International Journal of Agricultural Sciences ISSN: 2167-0447 Vol. 2 (7), pp. 2011-220, July, 2012.
Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Effect of chemical inducers on root rot and wilt diseases, yield and quality of tomato

[1]Montaser Fawzy ABDEL-MONAIM; [2]Mohsen Abdel-Wahab ABDEL-GAID; [3]Hanaa Aiead Haliam ARMANIOUS

[1]Plant Pathology Research Institute, Agriculture Research Center, Giza, Egypt
[2]Horticulture Research Institute, Agricultural Research Center, Giza, Egypt
[3]Minia University, Plant Pathology Department, Faculty of Agriculture, Egypt

Received May 14, 2012; Accepted July 07, 2012

Root rot and wilt in tomato caused by Rhizoctonia solani, Fusarium solani and F. oxysporum is one of the most destructive diseases. Effect of some chemical inducers viz. ethephon, hydrogen peroxide (H2O2), mannitol, salicylic acid (SA) at three different concentrations (50,100, 200 ppm) were used to treat tomato seedling by soaking into these to minimize root rot and wilt diseases incidence as well as influence of these chemicals on growth, quantity and quality parameters of tomato plants (cv. Super Strain B) e under greenhouse and field conditions were studied. All the tested chemical inducers significantly reduced root rot and wilt diseases severity either under both greenhouse and field conditions and the efficiency of these compounds increased with increasing concentrations. Mannitol was the most effective inducer for decreasing area under disease progress carve (AUDPC) followed by salicylic acid, while ethephon was recoded as the least effective for reducing AUDPC in greenhouse conditions. However, under laboratory conditions, all tested chemical inducers significantly reduced mycelial linear growth of all tomato root rot and wilt tested fungi compared with control. The highest decrease in linear growth wasobserved in ethephon at 200 ppm followed by SA at 200 ppm. Conversely, F. solani was more affected by chemical inducers than F. oxysporum and R. solani. Under field conditions, the selected chemicals significantly increased tomato growth, yield and quality. Application of mannitol at 200 ppm followed by SA at 200 was the most potent for growth, yield and quality of tomato compared with control. Therefore, tt could be suggested that application of mannitol and SA to treat seedling by soaking could be commercially used for controlling tomato root rot and wilt diseases and increased both quality and quantity of tomato since they are safe, less expensive and effective against these diseases in field conditions.

Keywords: Tomato, chemical inducers, root rot, wilt, yield and quality of tomato

INTRODUCTION

Tomato (Solanum lycopersicum L., syn., Lycopersicon esculentum Mill.); is an important vegetable crop not only for its economic value but also for its nutritional value. It has an antioxidant compounds, like vitamin C and carotenoids and it is cultivated in all countries either in fields or protected culture. It plays an important role in human health as it is a rich source of lycopene, which is used in the treatment of cancer, especially the prostate cancer (Giovannucci, 1999). Peoples who consume large amount of tomato products significantly decrease risk of prostate, lung and stomach cancer (NCI....year). Tomato is one of the most important vegetable crops in Egypt and it is used for food and industrial purpose (Abd-El Kareem et al., 2006).

Tomato plants are infected by several soil born fungal pathogens viz. Fusarium spp. and Rhizoctonia solani, that cause serious diseases as root rot and wilt and

Corresponding author Email: fowzy_2008@ yahoo.com

finally reduced both yield quality and quantity (Saad, 2006; Morsy et al., 2009; Abdel-Monaim, 2010) and control of such diseases mainly depend on fungicides treatments (Rauf, 2000; El-Mougy et al., 2004). However, intensive application of fungicides cause hazards to human health and environmental degradation. Therefore, alternative eco-friendly approach for the control of plant diseases should be emphasized (Mandal et al., 2009).

Systemic acquired resistance (SAR) or induction of plants to resist against pathogen is a promising approach for controlling plant diseases. Exogenous or endogenous factors could substantially affect host physiology, leading to rapid and coordinated activation of defense-gene in plants expressing susceptibility to pathogen infection (Mandal et al., 2009). The phenomenon of plant resistance to pathogens can be enhanced by the application of various abiotic agent (chemical inducers), caused induce systemic resistance in plants such as SA, mannitol, ethephon, H2O2 (Abdou et al., 1999; El-Khallal, 2007; Abdel-Monaim 2010; Akram and Anjum, 2011). Conversely, application of these chemical inducers under field conditions have increased growth parameters, yield components and quality of fruits in many vegetable plants (El-Mougy et al., 2004; Karlidag et al., 2009; Zahra et al., 2010). Hence, the present experiment was conducted to study the effects of SA, H2O2, ethephon and mannitol as resistance inducers in tomato plants against root rot, wilt pathogens and to provide new strategies to control the root rot and wilt diseases of tomatoes under greenhouse and field conditions along with its effect on growth parameters, yield quantity and tomato quality under field conditions.

MATERIAL AND METHODS

Isolation, Purification and Identification of Tomato Root Rot and Wilt Fungi

Roots of the diseased tomato plants were collected from different field growing in New Valley, Minia and Assuit governorates, Egypt, and washed with tap water to remove adhering soil particles. Small parts of infected roots were surface sterilized using sodium hypochlorite solution (3%) for 3 minutes, and washed with distilled sterilized water for several times. Then they were dried using sterilized filter paper and transferred into Petri-plates containing potato dextrose agar medium (PDA). Plates were incubated at 25±2°C for 5 days. Hyphal tips of fungi were grown on PDA medium. All fungi were purified using single spore or hyphal tip technique cultures and identified according to Booth (1985) and Barnett and Hunter (1986).

Pathogenicity Test

The obtained isolates (15 isolates) were purified, c isolated from diseased plants and tested for pathogenic ability on tomato plants (cv. Super Strain B) under greenhouse conditions.

Preparation of Fungal Inocula

Inocula of isolated fungi were prepared by culturing of each fungus (F. solani and F. oxysporum) on 50.0 ml potato dextrose broth (PDB) medium in 250 ml Erlenmeyer flasks for 10 days at 25±2°C following washing and blending in sterilized water. Colonies forming units (cfu) were adjusted to 106 cfu/ml using haemocytometer slide. Soil infestation was carried out at rate of 50 ml (106 cfu / ml) / kg soil (Elad and Baker, 1985).

Inocula of R. solani were prepared as the upper solid layers that grew were washed and air-dried with sterilized filter paper layers. The air-dry mycelium was blended in distilled water to obtain inocula pieces of 1-2 mm in diameter. Soil infestation was carried out at rate of 2.0 g dry mycelium / kg soil, (Al-Mahareeq, 2005).

Soil Infestation

Plastic pots (30 cm diameter, 5.0 kg soil) were filled with formalin disinfested soil following isolation of the artificially infested individual inocula of each fungs. Healthy and disinfected tomato seedlings (40 day-old, cv. Super Strain B) were sown in plastic pots at the rate of 5 seedlings/pot following three replicates for each treatment along with check treatment (un- infested soil).

Disease assessments

Root rot and wilt severity were estimated at 10 days interval for 60 after transplanting according to Abdou et al. (2001) using a rating scale of (0 – 5) on based on root discoloration or leaf yellowing grading, viz., 0 = neither root discoloration nor leaf yellowing, 1= 1-25% root discoloration or one leaf yellowing 2= 26-50% root discoloration or more than one leaf yellowing, 3= 51-75% root discoloration with one wilted leaf, 4= up to 76% root discoloration or more than one leaf wilted, and 5= completely dead plants. Disease severity index (DSI) described by Liu et al. (1995) was adapted and calculated as follows:

$$DSI= \sum d/(d\ max \times n) \times 100$$

Where: DSI the possible disease rating, d max the maximum disease rating and n the total number of plants/samples examined in each replicate.

The mean of area under disease progress curve (AUDPC) for each replicate was calculated as suggested by Pandy et al. (1989).

$$AUDPC= D\ [1/2\ (Y1+Yk) + (Y2+Y3+\ldots+Yk-1)]$$

Where D= Time interval; Y1= First disease severity; Yk= Last disease severity; Y2, Y3,……Yk-1=

Intermediate disease severity.

Effect of soaking tomato seedlings in chemical inducers on controlling root rot and wilt diseases under greenhouse conditions

Tomato seedlings (cv. Super Strain B) were soaked in the solutions of each tested chemical (H2O2, SA, Mannitol and Ethephon) at three different concentrations (50, 100 and 100%) for 6 h. (Abdel-Monaim, 2010) before planting in pots contained soil infested with F. solani, F. oxysporum and R. solani individually. Five seedlings per treatment were sown in plastic pot and three pots were used for each treatment as replicates. In control treatment, untreated tomato seedlings were planted in infested soil and area under wilt progress curve was recorded.

Effect of Chemical Inducers on Growth of Tomato Root Rot and Wilt Fungi

The inhibitory effect of H2O2, SA, mannitol and ethephon against tomato root rot and wilt fungi was tested in vitro at four concentrations, i.e. 0, 50,100 and 200 ppm. Chemical inducers were added to the sterilized PDA medium before solidifying and gently rotating and disbanding into sterilized Petri plates (9 cm diameter). Plates were individually inoculated at the centre with equal disks (6 mm in diameter) taken from 10 days old cultures of each F. solani; F. oxysporum and R. solani, and incubated at 25±2°C. Linear growth of tested fungi was measured when the control plates (medium free of chemical inducers) reached full growth and the average growth diameter was calculated. Each treatment was represented by 3 plates as replicates.

Field Experiments

Seedlings soaking treatment, the most promising treatments against tomato root rot and wilt diseases in pot experiments was grown in field conditions. Three concentrations viz. 50, 100 and 200 ppm of H2O2, SA, mannitol and ethephon were applied as seedling soaking for 6 h. to study their effect on root rot and wilt disease severity, growth parameters, yield components and seed quality of tomato plants under field conditions. This experiment was conducted following completely randomized block design maintaining sowing date of 1 st October in two suc¬cessive growing seasons 2010-2011 and 2011-2012 in a field naturally in¬fected with the causal organisms of root rot and wilt dis¬eases of tomato located at the Experimental Farm of Kharga Agric. Station, New Valley Governorate. Tomato seedlings (cv. Super Strain B, 40 days-age) were sacked at the rate of 100 transplanting per 100 ml for 6 hr. The field plots (15 m2) consisted of 3 rows of 5 m long and 1 m in between. One seedlings/hill was sown with 50 cm apart between hills. Untreated seedlings were used as control. Disease severity was re¬corded every 30 days for 4 months. The mean of area under disease progress curve (AUDPC) for each replicate was calculated as above. Plant height, the number of branches, number of fruits plant -1, fruit weight plant-1 (kg), fruit yield feddan -1 (ton), Number of fruit Kg -1, degree of fruit's color, fruit diameters (cm), firmness by penetration tester apparatus (kg So cm2), fruit length (cm) were calculated at the end of the growing season... Total soluble solids (T.S.S) measured by Refractometer.

Statistical Analysis

All experiments were performed twice. Analyses of variance were done using MSTAT-C program version 2.10 (1991).. Least significant difference (LSD) was calculated at P ≤ 0.05 according to Gomez and Gomez (1984).

RESULTS

Isolation, Purification and Identification of the Fungi Associated with Tomato Diseased Plants

Fifteen fungal isolates were isolated from tomato plants collected from different locations in New Valley, Assuit and Minia governorates that show wilt and root rot symptoms. Hyphal tip cultures of grown fungi were maintained on PDA medium. All fungi were purified using single spore or hyphal tip technique cultures, then they were identified. Results indicate that the most dominant fungi which identified are Fusarium solani, F. oxysporum and Rhizoctonia solani.

Pathogenicity Test

The purified isolates were tested for their pathogenic ability on tomato plants cv. Super Strain B under greenhouse conditions. The tested fungal isolates significantly varied in their ability to cause root rot or wilt infection of tomato plants under greenhouse conditions (Table 1). The most aggressive fungi are F. oxysporum (isolate TF8), R. solani (TF15) and F. solani (isolate TF4) as they covered 1131.2, 1103.7 and 1082.5 AUDPC, respectively. Meanwhile, F. oxysporum (isolate TF9) and R. solani (isolate TF13) caused least potentiality of infection in tomato plants, viz. 403.7 and 278.7 AUDPC, respectively.

Effect of Chemical Inducers Used for Seedling Soaking on Area of Disease Progress Curve in Tomato Plants under Greenhouse Conditions

Different concentrations of chemical inducers significantly reduced the area of disease progress curve

Table 1: Pathogenicity tests of *Fusarium oxysporum* f. sp. *lycopersici* isolates collected from different location to tomato cv. Strain B.

Tomato fungal isolates	Locations	Area under disease progress carve (AUDPC) [a]
Fusarium solani		
TF_1	Minia	831.2 ef
TF_2	Minia	820 f
TF_3	Assuit	636.2 i
TF_4	New Valley	1082.5 b
TF_5	New Valley	698.7 h
F. oxysporum		
TF_6	Minia	1007.5 c
TF_7	Minia	882.5 d
TF_8	Minia	1131.2 a
TF_9	Assuit	403.7 j
TF_{10}	Assuit	861.2 de
TF_{11}	New Valley	1007.5 c
Rhizoctonia solani		
TF_{12}	New Valley	822.5 f
TF_{13}	New Valley	278.7 k
TF_{14}	New Valley	781.2 g
TF_{15}	New Valley	1103.7 ab

Different letters indicate significant differences between tomato fungal isolates according to L.S.D. test (*P*=0.05). AUDPC= D [1/2 (Y_1+Yk) + (Y_2+Y_3+……..+Yk-1)]; Where D= Time interval, Y_1= First disease severity, Yk= Last disease severity, Y_2, Y_3,……Yk-1= Intermediate disease severity.

Table 2: Effect of different inducers in tomato seedling for the development of areas in disease progress carve caused by Fusarium solani, F. oxysporum and Rhizoctonia solani under green house conditions

Treatments	Concen. (ppm)	Area under wilt progress carve caused by;					
		Fusarium solani isolate FT4		*Fusarium oxysporum* isolate FT8		*Rhizoctonia solani* isolate FT15	
		AUWPC	Reduction (%)	AUWPC	Reduction (%)	AUWPC	Reductio n (%)
Ethephon	50	865.0 b	23.11	784.3 b	23.41	725.26 b	40.33
	100	651.7 e	42.07	546.6 e	46.62	628.75 c	48.27
	200	525.3 f	53.30	423.5 h	58.64	425.36 e	65.00
H_2O_2	50	716.0 d	36.36	624.4 d	39.02	523.65 d	56.91
	100	544.0 f	51.64	455.3 g	55.54	455.26 e	62.54
	200	325.0 h	71.11	301.3 i	70.58	255.42 g	78.98
Mannitol	50	631.0 e	43.91	654.3 d	36.10	311.56 f	74.36
	100	329.3 h	70.73	295.3 i	71.16	235.56 g	80.62
	200	156.7 j	86.07	124.2 k	87.87	99.26 h	91.83
Salicylic acid	50	825.3 c	26.64	736.7 c	28.06	326.25 f	73.16
	100	354.7 g	68.47	514.8 f	49.73	255.49 g	78.98
	200	225.0 i	80.00	199.5 j	80.52	125.48 h	89.67
Control		1125.0 a	-	1024.0 a	-	1215.36 a	-

Different letters indicate significant differences between treatments according to L.S.D. test (*P*=0.05).

(AUDPC) caused byevery tested fungi compared with untreated i.e. control seedlings (Table 2). Data also, showed that the AUDPC decreased significantly by increasing concentrations of any chemical inducers. However, mannitol at 200 ppm was the most effective inducer for decreasing AUDPC being 86.07, 87.87 and 91.83% followed by salicylic acid at 200 ppm being 80.0, 80.52 and 89.67% in an average in case of F. solani, F. oxysporum and R. solani, respectively. Conversely, tomato seedlings soaked in ethephon at 50 ppm performed the lowest protection against infection with all tested fungi which recorded 23.11, 23.41 and 40.32% reduction of AUDPC on the average in case of F. solani , F. oxysporum and R. solani., respectively. In addition, tomato seedlings treated by the tested chemical inducers were highly effective against

Table 3: Effect of different concentrations of chemical inducers on in vitro mycelial growthof F. oxysporum, F. *solani* and *R. solani*

Treatments	Concen. (ppm)	Mycelial leaner growth (mm)		
		F. oxysporum	*F. solani*	*R. solani*
Ethephon	50	60.83 ef	58.89 ef	69.63 de
	100	52.64 h	45.21 h	60.25 f
	200	40.20 i	35.12 i	55.89 f
H_2O_2	50	80.47 bc	71.67 d	82.56 bc
	100	62.97 e	56.00 f	71.52 d
	200	57.60 fg	50.00 gh	65.23 e
Mannitol	50	84.13 b	80.67 b	85.14 b
	100	80.63 bc	78.08 bc	82.23 bc
	200	76.27 c	74.33 cd	80.25 c
Salicylic acid	50	68.70 d	63.00 e	72.51 d
	100	64.67 de	54.15 fg	68.62 de
	200	54.93 gh	48.6 gh	65.45 e
Control		90.00 a	90.00 a	90.00 a

Different letters indicate significant differences between treatments according to L.S.D. test (*P*=0.05).

infection with R. solani than F. oxysporum or F. solani.

Effect of Chemical Inducers on the Linear Growth of Tomato Root Rot and Wilt Pathogens

There was a significant linear growth of the three tested fungi (F. oxysporum, F. solani and R. solani) due to the effect of all the tested chemical inducers (Table 3). and increased by increasing of chemical concentrations. The highest decrease in linear growth was obtained from ethephon at 200 ppm for all pathogens, while reduced linear growth from 90 mm in control to 40.2, 35.12 and 55.89 mm in case of F. oxysporum, F. solani and R. solani, respectively. Conversely,, F. solani was more sensitive to chemical inducers than F. oxysporum and R. solani.

FIELD EXPERIMENTS

Effects of chemical inducers on root rot, root wilt disease incidence, growth parameters, characteristics of tomato plants under field conditions in New Valley governorate was studied.

Effect of Chemical Inducers on Area under Disease Progress Curve

All chemical inducers in tested concentrations exhibit significant protection against root rot and wilt diseases compared with control in both growing seasons 2010-2011 and 2011-2012), and the protection against root rot and wilt diseases decreased by increasing concentrations of any chemical inducers(Table 4).. However, the most effective inducer was mannitol at 200 ppm (89.32 and 90.40% reduction of AUDPC) followed by SA at 200 ppm (87.21 and 86.47 % reduction of ADUPC) in first and second growing seasons, respectively. Conversely,, tomato seedlings treated with ethephon at 50 ppm showed the lowest protection against root rot and wilt diseases while recorded 13.35 and 18.94 % reduction of AUDPC in first and second growing seasons, respectively.

Effect of Growth Parameters

All of the tested chemical inducers significantly increased the tested growth parameters i.e. plant height and branch number per plant compared with control treatment in both growing seasons (Table 5) except ethephon, where seedlings soaked in 100 ppm was better than 200 ppm. The most effective chemical inducers on plant height (69.22 and 69.12 cm in first and second growing season respectively) was mannitol at 200 ppm, that followed by SA at 200 ppm (67.66, 67.67 cm in first and second growing season, respectively). Conversely, effect of ethephon for increasing plant height was lower compared with the others. The same trend was also observed in case of number of branches per plant, while tomato seedlings were soaked in mannitol at 200 ppm recoded the highest branch number per plant (7.89 and 8.02) followed by SA at 200 ppm (7.45 and 7.63), however ethephon recoded the lowest ones in both seasons.

Effect on chemical inducers on quantitative parameter of fruit yield

There was a significant effect of the chemical inducers on the tested quantitative parameters i. e. no. of fruits plant-1, fruit weight plant-1 (kg), total yield fed -1 (t), fruit weight (g), No. of fruit Kg -1 (Table 6) compared with control and increased with increasing concentrations of chemical inducers except of

Table 4: Effects of tomato seedling soaking in different inducers on area under disease progress carve under field conditions during seasons 2010-2011 and 2011-2012.

Treatments	Concen. (ppm)	Area under wilt progress carve caused by; Season 2010-2011 AUDPC	Reduction (%)	Season 2011-2012 AUDPC	Reduction (%)
Ethephon	50	715.26 b	13.36	612.52 b	18.95
	100	623.56 c	24.47	549.69 c	27.26
	200	415.56 e	49.66	326.56 g	56.79
H_2O_2	50	514.26 d	37.71	486.56 d	35.61
	100	412.52 e	50.03	398.23 e	47.30
	200	215.26 g	73.93	199.63 i	73.58
Mannitol	50	326.56 f	60.44	306.26 h	59.47
	100	105.69 i	87.20	102.23 k	86.47
	200	88.25 i	89.31	72.56 l	90.40
Salicylic acid	50	412.36 e	50.05	359.69 f	52.40
	100	215.56 g	73.89	205.56 i	72.80
	200	155.26 h	81.19	122.36 j	83.81
Control		825.5 a	-	755.69 a	-

Different letters indicate significant differences between treatments according to L.S.D. test (*P*=0.05).

Table 5: Effect of chemical inducers to treat seedling by soaking on growth parameters of tomato cv. Strain B.

Treatments	Concen. (ppm)	Season 2010-2011 Plant height (cm)	No. of branches plant^{-1}	Season 2011-2012 Plant height (cm)	No. of branches plant^{-1}
Ethephon	50	51.11 fg	5.56 d	53.12 ef	5.69 hi
	100	53.89 def	6.45 c	55.59 de	6.55 ef
	200	50.55 fg	5.67 d	52.53 ef	5.97 gh
H_2O_2	50	53.33 efg	6.20 c	55.33 de	6.29 fg
	100	56.67 de	6.45 c	58.67 cd	6.65 ef
	200	58.33 cd	7.22 b	59.33 cd	7.42 bc
Mannitol	50	65.66 ab	7.22 b	65.63 ab	7.55 b
	100	65.00 ab	7.18 b	67.00 ab	7.11 cd
	200	69.22 a	7.89 a	69.12 a	8.02 a
Salicylic acid	50	62.78 bc	6.45 c	62.78 bc	6.56 ef
	100	63.33 b	6.65 c	64.33 ab	6.78 de
	200	67.66 ab	7.45 ab	67.67 a	7.63 ab
Control		48.89 h	5.21d	49.06 f	5.35 i

Different letters indicate significant differences between treatments according to L.S.D. test (*P*=0.05).

ethephon, while seedlings soaked in 100 ppm was better than 200 ppm. The most effective inducers were mannitol at 200 ppm for all fruit quantity except number of fruit in kg-1, whoever recorded highly number of fruit plant-1 (77.67 and 88.23), fruit yield plant-1 (5.48 and 5.65 kg), total yield fed. -1 (29.5 and 30.46 ton), fruit weight (70.55 and 64.04 gm) compared with 30 and 32.23, 1.52 and 1.56, 8.95 and 9.20, 50.67 and 48.25 in control treatment in both seasons, respectively. While this treatment recoded less No. of fruit in kilogram (14.17 and 15.62 in both seasons) compared with 19.74 and 20.72 in control treatments. Salicylic acid at 200 ppm came after of mannitol in increased of all quantity parameters except of fruit weight.

Effect of Fruit yield Quality Parameters

The obtained data in Table (7) show that seedling soaked in the tested chemical inducers significantly improve the quality parameters of tomato compared with untreated seedlings (control). Also, these improve of quality tomato fruits significant increase by increasing of chemical inducer concentrations except in case of ethephon while seedlings soaking in 100 ppm were better than the other tested concentrations. The highest degree on fruit coloring (4.53 and 4.66) was obtained in case of ethephon treatment at 100 ppm followed by H2O2 at 200 ppm (4.27 and 4.35). While, the highest of fruit height and diameter was recoded in case of

Table 6: Effect of seedling soaking in chemical inducers on some quantity parameters of tomato crop during growing seasons 2010-2011 and 2011-2012.

Treatments	Concen. (ppm)	Season 2010-2011					Season 2011-2012				
		No. of fruits plant^{-1}	Fruit weight plant^{-1} (kg)	Fruit weight (gm)	No. of fruit Kg $^{-1}$	Total yield fed $^{-1}$ (Ton)	No. of fruits plant^{-1}	Fruit weight plant^{-1} (kg)	Fruit weight (gm)	No. of fruit Kg $^{-1}$	Total yield fed. $^{-1}$ (Ton)
Ethephon	50	42.33 efg	2.88 f	68.03 ab	15.17 bcd	15.04 e	52.00 f	3.04 e	58.46 bcd	17.11 bcd	15.91 f
	100	46.33 def	3.10 ef	66.91 ab	14.94 cd	21.48 d	55.00 ef	3.36 de	61.09 abc	16.37 cd	22.56 e
	200	33.00 g	1.86 g	56.36 ef	17.74 ab	13.22 e	38.67 g	2.01 f	51.98 efgh	19.24 abc	13.93 f
H_2O_2	50	33.67 fg	1.93 g	57.32 def	17.45 abc	14.81 e	43.33 g	2.06 f	47.54 h	21.03 a	15.66 f
	100	48.33 cde	2.92 f	60.42 cde	16.55 bcd	22.93 cd	58.67 e	3.11 e	53.01 efg	18.86 abcd	23.98 de
	200	55.67 bcd	3.67 d	65.92 b	15.17 bcd	26.87 ab	70.67 d	3.95 cd	55.89 cde	17.89 abcd	27.78 bc
Mannitol	50	62.67 b	3.94 cd	62.87 bc	15.91 bcd	26.12 b	77.26 bc	4.53 bc	58.63 bcd	17.06 bcd	27.31 c
	100	68.33 ab	4.20 c	61.47 cd	16.27 bcd	26.91 ab	80.33 b	4.95 ab	61.62 ab	16.23 cd	28.82 abc
	200	77.67 a	5.48a	70.55 a	14.17 d	29.50 a	88.23 a	5.65 a	64.04 a	15.61 d	30.46 ab
Salicylic acid	50	61.33 bc	3.32 e	54.13 fg	18.47 abc	25.65 bc	72.67 cd	3.59 de	49.40 fgh	20.24 ab	26.65 cd
	100	65.33 ab	3.76 d	57.61def	17.36 abc	27.49 ab	81.67 b	4.41 bc	54.00 def	18.52 abcd	27.79 bc
	200	76.67 a	4.80 b	62.61bc	15.97 bcd	29.08 a	90.33 a	5.1 ab	56.46 bcde	17.71 abcd	31.08 a
Control		30.00 g	1.52 h	50.67 g	19.74 a	8.95 f	32.32 h	1.56 f	48.27 gh	20.72 a	9.20 g

Different letters indicate significant differences between treatments according to L.S.D. test (*P*=0.05).

Table 7: Effect of seedlings soaking in chemical inducers on some quality parameters of tomato crop during growing seasons 2010-2011 and 2011-2012.

Treatments	Concen. (ppm)	Season 2010-2011					Season 2011-2012				
		Fruit coloring degree	Fruit height (cm)	Fruit diameter (cm)	Firmness (kg So cm^2)	T.S.S.	Fruit coloring degree	Fruit height (cm)	Fruit diameter (cm)	Firmness (kg So cm^2)	T.S.S.
Ethephon	50	3.50de	5.05 cde	4.84 d	2.19 d	4.15 fg	3.35 fgh	5.15 e	4.83 e	2.12 f	4.25 fg
	100	4.53a	5.80 abcd	5.40 b	2.46 c	4.26 ef	4.66 a	5.89 d	5.51b c	2.42 d	4.39 ef
	200	3.50de	5.03 cde	4.32 f	1.68 g	4.02 gh	3.64 bcd	5.12 e	4.40 f	1.72 h	4.14 gh
H_2O_2	50	3.17fg	6.08 abc	5.26 bc	1.64 gh	4.02 gh	4.21 bc	6.13 bcd	5.46 bc	2.24 e	4.46 e
	100	4.00bc	6.28 ab	5.39 b	2.04 e	4.36 de	3.25 gh	6.18 bc	5.49 bc	2.48 d	4.62 d
	200	4.27ab	6.33 ab	5.45 b	2.46 c	4.52 d	4.35 ab	6.22 abc	5.61 b	2.62 c	4.79 c
Mannitol	50	3.17fg	5.20 bcd	4.68 de	2.10 de	4.51 d	3.25 gh	5.25 e	4.67 e	1.64 h	4.02 h
	100	3.33efg	6.13 abc	5.36 bc	2.48 c	4.77 c	3.46 fgh	6.33 ab	5.32 cd	2.10 f	4.51 de
	200	3.67cd	6.64 a	5.84 a	2.52 c	4.89 bc	3.72 def	6.46 a	5.86 a	2.48 d	4.77 c
Salicylic acid	50	3.47def	4.73 de	4.58 e	1.89 f	4.13 fgh	3.51 efgh	4.56 f	4.68 e	1.92 g	4.23 g
	100	3.50de	5.39 bcd	5.14 c	2.78 b	5.05 b	3.62 defg	5.96 cd	5.21 d	2.82 b	5.19 b
	200	3.83c	5.68 abcd	5.30 bc	3.28 a	6.02 a	3.92 cde	6.32 ab	5.41 c	3.35 a	6.32 a
Control		3.02g	3.92e	3.57 g	1.51 h	3.96 h	3.12 h	3.82 g	3.47 g	1.61 h	4.02 h

Different letters indicate significant differences between treatments according to L.S.D. test (*P*=0.05).

seedling soaking in mannitol at 200 ppm (6.64, 6.46 and 5.84, 5.86 cm) in both seasons, respectively. On the other side, seedling treated with SA at 200 ppm gave the highest of firmness and T.S.S., while recoded 3.28, 3.35 kg So cm2 of firmness and 6.02, 6.32 TSS compared with 1.52, 1.61 kg So cm2 and 3.96, 4.02 TSS in control in both seasons, respectively.

DISCUSSION

Tomato (Solanum lycopersicum L., syn., Lycopersicon esculentum Mill.) is one of the most important vegetable crops. Soil borne diseases including wilt and root rot cause important considerable losses in yield. In the present investigation, extensive survey was conducted throughout three Egyptian governorates (Assuit, Minia, New Valley) to determine the main causal pathogens of these diseases. The obtained fungal isolates belonging to three genera were isolated from diseased plants viz. F. oxysporum, F. solani and R. solani. Pathogenicity test proved that all the obtained isolates were pathogenic and virulent for tomato plants. The most aggressive fungi are F. oxysporum (isolate TF8), R. solani (TF15) and F. solani (isolate TF4). These results are in harmony with those reported by other researchers (Saad, 2006, Morsy et al., 2009, Abdel-Monaim, 2010).

Controlling such diseases mainly depend on fungicides treatments. However, fungicidal applications cause hazards to human health and increase environmental pollution. Acquired resistance by using abiotic-agents as inducers seems to be one of alternatives to substitute for, or at least to decrease the use of fungicides in plant disease control. Excessive and improper use of pesticides including fungicides presents a menace to the health of human, animal and environment (Guzzo et al., 1993). In the present study, it was planning to investigate the possibility of minimizing the infection with root-rot and wilt diseases of tomato using ethephon, hydrogen peroxide (H2O2), mannitol and salicylic acid (SA) at three different concentrations as resistance inducer. The obtained data revealed that all chemical inducers caused significant reduction to both root rot and wilt diseases either in pot or field experiments, compared with the control treatment. In general, mannitol recoded the highest redaction of AUDPC followed by SA, while ethephon was recoded the lowest redaction ones.

Chemically induced resistance (IR) of plants against pathogens is a widespread phenomenon that has been investigated with respect to the underling signaling pathways as well as to its potential use in plant protection. Elicited by a local infection, plants respond with a salicylic acid dependent signaling cascade that leads to the systemic expression of a broad spectrum and long-lasting disease resistance that is efficient against fungi, bacteria and viruses (Heil and Bostock, 2002). The tested chemical inducers might stimulate some defense mechanisms such as phenolic compounds, oxidative enzymes and some metabolites (El- Khallal, 2007 and Abdel-Monaim et al., 2011). Also, many researches have been reported on the use of ethylene releasing compound ethephon and mannitol for induced resistance (Metwally, 2004 and Abdel-Monaim, 2010). Abdel-Kareem (1998) found that cucumber seed soaking in ethephon induced resistance to powder mildew, such reaction was accompanied by increasing of free phenol content, activation of peroxidase activity and an increase of protein with Mw 69 KD and Mw 33 KD. Mannitol at 1 mM reduced of strawberry fruit rots caused by Botrytis cinerea and increased of fruit yield under greenhouse and field conditions (Saber et al., 2003). Whereas some chemical inducers has a direct antimicrobial effect and is involved in cross-linking in cell walls, induction of gene expression, hypersensitive cell death, phytoalexin production and induced systemic resistance (Apel and Hirt, 2004; Abdel-Monaim 2010). Similar results also gave evidence to the role of H2O2 in activation of an array of host defense mechanisms including induced activity of enzymes as peroxidase and chitinase accompanied by a significant increase in the lignin and suberin content (Quiroga et al., 2000). Moreover, H2O2 plays also an essential role in lignifications, and cross linking of cell wall proteins with phenolic acids, leading to reinforcement of cell walls at the site of pathogen attack positively influences the local and systemic accumulation of SA that is correlated with the enhancement of peroxidase activity (Copes, 2009).

On the other hand, an important finding of this study revealed that these chemical inducers used had adverse effects on the plant growth, yield quantity and quality of tomato under field conditions. The obtained data indicate that all the tested chemical inducers significantly increased growth parameters, yield quantity and quality compared with untreated seedling (control) in both growing seasons. Mannitol followed by SA recoded the highest growth parameters i.e. plant height, number of branches plant-1, and yield quantity viz., No. of fruits plant-1, fruit weight plant-1 (kg), total yield fed -1 (Ton) and some yield quality (fruit diameters and fruit height). These increases in growth, yield quantity and quality may be attributed to elicitors' effect on physiological processes in plant such as ion uptake, cell elongation, cell division, enzymatic activation and protein synthesis (Amin et al., 2007; Gharib and Hegazi, 2010). Gunes, et al. (2007) reported that it has been proposed that salicylic acid acts as endogenous signal molecule responsible for inducing abiotic stress tolerance in plants. They emphasized that exogenous application of SA increased plant growth significantly both in saline and non saline conditions. H202 concentrations were increased by SA treatment (0 –

0.10 mM). Plants produce proteins in response to abiotic and biotic stress and many of these proteins are induced by phytohormones such as ABA (Jin et al., 2000) and salicylic acid (Hoyos and Zhang, 2000). Some chemical inducers are an endogenous growth regulator of phenolic nature, which influence a range of diverse processes in plants, including seed germination (Abdel-Monaim 2010; Gharib and Hegazi, 2010), ion uptake and transport, membrane permeability (Barkosky and Eiinihellig, 1993), photosynthetic and growth rate (Khan, et al., 2003). They added that, in most cases, treatment with these compounds increased leaf areas and plant dry mass. Moreover, Gunes, et al. (2007) demonstrated that exogenously applied SA increased plant growth significantly both in saline and non-saline conditions and this may be related to the strongly to its inhibiting effect on Cl- and Na+ and improving the uptake of N, Mg, Fe, Mn and Cu and / or due to its effect on lipid peroxidation, measured in terms of malondialdehyde (MDA) content and membrane permeability.

REFERANCES

Abdel-Kareem FI (1998). Induction of resistance to some disease of cucumber plants grown under greenhouse condition. Ph. D. thesis, Fac. of Agric. Ain Shams Univ.

Abd-El Kareem F, EL-Mougy NS EL-Gamal NG, Fatouh YO (2006). Use of chitin and chitisan against tomato root rot disease under greenhouse conditions. Res. J. Agric. Biological Sci., 2(4): 147-152.

Abdel-Monaim MF (2010). Induced systemic resistance in tomato plants against Fusarium wilt disease. Minia 2nd Conf. Agric. Environ. Sci. 253-263.

Abdel-Monaim MF, Ismail ME, Morsy KM (2011). Induction of systemic resistance of Benzothiadiazole and Humic acid in soybean plants against Fusarium wilt disease. Mycobiology. 39(4): 290-298.

Abdou El-S, Abd-Alla HM, Galal AA (2001). Survey of sesame root rot/wilt disease in Minia and their possible control by ascorbic and salicylic acids. Assuit J. of Agric. Sci.; 32(3): 135-152.

Abdou S, Abd-Alla HM, Galal AA (1999). Influence of hydrogen peroxide on sunflower rust infection. Arab Univ. J. Agric. Sci., Ain-Shams Univ., Cairo,7(1): 289-302.

Akram W, Anjum T (2011). Use of bioagents and synthetic chemicals for induction of systemic resistance in tomato against diseases. International Res. J. of Agric. Sci. and Soil Sci., 1(8): 286-292.

Al-Mahareeq FAA (2005). Biological control of Rhizoctonia solani and Sclerotium rolfsii by using local isolates of Trichoderma spp. M. Sc., Thesis, Fac. Graduate Studies, An- Najah National Univ., Nablus, Palestine.

Amin AA, Rashad EL-ShM, EL-Abagy HMH (2007). Physiological effect of indole-3-butyric acid and salicylic acid on growth, yield and chemical constituents of onion plants. J. Appl. Sci. Res., 3 (11): 1554-1563.

Apel K, Hirt H (2004). Reactive oxygen species metabolism, oxidative stress, and signal transduction. Annu. Rev. Plant Biol. 55:373–399.

Barkosky RR, Eiinihelli FA (1993). Effects of salicylic acid on plant water relationship. J. of Chemical Ecolology, 19: 237-247.

Barnett HL, Hunter BB (1986). Illustrated Genera of Imperfect Fungi, fourth ed. Macmillan Publishing Co., New York.

Booth C (1985). The genus Fusarium. Kew, Surrey Commonwealth Mycological Institute, 2nd Ed., 237 pp.

Copes WE (2009). Concentration and intervals of hydrogen dioxide applications to control Puccinia hemerocallidis on daylily. Crop Protection, 28: 24–29.

El- Khallal Samia M (2007). Induction and modulation of resistance in tomato plants against Fusarium wilt disease by bioagent fungi (arbuscular mycorrhiza) and/or hormonal elicitors (jasmonic acid and salicylic acid): 1- changes in growth, some metabolic activities and endogenous hormones related to defense mechanism. Australian J. of Basic and Appl. Sci., 1(4): 691-705.

Elad Y, Baker R (1985). The role of competition for iron and carbon in suppression of chlamydospore germination of Fusarium spp. by Pseudomonas spp. J. phytopathol. 75:1053-1059.

El-Mougy NS, Abd-El-Karem F, El-Gamal NG Fotouh YO (2004). Application of fungicides alternatives for controlling cowpea root rot diseases under greenhouse and field conditions. Egypt. J. Phytopathol., 32: 23-35.

Gharib FA, Hegazi AZ (2010). Salicylic acid ameliorates germination, seedling growth, phytohormone and enzymes activity in bean (Phaseolus vulgaris L.) under cold stress. J. of American Sci., 6(10): 675-683.

Giovannucci E (1999). Tomatoes tomato-based products, lycopene and canser: Review of the epidemiologic literature. J. Nat. Cancer Inst., 91:317-331.

Gomez KA, Gomez AA (1984). Statistical Procedures for Agricultural Research. A. Lviley. Interscience Publication. New York, pp.678.

Gunes A, Inal A, Eraslan F, Bacci EG, Cicek N (2007). Salicylic acid induced changes of some physiological parameters sympomatic for oxclative stress and mineral nutrition in maize (Zea mays L.) grown under salinity. J. Plant Physiol., 164 (6):728-736.

Guzzo SD, Back EA, Martins EM, Moraes Wb (1993). Crude expolysaccarides (EPS) from Xanthomonas campestris pv. maniohtis, Xanthomonas campestris pv. campestris and commercial xanthan gum as inducers of protection in coffee plants against Hemileia vastatrix. J. Phytopathol., 139: 119-128.

Heil M, Bostock RM (2002). Induced systemic resistance (ISR) against pathogens in the context of induced plant defences. Ann. Bot. 89:503-512.

Hoyos ME, Zhang SQ (2000). Calciumindependent activation of salicylic acid- induced protein kinase and a 40- kilodalton protein kinase by hyperosmotic stress. Plant Physiology, 122: 1355-1363.

Jin S, Chen CCS, Plant AL (2000). Regulation by ABA of osmotic stress induced changes in protein synthesis in tomato roots. Plant Cell and Environment, 23: 51-60.

Karlidag H, Yildirim E, Turan M (2009). Exogenous applications of salicylic acid affect quality and yield of strawberry grown under antifrost heated greenhouse conditions. J. of Plant Nut. and Soil Sci., 172 (2): 270-276.

Khan W, PrJrithivira B, Smith A (2003). Photosynthetic responses of corn and soybean to foliar application of salicylates. J. of Plant Physiol., pp: 18.

Liu L, Kloepper JW, Tuzun S (1995). Introduction of systemic resistance in cucumber against Fusarium wilt by plant growth-promoting rhizobacteria. Phytopathology, 85:695-698.

Mandal S, Mallick N, Mitra A (2009). Salicylic acid- induced resistance to Fusarium oxysporum f.sp. lycopersici in tomato. Plant Physiol Biochem., 47: 642-649

Metwally MM (2004). Resistance induction against disease of faba bean crop. Ph.D. Thesis, Fac. of Agric., Cairo Univ.

Morsy Ebtsam M, Abdel-Kawi KA, Khalil MNA (2009). Efficiency of Trichoderma viride and Bacillus subtilis as Biocontrol Agents gainst Fusarium solani on Tomato Plants. Egypt. J. Phytopathol., Vol. 37, No. 1, pp. 47-57.

MSTAT-C, 1991. A Software Program for the Design, Management and Analysis of Agronomic Research Experiments. Michigan State University, pp. 400.

Pandy HN, Menon TCM, Rao MV (1989). Simple formula for calculating area under disease progress curve. Rachis, 8 (2): 38-39.

Quiroga M, Guerrero C, Botella MA, Barcelo A, Amaya I, Medina M, Alonso FJ, De Forchetti SM, Tigier H Valpuesta V (2000). A tomato peroxidase involved in the synthesis of lignin and suberin. Plant Physiol., 122: 1119–1127.

Rauf BA (2000). Seed-borne disease problems of legume crops in Pakistan. Pak. J. Sci. and Industrial Res., 43: 249-254.

Saad MM (2006).destruction of Rhizoctonia solani and Phytophthora capsici causing tomato root-rot by Pseudomonas fluorescences Lytic Enzymes. Res. J. of Agric. and Biolog. Sci., 2(6): 274-281.

Saber MM, Sabet KK, Moustafa SM, Khafagi, Iman YS (2003). Evaluation of biological products, antioxidants and salts for control of strawberry fruit rots. Egypt. J. Phytopathol., 31(1-2): 31-43.

Zahra Sh, Amin B, Mehdi Y (2010). The salicylic acid effect on the tomato (lycopersicum esculentum Mill.) germination, growth and photosynthetic pigment under salinity stress (NaCl). J. of Stress Physiol. Biochem., 6 (3): 4-16.