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مرض الذبول الفيوزاريومي في الطماطم

محمد أحمد عوض – السعيد زكي خليفة – نشوى عاصم الطويل

قسم النبات الزراعي– كلية الزراعة– جامعة المنوفية– شبين الكوم – مصر

الملخص العربي

تنتشر زراعات الطماطم في مصر على نطاق واسع وعلى مدار العام في عدة عروات في الحقول المكشوفة والزراعات المحمية في أراضي الوادي وكذا المستصلحة حيث أن الطماطم من المحاصيل الهامة للإستهلاك المحلي والتصنيع. تصاب نباتات الطماطم بالعديد من الأمراض في الحقلويعتبر الذبول الفيوزاريومي من أهم الأمراض التي تصيب النباتات النامية في أي مرحلة من مراحل نموها حيث يسبب موت النباتات المصابة وخسائر جسيمة للمحصول. تم عزل ٢١ عزلة من فطر فيوزاريوم أوكسيسبورم من عينات طماطم مصابة تم جمعها من تسعة محافظات حيث وجدت أنها جميعا ممرضة لنباتات الطماطم بدرجات متفاوتةز تم استخدام عدة طرق مختلفة للمقاومة منها مستويات تسميد النيتروجين (N) ،الفوسفور (P) والبوتاسيوم (K) وكذلك الخليط منها (NPK) ودراسة تأثيرها على شدة الإصابة. التعقيم الشمسي للتربة المحقونة في الأصص تم اجراؤه خلال أيام الصيف الحارة. في المقاومة البيولوجية تحت ظروف الصوبة تم حقن الأصص بفطر التضاد الحيوي ترايكوديرما هارزيانم عزلة رقم (٢) قبل الزراعة بأسبوعين بمعدل ٣% من وزن التربة، أما المزارع النامية من الأكتينومايسيتات تم تخفيفها بالماء المعقم ليصل تركيز محلولها إلى ١٠ خلية/مل ثم أضيفت إلى التربة بمعدل ٧٥ مل/أصيص . مضادات الأكسدة مثل حمض الأسكوربيك ، الهيدروكوينون ، حمض السالسيلك وبنزوات الصوديوم بتركيزات (١٢,٥ – ٢٥ – ٥٠ – ١٠٠ – ٢٠٠ جزء من المليون) تم استخدامها لنقع البذور ومعاملة ري التربة خمس مرات بفاصل زمني أسبوعين. تمت دراسة تأثير بعض المبيدات مثل التشجارين ، مونكت وتويسين م–٧٠بإضافتها إلى التربة بالجرعات الموصى بها بمعدل ٢٥٠ جم/ ١٠٠لتر ماء ري ، وتغطية البذور بمعدل ٣ جم / كجم بذور . وقد تم إجراء المقاومة المتكاملة باستخدام معاملات المقاومة الناجحة سابقا.

TOMATO FUSARIUM WILT DISEASE

M. A. Awad, E.Z. Khalifa and Nashwa A. El-Taweel
Agric. Botany Dept., Faculty of Agric., Minufiya Univ. Shebin El-Kom, Egypt
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ABSTRACT: ***Tomato plants are widely grown in Egypt. They can be grown in different seasons throughout the year round in open fields and in protected cultivations. Tomato is considered one of the major vegetable crops for local consumption and industry. Fusarium oxysporum f.sp. lycopersici (Sacc) Snyder and Hansen. This fungus can infect tomato plants at all growth stages. The fungus grows in the vascular bundles and inhibits water flow causing wilting, ultimately leading to plant death. Isolation and identification of the causal pathogen were done using samples collected from different tomato growing areas from nine governorates in Egypt. 21 F. oxysporum f.sp. lycopersici isolates were used in pathogenicity tests and revealed as pathogenic to tomato plants and caused the same identical symptoms with various degrees of disease . different nitrogen (N), phosphate (P) and potassium (K) fertilizers in combinations (NPK) on tomato wilt disease severity percentage. Effect of soil solarization, as a physical mean, on the control of tomato wilt disease was studied in black pots. This trial was done during hot summer days. Biological control was carried out under greenhouse conditions. The pots were artificially infested with T.harzianum isolate No.2, two weeks before sowing at the rate of 3% of the soil weight (w/w). The grown cultures of Actinomycetes (gray group) were diluted with sterile water to give a cell concentration of 10 cell/mel and it was added to the soil at the rate of 75 ml/pot. Antioxidants i.e., Ascorbic acid, Hydroquinone, Salicylic acid and Sodium benzoate at different rates of concentrations (12.5, 25, 50, 100, 200 ppm) were used as Seed soaking the and Soil drenching by irrigated the pots five times with antioxidants solutions two weeksintervals. The effect of some fungicides i.e., Tashgareen, Moncut and Topsin M-70 were applied at the recommended dose as seed dressing with the rate of 3glkg seeds, also as soil drenching at the rate of 250g/ 100 liter, respectively. Integrated control was done using the successfully individual control treatments in the above trials of control.***

Key words ***:Tomato, Fusarium wilt, Disease control***

INTRODUCTION

Lycopersicum esculentum **L. (Tomato) is widely grown in Egypt. It can be grown in different seasons throughout the year in open fields and in protected cultivations. Tomato considered one of the major vegetable summer crops in commercial fields.. *Fusarium* spp., and many soil borne pathogens attacking tomato plants are the most common pathogens on**

tomato plants causing damping-off and wilt of tomato which reduce the yield. Fusarium wilt in tomato (*Lycopersicon esculentum* L.) caused by *Fusarium oxysporum* f.sp. *lycopersici* (Sacc) Snyder and Hansen. This fungus can infect tomato plants at all growth stages. The fungus grows in the vascular bundles and inhibits water flow causing wilting, ultimately leading to plant death. Bao and Lazarovits (2001) and Cerkauskas (2005). High doses of nitrogen resulted in maximum disease severity. Application of potassium alone or in combination with nitrogen reduced disease severity. Phosphorus did not affect disease severity except in combination with nitrogen Harender Raj and Kapoor (1995). El-Shami *et al.,* (1990) mentioned that soil solarization through mulching with transparent polyethylene increased growth and fruit yield of tomato plants in soil artificially infested with *Fusarium oxysporum* f.sp. *lycopersici,* and in noninfested soil. Bazanboor (2010) reported that covering the pots with black sheets increased the soil temperature in the two depths of test soil to 47 and 45.5°C; respectively. He also indicated that covering of inoculated pots decreased all disease parameters comparing to control (non-covered) treatment. Bandyoadhyaya and Cardwel (2002) indicated that the genus *Trichoderma* is being extensively used as biological control agent against plant pathogens. Maina *et al.,* (2008) indicated that the rhizobacteria *Bacillus sphaericus, Pseudomonas fluorescens* and *P. putida* are able to induce systemic resistance against *Fusarium oxysporum* f.sp. *lycopersici* in tomato. Campanella and Nigro (2002) reported that, the effect of 10 calcium salts in controlling Phytophthora rot rot of citrus was evaluated both *in vitro*, on agar and liquid media, and *in vivo,* on sour orange citrus seedlings Galal *et al.,* (2002) mentioned that, applications of salicylic acid (SA), benzoic acid (BA) and propygallate (PG) at 200 ppm to garlic seed cloves 48 hour before planting resulted in resistant garlic cloves against *Fusarium oxysporum* and/or *Bacillus polymyxa* infection. Bazanboor (2010) selected four antioxidants i.e., Ascorbic acid, Hydroquinone, Salicylic acid and Sodium benzoate. Each antioxidant was applied in five concentrations i.e., 12.5, 25, 50, 100 and 200 ppm. They were applied as soil drenching and seed soaking on cucumber and cantaloupe plants. Mansour (2005) under greenhouse conditions, Benlate, Maxim, Topsin-M and Vitavax-C were the most effective fungicides in reducing disease incidence and disease severity caused by the three-wilt pathogens. Meanwhile, Rizolex-T was the least effective fungicide. Narayan Musmade *et al.,* (2009) evaluated two fungicides both *in vitro* and *in vivo* conditions. *In vitro* evaluation of Carbindazim (0.1%) completely inhibited the growth of tomato wilt pathogen. *In vivo*, seedling dip treatment of Carbindazim (1 g/L water) was found most significant. Bazanboor (2010) reported that integrated control of charcoal rot disease of cucumber and cantaloupe plants under field conditions was done using the successfully individual control treatments. Black mulch + Calcium phosphate 400 ppm + *Trichoderma harzianum* + Salicylic acid 200 ppm, followed by Black mulch + Salicylic acid + *Trichoderma harzianum* and Rizolex-T were

the most effective treatment in controlling charcoal rot disease on cucumber and cantaloupe plants and increased number of survival plants compared with other treatments and control.

MATERIALS AND METHODS

Effect of mineral fertilization was carried out to evaluate the effect of different nitrogen (N), phosphate (P) and potassium (K) fertilizers in combinations (NPK) on tomato wilt disease severity percentage. The nitrogen and potassium fertilizers were added to the soil after 7, 15 and 30 days from transplanting, whereas phosphorus was mixed with the top layer of the soil, 3 days before transplanting. Effect of soil solarization, as a physical mean, on the control of tomato wilt disease was studied in black pots. This trial was done during hot summer days for one month pre-sowing of seeds. Biological control was carried out under greenhouse conditions. The pots were artificially infested with *T.harzianum* isolate No.2, two weeks before sowing at the rate of 3% of the soil weight (w/w). The grown cultures of Actinomycetes (gray group) were diluted with sterile water to give a cell concentration of 10 cell/mel and it was added to the soil at the rate of 75 ml/pot. The bacterial grown cultures were diluted with sterile water to give a cell concentration of 10 cell/mel and it was added to the soil at the rate of 100 ml/pot. Antioxidants i.e., Ascorbic acid, Hydroquinone, Salicylic acid and Sodium benzoate at different rates of concentrations (12.5, 25, 50, 100, 200 ppm) were used as : A- Seeds were soaked in the prepared antioxidants solutions for 12 hr (270 seeds per 100 ml of the tested solutions). B- Soil drenching by irrigated the pots five times with antioxidants solutions two weeks intervals. The effect of some fungicides i.e., Tashgareen, Moncut and Topsin M-70 were applied at the recommended dose as seed dressing with the rate of 3g/kg seeds, also as soil drenching at the rate of 250g/ 100 liter, respectively. Integrated control was done using the successfully individual control treatments in the above trials of control. This trial was done during hot summer days for two months. The inoculated pots were covered with one layer (100 µm) of black polyethylene sheets and left to sun light under field conditions.

RESULTS AND DISCUSSION

Results obtained in Table (1) indicated that, the lowest infection of shoot and root system was obtained when the soil was fertilized with the recommended dose of (1N:2P:2K). The second best treatment comparison with control treatment was the recommended dose of (1N:1P:2K). These results may be due to the effects of NPK fertilization in the physiological relation into infected tomato plant tissues; i.e., water contents, cytoplasmic dynamics, cell wall thickness, etc…. These results are in accordance with those obtained by Taiwo *et al.,* (2007).

Table 1

Data in Table (2) indicated that covering of inoculated pots decreased all disease parameters (pre- and post-emergence damping- off) . Data also indicated that wilt disease index (external and internal)were also decreased by covering pots with black sheets followed by transparent sheets. Wilt infection also great affected by covering the inoculated pots and the same trend of wilt index was revealed in wilt infection. Similar results were reported by Katan (1998), Ahmed *et al.,* (2000) and Bazanboor (2010).

Data in Table (3) indicated that bioagents were effected the virulence of Fusarium wilt disease incidence on tomato. The highest external wilt index was recorded by (Bs), while the lowest percentages were recorded by (Thz2). Whereas the highest percentages of internal wilt index were recorded by (Bs) and the lowest percentages were recorded by (Thz2). These results are in accordance with those obtained by Matta (2001), Landa *et al.,* (2002) and Ndiaye (2007).

Data in Table (4) revealed that treating of tomato seeds by soaking in antioxidants solutions at their concentrations greatly affected Fusarium wilt symptoms as well as survival plants. Significant differences noticed between antioxidants and their concentrations. Disease wilt index was affected by seed soaking where it decreased significantly. The high concentrations of antioxidants decreased wilt index % significantly comparing to control.

Data in Table (5) indicated that, soil drenching with antioxidants solutions to pots decreased all disease parameters compared to control (infested) plants. Soil drenching with solutions of antioxidants in all five concentrations were affected also wilt infection and survival plants. But the effect of antioxidants in these soil drenching treatments were not clear as in seed soaking experiment. Similar results were reported by Mandavia *et al.,* (2000), Khalifa (2003) , Abdou (2007) and Bazanboor (2010).

Data in Table (6) indicated that, the incidence of disease in both pre- and post-emergence stages were decreased as a result of fungicidal treatment, the lowest percentages were recorded by Topsin M-70. Also wilt index (external and internal) was recorded the lowest percentages by Topsin M-70. The double fungicidal application to the soil was more effective than when applied once. Cultivation of the treated seeds in the twice treated soil with Topsin M-70 gave the best control of tomato wilt disease. Similar results were reported by Mansour (2005) and Narayan Musmade *et al.,* (2009).

Data in Table (7) indicated that, solarization + salicylic acid at 200 ppm + (Thz2) + 1N:2P:2K , followed by solarization + salicylic acid at 200 ppm + (Thz2) + 1N:2P:2K + (ZN+Mn) were the most effective treatments . Data also indicated that the treble combinations and the combination of all treatments were the best treatments for controlling Fusarium wilt disease of tomato. Similar results were reported by Minuto *et al.,* (2006), Sing *et al.,* (2007) and Bazanboor (2010).

Table 2

Table 3

Table 4

Table 5

Table 6

Table 7

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تنتشر زراعات الطماطم في مصر على نطاق واسع وعلى مدار العام في عدة عروات في الحقول المكشوفة والزراعات المحمية في أراضي الوادي وكذا المستصلحة حيث أن الطماطم من المحاصيل الهامة للإستهلاك المحلي والتصنيع. تصاب نباتات الطماطم بالعديد من الأمراض في الحقلويعتبر الذبول الفيوزاريومي من أهم الأمراض التي تصيب النباتات النامية في أي مرحلة من مراحل نموها حيث يسبب موت النباتات المصابة وخسائر جسيمة للمحصول. تم عزل ٢١ عزلة من فطر فيوزاريوم أوكسيسبورم من عينات طماطم مصابة تم جمعها من تسعة محافظات حيث وجدت أنها جميعا ممرضة لنباتات الطماطم بدرجات متفاوتةز تم استخدام عدة طرق مختلفة للمقاومة منها مستويات تسميد النيتروجين (N) ،الفوسفور (P) والبوتاسيوم (K) وكذلك الخليط منها (NPK) ودراسة تأثيرها على شدة الإصابة. التعقيم الشمسي للتربة المحقونة في الأصص تم اجراؤه خلال أيام الصيف الحارة. في المقاومة البيولوجية تحت ظروف الصوبة تم حقن الأصص بفطر التضاد الحيوي ترايكوديرما هارزيانم عزلة رقم (٢) قبل الزراعة بأسبوعين بمعدل ٣% من وزن التربة، أما المزارع النامية من الأكتينومايسيتات تم تخفيفها بالماء المعقم ليصل تركيز محلولها إلى ١٠ خلية/مل ثم أضيفت إلى التربة بمعدل ٧٥ مل/أصيص . مضادات الأكسدة مثل حمض الأسكوربيك ، الهيدروكوينون ، حمض السالسيلك وبنزوات الصوديوم بتركيزات (١٢,٥ – ٢٥ – ٥٠ – ١٠٠ – ٢٠٠ جزء من المليون) تم استخدامها لنقع البذور ومعاملة ري التربة خمس مرات بفاصل زمني أسبوعين. تمت دراسة تأثير بعض المبيدات مثل التشجارين ، مونكت وتويسين م–٧٠بإضافتها إلى التربة بالجرعات الموصى بها بمعدل ٢٥٠ جم/ ١٠٠لتر ماء ري ، وتغطية البذور بمعدل ٣ جم / كجم بذور . وقد تم إجراء المقاومة المتكاملة باستخدام معاملات المقاومة الناجحة سابقا.

Table (1): Effect of NPK fertilization on wilt disease incidence of tomato plants "Strain-B" cultivar under stress of three aggressive isolate of *Fusarium oxysporm* f.sp. *lycopersici* under greenhouse conditions.

Treatment N : P : K	Isolate 7				Isolate 10				Isolate 14			
	% wilt index		% wilt infection	% survival plants	% wilt index		% wilt infection	% survival plants	% wilt index		% wilt infection	% survival plants
	Ex.	In.			Ex.	In.			Ex.	In.		
0 0 0	62.8 a	40.2 a	84.6 a	13.4 l	59.4 a	38.2 a	84.6 a	15.4 l	55.6 a	37.2 a	81.4 a	18.6 k
0 1 0	55.7 c	35.3 c	80.5 b	19.5 j	51.6 c	32.9 c	79.4 c	20.6 j	48.9 c	29.8 c	75.2 c	24.8 i
0 0 1	51.8 d	32.6 d	76.3 c	23.7 i	47.9 d	29.4 d	75.6 d	24.4 i	44.6 d	27.4 d	72.4 d	27.6 h
1 0 0	60.4 b	38.4 b	83.4 a	16.6 k	57.4 b	35.5 b	80.7 b	19.3 k	52.7 b	32.6 b	77.6 b	22.4 j
0.5 0.5 0.5	47.3 e	29.7 e	65.9 d	34.1 h	42.2 e	26.4 e	63.9 e	36.1 h	40.8 e	25.2 e	60.6 e	39.4 g
1 1 1	40.5 g	27.6 f	46.5 f	53.5 f	38.6 g	24.6 f	43.5 g	56.5 f	35.4 g	21.8 f	40.5 f	59.5 f
1 1 2	31.4 j	20.4 j	39.2 h	60.8 c	31.4 i	17.9 i	37.2 j	62.8 c	25.6 j	15.5 j	33.2 i	66.8 c
1 2 1	38.2 h	24.4 h	45.6 f	54.4 e	34.8 h	22.26 h	42.66 h	57.4 e	30.5 h	19.9 g	38.4 g	61.6 e
2 1 1	35.6 i	21.3 i	42.4 g	57.6 d	31.9 i	17.5 j	39.8 i	60.2 d	27.9 i	17.1 i	35.6 h	64.4 d
1 2 2	28.6 k	19.8 k	36.8 i	63.2 b	24.4 j	18.2 i	33.4 k	66.6 b	22.3 k	15.4 j	30.5 j	69.5 h
2 2 2	44.8 f	26.4 g	50.9 e	49.1 g	40.3 f	23.3 g	45.7 f	54.1 g	37.9 f	19.5 h	40.7 f	59.3 f
Control (un-infested)	19.6 L	15.2 L	23.6 j	76.4 a	19.6 k	15.2 k	23.6 l	76.4 a	19.6 l	15.2 j	23.6 a	76.4 a
L.S.D.	0.3334	0.334	1.719	0.2815	1.6691	0.3056	0.331	0.2989	0.3334	0.3016	0.3179	0.2989

Ex. = External wilt index.
In. = Internal wilt index

Table (2): Effect of soil solarization on Fusarium wilt incidence of tomato cultivar "Strain B" incited by three aggressive isolates of *Fusarium oxysporum* f.sp. *lycopersici* under field conditions.

Treatment	Isolate 7						Isolate 10						Isolate 14					
	% Disease incidence		% Wilt index		% Wilt infection	% Survival plants	% Disease incidence		% Wilt index		% Wilt infection	% Survival plants	%Disease incidence		% Wilt index		% Wilt infection	% Survival plants
	Pre	Post	Ex.	In.			Pre	Post	Ex.	In.			Pre	Post	Ex.	In.		
Transparent sheet	11.9e	6.2e	24.0e	13.5e	20.4e	79.6c	10.2e	3.9f	20.8e	10.0e	18.6e	81.4c	8.4de	2.4f	18.2de	8.7de	14.2f	85.8b
Green sheet	14.8b	7.5cd	25.0bcd	18.2b	24.0d	76.0d	11.8d	7.9bc	24.0b	13.6d	20.3d	79.7d	9.5d	6.1cd	20.3c	10.4bc	18.4d	81.6d
Yellow sheet	14.5bc	8.5b	26.2b	17.5d	25.3c	74.7e	12.4bc	7.5bcd	23.2c	15.4b	22.7b	77.3ef	10.7b	5.2de	21.0b	11.2b	19.2bc	80.8de
Red sheet	14.0bcd	8.0bc	25.8bc	17.9bc	26.0b	74.0ed	12.8b	8.2b	22.7cd	14.4c	21.5bc	78.5e	10.3bc	6.8c	19.9d	9.7d	20.5b	79.5f
Black sheet	9.2f	5.0ef	22.4f	11.25f	19.8f	80.2b	7.5f	3.8fg	19.3f	9.25ef	13.5g	86.5a	7.0f	2.0fg	16.5f	7.5f	11.8g	88.2a
Control(Non-covered)	17.5a	11.4a	30.4a	21.9a	28.9a	71.1g	16.4a	10.4a	28.9a	21.5a	25.6a	74.4g	14.3a	8.9a	25.3a	16.2a	24.5a	75.5g
Control(Non-covered and Non-infested)	5.2g	7.25cde	12.5g	8.4g	16.4g	83.6a	5.2g	7.25cde	12.5g	8.4g	16.4f	83.6b	5.2g	7.25b	12.5g	8.4g	16.4e	83.6c
L.S.D	0.922	0.836	0.767	0.819	1.236	0.412	0.915	0.813	0.716	0.880	1.317	0.467	0.990	0.823	0.710	0.812	1.121	0.450

Pre=Pre-emergence
Post=Post- emergence
Ex. = External
In. = Internal

Table (3) : Effect of some biocontrol agents on three virulent isolates of *Fusarium oxysporum* f.sp. *lycopersici*; the causal pathogen of tomato (Strain-B cultivar) wilt disease under greenhouse conditions.

Treatment	Isolate 7				Isolate 10				Isolate 14			
	Wilt index		% wilt infection	% survival plants	Wilt index		% wilt infection	% survival plants	Wilt index		% wilt infection	% survival plants
	Ex.	In.			Ex.	In.			Ex.	In.		
Trichoderma (T)	25.4 g	20.8 i	7.4 j	92.7 a	24.4 g	20.3 j	28.4 i	71.6 a	23.0 g	18.8 j	5.4 L	94.6 a
Actinomycetes (A)	25.9 f	27.0 c	8.4 i	91.7 b	27.4 f	24.2 d	7.8 i	92.2 a	26.3 e	23.3 d	6.0 k	94.0 b
Bacillus subtilis (BS)	31.3 c	25.3 d	7.4 j	92.6 a	30.2 c	23.4 e	7.9 h	92.1 c	28.2 c	24.6 c	6.4 j	93.0 c
Fusarium (F)	78.6 a	76.0 a	92.0 a	8.0 j	80.3 a	74.3 a	91.3 a	8.7 j	79.5 a	74.9 a	90.5 a	9.5 L
F + T	23.4 i	21.6 h	29.0 h	71.0 c	22.8 k	20.5 i	29.4 ef	70.6 e	21.5 i	19.5 i	27.3 g	72.7 f
F + A	29.2 es	22.8 f	37.3 c	62.7 h	27.8 e	20.9 h	36.0 c	64.0 h	25.6 f	21.4 f	34.3 c	65.7 j
F + BS	30.0 d	23.8 e	39.4 b	60.6 i	29.2 d	25.7 c	38.2 b	61.8 i	27.0 d	24.7 c	36.8 b	63.2 k
F + T + A	25.5 g	22.0 g	31.0 f	69.0 e	24.0 i	21.3 g	29.6 e	70.4 f	22.0 h	20.9 g	28.9 e	71.1 h
F + T + BS	26.0 f	20.9 i	33.0 d	67.0 g	23.9 i	20.9 h	31.2 d	68.82 g	22.9 g	21.7 e	29.4 d	70.6 i
F + A + BS	23.6 i	20.9 i	32.4 e	67.6 f	24.2 h	22.0 f	29.3 f	70.7 e	21.9 h	20.0 h	28.0 f	72.0 g
F + T + A + BS	24.6 b	21.4 h	29.6 g	70.4 d	23.6 j	20.3 ij	28.4 g	71.6 d	21.0 j	18.9 j	26.6 h	73.2 e
Control (un-infested)	32.9 d	28.4 b	8.3 i	91.7 b	32.9 b	28.4 b	8.3 h	91.7 b	32.9 b	28.4 b	8.3 i	91.7 d
L.S.D.	0.2011	0.2011	0.2011	0.2011	0.2034	0.205	0.2248	0.1984	0.2011	0.2235	0.2011	0.2011

Ex = External wilt index
In = Internal wilt index

Table (4): Control of Fusarium wilt disease on tomato plants with antioxidants by seed soaking under greenhouse conditions.

Antioxidants	Concentrations ppm	Isolate 7						Isolate 10						Isolate 14					
		% Disease incidence		% wilt index		% wilt nfection	% survival plants	% Disease incidence		% wilt index		% wilt nfection	% survival plants	% Disease incidence		% wilt index		% wilt nfection	% survival plants
		Pre.	Post.	Ex.	In.			Pre.	Post.	Ex.	In.			Pre.	Post.	Ex.	In.		
Ascorbic acid	12.5	24.52ab	48.05a	57.15a	37.5 a	75.48c	24.52 c	48.05a	0.00 b	57.15 a	37.5 a	51.95ab	48.05ab	24.52ab	24.52ab	57.15 a	37.5 a	75.48 c	24.52 c
	25	48.05a	24.52ab	51.27ab	31.6ab	51.95bc	48.05bc	0.00 b	24.52ab	57.15 a	37.5 a	28.42ab	71.58ab	48.05a	24.52ab	51.27ab	31.6ab	51.95bc	48..05bc
	60	24.52ab	0.00 b	45.9bc	25.2bc	4.89 a	95.11 a	24.52ab	0.00 b	51.27bc	31.6 bc	28.42ab	71.58ab	26.54ab	0.00 b	45.9 bc	25.2bc	4.89 a	95.11 a
	100	24.52ab	0.00 b	39.4cd	19.1cd	28.42ab	71.58ab	0.00 b	0.00 b	45.9 de	25.2 de	4.89 a	95.11 a	26.54ab	0.00 b	39.4 cd	19.1cd	28.42ab	71.58ab
	200	0.00 b	0.00 b	22.9ef	12.39ef	4.89 a	95.11 a	0.00 b	0.00 b	33.5 g	13.2 g	4.89 a	95.11 a	0.00 b	0.00 b	22.9 ef	12.39ef	4.89 a	95.11 a
Hydro-quinone	12.5	24.52ab	0.00 b	51.27ab	31.6ab	28.42ab	71.58ab	24.52ab	24.52ab	45.6 ab	34.1 ab	54.95ab	48.05ab	24.52ab	0.00 b	51.27ab	31.6ab	28.42ab	71.58ab
	25	0.00 b	0.00 b	41.3cd	21.7cd	28.42ab	71.58ab	24.52ab	0.00 b	47.9 cd	27.8 cd	28.42ab	71.58ab	0.00 b	0.00 b	41.3 cd	21.7cd	28.42ab	71.58ab
	60	0.00 b	0.00 b	45.2bc	25.9bc	4.89 a	95.11 a	0.00 b	0.00 b	39.4 f	19.1 f	28.42ab	71.58ab	0.00 b	0.00 b	45.2 bc	25.9bc	4.89 a	95.11 a
	100	0.00 b	0.00 b	39.4cd	19.1cd	28.42ab	71.58ab	24.52ab	0.00 b	33.5 g	13.2 g	4.89 a	95.11 b	0.00 b	0.00 b	39.4 ed	19.1ed	28.42ab	71.58ab
	200	0.00 b	0.00 b	15.7 f	7.82 f	4.89 a	95.11 a	0.00 b	0.00 b	15.7 h	7.82 h	4.89 a	95.11 a	0.00 b	0.00 b	15.7 f	7.82 f	4.89 a	95.11 a
Salicylic acid	12.5	24.25ab	0.00 b	42.3 c	22.5 e	51.95bc	48.05bc	24.52ab	24.52ab	57.15 a	37.5 a	51.95ab	48.05ab	0.00 b	24.52ab	57.15a	37.5 a	51.95ab	48.05ab
	25	0.00 b	24.52ab	51.7ab	31.1ab	28.42ab	71.58ab	0.00 b	48.05 a	57.15 a	37.5 a	51.95ab	48.05ab	24.52ab	0.00 b	57.15a	37.5 a	51.95ab	48.05ab
	60	0.00 b	24.52ab	39.4cd	19.1cd	28.42ab	71.58ab	0.00 b	24.52ab	45.9 de	25.2 de	28.42ab	71.58ab	24.52ab	0.00 b	45.9 de	25.2de	28.42ab	71.58ab
	100	0.00 b	0.00 b	33.5de	13.2de	4.89 a	95.11 a	0.00 b	0.00 b	33.5 g	13.2 g	4.89 a	95.11a	0.00 b	0.00 b	33.5 g	13.2 g	4.89 a	95.11 a
	200	0.00 b	0.00 b	15.7 f	7.53 f	4.89 a	95.11 a	0.00 b	0.00 b	33.5 g	13.2 g	4.89 a	95.11 a	0.00 b	0.00 b	33.5 g	13.2 g	4.89 a	95.11 a
Sodium benzoate	12.5	0.00 b	24.52ab	51.7ab	31.1ab	28.42ab	71.58ab	24.52ab	0.00 b	57.15a	37.5 a	51.95ab	48.05ab	24.52ab	0.00 b	57.15 a	37.5 a	51.95ab	48.05ab
	25	0.00 b	24.52ab	57.15a	37.5 a	28.42ab	71.58ab	0.00 b	24.52ab	45.9 de	25.2 de	51.95ab	48.05ab	24.52ab	0.00 b	45.9 de	25.2de	51.95ab	48.05ab
	60	0.00 b	0.00 b	39.4cd	19.3cd	4.89 a	95.11 a	24.52ab	0.00 b	45.9 de	25.2 de	4.89 a	95.11a	0.00 b	0.00 b	45.9 de	25.2de	4.89 a	95.11 a
	100	0.00 b	0.00 b	33.5de	13.2de	4.89 a	95.11 a	0.00 b	0.00 b	41.3 ef	21.7 ef	4.89 a	95.11a	0.00 b	0.00 b	41.3 ef	21.7ef	4.89 a	95.11 a
	200	0.00 b	24.52ab	45.9bc	25.2bc	28.42ab	71.58ab	0.00 b	0.00 b	33.5 g	13.2 g	4.89 a	95.11a	24.52ab	0.00 b	33.5 g	13.2 g	4.89 a	95.11 a
Mean		28.45	22.88	40.98	21.63	23.71	76.29	30.40	28.44	43.90	24.80	24.89	75.11	27.27	32.4	43.17	24.16	26.17	73.93
Control (infested)		24.52	48.05	56.75	36.5	75.48	24.52	32.37	55.90	34.50	14.60	91.16	8.84	25.6	45.9	58.3	29.8	70.15	29.85

Isolates = 1.70
Ex. = External wilt index.
Isolates x concentrations = 1.625
In. = Internal wilt index.

Key : Pre = pre-emergence damping-off.
L.S.D. : Concentrations = 1.25
Post = post -emergence damping-off.

Table (5): Control of Fusarium wilt disease on tomato plants incited by three aggressive isolates of *F.oxysporum* f.sp. *lycopersici*; with antioxidants by soil drenching under greenhouse conditions.

Antioxidants	Concentrations ppm	Isolate 7						Isolate 10						Isolate 14					
		% Disease incidence		% wilt index		% wilt infection	% survival plants	% Disease incidence		% wilt index		% wilt infection	% survival plants	% Disease incidence		% wilt index		% wilt infection	% survival plants
		Pre.	Post.	Ex.	In.			Pre.	Post.	Ex.	In.			Pre.	Post.	Ex.	In.		
Ascorbic Acid	12.5	29.07abcd	50.12 a	57.15 a	36.96 a	77.95 g	22.05 g	64.15 a	29.07abc	57.95 ab	37.5 ab	84.97 de	15.03 de	29.07abcd	50.12a	59.2a	37.9a	77.95g	22.05g
	25	29.07abcd	15.03 cd	54.15ab	34.05ab	35.85bcde	64.15bcdef	36.08bcde	43.10ab	54.7 abc	34.35abc	84.94 de	15.03 de	29.07abcd	15.03cd	55.6ab	34.08ab	35.85bcdef	64.15bcdef
	60	8.01 de	15.03 cd	41.65ef	21.5 ef	7.78 ab	92.22 ab	15.03def	36.08abc	59.12 a	39.2 a	42.86 abc	57.14abc	E	15.03cd	41.65ef	20.5ef	7.78ab	92.22ab
	100	8.01 de	22.05bcd	53.27abcd	33.7abcd	21.81abcd	78.19abcd	36.08bcde	29.07abc	57.9 ab	37.5 ab	56.9 bcd	43.10bcd	8.01de	22.05bcd	55.27abcd	33.9abcd	21.81bcd	78.19bcd
	200	8.01 de	22.05bcd	40.4 if	20.9 if	21.81abed	78.19abcd	36.08bcde	8.01 c	53.8 abc	33.5abc	35.85 ab	64.15 ab	8.01de	22.05bcd	40.4f	20.9f	21.81abcd	78.19abcd
Hydroquinone	12.5	22.05cde	29.07abc	49.47 d	29.72 d	63.92 fg	36.08 fg	29.07bcde	50.12 a	52.2 bc	32.5 bc	91.99 e	8.01 e	22.05cde	29.07abc	49.7d	29.2d	63.92fg	36.08
	25	8.01 de	29.07abc	48.9 d	28.5 d	49.88defg	50.12defg	43.10abcd	22.05abc	53.8 abc	33.5abc	63.92bcde	36.08bcde	8.01de	29.07abc	50.9d	30.5d	49.88defg	50.12
	60	8.01 de	15.03 cd	41.6 ef	21.7 ef	14.79abc	85.21 abc	36.08bcde	15.03 bc	52.2 bc	32.5 bc	42.86abc	57.14 abc	E	15.03cd	41.6ef	21.7ef	14.79abc	85.21
	100	8.01 de	29.07abc	39.8 f	19.2 f	35.85bcde	64.15bcdef	8.01 ef	15.03 bc	41.5 d	21.7 d	14.79 a	85.21 a	8.01de	29.07abc	39.8f	19.2f	35.85bcdef	64.15bcdef
	200	15.03cde	8.01 cd	36.31 fg	16.15 fg	14.79abc	85.21 abc	22.05cdef	15.03 bc	36.3 e	16.5 e	35.85 ab	64.15 ab	15.03cde	D	36.3fg	18.15fg	14.79abc	85.21abc
Salicylic Acid	12.5	43.10ab	8.01 cd	54.44abcd	34.8abcd	42.86cdef	57.14cdef	64.15 a	15.03 bc	56.4 ab	36.9 ab	77.95 de	22.05 de	64.15a	15.03bc	56.4ab	36.9ab	77.95de	22.05de
	25	43.10ab	22.05bcd	50.9 d	30.5 d	77.95 g	22.05 g	15.03def	36.08abc	49.7 c	29.6 c	56.9 bed	43.10 bcd	15.03def	36.08abc	49.7c	29.6c	56.09bcd	43.10bcd
	60	8.01 de	8.01 cd	35.7 fg	15.3 fg	21.81 a	78.19 a	57.14 ab	15.03 bc	57.9 ab	37.5 ab	63.92bcde	36.08bcde	57.14ab	15.03bc	57.9ab	37.5ab	63.92bcde	36.08bcde
	100	22.05bcde	8.01 cd	39.8 f	19.2 f	28.83abcde	71.17abcde	36.08bcde	43.10 ab	55.6 abc	35.1abc	77.95 de	22.05 de	36.08bcde	43.10ab	55.6aqbc	35.1abc	77.95de	22.05de
	200	8.01 de	22.05 bcd	40.4 f	20.5 f	14.79abc	85.21 abc	8.01 ef	15.03 bc	32.8 e	12.5 e	14.79 a	85.21 a	8.01ef	15.03bc	32.8e	12.5e	14.79a	85.21a
Sodium Benzoate	12.5	29.07abcd	43.10 ab	53.8abcd	33.5abcd	77.95 g	22.05 g	22.05cdef	43.10 ab	54.7 abc	34.5abc	63.92bcde	36.08 bcde	22.05cdef	43.10ab	54.7abc	34.5abc	63.92bcde	36.08cde
	25	22.05bade	15.03 cd	49.7 cd	29.5 ed	42.86edge	57.14cdef	43.10abcd	36.08abc	57.3 ab	37.6 ab	77.95 de	22.05 de	43.10abcd	36.08abc	57.3ab	37.6ab	77.95de	22.05de
	60	8.01 de	29.07abc	48.5 d	28.9 d	35.85bcde	64.15bcdef	28.07bcde	36.08abc	49.7 c	29.6 c	77.95 de	22.05 de	28.07bcde	36.08abc	49.7c	29.6c	77.95de	22.05de
	100	43.10 ab	8.01 cd	48.5 d	30.4 d	42.88cdef	57.14cdef	8.01 ef	29.07abc	43.9 d	23.9 d	35.85 ab	64.15 ab	8.01ef	29.07abc	43.9d	23.9d	35.85ab	64.15ab
	200	50.12 a	22.05bcd	54.5abcd	34.9abcd	63.92 fg	36.08 fg	8.01 ef	29.07abc	43.3 d	23.3 d	35.85 ab	64.15 ab	F	29.07abc	43.3d	23.3d	35.85ab	64.15ab
Mean		25.33	22.44	46.94	27.13	39.60	60.22	31.03	27.94	51.01	31.12	56.95	41.97	24.12	27.69	48.56	28.23	46.31	53.63
Control (infested)		3.10	6.08	9.12	9.10	7.95	2.05	9.07	7.07	7.3	1.2	4.5	.01	3.07	7.07	1.2	8.5	5.70	2.05

Isolates = 1.047 **Key : Pre = pre-emergence damping-off.**

Ex. = External wilt index. **L.S.D. : Concentrations = 1.00**

Isolates x concentrations = 1.685 **Post = post -emergence damping-off.** **In. = Internal wilt index.**

Table (6): Effect of three fungicides on the most three aggressive isolates of *Fusarium oxysporum* f.sp.*lycopersici*; the causal pathogen of tomato (Strain-B cultivar) wilt disease under greenhouse conditions.

Fungicides	Fungicidal treatment	Isolate 7						Isolate 10						Isolate 14					
		% Disease incidence		% wilt index		% wilt infection	% survival plants	% Disease incidence		% wilt index		% wilt infection	% survival plants	% Disease incidence		% wilt index		% wilt infection	% survival plants
		Pre.	Post.	Ex.	In.					Ex.	In.			Pre.	Post.	Ex.	In.		
Tashgarin	A	29.67	35.0	20.3	12.20	68.3	31.7	26.6	34.6	18.3	10.6	53.6	46.4	24.2	31.3	15.6	9.8	39.4	60.6
	B	25.35	32.33	19.2	10.27	61.6	38.4	23.7	29.4	15.4	8.4	52.5	47.5	21.4	25.5	12.3	7.6	29.6	70.4
	C	20.31	29.0	13.23	9.13	53.7	46.3	19.2	25.3	10.2	8.9	47.6	52.4	16.9	20.4	8.4	8.4	23.8	76.2
Topsin M-70	A	19.0	30.3	8.85	6.6	52.4	47.6	17.8	25.3	9.2	5.9	45.3	44.7	15.4	22.4	8.8	5.0	57.2	42.8
	B	12.33	22.7	11.1	8.98	39.6	60.4	11.9	21.7	12.3	7.2	35.6	64.6	9.2	18.5	10.8	6.4	49.3	50.7
	C	5.67	19.0	9.4	5.8	29.4	70.6	6.8	17.6	7.4	5.5	27.4	72.6	5.3	15.6	6.4	5.9	39.4	60.6
Mooncut	A	38.6	46.6	30.5	20.8	87.4	12.6	35.5	42.6	25.5	17.3	79.8	20.2	30.6	44.8	21.6	15.7	77.3	22.7
	B	36.3	41.8	34.43	21.4	73.5	26.5	31.3	37.4	22.6	18.9	71.3	28.7	28.9	38.7	20.5	14.8	68.7	31.3
	C	39.4	40.7	33.35	19.3	82.6	17.4	37.4	39.3	20.4	15.4	78.4	21.6	32.2	40.4	17.6	12.7	64.4	35.6
Control (infested)		40.5	52.7	36.4	29.2	90.3	9.7	42.8	56.4	32.6	20.2	83.9	16.1	40.9	44.3	27.4	20.3	80.8	19.2
Control (uninfested)		7.4	3.3	13.4	7.2	14.5	85.8												

A = Seed treatment with fungicide before sowing.
B = A+ Soil drench with fungicide after 30 days.
C = B+ Soil drench with fungicide after 60 days.