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Full Length Research Paper

Effectiveness of organic compounds in controlling root rot/wilt diseases, growth and yield parameters of pepper

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Root rot and wilt caused by *Fusarium solani* and *F. oxysporum*, are the most important diseases of pepper in Egypt. The possibility to reduce disease severity using some organic compounds viz. Humic acid, Inicium, Bio-Health, Alga Grow-4 and Effective Microorganisms (EM1) was investigated on two pepper cultivars (Long Red Cayenne and California Wonder) under greenhouse and field experiments. Pepper transplanting treated with Humic acid followed by Inicium was the highest efficient in reducing area under disease progress curve (AUDPC) compared with to the other treatments under green house and field conditions. While, pepper transplanting treated with Alga Grow-4 and EM1 recorded the lowest reduction in area under disease progress curve (AUDPC) in this respect. On the other hand, all treatments significantly improved plant growth (plant height and number of branches plant^{-1}) and yield parameters (fruit height, fruit diameter, fruit weight plant^{-1}, No. of fruits plant^{-1}, pod weight and total yield feddan^{-1} (Kg) in both cultivars during growing seasons (2010-2011 and 2011-2012). Humic acid and Inicium were the most effective in improving plant growth and yield parameters. On the contrary pepper transplanting treated with Alga Grow-4 and EM1 gave the lowest increased of these parameters in both cultivars during growing seasons.

Key words: Pepper, root rot and wilt, organic compounds, effective microorganisms, growth parameters, yield parameters.

INTRODUCTION

Hot and sweet pepper (*Capsicum annuum* L.) is one of the most popular vegetable crops in many parts of the world. Green and red pods are used for fresh meal and food industries. Under Egyptian conditions, pepper plants are liable to be attacked by several diseases, among which damping-off, root rots and wilt are widespread and serious in many governorates both in open fields and protected cultivation, in young and relatively even aged plants (Abada, 1994; Abdel-Kader, 1999; Abdel-Monaim and Ismail, 2010; Ragab et al., 2012).

Root rot and wilt diseases caused by soil borne pathogenic fungi is one of the most serious diseases affected several cultivated plants worldwide. It results in poor production, poor quality, poor milling returns and reduced agriculture income (Abdel-Monaim and Ismail, 2010; Ragab et al., 2012).

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Fungal disease control is achieved through the use of fungicides which is hazardous and toxic to both people and domestic animals and leads to environmental pollution. Therefore, a more balanced, cost effective and eco-friendly approach must be implemented and adopted by farmers (Attia et al., 2003). In order to overcome such hazardous control strategies, scientists, researchers from all over the world paid more attention towards the development of alternative methods which are, by definition, safe in the environment, non-toxic to humans and animals and are rapidly biodegradable. Such strategy is use of effective microorganisms to control fungal plant diseases (Dhahira and Qadri, 2010) as well as other fungicides alternatives, that is plant resistance inducers (Abdel-Monaim and Ismail, 1010; Abdel-Monaim et al., 2011) organic compounds (El-Morsi et al., 2009).

The present study aims to evaluate organic compounds

that is Humic acid, Inicium, Bio-Health, Alga Grow-4 and Effective Microorganisms (EM1) as resistance inducers on pepper plants against root rot and wilt diseases under greenhouse and field conditions. Also, its effect on growth parameters and yield parameters of tow pepper cultivars were studed in field.

MATERIAL AND METHODS

Host and Pathogens

Pepper seeds (*Capsicum annuum* L.), cvs. Long Red Cayenne and California Wonder used in the experiments were obtained from unit sale vegetable crops seeds, Horticulture Res. Institute, Agric. Res. Center, Giza, Egypt. Seeds were sown in trays containing sterilized peat vermiculite.

The plants were grown under greenhouse conditions for about 40 days. The highly pathogenic *Fusarium solani* and *F. oxysporum* were grown on potato dextrose agar (PDA) medium and spore suspension (10^4 spores/ml) was prepared.

Source of Organic Compounds and EM1

In this experiment, four organic compounds and effective microorganisms (EM1) (Table 1) were evaluated under green house and field conditions to control root rot and wilt diseases on two pepper cultivars (Long Red Cayenne and California Wonder).

Effect of Organic Compounds and EM1 on Root Rot and Wilt Diseases of Pepper Under Greenhouse Conditions

The trials were carried out in the greenhouse of Plant Pathology Dep., New Valley Agric. Res. Station. Pot experiments were conducted in 2010-2011 season to investigate the influence of seedlings treated with each of organic compounds and EM1 listed in Table 1 against root rot and wilt diseases caused by *F. solani* and *F. oxysporum*. Surface sterilized seedlings of two pepper cultivars (40 days old) were used for all experiments. Pepper seedlings were treated by dipping the root at rate 100 seedlings per 100 ml of the following treatments, Inicium, Bio-Health, Elga Grow-4, Humic acid and EM1 at the recommended concentrations, for one hour. The treated pepper seedlings were then transferred to the pathogen infested pots. Four seedlings were transplanted in each pot and 4 replicates were planted for each treatment. In addition, untreated seedlings were transplanted in pots containing infested soil (infected control). Plants were irrigated when needed and fertilized as usual.

Disease Assessments.

Root rot and wilt severity was estimated at 10 days interval for 60 days after transplanting according to Abdou et al. (2001) using a rating scale of (0 – 5) on based on leaf yellowing grading, viz., 0 = healthy, 1= one leaf yellowing 2= more than one leaf yellowing, 3= one wilted leaf, 4= 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:

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

Where: d is the disease rating of each plant, 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).

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

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

Field Experiments

Field experiments were carried out at New Valley Agric. Res. Station Farm, New Valley governorate, Egypt, during 2010-2011 and 2011-2012 growing seasons, to evaluate the efficiency of the tested organic compounds and EM1 for controlling root rot and wilt diseases of pepper plants (Long red Cain and California Wander) as well as its effect on growth parameters and yield parameters. The chosen field test area was naturally infested with root rot and wilt pathogens. The experimental design was a complete randomized block with four replicates. The experimental unit area was 15 m^2 (5 × 3 m). Each unit included three rows; each row was 5 m in length and 1 m width. Pepper seedlings cvs. Long red Cain and California Wander were treated by dipping the roots for one hour at rate 100 seedlings per 100 ml of the following treatments: Inicium, Bio-Health, Elga Grow 4, Humic acid and EM1 at the recommended concentrations, for one hour. Seedlings transplanted into the field in 10 October in both seasons at rate 10 seedlings per row; one seedling/hill was sown with 50 cm apart between hills. Untreated seedlings were used as control. The NPK mineral fertilizers were applied at the recommended dose of Ministry of Agriculture and Land Reclamation. Disease severity was recorded every 30 days for 4 months. The mean of area under disease progress curve (AUDPC) for each replicate was calculated as above. Plant height, number of branches, fruit length (cm) and fruit diameters, number of fruits $plant^{-1}$, fruit weight $plant^{-1}$ (kg), number of fruit Kg^{-1}, fruit yield $feddan^{-1}$ (kg) were calculated at the end of the growing season.

Table 1. Trade name, common name, active ingredient (%) and recommended doses of the used organic compounds and EM1.

Trade name	Common name	% Active ingredient	Recommended doses	Company
Inicium	Amino acids and phosphorus pentoxide.	10%FS	5 mL/L	Grow Tech for Agricultural Development
Bio- Health	*T. harzianum*, *B. subtilis*, Amino acids, Trace elements, Humic acid, Fulvic acid, Vitamins, Auxin and Cytokinin.	100% WSG	2.5 g/L	Grow Tech for Agricultural Development
Alga Grow-4	Algae extract, nitrogen, phosphorus pentoxide and potassium oxide.	16% FS	1 mL/L	Grow Tech for Agricultural Development
Humic acid	Potassium humate soluble granule	85% WSG	4 g/L	Broadtech Chemical International Co. Ltd., Inner Mongolia, China
Effective Microorganisms (EM1)	Photosynthetic bacteria (*Rhodopseudomonas plastris* and *Rhodobacter sphacrodes*), lactobacilli (*Lactobacillus plantarum*, *L. casei*, and *Streptococcus lactis*), yeasts (*Saccharomyces* spp.), and actinomycetes (*Strptomyces* spp.)	100% FS	5 mL/L	EMRO

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 $P \leq 0.05$ according to (Gomez and Gomez, 1984).

RESULTS

Efficiency of Organic Compounds and EM1 on Area Under Disease Progress Curve Under Greenhouse Conditions

A pot experiment was carried out to examine the efficiency of organic compounds and EM1 against root rot and wilt diseases caused by *F. solani* and *F. oxysporum* in two pepper cultivars (Long Red Cayenne and California Wonder) under greenhouse conditions. Presented data in Figures (1 and 2) revealed that all the tested organic compounds and EM1 significantly reduced area under disease progress curve (AUDPC) comparing with un-treated check control. In this respect, pepper transplanting treated with Humic acid was the highest efficient in reducing AUDPC compared with the other treatments. In case of Long Red Cayenne cultivar, the AUDPC reduced from 1105.33 and 1042.33 to 258.69 and 141.29 AUDPC cased by *F. solani* and *F. oxysporum*, respectively. While, in case of the California Wonder cultivar AUDPC reduced from 1205.33 and 1042.33 to 321.69 and 152.48 in case of soil infested with *F. solani* and *F. oxysporum*, respectively.

On the other hand, pepper transplanting treated with Alga Grow-4 and EM1 recorded the lowest reduction in AUDPC caused by *F. solani* and *F. oxysporum* in both cultivars.

Efficiency of Organic Compounds and EM1 Under Field Conditions

On area under disease progress curve (AUDPC)

Data in Figure (3) revealed that the high infection percentage of pepper plants (cv. Long Red Cayenne) with the pathogen recorded with control whereas, low infection percentage was observed in the treated seedlings with Humic acid, where gave 121.36 and 135.24% AUDPC compared with 812.36 and 912.23 AUDPC in control during first and second growing seasons, respectively, followed by treatment Inicium. Conversely,

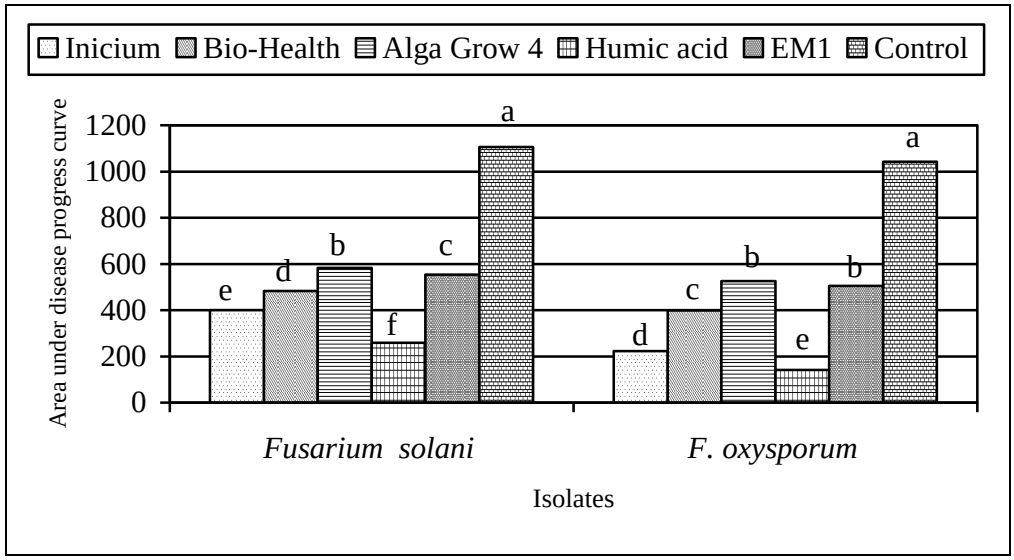

Figure 1. Effect of pepper transplanting (cv. Long Red Cayenne) soaking in organic compounds and effective microorganisms (EM1) on area under disease progress curve (AUDPC) caused by *Fusarium solani* and *F. oxysporum* in pots. Different letters indicate significant differences among treatments according to least significant difference test (L.S.D.) ($P \leq 0.05$).

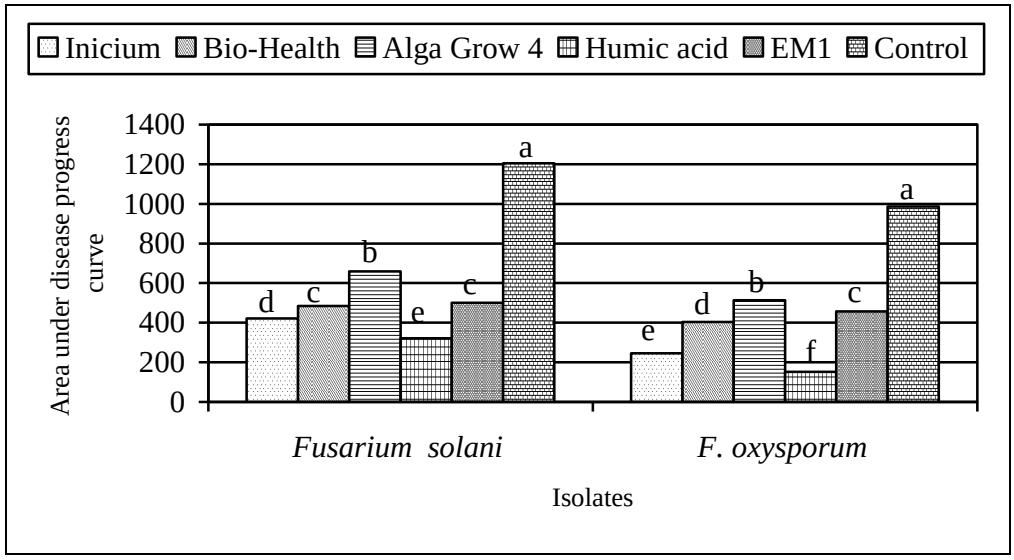

Figure 2. Effect of pepper transplanting (cv. California Wonder) soaking in organic compounds and effective microorganisms (EM1) on area under disease progress curve (AUDPC) caused by *Fusarium solani* and *F. oxysporum* in pots. Different letters indicate significant differences among treatments according to least significant difference test (L.S.D.) ($P \leq 0.05$).

pepper transplanting treated with Alga Grow-4 and EM1 showed the lowest protection against root rot and wilt diseases. Also the same data obtained in case of pepper plants cv. California Wonder (Figure 4), were Humic acid recorded the lowest AUDPC followed by Inicium in both seasons. Conversely, pepper transplanting treated with Alga Grow-4 and EM1 gave the lowest protection in both growing seasons.

On growth parameters.

Data in Tables (2 and 3) indicate that all tested organic compounds and effective microorganisms (EM1) significantly increased growth parameters (plant height and number of branches plant^{-1}) in both cultivars during both growing seasons (2010-2011 and 2011-2012) compared with untreated transplanting. Humic acid recorded

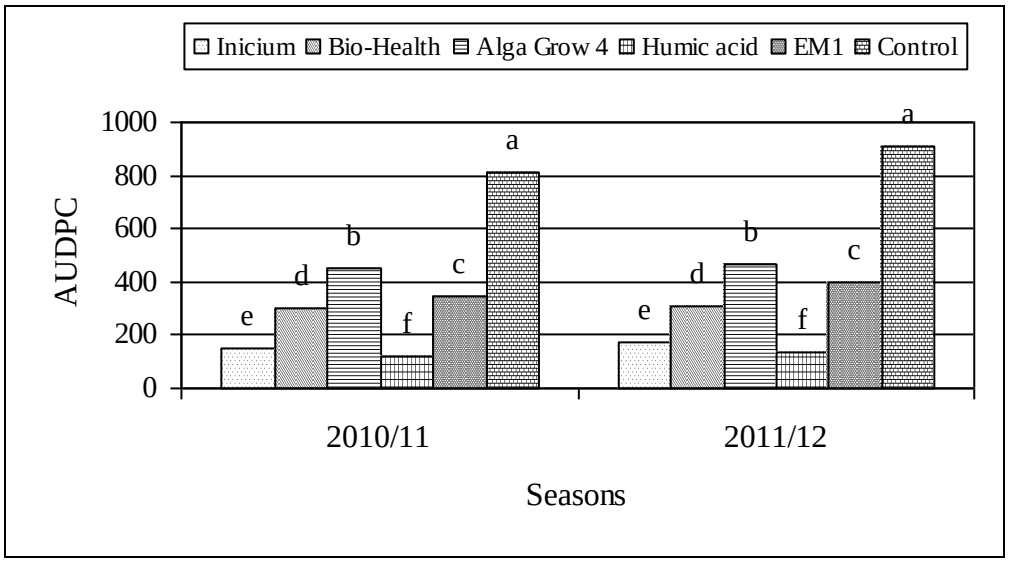

Figure 3. Effect of pepper transplanting (cv. Long Red Cayenne) soaking in organic compounds and effective microorganisms (EM1) on area under disease progress curve (AUDPC) under field conditions during seasons (2010-2011 and 2011-2012). Different letters indicate significant differences among treatments according to least significant difference test (L.S.D.) ($P \leq 0.05$).

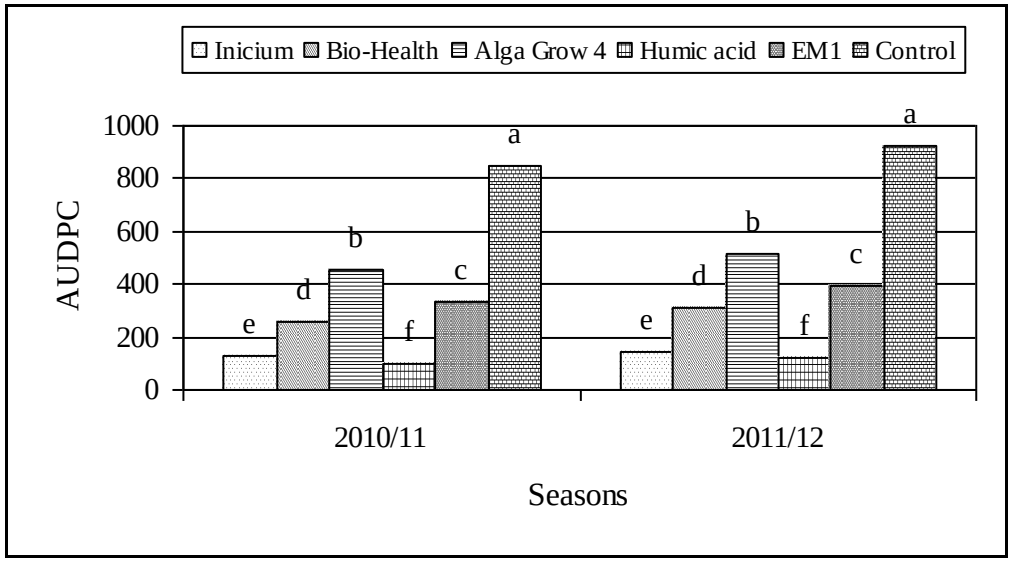

Figure 4. Effect of pepper transplanting (cv. California Wonder) soaking in organic compounds and effective microorganisms (EM1) on area under disease progress curve under field conditions during seasons (2010-2011 and 2011-2012). Different letters indicate significant differences among treatments according to least significant difference test (L.S.D.) ($P \leq 0.05$).

the highest growth parameters in both cultivars, where increased plant height from 66.67 and 67.33 in control to 88.33 and 90.25 in case of cv. Long Red Cayenne in both seasons, respectively. While in case of cv. California Wonder, plant height increased from 63.33 and 62.15 cm in control to 85 and 89.39 cm in both growing seasons, respectively. Also, the obtained data show that Humic acid recorded the highest number of branches plant^{-1} in both cultivars during both growing seasons where increased number of branches in cv. Long Red Cayenne from 3.44 and 3.49 to 7.56 and 8.26 and increased number of branches plant^{-1} from 3.67 and 3.21 to 6.67 and 7.85 in case of cv. California Wonder in both seasons respectively.

On the other hand, pepper transplanting treated with Alga Grow-4 and EM1 gave the lowest increased of plant

Table 2. Effect of organic compounds and effective microorganisms (EM1) on growth parameters of pepper (cv. Long Red Cayenne) during seasons (2010-2011and 2011-2012).

Treatments	Season 2010-2011		Season 2011-2012	
	Plant height (cm)	No. of branches plant^{-1}	Plant height (cm)	No. of branches plant^{-1}
Inicium	83.33 ab	6.78 b	86.36 ab	6.99 b
Bio-Health	80.00 bc	5.78 c	84.26 b	5.72 c
Alga Grow 4	78.33 bc	5.33 c	79.60 c	5.39 cd
EM1	75.00 c	4.67 d	76.38 c	4.82 d
Humic acid	88.33 a	7.56 a	90.25 a	8.26 a
Control	66.67 d	3.44 e	67.33 d	3.49 e

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

Table 3. Effect of organic compounds and effective microorganisms (EM1) on growth parameters of pepper (cv. California Wonder) during seasons (2010-2011and 201-2012).

Treatments	Season 2010-2011		Season 2011-2012	
	Plant height (cm)	No. of branches plant^{-1}	Plant height (cm)	No. of branches plant^{-1}
Inicium	80.00 ab	6.22 a	83.63 ab	6.59 b
Bio-Health	78.33 bc	5.56 b	79.30 bc	5.67 bc
Alga Grow 4	73.67 cd	4.26 c	75.12 cd	5.01 cd
EM1	72.00 d	4.22 c	72.56 d	4.01 de
Humic acid	85.00 a	6.67 a	89.39 a	7.85 a
Control	63.33 e	3.67 d	62.15 e	3.21 e

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

height and number of branches in both cultivars during growing seasons (2010-2011 and 2011-2012).

On yield parameters.

Data present in Tables (4 and 5) show that all treatments significantly increased yield parameters viz. fruit height (cm), fruit diameter (cm), pod weight plant^{-1} (gm), Number of fruits plant^{-1}, pod weight (gm), total yield feddan^{-1} (kg) in both cultivars during growing seasons 2010-2011 and 2011-2012) compare with untreated plants (control). Pepper transplanting (cv. Long Red Cayenne) treated with Humic acid recorded the highest increased of fruit height (9.19, 10.24 cm); fruit diameter (1.25, 1.29 cm); fruit weight plant^{-1} (726.86, 802.14 gm); Number of fruits plant^{-1} (115.37, 802.14); pod weight (6.30, 6.72 gm); total yield feddan^{-1} (4088.74, 4120.36 kg) compared with 6.79 and 6.91 cm; 1.09 and 1.12 cm; 417.60 and 455.36 gm; 92.06 and 94.12; 4.54 and 4.84 gm; 1796.47 and 1805.00 kg in control during both seasons, respectively. Also the same trained in cultivar were recorded the highest fruit height (7.12, 7.32 cm); Fruit diameter (4.45, 4.50 cm); Fruit weight plant^{-1} (745.24, 785.36 gm); Number of fruits plant^{-1} (45.23, 46.36); Pod weight 16.48, 16.94 gm); total yield fed^{-1} (5433.40, 551236 kg) compared with 5.12 and 6.09 cm; 3.01 and 3.09 cm; 420.61 and 402.15 gm; 32.34 and 36.25; 13.01 and 11.09 gm; 2070.52 and 1998.25 kg in control during both seasons, respectively. On the other hand, pepper transplanting treated with Inicium and EM1 gave the lowest increased of all yield parameters in both cultivars during both growing seasons.

DISCUSSION

Pepper plants are subject to infection with many diseases (Dmitriev et al., 2003; Utkhede and Mathur, 2005; Abdel-Monaim and Ismail, 2010), among which the soil-borne diseases are the most important. Many fungi that is *Fusarium, Macrophomina, Rhizoctonia, Pythium, Verticilium* and Sclerotinia causing damping-off, root rot and wilt diseases are commonly encountered in the greenhouse, nurseries and fields (Soner et al., 2005; Goicoechea, 2006; Abdel-Monaim and Ismail, 2010).

Because high disease pressure and high crop value require frequent applications of chemical pesticides, significant environmental pollution and selection of resistant pathogen strains are among the main problems

Table 4. Effect of organic compounds and effective microorganisms (EM1) on yield parameters of pepper (cv. Long Red Cayenne) during seasons (2010-2011and 201-2012).

Treatments	Season 2010-2011						Season 2011-2012					
	Fruit height (cm)	Fruit diameter (cm)	Fruit weight plant-1 (gm)	No. of fruits plant^{-1}	Pod weight (gm)	Total yield fed dan^{-1} (kg)	Fruit height (cm)	Fruit diameter (cm)	Fruit weight plant-1 (gm)	No. of fruits plant^{-1}	Pod weight (gm)	Total yield fed dan^{-1} (kg)
Inicium	9.19a	1.25a	664.84b	110.59ab	6.01ab	3640.73a	9.96a	1.32a	725.35b	115.26ab	6.29a	3758.26b
Bio-Health	8.77a	1.21a	567.90c	101.57bc	5.59bc	2859.74b	8.99a	1.29a	615.25c	109.60abc	5.61b	2909.36c
Alga Grow-4	8.61a	1.19a	520.93d	93.16c	5.39cd	2546.12bc	8.82a	1.28a	602.30c	96.23cd	6.26a	2631.10d
EM1	8.37a	1.19a	507.12d	98.28c	5.16d	2254.94cd	8.12a	1.25a	525.69d	102.34bcd	5.14bc	2318.36e
Humic acid	9.48a	1.29a	726.86a	115.37a	6.30a	4088.74a	10.24a	1.29a	802.14a	119.36a	6.72a	4120.36a
Control	6.79b	1.09a	417.60e	92.06c	4.54e	1796.47d	6.91a	1.12a	455.36e	94.12d	4.84c	1805.00f

Different letters indicate significant differences between treatments according to L.S.D. test ($P \leq 0.05$).

Table 5. Effect of organic compounds and effective microorganisms (EM1) on yield parameters of pepper (cv. California Wonder) during seasons (2010-2011and 201-2012).

Treatments	Season 2010-2011						Season 2011-2012					
	Fruit height (cm)	Fruit diameter (cm)	Fruit weight plant-1 (gm)	No. of fruits plant^{-1}	Pod weight (gm)	Total yield feddan^{-1} (Kg)	Fruit height (cm)	Fruit diameter (cm)	Fruit weight plant-1 (gm)	No. of fruits plant^{-1}	Pod weight (gm)	Total yield fed dan^{-1} (Kg)
Inicium	6.05cd	3.48b	700.04ab	44.04a	15.89a	4357.08b	6.39b	3.55b	725.26b	45.26ab	16.02a	4523.60b
Bio-Health	6.56b	4.25a	658.25b	42.05a	15.65a	3394.84c	6.45b	4.35a	682.45b	43.26abc	15.78a	3421.52c
Alga Grow-4	6.47bc	3.31bc	565.35c	37.96b	14.89ab	3015.15d	6.52b	3.56b	599.02c	39.36bcd	15.22a	3105.05c
EM1	5.82d	3.59b	488.34d	36.54b	13.36bc	2518.56e	6.15b	3.62b	525.36d	37.45cd	14.03ab	2635.12d
Humic acid	7.12a	4.45a	745.24a	45.23a	16.48a	5433.40a	7.32a	4.50a	785.36a	46.36a	16.94a	5512.36a
Control	5.12e	3.01c	420.61e	32.34c	13.01c	2070.52f	6.09b	3.09c	402.15e	36.25d	11.09b	1998.25e

Different letters indicate significant differences between treatments according to L.S.D. test ($P \leq 0.05$).

encountered in fields. This situation has prompted the search for biological alternatives that could be efficient either for conventional disease management programs or for integration with other methods (Hibar et al., 2006). Various organic compounds were tested for biological control of root rot and wilt diseases in pepper plants. Data obtained in this study demonstrated that all organic compounds viz. Inicium, Bio-Health, Alga Grow-4, Humic acid, EM1 reduced significantly area under disease progress curve caused by *F. solani* and *F. oxysporum* under artificial infection in greenhouse and natural infection in field in both pepper cultivars (Long Red Cayenne and California Wonder). Pepper transplanting treated with Humic acid recorded the lowest AUDPC compared with the other organic compounds followed with Inicium. Conversely, pepper seedlings treated with Alga Grow-4 and EM1 showed the lowest protection against root rot and wilt diseases. On the other hand, all tested organic compounds improved growth and yield parameters of both pepper cultivars under field conditions compared with untreated plants (control). Humic acid followed by Inicium gave the highest plant height, number of branches plant^{-1}, fruit height (cm), fruit diameter (cm), fruit weight plant^{-1} (gm), number of fruits plant^{-1}, pod weight (gm), total yield feddan^{-1} (Kg). On the contrary, pepper plants treated with Alga Grow-4 and EM1 recorded the lowest increased of growth parameters and yield parameters in both cultivars. Similar studies have been conducted for other pathogens using the same organic compounds to try to demonstrate if these ones can reduced root rot and wilt severity and improved growth parameters and yield parameters (El-Morsi et al., 2009; Abdel-Monaim et al., 2011). The role of the tested organic compounds in reducing root rot/wilt diseases severity and stimulating plant growth may be due to enhanced natural resistance against plant diseases and pests, stimulated plant growth through increased cell division, as well as optimized uptake of nutrients, water and stimulated the soil microorganisms (Chakroune, 2008; El-Morsi et al., 2009; Okorski et al., 2010; Abdel-Monaim et al., 2011). Application of Humic acid enhances the activity of antioxidants such as α - tocopherol, α - carotene, superoxide dismutases and ascorbic acid concentrations in turf grass species. These antioxidants may play a role in the regulation of plant development, flowering and chilling of disease resistance (Demirci and Dolar, 2006).

REFERENCES

Abada KA (1994). Fungi associated with root rot of pepper and some facters affecting disease incidence. Proc. 7th Coong. of Phytopathol., Giza: 219-226.

Abdel-Kader MM (1999). Biological and chemical control of wilt disease of hot pepper *capsicum annum L.* Egypt. J. Phtopathol, 27 (1): 1-8.

Abdel-Monaim MF, Ismail ME (2010). The use of antioxidants to control root rot and wilt diseases of pepper. Not. Sci. Biol. 2 (2): 46-55.

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. Agric. Sci. 32 (3): 135-152.

Attia MF, Arafa AM, Moustfa MA, Mohamed MA (2003). Pepper grafting, a method of controlling soilborne diseases and enhancement of fruit yield:1- Improvement of pepper resistance to Fusarium wilt. Egypt. J. Phytopathol. 31 (1-2): 151-165.

Chakroune K, Bouakka M, Lahlali R, Hakkou A (2008). Suppressive effect of mature compost of date palm by products on *Fusarium oxysporum* f. sp. albedinis. Plant Pathol. J. 7 (2): 148-154.

Demirci F, Dolar FS (2006). Effects of some plant materials on phytophthora blight (*Phytophthora capsici Leon.*) of pepper. Turk. J. Agric. 247-252.

Dhahira BN, Qadri SMH (2010). Biological control of mulberry root rot disease (*Fusarium spp.*) with antagonistic microorganisms. J. Biopesticides. 3 (1): 90 – 92.

Dmitriev A, Tena M, Jorrin J (2003). Systemic acquired resistance in sunflower (*Helianthus annuus L.*). Tsitol Genet. 37: 9-15.

El-Morsi MEA, Kamhawy MAM, Sallam MAA (2009). Effectiveness of some organic compounds in controlling pathogenic fungi associated with roots of date palm offshoots in New Valley Governorate, Egypt. The 3 rd Conference of Young Scientists, Fac. of Agric., April. Assiut J. Agric. Sci. 28 (40): 137-150.

Goicoechea N (2006). Verticillium-induced wilt in pepper: Physiological disorders and perspectives for controlling the disease. Plant Pathol. J. 5 (2): 258-265.

Gomez KA, Gomez AA (1984). Statistical procedures for Agricultural Research. Interscience Publication. New York.

Hibar K, Daami-Remadi M, Hamada W, El-Mahjoub M (2006). Bio-fungicides as an alternative for tomato Fusarium crown and root rot control. Tunisian J. Plant Protection, 1: 19-29.

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.

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

Okorski A, Olszewski J, Głowacka K, Okorska S, Pszczółkowska A (2010). The effect of the application of the biological control agent EM1 on gas exchange parameters and productivity of *Pisum sativum L.*

infected with *Fusarium oxysporum* Schlecht. Acta Agrobotanica 63 (2): 105–115.

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

Ragab MMM, Ashour AMA, Abdel-Kader MM, El-Mohamady R, Abdel-Aziz A (2012). In Vitro evaluation of some fungicides alternatives against Fusarium oxysporum the causal of wilt disease of pepper (*Capsicum annum L.*). Int. J. Agric. Forestry, 2 (2): 70-77.

Soner S, Mine S, Sener K, Ekici OK (2005). Antagonistic potentials of rhizosphere associated bacterial isolates against soil-borne diseases of tomato and pepper caused by *Sclerotinia sclerotiorum* and *Rhizockgia solani*. Pakistan J. Biol. Sci. 8 (1): 43-48.

Utkhede RS, Mathur S (2005). Biological and chemical control of fruit rot in greenhouse sweet peppers (*Capsicum annum L.*) caused by *Fusarium subglutinans*. J. Biol. Sci. 5 (5): 610-615.