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Integrated Management of Tomato White Mold Disease Caused by *Sclerotinia sclerotiorum* using the Combined Treatments of Compost, Chemical Inducers and Fungicides

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ABSTRACT

Efficacy of compost, chemical inducers and fungicides individually or in combination for managing tomato white mold caused by *Sclerotinia sclerotiorum* (Lib.) de Bary under greenhouse and field conditions was studied. Results indicated that all treatments significantly reduced disease incidence and severity of tomato white mold disease comparing with untreated control. Moreover, the integrated SA and $FeSO_4$ with compost recorded the highest increase of fresh weight and dry weight of shoots and roots compared with the individual treatments and control. The integrated SA with compost was the highest effective treatment where it reduced disease incidence and disease severity to be 11.1 and 5.20% comparing with control treatment which recorded 100 and 77.4% respectively under greenhouse conditions. Under field conditions, adding compost to the soil pre-transplanting decreased the percentage of infection and increased yield of tomato plants compared with un-amended treatments with compost. In this respect, the integration between Billis and compost was the most effective treatment where it reduced effectively the disease incidence and disease severity (88.24 and 92.37%) respectively. As well as, it increased fruit weight per plant by 154.76%. It could be concluded from the obtained results that the combination between compost, chemical inducers and fungicides might be useful as a good tool for controlling tomato white mold disease caused by *Sclerotinia sclerotiorum* under greenhouse and field conditions.

Key words: Tomato- *Sclerotinia* rot - fungicides- chemical inducers - compost - enzymes

Introduction

Egypt is one of the top tomato producers in the world. Production of tomato of Egypt recorded 8533803 million tons in 2013 (5.24% of the world production), (FAOSTAT, 2016). *Sclerotinia sclerotiorum* (Lib.) de Bary is worldwide in distribution and pathogen to more than 400 plant species. This disease causes significant yield losses of various important crops including tomato (Lu, 2003). The capability of sclerotia to survive for more than 4 years becomes very difficult to manage the crop from the infection of white mold fungus (Fernando *et al.,* 2004). The major methods of controlling *Sclerotinia* disease are applying fungicides and crop rotation. However, fungicide chemicals are expensive and not all environmentally safe (Lu, 2003). Complete growth inhibition was recorded for both *S. sclerotiorum* and *S. minor* at 100 mg/L of Topsin-M and Ridomil Gold, while Rizolex-T gave the same effect at 200 mg/L (Abdel-Kader *et al.*, 2012). Development of new disease protection strategies is essential to achieve an efficient and sustainable tomato industry. The induction of systemic resistance in crops by exogenous application of inducer chemicals would be particularly useful against pathogens that are currently poorly controlled. Induced resistance by chemicals is also a promising approach to prevent diseases caused by soil-borne pathogens (Okubara and Paulitz, 2005). Hilal *et al.,* (2006) found that, Bion, Chitosan, Oxalic acid and Salicylic acid at 5 mM concentrations significantly reduced the growth of *S. sclerotiorum* growth on PDA and Soaking seeds in each one of the four elicitors or the fungicide Switch tested significantly decreased pre- & post-emergence as well as increased survivals in caraway, coriander and fennel plants. Soaking sesame seeds in 2, 4 and 8mM of salicylic acid decreased charcoal rot rotted plant and increased healthy plants, increased peroxidase, polyphenoloxidase and catalase activity comparing to check plants (El-Fiki *et al.,* 2004). Addition of 10% compost to soil significantly decreased diseases as Aphanomyces root rot of peas; Rhizoctonia root rot of bean, cotton, and radish; Sclcrotinia drop of lettuce, Fusarium wilt of cucumber and phytopthora crown rot of pepper (Lumsden *et al.*, 1983).

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The objective of the current work was to control tomato Sclerotinia disease by studying the compatibility of compost in combination with chemical inducers and fungicides in the greenhouse and field conditions.

Materials and Methods

1- Isolation and identification of the causal organism:

Diseased samples of tomato plants showing *Sclerotinia* mold symptoms were collected from EL-Behaira governorate and subjected to isolation trails. *Sclerotinia* spp. were isolated from the lesions appeared on diseased plants. The infected tissues were cut into small pieces, surface sterilized with sodium hypochlorite (0.5%) for 2-3 minutes, washed for several times with sterilized distilled water, dried between sterilized filter papers and transferred directly to the PDA medium in plate 9cm. The plates were incubated for 1-2 days at 22±2ºC.The fungi grown from the lesion pieces were transferred to potato dextrose agar (PDA) slants. The fungus was purified by hyphal tip technique (Brown, 1924). The purified fungal isolates were identified according to Kora, (2003). PDA slants from the fungus were kept in refrigerator at 4 ºC for further experiments.

2- Laboratory Experiments:

2.1. Effect of different resistant inducing chemicals on linear growth and sclerotia formation of Sclerotinia sclerotiorum in vitro:

This study was designed to investigate the inhibitory effect of some chemicals, which used later as resistant inducing compounds, on linear growth and sclerotial formation of *S. sclerotiorum in vitro*. The used chemicals were tested at 3 concentrations as follow:

1- The antioxidants (K_2HPO_4, $FeSO_4$, K_2SiO_3, and salicylic acid) were tested at concentration of 2, 4 and 8 mM.
2- Chitosan (1000, 1500 and 2000 mg/L.
3- Cobalt sulphate ($CoSO_4$) was tested at concentrations 5, 10 and 20 mg/L.

The amount required for obtaining a known concentration of any chemical was calculated and added aseptically to known amount of warm sterilized Czapek's agar medium and poured before solidification into plate (ϕ 9 cm) then plates were inoculated at the center with equal discs (ϕ 5 mm) obtained from the periphery of 10 days old cultures of *S. sclerotiorum*. Plate contained media without any chemical inoculated with *S. sclerotiorum* was served as control treatment. Three plates were used for each particular concentration. All plates were incubated at 22±2°C. The experiment was terminated when mycelial mats covered medium surface in control treatment. Percentage of the fungal growth reduction (X) was calculated by using the following formula (4) suggested by Abd-El-Moity, (1985).

$X = G1- G2 / G1 \times 100$

Where: X= fungal growth reduction.
G1= linear growth of the pathogen inoculated alone.
G2= linear growth of the pathogen inoculated against the antagonistic fungus.

2.2. Effect of different fungicides on linear growth and sclerotia formation of Sclerotinia sclerotiorum in vitro:

This study was designed to investigate the inhibitory effect of some fungicides, on linear growth and sclerotial formation of *S. sclerotiorum in vitro*. The used fungicides were tested at 4 concentrations as follow:

A. Moncut was tested at concentrations of 1000, 1500, 2000, 3000 mg/L.
B. Maxim-xl was tested at concentrations 200, 400, 800, 1000 mg/L.
C. Banch was tested at concentrations 200, 400, 800, 1000 mg/L.
D. Billis was tested at concentrations1, 3, 4, 7 mg/L.
E. Rovaral was tested at concentrations 50, 400, 800, 1000 mg/L.

The amount required for obtaining a known concentration of any fungicide was calculated and added aseptically to known amount of warm sterilized Czapek's agar medium and poured before solidification into plate (ϕ 9 cm) then plates were inoculated at the center with equal discs (ϕ 5 mm) obtained from the periphery of 10 days old cultures of *S. sclerotiorum*. Plates contained media without any fungicide inoculated with *S. sclerotiorum* was served as control treatment. Three plates were used for each particular concentration. All plates were incubated at 20 ±2°C. The experiment was terminated when

mycelial mats covered medium surface and formation the sclerotia in control treatment, all plates were examined and growth reduction was calculated as mentioned before**.**

3- Greenhouse experiments:

The inoculum of *S. sclerotiorum* was grown for two weeks on sand barley medium (3:1, w:w and 40% water). Inoculum of *S. sclerotiorum* fungus was added to the potted soil at rate of 3.0% w/w, mixed thoroughly with the soil surface of each pot then watered and left for one week to insure even distribution of the inoculums**.**

3.1. Effect of dipping tomato transplants root in some chemical inducers resistance against infection with white rot disease:

In this study, six chemical inducers were evaluated as root dipping treatments for controlling sclerotinia mold of tomato under greenhouse conditions. The chemical inducers tested were: Salicylic acid (SA), ferrous sulphate ($FeSO_4$) Potassium diphosphate (K_2HPO_4), potasioum silicate (K_2SiO_3) at 8mM, cobalt sulfhate ($CoSO_4$) at 20mg/L and chitosan at 2g/L.

Loamy sand soil [3clay:1sand w/w] was sterilized by thoroughly mixing with 5% commercial formalin solution (one L of 5% formalin solution/cubic feet of soil mixture) and covered with polythene for 2 weeks. Later, polythene cover was removed and soil was raked for 10 days for ventilation and formalin evaporation. Similarly, plastic pots (ϕ 20 cm) were sterilized by dipping in 5.0% commercial formalin solution for 15 minutes, left to dry for 24 hrs. then filled with the previously sterilized soil.

Apparently healthy tomato transplants of Super Strain B were dipped in each particular chemical inducer for 2 h., then raised and left to air dried before planting. Transplants were planted in pots amended with mixture of soil compost or soil without compost. Untreated transplants were used as control. Soil infestation was carried out as previously mentioned. Three pots were used as replications for each treatment. The disease severity of white rot that caused by *S. sclerotiorum* was assessed using disease scale proposed by Grau *et al.* (1982) consisted of three categories: 0 to 3, where; (0= no detectable symptoms,1= appearance of a 1-2 cm water-soaked lesion on the crown region of the plant, 2= appearance of a 2 cm water-soaked lesion covering the stem base of the plant, 3= plant completely dead)

$$\text{Disease Severity \%} = \Sigma (a \times b) / N \times K \times 100$$

Where: a = Number of infected leaves in each category.
b = Numerical value of each category.
N = Total number of examined leaves.
K = The highest degree of infection category.

3.2. Effect of dipping tomato transplants root in some fungicides against infection with white rot disease:

Five fungicides, namely Banch (0.2mL /L water), Moncut (2g /L water), Billis (0.05g/L water), Rovaral (1.5g/L water) and Maxim-xl (2.0 mL /L water), were used as root dipping treatments. Apparently healthy tomato transplants of Super Strain B were dipped in each particular fungicides solution for 5 min then raised and left to air dried before planting. Transplants were planted in pots amended with composted soil or without compost. Untreated transplants were used as control. Soil infestation was carried out as previously mentioned before. Three pots were used as replications for each treatment.

4- Field Experiment:

This experiment was conducted at the Experimental Farm of Faculty of Agriculture, Benha Univ., during October to January 2014 and 2015 in a field with fine texture soil heavily natural infested with *S. sclerotiorum* to evaluate the disease incidence and disease severity and fruits weight as result of integrated management of *S. sclerotiorum* in tomato especially with the treatments appeared an efficiency in greenhouse. The experiment involved 8 treatments with three replicates as follow: Billis, SA, Compost, Billis + SA, Billis + compost, SA + compost, SA + Billis + compost, and control.

Statistical analyses:

Statistical analyses of all the previously designed experiments have been carried out according to the procedures (ANOVA) reported by Snedecor and Cochran (1989). Treatment means were compared by the least significant difference test " L.S.D " at 5% level of probability.

Results and Discussion

1- Effect of some chemical inducers on linear growth and sclerotial formation of *S. sclerotiorum in vitro*:

Results in **Tables 1** show that, both growth and production of sclerotia of *S. sclerotiorum* were significantly reduced by most tested chemical treatments compared with control. Regarding linear growth, the salicylic acid (SA) at 8 mM completely inhibited the mycelial growth and production of sclerotia followed by salicylic acid (SA) at 4 mM which reduced linear growth and production of sclerotia by 67.77 and 88.89% respectively. Other treatment not affected growth of *S. sclerotiorum*. Reduction in sclerotial formation was increased by increasing concentration of most tested chemical. These results are in agreement with those of Abdel-Ghany, (2008) who found that, salicylic acid, reduced growth of *S. rolfsii* , *F. solani* and *R. solani*. Whereas, some abiotic inducers had no inhibitory effect on the fungal growth *i.e.* $MgSO_4$ (against all fungi), $CuSO_4$ (against *M. phaseolina* and *P. ultimum*), Bion 50% (against *S. rolfsii*, *M. phaseolina* and *P. ultimum*); Boric acid (against *M. phaseolina*). Hilal *et al.* (2006) found that, Bion, Chitosan, Oxalic acid and Salicylic acid at 5 mM concentrations significantly reduced the growth of *S. sclerotiorum* growth on PDA.

Table 1: Effect of chemical inducers on linear growth and Sclerotial formation of *S. sclerotiorum in vitro*

Treatment	Conc.	Mycelium growth (mm)	Sclerotial formation	Efficacy	
				Mycelium Growth (mm)	Sclerotial formation
Salicylic acid (SA)	2mM	90.00	11.30	0.00	68.61
	4mM	29.00	4..00	67.77	88.89
	8mM	0.00	0.00	100	100
Chitosan	500 mg/L	90.00	13.30	0.00	63.05
	1000 mg/L	90.00	10.30	0.00	71.38
	2000 mg/L	90.00	7.50	0.00	79.16
Ferrous sulphate ($FeSO_4$)	2mM	90.00	12.00	0.00	66.67
	4mM	90.00	17.00	0.00	52.78
	8mM	90.00	6.60	0.00	81.67
Cobalt sulfhate ($CoSO_4$)	5 mg/L	90.00	14.00	0.00	61.11
	10mg/L	90.00	11.30	0.00	68.61
	20mg/L	90.00	13.00	0.00	63.89
Potassium diphosphate (K_2HPO_4)	2mM	90.00	22.30	0.00	38.05
	4mM	90.00	19.00	0.00	47.22
	8mM	90.00	11.60	0.00	67.78
Potasioum silicate (K_2SiO_3)	2mM	90.00	25.00	0.00	30.56
	4mM	90.00	21.00	0.00	41.67
	8mM	90.00	23.30	0.00	35.27
Control	--------	90.00	36.00	0.00	0.00
LSD 0.05 =	Chemical	0.14	5.06	--------	--------
	Conc.	0.12	1.78	--------	--------
	Interaction	0.11	8.23	--------	--------

2- Effect of fungicides with different concentrations on linear growth and sclerotial formation of *S. sclerotiorum in vitro*:

The present results in Table 2 illustrate that, the linear growth of *S. sclerotiorum* was completely inhibited by most tested fungicides. In general, the mycelial growth of *S. sclerotiorum* was completely stopped at 3, 4 and 7 mg/L of Billis; 50, 400, 800 and 1000 mg/L of Rovral; 400, 800 and 1000 mg/L of Banch and Maxim-XL respectively.

Moreover, all fungicides caused complete inhibition of sclerotial formation of *S. sclerotiorum*. These results are in harmony with the results of Iqbal, (2003) who found that, the fungicides Ridomil gold,

Benlate, Tecto-60 and Topsin-M were the most effective fungicides in inhibiting the sclerotial germination of *Sclerotinia* spp. Shivpuri *et al.* (2001) observed that fungicides, carbendazim, thiophenate methyl and phenylpyrrole had completely inhibited the growth of *S. sclerotiorum* at all tested concentrations *in vitro*.

Table 2: Effect of fungicides with different concentrations on linear growth and sclerotial formation of *S. sclerotiorum in vitro*

Treatment	Conc. (mg/L)	Mycelium growth (mm)	Sclerotial formation	Efficacy	
				Mycelium growth (mm)	Sclerotial formation
Moncut	1000	8.30	0.00	7.77	100
	1500	4.50	0.00	50.00	100
	2000	3.06	0.00	66.00	100
	3000	1.03	0.00	88.55	100
Maxim-XL	200	1.60	0.00	82.22	100
	400	0.00	0.00	0.00	100
	800	0.00	0.00	0.00	100
	1000	0.00	0.00	0.00	100
Banch	200	0.50	0.00	94.44	100
	400	0.00	0.00	0.00	100
	800	0.00	0.00	0.00	100
	1000	0.00	0.00	0.00	100
Billis	1	3.53	0.00	60.78	100
	3	0.00	0.00	0.00	100
	4	0.00	0.00	0.00	100
	7	0.00	0.00	0.00	100
Rovral	50	0.00	0.00	0.00	100
	400	0.00	0.00	0.00	100
	800	0.00	0.00	0.00	100
	1000	0.00	0.00	0.00	100
Control	--------	90.00	24	0.00	0.00
LSD 0.05 =	Fungicides	0.16	1.29	--------	--------
	Conc.	0.13	7.25	--------	--------
	Interaction	0.56	3.08	--------	--------

Greenhouse experiments:

1- Effect of chemical inducers as root dipping treatment on white rot disease incidence, disease severity, fresh weight and dry weight in tomato

Results shown in Table 3 indicate that all applied treatments significantly reduced white rot disease incidence and disease severity, as well as increased fresh weight and dry weight of shoots and roots. Integrated treatments with compost were effective more individually. The highest increase in shoot fresh weight was recorded for plants treated with SA combined with compost. SA integrated with compost was the highest effective treatment and reduced disease incidence and disease severity from 100 and 77.4 in control to 11.1 and 5.20% respectively, followed by $FeSO_4$ integrated with compost, which reduced disease incidence and disease severity to 11.1 and 5.60 % respectively. In addition to, SA and $FeSO_4$ integrated with compost recorded the highest increases in shoot and root fresh and dry weight compared with individually treatments and control. These positive results in decreasing sclerotinia stem rot severity may due to the induction of systemic resistance similar to that reported against *S. sclerotiorum* in kiwi fruit using SA or OA as inducers (Reglinski *et al.,* 1997) and in oilseed rape using OA (Toal & Jones, 1999). Incidence and severity of white mold on dry bean were significantly reduced with application of calcium chloride and calcium silicate (Paula Junior *et al.,* 2009).

2- Effect of fungicides as root dipping treatment on white rot disease incidence, disease severity, fresh weight and dry weight in tomato.

Results in Table 4 indicate that integration between the tested fungicides and compost had a great combatable impact in reducing white rot disease incidence, disease severity and increasing fresh weight and dry weight of shoots and roots compared to untreated control treatment. In this respect, the highest reduction% of disease incidence and disease severity was obtained in case of Billis and Banch integrated

with compost where they reduced the disease incidence by 22.2 and 33.3% and disease severity by 7.16 and 11.56% respectively.

Moreover, integration between Billis and Banch with compost significantly increased both fresh and dry weight of shoots and roots per plant. On the other hand, the other treatments recorded moderately effect. These results are in harmony with those reported by Singh *et al.,* (1994) who reported that the benomyl, carbendazim and mancozeb 0.2% controlled *S. sclerotiorum* on mustard and reduced the disease by 91.3, 85.7 and 54.7 %, respectively. Abo Rehab *et al.* (2013) found that Billis, Saprol, Syllet and Conazol were the effective fungicides in inhibiting the spore viability and mycelial growth of *Phomopsis viticola* when tested *in vitro* and reduced the percentage of infection by 75, 70, 62 and 55%, respectively.

Table 3: Effect of chemical inducers as root dipping treatment on white rot disease incidence, disease severity, fresh weight and dry weight of tomato.

Treatment	Without Compost						With Compost					
	Disease incidence%	Disease severity%	Fresh weight (g)		Dry weight (g)		Disease incidence (%)	Disease severity (%)	Fresh weight (g)		Dry weight (g)	
			root	shoot	root	shoot			root	shoot	root	shoot
$FeSO_4$	33.3	21.36	1.12	2.08	0.36	0.56	11.1	5.6	2.53	3.36	0.71	0.83
Chitosan	44.4	21.86	2.05	2.36	0.60	0.69	22.2	6.46	2.52	2.77	0.70	0.79
Ox	44.4	33.46	1.60	2.06	0.46	0.54	33.3	19.46	1.62	2.26	0.67	0.72
K2HPo4	44.4	22.30	1.50	2.13	0.37	0.76	44.4	23.4	1.13	1.39	0.53	0.62
K2Sio3	66. 6	24.30	1.72	2.03	0.50	0.62	55.5	21.30	1.26	1.66	0.54	0.66
SA	33.3	18.26	3.09	3.40	0.72	0.82	11.1	5.20	3.60	4.46	0.82	0.92
Compost	---	---	---	---	---	---	88.89	45.2	0.44	0.93	0.22	0.13
S. sclerotiorum	100	77.4	0.27	0.37	0.16	0.33	---	---	---	---	---	---
LSD 0.05 =	20.69	1.85	0.29	0.21	0.14	0.14	20.69	1.85	0.29	0.21	0.14	0.14

Table 4: Effect of some fungicides as root dipping treatment on white rot disease incidence, disease severity, fresh weight and dry weight in tomato.

Treatment	Without compost						With compost					
	Disease incidence (%)	Disease severity (%)	Fresh weight(g)		Dry weight(g)		Disease incidence (%)	Disease severity (%)	Fresh weight(g)		Dry weight(g)	
			Root	Shoot	Root	Shoot			Root	Shoot	Root	Shoot
Banch	33.3	21.8	2.09	2.81	0.67	0.77	33.3	11.56	2.31	2.64	0.65	0.73
Billis	22.2	14.56	4.22	4.75	0.84	0.87	22.2	7.16	5.33	5.75	0.95	0.97
Rovral	44.4	33.53	3.15	3.86	0.82	0.83	55.5	23.16	4.47	4.59	0.92	0.95
Moncut	55.5	32.53	2.12	2.74	0.68	0.76	66.6	25.06	3.52	3.77	0.82	0.89
Maxim-XL	44.4	16.5	2.16	2.23	0.77	0.77	55.5	13.56	2.41	2.77	0.74	0.85
Compost	---	---	---	---	---	---	88.89	45.2	0.44	0.93	0.22	0.13
S. sclerotiorum	100	77.4	0.27	0.37	0.16	0.33	---	---	---	---	---	---
LSD 0.05 =	20.53	3.72	0.25	0.20	0.13	0.15	20.53	3.72	0.25	0.20	0.13	0.15

3-Effect of different combination of Billis, SA and compost on white rot disease incidence, disease severity and fruits weight under field conditions.

This experiment was carried out under field conditions in season 2015. Data in Table 5 indicate that tested treatments significantly reduced disease incidence, disease severity and increased fruit weight per plant. Adding compost to the soil pre-transplanting decreased the percentage of infection and increased yield of plants compared with un-amended treatments with compost. Integration between Billis and compost was the most effective treatment and reduced disease incidence and disease severity by 88.24 and 92.37% respectively. As well as, increased fruit weight per plant by 154.76%. The effects of organic amendments, suggests that both chemical and biological components of compost-amended soils can contribute to disease suppression (Abbasi *et al*, 2002 and Metcalf *et al*., 2004). The addition of good quality compost is essential for increasing soil organic matter and providing nutrients for the crop. Further, increasing organic matter results in a more extensive and varied microbial community, resulting in suppression of soil-borne pathogens and improved plant health. Eisa *et al.,* (2013) recorded that, under field conditions combining the fungicide Folicur with compost has enhanced the control of white rot of onion and bulb yield compared with using alone. Abdel-Kader *et al*., (2013) found that, combination of (compost + *T. harzianum* + thyme) and (compost + *T. harzianum* + lemongrass) reduced the peanut crown rot disease incidence at both pre- and post-emergence growth stages, respectively compared with Vitavax-

Captan at 3 g/kg and untreated control. (Trotel-Aziz, *et al*., 2006) revealed that the combination of Chitosan and $CuSO_4$ increased phytoalexin production. This elicitor capacity of Chitosan and/or $CuSO_4$ appeared to be associated with an induced protection of grapevine leaves against gray mold and downy mildew diseases. The incidence of several soil-borne plant pathogens has been reduced by using composts made of different raw materials (Lumsden *et al*., 1983 and Borrero *et al*., 2004).

Table 5: Effect of different combination of Billis, SA and compost on white rot disease incidence, disease severity and fruit weight per plant of treated tomato

Treatment	Disease incidence (%)	Disease severity (%)	Weight fruits per plant (kg)	Efficiency		
				Disease incidence (%)	Disease severity (%)	Weight fruits per plant (kg)
Billis	8.33	4.7	3.95	-88.24	-86.72	88.10
SA	16.66	8.9	3.30	-76.48	-74.86	57.14
SA + Billis	12.5	7.5	3.65	-82.35	-78.81	73.81
Compost	52.63	20.7	2.96	-25.70	-41.53	40.95
Billis + compost	8.33	2.7	5.35	-88.24	-92.37	154.76
SA + compost	16.66	6.9	5.11	-76.48	-80.51	143.33
SA + Billis + Compost	12.5	5.5	4.57	-82.35	-84.46	117.62
Control	70.83	35.4	2.10	0.00	0.00	0.00
LSD 0.05	9.42	3.93	0.21			

References

Abbasi, P.A., J. Al-Dahmani, F. Sahin, H.A.J. Hoitink and S.A. Miller, 2002. Effect of compost amendments on disease severity and yield of tomato in conventional and organic production systems. Plant Dis., 86: 156-161.

Abdel-Ghany, R.E.A., 2008. Induced resistance for controlling root-rot disease of strawberry and their side effects on biological activities in soil. Ph.D. Thesis., Fac. Agric., Benha Univ.

Abdel-Kader, M.M., F. Abdel-Kareem, N.S. El-Mougy and R.S. El-Mohamady, 2013. Integration between compost, *Trichoderma harzianum* and essential oils for controlling Peanut crown rot under field conditions. Journal of Mycology, pp: 1-7.

Abdel-Kader, M.M., N.S. El-Mougy, E.I. Embaby and S.M. Lashin, 2012. Occurrence of Sclerotinia foliage blight disease of cucumber and pepper plants under protected cultivation system in Egypt. I. Chemical and Biological Control Measures in *Vitro*chemical and biological control measures *in vitro*. Advances in Life Sciences, 2(1): 20-27.

Abd-El-Moiety, T.H. and N.M. Abou-Zeid, 1985. Studies on the control of *Botrytis fabae* on faba bean in Egypt. Proceeding of the 1st. National Confference of Pests and Disease of Vegetable and Field Crops in Egypt, (PDVFCE'85) Ismailia, pp: 779-790.

Abo Rehab, M.E.A., A.K.M. Korra, M.A.M. Kamhawy and K.Y.A. Youssef, 2013. Fungal species associated with graft union on grapevine, its impact on graft failure process and attempted solutions in Egypt. International Journal of Agriculture and Forestry, 3(2): 52-59.

Borrero, C., M.I. Trillas, J. Ordov´as, J.C. Tello and M. Avil´es, 2004. Predictive factors for the suppression of fusarium wilt of tomato in plant growth media. Phytopathology, 94(10): 1094-1101.

Brown, N., 1924. Two mycological method. II- a method of isolated single strain fungi by cutting a hyphal tip. Ann. Bot., 38: 402-406.

Eisa, N.A., M.A. Hafez, M.M.A. Khalifa, E. Eid, Kh. and H.A.M.M. Mahdy, 2013. Effect of different types of compost in combination with some biological agents and folicur fungicide on onion white rot disease. Journal of Applied Sciences Research, 9(4): 2803-2810.

El-Fiki, A.I.I., F.G. Mohamed, A.A. El-Deeb and M.M.A.K halifa, 2004. Some applicable methods for controlling charcoal rot disease (*Macrophomina phaseolina*) under greenhouse conditions. Egypt J. Phytopathol., 32 (1-2): 87-101.

FAOSTAT, 2016. Statistics division. FAO. http://faostat.fao.org.

Fernando, W.G., S. Nakkeeran and Y. Zhang, 2004. Ecofriendly methods in combating *Sclerotinia sclerotiorum* (Lib.) de Bary. Recent Res. Devel. Environ. Biol., 1: 329-347.

Grau, C.R., V.L. Radke and F.L. Gillespie, 1982. Resistance of soybean cultivars to *Sclerotinia sclerotiorum*. Plant Dis., 66: 506-508.

Hilal, A.A., M.G.A. Nada and W.H. Zaky, 2006. Induced resistance against *Sclerotinia sclerotiorum* disease in some umbelliferous medicinal plants as a possible and effective control mean. Egypt. J. Phytopathol., 34(2): 85-101.

Iqbal, S.M., A. Ghafoor and A.M. Haqqani, 2003. Pathogenicity and fungicidal efficacy for sclerotinia rot of brinjal. International Journal of Agriculture & Biology, 4: 618-620.

Kora, C., 2003. Etiology, epidemiology and management of Sclerotinia rot of carrot caused by *Sclerotinia sclerotiorum* (Lib.) be Bary. Ph.D. Thesis University of Guelph, Guelph, Ontario.

Lu, G., 2003. Engineering *Sclerotinia sclerotiorum* resistance in oilseed crops. African journal of biotechnology, 2(12): 509-516.

Lumsden, R.D., J.A. Lewis and P.D. Millner, 1983. Effect of composted sewage sludge on several soilborne pathogens and diseases. Phytopathology,73(11): 1543-1548.

Metcalf, D.A., J.J.C. Dennis and C.R. Wilson, 2004. Effect of inoculum density of *Sclerotium cepivorum* on the ability of *Trichoderma koningii* to suppress white rot of onion. Plant Disease, 88: 287-291.

Okubara, P.A and T.C. Paulitz, 2005. Root defense responses to fungal pathogens: A molecular perspective. Plant and Soil., 274: 215-226.

Paula Junior, T.J., R.F. Vieira, H. Teixeira and J.S. Carneiro, 2009. Foliar application of calcium chloride and calcium silicate decreases white mold intensity on dry beans. Tropical Plant Pathology, 34: 171-174.

Reglinski, T., P.R. Poole, G. Whitaker and S.M. Hoyte, 1997. Induced resistance against *Sclerotinia sclerotiorum* in kiwi fruit leaves. Plant Pathol., 46: 716-721.

Shivapuri, A., A.K. Bhargava and H.P. Chippa, 2001. *Sclerotinia sclerotiorum*- a new threat to mustard cultivation in Rajasthan, In: Proceeding of Sclerotinia 2001, the XI International Sclerotinia Workshop (C.S. Young and K.J.D. Hughes. eds.). York 8-12, July, 2001, Central Science Laboratory, York, England., pp: 177-178.

Singh, R., N.N. Tripathi and C.D. Kaushik, 1994. Management of Sclerotinia rot of Indian mustard (Brassica juncea (L.) Czern and Coss.) by fungicides. Crop Res., 7: 276-281.

Snedecor, G.W. and W.G. Cochran, 1989. Statistical methods. Oxford and J. PH. Publishing Com. 8th edition.

Toal, E.S. and P.W. Jones, 1999. Induction of systemic resistance to *Sclerotinia sclerotiorum* by oxalic acid in oilseed rape. Plant Pathol., 48(6): 759-767. (C.f. Rev. Pl. Pathol., 79 (5): 306, 2000).

Trotel-Aziz, P., M. Couderchet, G. Vernet and A.A ziz, 2006. Chitosan stimulates defense reactions in grapevine leaves and inhibits development of *Botrytis cinerea*. Eur J Plant Pathol., 114: 405-413.