *M. phaseolina* , (10 and 6.5% for DS)for *C. acutatum*, *T. viride* (16 and 16% for DI), (26 and 11% for DS) and *Streptomyces canescens* (20 and 21% for DI), (25 and 26% for DS), respectively. Moreover; Rizolex gave best results in pathogens control more than Topsin-M fungicide. In field experiment; the effect of soil disinfection using three treatments; two fumigants (Methyl bromide and Agrocelhone) and solar heating solarization applied on two strawberry cultivars (Festival and N-70) during 2015 and 2016 seasons were studied. Soil fumigation with Agrocelhone™ compound and Methyl bromide (MB) led to the best results for soil disinfection on both Festival and N70 Strawberry cultivars during two seasons. Percentage DI and DS of crown and root rot diseases occurred were (9.4, 9.0%) and (8.4, 7.5%) for both cultivars, respectively in 2015 it was very low (2.9, 3.0%) and (2.5 and 3.0%); respectively when applied again in 2016.

Keywords: Strawberry, Crown and Root Rot, *Colletotrichum acutatum* and *Macrophomina phaseolina,* Bioagents, Solar Heating Solarization, Soil Fumigation, Methyl bromide.

INTRODUCTION

Strawberry *(Fragaria ananessa* Duch) is considered as important economic vegetable crop in Ismailia Governorate. Ismailia growers produce 25.3% of the Egyptian strawberry production are 10,367 feddan produced 134,78 tons (Essa, 2015). Ismailia strawberry production dominates the market not only because its highly yielding, but also because the adapted of climates in the governorate allows strawberries to be harvested almost six months around the year. The control of both diseases in strawberry is challenging because the causal pathogens, *M. phaseolina*, and *Colletotrichum* spp. can survive for long periods in soil as resistant structures, Chemicals currently available for pre-plant soil disinfestation are not effective for eradication of *M. phaseolina* (Zveibil *et al.*, 2012 and Chamorro *et al,* 2015), Crown and root rot of strawberry, caused by *M. phaseolina* and soil-borne fungi have become predominant soil-borne diseases of strawberry in Egypt over the past years. The causal pathogens were isolated from infected strawberry plants of commercially grown cultivars. There is an increasing awareness toward pesticides and fertilizers which cause hazard to the environment and human health (Perkins and Patterson, 1997). Consequence, there is a trend to minimize the use of fungicides (Maas and Galletta, 1997). Ultimately the control of pathogens and pests of strawberry requires a combination of chemical and cultural methods. The effectiveness of chemicals for controlling diseases in fruiting fields is unclear. May be the incubation time between infection and disease occurrence is too long that most chemicals are ineffective in controlling diseases. Regular pesticide applications are also environmental contaminants and have harmful effects on human health. Thus, their use is not yet considered an appropriate cultivation practice (Fernandes *et al.* 2011). The pathogenic soil-borne fungi cause serious problems for strawberry sustainable production under continuous cropping (Wang *et al*., 2007). Soil-borne fungi infect host plants by penetrating plants through roots and it is responsible of severe damage and yield losses on many economically important plant species (Michielse and Rep, 2009). Management of soil-borne pathogens is mainly through chemical soil fumigation and resistant cultivars (Fravel *et al*., 2003).

The goal of this paper is to study the crown and root rot diseases in commercial fields of strawberry in Ismailia Governorate through isolation of causal pathogens, effect of soil treatments with bioagents and soil disinfection using combined chemical fumigants and solarization to control these diseases.

MATERIALS AND METHODS

Isolation and identification of the associated fungi:

The naturally infected plants in commercial fields at the three different districts; Abo-Swar, EL-Kassasin and El-Manayef in Ismailia Governorate were chosen for isolation of associated fungi. Isolation was undertaken from infected and apparent healthy plant including roots, crown and runner parts. Plants were first washed in water. Plant parts selected to be sectioned were removed from the plant and washed an additional 30 min in running water. Plant segments were cut 1-2 cm in length, dipped in 0.3% Sodium Hypochlorite solution for 15 secs, given double 1-minute washes in sterile water and dried between two sterilized filter papers, then placed on PDA medium in Petri's dishes. Four segments were placed in each plate and replicated in 3 Petri's dishes. Plates were stored in the dark at 23-25 C^o and periodically examined for fungi. Hyphal tip or single spore of each the developing fungi was transferred to PDA medium. Inoculum of each purified culture was transferred to PDA slants and incubated at 25 C^o. All fungal isolates were cultured on PDA for identification. The various filamentous isolated fungi were identified, based on its characteristics including morphological characteristics.

According to Gillman 1957, Clements and Shear 1957, Barnet and Hunter 1987, Booth 1971 and Domsch *et al*. 1980. The identification of all isolated fungi was confirmed by The Assuit University Mycological Center. (AUMC).

Biological control of strawberry crown and root rot disease under field conditions

Effect of dipping strawberry root in bioagent suspension was conducted to study its effect on crown rot and root rot diseases at the experimental farm of Faculty of Agriculture, Suez Canal Univ., during 2015 and 2016. The field soil belongs to sandy type with heavily natural infested with *M. phaseolina* and *C. acutatum* pathogens. The aim to evaluate effect of bioagent on the disease incidence and disease severity Seven antagonistic organisms were kindly obtained from Prof. Abdel Moiety, T. H., Central Lab. Of Organic Agriculture, Agr. Res. Center, Giza, Egypt. After screening isolates in dual culture test, four effective antagonists were selected to be tested in field experiments.

Inoculum preparation and transplants treatments

Starch Nitrate broth (StNb) Medium (Waksman 1959) was used for *Bacillus subtilis* and *Streptomyces canescens* inocula suspension. Six-weeks-old strawberry transplants (certified disease-free) of Festival cv. was used for root inoculation by dipping roots for 30 minutes in suspensions of bioagent grown on specific for liquid media according to Brain and Hemming 1945 or other material treatments (fungicides). The experiment involved four treatments out of the seven with three replicates as follow: *Trichoderma harzianum*, *Trichoderma viride* , *Bacillus subtilis* , *Streptomyces canescens* , Rizolex (fungicide) Topsin M (fungicide) and blank control treatment. These treatments were repeated in the natural infested soil. Three plots (each of 1.2 x 5m) in natural infested soil were used for each treatment. Artificial infested soil was peat moss soil packed in 30 cm diam. plastic pots inoculated with conidial suspensions (10^6/ml of *C. acutatum* and 5×10^5 /ml sclerotia of *M. phaseolina*). Three replicates were used for each treatment in addition to, control treatment was used. Each replicate contains 100 strawberry transplants. All strawberry transplants received the same fertilizers and irrigation regime. In all experiments strawberry cultivar Festival was used and dipped in diluted (1:50) as recommended dose of different bioagent preparation as suspension at concentration as above mentioned separately for 30 minutes then mixed with Tween 20 and 5% potassium soap to increase adhesive capacity and improve distribution of bioagent on the surface of treating transplant, just before transplanting. Transplants were soaked in water only for the same period to act as control. All experiments were designed in complete randomize plots design.

Diseases assessment: Percentages of disease incidence (DI%) of total crown and root rot diseases were determined 7-weeks after transplanting as follow: -

DI % of root rot = Number of with plants rotted roots /Total number of plants X 100.

(DS % was estimated using the following equation as described by Liu *et al*. (1995):

$$DS\% = \Sigma d / (d\ max \times n) \times 100.$$

Where: **(d) is the disease rating of each plant, (d max) means the maximum disease rating and (n) represents the total number of plants tested in each replicate.**

Effect of soil disinfection using chemical fumigants and solarization

The experiment was undertaken in naturally infested field with *C. acutatum* and *M. phaseolina* pathogens at the commercial farm of strawberry growers in Abo Swar district, Ismailia Governorate. Experiment was performed during two successive seasons (2015 and 2016). The following treatments were applied. Two soil fumigants were used; (1) Agroquimicos; A product is categorized as soil fumigant against fungi and nematode. The product active ingredient is composed of Dicloropropene 81.9% and Cloropicrine 46.5%. It was applied as soil fumigant at the rate of 50 grams per m^2 with irrigation water through drip irrigation system Treated soil was then covered using waterproof plastic sheet (min. 20 gauges) to allow the gas to transcend through the soil layers. Agrocelhone treatment was continued for a 15 days period, and then the plastic was removed to allow the aeration of the soil that took 7 days. (2) The other fumigant was Methyl bromide (MB- Metabrom, 98%). MB was applied before transplanting as fumigator (50g/ m^2) at a depth of 20 - 25 cm. mixed thoroughly and incorporated with the soil that covered with plastic film. Soil was uncovered seven days after the fumigation treatment.

Soil solarization treatment was carried out for 10 weeks during hot summer months of June and August in two seasons (2015 and 2016). Black polyethylene mulch (35µm thick), produced by El-Ahram Company was used to cover soil surface. Soil was provided every week with water for 1 hour through the drip irrigation system that located under the plastic mulch to increase the thermal sensitivity of soil pests and improve heat conduction for the more efficient eradication of pests in deeper soil layers. The plastic cover was removed, and the soil was good plowed (Katan, 1981).

The control treatment is natural infected soil with a history of root and crown rot disease at commercial farm of strawberry. This experiment was carried out under field conditions during 2015-2016 growing seasons at commercial arm in Abo Swar district, Ismailia Governorate, where soil is light sand loamy textured with natural infestation. Nile water is available in this area with drip irrigation system. Plots (each of 1.2 x 5m) were used as replicate. Three replicates were used for each treatment in addition to control treatment of untreated soil were used. Each replicate contains 100 strawberry transplants. All strawberry transplants received the same fertilizers and irrigation regime. In all experiment treatments strawberry cultivars Festival and N 70 were cultivated. The experiment was designed in complete randomize plots design. Percentages of DI and DS % using the above-mentioned equations for total crown and root rot diseases 7-weeks after transplanting and recorded up to three months after sowing until the end of the experiment.

Statistic analysis

Data from experiment were statistically analyzed with one-way ANOVA according to Steel and Torrie (1981). Software program, COSTAT version 6.311 was used to perform the analysis and means were compared using Duncan`s test at significant levels 0.05.

RESULTS

Isolation and identification of the associated fungi:

Data illustrated in Table (1) show that 13 fungal species belonging to 13 genera were isolated from infected roots, runners and crowns segments of strawberry plants collected from the three districts (Abo-Swar, EL-Manayef and EL-Kassasin) in Ismailia Governorate. These fungi were identified (alphabetically ordered in Table 1) as; *Alternaria alternata* (Fr.) Keissl, *Aspergillus niger* Tiegh, *Colletotrichum acutatum* J.H. Simmonds, *Fusarium oxysporum* Schlecht, *Macrophomina phaseolina* (Tassi) Goid., *Penicillium oxalicum* (Currie.) Thom ., *Pestalotia longisetula* Guba, *Phoma exigua* Sacc., *Rhizoctonia solani* Kuhn, *Rhizopus stolonifer* (Ehrenb.) Vuill., (Lib.) *Sclerotinia sclerotiorum* de Bary, *Sclerotium rolfsii* Sacc, and *Verticillium dahliae* Klebahn.

Statistical analysis shows that fungi with high frequency percentages was *M. phaseolina* (53.33%) followed by *C. acutatum* (33.33%), *R. solani* (33.33% in roots), *F. oxysporum* (25.93%), *A. alternata* (25%) while the lower number of fugal genera were belonging to *Phoma, Verticillium, Sclerotinia, Sclerotium* and *Pestalotia*. For plant segments; root segments yielded the higher number of isolated fungi followed by the crown and runner segments. The higher significant number of fungi was isolated from plants from Abo Swar districts followed by El Kassasin while the lower was from El Manayef district.

Table 1. Identified species of different fungal genera isolated from infected strawberry root, crown and runners parts *in vitro*

	Counties surveyed at Ismailia Governorate											
	Abo Swar				El-Kassasin				El-Manayef			
	Frequency (%)** of pathogen in plant segments*											
	A[1]	B[2]	C[3]	x̄	A[1]	B[2]	C[3]	x̄	A[1]	B[2]	B[3]	x̄
Alternaria alternata	8.33c[a]	8.33c	16.67b	11.11d	25.00a	0.00c	13.33c	12.78c	0.00d	0.00d	0.00d	0.00g
Aspergillus niger	8.33c	8.33c	8.33c	8.33e	0.00d	0.00c	0.00d	0.00g	0.00d	0.00d	0.00d	0.00g
Colletotrichum acutatum	8.33c	16.67b	16.67b	13.89c	12.50c	16.67b	33.33b	20.83b	20.00b	14.81c	19.05b	17.95d
Fusarium oxysporum	16.67b	16.67b	16.67b	16.67b	0.00d	0.00c	0.00d	0.00g	13.33c	25..93b	19.05b	19.44c
Macrophomina phaseolina	33.34a	25.00a	33.33a	25.00a	18.75b	33.33a	53.33a	35.14a	13.33c	29.63a	28.57a	23.84a
Penicillium oxalicum	0.00d	0.00d	0.00d	0.00f	0.00d	33.33a	0.00d	11.11d	0.00d	0.00d	0.00d	0.00g
Pestalotia longisetula	0.00d	0.00d	0.00d	0.00f	0.00d	0.00c	0.00d	0.00g	20.00b	0.00d	0.00d	6.67e
Phoma exigua	0.00d	0.00d	0.00d	0.00f	12.50c	0.00c	0.00d	4.17f	0.00d	0.00d	0.00d	0.00g
Rhizoctonia solani	16.67b	16.67b	0.00d	16.67b	12.50c	16.67b	0.00d	9.72d	33.33a	29.63a	0.00d	20.99b
Rhizopus stolonifer	8.33c	8.33c	8.33c	8.33e	0.00d	0.00c	0.00d	0.00g	0.00d	0.00d	0.00d	0.00g
Sclerotinia sclerotiorum	0.00d	0.00d	0.00d	0.00f	18.75b	0.00c	0.00d	6.25e	0.00d	0.00d	0.00d	0.00g
Sclerotium rolfsii	0.00d	0.00d	0.00d	0.00f	0.00d	0.00c	0.00d	0.00g	0.00d	0.00d	19.05b	6.35e
Verticillium dahliae	0.00d	0.00d	0.00d	0.00f	0.00d	0.00c	0.00d	0.00g	0.00d	0.00d	14.29c	4.76f
LSD (0.05)	1.916	1.798	2.303	1.656	1.682	1.063	0.473	1.395	1.369	0.868	1.168	0.409

*** Four segments (1–2 cm) of root, crown and runner were placed in each plate and replicated in 3 Petri's dishes. A[1]=roots, B[2]=runners, C[3]=crowns, = mean total, **Percentage of detected fungus = No. of infected segments / 12 X100**

a Each value represents the mean of 3 replicates. Values within same column followed by the same letter are not significantly different according to Duncan's multiple range test (P = 0.05)

Data presented in Table (2) show the effect of bioagents applied to the strawberry plants (Festival cv.) by dipping method of transplant roots in suspensions of bioagents for 30 min. before transplanting in either naturally or artificially infested soil with each pathogen. Results of experiment show significant differences in DI% and DS% among treatments of bioagents and chemical fungicides compared with control treatments. Lowest DI and DS% were 0% occurred in *B. subtilis* and Rizolex treatments in plots of artificial infested soil with *M. phaseolina* and *C. acutatum* followed by *T. harzianum* (15 and 7.4% for DI), (10 and 6.5% for DS), *T. viride* (16 and 16% for DI), (26 and 11% for DS) and *S. canescens* (20 and 21% for DI), (25 and 26% for DS) in artificial infested soil with *M. phaseolina* and *C. acutatum,* respectively. Moreover; Rizolex gave best results in pathogens control more than Topsin-M fungicide.

Data presented in Table (3) show the effect of soil disinfection treatments using 2 chemical fumigants and solarization applied on 2 strawberry cultivars (Festival and N-70) infected with crown and root rot diseases under field condition during two seasons. Results indicated significant differences among treatments for DI and DS compared with control. Soil fumigation with Methyl bromide (MB) led to the best results for soil disinfection (9.40%DI, 9 %DS), (2.9%DI, 3%DS), (8.4%DI, 7.5%DS) (2.5%DI, 3%DS) in both Festival and N70 cvs. during 2015 and 2016 seasons; respectively. Also, soil solarization led to significant results and came in the second order after Methyl bromide for lower values of DI and DS (6.25%DI, 10 %DS), (5.2%DI, 7%DS), (5.55%DI, 11%DS) (5.9%DI, 6.5%DS) in both Festival and N70 cvs. during 2015 and 2016 seasons; respectively.

The third treatment was soil treated with Agrocelhone (chemical compound) for soil fumigation. It caused significant reduction (35.0%DI, 15.6%DS) and (31.9%DI, 31%DS) in infection with crown and root rot diseases compared with control treatments in 2015 (64.0%DI, 66.0%DS) and (66.0%DI, 74.0%DS) in 2016 but, it was low-significant (32%DI, 18%DS) and (33%DI, 31%DS) in the second year 2016 when compared with the control treatment. Also, it was less effective compared with soil treatment with solarization or MB.

Table 2. Effect of dipping strawberry seedlings in bioagent suspensions for 30 min against strawberry crown and root rot diseases and grown in soil infested with *M. phaseolina* and *C. acutatum in vivo*.

Treatments	Disease incidence (%)		Disease severity (%)	
	M. phaseolina	*C. acutatum*	*M. phaseolina*	*C. acutatum*
	Natural infested soil			
T. harzianum	75.0b*	62.5a	60.0b	35.0c
T. viride	50.0d	50.0b	34.5d	21.0f
B. subtilis	62.5c	50.0b	52.5c	63.0a
S. canescens	62.5c	50.0b	53.6c	31.0d
	Artificially infested soil			
T. harzianum	15.0f	10.0d	7.40h	6.50h
T. viride	16.0f	26.0c	16.0g	11.0g
B. subtilis	0.00g	0.0e	0.00i	0.0i
S. canescens	20.0f	25.0c	21.0f	26.0e
Rizolex	0.00g	0.0e	0.00i	0.0i
Topsin – M	44.0e	10.0d	28.3e	2.0i
Control (without pathogen)	0.00g	0.0e	0.00i	0.0i
Control (with pathogen)	100a	62.5a	83.0a	57.5b
LSD (0.05)	5.413	5.557	2.869	2.815

*** Each value represents the mean of 5 replicates and values within same column followed by the same letter are not significantly different according to Duncan's multiple range test (*P = 0.05*)**

Table 3. Effect of soil disinfection by 2 chemical fumigants and solarization on strawberry infection with crown and root rot diseases under field condition during 2015 and 2016 growing seasons.

Treatments	2015				2016			
	Cultivar							
	Frestival		N70		Frestival		N70	
	DI	DS	DI	DS	DI	DS	DI	DS
Agrocelhone	35.00c	15.60b	31.90b	31.00b	32.00b	18.00b	33.00b	31.00b
Methyl bromide	9.40b	9.00c	2.90c	3.00d	8.40c	7.50d	2.50c	3.00d
Soil solarization	6.25c	10.00c	5.20c	700c	5.55c	11.00c	5.90c	6.50c
Control	64.00a	66.00a	35.00a	64.00a	66.00a	74.00a	48.00a	58.00a
LSD (0.05)	4.23	1.73	2.61	1.49	3.00	2.86	3.89	3.43

DI- Disease incidence % = No. of infected plants / Total cultivated plants X 100

DS%= Σd/ (d max × n) ×100. Where: (d) is the disease rating of each plant, (d max) means the maximum disease rating and (n) represents the total number of plants tested in each replicate.

*** Each value represents the mean of 5 replicates and values within same column followed by the same letter are not significantly different according to Duncan's multiple range test (P = 0.05)**

DISCUSSION

Data collected from the 3 districts in Ismailia Governorate show that 13 fungal species belonging to 13 genera (Table 1) were isolated from rotted, wilted roots, runner and crowns of strawberry plants collected from the three districts (Abo-Swar, EL-Manayef and EL-Kassasin), Ismailia Governorate. Also, observation of data revealed that strawberry runner's infection didn't appear in early season due to death of plant roots and farmers compensate the absent infected plants with new healthy transplants.

The variations of frequencies of different fungi isolated might be due to different root rot exudates produced by different varieties. These root exudates act as stimulator or suppressor for the saprophytes in the rhizosphere of plants consequently it increases number of saprophytes around roots and protect root from infection or clean up the saprophytes and prepare stage for pathogen to invade healthy root causing root rot (Xue Jing *et al.,*2011).

This finding agrees with the results obtained by Abd Sattar *et. al*., (2008) and Essa (2015), they reported that the pathogenicity test carried out on five strawberry cvs. against *R. solani* revealed that Tudla cv. was more resistance, while Gavuta cv. was the most susceptible followed by Chandler cv. The other two cultivars; Festival and Camarosa showed moderate susceptibility to root rot disease.

Abdet-Sattar *et al*., (2008) found similar results in survey carried out during 2007 season in five locations at Ismailia Governorate on fresh strawberry cv. (Frigo). Percentage of crown and root rot infection recorded at El-Manayef on fresh Gavuta plants reached 12.1%. Percentage infection recorded on Camarosa cv. at El-Kassasin; Festival cv. at Sarabium and Camarosa at El Wasfia were 8.4, 8.3

and 7.3 %; respectively. Whereas, Sweet Charlie cv. showed the lowest percentage of root rot infection for both fresh and Frigo plants. The control of soil-borne diseases in strawberry is challenging because the causal pathogens, *M. phaseolina, R. solani* and *C. acutatum* can survive for long periods in soil as resistant structures. It disseminated by various means, including wind, soil and infected plant material. Chemicals currently available for pre-plant soil disinfestation are not effective for the eradication of *M. phaseolina* (Zveibil *et al.*, 2012; Chamorro *et al.,* 2015). In our survey and isolation, *Phoma exigua*. was isolated and its recorded frequency was 4.17% from root in El-Kassasin district only. These findings in agreement with the results obtained by Gozlar *et al.,* (2007) in Australia and in Latvia by Grantina-Ievina and Kalniņa (2016).

Results in Table (2) indicated that dipping transplant roots in *T. harzianum, T. viride, B. subtilis* and *S. canescens* suspensions showed significant reduction of percentages of DI and DS% compared with control (100% DI) treatment with pathogen only. Also, the treatments of dipping roots in Rizolex and Topsin-M fungicides showed higher reduction in DI% and DS% for *M. phaseolina* or *C. acutatum*. It was 0.0% in case of Rizolex treatment while it was 44.0 and 10.0% for DI and 28.0% and 2.0% for DS for Topsin-M fungicide compared with the control of infested soil with each pathogen only. Biological control agents in the genera of *Trichoderma* and *Bacillus* have been extensively used for the control of other plant diseases (Cawoy *et al*., 2011; Naher *et al*., 2014). *T. harzianum* acts through different modes of action i.e. mycoparasitism (Lumsden *et al*., 1995, Abada, 2002 and Ahmed, 2013) as production of antifungal substances (Robinson *et al*., 2009), also it owns an enzymatic system that causes destruction of the pathogens (Elad and Kapat, 1999 and Ziedan *et al*., 2005). In addition to these modes of action, *Trichoderma* also acts as inducer for resistance in treated plants against certain pathogens (Harman, 2006); it can grow within wide range of temperature and other environmental conditions (Bailey *et al*., 2008 and Zaman *et al.*, 2015).

Regarding the effect of soil disinfection using chemical fumigants and solarization on strawberry infected with crown and root rot diseases under field condition; our results showed that soil fumigation with Methyl bromide (MB) led to the best results for soil disinfection planted with both Festival and N70 cvs. during 2015 and 2016 seasons. Percentages of DI and DS of crown and root rot disease symptoms occurred were very low for both cultivars. Soil solarization treatment occupied the second order after MB and led to best natural control results for soil disinfection in both Festival and N70 cvs. during 2015 and 2016 seasons. Infection with crown and root rot diseases was low compared to control treatments. Our findings are also in conformity with the work of Razik *et al*., (1989). They studied the short- and long-term effects of solarization and fumigation with methyl bromide (MB) on strawberry growth and yield and on weed control. In these experiments, weed control was observed and no major soil-borne diseases were detected. Solarization is an additional nonchemical control method effective against potential pathogens.

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مكافحة مرض عفن التاج والجذور فى حقول الأنتاج التجارى للفراوله فى مصر

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تم عمل حصر للنباتات المصابه فى حقول انتاج الفراولة التجارية فى مراكز ابو صوير والقصاصين والمنايف بمحافظة الأسماعيليه خلال المواسم الزراعية فى ٢٠١٤-٢٠١٦. وذلك لعزل الفطريات الممرضة المسببه لأعفان التاج والجذر . وأجريت تجارب لدراسة المقاومة الحيويه للمسببات المرضية لمرض عفن التاج والجذر فى تربة بها اصابه طبيعية أظهرت النتائج ان نسب وشدة الأصابة التى تم تقديرها بعد أجراء المعاملات بأستخدام اسلوب النقع للشتلات فى معلقات محاليل كائنات التضاد الحيوى وتشمل انواع فطريات *Trichoderma* وبكتيريا *Bacillus* and *Streptomyces* ادت الى مقاومة أكثر من ٥٠% من نسب الأصابه بينما كانت شدة الأصابه تتراوح بين (٢١-٣٦%) وفى المعاملة ببكتريا *Bacillus subtilis* كانت ٦٣% اما فى التجربه التى اجريت فى تربه تم عمل عدوى صناعية لها بكلا لقاحين المسببين المرضين أظهرت النتائج لنسب وشدة الأصابه كانت ١٠٠% و ٥٠% على التوالى بينما كانت ٦٠ و ٣٥% بالنسبة لشدة الأصابه على التوالى لكلا الفطرين الممرضين. وبالنسبة لتجارب تعقيم التربة بمعاملات التعقيم الشمسى ومبخرات التربة وتأثيرها على الأصابة بمرض عفن التاج والجذور فى أصناف الفراولة (Festival and N-70) تحت ظرف الحقل. أظهرت النتائج أن استخدام مركب Agrocelhone أدى الى خفض الاصابة بنسب تصل الى ٥٠% و الميثيل بروميد الى ٩٠% حيث أنخفضت نسب الأصابة وشدة الأصابة فى الصنفين Festival and N-70 الى ٩.٠-٩.٤% و ٨.٤-٧.٥% فى سنة ٢٠١٥ بينما كانت ٢.٩-٣.٠% و ٢.٥-٣.٠% فى ٢٠١٦ على التوالى.