J. Agric. Sci. Mansoura Univ., 33 (3): 2273 - 2284, 2008

CHEMICAL AND BIOLOGICAL CONTROL OF WILT AND DAMPING-OFF DISEASES OF TOMATO.

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ABSTRACT

Seven fungicides (i.e. tetraconazole, difenoconazole, trifloxystrobin, pyraclostrobin +metiram, metiram, mancozeb and flutolanil) and three biological agents (i.e. *Trichoderma harzianum*, *Trichoderma album* and *Bacillus subtilis*) were evaluated in laboratory against two pathogenic fungi; *Fusarium oxysporum* f. sp. *lycopersici* and *Rhizoctonia solani* causing wilt disease and damping off of tomato seedlings, respectively. Depend upon EC_{50} values of the tested fungicides, the *in vitro* studies showed that the descending order of fungicidal activity against *Fusarium oxysporum* f. sp. *lycopersici* growth was as follows; difenoconazole > tetraconazole > pyraclostrobin + metiram > trifloxystrobin > metiram > mancozeb > flutolanil, while it was flutolanil > difenoconazole > tetraconazole > mancozeb > pyraclostrobin + metiram >trifloxystrobin > metiram against *Rhizoctonia solani* growth. In greenhouse trials, the fungicides were applied at 1500 and 3000 µg a.i./ml water as seed treatment, while biological agents were applied at 1.5 and 3.0 x 10^6 spore/ml water as soil treatment. The results showed that all fungicides and bioagents treatments significantly reduced diseases incidence and increased emergence and plant stands. Fungicides tested were better to control wilt and damping off than bioagents. Generally the most effective treatments for controlling wilt disease were difenoconazole, tetraconazole, pyraclostrobin + metiram, followed by trifloxystrobin, metiram, mancozeb, *T. harzianum*, while the lowest were *B. subtilis*, *T. album* and flutolanil as compared with the control treatment, while the most effective fungicide for controlling damping off was flutolanil followed by difenoconazole, tetraconazole, pyraclostrobin + metiram, mancozeb and the lowest was metiram as compared with the control treatment. *Trichoderma harzianum* was the most effective bioagent tested for controlling damping off, followed by *B. subtilis* while *T. album* was the least effective one. Castel rouck cultivar was more resistant to the two diseases under artificial inoculation and greenhouse conditions, whereas Money Maker seemed to be highly susceptible.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important and widely distributed vegetable crops in the world. This crop is subjected to be attacked by many diseases including Fusarium wilt and damping-off which have long been known as two of the most important diseases of tomato in many parts of the world. The causal pathogens are the two soil-borne fungi *Fusarium oxysporum* f. sp. *lycopersici* and *Rhizoctonia solani*, respectively. These pathogens seriously attack tomato seedlings both in the nurseries and in the open fields after transplanting particularly through early summer and Nili tomato plantations at Upper Egypt Governorates and new reclaimed sandy regions (Awad, 1990).

In addition to the previously mentioned diseases, the most important pathogens affecting tomato crop under greenhouse conditions are *Pyrenochaeta lycopersici, Phytophthora parasitica* and *Fusarium solani*

(Apablaza, 2000). In many cases, some of them may cause damage as a complex (*F. oxysporum* f. sp. *lycopersici, F. solani, P. lycopersici*, and *R. solani*) (Montealegre *et al*., 2004).

The susceptibility of different tomato cultivars to soil borne fungi has been detected by several investigators (Pugacheva, 1982; Yousef *et al*., 1992 and Mosa, 1997).

Systemic and non-systemic fungicides have been used for controlling tomato diseases by several means of applications. Tetraconazole and difenoconazole were used by Arie *et al*. (2007). The fungicidal action of trifloxystrobin and pyraclostrobin was evaluated by Margot *et al.*(1998) and Manaresi *et al*. (2002) who reported that these compounds have a wide range of activity against fungal pathogens belonging to different fungal classes. The fungicidal activity of flutolanil was studied by Yamaguchi *et al*. (1998), Kondoh *et al*. (2000) and Arie *et al*. (2007). On the other hand, metiram and mancozeb were among fungicides evaluated against *Fusarium moniliforme* in rice under laboratory and field conditions (Gumustekin and Akn (2001).

Also, biological agents have been widely used for controlling tomato plant diseases, for example, *Trichoderma* spp., were found to exhibit significant action against diseases caused either by *F. oxysporum* (Aboul-Nasr & EL-Farawany, 1995 and Larkin & Fravel, 1998) or *Rhizoctonia solani* (Durman *et al*., 1999). Cazorla-Lopez *et al*. (2001) found that *Bacillus subtilis* had a good biological control against *Fusarium oxysporum* f. sp. *radicis lycopersici* in tomato.

The present investigation was conducted to test the effect of seven fungicides belonging to different fungicidal groups and three bioagents against *Fusarium oxysporum* f. sp. *lycopersici* and *Rhizoctonia solani*. The evaluation was carried out both *in vitro* and in greenhouse.

MATERIAL AND METHODS

1. Fungicides and Bioagents.

Seven fungicides and three bioagents were evaluated against the two pathogenic fungi. The fungicides tested were: tetraconazole (Domark 10 % E.C.), difenoconazole (Score 25 % E.C.), trifloxystrobin (Flint 50 % W.G.), pyraclostrobin + metiram (Cabrio Top 60 % (5 + 55) W.G.), metiram (Polyram 80 % D.F.), mancozeb (Anadoul 80 % W.P.) and flutolanil (Moncut 25 % W.P.). The used bioagents were: Plant-guard (Egyptian strains of the fungus *Trichoderma harzianum* each one cm^3 of the liquid contain 30 million organisms), Bio zeid (Egyptian strains of the fungus *Trichoderma album* each one g contain 10 million organisms) and Bio arc (Egyptian strains of the bacterium *Bacillus subtilis* each one g contain 25 million organisms). Samples of these fungicides and bioagents were obtained as gifts from the project of "Control of tomato diseases" at the Plant Protection Department, Faculty of Agriculture, Al-Azhar University.

2. *In vitro* sensitivity tests.

Sensitivity of *Fusarium oxysporum* f. sp. *lycopersici* and *Rhizoctonia solani* to the tested fungicides was evaluated according to Frisina and

Benson (1988). The fungicides were suspended or emulsified in sterile distilled water then added to cooled (ca., 50° C) PDA medium at concentrations of 0.01, 0.05, 0.1, 0.5, 1.0, 5.0, 10.0, 50.0 and 100.0 µg a.i / ml for each fungicide. A 0.5 cm diameter disk was removed with a cork borer from the growing margin of a 7-day old of tested fungi colony and transferred to the center of a new PDA medium plate into which the fungicides to be tested were incorporated. All treatments were replicated three times and incubated at 25° C for 7 days. The percent inhibition as indicated by measuring the radial growth for each fungus was estimated based on the nonamended treatment. Activity of fungicides were determined by calculating EC_{50} value according to Finney (1971).

3. Pot experiments.

3.1. Soil infestation.

To prepare inocula required for the test, the isolates of *Fusarium oxysporum* f. sp. *lycopersici* and *Rhizoctonia solani* were grown in 500 ml conical flask contained barley grains medium. The used soil (clay loamy) was air dried, sieved and packed in some polyethylene bags which were steamed in an autoclave until a temperature of 100° C (1.3 – 1.4 pressure) was reached and then holding the temperature at 90 -110° C (1.1 -1.4 pressure) for 1.0 hours (Knudsen and Bin, 1990). The inoculum of each fungus was incorporated into the autoclaved soil at the level of 5% w/w and thoroughly mixed. Plastic pots (25 cm in diameter), which were previously sterilized by 5 % formalin solution, were filled with infested soil, except control without infestation (the same amount of the sterile barley grains without fungus). All pots were daily irrigated for 7 days to stimulate the fungal growth and to ensure its distribution within the soil before cultivation.

3.2. Fungicidal seed and biocontrol treatments.

The experiments were carried out at the greenhouse at the same department to investigate the efficiency of the fungicides as seed treatment and biological agents as soil treatment against Fusarium wilt and Rhizoctonia root rot. The fungicides were applied at the concentrations of 1500 and 3000 µg a.i/ml. Seeds were treated with the tested fungicides according to the method described by Abang and Iloba (2002). An emulsion or a suspension of each of the fungicides was prepared in sterile distilled water at a concentration of 1500 and 3000µg a.i/ml and these treatments were applied as soak treatments. Sterile distilled water served as control. Seeds of the tomato cultivars (Castel rouck and Money Maker) were shaken in conical flasks containing the concentrations of fungicides (100 ml solution) on a mechanical shaker for 20 minutes and allowed to stand for 30 minutes. Biological control treatments were carried out by adding spore suspension (10 ml/pot) of the biological agents, at concentrations of 1.5 and 3.0 x 10^6 spore /ml water on the surface of infested soil.

The experiments were designed as follows:

1. Fungicide – free seeds in non – infested soil.
2. Fungicide – free seeds in soil infested with *F. oxysporum* or *R. solani.*
3. Fungicide – treated seeds in soil infested with *F. oxysporum* or *R. solani.*
4. Fungicide – free seeds in soil infested with *F. oxysporum* or *R solani* and biological agent.

Each pot was planted with 15 tomato seeds and each treatment was replicated four times. In case of *Fusarium oxysporum* f. sp. *lycopersici*, pre-emergence damping - off % was calculated one month after sowing, while wilted plants percents were recorded another month later. For *Rhizoctonia solani*, the pre- and post-emergence damping-off % were recorded after 15 and 45 days from sowing, respectively.

RESULTS AND DISCUSSION

1. Sensitivity of the fungi to the fungicides.

The *in vitro* sensitivity of *Fusarium oxysporum* f. sp. *lycopersici* and *Rhizoctonia solani* to seven fungicides were determined. The concentration that inhibits 50 % of the fungal growth (EC_{50} values) of the tested fungicides are listed in Table (1).

Table (1): EC_{50} values (µg a.i. / ml) of the tested fungicides against mycelial growth of two fungi grown on PDA medium.

Fungicides	EC_{50}	
	Fusarium oxysporum* f. sp. *lycopersici	***Rhizoctonia solani***
Tetraconazole	1.15	1.17
Difenoconazole	0.78	0.98
Trifloxystrobin	8.51	16.22
Pyraclostrobin + metiram	1.51	3.63
Metiram	12.88	17.38
Mancozeb	16.60	1.55
Flutolanil	67.61	0.29

Fusarium oxysporum f. sp. *lycopersici* was highly sensitive to difenoconazole, tetraconazole and pyraclostrobin + metiram (EC_{50} = 0.78, 1.15 and 1.51 µg a.i. / ml, respectively), however, it was moderately sensitive to trifloxystrobin, metiram and mancozeb (EC_{50} = 8.51, 12.88 and 16.60 µg a.i. / ml, respectively). On the other hand, flutolanil was the least effective against this fungus (EC_{50} = 67.61 µg a.i. / ml).

The results also indicated that flutolanil, difenoconazole, tetraconazole and pyraclostrobin + metiram were the most effective fungicides in inhibiting the mycelial growth of *Rhizoctonia solani* (EC_{50} were 0.29, 0.98, 1.17 and 3.63 µg a.i. / ml, respectively). However, the EC_{50} values for trifloxystrobin and metiram were considerably higher (EC_{50} = 16.22 and 17.38 µg a.i. / ml, respectively), indicating less sensitivity of the fungus.

Data listed in Table (1) showed high efficacies of triazole compounds (difenoconazole and tetraconazole) against both *F. oxysporum* f. sp. *lycopersici* and *R. solani* under laboratory condition. This result is in accordance with that obtained previously (Mathieson and Rush, 1991; Decognet *et al*., 1999 and El-Khawaga, 2006). Similarly, Manaresi *et al*. (2002) indicated that pyraclostrobin alone showed a broad - spectrum activity against different fungi on several crops including tomatoes.

Trifloxystrobin fungicide exhibited a moderate effect against the growth of *F. oxysporum* f. sp. *lycopersici* and it was less effective against *R.*

solani growth (Table 1). This result was confirmed by El-Khawaga (2006) who found that the EC_{50} values of trifloxystrobin to *F. oxysporum* f. sp. *lycopersici* and *R. solani* were 22.41 and 117.48 µg a.i. / ml, respectively. Gullino *et al*. (2000 a and b) found that trifloxystrobin was very effective to *F.oxysporum* in ornamental plants.

Data listed in Table (1) indicated that metiram and mancozeb were less effective to *F. oxysporum* f. sp. *lycopersici* which is in agreement with that obtained by Gumustekin and Akn (2001) who found that both metiram and mancozeb were not effective against *Fusarium moniliforme* on rice.

Same table showed that flutolanil was the most effective fungicide against *R. solani* growth, but it was the least effective one against *F. oxysporum* f. sp. *lycopersici*. Similar results were previously obtained by (Kondoh *et al*., 2000; El-Khawaga, 2006). Moreover, Yamaguchi *et al*. (1998) found that flutolanil did not inhibit *F. oxysporum* growth at up to 1000 ppm.

Tetraconazole and difenoconazole are members of triazole fungicides or demethylation inhibitors (DMIs) that inhibit the biosynthesis of ergosterol, which is an important component of the fungal cell membrane, by inhibiting C_{14}– demethylase. Trifloxystrobin and pyraclostrobin are members of strobilurins fungicides that inhibit the mitochondrial respiration at complex III. Metiram and mancozeb are members of dithiocarbamate fungicides that have multi-site of action. Flutolanil isa benzanilide fungicide which inhibit respiration at complex II. The chemical structures of the tested fungicides (their functional groups), their mode of actions and the nature of the target fungus may be contributory factors affecting their fungicidal activities.

2. Pot experiments.

2.1. Effect of fungicides and biological agents on the disease caused by *Fusarium oxysporum* f. sp. *lycopersici*.

It is clear from the data presented in Table (2) that all fungicides tested as seed treatment and bioagents tested as soil treatment, significantly reduced disease incidence and increased emergence and plant stands compared to the control treatment (seeds planted in infested soil). Decrease of pre-emergence damping-off with the treated seeds or soil may be attributed to the effect of fungicides or bioagents on the pathogen attacking the seeds causing seed decay (Yousef *et al*., 1992). Data indicated also that the tested fungicides and bioagents were effective in reducing the wilted seedlings when compared with untreated seeds or soil. It was noticed that increasing the concentration of the tested fungicides and / or bioagents resulted in enhancing their efficiencies against the pathogenic fungus with increasing the growing plants. Triazole fungicides and pyraclostrobin + metiram were more effective in controlling pre-emergence damping-off and wilted plants caused by *F. oxysporum* f. sp. *lycopersici*, followed by trifloxystrobin, metiram, mancozeb, *Trichoderma harzianum*, while *Bacillus subtilis*, *Trichoderma album* and flutolanil were the least effective ones. Regarding the plant survivals, the effect of fungicides significantly differed from that of bioagents. However, the difference between tetraconazole and difenoconazole was not significant. Also, there was a significant difference between difenoconazole and pyraclostrobin + metiram, while there was no

significant difference between tetraconazole and pyraclostrobin + metiram. The statistical analysis showed that the difference between pyraclostrobin + metiram and trifloxystrobin was significant at 5 % level of p. only, but there was significant difference between triazole compounds and trifloxystrobin at the two levels of p. The statistical analysis also showed that the difference between trifloxystrobin and *T. harzianum*, metiram was not significant in Castel rouck cv., but significant in Money Maker cv. L.S.D. values for treatments indicated also that there were no significant differences between *T. harzianum*, metiram and mancozeb. Also, there was no significant difference between *B. subtilis* and *T. album* in case of Castel rouck cv., but there was significant only at 5 % level of p. in case of Money Maker cv. On the other hand, Table (2) showed also that flutolanil fungicide, which was the least effective one, significantly differed from all tested fungicides. Its effect however did not significantly differ from that of *T. album*. The statistical analysis also showed that the difference between the efficiency of the two applied concentrations was highly significant in all treatments. Concerning the difference between the two cultivars (Castel rouck and Money Maker), results showed that they differed significantly from each other in susceptibility to *Fusarium oxysporum* f. sp. *lycopersici* and the response to different treatments.

The results obtained are in agreement with those obtained by many investigators. Decognet *et al*. (1999) found that difenoconazole had a strong effect on radial and germ tube growth of the *Fusarium* sp. Trifloxystrobin was among compounds tested by Gullino *et al*. (2002) who cited that such compound was found to be highly effective against Fusarium wilt of carnation (*Fusarium oxysporum* f. sp. *dianthi*). This compound and other strobilurins controlled the disease when applied at transplant as soil drenching at the rate of 1-2 g / m^2. Manaresi *et al*. (2002) reported that pyraclostrobin had protectant, curative, translaminar and locosystemic properties. It was highly active fungicide against Deuteromycetes. Mancozeb, which significantly proved the plant survivals and reduced damping-off and wilted plants (Table 2) was tested earlier by Yousef *et al.* (1992) who found that it was effective in reducing the Fusarium wilt incidence on tomato plants under greenhouse conditions and increase emergence and plant stands. Mancozeb, in their results, was used as a mixture with Tecto showed the lowest fungicidal activity. Gumustekin and Akn (2001) however found that Polyram DF (metiram) and Dithane M-45 (mancozeb) were not effective against *Fusarium moniliforme* in rice under laboratory and field conditions, they recorded less than 50% disease control. Flutolanil, which was the least effective in our results, was found to be one of the non active fungicides tested by Yamaguchi *et al*. (1998) against an isolate of *Fusarium oxysporum* at a concentration of up to 1000 ppm.

Table (2): Greenhouse effect of fungicides and bioagents on *Fusarium oxysporum* f. sp. *lycopersici*.

Treatments and Concentrations (µg/ml)	Castel rouck			Money Maker		
	Average % of			Average % of		
	Pre-emergence damping-off	Wilted plants	Plant survivals	Pre-emergence damping-off	Wilted plants	Plant survivals
Control (1)*	3.33	3.57	93.33	3.33	1.66	95.00
Control (2)**	30.00	43.81	40.00	41.66	63.88	21.66
Tetraconazole (1500)	16.66	25.95	61.66	18.33	28.84	58.33
Tetraconazole (3000)	10.00	14.83	76.66	11.66	15.10	75.00
Difenoconazole (1500)	15.00	21.46	66.66	18.33	26.76	60.00
Difenoconazole (3000)	10.00	12.90	78.33	10.00	11.26	80.00
Trifloxystrobin (1500)	18.33	30.60	56.66	21.66	34.08	51.66
Trifloxystrobin (3000)	13.33	23.07	66.66	16.66	23.87	63.33
Pyraclostrobin + metiram (1500)	18.33	28.36	58.33	21.66	31.81	53.33
Pyraclostrobin + metiram (3000)	11.66	15.10	75.00	11.66	16.89	73.33
Metiram (1500)	21.66	31.81	53.33	28.33	39.77	43.33
Metiram (3000)	16.66	26.11	61.66	20.00	29.16	56.66
Mancozeb (1500)	23.33	32.49	51.66	31.66	41.56	40.00
Mancozeb (3000)	18.33	26.44	60.00	21.66	32.28	53.33
Flutolanil (1500)	26.66	36.36	46.66	38.33	54.51	28.33
Flutolanil (3000)	25.00	33.33	50.00	33.33	47.50	35.00
T. harzianum ($1.5x10^6$)***	21.66	30.18	55.00	30.00	42.92	40.00
T. harzianum ($3.0x10^6$)***	18.33	24.52	61.66	21.66	32.00	53.33
T. album ($1.5x10^6$)***	26.66	34.24	48.33	36.36	52.77	30.00
T. album ($3.0x10^6$)***	21.67	32.00	53.33	28.33	44.31	40.00
B. subtilis ($1.5x10^6$)***	25.00	33.52	50.00	33.33	47.97	35.00
B. subtilis ($3.0x10^6$)***	20.00	29.63	56.66	26.66	38.59	45.00

L.S.D. at	Pre-emergence damping-off		Wilted plants		Plant survivals	
	1%	5%	1%	5%	1%	5%
Treatments (T) =	4.20	3.25	5.64	4.27	5.87	4.44
Cultivars (C) =	1.75	1.33	2.30	1.75	2.39	1.81
TxC =	6.06	4.59	7.98	6.05	8.29	6.28
Concentration (X) =	1.75	1.33	2.30	1.75	2.39	1.81
TxX =	N.S	N.S	N.S	6.05	8.29	6.28
CxX =	N.S	N.S	N.S	N.S	N.S	N.S
TxCxX =	N.S	N.S	N.S	N.S	N.S	N.S

*** Control (1) = Seeds planted in non-infested soil.**
**** Control (2) = Seeds planted in infested soil.**
***** Spores per ml.**

EL-Kazzaz *et al*. (2002 a and b) found that *Trichoderma harzianum*, *Bacillus subtilis* had substantial effect against the soil borne pathogens causing wilt and root rot diseases of tomato. Under greenhouse conditions results showed that significant reduction in post-emergence damping-off and disease index of tomato plants caused by *Fusarium oxysporum* f. sp. *lycopersici* and *Rhizoctonia solani* were achieved by the application of the tested antagonists. However, these authors found that *T. harzianum* was the best antagonist among the tested bioagents.

There is a degree of variation in susceptibility to *Fusarium* sp. between the two tested cultivars (Table 2). Castel rouck was more resistant under artificial inoculation and greenhouse conditions, whereas Money Maker seemed to be highly susceptible. Similar results were obtained by Awad (1990); Yousef *et al*. (1992) and Mosa (1997) when they tested the sensitivity of different tomato cultivars to Fusarium wilt disease.

2.2. Effect of fungicides and biological agents on the disease caused by *Rhizoctonia solani*.

The effects of the tested fungicides applied at 1500 and 3000 µg a.i. / ml and bioagents at 1.5 x 10^6 and 3.0 x 10^6 spores/ ml to control the incidence of pre- and post-emergence damping off of tomato caused by *Rhizoctonia solani* are listed in Table (3). The incidence of pre- and post- emergence of untreated seeds and soil were 46.66 and 37.80 %, respectively for Castel rouck cultivar and 55.00 and 52.37 %, respectively for Money Maker cultivar. Castel rouck was more resistant under artificial inoculation and greenhouse conditions, whereas Money Maker seemed to be highly susceptible.

Results indicated that all fungicides tested as seed treatment and bioagents tested as soil treatment were able to control damping-off caused by *Rhizoctonia solani,* with different degrees. Fungicides tested were more able to control damping-off than bioagents. Flutolanil was the most effective fungicide tested, followed by difenoconazole, pyraclostrobin + metiram, tetraconazole, mancozeb, but trifloxystrobin and metiram were the least effective. *Trichoderma harzianum* was the most effective bioagent tested, followed by *Bacillus subtilis*, while, *Trichoderma album* was the least effective. The L.S.D. values for treatments in Table (3) revealed that flutolanil significantly raised the plant survival over all fungicidal treatments. The activity of fungicides were generally more than all bioagents tested. The statistical analysis showed that the difference between difenoconazole and pyraclostrobin + metiram was not significant in Castel rouck cv., but it was significant in Money Maker cv. The two triazole compounds, difenoconazole and tetraconazole had significant difference in their effect. The effect of mancozeb differed significantly than other fungicidal treatments. Moreover, the two fungicides, pyraclostrobin + metiram and mancozeb are significantly differed in their effect only at 5 % p. on Money Maker cv. but not on the Castel rouck cv. Similarly, the less effective fungicides, trifloxystrobin and metiram are only significantly differed from each other in Money Maker cv. This low active fungicide, trifloxystrobin proved to be more active than all the tested bioagents. In addition, metiram gave the same trend except with T. harzianum. Again, statistical analysis showed that the two bioagents, *T. harzianum* and *B. subtilis* are differed significantly in their effect at 5 % level of p. only on the Money Maker cv. and not the other. In general, there was a significant difference between the activity of the low and the high conc. of the tested fungicides and bioagents. Similarly, the two used tomato cultivars are significantly differed from each other. This was true concerning their sensitivity or their response to the effect of different material tested. Finally, the interaction between treatments, cultivars and concentrations had no significant effect on the percent of plant survivals.

Our present results are in agreement with those obtained previously. For example, Mathieson and Rush (1991) found that difenoconazole significantly reduced the mycelial growth of *Rhizoctonia solani*, but only at the concentration of 1.0 µg /ml or more. Difenoconazole and trifloxystrobin were among fungicides evaluated by Abd El-Aziz (2001) in the control of *Alternaria solani*, the causal fungus of the early blight on tomato. The greenhouse results showed that difenoconazole at 1000 µg /ml completely prevented the

infection, when it was applied 48 hrs after infection and it was more effective than trifloxystrobin. The later was, however, one of fungicides found to be highly effective in complex controlling of tomato diseases (*R. solani* was not included) both in the field and in the greenhouse (Sobolewski and Robak, 2002). Early blight on tomato was also successfully controlled by both mancozeb and metiram (Klokocar-Smtmit *et al*., 1997). Recently, Capriotti *et al*. (2005) cited that CABRIO TOP, active ingredient pyraclostrobin + metiram (5 + 55 % WG), used at the rate of 1.5 – 2.0 kg fp/ha, had a high fungicidal activity against the main tomato fungal diseases. Flutolanil, the most active compound in our study, effectively suppressed tomato damping - off confirming the antirhizoctonial activity as carried out by Kita *et al*. (2005). The post- emergence damping-off and disease index of tomato plants caused by *Fusarium oxysporum* f. sp. *lycopersici* and *Rhizoctonia solani* were significantly reduced by the application of *T. harzianum* and *B. subtilis* in a greenhouse study (El-Kazzaz *et al*., 2002 a, b).

Table (3): Greenhouse effect of fungicides and bioagents on *Rhizoctonia x solani*.

Treatments and Concentrations (µg/ml)	Castel rouck			Money Maker		
	Average % of			Average % of		
	Pre-emergence damping-off	Post-emergence damping-off	Plant survivals	Pre-emergence damping-off	Post-emergence damping-off	Plant survivals
Control (1)*	3.33	5.23	91.66	0.00	0.00	100.0
Control (2)**	46.66	37.80	33.33	55.00	52.37	21.66
Tetraconazole (1500)	31.66	21.81	53.33	35.00	28.05	46.66
Tetraconazole (3000)	20.00	14.57	68.33	18.33	14.25	70.00
Difenoconazole (1500)	30.00	21.36	55.00	31.66	19.54	55.00
Difenoconazole (3000)	15.00	7.69	78.33	15.00	7.85	78.33
Trifloxystrobin (1500)	36.66	23.88	48.33	41.66	22.91	45.00
Trifloxystrobin (3000)	25.00	17.80	61.66	26.66	18.18	60.00
Pyraclostrobin + metiram (1500)	33.33	20.00	53.33	36.66	21.11	50.00
Pyraclostrobin + metiram (3000)	16.66	12.01	73.33	18.33	10.25	73.33
Metiram (1500)	40.00	30.55	41.66	43.33	38.54	35.00
Metiram (3000)	26.66	15.90	61.66	28.33	18.63	58.33
Mancozeb (1500)	35.00	20.55	51.66	36.66	21.11	46.66
Mancozeb (3000)	20.00	12.49	70.00	20.00	14.57	68.33
Flutolanil (1500)	25.00	15.71	63.33	26.66	18.67	60.00
Flutolanil (3000)	10.00	9.20	81.66	11.66	7.69	81.66
T. harzianum ($1.5x10^6$)***	36.66	29.16	45.00	40.00	27.63	43.33
T. harzianum ($3.0x10^6$)***	28.32	20.90	56.66	31.66	24.31	51.66
T. album ($1.5x10^6$)***	40.00	33.33	40.00	45.00	39.58	33.33
T. album ($3.0x10^6$)***	31.66	29.54	48.33	33.33	29.10	46.66
B. subtilis ($1.5x10^6$)***	40.00	31.04	41.66	43.33	35.63	36.66
B. subtilis ($3.0x10^6$)***	30.00	23.86	53.33	31.66	27.04	50.00

	Pre-emergence		Post-emergence		Plant survivals	
L.S.D. at	1%	5%	1%	5%	1%	5%
Treatments (T) =	3.27	2.48	4.99	3.79	4.79	3.63
Cultivars (C) =	1.33	1.01	2.04	1.55	1.96	1.48
TxC =	N.S	3.50	5.35	7.06	6.77	5.13
Concentration (X) =	1.33	1.01	2.04	1.55	1.96	1.48
TxX =	4.59	3.50	7.06	5.35	6.77	5.13
CxX =	N.S	N.S	N.S	N.S	N.S	N.S
TxCxX =	N.S	N.S	N.S	N.S	N.S	N.S

*** Control (1) = Seeds planted in non-infested soil.**
**** Control (2) = Seeds planted in infested soil.**
***** Spores per ml.**

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المكافحة الكميائية و الحيوية لأمراض ذبول و سقوط بادرات الطماطم

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تم تقيم سبعة مبيدات للفطريات (تتراكونازول و دافينوكونازول و ترافلوكسستروبين و بيراكلوستروبين + ميتيرام و ميتيرام و مانكوزيب و فلوتولانيل) و ثلاثة مركبات حيوية (ترايكوديرما هارزيانم و ترايكوديرما البوم و باسيلس سابتيلس) ضد فطرين ممرضين " فيوزاريوم أوكسيسبورم لايكوبيرسيكاى و ريزوكتونيا سولانى" المسببان لمرض الذبول و سقوط البادرات في الطماطم . بناء على قيم EC_{50} للمبيدات أظهرت الدراسات المعملية أن كفاءة المبيدات على نمو فطر الفيوزاريوم أوكسيسبورم لايكوبيرسيكاى كانت كالتالي: دافينوكونازول > تتراكونازول > بيراكلوستروبين + ميتيرام > ترافلوكسستروبين > ميتيرام > مانكوزيب > فلوتولانيل , بينما كانت فلوتولانيل > دافينوكونازول > تتراكونازول > مانكوزيب > بيراكلوستروبين + ميتيرام > ترافلوكسستروبين > ميتيرام ضد نمو فطر ريزوكتونيا سولانى. في دراسات الصوبة تم تطبيق مبيدات الفطريات بتركيزات ١٥٠٠ و ٣٠٠٠ ميكروجرام/ مل ماء كمعاملات بذور بينما المركبات الحيوية تم تطبيقها بتركيزات 10^6 x 1.5 و 10^6 x 3.0 جرثومة/مل ماء كمعاملات تربة. أوضحت النتائج أن جميع مبيدات الفطريات و المركبات الحيوية سببت نقص في حدوث الأمراض كما أنها سببت زيادة في الانبثاق و زيادة في النباتات السليمة. مبيدات الفطريات المختبرة كانت أكثر كفاءة في مكافحة الأمراض من المركبات الحيوية. كانت المعاملات الأكثر فاعلية في مكافحة مرض الذبول هي دافينوكونازول و تتراكونازول و بيراكلوستروبين + ميتيرام ثم يليهم ترافلوكسستروبين و ميتيرام و مانكوزيب و ترايكوديرما هارزيانم بينما المعاملات الأقل كفاءة كانت باسيلس سابتيلس و ترايكوديرما البوم و أخيرا الفلوتولانيل مقارنة بالكنترول. مبيد الفطريات الأكثر كفاءة في مكافحة مرض سقوط البادرات كان الفلوتولانيل و يليه مبيدات دافينوكونازول و تتراكونازول و بيراكلوستروبين + ميتيرام و مانكوزيب بينما كان الميتيرام هو الأقل كفاءة مقارنة بالكنترول. ترايكوديرما هارزيانم كانت أكثر المركبات الحيوية كفاءة في مكافحة مرض سقوط البادرات يليها باسيلس سابتيلس بينما ترايكوديرما البوم كانت أقل المركبات الحيوية كفاءة. صنف كاسل روك كان أكثر مقاومة للمرضين تحت ظروف العدوى الصناعية و ظروف الصوبة بينما صنف مني ميكر كان مرتفع الحساسية.