Evaluation of the Efficiency of some Environmentally Safe Means for Controlling Gray Mold of Lentil in Comparison with Diathane M45

Rania Z. El-Shennawy, Sahar A. El-Syed and A. I. Ismail

Plant Pathology Research Institute, Agricultural Research Center, Giza, Egypt.

ABSTRACT

Salycilic acid, sodium bicarbonate, indol acetic acid and Diathane M 45 were evaluated for the control of gray mold of lentil caused by *Botrytis cinerea*. Two lentil cultivars were used in this study i.e., Sinai 1 and Giza 9. *In vitro* studies showed complete inhibition of linear growth of *Botrytis cinerea* was obtained at 10 mM of salycilic acid, 200 ppm of indol acetic acid and 100 ppm for Diathane M 45, while the growth was decreased by 64.08% as a result of the effect of sodium bicarbonate at 200 ppm. In greenhouse experiments, foliar application of all treatments tested were effective for controlling gray mold disease. The most effective treatments were salycilic acid at 10 mM, sodium bicarbonate and Diathane M 45 at 200 ppm which reduced the gray mold incidence by 100% in the two cultivars. On the other hand IAA caused significant decrease in the disease incidence reached to (100%) for Sini-1 and (71.6%) for Giza-9 cultivar. The promising treatments in pot experiments were evaluated under field conditions in two locations. Results indicated that Diathane M45 followed by IAA could reduce significantly the percentage of gray mold estimated by (91.9 and 92.1%), (80.0 and 80.0%) and (61.8 and 62.1%), (56.5 and 58.6%) after 55 and 75 days at Sers El-Lyain and El-Gemiza locations, respectively. As for lentil yield, Diathane caused an increase in lentil yield estimated as (54.5 and 50.5%) in Sers El-Lyain and El-Gemiza location followed by IAA and sodium bicarbonate (35.6 and 34.9%) in Sers El-Lyain, followed by sodium bicarborate and IAA (37.3 and 28.9%) in El-Gemiza locations. Salycilic acid caused an increase (24.1 and 20.2%) in Sers El-Lyain and El-Gemiza locations, respectively. The present study provide insight into alternative antifungal compounds. Further studies are needed to utilize sodium bicarbonate, indol acetic acid and salicylic acid in controlling various plant pathogens. Data showed that Sinai-1 gave higher seed yield / feddan, crude protein, phosphorus and potassium seed contents (kg / fed) than Giza-9. Diathane M45 and IAA were the most effective treatments in increasing the protein, phosphorus and potassium contents. On the other hand, the treated plants with salycilic acid showed little increase.

Key words: *Botrytis cinerea*, lentil, gray mold and induced resistance.

INTRODUCTION

Lentil (*Lens cultinaris* Medik.) is an important legume crop (Beniwal *et al.*, 1994). Seed borne *Botrytis cinerea* Pers. Ex. Fr. is associated with

number of plant species (Antonov *et al.*, 1997). Gray mold caused by *B. cinerea* is the most important disease that attacks lentil plants (Morrall, 1997). Controlling this disease depends mainly on fungicides application. However, fungicides are hazard to human health and the environment. Alternatives of these fungicides are needed. Systemic induced resistance proved its efficiency in controlling diseases and increasing yield (Tuzun and Kuc, 1985; Aly *et al.*, 1993 and Abd El-Kareem, 1998).

Several reports have been published on the use of salicylic acid and its derivatives as potential activators for induction resistance in plants Kanss
et al. (1992). These has been considerable interest in the use of sodium bicarbonate, (Na HCO_3) for controlling various fungal disease in plants (Karabulut *et al.*, 2003 and Smilanick *et al.*, 2006), Bicarbonate are widely used in the food industry (Lindsay, 1985) and were found to suppress several fungal diseases of cucumber plants (Ziv and Zitter, 1992). Moreover, certain growth regulators such as IAA (van Andel and Fuchs, 1972 and Sallam, 1997) were recorded in this respect. The objective of the present investigation was to evaluate the efficacy of various compounds against gray mold disease in comparison with Diathane M45 and also, the effect of this compound on some growth parameters and crude protein, phosphorus and potassium of lentil seeds.

MATERIALS AND METHODS

1. Isolation, purification and identification of the pathogen:

Lentil plants showing typical symptoms of gray mold were collected from Sers El-Lyain (Minufiya Governorate) Agric. Res. Station farm and El-Gemiza Agri. Res. Station (Gharbia Governorate) during 2007 growing season. The infected capsules were surface sterilized and placed on wetted filter paper in Petri-dish at 20 $\pm$ 2°C. After 4 days the formed Condia were picked off using single spore method and used for identification according to Morgan (1971) and Munijal (1980).

2. Laboratory experiment:

Different concentrations of salicylic acid, sodium bicarbonate, indol acetic acid and Diathane M45 were tested to study their inhibitory effect on linear growth of *Botrytis cinerea in vitro*. Five concentrations of salycilic acid
(0.0, 2.5, 5.0, 7.5 and 10.0 mM), sodium bicarbonate, IAA and Diathane M45 (0.0, 25, 50, 100 and 200 ppm). Plates were then incubated at the

center by equal disces (5 mm) taken from the edge of 10 days old culture of *B. cinerea*. Three replicates were used for each concentration. Plates was incubated at 22°C. The linear growth of each tested treatment was measured when the growth in any plate reached the maximum. Diathane M45 and other compounds are shown in Table (1). The inhibition percentage of mycelial growth calculated as formula (Panday *et al.*, 1982).

Percentage of mycelial growth inhibition = [(dc – dt) / dc] × 100

where: dc: average diameter of fungal calony in the check.

dt: average diameter of fungal colony in treatments.

3. Greenhouse experiments:

The effect of the tested compounds were evaluated on incidence of lentil gray mold disease under greenhouse conditions. Lentil seeds (Sinai-1 and Giza-9 cv.), obtained from Dept. of Legume Crop Res., Agric. Res. Centre, Giza. Seeds were sown in plastic pots (20 cm diam.) containing loamy soil at rate 10 seeds / pot.

Five pots were used for each treatment. Salycilic acid at concentrations 5.0, 7.5 and 10.0 mM, sodium bicarbonate, indol acetic acid as well as Diathane M45 at 50, 100 and 200 ppm, were applied for testing their efficacy against gray mold disease. The prepared concentrations were sprayed on the grown plants 35 days old one day before inoculation with the causal pathogens. Plant inoculation with a spore suspension with isolate conidiphore (2.5×10^5 spore / ml) of 10-day-old culture of *Botrytis cinerea* the causal of gray mold disease. Plants sprayed with tap water served as check. Plants covered with polyethelen bage for 24 hr, to maintain high relative humidity necessary for fungal infection. The results were recorded after four days of inoculation as percentage of infection.

4. Filed experiments:

The field experiments were carried out during (2007 / 2008) in Sers El-Lyain and El-Gemiza experimental stations at Minufiya and Gharbia Governorates, respectively. The most effective treatments in pot experiment against gray mold disease were applied to study their efficiency against the occurrence of disease under natural conditions in addition to determination of crop yield. Five compounds salycilic acid 75 and 10 mM, sodium bicarbonate 100 and 200 ppm, indol acetic acid 100 and 200 ppm, Diathane M45 100 and 200 ppm were used as foliar application. The field were divided into plots (1.8 × 3 m). Each plot consists of three rows, each row contained 20 hills on the two sides with seeds / hill of lentil Sinai-1 or

Giza-9 cv.

The seeds were sown on 15th of November during 2007 / 2008 for the growing locations. Each treatment was repeated three times. All treatments were sprayed three times at 15 days intervals, the first spray was carried out at 15th of January. Percentage of disease incidence in 20 randomly chosen plants each plot, were calculated after 55 and 75 days from sowing and the gray mold incidence was estimated. At the harvest twenty plants were taken at random on which the following growth characters were recorded: plant height (cm), No. of branches / plant, seed weight / 20 plants, seed No. / 20 plants, 1000 seeds weight (g), seed yield / fed (kg), crude protein, phosphorus and potassium seed contents.

5. Chemical analysis:

Seed samples of Sinai-1 and Giza-9 cv. was taken, dried in an electric oven at 70°C till content weight and ground for determination of total N according to Hafez and Mikkelsen (1981). Potassium and sodium % according to Brown and Lilliand (1966) by flame photometer.

RESULTS

In vitro experiment:

The effect of salycilic acid, sodium bicarbonate, indol acetic and Diathane M45 on growth of *B. cinerea* is shown in Table (1). Results indicate that all treatments have significantly inhibited mycelial growth of *B. cinerea*. Diathane M45 followed by SA and IAA were the most effective ones. Moreover, a positive relationship between the effect of the treatments and their concentrations was realized. Diathane M45 at (100 and 200 ppm), SA at (10 mM) and IAA at 200 ppm have completely inhibited the mycelial growth. On the other hand Na HCO_3 was the least efficient on this respect.

Greenhouse experiments:

The effect of the tested compounds against gray mold disease was studied. The results in Table (2) indicate that disease incidence was significantly reduced with application of all treatments as foliar spray. The SA (10 mM) followed by IAA (200 ppm) and Diathane M45 (100 and 200 ppm) were the most effective treatments on the two tested cultivars Sinai-1 and Giza-9 recording 100% reduction. On the other hand, IAA and Na HCO_3 were less effective.

Table (1). Linear growth (cm) of *Botrytis cinerea* as affected with different concentrations of salycilic acid, sodium bicarbonate, indol acetic acid and Diathane M45 *in vitro*.

Treatment	Concentration	Linear growth	Reduction %	Mean	
				Linear growth	Reduction
Salycilic acid	0.0	9.0	0.0	4.98	44.66
	2.5	8.3	7.4		
	5.0	5.5	38.9		
	7.5	2.1	77.0		
	10 mM	0.0	100.0		
Sodium bicarbonate	0.0	9.0	0.0	6.60	26.94
	25	8.6	4.9		
	50	7.1	21.1		
	100	5.1	43.7		
	200 ppm	3.2	64.8		
Indol acetic acid	0.0	9.0	0.0	5.06	43.84
	25	7.8	13.7		
	50	5.8	35.2		
	100	2.7	70.3		
	200 ppm	0.0	100		
Diathane M45	0.0	9.0	0.0	3.88	57.02
	25	6.8	24.8		
	50	3.6	60.3		
	100	0.0	100		
	200 ppm	0.0	100		

L.S.D at 0.05: Treatment (T) = 0.4, Concentration (C) = 1.2, Interaction (T × C) = 2.3

Table (2). Gray mold incidence on lentil plants as affected with different concentration of salycilic acid, sodium bicarbonate, indol acetic acid and Diathane M45 under greenhouse conditions.

Cultivar	Treatment	Concentration	G. M. infection %	Reduction %	Mean G.M.	Mean Reduction
Sinai-1	Salycilic acid	5.0	16.66	79.18	9.26	88.43
		7.5	11.11	86.11		
		100 mM	0.00	100.00		
	Sodium bicarbonate	50	20.00	75.00	17.78	77.78
		100	33.33	58.33		
		200 ppm	0.00	100.00		
	Indol acetic acid	50	25.00	68.75	21.67	72.92
		100	40.00	50.00		
		200 ppm	0.00	100.00		
	Diathane M45	50	11.11	86.11	3.70	95.37
		100	0.00	100.00		
		200 ppm	0.00	100.00		
	Control	–	80.00	–	–	–
	Mean	–	18.25	–	–	–
Giza-9	Salycilic acid	5.0	22.22	75.31	7.41	91.77
		7.5	0.00	100.00		
		100 mM	0.00	100.00		
	Sodium bicarbonate	50	55.55	38.28	33.70	62.56
		100	45.55	49.39		
		200 ppm	0.00	100.00		
	Indol acetic acid	50	55.00	38.88	37.96	57.82
		100	33.33	62.97		
		200 ppm	25.55	71.61		
	Diathane M45	50	15.55	82.72	5.18	94.24
		100	0.00	100.00		
		200 ppm	0.00	100.00		
	Control	–	90.00	–	–	–
	Mean	–	23.29	–	–	–

L.S.D at 0.05: Cultivars (Cu) = 2.27, Treatments (T) = 3.49 Concentration (C) = 6.99, Interaction (Cu × T × C) = 6.99

Field conditions:

A) Disease incidence:

1. Sers El-Lyain location:

Data presented in Table (3) showed that a significant decrease in disease incidence was recorded in all tested compounds in comparison

with control. The highest reduction was found in case of Diathane M45 at 200 ppm (100 and 100%) and (84.1 and 85.2%) followed by Diathane M45 at 100 ppm (80 and 85.5%) and (70.6 and 70.4%) after 55 and 75 days from sowing on Sinai-1 and Giza-9, respectively, IAA and 200 and 100 ppm gave (67.6 and 69.5%), (64.0 and 69.5%) for Sinai-1 and (57.1 and 55.6%), (52.4 and 52.6%) for Giza-9 after 55 and 75 days, respectively.

Table (3). Effect of salycilic acid, sodium bicarbonate, indol acetic acid and Diathane M45 on controlling gray mold disease incidence in field conditions.

Cultivar	Treatment	Concentration	% infection after 55 days from sowing		% infection after 75 days from sowing	
			Sers El-Lyain	Gemiza	Sers El-Lyain	Gemiza
Sinai-1	Salycilic acid	7.5 mM	25.55	30.00	25.55	33.33
		10 mM	22.22	25.00	23.33	25.00
	Mean	–	23.88	27.50	24.44	29.16
	Sodium bicarbonate	100 ppm	25.55	32.00	26.00	35.00
		200 ppm	22.22	30.00	23.33	33.33
	Mean	–	23.88	31.00	24.66	34.16
	Indol acetic acid	100 ppm	20.00	22.00	20.00	25.55
		200 ppm	18.00	20.00	20.00	22.22
	Mean	–	19.00	21.00	20.00	23.91
	Diathane M45	100 ppm	11.11	22.22	9.50	22.22
		200 ppm	0.00	9.55	0.00	11.11
	Mean	–	5.55	15.88	4.70	16.66
	Control		55.55	60.00	65.55	70.00
Giza-9	Salycilic acid	7.5 mM	35.55	45.00	35.55	45.00
		10 mM	33.33	40.00	33.33	42.22
	Mean	–	34.44	42.50	34.44	43.61
	Sodium bicarbonate	100 ppm	30.00	50.00	32.00	52.22
		200 ppm	40.00	45.00	42.00	47.77
	Mean	–	35.00	47.50	37.00	49.99
	Indol acetic acid	100 ppm	33.33	48.88	35.55	48.88
		200 ppm	30.00	40.00	33.33	42.00
	Mean	–	31.66	44.44	34.44	45.44
	Diathane M45	100 ppm	20.55	22.00	22.22	22.00
		200 ppm	11.11	18.00	11.11	20.00
	Mean	–	15.83	20.00	16.66	21.00
	Control		70.00	78.00	75.00	85.00

L.S.D at 0.05: Cultivars (Cu) = 1.30 = 1.30
Treatments (T) = 2.40 = 1.90
Concentration (C) = 3.70 = 2.90
Interaction (Cu × T × C) = 5.25 = 4.82

2. El-Gemiza location:

Similar results of that obtained in Sers El-Lyain relatively higher than Sers El-Lyain. The application of these compounds led to decrease disease incidence of about [(84.10 and 84.17), (76.5 and 76.91)] and [(63.00 and 68.30%), (71.80 and 74.10%)], in Diathane M45 at (200 and 100 ppm) after 55 and 75 days from sowing in two cultivars, respectively, followed by IAA at 200 and 100 ppm [(66.7 and 68.6%), (63.3 and 63.5%)] in Sinai-1 cultivar after 55 and 75 days and SA at 10 and 7.5 mM [(48.7 and 50.3%), (12.3 and 47.1%)] in Giza-9.

B) Crop parameters:

1. Plant height and number of branches:

Data in Table (4) show a significant increase in stem length of the two cultivars Sinai-1 and Giza-9 sprayed with all treatments. The most effective treatment was IAA (100 and 200 ppm) [(48.3, 50.0) and (51.3, 50.3)], [(50.0, 46.0) and (54.0, 50.0 cm)] followed by Diathane M45 (100 and 200 ppm) [(36.7, 39.3) and (44.0, 44.0)] and [(36.0, 36.7), (42.0, 42.7 cm)] in Sinai-1 and Giza-9 in Sers El-Lyain and El-Gemiza location, respectively, while sodium bicarbonate was the less effective. On the other hand, Diathane M45 was generally effective in increasing No. of branches / plant in El-Gemiza location than Sers El-Lyain at (100 and 200 ppm) followed by IAA (Sinai-1 / two locations) and (Giza-9 / two locations). On the contrary, N HCO_3 was the least effective one.

2. Seed weight / 20 plant, seed number / 20 plant, 1000 seed weight and seed yield / fed. (kg):

Data in Table (5) clear that foliar spray with salycilic acid, sodium bicarbonate, indol acelic acid and Diathane M45 led to increasing the crop parameters (including seed weight / 20 plants, seed number / 20 plant, 1000 seed weight (g) and seed yield / fed (kg) compared with untreated control. On the other hand, all these parameters were increased significantly in the plants sprayed with Diathane M45 (200 ppm) followed by indol acetic acid (200 ppm) sodium bicarbonate (50 mM) and salycilic acid (10 mM). The excess percentage in Diathane M45 treatment for two varieties was (100, 84.6, 34.4 and 54.5%) in Sers El-Lyain and (65.4, 42.2, 20.0 and 50.5%) in Sers El-Lyain and (65.4, 72.2, 20.0 and 50.5%) in El-Gemiza location followed

by IAA (46.3, 56.7, 84.6 and 58.5), sodium bicarbonate (66.8, 56.7, 19.2 and 34.9%) in Sers El-Lyain location, while the lowest treatment was salycilic acid except the 1000 seed weight (g) in El-Gemiza location.

C) Protein, phosphorus and potassium content:

Table (6) indicated that the two cultivars Sinai-1 and Giza-9 have significant differences on lentil seed crude protein, phosphorus and potassium contents in both locations Sers El-Lyain and El-Gemiza. Sinai-1 recorded the highest values for the above three parameter whereas Giza-9 recorded the lowest values. On the other hand, the foliar spray with Diathane M45 increased the three parameters significantly over the control treatment. The excess percentages in the Diathane treatment for two cultivars was (41.2, 42.5 and 50.8%) and (42.4, 28.6 and 36.6%) followed by IAA (41.2, 18.3 and 35.4) and (35.4, 14.3 and 22.1%) in Sers El-Lyain and El-Gemiza locations for protein, phosphorus and potassium contents, respectively, while the salycilic acid was the less effective in Sers El-Lyain and was the most effective on phosphorus and potassium contents in El-Gemiza location.

Table (4). Effect of salycilic acid, IAA, sodium bicarbonate and Diathane M45 spray on lentil plant height (cm) after harvest and number of branches under field conditions.

Cultivar	Treatment	Concentration	Sers El-Lyain		El-Gemiza	
			Plant height	No. of branches / plant	Plant height	No. of branches / plant
Sinai-1	Salycilic acid	7.5 mM	34.7	5.7	40.0	7.7
		10 mM	39.3	6.0	39.7	8.3
	Mean	–	37.0	5.85	39.85	8.0
	Sodium bicarbonate	100 ppm	32.0	4.7	40.0	7.3
		200 ppm	34.3	5.3	38.7	8.7
	Mean	–	33.15	5.0	39.35	8.0
	Indol acetic acid	100 ppm	48.3	6.7	51.3	9.3
		200 ppm	50.0	7.3	50.3	9.3
	Mean	–	49.15	7.0		
	Diathane M45	100 ppm	36.7	8.0	44.0	9.3
		200 ppm	39.3	8.0	44.0	9.7
	Mean	–	38.0	8.0	44.0	9.5
	Control	–	30.0	5.0	36.0	6.3
Giza-9	Salycilic acid	7.5 mM	35.0	4.0	39.33	6.33
		10 mM	36.0	4.3	39.30	6.70
	Mean	–	35.5	4.2	39.31	6.5
	Sodium bicarbonate	100 ppm	33.0	4.0	35.0	7.7
		200 ppm	34.3	4.0	38.7	8.0
	Mean	–	33.6	4.0	36.8	7.8
	Indol acetic acid	100 ppm	50.0	5.3	54.0	7.3
		200 ppm	46.0	6.0	50.0	7.5
	Mean	–	48.0	5.6	52.0	7.4
	Diathane M45	100 ppm	36.0	6.0	42.0	8.7
		200 ppm	36.7	6.7	42.7	7.7
	Mean	–	36.3	6.4	42.4	8.2
	Control	–	32.3	3.7	32.0	5.3
L.S.D at 0.05: Cultivars (Cu)		=	1.96	0.29	1.03	0.31
Treatments (T)		=	1.74	0.56	1.60	0.86
Concentration (C)		=	2.46	0.82	2.20	1.22
Interaction (Cu × T × C)		=	4.92	2.95	5.25	4.21

Table (5). Effect of salycilic acid, IAA, sodium bicarbonate and Diathane M45 spray on seed weight / 20 plant (g), seed number / 20 plants and 1000 seed weight (g) / under field conditions.

Cultivar	Treatment	Concent-ration	Sers El-Lyain				El-Gemiza			
			Seed weight 20 plant	Seed number /20 plant	1000 seed weight (g)	Seed yield fed (kg)	Seed weight 20 plant	Seed number /20 plant	1000 seed weight (g)	Seed yield fed (kg)
Sinai-1	Salycilic acid	7.5 mM	31.00	724.0	40.00	760.0	40.60	734.0	39.67	790.0
		10 mM	32.00	730.0	43.00	790.0	41.00	780.0	41.67	815.0
	Mean	–	31.50	727.0	41.50	77.5	40.80	757.0	40.67	802.5
	Sodium bicarbonate	100 ppm	33.00	755.3	44.33	800.0	37.00	812.0	38.33	840.0
		200 ppm	43.30	800.0	47.00	900.0	40.60	883.0	40.67	1000.0
	Mean	–	38.15	777.6	45.66	850.0	38.80	847.5	39.50	920.0
	Indol acetic acid	100 ppm	43.33	815.0	48.00	800.0	49.33	865.0	41.67	873.0
		200 ppm	46.67	844.8	49.33	898.0	50.00	865.0	39.67	900.0
	Mean	–	45.00	829.7	48.66	849.0	49.66	865.0	40.67	886.5
	Diathane M45	100 ppm	48.33	879.3	50.33	924.0	54.33	930.0	45.33	1012.0
		200 ppm	55.00	922.0	53.33	1009.0	55.67	984.0	46.00	1050.0
	Mean	–	51.66	900.65	51.83	966.5	5.500	957.0	45.66	1031.0
	Control	–	30.00	712.5	40.33	659.0	30.67	750.0	38.67	700.0
Giza-9	Salycilic acid	7.5 mM	18.00	865.0	20.67	370.0	24.33	893.0	22.33	390.0
		10 mM	20.00	880.0	23.33	400.0	28.67	930.0	23.00	411.0
	Mean	–	19.00	872.5	22.00	385.0	26.50	911.5	22.66	395.0
	Sodium bicarbonate	100 ppm	19.00	800.0	24.00	360.0	28.67	870.0	23.33	390.0
		200 ppm	25.00	924.0	25.67	394.0	30.67	985.0	23.67	400.0
	Mean	–	22.00	862.0	24.84	377.0	29.67	927.5	23.50	395.0
	Indol acetic acid	100 ppm	22.00	876.0	25.67	360.0	21.67	800.0	20.67	380.0
		200 ppm	22.00	900.0	28.67	402.0	23.67	883.0	23.33	415.0
	Mean	–	22.00	888.0	27.17	381.0	22.67	842.5	22.00	397.5
	Diathane M45	100 ppm	25.00	984.0	28.00	450.0	26.00	944.0	25.67	470.0
		200 ppm	27.00	1110.0	28.67	473.0	27.00	1000.0	26.00	485.0
	Mean	–	26.00	1047.0	28.33	461.5	26.50	972.0	25.84	477.5
	Control	–	11.00	488.0	20.67	380.0	19.33	502.0	21.33	400.0
L.S.D at 0.05: Cultivars (Cu) =			1.60	22.70	1.10	26.0	0.63	23.42	0.52	25.80
Treatments (T) =			2.40	20.12	0.51	27.0	1.80	22.00	1.15	27.12
Concentration (C) =			3.52	45.80	1.70	59.0	2.60	46.73	1.60	47.00
Interaction (Cu×T×C) =			n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s

Table (6). Effect of foliar application of salycilic acid, sodium bicarbonate, indol acetic acid and Diathane M45 on protein, phosphorus and potassium contents in lentil seed under field conditions.

Cultivar	Treatment	Concent-ration	Sers El-Lyain			El-Gemiza		
			Protein	Phosph-orus	Potass-ium	Prot-ein	Phosph-orus	Potass-ium
Sinai-1	Salycilic acid	10 mM	24.50	2.95	11.00	24.50	2.81	10.95
	Sodium bicarbonate	50 ppm	26.00	3.00	12.71	25.00	2.83	11.73
	Indol acetic acid	200 ppm	27.50	3.00	11.55	28.00	2.80	10.60
	Diathane M45	200 ppm	28.00	3.80	14.00	28.50	3.00	12.80
	Control	–	22.00	2.80	10.50	22.50	2.90	10.80
Mean	–	–	25.60	3.11	11.95	25.70	2.87	11.37
Giza-9	Salycilic acid	10 mM	23.55	2.15	9.40	24.00	2.30	10.00
	Sodium bicarbonate	50 ppm	22.60	2.18	9.80	23.11	2.50	9.80
	Indol acetic acid	200 ppm	23.80	2.50	10.00	24.00	2.60	10.30
	Diathane M45	200 ppm	24.50	3.00	10.80	25.00	3.20	11.00
	Control	–	20.50	2.90	8.90	20.70	2.95	9.50
Mean	–	–	22.99	2.55	9.78	23.36	2.71	10.12

DISCUSSION

Lentil (*Lens culinaris* Medik) is an important Legumenous food, the crop has great nutritional value for human consumptition having a high content of protein. Gray mold disease is the most important disease that attack foliar system of lentil causing considerable reduction in seed yield. Salycilic acid, sodium bicarbonate, indol acetic acid and Diathane M45 differed as regards the concentration required for inhibiting the fungal

growth. In this respect, Diathane M45, salycilic acid and indol acetic acid were the most effective in inhibition of fungal growth of *Botrytis cinerea*. These findings are in accordance with those previously reported by Shashi-Chauhan *et al.* (1989) reported that, SA was highly toxic to the mycelial growth of most of deterophytic fungi. They added that the toxicity increased with the increase of concentration. Durivedi (1990) and Rahhal *et al.* (2007) reported that Diathane M45 decreased the fungal growth of *Botrytis cinerea* causing gray mold on lentil by 100% at 250 ppm. On the other hand, all treatments affect significantly the growth of *B. cinerea*, where Diathane M45 was the most effective followed by salycilic acid and indole acetic acid, respectively.

Under greenhouse experiments, the pre-treatment lentil plant with the materials used in this study as folia treatment resulted in signification reduction in disease incidence of compared with the control. Salycilic acid (10 mM), indol acetic acid and Diathane M45 (200 ppm) recorded the highest reduction in disease incidence. Such obtained results were similar to that obtained by Galal *et al.* (1996) who found that the average effect of reduction 55.83 and 55.71 / in the two seasons by Diathane M45 against gray mold on lentil plants. Diathane M45 was the most effective fungicide in the decrease in disease incidence followed by indol acetic acid, salycilic acid and sodium bicarbonate. The present results are in agreement with those reported by Metwaly (2004) who reported that the SA (5 mM), *Ps. Fluorscens* (2.8×10^8 cfu) were the most effective inducers against chocolate spot caused by *B. fabae*. Abd El-Saied *et al.* (1996) who reported that the asprin or salycilic acid effectively reduced disease of bacterial wilt caused by *Pseudomonas solanacearum*. Salycilic acid also, reduced disease severity of chocolate spot disease and increased faba bean (Nasr, 2002). Spray of Diathane M45 was reported to reduce infection with gray mold in lentil (Rahhal *et al.*, 2007). Spraying lentil plants with some environmentally reduced significantly the disease severity of gray mold compared with the control. These results could be interpret in light that spraying with some treatment induced systemic acquired resistance through enhancing the formation of phytoalexin.

Zaky *et al.* (2006) reported that, IAA (20 ppm) and SA (400 mg / l) were recorded the highest significant reduction in disease severity of rust Anise and causes maximum yield fruits. Abd El-Kareem (2007) reported that, conciderable decrease in disease incidence of early blight of potato was obtained with potassium or sodium bicarbonate at 1.0 or 2.0,

respectively, plus Nerol at 0.5%. Spraying plants with Na HCO_3 solution provided good control of several plant diseases (Harst *et al.*, 1992 and Janisiewicz and Peterson, 2005). Under field conditions, in both, Sers El-Lyain and Gemiza locations the aforementioned treatments showed remarkable increase in crop parameters [including length of plant, branch number / plant, seed weight / 20 plants, seed number / 20 plant, 1000 seed weight (g) and seed yield / fed (kg)] compared with untreated control. The increase in yield was not only due to the reduction in disease incidence, but also due to a positive effect of the treatments the themthelves (Abd El-Kareem, 1998). In this respect, treatment with SA increased pod number and yield in mung bean (Sing and Kaur, 1980). As well as, Metwaly (2004) found that salicylic acid (25 m⁻) seed treatment or foliar treatment was the most effective inducer as followed by ethanol as foliar treatment (800 ppm) or seed treatment (1000 ppm) when applied under greenhouse or field applications and resulted in a significant increase in crop parameters of lentil compared with untreated control.

Spraying with Diathane M45, followed by IAA had a positive effect on chemical components of lentil seed i.e., crude protein, phosphorus and potassium and Sinia-1 recorded the highest value for the above three parameters than Giza-9 cv. These results are in agreement with the findings of Rahnal *et al.* (2007). On the other hand, sodium bicarbonate followed by IAA and Diathane M45 showed inhibiting *B. cinerea*.

REFERENCES

Abd El-Kareem, F. (1998). Induction of resistance to some disease of cucumber plants grown under greenhouse conditions. Ph.D. Thesis, Fac. Agric., Ain Shams Univ., p. 116.

Abd El-Kareem, F. (2007). Potassium or sodium bicarbonate in combination with Neral for controlling early blight disease of potato plants under laboratory, greenhouse and field conditions. Egypt. J. Phytopathol., 35 (1): 73 – 86.

Abd El-Saied, W. M.; Abd El-Ghafar, N. Y. and Shehala, S. A. M. (1996). Application of SA and asprin for induction of resistance to tomato plants against bacterial wilt and its effect on endogenous hormones. Ann. Shams. Agric. Sci. Univ., 41: 1007 – 1020.

Aly, M. M.; Ashour, W. E.; Diab, M. M. and Abd El-Kareem, F. (1993). Induced (resistnace to fusarium wilt of watermelon under filed conditions. Proc. of 5th Nat. Conf. of Pests and Dis. of Veg. and

Fruits in Egypt, Ismailia, pp. 441 – 445.

Antonov, A.; Stewart, A. and Walter, M. (1997). Inhibition of conidium germination and mycelial growth of *Botrytis cinerea* by natural products. 50th Conf. of the New Zeland Plant Protection Society, pp. 159 – 164.

Beniwal, S. P.; Baya'a, B.; Weigand, S.; Makkouk, K. H. and Saxenal, M. C. (1994). Field guide to lentil diseases and insect pests. ICARDA.

Brown, J. D. and Lilliand, O. (1966). Rapid determination of potassium and sodium in plant material and soil extract. Proc. Amer. Soc., 48: 341 – 346.

Durivedi, S. K. (1990). Antifungal activity of some phenolic compounds on *Fusarium oxysporum f.sp. psidi* causing guava wilt. Hindustan Antibiotics Bulletin, 32: 33 – 35.

Galal, A. A. (1996). Acquired resistance to sunflower rust infection and effect of plant growth regulators. Egypt. J. Phytopathol., 24 (1 – 2): 71 – 80.

Hafez, A. and Mikkelsen, D. S. (1981). Colorimetric determination of nitrogen for evaluating the nutritional status of rice. Commnu., 12 (1): 61 – 69.

Harst, R. K.; Kawanoto, S. O. and Porter, L. L. (1992). Effect of sodium bicarbonate and oils on control of powdery mildew and black spot of roses. Plant Dis., 76: 247 – 251.

Janisiewicz, W. J. and Peterson, D. L. (2005). Experimental Bindrenching system for testing biocontrol agents to control postharvest decay of apples. Plant Dis., 89: 487 – 490.

Kanss, H.; THeisinger-Hinkel, E.; Mindermann, R. and Conrath, U. (1992). Dichloroisonicotinic acid and salicylic acid inducers of systemic acquired resistance, enhance fung elicitor responses in parsley cells. Pl. J., 2: 655 – 660.

Karabulut, O. A.; Bursa, G. and Mansour, M. (2003). Near-harvest applications of *Metschnikowia fructicola*, ethanol and sodium bicarbonate to control postharvest diseases of grape in Central California. Plant Dis., 87: 1384 – 1389.

Lindsay, R. C. (1985). Food additions. In: Fennema. Chapter 10. Food Chemesitry Marcel Dekker, Inc., New York, USA.

Metwaly, M. M. M. (2004). Resistance induction against diseases of faba bean crop. Ph.D. Thesis, Plant Pathology Dept., Fac. Agric., Suez Canal Univ.

Morgan, D. T. (1971). Numerical taxonomic studies of the genus botrytis. Trans. Br. Mycol. Soc., 56 (3): 327 – 335.

Morrall, R. A. A. (1997). Evaluation of lentil disease over 25 years in western Canada. Can. J. Plant Pathol., 19: 197 – 207.

Munijal, R. L. (1980). Faba bean disease situation in Egypt and future research projections. ICARDA/IFAD Nile valley project on faba bean, p. 33.

Nasr, M. A. H. (2002). Studies on some foliar disease of faba bean. M.Sc. Thesis Fac. of Agric., Zagazig Univ.

Panday, D. K.; Tripathi, N. N.; Tripathi, R. D. and Dixit, S. N. (1982). Fungitoxic and phytotoxic properties of the essential oil of the *Hyptis suaveolens*. Z. Pflakrankh. Pflschutz., 89 (6): 344 – 349.

Rahhal, M. M. H.; Ismail, I. A. and Rahmou, A. A. (2007). Efficacy of repeated spray of neem oil for control of gray mold disease of lentil plants caused by *Botrytis cinerea* and on some of the chemical components of lentil seeds. J. Pest Cont. and Eriviron. Sci., 15 (1): 43 – 67.

Sallam, Minnas El-Sayed (1997). Studies on leaf rust of wheat in Egypt. Ph.D. Thesis Fac. Agric., Zagazig Univ., Egypt.

Shashi-Chauhan; Sharma, M. and Chauhan, S. (1989). *In vitro* efficacy of certain antifungal lotions on the growth of deratophytic fungi. National Academy of Science letters, 12: 11 – 13.

Sing, R. K. and Kaur, M. (1980). Effect of growth regulators on poding and yield of mung bean. Indian J. Plant Physiology, 23: 366 – 370.

Smilanick, J. L.; Mansour, M. F. and Sorenson, D. (2006). Pre-and post harvest treatments to control green mould of citrus fruit during ethylene degreasing. Plant Dis., 90: 89 – 96.

Tuzun, S. and Kue, J. (1985). A modified technique for inducing systemic resistnace to blue mould and increasing growth in tobacco. Phytopathology, 75: 1127 – 1129.

Van Andel, O. M. and Fuchs, A. (1972). Interference with plant growth regulation by microbial metabolites. Pages: 227 – 249. In: Phytoalexins in Plant Diseases. Wood, R. K. S.; A. Ballio and A. Graniti (eds.) Acad. Press, London.

Zaky, Wafaa, H.; Nada, M. G. A. and Hilal, A. A. (2006). Evaluation of the efficiency of some environmental safe means for controlling rust disease of anise (*Pimpinella anisum* L.), as important medicinal plant in Egypt. Egypt. Phyopathol., 34 (2): 103 – 119.

Ziv, O. and Zitter, T. A. (1992). Effect of Bicarbonates and Filmforming Polymers on cucumbit foliar Diseases. Plant Dis., 76: 513 – 517.

الملخص العربى

تقييم فعالية بعض الوسائل الآمنة على البيئة فى مقاومة مرض العفن الرمادى فى العدس مقارنةً بالدياثين م ٤٥

راتيا زكى الشناوى ، سحر عباس السيد ، إسماعيل عبد المنعم إسماعيل

معهد بحوث أمراض النباتات – مركز البحوث الزراعية – الجيزة – مصر

تم تقييم فعالية حمض السالسليك وبيكربونات الصوديوم وأندول حمض الخليك والدياثين إم ٤٥ رشاً على المجموع الخضرى تحت ظروف الصوبة والحقل .

وأظهرت الاختبارات المعملية على الفطر المُسبب للعفن الرمادى حدوث تثبيط كامل لنمو الفطر بوتريتس سينيريا *Botrytis cinerea* عند إضافة كل من حامض السالسليك وأندول حمض الخليك والدياثين م ٤٥ إلى بيئة النمو بتركيز (١٠ ملليمول ، ٢٠٠ جزء فى المليون ، ١٠٠ جزء فى المليون) على التوالى ، بينما أظهر التأثير التثبيطى الملح بيكربونات الصوديوم عند تركيز ٢٠٠ جزء فى المليون نسبة ٦٤,٠٨% .

وجد فى التجارب الحقلية أن رش هذه المواد على المجموع الخضرى أدى إلى انخفاض ملحوظ فى نسبة الإصابة بالفطر المُسبب للمرض مُقارنةً بالكنترول غير المعامل فقد وجد أن كلاً من حمض السالسليك (١٠ ملليمول) بيكربونات أفضل المواد المستخدمة حيث قللت نسبة حدوث الإصابة إلى ١٠٠% فى كل من الصنفين سينا-١ وجيزة-٩ يلى ذلك أندول حمض الخليك (٢٠٠ جزء فى المليون) إلى اختزال فى نسبة حدوث الإصابة تصل إلى ١٠٠% للصنف سينا-١ ، ٧١,٦% للصنف جيزة-٩ .

تم تأكيد هذه النتائج وذلك عند إجراء تطبيق لهذه المعاملات تحت ظروف الحقل فى محطة بحوث سرس الليان ، الجميزة حيث أوضحت النتائج حدوث نقص فى نسبة الإصابة بالمرض تُقدر بحوالى (٩١,٩ ، ٩٢,١%) ، (٨٠ ، ٨٠%) وذلك عند استخدام الدياثين م ٤٥ (٢٠٠ جزء فى المليون) يليه الرش بالأندول حمض الخليك (٢٠٠ جزء فى المليون) ، حيث كان النقص فى نسبة الإصابة (٦١,٨ ، ٦٢,١%) ، (٥٦,٥ ، ٥٨,٦%) وذلك بعد ٥٥ ، ٧٥ يوم من الزراعة فى محطة سرس الليان والجميزة على الترتيب.

لوحظ تأثير المعاملات السابقة على زيادة محصول نبات العدس وذلك بالنسبة لمعاملة المقارنة فقد وجد أن أعلى زيادة فى المحصول تم تسجيلها بالنسبة لمعاملة الديائين م ٤، هما (٥٤,٥ ، ٥٠,٥%) فى محصول البذرة كجم للفدان فى محطتى سرس الليان والجميزة على الترتيب متبوعاً بأندول حمض الخليك ثم بيكربونات الصوديوم ثم أندول حمض الخليك (٣٧,٣ ، ٢٨,٩%) فى محطة الجميزة بينما كانت الزيادة بالمعاملة بحمض السالسليك (٢٤,١، ٢٠,٢%) فى محطة سرس الليان والجميزة على الترتيب إذا ما قورنت بمعاملة المقارنة .

كما أظهرت النتائج أيضاً أن الصنف سينا-١ هو الأكثر فى محتوى بعض الصفات المحصولية مثل وزن البذرة ، عدد البذور ، ووزن ألف بذرة (جم) محصول البذرة / فدان كذلك فى محتوى البذور من البروتين الكلى والفوسفور والبوتاسيوم عن الصنف جيزة-٩ ، كما أن المعاملة بمبيد الديائين م ٤، يليه المعاملة بالأندول حمض الخليك من أفضل المعاملات وكانت المعاملة بالأندول حمض الخليك من أفضل المعاملات فى زيادة محتوى البروتين والفوسفور والبوتاسيوم ، بينما أظهرت المعاملة بالسالسليك تأثيراً أقل .

تُشير النتائج التى تم الحصول عليها فى هذه الدراسة إلى إمكانية استخدام كل من بيكربونات الصوديوم ، حمض السالسليك ، أندول حمض الخليك كبدائل للمبيدات ضد بعض الفطريات المُمرضة للنبات مع الأخذ فى الاعتبار بأن هذه المواد تُستخدم لزيادة المقاومة ضد العديد من الفطريات كما أنه يُقترح إجراء دراسات وقائية فى هذا المجال لاستخدام هذه المواد كمعاملات علاجية للنباتات عند بداية ظهور أعرضا المرض .