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Induce Onion Plants Resistance Against *Sclerotium cepivorum* Berk. Mediated Through Salicylic Acid and Sil-Matrix 29% SL.

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ABSTRACT

Salicylic acid (SA) and Sil-Matrix 29% SL (SM) (potassium silicate, potassium salt of silicic acid) were used to manage white rot of onion caused by *Sclerotium cepivorum* Berk. at the rate of 1, 2 and 3mM of SA and 1.5, 3 and 6ml/L of SM as transplants dipping followed by foliar spray by the same concentrations at 6 and 12 weeks from transplanting under greenhouse and open field conditions. The fungicide folicure 25% EC (Tebuconazole 25%) was used as comparison. All treatments reduced white rot infection compared with non-treated plants either in greenhouse or field. SA at the rate of 3mM gave the best reduction where it gave 35.0% and 26.0% infection under greenhouse and field respectively. The best treatment of SM was 6ml/L which gave 45% and 38.2% infection under greenhouse and field respectively. Compared to non-treated plants, all treatments increased onion yield, bulb weight, and plants height. SA at the rate of 3mM gave 144.3% and 160.4% increase in yield and bulb weight respectively, while SM at the rate of 6ml/L gave 24% as best increase in plants height. Soluble protein, free amino acids, reducing sugars, phenolic compounds, peroxidase and polyphenol oxidase activity increased after dipping while it varied after spraying.
Keywords: Onion white rot, Salicylic acid, *Sclerotium cepivorum*, Silicon, Sil-Matrix.

INTRODUCTION

Allium white rot caused by soil-born fungus *Sclerotium cepivorum* Berk. is a major problem for the onion-growing in many countries. In Egypt onion occupies an important position among all crops. Many researchers attempt to find away to control that disease by different ways such as, chemical control, biological control, agricultural practices, soil solarization, plant extracts and induced resistance (Abd-El-Moity *et al*., 1982, Salama *et al*., 1985 and 1988, Khaled *et al*., 1997, Amin, 2003 and Smolinska and Kowalska, 2006).

Induced resistance is the phenomenon by which the plant can utilize the own defense mechanism to increase the level of resistance without changing plant genome (Kuć, 1982 and Van Loon, 1997). There are two types of induced resistance, local acquired resistance (LAR), which is limited at the site of induction, and systemic acquired resistance (SAR), which develops in plant tissues not directly exposed to induction (Kessmann *et al*., 1994, Deverall, 1995 and Lyon & Newton, 1997). Several natural and synthetic chemical agents have been described as activators of defense-related processes when applied to plants. Some of these activators may have potential application in agriculture (Kessmann *et al*., 1994 and Yamaguchi, 1998).

Salicylic acid and silicon were used by many researchers to study their effect as chemical agent for induce plants resistance against many pathogens (Salama *et al*., 1985, Chérif *et al.,* 1992 and Buck *et al.,* 2008).

The present study was conducted to investigate the effects of SA and SM as resistance inducers agents in onion plants against white rot pathogen under greenhouse and field conditions and to more elucidate their impacts on onion yield and growth parameters compared with Folicure.

MATERIALS AND METHODS

Sclerotium cepivorum

An isolate of *S. cepivorum* was isolated from infected onion plants collected from Menia Governorate. Identified based on the morphological characteristics as mentioned by Mordue (1976). The isolate was used to inoculate sterilized barley seeds medium for 3 weeks at 20^{o} C (Van der Meer *et al*., 1983) to use as inoculum.

Salicylic acid (SA)

SA (C7H6O3) is a monohydroxybenzoic acid, a type of phenolic acid and a beta hydroxy acid. Manufactured by El Nasr Pharmaceutical chemicals co. Abu Zaabal, Egypt.

Sil-Matrix 29% SL (SM)

Sil-Matrix 29% SL (potassium silicate) is a potassium salt of silicic acid. Manufactured by PQ Corporation-USA.

Folicure

The fungicide Folicure 25% EC (tebuconazole 25%) collected from Ministry of Agriculture, Egypt, used in this investigation as a comparison with the treatments.

Greenhouse experiment

Pot experiments were carried out in the greenhouse of Onion, Garlic and Oil Crops, Plant Pathology Res. Inst., ARC during 2013/2014 and 2014/2015 seasons. Plastic pots (25-cm-diam) filled with sterilized sand-clay soil (1:1 v/v) and infested by 2% w/w, 7 days before transplanting. Four pots were used for each treatment and control. Five transplants of cv. Giza 6 (60-day-old) were transplanted in each pot in November and irrigated when needed. Transplants were dipped for 10 min. in 1, 2 and 3mM solution of SA or 1.5, 3 and 6 ml/L SM separately just before transplanting, then growing plants were sprayed at 6 and 12 weeks by the same concentrations. As check control transplants were dipped for 5 min. in Folicure 25% (25 ml/L water) just before transplanting, then growing plants sprayed at 6 and 12 weeks by 187.5 ml/100L water.

Field experiment

Field experiments were carried out during 2013/2014 and 2014/2015 seasons in soil naturally infested with *S. cepivorum* at Mallawy Agriculture Research Station, Menia Governorate. All treatments were conducted under field conditions as described in greenhouse experiments. Complete randomized blocks design were used. Sixty days old onion transplants cv. Giza 6 were transplanted on November. Four plots were used as replicates for all treatments and control. The area for each plot was 10.5 m^2 (3.0 X 3.5 m). All treatments received the same normal agricultural practice till harvest in April.

Chemical assay

Changes of soluble protein, free amino acids, reducing sugars, total phenolic compounds, peroxidase (POD) and polyphenol oxidase (PPO) activity were determined colorimetrically (UV-Vis spectrophotometer UV 9100 B, LabTech).

Onion samples were prepared according to Ackerson (1981) to measure free amino acids according to Jayeraman (1985) and reducing sugars according to Miller (1959). Phenolic compounds were assessed as described by Shahidi and Naczk (1995). In the crude extract, soluble proteins were quantified by the method of Bradford (1976), while POD and PPO activity was measured as described by Hammer Schmidt *et al.* (1982) and Benjamin and Montegomery (1973) respectively.

Measurements

Under greenhouse and field conditions, the assessment of infection % was done at the end of each season in April. While under field conditions, onion yield, bulb weight and plant height were assessment at harvest in April. In 2014/2015 growing season, soluble protein, free amino acids, reducing sugars, phenolic compounds, POD and PPO activity were determined five times during season i.e.; one week after transplanting, before spraying at 6 weeks, one week after spraying at 6 weeks, before spraying at 12 weeks and one week after spraying at 12 weeks.

Statistical analysis:

Collected data were statistically analyzed at lest significant difference (LSD) at 5% probability level using SAS ANOVA program V.9 (Anonymous, 2014).

RESULTS

Under greenhouse conditions, all treatments reduced white rot of onion infection compared with non-treated plants as described in Table (1). The percentage of infection decreased gradually with increasing of concentration either with SA or with SM treatments. The best treatment in reducing percentage of infection was SA at 3mM that gave 35.0% infection in mean of two season with 44.0% efficacy compared with non treated plants. SM at the rate of 6ml/L gave the best level of infection reduction (45% infection and 28% efficacy) equal with SA treatment at the rate of 2mM. On other hand, Folicure treatment superiority was significantly on all tested treatments where it gave 17.5% infection and 72.0% efficacy compared with non-treated plants.

Table 1. Percentage of white rot infection in onion plants cv. Giza 6 treated by salicylic acid, Sil-Matrix 29% SL and Folicure (25%) under greenhouse conditions during growing seasons 2013/2014 and 2014/2015.

Treatment	Concentration	Infection (%) 2013/14	2014/15	Mean	Efficacy* (%)
Salicylic acid (mM)	1.0	45.0	55.0	50.0	20.0
	2.0	50.0	40.0	45.0	28.0
	3.0	40.0	30.0	35.0	44.0
Sil-Matrix 29% SL (ml/L)	1.5	60.0	55.0	57.5	8.0
	3.0	55.0	45.0	50.0	20.0
	6.0	50.0	40.0	45.0	28.0
Folicure**		20.0	15.0	17.5	72.0
Control		65.0	60.0	62.5	-
L.S.D. at 0.05%		12.3	11.9	-	-

***Relative to the control. **transplants were dipped for 5 min. in Folicure 25% (25 ml/L water) just before transplanting, then growing plants sprayed at 6 and 12 weeks by 187.5 ml/100L water.**

Under field conditions, data present in Table (2) show that all treatments significantly reduced percentage of infection compared with non-treated plants. SA at the rate of 3mM was the best treatment of white rot infection reduction that gave 26.0% with 56.8% efficacy, followed by SA at the rate of 2mM that gave 35.3% infection and 41.3% efficacy, while the best SM treatment was 6.0ml/L that gave 38.2% infection and 36.4% efficacy.

Table 2. Percentage of white rot infection in onion plants cv. Giza 6 treated by salicylic acid, Sil-Matrix 29% SL and Folicure (25%) under naturally infested field by *S. cepivorum* at Mallawi Agric. Res. Sta., Menia Governorate, during growing seasons 2013/2014 and 2014/2015.

Treatment	Concentration	Infection (%) 2013/14	2014/15	Mean	Efficacy* (%)
Salicylic acid (mM)	1.0	46.4	41.3	43.9	27.0
	2.0	40	30.6	35.3	41.3
	3.0	30	21.9	26.0	56.8
Sil-Matrix 29% SL (ml/L)	1.5	59.4	55.8	57.6	4.2
	3.0	54.8	56.3	55.6	7.6
	6.0	38.3	38.1	38.2	36.4
Folicure**		11.8	13.3	12.5	79.1
Control		56.3	63.8	60.1	-
L.S.D. at 0.05%		2.5	3.4	-	-

***Relative to the control.**
**** transplants were dipped for 5 min. in Folicure 25% (25 ml/L water) just before transplanting, then growing plants sprayed at 6 and 12 weeks by 187.5 ml/100L water.**

Concerning to onion bulb yield at field experiments as illustrated in Table (3), yield increase in all treatments ranged between 144.3% with SA 3mM and 100% with SM 1.5ml/L. Meanwhile best treatment of SM achieved at the rate of 6mL/L that gave 121.6% increase relative to non-treated plants. While Folicure treatment increased bulb yield by 146.6%.

Table 3. Effects of salicylic acid, Sil-Matrix 29% SL and Folicure (25%) on onion bulb yield (cv. Giza 6) under naturally infested field by *S. cepivorum* at Mallawi Agric. Res. Sta., Menia Governorate, during growing seasons 2013/2014 and 2014/2015.

Treatment	Concentration	Yield (kg/plot) 2013/14	2014/15	Mean	Increases* (%)
Salicylic acid (mM)	1.0	9.7	10.5	10.1	129.5
	2.0	10.2	10.6	10.4	136.4
	3.0	10.5	11	10.8	144.3
Sil-Matrix 29% SL (ml/L)	1.5	8.3	9.3	8.8	100.0
	3.0	9.1	10.3	9.7	120.5
	6.0	9.4	10.1	9.8	121.6
Folicure**		11.8	9.9	10.9	146.6
Control		4.4	4.4	4.4	-
L.S.D. at 0.05%		0.5	o.6	-	-

*Relative to the control.** transplants were dipped for 5 min. in Folicure 25% (25 ml/L water) just before transplanting, then growing plants sprayed at 6 and 12 weeks by 187.5 ml/100L water.

As illustrated in Table (4) all treatments increased bulb weight, and plants height compared to non-treated plants. The highest increase in bulb weight achieved with SA at the rate of 3mM that gave 160.4%, while SM at the rate of 1.5mL/L gave 96.7%. All treatments increased bulb weight more than Folicure treatment that gave 81.8% compared to none treated plants. Also, all treatments increased plants height more than Folicure treatment that gave 16.1% except SA at the rate of lmM that gave 12.7%. SM treatment at the rate of 6ml/L gave 24% as best increase in plants height compared to control.

Data present in Table (5) shows that total phenols content decreased gradually between applications time and increased after applications. All SA concentrations increased phenols content more than control. The best treatment is SA at the rate of 2 and 3mM. Application of SM at the rate of 6ml/L increased phenols content after dipping while all concentrations increased phenols content after spraying.

Table 4. Effects of salicylic acid, Sil-Matrix 29% SL and Folicure (25%) on bulb weight and plant height (onion cv. Giza 6) under naturally infested field by *S. cepivorum* at Mallawi Agric. Res. Sta., Menia Governorate, during growing seasons 2013/2014 and 2014/2015.

Treatment	Concentration	Bulb weight (gm) 2013/14	2014/15	Mean	Increases* (%)	Plant height (cm) 2013/14	2014/15	Mean	Increases* (%)
Salicylic acid (mM)	1.0	72.0	73.6	72.8	102.3	48.3	49.8	49.0	12.7
	2.0	85.3	85.0	85.1	136.5	51.9	52.3	52.1	19.7
	3.0	96.3	91.3	93.8	160.4	52.0	52.4	52.2	20.0
Sil-Matrix 29% SL (ml/L)	1.5	71.6	70.0	70.8	96.7	52.9	52.1	52.5	20.7
	3.0	79.3	81.0	80.1	122.6	50.4	53.3	51.8	19.1
	6.0	83.4	85.5	84.4	134.5	51.8	56.1	53.9	24.0
Folicure**		67.0	63.9	65.4	81.8	49.6	51.4	50.5	16.1
Control		34.3	37.8	36.0	-	44.8	42.3	43.5	-
L.S.D. at 0.05%		8.5	3.8	-	-	2.0	1.4	-	-

*Relative to the control. ** transplants were dipped for 5 min. in Folicure 25% (25 ml/L water) just before transplanting, then growing plants sprayed at 6 and 12 weeks by 187.5 ml/100L water.

Table 5. Effect of salicylic acid and Sil-Matrix 29% SL on phenols content in onion plants cv. Giza 6 grown in naturally infested field with *S. cepivorum* at Mallawi Agric. Res. Sta., Menia Governorate, during growing season 2014/2015.

Treatment	Concentration	Phenols content (mg/100 g f. wt.) A	B	C	D	E
Salicylic acid (mM)	1.0	80.0	44.7	69.4	66.0	80.0
	2.0	86.9	70.0	94.0	67.0	89.8
	3.0	90.0	77.0	89.8	80.0	89.6
Sil-Matrix 29% SL (ml/L)	1.5	49.0	35.1	75.2	37.0	70.0
	3.0	55.0	30.0	80.9	41.5	65.0
	6.0	67.1	50.0	78.9	45.0	69.8
Control		55.9	61.0	55.5	63.0	55.0
L.S.D. at 0.05%		26.0	28.0	23.6	25.1	23.8

(A) transplants dipping for 10 minutes before transplanting, (B) before spraying at 6 weeks, (C) One week after spraying at 6 weeks, (D) before spraying at 12 weeks and (E) One week after spraying at 12 weeks.

As for amino acids, the data present in Table (6) show that the content in plants were increased after all treatments with SA and at 3 and 6ml/L with SM. Content of amino acids decreased gradually between all applications and increased after applications. Best treatment for increasing amino acids content was SA at the rat of 3mM, while the best SM treatment was 6ml/L.

Table 6. Effect of salicylic acid and Sil-Matrix 29% SL on amino acids content in onion plants cv. Giza 6 grown in naturally infested field with *S. cepivorum* at Mallawi Agric. Res. Sta., Menia Governorate, during growing season 2014/2015.

Treatment	Concentration	Amino acids content (mg/100 g f. wt.) A	B	C	D	E
Salicylic acid (mM)	1.0	277.0	138.2	170.0	91.2	165.0
	2.0	450.0	92.0	190.0	103.4	250.0
	3.0	709.9	206.7	667.0	130.5	402.0
Sil-Matrix 29% SL (ml/L)	1.5	185.0	130.0	170.0	123.2	145.0
	3.0	370.0	185.9	255.0	176.4	200.0
	6.0	410.0	220.0	385.4	188.9	270.0
Control		190.0	195.0	210.0	190.0	170.0
L.S.D. at 0.05%		72.9	36.7	116.5	12.1	36.3

(A) transplants dipping for 10 minutes before transplanting, (B) before spraying at 6 weeks, (C) One week after spraying at 6 weeks, (D) before spraying at 12 weeks and (E) One week after spraying at 12 weeks.

The present data in Table (7) show that all treatments increased reducing sugars more than control at all applications. Reducing sugars decreased gradually between all applications and increased after applications. Best treatment for increase reducing sugars content was SA at the rate of 3mM, while the best SM treatment was 6ml/L treatment.

Table 7. Effect of salicylic acid and Sil-Matrix 29% SL on reducing sugars content in onion plants cv. Giza 6 grown in naturally infested field with *S. cepivorum* at Mallawi Agric. Res. Sta., Menia Governorate, during growing season 2014/2015.

Treatment	Concentration	Reducing sugars content (mg/100 g f. wt.)				
		A	B	C	D	E
Salicylic acid (mM)	1.0	175.0	105.0	160.0	97.0	100.0
	2.0	199.0	100.0	180.0	95.0	105.0
	3.0	210.0	105.0	185.0	93.0	110.0
Sil-Matrix 29%SL (ml/L)	1.5	155.0	95.0	120.0	90.0	95.0
	3.0	170.0	100.0	135.0	87.0	100.0
	6.0	195.0	103.0	150.0	91.0	105.0
Control		115.0	103.0	99.0	85.0	75.0
L.S.D. at 0.05%		8.7	9.0	12.0	8.8	6.2

(A) transplants dipping for 10 minutes before transplanting, (B) before spraying at 6 weeks, (C) One week after spraying at 6 weeks, (D) before spraying at 12 weeks and (E) One week after spraying at 12 weeks.

Soluble protein was increased with all treatments and applications more than control as described in Table (8). The highest increase was achieved with SA at the rate of 3mM, while the best SM treatment was 6ml/L.

Table 8. Effect of salicylic acid and Sil-Matrix 29% SL on soluble protein content in onion plants cv. Giza 6 grown in naturally infested field with *S. cepivorum* at Mallawi Agric. Res. Sta., Menia Governorate, during growing season 2014/2015.

Treatment	Concentration	Soluble protein content (mg/100 g f. wt.)				
		A	B	C	D	E
Salicylic acid (mM)	1.0	17.8	13.3	20.0	18.8	17.5
	2.0	20.8	18.5	22.6	13.3	20.0
	3.0	33.4	17.5	25.0	12.4	25.5
Sil-Matrix 29% SL (ml/L)	1.5	15.1	10.0	20.1	12.5	14.5
	3.0	17.5	15.0	16.5	13.6	19.5
	6.0	19.0	12.5	22.5	17.9	25.4
Control		14.2	10.0	14.0	15.0	13.0
L.S.D. at 0.05%		12.0	10.5	6.0	8.0	8.5

(A) transplants dipping for 10 minutes before transplanting, (B) before spraying at 6 weeks, (C) One week after spraying at 6 weeks, (D) before spraying at 12 weeks and (E) One week after spraying at 12 weeks.

Data present in Table (9) showed that all treatments increased POD activity after dipping. POD activity increased after spraying with SA at all concentrations and SM 6ml/L, while increased with SM 3ml/L only at C sample. SA at the rate of 3mM gave highest increase in POD activity while the best SM treatment was 6ml/L.

Table 9. Effect of salicylic acid and Sil-Matrix 29% SL on peroxidase activity in onion plants cv. Giza 6 grown in naturally infested field with *S. cepivorum* at Mallawi Agric. Res. Sta., Menia Governorate, during growing season 2014/2015.

Treatment	Concentration	Peroxidase activity (unit/mg protein)				
		A	B	C	D	E
Salicylic acid (mM)	1.0	97.5	57.5	94.5	52.5	85.0
	2.0	135.0	67.5	105.0	57.5	97.5
	3.0	178.5	80.0	147.5	67.5	115.0
Sil-Matrix 29% SL (ml/L)	1.5	100.0	48.5	82.5	49.0	63.5
	3.0	123.5	52.5	93.5	52.5	78.5
	6.0	153.5	63.5	108.5	62.5	89.0
Control		95	97.5	90.5	94.5	80.5
L.S.D. at 0.05%		11.0	18.0	11.0	14.4	25.8

(A) transplants dipping for 10 minutes before transplanting, (B) before spraying at 6 weeks, (C) One week after spraying at 6 weeks, (D) before spraying at 12 weeks and (E) One week after spraying at 12 weeks.

PPO activity increased in all treatments after dipping as described in Table (10). PPO activity increased after all spraying treatments except SM 1.5 and 3ml/L at 12 weeks (E). SA treatment at the rat of 3mM gave the best induction of PPO activity, while the best induction by SM achieved at the rate of 6ml/L treatment.

Generally, we can conclude that, SA treatment at the rate of 3mM gave the best result in reducing white rot of onion either in pots or open field, increased bulb yield and induced evaluated chemical compounds in treated plants compared with non-treated plants.

Table 10. Effect of salicylic acid and Sil-Matrix 29% SL on Polyphenol oxidase activity in onion plants cv. Giza 6 grown in naturally infested field with *S. cepivorum* at Mallawi Agric. Res. Sta., Menia Governorate, during growing season 2014/2015.

Treatments	Concentration	Polyphenol oxidase activity (unit/ mg protein)				
		A	B	C	D	E
Salicylic acid (mM)	1.0	111.0	50.0	120.0	60.0	70.0
	2.0	148.0	75.0	160.0	60.0	70.0
	3.0	173.0	95.0	173.5	80.0	147.5
Sil-Matrix 29% SL (ml/L)	1.5	100.0	45.0	97.5	62.5	50.0
	3.0	121.5	47.5	97.5	65.0	60.0
	6.0	157.5	85.0	135.0	70.0	105.0
Control		100	111.0	90.0	93.0.0	65.0
L.S.D. at 0.05%		39.0	35.0	33.0	28.3	17.1

(A) transplants dipping for 10 minutes before transplanting, (B) before spraying at 6 weeks, (C) One week after spraying at 6 weeks, (D) before spraying at 12 weeks and (E) One week after spraying at 12 weeks.

DISCUSSION

Chemical inducers are largely used as bioactive substances in controlling soil-borne as well as foliar plant pathogens (Abd-El-Kareem, 1998, Abd-El-Kareem *et al.,* 2001, Abd-El-Kareem *et al.,* 2002, El-Gamal *et al.,* 2003, Amin *et al.,* 2007, Abd-El-Monaim, 2010, Abd-El-Monaim *et al.,* 2011 and El-Mohamedy *et al.,* 2013). In the present study, different concentrations of salicylic acid and Sil-Matrix 29% SL were used as transplants dipping followed by foliar application of the same chemical inducers in order to evaluate their efficacy in controlling white rot of onion in artificially infested soil as well as naturally infested soil under greenhouse and open field conditions respectively. All treatments gave a significant disease reduction in greenhouse and confirmed under field conditions, increased bulb yield, bulb weight, plant height, and content of phenols, amino acids, reducing sugars, soluble protein, peroxidase, and polyphenol oxidase activity compared with non-treated plants.

The first hint that SA might be involved in plant defense was provided by White (1979) who found that injection of SA or aspirin into tobacco leaves enhanced resistance to subsequent infection tobacco mosaic virus. SA can enhance resistance to virus, bacteria, and fungi even in susceptible plants (Chivasa *et al.*, 1997). Mills *et al.* (1986) and Yalpani *et al.* (1991) reported that SA induced local and systemic resistance of cucumber and tobacco plants. Dean and Kuc (1987) reported that SA enhance host resistance systemically. Walters *et al.* (1993) showed that barley plants treated with SA or ASA reduced mildew infection. Hadi and Balali (2010) found that weekly treatment by 0.2mM SA resulted in 73% reduction in *Rizoctonia solani* infection symptoms on the potato tubers under greenhouse conditions. Moreover, the intensity of infection symptoms was further reduced by increase in the concentration of SA (0.2-0.5mM). El-Mohamedy *et al.,* (2014) stated that the incidence and severity of tomato root rot caused by *F. solani, R. solani* and *S. rolfsii* were reduced by using different concentrations of SA.

Number of potato tubers was increased by the application of 2mM SA to plants that had been infected with fungi (Hadi and Balali, 2010). In the same trend, El-Mohamedy *et al.,* 2013 and El-Mohamedy *et al.,*(2014) found positive effects of SA on tomato plants growth, yield and fruit quality under field conditions during two cropping seasons. 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, protein synthesis and the reduction of disease incidence or their hormonal effects on treated plants (Baldwin, 1998, Amin *et al.,* 2007 and Gharib and Hegazi 2010).

Resistance in plants could be induced by different ways as a response to many induced factors including biotic and abiotic agents. The onset of systemic acquired resistance has been shown to be accompanied by the accumulation of SA, a wide variety of mRNA species and their encoded protein products (Delaney, 2004). At low concentrations, SA and its derivatives can play as inducing resistant agent (Vernooij *et al.,* 1994, Nawrath and Metraux, 1999 and Rocher *et al.,* 2005) but at higher concentrations they act as protein synthesis inhibitor (Kwon *et al.,* 1997), alter electron transport and oxidative phosphorylation in mitochondria (Zhixin and Chen, 1999 and Norman *et al*., 2004). SA induce number of defense related genes including some of these that encode pathogenic related protein (Van loon and Van Strien, 1999). Pathogenesis related proteins, β 1,3-glucanase and chitinase accumulate in immunized plants that were treated by SA would be en-counted intercellular or in the vacuole and act against pathogens in early or late stage of infection according to their position in plant (Kuć, 1995 and Ye *et al.,* 1995, Van Loon, 1997, Dann *et al.,* 1998 and Owen *et al.,* 2002). Induced lignification is accompanied by an increase in the activity of the key enzymes of the phenylpropanoid pathway such as phenylalanine ammonia-lyase, cinnamyl alcohol dehydrogenase and peroxidases (Nicholson and Hammerschmidt, 1992 and Meuwly *et al.,* 1995). SA had a stimulatory effect on the production of hemicellulose and lignin in shoots and roots of wheat plants and increased the cell wall associated proteins of all organs (Gunes *et al.,* 2007). Increasing of POD activity with SA treatment was in the same trend with many authors (Stahmann *et al.*, 1966, Loverkovich *et al.*, 1967, Kosuge, 1969, Rathmell and Segueira, 1975 and Harfoush and Salama, 1992). While Schneider and Ullrich (1994) stated that the extent and the time-course of the increase of PPO varied according to the inducers and host. Phenols in plants are well-known to play a role as antifungal, antibacterial and antiviral (Sivaprakasan and Vidhyasekaran, 1993, Rengel *et al.*, 1994 and Gogoi *et al.*, 2001), and increase in plants by spraying different inducers (Menden *et al.,* 1994). Phenylalanine ammonia-lyase is the initial gateway enzyme in phenolic compound biosynthesis, and therefore it is critical in determining flux through the phenylpropanoid pathway and the production rate of phenolic compounds (Whetten and Sederoff, 1995 and Zhang *et al.*, 1997). Phenolic compounds can bind to certain polysaccharides and glycoproteins to form gels which can be accumulated in the cell wall and act as an efficient physical barrier this may be correlated to the higher rate of lignifications due to treatment with different chemical inducers. (Fry, 1986 and Gregerson *et al.*, 1997). Generally, it is likely that a complex mechanism accounts for the SA regulation of the alternative respiratory pathway (Rhoads and Mcintosh, 1993 and Walters *et al.*, 1993).

Application of Si materials such as soluble silicon, potassium silicate, sodium silicate and silica gel accumulate Si in leaves and tissues and improved growth and yield of rice plants as well as enhanced plant resistance against insect, biotic, abiotic stresses, improve erectness of leaves, alleviate water stress, salinity stress and nutrient deficiency or toxicity (Bélanger *et al.,* 1995, Bowen *et al.,* 1995, Datnoff *et al.,* 1997, Seebold *et al.,* 2001, Mitani *et al.,* 2005 and Ma and Takahashi, 2002). Increased plant growth under normal and stress conditions (Rodrigues *et al.,* 2003 and Ma, 2004) and increased shoot dry weight of rice plants (Abed-Ashtiani *et al.,* 2012)

The mechanism of enhanced resistance to disease via Si application can be associated with accumulation of Si in leaf epidermal cells which acts as a mechanical barrier against fungal infestation (Bowen *et al.,* 1992, Cai *et al.,* 2008 and Hayasaka *et al.,* 2008) and blocking fungus ingress (Seebold *et al.,* 2001). Kim *et al.* (2002) through their study of X-ray microanalysis demonstrated that Si enhance cell wall fortification. Liang *et al.* (2005) showed that foliar application of Si reduced powdery mildew in cucumber plants through a physical barrier on leaf epidermis and the activity of enzymes associated with host resistance against pathogen attack were induced via root application of Si. Increased the activity of defense related enzymes such as POD, PPO and chitinases as well as higher accumulation of antifungal compounds such as β-,3-glucanase, phenylalanine ammonia lyase, phenolics and phytoalexins (Chérif *et al.,* 1992 and 1994, Schneider and Ullrich 1994, Fawe *et al.,* 1998, Bélanger *et al.,* 2003 Rodrigues *et al.,* 2004, Borel *et al.,* 2005, Bekker *et al.,* 2006).

REFERENCES

Abd-El-Kareem, F.I. 1998. Induction of resistance to some disease of cucumber plants grown under greenhouse condition. Ph.D. Thesis, Fac. of Agric. Ain Shams Univ., 96 pp.

Abd-El-Kareem, F.I., Abd-Alla, M.A. and El-Mohamedy, R.S.R. 2001. Induced resistance in potato plants for controlling late blight disease under field conditions. Egypt. J. Phytopathol., 29: 29-41.

Abd-El-Kareem, F.I., Abd-Alla, M.A. and El-Mohamedy, R.S.R. 2002. Induced resistance in potato plants for controlling early blight disease under field condition. Egypt. J. Appl. Sci., 17: 51-66.

Abd-El-Moity, T.H., Papavizas, G.C. and Shatla, M.N. 1982. Induction of new isolates of *Trichoderma harzianum* tolerant to fungicides and their experimental use for control of white rot of onion. Phytopathol., 72: 396-400.

Abd-El-Monaim, M.F. 2010. Induced systemic resistance in tomato plants against Fusarium wilt disease. Pages 253-263. In Proceedings of the 2nd Minia Conference for Agriculture and Environmental Science, 22-25 March, 2010, Minia, Egypt.

Abd-El-Monaim, M.F., Ismail, M.E. and Morsy, K.M. 2011. Induction of systemic resistance of benzothiadiazole and humic acid in soybean plants against Fusarium wilt disease. Mycobiology 39: 290-298.

Abed-Ashtiani, F., Kadir, J., Selamat, A., Hanif, A.H.M. and Nasehi, A. 2012. Effect of foliar and root application of silicon against rice blast fungus in MR219 Rice Variety. Plant Pathol. J., 28(2): 164-171.

Ackerson, R.C. 1981. Osmoregulation in cotton in response to water stress II- leaf carbohydrate state in relation to osmotic adjustment. Plant Physiol. 67: 489-493.

Amin, A.A., El-Shamy, R. and El-Abagy H.M.H. 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: 1554-1563.

Amin, M.M. 2003. Controlling white rot of onion (*Sclerotium cepivorum*) by biotic and abiotic treatments. M.Sc. Thesis, Fac. Agric., Ain Shams Univ., Cairo, Egypt.

Anonymous, 2014. "Statistical Analysis System". SAS User's Guide: Statistics. SAS Institute Inc. Editors, Cary, NC, 27513, USA.

Baldwin, I.T., 1998. Jasmonate-induced responses are costly but benefit plants under attack in native populations. Proc. Natl. Acad. Sci. USA, 95: 8113-8118.

Bekker, T.F., Kaiser, C. and Labuschagne, N. 2006. Efficacy of water soluble silicon against *Phytophthora cinnamomi* root rot of avocado: A progress report. South African Avocado Growers' Association Yearbook 29:58-62.

Bélanger, R.R., Benhamou, N. and Menzies, J.G. 2003. Cytological evidence of an active role of silicon in wheat resistance to powdery mildew (*Blumeria graminis* f.sp. *tritici*). Phytopathol., 93: 402-412.

Bélanger, R.R., Bowen, P.A., Ehret, D.L. and Menzies, J.G. 1995. Soluble silicon: its role in crop and disease management of greenhouse crops. Plant Dis., 79: 329-336.

Benjamin, N. and Montgomery, M.W. 1973. Polyphenol oxidase of royal ann cherries: purification and characterization. J. Food Sci. 38: 799-806.

Borel, W., Menzies, J.G. and Bélanger, R.R. 2005. Silicon induces antifungal compounds in powdery mildew infected wheat. Physiol. Mol. Plant. Pathol., 66: 108-115.

Bowen, P.A., Ehret, D.L. and Menzies, J.G. 1995. Soluble silicon: It's role in crop and disease management of greenhouse crops. Plant Dis., 79:329-336.

Bowen, P.A., Menzies, J.G., Ehret, D., Samuels, L. and Glass, A.D.M. 1992. Soluble silicon sprays inhibit powdery mildew development on grape leaves. J. Am. Soc. Hort. Sci., 117: 906-912.

Bradford, M.M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principal of protein-Dye Binding. Anal. Biochem., 72: 248-254.

Buck, G.B., Korndorfer, G.H., Nolla, A. and Coelho, L. 2008. Potassium silicate as foliar spray and rice blast control. J. Plant Nutri., 31: 231-237.

Cai, K., Gao, D. Luo, S., Zeng, R., Yang, J. and Zhu, X. 2008. Physiological and cytological mechanisms of silicon induced resistance in rice against blast disease. Physiol. Plant. 134:324-333.

Chérif, M., Asselin, A. and Bélanger, R.R. 1994. Defense responses induced by soluble silicon in cucumber roots infected by *Pythium* spp. Phytopatholo. 84: 236-242.

Chérif, M., Benhamou, N., Menzies, J.G. and Bélanger, R.R. 1992. Silicon induced resistance in cucumber plants against *Pythium ultimum*. Physiol. Mol. Plant Pathol. 41: 411-425.

Chivasa, S., Murphy, A.M., Naylor, M. and Carr, J.P. 1997. Salicylic acid interferes with tobacco mosaic virus replication via a novel salicyhydroxamic acid-sensitive mechanism. Plant Cell, 9: 547-557.

Dann, E., Diers, B., Byrum, J. and Hammerschmidt, R. 1998. Effect of treating soybean with 2,6 dichloroisonicotinic acid (INA) and benzothiadiazole (BTH) on seed yield and the level of disease caused by *Sclerotinia sclerotiorum* in field and greenhouse studies. Eur. J. Plant Pathol, 104: 271-278.

Datnoff, L.E., Deren, C. and Snyder, G. 1997. Silicon fertilization for disease management of rice in Florida. Crop Prot. 16: 525-531.

Dean, R.A. and Kuc, J. 1987. Immunization against disease: The plant fight back, Pp 383-410. In: Fungal infection of plants. (Ed) Page, F. and P.G. Qyres,Cambridge Univ.Press,Cambridge,428 pp.

Delaney, T.P. 2004. Salicylic Acid. In: P.J., Davies, (Ed.), Plant Hormones: Biosynthesis, Signal Transduction, Action! Kluwer Academic Publishers, Dordrecht, pp: 635-653.

Deverall, B.J. 1995. Plant protection using natural defense systems of Plant. Adv. Plant Pathol., 11: 211-228.

El-Gamal, N.G., El-Mougy, N.S. and Ismail, B. 2003. Induction of resistance in bean against root rot and leaf spot diseases incidence under field conditions J. Appl. Sci., 18: 47-67.

El-Mohamedy, S.R, Khiareddine, Hayfa, J. and Remadi, Mejda, D. 2014. Control of root rot diseases of tomato plants caused by *Fusarium solani, Rhizoctonia solani* and *Sclerotium rolfsii* using different chemical plant resistance inducers. Tunisian Journal of Plant Protection, 9(1): 45-56.

El-Mohamedy, S.R., Abdel-Kader, M.M., Abd-El-Kareem, F. and El-Mougy, N.S. 2013. Essential oils, inorganic acids and potassium salts as control measures against the growth of tomato root rot pathogens in vitro. J. Agric. Technol., 9: 1507-1520.

Fawe, A., Abou-Zaid, M., Menzies, J.G. and Bélanger, R.R. 1998. Silicon-mediated accumulation of flavonoid phytoalexins in cucumber. Phytopathol., 88:396-401.

Fry, S.C. 1986. Cross-linking of matrix polymers in the growing cell walls of angiosperms. Annu. Rev. Plant Physiol., 37: 165-186.

Gharib, F.A. and Hegazi, A.Z. 2010. Salicylic acid ameliorates germination, seedling growth, phytohormone and enzymes activity in bean (*Phaseolus vulgaris* L.) under cold stress. J. Am. Sci., 6: 675-683.

Gogoi, R., Singh, D.V. and Srivastava, K.D. 2001. Phenols as a biochemical basis of resistance in wheat against karnal bunt. Plant Pathol., 50: 470-476.

Gregersen, P.L., Thordal-Christensen, H., Förster, H. and Collinge, D.B. 1997. Differential gene transcript accumulation in barley leaf epidermis and mesophyl in response to attack by *Blumeria graminis* f.sp. *hordei* (syn. *Erysiphe graminis* f.sp. *hordei*). Physiol. Mol. Plant Pathol., 51: 85-97.

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

Hadi, M.R. and Balali, G.R. 2010. The effect of salicylic acid on the reduction of *Rizoctonia solani* damage in the tubers of Marfona potato cultivar. American-Eurasian J. Agric. & Environ. Sci., 7(4): 492-496.

Hammer Schmidt, R., Nuckles, E.M. and Kuc, J. 1982. Association of enhanced peroxidase activity with induced systemic resistance of cucumber to *colletotrichum lagenarium*. Physiol. Plant., 20:73-82.

Harfoush, D.I. and Salama, D.A. 1992. Induction of systemic resistance to powdery mildew in cucumber leaves by seed soaking application with cobalt sulfate. J. Agric. Sci. Mansoura Univ., 17: 3555-3565.

Hayasaka, T., Fujii, H. and Ishiguro, K. 2008. The role of silicon in preventing appressorial penetration by the rice blast fungus. Phytopathol., 98:1038-1044.

Jayeraman, J. 1985. Laboratory manual in biochemistry. Wiley Eastern Ltd. New Delhi, India., 107.

Kay, S.J. and Stewart, A. 1994. Evaluation of fungal antagonists for control of onion white rot in soil box trials. Plant Pathol., 43: 371-377.

Kessmann, H., Staub, T., Hofmann, C., Maetzke, T., Herzog, J., Ward, E., Ukness, S. and Ryals, J. 1994. Induction of systemic acquired resistance in plants by chemicals. Annu. Rev. Phytopathol., 32: 439-459.

Khaled, S.A., Abd-El-Sattar, M.A., Barka, M.A. and Abd-El-Magid, M.S. 1997. Chemical control of garlic soil borne diseases in Egypt. Egypt. J. Agric. Res., 75: 25-34.

Kim, S.G., Kim, K.W., Park, E.W. and Choi, D. 2002. Silicon induced cell wall fortification of rice leaves: a possible cellular mechanism of enhanced host resistance to blast. Phytopathol., 92: 1095-1103.

Kosuge, T. 1969. The role of phenolic in host response to infection. Annu. Rev. Phytopathol., 7: 195-199.

Kuć, J. 1982. Induced immunity to plant disease. Bio Science, 32:854-860.

Kuć, J. 1995. Induction systemic resistance. An Overview. pp. 169-175. Kluwer Academic Publishers, Netherlands.

Kwon, G., Hill, J.R., Corbett, J.A. and McDamiel, M.L. 1997. Effects of aspirin on nitric oxide formation and de novo protein synthesis by RIN m5 F cells and rat islets. Molecular Pharmacology,53: 398-405.

Liang, Y., Sun, W., Si, J. and Romheld, V. 2005. Effects of foliar and root-applied silicon on the enhancement of induced resistance to powdery mildew in *Cucumis sativus*. Plant Pathol. 54: 678-685.

Lovrekovich, L., Low, H. and Stahmann, M.A. 1967. The importance of peroxidase in the virulent fire disease. Phytopathol., 57: 193-198.

Lyon, G.D and Newton, A.C. 1997. Do resistance elicitors offer new opportunities in integrated disease control strategies? Plant Pathol., 46: 636-641.

Ma, J.F. 2004. Role of silicon in enhancing the resistance of plants to biotic and abiotic stresses. J. Soil Sci. Plant Nutr. 50: 11-18.

Ma, J.F. and Takahashi, E. 2002. Soil fertilizer and plant silicon research in Japan. Elsevier Science, Amsterdam, The Netherlands. 281 pp.

Marais, L.J. 2015. Efficacy of water soluble silicon in managing Fusarium dry root rot of citrus. Proc. XIIth Intl. Citrus Congress. Eds.: B. Sabater-Muñoz et al. Acta Hort. 1065, ISHS.

Menden, B.P., Kaum, C., Moerschbacher, B.M., Geibel, M., Treutter, D. and Feuchet, W. 1994. Phenolic acids in the resistance of wheat to stem rust. Acta-Horticulture, 381: 557-560.

Meuwly, P., Molders, W., Buchala, A. and Metraux, J.P. 1995. Local and systemic biosynthesis of salicylic acid in infected cucumber plants. Plant Physiol., 109: 1107-1114.

Miller, G.L. 1959. Use of dinitrosalicylic acid reagent for determination of reducing sugar, Anal. Chem., 31: 426.

Mills, P.R., Gussin, E.J. and Wood, R.K. 1986. Induction of resistance in cucumber to *Colletotrichum lagenarium* by 6-benzylamino purine. J. Phytopathol., 116: 11-17.

Mitani, N., Ma, J. F. and Iwashita, T. 2005. Identification of the silicon form in xylem sap of rice (*Oryza sativa* L.). Plant Cell Physiol., 46: 279-283.

Mordue, J.E.M. 1976. *Sclerotium cepivorum* IMI Descriptions of fungi and bacteria, No. 52, Sheet 512. Kew, Surrey, UK: Commonwealth Mycological Institute.

Nawrath, C. and Metraux, J.P. 1999. Salicylic acid induction deficient mutants of Arabidopsis express PR-2 and PR-5 and accumulate high levels of camalexin after pathogen inoculation. Plant Cell, 11: 1393-1404.

Nicholson, R.L. and Hammerschmidt, R. 1992. Phenolic compounds and their role in disease resistance. Annu. Rev. of Phytopathol., 30: 369-389.

Norman, C., Howell, C.A., Milar, A.H., Whelan, J.M. and Day, D.A. 2004. Salicylic acid is an uncoupler and inhibitor of mitochondrial electron transport. Plant Physiol., 134: 492-501.

Owen, K.J., Green, C.D. and Deveral, B.J. 2002. A benzothiadiazole applied to foliage reduces development and egg deposition by *Meloidogyne* spp. in glasshouse-grown grapevine roots. Austr. Plant Pathol., 31: 47-53.

Rathmell, W.G. and Sequira, L. 1975. Induced resistance in tobacco leaves. The role of inhibitors of bacterial growth in the intercellular fluid. Physiol. Plant Pathol., 5: 65-73.

Rengel, D., Graham, R. and Pedler, J. 1994. Time course of biosynthesis of phenolics and lignin in roots of wheat genotypes differing in manganese efficiency and resistance to take-all fungus. Ann. Bot., 74: 471- 477.

Rhoads, D.M. and McIntosh, L. 1993. The SA-inducible Aox gene aox1 and genes encoding PR protein share regions of sequence similarity in their promoter's. Plant Mol. Biol., 21: 615-624.

Rocher, F., Chollet, E., Jonsse, C. and Bonnemain, L. 2005. Salicylic acid, an ambimobile molecular exhibiting a high ability to accumulate in the phloem. Plant Physiol., 141: 1684-1693.

Rodrigues, F.A., Benhamou, N., Datnoff, L.E., Jones, J.B. and Bélanger, R.R. 2003. Ultrastructural and cytochemical aspects of silicon-mediated rice blast resistance. Phytopathol., 93: 535-546.

Rodrigues, F.A., Mcnally, D.J., Datnoff, L.E., Jones, J.B., Labbe, C., Benhamou, N., Menzies, J.G. and Bélanger, R.R. 2004. Silicon enhances the accumulation of diterpenoid phytoalexins in rice: a potential mechanism for blast resistance. Phytopathol., 94: 177-183.

Salama, A.A.M., Ismail, I.M.K., Ali, M.I.A. and Ouf, S.A.E. 1985. Soaking *Sclerotium cepivorum* in phenolic compounds and their effect on germination, growth and sclerotial formation. Bulletin of the Faculty of Science, Cairo University, 53: 309-319.

Salama, A.A.M., Ismail, I.M.K., Ali, M.I.A. and Ouf, S.A.E. 1988. Possible control of white rot disease of onions caused by *Sclerotium cepivorum* through soil amendment with *Eucalyptus rostrata* leaves. Revue de Ecologie et de Biologie du sol., 25(3): 305-314. (C. F. CAB Abstract AN 891133821).

Schneider, S. and Ullrich, W.R. 1994. Differential induction of resistance and enhanced enzyme activities in cucumber and tobacco are caused by treatment with various abiotic and biotic inducers. Physiol. Mol. Plant Pathol., 45:291-305.

Seebold, K., Kucharek, T., Datnoff, L.E., Correa-Victoria, F. and Marchetti, M. 2001. The influence of silicon on components of resistance to blast in susceptible, partially resistant, and resistant cultivars of rice. Phytopathol., 91: 63-69.

Shahidi, F. and Naczk, M. 1995. Methods of analysis and quantification of phenolic compounds. Food phenolic: sources, chemistry, effects and applications. Technomic Publishind Company, Inc: Lancaster, PA, 287-293.

Sivaprakasan, K. and Vidhyasekaran, P. 1993. Phenylalanine ammonialyase gene for crop disease management. In: Genetic Engineering, Molecular Biology and Tissue Culture for Crop Pest and Disease Management. Vidhyasekaran P, ed. Daya Publishing House Delhi, India: pp. 113-122.

Smolinska, U. and Kowalska, B. 2006. The effectivity of plant extracts and antagonistic microorganisms on the growth inhibition of French bean pathogenic fungi . Vegetable Crops Research Bulletin, 64: 67-76.

Stahmann, M.A., Clare, B.G. and Woodbury, W. 1966. Increased disease resistance and enzyme activity induced by ethylene and ethylene production by black rot infected sweet potato tissue. Plant Physiol., 41: 1505-1512.

Van der Meer, Q.P., Van Bennekom, J.L. and Van der Giessen, A.C. 1983. Screening for resistance to white rot caused by *Sclerotium cepivorum* Berk. in onions (*Allium cepa* L.) and leek (*Allium porrum* L.). Euphytica, 32: 697-701.

Van Loon, L.C. 1997. Induced resistance in plants and the role of pathogenesis-related proteins. Eur. J. Plant Pathol., 103: 753-765.

Van Loon, L.C. and Van Strien, E.A. 1999. The families of pathogenesis-related proteins, their activities, and comparative analysis of PR-1 type proteins. Physiol. Mol. Plant Pathol., 55: 85-97.

Vernooij, B., Friedrich, L., Morse, A., Kolditz-Jawhar, R., Ward, E., Uknes, S., Kessmann, H. and Ryals, J. 1994. Salicylic acid is not the translocated signal responsible for inducing systemic acquired resistance but is required in signal translocation. Plant Cell, 6: 959-965.

Walters, D.R., Mitchell, A.F., Hampson, A. and Mcpherson, A. 1993. The induction of systemic resistance in barley to powdery mildew infection using salicylates and various phenolic acids. Annals of Applied Biology,122: 451-456.

Whetten, R. and Sederoff, R. 1995. Lignin Biosynthesis. The Plant Cell, 7: 1001-1013.

White, R.F. 1979. Acetylsalicylic acid (aspirin) induces resistance to tobacco mosaic virus in tobacco. Virology, 99: 410-412.

Yalpani, N., Silverman, P., Wilson, T.M.A., Kleier D.A. and Raskin, I. 1991. Salicylic acid is a systemic signal and an inducer of pathogenesis-related proteins in virus-infected tobacco. Plant Cell, 3: 809-818.

Yamaguchi, I. 1998. Activators of systemic acquired resistance. In: Fungicidal activity: Chemical and biological approaches to plant protection. Hutson D.H. Miyamoto J., eds. New York: Wileyev & S611s Inc., pp. 193-219.

Ye, X.S., Sterobel, N.E. and Kuć, J. 1995. Induced systemic resistance (ISR): Activation of natural defense mechanisms for plant disease control as part of integrated pest management (IPM). Noval Approaches to IPM, Chapter 5 pp. 95-113.

Zhang, L., Robbins, M.P., Carver, T.L.W. and Zeyen, R.J. 1997. Induction of phenylpropanoid gene transcripts in oat attacked by *Erysiphe graminis* at 208 C and 108 C. Physiol. Mole. Plant Patholo., 51: 15-33.

Zhixin, X. and Chen, Z. 1999. Salicylic acid induces rapid inhibition of mitochondrial electron transport and oxidative phosphorylation in tobacco cells. Plant Physiol., 120: 217-226.

حث مقاومة نباتات البصل ضد *Sclerotium cepivorum* **Berk.** من خلال أستخدام حامض الساليسيليك و سيل ماتركس ٢٩%

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تم أستخدام حامض الساليسيليك و سيل ماتريكس ٢٩% (سيليكات البوتاسيوم، ملح البوتاسيوم لحامض السليسيلك) لمقاومة العفن الأبيض فى البصل المتسبب عن فطر *Sclerotium cepivorum* Berk. بتركيز ٣،١،٢ مللي مول حامض ساليسيليك و ١.٥، ٣، ٦ مل/لتر سيل ماتريكس كمعاملة شتلات متبوعة برشتين للمجموع الخضرى عند عمر ٦، ١٢ أسبوع بنفس التركيزات فى وجود مبيد الفوليكور ٢٥% (تيبوكونازول ٢٥%) كمقارنة. أدت جميع المعاملات الى أختزال نسبة الأصابة بالعفن الأبيض مقارنةً بغير المعامل سواء تحت ظروف الصوبة أو الحقل، و كانت أفضل المعاملات هى معاملة حامض الساليسيليك عند تركيز ٣ مللي مول حيث أعطت ٣٥% و ٢٦% أصابة تحت ظروف الصوبة و الحقل على الترتيب. كانت أفضل معاملات السيل ماتريكس عند تركيز ٦ مل/لتر حيث أعطت ٤٥% و ٣٨.٢% أصابة تحت ظروف الصوبة و الحقل على الترتيب. مقارنةً بالنباتات الغير معاملة، أدت جميع المعاملات الى زيادة وزن المحصول، وزن الأبصال و أرتفاع النباتات. أعطت معاملة حامض الساليسليك بتركيز ٣مللى مول زيادة قدرها ١٤٤.٣% و ١٦٠.٤% فى المحصول و وزن الأبصال على الترتيب، بينما زاد أرتفاع النباتات بمقدار ٢٤% مع السيل ماتركس بتركيز ٦ مل/لتر كأفضل معاملة. أدت معاملة النقع الى زيادة كلً من البروتينات الذائبة، الأحماض الأمينية الحرة، السكريات المختزلة، المركبات الفينولية، نشاط البيرأوكسيديز و البولى فينول أكسيديز، بينما أختلف تأثير المعاملات بعد الرش.