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PERFORMANCE OF SOME CHEMICAL COMPOUNDS AND NEEM OIL IN CONTROLLING WHITE STEM ROT AND IMPROVING CHICKPEA PRODUCTIVITY

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ABSTRACT

Laboratory, greenhouse and field experiments were preformed to evaluate the antifungal activity of cobalt sulphate, salicylic acid, ethephone, dipotassium phosphate, ascorbic acid and neem oil at three concentrations for each against *Sclerotinia sclerotiorum* growth and sclerotial formation on PDA (Potato Dextrose Agar) and to verify its positive efficacy as defence activators (elicitors) in chickpea seedling and plants against damping-off and white stem rot disease. Also, efficacy of the five elicitors and neem oil in improving some growth parameters, protein, nitrogen, potassium and phosphorus contents of seed was determined.

1-Neem oil (2.5, 5.0 or 7.5 ml L^{-1}) and salicylic acid at higher concentration (7.5 mM) significantly reduced the fungal growth and number of sclerotial formation *in vitro*. Reduction was always increased by increasing concentration of neem oil.

2-Soaking seeds in each one of the five elicitors or the neem oil tested, except ethephone, decreased seedling damping-off pre- (in most cases) or post-emergence and increased survivals. The most effective inducers, however, were cobalt sulphate (1 mg L^{-1}), salicylic acid (7.5 mM), neem oil (5 ml L^{-1}), dipotassium phosphate (5 mM) and ascorbic acid (10 mM). While, ethephone treatment was the least effective. In the field experiments, white stem rot disease incidence was significantly minimized with all tessted treatments tested in both seasons, except ethephone. The highest reduction in the disease incidence was recorded with neem oil, followed by dipotassium phosphate and cobalt sulphate.

3- Giza 2 cv. was the highest susceptible to infection under greenhouse and field conditions. While, Giza195 and Giza 531 cvs. were the least.

4- Results of the field experiments indicated that application of all treatments, except ethephone, resulted in a significant improve in crop parameters of chickpea cultivars compared with the untreated control. Dipotassium phosphate recorded the highest number of tillers, weight of seed yield per plant, number of capsules per plant, and seed yield / feddan.

5- Giza 1 cultivar had the higher value of seed yield/fed. In the 1st season, whereas Giza195 cultivar in the 2nd season.

6- Giza 195 seeds had the higher crude protein content in the 1st season, while Giza 531 showed the higher protein content in the 2nd season.

7- Giza1 seeds had the higher content in phosphorus and potassium in the two seasons.

8- Ethephone exhibited the highest reduction in plant height, 100-seed weight, seed yield per feddan and N,P and K content in seeds..

9- Dipotassium phosphate and neem oil treatments were superior than the other in increasing values of seed yield/fed., nitrogen, protein, phosphorus, potassium contents in Giza1, and Giza 195 cvs., while the lowest of them was detected in Giza2.

Keywords: Chickpea cultivars - *Sclerotinia sclerotiorum* - stem rot - Inducers, Nitrogen, protein content, Phosphorus and Potassium.

INTRODUCTION

Scleortinia sclerotiorum (Lib.) de Bary is an important pathogen distributed ubiquitously, attacking over 360 species of plant comprising 64 families (Purdy, 1979). Diseases caused by *S. sclerotiorum*, however, are difficult to control and may result in substantial yield losses ranged from 0-100% (Purdy, 1979). This pathogen can stay alive in the soil for many years without its host due to formation of sclerotia (El-Morsy and Abou Zeid, 1997). In Egypt, chickpea is one of the major feed food legume crops which is attacked with white stem rot caused by *S. sclerotiorum* (Omar *et al*., 1992).

Induced resistance in plants to fungal, bacteria and viral pathogens has been demonstrated after pretreatment with a number of physical, chemical and biotic agents (Tuzun *et al*., 1989). The use of chemical agents has been widely studied; salicylic acid against *Phytophthora infestans* of potato plants (Floryszek and Wieczorek, 1993); K_2HPO_4or K_3PO_4 treatments against powdery mildew of cucumber (Mosa, 1997), Cobalt seed treatment of water melon against Fusarium wilt under pot and field experiments (Aly *et al*., 1993); ascorbic acid (10 mM) as seed soaking against damping-off of soybean (El-Blasy, 2006); neem oil as spray against gray mold of lentil (Rahhal *et al*., 2007).

In the challenge to fill the gap between production and consumption of protein, increasing productivity as well as cultivated area led to increasing the use of more chemical fertilizers (especially nitrogen and phosphorus), which are not only so expensive but also polluting agro ecosystems. Therefore, the current trend is to reduce the use of mineral fertilizers and keep high productivity in the meantime. Recently, some compounds as growth regulators were experimented on some crops and had remarkable responses in growth and yield. Glycolysis and tricarboxlic acid cycle as the main source of respiratory plant growth and all nutritional processes which reflect on plant growth and nutrient uptake are dependent on organic acids level in plant tissues (Givan, 1979). Ascorbic and salicylic have been synthesized in higher plant through glucose metabolism (Miernyk and Trelease, 1981 and Helsper *et al*., 1982). These acids are also considered as physiological relevant factor which may lead to the activity of some enzymes (Reibstein *et al*., 1986 , Nofal *et al*., 1990). Hammada and El-Hakimi (2000) found that salicylic acid was more effective on carbohydrate constituent. Nasef *et al*.(2004) reported that applied Co showed a significantly affect on all peanut plant growth yield parameters and N,P and K uptake by forage or seeds. Sallam (1997) represented that cobalt and ethephone; IAA and kinetin increased NPK and protein contents in wheat plants. Mengel & Kirkdy (1979) suggested that potassium phosphate as a complete soluble fertilizer was used to correct the deficiency of both P and K in soils suffered phosphate fixation or low availability. Also, many investigators observed that phosphatic fertilization induced significant increases in both seed and straw yields of lupin as well as seed protein and P contents. On the other hand, the phosphorus application did not markedly affect the protein and phosphorus contents (Hamissa *and Mostafa* , 1998; Bremer *et al.,* 1989 and Abd El-Latef,

1996). Rahhal *et al*. (2007) found that neem oil increased chickpea seed yield and seed contents protein, phosphorus and potassium.

This investigation was planned to study the efficacy of five different chemical inducers and neem oil on fungal growth in laboratory and incidence of white stem rot in chickpea seedlings and plants under greenhouse and field conditions and to evaluate their efficacy on seed yield and yield components.

MATERIALS AND METHODS

I. *In vitro* studies:

Efficacy of five elicitors namely; cobalt sulfate, salicylic acid, ethephone, K_2HPO_4 and ascorbic acid in addition to neem oil was determined on radial growth of *S. sclerotiorum* isolate on PDA (Potato Dextrose Agar) medium. The medium was amended with each elicitor just before solidification. The appropriate amount of each treatment, however, was prepared to mix in 50 ml medium in each flask to give concentrations of 0.5, 1.0 and 2.0 mg L^{-1} of cobalt sulfate; 2.5, 5.0 and 7.5 mM of salicylic acid; 100, 200 and 300 mg L^{-} of ethephone; 5.0 , 7.5 and 10.0 mM of dipotassium phosphate or ascorbic acid and neem oil (2.5, 5.0 and 7.5 ml L^{-1}.). Ten ml of each treated PDA medium was poured in each Petri dish. Then, they were inoculated with 5 mm discs of the fungal growth and incubated at 20 Cº. The fungal growth was measured when radial growth in control plates reached its maximum; also the number of sclerotia was recorded.

II. *In vivo* studies:-

Seeds of chickpea varieties, Giza1, Giza2, Giza 195 and Giza 531. The were kindly obtained by legume Crop Dept., Field Crop Research Institute, ARC, Giza.

Seed soaking: Seeds (200g) from each tested chickpea cultivars were soaked for 24 hrs.in 1L solution of cobalt sulfate (0.5, 1 or 2.0 mg L^{-1}); salicylic acid (2.5, 5.0 or 7.5mM); ethephone (100, 200 or 300 mg L^{-1}); dipotassium phosphate and ascorbic acid (5.0, 7.5 and 10.0 mM) and neem oil (2.5, 5.0 and 7.5 ml L^{-1}) .

Preparation of inoculum: The discs (5.0 mm diam.) of seven day old culture of *S. sclerotiorum* isolate were placed in bottles (500 ml) containing autoclaved sorghum grain-sand medium (75 gm sorghum grains + 25 gm clean sand + 100 ml sterilized water) and inculcated at 20 ºC for 15 days.

Pot experiment: This experiment was to assign the most effective concentration of each elicitors against plant damping off soil infestation was carried out by adding the inoculum of the fungus to the past containg the formalin-sterilized soil at the rate of 5% soil weight (w/w). Pots were watered every other day for one week before planting. The same amount of autoclaved sand sorghum mixture was added to the pots as a chek treatment. Five seeds of chickpea Giza1, Giza2, Giza195 and Giza531 treated with the chemical inducers and neem oil were sown in pots (20 cm in diam) and four pots were used for each treatment. Seeds of untreated control were soaked in tap water for the same time period. Pre-, post-emergence damping-off and survival plants were recorded after 15, 45, and 75 days after planting (DAP).

Table(1): Chemical structures formula of the used elicitors and their concentratios used the pot experiment

Treatments	Chemical structure	Molecular weight	Concentrations
Cobalt sulfate	$CoSO_4.7H_2O$	281.1	0.5, 1.0and 2.0 mg L^{-1}
Salicylic acid	$C_7H_6O_3$	138.1	2.5,5.0 and 7.5 mM
Ethephon	2-chloroethyl phosphonic	144.5	100,200and300 mg L^{-1}
Dipotassium	acid	174.2	5.0,7.5and10.0 mM
phosphate	K_2HPO_4	176.1	5.0, 7.5 and 10.0mM
Ascorbic acid	$C_6H_80_6$	--	2.5,5.0 and 10.0 ml L^{-1}
Neem oil	Commercial oil		

Field experiments:

Experiments were carried out at Etay El-Baroud Agrc. Res. Station, Behira, governorate during the two successive seasons (2004/05 & 2005/06) to evaluate the efficacy of five chemical inducers and neem oil effective at the most concentrations on controlling chickpea white stem rot disease under natural conditions and productivity of chickpea cultivars (Giza1, 2 ,195 & 531).

Soil analysis: Soil samples were taken from the soil surface layer of the farm (0-30 cm depth) before planting for physical and chemical analyses according to Black (1965). The results of soil analysis are shown in Table (2).

Table (2): Physical and chemical analysis of the field soil.

Seasons	Organic matter (%)	$CaCO_3$ (%)	Particle size distribution (%)				Soil texture	Available nutrients mg kg^{-1}		
			Coarse sand	Fine sand	Silt	Clay		N	P	K
2004/05	1.32	3.84	11.30	9.50	39.00	40.20	Clayey	58	8	323
2005/06	1.39	3.74	11.14	9.66	38.58	40.62	Clayey	73	5	255
Soluble cations and anions(meq L^{-1})										
Seasons	**pH 1:2.5 soil: water**	**EC, dS/m 1:5 soil: water**	**Ca^{++}**	**Mg++**	**Na^{+}**	**K^{+}**	**CO_3^{--}**	**HCO_3^{-}**	**Cl^{-}**	**$SO_4^{=}$**
2004/05	7.94	0.59	1.09	0.87	1.08	0.23	-	0.48	0.47	2.31
2005/06	8.03	0.71	0.89	0.82	1.05	0.21	-	0.43	0.45	2.09

Experimental design: The experimental layout was split plot design with 3 replicates, where the varieties were allocated in the main plots and the treatments occupied sub plots. The area of each plot was 7.2 m^2 consisting of 4 ridges of 3 m in length and 0.60 m in between.

Treatments: The used concentrations of the chemical inducers for the field trail were cobalt sulphate 1 mg L^{-1}; salicylic acid 7.5 mM; ethephone 300 mg L^{-1}; neem oil 5.0 ml/L; K_2HPO_4 5.0 mM and ascorbic acid 10.0 mM were used in the field experiment. These concentration were found be the most effective from the pot experiment.

Seeds of chickpea cultivars were soaked in each solution of inducers and neem oil at the above mentioned concentration for 24 hours and left for one day to dry before planting and then sowing in hill of 10 cm apart in two sides/ridge with two seeds/hill. Seeds of untreated control were soaked in tap water for the same period before planting.

Fertilization: Primary additions of N, P and K fertilizers were practiced as soil application for all plots. Nitrogen was added at the rate of 15 kg N/fed. as ammonium sulphate (20.6% N) after 15 days from sowing. Phosphorus at rate of 30 kg P_2O_5/fed as superphosphate (15 %P_2O_5) and potassium at the rate of 24 kg K_2O/fed. as potassium sulphate (48 % K_2O) were added at sowing.

Disease assessment: Disease incidence of stem rot was recorded 90 and 120 days after sowing according to the method of Purdy (1979).

Yield and yield component: At harvest, two ridges from each plot were taken at random and the following growth characters were recorded: plant height (cm), no. of branches/plant, weight of 100 seeds (g), capsule number / plant and seed yield (kg/fed).

Analysis of seeds: Composite seed samples were taken in order to be dried at 70 Cº and ground then 0.5 g was subjected to wet ashing. Aliquots were taken for N determinate using the micro-Kjeldahl method as described by A.O.A.C. (2000). The N content was multiplied by 6.25 to obtained protein percentage. Phosphorus was determined calorimetrically and potassium was estimated by flam photometer according to Jackson (1973). Data were also statistically analyzed according to Snedecor and Cochran (1981).

RESULTS

I- *In vitro* studies:

Data in Table (3) show that the fungal linear growth was significantly reduced with only the high concentration (7.5 mM) of salicylic acid and 7.5 ml L^{-1} of neem oil, among the five inducers tested. However, efficacy of neem oil was significantly higher than that of salicylic acid . Generally, the three concentrations of neem oil reduced the fungal linear growth significantly than the control or the other tested treatments. On the other hand, the high concentration of salicylic acid and the three of ones of neem oil were the most effective treatments in reducing number of sclterotia/plate compared with the control, and the reduction was significant.

II. *In vivo* studies:

1- Greenhouse experiments:

Data in Table (4) show that a significant decrease of pre-emergence damping-off below that of the control resulted when the seeds were soaked in cobalt sulphate (1.0 and 2.0 mg L^{-1}; salicylic acid (5.0 and 7.5 mM); neem oil (2.5 , 5.0 and 7.5 ml L^{-1}); K_2HPO_4 (5.0 and 7.5 mM) and ascorbic acid (10.0 mM). Only, soaking in ethephone significantly increased percentage of pre-emergence damping-off, than the control of Giza 1, Giza 195 and Giza 531.

Table (3): Effect of chemical inducers and neem oil at different concentrations on linear growth and number of the fungal sclerotia *in vitro*:

Treatments	Concentration	Linear growth (cm)	No. of sclerotia/plate
Cobalt sulphate	**0.5 mg L^{-1}**	8.975	45.500
(CS)	**1.0 mg L^{-1}**	8.900	46.500
	2.0 mg L^{-1}	8.900	45.250
Salicylic acid	**2.5 mM**	8.950	46.000
(SA)	**5.0 mM**	8.900	45.750
	7.5 mM	4.775	20.250
Ethephone	**100 mg L^{-1}**	8.900	45.250
(Et)	**200 mg L^{-1}**	8.925	47.000
	300 mg L^{-1}	8.925	45.000
Neem oil	**2.5 ml L^{-1}**	7.025	40.000
(NO)	**5.0 ml L^{-1}**	5.950	25.000
	7.5 ml L^{-1}	2.875	11.750
K_2HPO_4	**5 mM**	8.975	47.750
(DKP)	**7.5 mM**	8.950	46.250
	10.0 mM	8.425	46.000
Ascorbic	**5.mM**	9.000	45.750
(AA)	**7.5 mM**	8.975	44.750
	10 mM	8.925	47.000
Control	**0.0**	9.000	46.75
L.S.D. at 5% for:			
Elicittors (T)		0.12	1.03
Concentration(C)		0.19	1.58
C x T		0.33	2.73

A significant reduction in post-emergence damping-off was obtained when seeds were soaked in solution either of cobalt sulphate (0.5, 1.0 and 2.0 mg L^{-1}); salicylic acid (2.5, 5.0 and 7.5 mM), neem oil (2.5, 5.0 and 7.5 ml L^{-1}); K_2HPO_4(5.0, 7.5 and 10.0 mM) and ascorbic acid (5.0, 7.5 and 10.0 mM) in case of Giza1 cultivar.

As for ethephone, it gave increase or equal percentage of post-emergences, except in Giza 195 at 100 mg L^{-1} since it caused significant decrease compared with the control. Taking survival plants into consideration, the highest percentages were obtained from cobalt sulphate treatment (1.0 mg L^{-1}); salicylic acid (7.5 mM); neem oil (5.0 ml L^{-1}); K_2HPO_4 (5.0 mM) and ascorbic acid at (10.0 mM) where the percentages were significantly higher than the control of four chickpea cultivars tested with no significant differences among them. So, these concentrations of the used inducers were applied in the field experiment.

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2- Field experiment:

2.1. White stem rot disease:

Chemical inducers ,i.e. CS , SA , Et , DKP , AA and NO at the concentrations of 1 mg L^{-1} , 7.5 mM ,300 mg L^{-1} , 5 mg L^{-1}, 10.0 mM and 5 m L^{-1} respectively were used in the field experiment since in the application in the pot experiment resulted in the highest percent of survival plants. Data in Table (5) showed that in the first season, dipotassium phosphate as seed soaking ranked as the most effective treatment to control whit stem rot diseasefollowed by neem oil, cobalt sulphate and salicylic acid, respectively while cobalt sulphate, K_2HPO_4, salicylic acid and neem oil occupied the first four ranks in second season exhibiting effectiveness over the untreated control. These results confirm the role of K to increase the plant ability to resist Fungal and bacterial deseases. Ascorbic acid and ethephone, however, were the least effective chemical inducers in both growing seasons. Data also show that mean percentages of stem rot on Giza1 and Giza2 plants were greater than the other cultivars tested, while Giza 531 exhibited less infection (%).(Table 5).

In general, dipotassium phosphate and neem oil were the most effective treatments for all cultivars used followed by cobalt sulphate and salicylic acid, except Giza 195 cultivar, while ethephone was less effective treatment in decreasing disease incidence in all cases, showing that K nutrient had a predominating influence on resistance to white stem rot disease.

2.2. Plant height: In most cases, the height of chickpea plant was decreased by all inducers and neem oil treatments as seed soaking treatments as compared with the control in the 1st season in case of all cultivars (Table, 6). On contrary, plant height was significantly higher with cobalt sulphate, K_2HPO_4 and ascorbic acid in the 2nd season over the control. Ethephone treatment in both seasons, however, gave the shortest plants among the other treatments.

2.3. Number of tillers per plant: All chemical inducers and neem oil (Table, 6) gave significant increase in number of tillers over the control in both growing seasons. No significant differences were observed among the four cultivars tested. K_2HPO_4 and ascorbic acid were the best treatments in increasing number of tillers in both seasons, while cobalt sulphate treatment was the less effective if compared with the other treatments.

2.4. Weight of 100 seeds (g): Data in Table (7) show that in the 1st season no significant differences between the treatments tested on weight of 100 seeds in the 1st season. At the same time, there is no significant difference between cultivars in 100 g seeds weight. While, in the 2nd season, there is a significant difference between the substances tested in increasing seed index. Neem oil, ascorbic acid and salicylic acid were the most effective inducers, while ethephone was the least affective if compared with the control.

2.5. Dry weight/plant: All chemical inducers and neem oil (Table,7) except ethephone treatment, significantly, increased dry weight per plant over the control. K_2HPO_4 followed by cobalt sulphate and ascorbic acid were effective treatments in increasing dry weight of chickpea plant.

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On the other hand, all treatments significantly increased dry weight of plant compared with the control. The most effective treatments was cobalt sulphate followed by ascorbic acid and salicylic acid. The worst treatment in this respect, however, was ethephone.

2.6. Seed weight plant: K_2HPO_4 treatment gave the highest seed weight among the tested treatments in two successive growing seasons (Table, 8). In the two experimental seasons, significant increases in seed weight for all treatments were recorded. Differences between Giza1 and G.195 were not significant in both trial seasons.

2.7. Number of capsules/plant: All treatments (Table, 8) gave significant increases in number of capsules per plant, except ethephone, compared with the control in the two growing seasons. In these respect, seed soaking with K_2HPO_4 followed by neem oil were the most effective in increasing number of capsules over the other treatments. Whereas, ethephone treatment gave the least no. of capsules per plant and caused a significant decrease when compared with the control. On contrast, K_2HPO_4 treatment was the best in increasing no. of capsules per plant compared with the other treatments on the cultivars tested.

2.8. Seed yield feddan (kg): Data presented in Table (9) show that all inducers and neem oil, except ethephone treatment, significantly increased seed yield of feddan over the untreated control in both seasons. However, K_2HPO_4 treatment was superior in increasing seed yield for all cultivars (Giza1, Giza 195, Giza 531 and Giza2) in both trial seasons, followed by neem oil that gave the highest seed yield of Giza 1 in 1st season and G.195 in the 2nd season. Ethephone was the least effective if compared with the other treatments on the tested cultivars, since it caused significant reduction in seed yield of the tested cultivars compared to the controls.

2.9. Protein content and removal N,P and K by seeds:

A. Nitrogen content:

Data in Table (10) indicate that nitrogen content has considerably varied in the tested cultivars in the produced seeds from the five inducers or neem oil. The seeds of Giza1 produced from K_2HPO_4 and neem oil treatments contained the highest seed nitrogen amount during the both seasons, meanwhile the lowest nitrogen amount was detected in Giza2. Ethephone treatment, however, exhibited the lowest amount of nitrogen in the all tested cultivar seeds in both seasons.

B. Protein content:

The chickpea cultivars were significantly variable in their seed protein content (Table, 10). The highest seed protein was produced by Giza1 in second season. Meanwhile, the lowest protein content was detected in Giza2. In general, the higher protein content was recorded with K_2HPO_4 and neem oil treatments in all cultivar seeds. On contrary, the ethephone treatment exhibited the lowest protein amount.

C. Phosphorus content:

Phosphorus content was higher in seeds of all chickpea cultivars treated with each of all chemical inducers and neem oil as seed soaking, except ethephone (Table, 11).

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Phosphorus content was mostly significantly and higher in seeds treated with K_2HPO_4 or neem oil, followed by cobalt sulphate, salicylic acid and ascorbic acid in all cultivar seeds. Significant increases over the control were obtained with cobalt sulphate and salicylic acid treatments in seeds of Giza 2 and Giza 531. Also, significant increase over the control were obtained with ascorbic acid and salicylic acid treatments in seeds of Giza1. Salicylic acid treatment ,however, was the third superior treatment after K_2HPO_4 and neem oil treatments in seeds of Giza195. On the other hand, soaking seeds in ethephone for all chickpea cultivars tested caused a significant decrease in phosphorus content than the control treatment in the two seasons.

D. Potassium content:

In general, the amount of potassium content was higher in seeds of all chickpea cultivars treated with each of chemical inducers and neem oil, except with ethephone(Table, 11). The highest amount of potassium content was detected in Giza1 using K_2HPO_4 and neem oil treatments in the second season, followed by Giza 195. The lowest amount was detected in Giza2 and the potassium amount in seeds of ethephone treatment was significantly lower than the other treatments and control.

DISCUSSION

Sclertinia sclerotiorum (Lib.) de Bary, the causal fungal organism of stem rot disease, is considered a serious disease that attacks legume crops, forage and vegetable in Egypt. The impact of the disease was increased notably during the last decade causing a remarkable yield losses (Omar *et al*., 1992 and Mazen 1995).

S. sclerotiorum is among the most non specific omnivorous, and successful of plant pathogen. Plants susceptible to infection by this pathogen encompass 64 families, 225 genera and 361 species (Purdy, 1979). Moreover, this fungus is geographically cosmopolitan and has a broad ecological distribution including the four different chickpea cultivars which were evaluated under greenhouse and field conditions to infect by stem rot disease. Giza 2 cultivar , however , was the highly infected by *S. sclerotiorum* under greenhouse and field conditions, while Giza 531 was the least susceptible. These results are in agreement with the results obtained by El-Blasy (2006).

Significant reduction in the disease incidence was obtained as a result of resistance induced by soaking seeds of susceptible chickpea cultivars in one of the five elicitors tested. Data obtained here supports those previously mentioned by several authors (Yurina *et al.*, 1993).

However, dipotassium phosphate was more effective in decreasing the disease incidence than the other elicitors used, either under soil contamination with the pathogen in greenhouse or with natural infection under field conditions. The obtained results coincide with Abd-El-Kareem (1998).

On the other hand, neem oil was found to be the second effective treatment after dispotassium phosphate as controlling stem rot disease. This

result is in complete agreement with the finding of Rahhal *et al.* (2007). Soaking seeds in cobalt sulphate suspension significantly reduced chickpea stem rot. In this respect different cobalt concentrations were previously used as an effective treatment in inducing resistance against numerous plant diseases (Sallam, 1997).

Contrary to the result of Ibrahim (1993) and Abd El-Kareem,(1998), ethephone treatment exhibited increasing in damping-off and stem rot disease and decrease total seed yield and another growth parameters, this result is not agreement with Ibrahim,(1993) . This may be attributed to the low concentration.

Under field conditions, the affirmable treatment except ethephone showed remarkable increase in crop parameters including number of tillers, seed yield/ plant, number of capsule/ plant and seed yield per feddan and weight of 100 seeds 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 than themselves (Abd El-Kareem, 1998). In this respect, treatment with cobalt sulphate increased significantly most of yield component, seed yield, and protein content and removed N,P and K by seeds. It is thought to be a regulatory element affecting some plant process such as N-fixation and vitamin B_{12} accumulations (Ahmed and Evans, 1959). These results are in agreement with those obtained by Youssef *et al*.(2001) who attributed to the effect of Cobalt on increasing plant of studied elements to the Cobalt stimulating effect on growth, since Cobalt is involved in Cobalt-enzyme and hence is essential for several enzymatic reaction. Nasef *et al*. (2004) showed that the growth, yield component and uptake of N, P, K of peanut increased significantly with increasing the applied Co for surface, foliar and coating application.

Application of salicylic acid, neem oil and ascorbic acid increased significantly most of yield component, seed yield, and protein content and removed N,P and K. In this respect, Genaidy *et al*.(1995) found good response in growth and yield of some main field crop plants as a result of foliar application of some organic acids such as ascorbic and citric. Also ,Hammada and El-Hakimi, (2000) reported that the foliar application of salicylic acid was more effective on carbohydrate constituent. However, the promotive effect of ascorbic acid could be attributed to its effect on metabolic and physiological processes as well as increasing the organic acids exerted from the root into the soil, consequently increasing the solubility of most nutrients which slowly release into the rhizosphere zone where it may be utilized by the plant. These results are in harmony with those reported by Zahran (1993), Negm *et al*.(1996) and Nassar & Ismail (1999). Abd El-Magid *et al*.(2004) found that the application of salicylic acid gave significant increases of root and growth of sugar beat plants as compared to the control. As for N, P and K contents of seeds, Negm *et al*.(1996) stated that ascorbic acid had no significant effect on the content of protein, P and K in lentil seeds. In the respect of neem oil, Rahhal *et al*.(2007) found that neem oil increased yield component, seed yield, crude protein, phosphorus and potassium content for seed lentil.

The highest yield component, seed yield, protein and removal of N,P and K was recorded with dipotassium phosphate. It corrected directly P and K deficiencies and indirectly by the nutrition balance in plants. The present results are in agreement with those found by (Sparks, 1986) on foliate peanut, (Hassaballa *et al*., 1991) on citrus and (Hamida *et a*l., 2000) on maize. Abou-Zeid *et al*.(2005) found that foliar application of KH_2PO_4 increased fresh yield, dry yield and N,P and K uptake by clover plants. Regarding KH_2PO_4 foliation effect on increasing N content by plant. Sparks (1986) and Hassaballa *et al*.(1991) attributed that effect to correction of the nutritional balance in plant. The increases in P content by KH_2PO_4 are in agreement with the results obtained by Hassaballa *et al*.,(1991) and Hamdia *et al*.,(2000).

Contrary to the result of ethephone treatment, it exhibited significant reduction in plant height, number of branches/plant, number of pods/plant, number of seeds per pod, weight of 100 seed, seed yield, protein and removal N,P and K in seeds. This result is similar to those found by Salem *et al*.(1994) on faba bean.

The highest seed yield of Giza1 and Giza 195 might be due to its large seed size and at the same time, its larg vegetative growth reflected on synthesis and building metabolites and these two seasons caused the seed high levels from protein and nitrogen, phosphorus, potassium contents. Such variations in characters between cultivars might be reflected by the deficiency of the plant in building metabolites or might be ascribed to the gentical differences. Also, data show that there are significantly differences between the cultivars tested in plant growth and yield component. These results are in harmony with findings of Mokhtar (1993), Magawer (1990) Rahmou and Zidan (2006) on chickpea and Rahhal *et al*.,(2007) on lentil.

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فاعلية بعض المركبات الكيماوية وزيت النيم على مكافحة مرض عفن الساق الابيض وتحسين انتاجية الحمص

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اجرى هذا البحث فى المعمل والصوبة والحقل لتقييم فعالية نقع بذور الحمص فى ثلاثة تركيزات من سلفات الكوبلت (٠,٥-١-٢.ملليجرام/لتر)، حمض السالسيلك (٢,٥-٥,٠-٧,٥ ملليمول)، الاثيفون (١٠٠-٢٠٠-٣٠٠ ملليجرام/لتر)،الفوسفات ثنائية البوتاسيوم (٠,٥-٥,٧-١٠ملليمول)، حمض الاسكوربك (٠,٥-٥,٧-١٠ ملليمول) وزيت النيم (٢,٥- ٠,٥- ٧,٥ مل/لتر) ضد نمو وتكوين الاسكليروشيات للفطر *Sclerotinia sclerotiorum* النامى على بيئة البطاطس والدكستروز كمنشطات دفاعية لمقاومة مرض موت البادرات وعفن الساق على البادرات فى الصوبه والنباتات بالحقل. ولقد تمت زراعة البذور المعاملة فى الحقل فى موسمى ٢٠٠٤ ــ ٢٠٠٥ و ٢٠٠٥ ــ ٢٠٠٦ وتم تقدير بعض صفات النمو الخضرية والمحصولية وكذلك محتوى البذور من البروتين والنيتروجين والفوسفور والبوتاسيوم لاربعة أصناف من الحمص وهى: جيزة١، جيزة ٢، جيزة١٩٥، جيزة٥٣١

كانت النتائج كمايلى:

١- خفضت معاملتى زيت النيم (جميع التركيزات) وحمض السالسيلك (التركيز ٧,٥ ملليمول) النمو الفطرى وكذلك عدد الاسكليروشيات فى المعمل بينما لم يكن لباقى المعاملات أى تأثير فى هذا المجال.

٢- أدى نقع البذور فى اى من هذه المعاملات وزراعتها فى تربة ملوثة صناعيا بالفطر الى خفض معنوى للنسبه المئوية لمرض موت البادرات قبل ظهورها أو بعد ظهورها فوق سطح التربة

كما أدى الى زيادة النسبة المئوية للنباتات الحية المتبقية ماعدا المعاملة بالاثيفون ولقد تفوقت المعاملات سلفات الكوبلت (١ملليجرام/لتر)، حمض السالسيلك(٧,٥ ملليمول)، زيت النيم (٥ مل/لتر) ، فوسفات ثنائية البوتاسيوم (٥ملليمول)ثم حمض الاسكوربيك (١٠ ملليمول/لتر) على الاصناف جيزة٥٣١، جيزة١٩٥ بينما ادت المعاملة بالاثيفون الى تقليل من نسبة النباتات الحية المتبقية.

٣- وفى تجربة حقلية تم اختبار اربعة اصناف من الحمص وهى: جيزة١، جيزة٢، جيزة١٩٥ ، جيزة٥٣١ وأظهرت المعاملة بزيت النيم (٥مل/لتر) يليها المعاملة بفوسفات ثنائية البوتاسيوم ثم سلفات الكوبلت تفوقاواضحا فى خفض نسبة الاصابة. كذلك أظهر الصنف جيزة٢ حساسية عالية للمرض بينما كان الصنف جيزة٥٣١ اقل الاصناف قابلية للاصابة بالمرض.

٤- كانت المعاملة بفوسفات ثنائية البوتاسيوم من أفضل المعاملات فى زيادة عدد الافرع خلال سنوات التجربة كما انتجت اعلى محصول بذرة للنبات فى جميع الاصناف وأعلى زيادة فى عدد الكبسولات للنبات ، محصول البذرة للفدان ، زيادة الوزن الجاف للنبات. ولقد كانت المعاملة بزيت النيم من ثانى أفضل المعاملات فى زيادة عدد الكبسولات ومحصول البذرة للفدان.

٥- حقق صنف جيزة١ أعلى قيمة فى محصول البذرة/فدان فى السنة الاولى، وصنف جيزة ١٩٥ فى السنة الثانية.

٦- حقق صنف جيزة ١٩٥ أعلى قيمة فى نسبة البروتين فى السنة الاولى بينما صنف جيزة١ وجيزة ٥٣١ فى السنة الثانية.

٧- حقق صنف جيزة١ أعلى قيمة فى محتوى الفوسفور والبوتاسيوم فى موسمى الزراعة.

٨- سجل الصنف جيزة١ وكذلك صنف جيزة ١٩٥ أعلى قيمة فى محتوى البروتين، البوتاسيوم والفوسفور فى البذور نتيجة معاملة البذور بكل من فوسفات البوتاسيوم وزيت النيم عن بقية المعاملات بينما كان محتوى هذه المواد أقل ما يمكن فى الصنف جيزة٢.

٩- سجل الصنف جيزة ١ وكذلك جيزة ١٩٥ أعلى قيمة فى محصول البذرة/فدان ومحتوى النيتروجين والفوسفور والبوتاسيوم فى البذرة.

Table (6): Effect of seed soaking of four chickpea cultivars in each of chemical inducers and neem oil on plant height and number of tillers/plant under naturally infection by *S.sclerotiorum* in field ,at 120 days after planting in 2004/2005& 2005/2006 seasons.

Treatments	Plant height (cm)										No. of tillers/plant									
	1st season					2nd season					1st season					2nd season				
	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean
Cobalt sulfate (1mg L^{-1})	49.0	56.3	55.7	47.7	52.17	64.87	67.97	64.03	66.93	65.95	1.57	1.40	1.67	1.67	1.58	1.53	1.33	1.80	1.60	1.57
Salicylic acid (7.5mM)	45.3	59.0	53.0	56.3	53.42	56.63	52.1	55.83	63.47	57.01	1.67	1.57	1.60	1.43	1.57	1.83	1.40	1.63	1.77	1.66
Ethephone (300 mg L^{-1})	37.3	47.7	42.7	34.7	40.67	48.03	49.87	44.97	51.87	48.68	1.87	2.13	1.80	1.90	1.93	1.70	2.00	1.37	1.53	1.65
Neem oil (5 ml L^{-1})	50.0	60.3	54.3	52.0	54.17	54.07	66.33	56.67	64.40	60.37	1.70	1.50	1.73	1.73	1.67	1.80	1.40	1.53	1.80	1.63
K_2HPO_4 (5 mM)	46.0	49.7	53.0	58.0	51.67	72.20	66.87	67.00	61.87	66.98	2.00	1.90	1.83	1.83	1.89	1.77	1.90	1.67	1.60	1.73
Ascorbic acid (10 mM)	54.7	59.3	51.0	59.0	56.00	61.53	68.30	66.20	66.87	65.73	1.73	2.23	1.63	1.53	1.78	1.53	2.13	1.40	1.93	1.75
Control (tap water)	55.7	67.3	54.7	55.3	58.25	61.0	64.8	55.27	67.10	62.04	1.23	1.70	1.20	1.30	1.36	1.20	1.20	1.33	1.47	1.30
Mean	48.3	57.1	52.05	51.86	-	59.76	62.32	58.57	63.21	-	1.68	1.78	1.64	1.63	-	1.62	1.62	1.53	1.67	-
L.S.D. at 5%for:																				
Treatments (T)			2.65					2.13					0.17					0.17		
Cultivar(C)			3.72					3.09					N.S.					N.S.		
C x T			5.24					4.26					0.35					0.35		

Table (7): Effect of seed soaking of four chickpea cultivars in each of chemical inducers and neem oil weight of 100 seeds (g) and dry weight of plant (g) under naturally infection by *S.sclerotiorum* in field, at harvest in 2004/2005& 2005/2006 seasons.

Treatments	weight of 100 seeds (g)										Dry weight /plant (g)									
	1st season					2nd season					1st season					2nd season				
	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean
Cobalt sulfate (1 mg L^{-1})	24.07	20.60	21.70	22.63	22.25	27.77	21.83	22.63	23.33	23.89	30.03	25.67	33.00	22.10	27.70	34.27	24.20	37.40	23.77	29.91
Salicylic acid (7.5mM)	26.77	19.27	21.37	23.87	22.82	28.17	20.47	21.80	24.73	23.79	31.70	23.00	26.60	23.33	26.16	35.60	24.97	25.53	25.93	28.01
Ethephone (300 mgL^{-1})	26.00	18.83	18.13	21.13	21.02	25.43	18.33	18.37	20.83	20.74	17.30	13.60	12.60	14.27	14.44	17.47	16.40	11.60	14.83	15.08
Neem oil (5 ml L^{-1})	26.13	22.60	23.27	22.83	23.71	27.37	23.93	23.90	24.87	25.02	24.60	25.30	19.60	30.00	24.88	26.10	23.33	21.30	28.23	24.74
K_2HPO_4 (5 mM)	27.63	20.60	21.60	23.30	23.28	28.47	20.90	21.87	23.37	23.65	24.30	25.00	38.60	26.00	28.48	22.30	28.07	35.47	24.73	27.64
Ascorbic acid (10 mM)	23.70	24.60	21.70	16.90	21.73	25.50	23.67	22.53	25.00	24.18	26.33	27.60	22.30	28.60	26.21	26.17	28.93	25.67	34.53	28.83
Control (tap water)	22.20	21.33	20.90	15.60	20.01	23.23	22.03	21.23	22.53	22.26	22.00	18.30	22.30	18.60	20.30	20.77	20.03	24.07	17.57	20.61
Mean	25.21	21.11	21.24	20.90	--	26.56	21.60	21.76	23.52	--	25.18	22.64	25.00	23.27	--	26.10	23.70	25.86	24.23	--
L.S.D. at 5% for:																				
Treatments (T)			N.S.					1.15					1.49					2.14		
Cultivar(C)			N.S.					0.84					0.70					1.27		
C x T			N.S.					2.30					2.98					4.27		

Table (8): Effect of seed soaking of four chickpea cultivars in each of chemical inducers and neem oi on seeds weight/ plant (g) and number of capsules/plant under naturally infection by *S.sclerotiorum* in field, at harvest in 2004/2005& 2005/2006 seasons.

Treatments	Seeds weight /plant (g)										No. of capsules/plant									
	1st season					2nd season					1st season					2nd season				
	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean
Cobalt sulfate (1 mg L^{-1})	22.30	21.67	26.93	24.93	23.96	23.90	23.50	26.90	26.80	25.28	93.67	104.67	128.00	122.67	112.25	91.67	103.0	120.3	114.67	107.41
Salicylicacid (7.5mM)	23.80	24.90	27.47	22.47	24.66	26.60	22.40	25.47	23.90	24.59	98.00	108.33	133.00	128.00	116.83	94.67	108.67	130.0	127.0	115.09
Ethephone (300 mg L^{-1})	20.70	15.83	12.27	17.93	16.68	14.47	15.90	11.70	19.97	15.51	68.00	80.00	61.33	101.00	77.58	62.67	76.67	58.3	93.0	72.66
Neem oil (5 ml L^{-1})	28.83	23.10	28.20	22.43	25.64	30.27	23.60	30.60	27.80	28.07	125.67	128.67	139.00	143.00	134.09	120.67	124.0	132.0	137.7	128.59
K_2HPO_4 (5 mM)	33.30	28.20	31.57	26.03	29.78	30.87	24.07	33.20	30.60	29.69	136.67	138.33	146.00	147.00	142.00	127.67	134.3	141.3	144.3	136.89
Ascorbic acid (10 mM)	27.73	20.97	22.30	23.27	23.57	33.33	21.30	24.13	25.60	26.09	107.33	116.67	123.00	131.00	119.50	102.67	96.69	120.3	128.0	111.91
Control (tap water)	21.53	19.50	21.47	22.00	21.13	23.40	18.50	22.60	22.80	21.83	90.33	93.67	120.00	118.00	105.50	88.67	89.3	114.0	119.0	102.74
Mean	25.46	22.02	24.32	22.72		26.12	21.32	24.94	25.35	-	102.81	110.05	121.48	127.24	--	98.38	104.66	1116.62	123.38	-
L.S.D. at 5% for:																				
Treatments (T)			2.62					2.43					5.10					4.13		
Cultivar(C)			1.79					1.47					3.88					2.70		
C x T			5.23					4.87					1019					8.26		

Table (9): Effect of seed soaking of four chickpea cultivars in each of chemical inducers and neem oil on seeds yield (kg/fed.) under naturally infection by *S.sclerotiorum* in field conditions at harvest in 2004/2005& 2005/2006 seasons.

Treatments	Seeds yield (kg/feddan)									
	1st season					2nd season				
	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean
Cobalt sulfate (1 mg L^{-1})	744.7	815.7	884.0	776.7	805.3	842.0	905.33	1045.33	890.67	920.83
Salicylic acid (7.5mM)	872.3	689.3	758.0	691.3	752.7	989.33	759.67	855.33	803.00	851.83
Ethephone (300 mgL^{-1})	373.7	376.3	364.0	466.0	395.0	330.33	368.00	315.37	507.00	380.17
Neem oil (5 ml L^{-1})	1104.7	839.3	996.7	925.0	996.4	1098.33	952.0	1229.67	1100.00	1095.00
K_2HPO_4 (5 mM)	1280.3	1012.3	1290.0	1163.3	1186.5	1502.67	1221.0	1439.67	1263.00	1356.58
Ascorbic acid (10 mM)	828.7	725.0	750.0	703.3	751.8	841.67	810.33	837.67	820.66	827.58
Control (tap water)	719.70	585.0	766.3	671.7	685.7	815.67	575.67	742.00	787.33	730.17
Mean	846.3	720.4	829.66	771.0	--	917.14	798.86	923.57	881.67	--
L.S.D. at 5%:for:										
Treatments (T)			47.71					71.20		
Cultivar(C)			41.88					N.S.		
C x T			95.41					142.47		

Table (10): Effect of seed soaking of four chickpea cultivars in each of chemical inducers and neem oil on removal N and protein content (kg/fed.) under naturally infection by *S.sclerotiorum* in field ,at harvest in 2004/2005 & 2005/2006 seasons.

Treatments	N (kg/fed.)										Protein (kg/fed.)									
	1st season					2nd season					1st season					2nd season				
	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean
Cobalt sulfate (1 mg L^{-1})	31.28	39.15	38.90	34.95	36.1	35.26	43.46	46.00	40.08	41.20	195.85	244.70	243.98	216.69	225.3	220.61	272.51	258.2	250.28	250.4
Salicylic acid (7.5mM)	40.13	31.71	36.38	33.88	35.5	46.18	34.95	41.06	39.35	40.38	251.23	199.22	227.4	209.47	221.8	282.95	220.30	255.8	244.92	250.98
Ethephone (300 mgL^{-1})	15.32	12.80	16.02	19.57	15.9	14.54	12.52	13.88	21.29	15.55	103.13	79.03	100.46	122.56	101.3	90.18	78.02	86.72	133.34	97.06
Neem oil (5 ml L^{-1})	54.13	38.61	46.84	45.33	46.2	53.82	43.79	57.79	53.90	52.33	338.03	242.57	293.02	283.05	289.2	336.09	275.13	361.5	336.6	327.34
K_2HPO_4 (5 mM)	61.46	42.52	58.05	54.68	54.2	72.13	51.28	64.79	60.62	62.20	384.10	266.24	362.49	342.02	338.7	452.30	322.34	407.4	242.92	389.61
Ascorbic acid (10 mM)	28.17	30.45	34.50	33.76	31.72	33.67	34.03	38.53	38.57	36.20	206.32	190.68	215.63	208.89	318.0	211.26	213.93	242.09	242.92	227.55
Control (tap water)	31.67	22.23	32.19	30.90	29.30	35.89	22.00	31.16	37.01	31.52	198.63	138.06	201.55	194.11	183.1	223.49	137.8	193.6	229.11	196.02
Mean	37.45	31.07	37.55	37.15	--	41.64	34.58	41.89	41.55	--	239.61	194.36	234.93	225.26	--	259.55	217.15	257.82	259.08	--
L.S.D. at 5%for:																				
Treatments (T)			2.14					3.34					14.00					20.83		
Cultivar(C)			1.91					3.34					14.32					20.56		
C x T			4.28					6.68					28.65					41.65		

Table (11): Effect of seed soaking of four chickpea cultivars seeds in each of chemical inducers and neem oil on removal P and K (kg/fed.) under naturally infection by *S.sclerotiorum* in field , at harvest in 2004/2005& 2005/2006 seasons

Treatments	P (kg/fed)										K (kg/fed)									
	1st season					2nd season					1st season					2nd season				
	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean	G1	G2	G195	G 531	Mean
Cobalt sulfate (1 mg L^{-1})	2.89	3.83	4.15	3.01	3.47	3.28	4.30	5.02	3.48	4.02	11.63	10.28	11.67	12.59	11.54	14.40	12.09	14.12	14.33	13.73
Salicylic acid (7.5mM)	3.82	3.47	2.84	3.03	3.29	4.32	3.88	3.26	3.40	3.71	13.61	10.34	10.46	9.96	11.09	16.92	11.97	12.20	11.81	13.22
Ethephone (300 mg L^{-1})	1.40	1.77	1.83	1.74	1.69	1.24	1.74	1.60	1.92	1.62	5.39	6.09	7.83	6.71	6.50	5.25	6.24	5.45	7.08	6.00
Neem oil (5 ml L^{-1})	4.84	3.94	4.68	4.26	4.43	4.86	4.52	5.80	5.14	5.08	17.67	11.09	13.76	12.50	13.64	18.78	13.28	17.90	15.64	16.41
K_2HPO_4 (5 mM)	5.61	3.92	5.01	4.70	4.81	6.64	4.76	5.64	5.08	5.53	17.67	14.58	17.81	17.45	16.88	23.00	18.49	21.12	20.09	20.69
Ascorbic acid (10 mM)	3.89	3.93	3.14	2.63	3.16	3.92	3.38	3.52	3.04	3.46	11.94	10.44	10.35	10.98	10.93	13.38	12.27	12.44	12.68	12.75
Control (tap water)	2.61	2.12	2.47	2.51	2.43	2.98	2.14	2.42	2.92	2.61	12.53	7.73	8.04	9.27	9.39	15.42	8.25	8.46	11.34	10.86
Mean	3.58	3.15	3.45	3.13	--	3.89	3.53	3.89	3.57	--	12.86	10.08	11.42	11.35	--	15.31	11.79	13.10	13.28	--
L.S.D. at 5%for:																				
Treatments (T)			0.15					1.58					0.84					0.68		
Cultivar(C)			0.14					1.16					0.51					0.84		
C x T			0.30					3.14					0.87					1.62		

Table (5): Effect of seed soaking of four chickpea cultivars in each of chemical inducers and neem oil on white stem rot disease incidenc (%) under naturally infection by *S.sclerotiorum* in field, at 90 and 120 days of planting in 2004/2005& 2005/2006 seasons.

Treatments	Mean % of rot stem disease incidence(1st season)											
	Giza 1			Giza 2			Giza 195			Giza 531		
	90 days	120 days	Mean	90 days	120 days	Mean	90 days	120 days	Mean	90 days	120 days	Mean
Cobalt sulfate(1mg L^{-1})	6.2	7.9	7.05	6.1	8.2	7.15	5.8	7.9	6.85	5.3	6.8	6.05
Salicylic acid (7.5mM)	6.9	7.9	7.40	7.3	9.2	8.25	5.4	7.6	6.50	5.4	6.9	6.15
Ethephone (300 mg L^{-1})	8.5	12.7	10.60	8.4	13.5	10.95	8.1	12.8	10.45	6.8	9.8	8.30
Neem oil (5 ml L^{-1})	5.2	7.1	6.15	5.4	7.4	6.40	5.1	6.4	5.75	5.1	5.9	5.50
K_2HPO_4(5 mM)	3.9	6.7	5.30	4.8	6.8	5.80	3.8	6.3	5.05	3.5	4.7	4.10
Ascorbic acid(10 mM)	7.5	8.2	7.85	7.7	9.4	8.55	4.8	7.5	6.12	5.0	7.8	6.40
Control	9.1	13.9	11.50	9.5	15.7	12.60	8.8	12.9	10.85	7.6	9.7	8.65
Mean	6.76	9.2	-	7.03	10.03	--	5.97	8.77	--	5.53	7.37	--
L.S.D. at 5%for:												
Treatments (T)		1.48			1.36			1.34			0.96	
Period(P)		1.10			1.48			1.33			0.95	
P x T		2.10			1.93			N.S.			N.S.	

Treatments	Mean % of rot stem disease incidence (2nd season)											
	Giza 1			Giza 2			Giza 195			Giza 531		
	90 days	120 days	Mean	90 days	120 days	Mean	90 days	120 days	Mean	90 days	120 days	Mean
Cobalt sulfate(1mg L^{-1})	5.9	7.5	6.70	6.2	9.2	7.70	5.3	7.5	6.40	5.0	5.8	5.40
Salicylic acid (7.5mM)	6.5	9.1	7.80	7.2	10.7	8.95	6.1	8.9	7.50	5.8	6.3	6.05
Ethephone (300 mgL^{-1})	9.1	12.7	10.65	11.2	15.7	13.45	9.2	10.1	9.65	7.3	9.4	8.35
Neem oil (5 ml L^{-1})	7.3	8.6	7.95	7.5	12.7	10.10	7.2	9.4	8.30	6.2	6.8	6.50
K_2HPO_4(5 mM)	6.3	8.7	7.50	7.7	11.2	9.45	6.5	8.1	7.30	5.3	5.8	5.55
Ascorbic acid(10 mM)	8.2	10.6	9.40	9.9	14.1	12.00	7.2	8.8	8.00	6.9	7.3	7.10
Control	10.9	15.7	13.30	12.1	17.3	14.70	9.8	12.4	11.10	8.4	10.6	9.50
Mean	7.74	10.41	--	8.83	12.99	--	7.33	9.31	--	6.41	7.43	--
L.S.D. at 5% for:												
Treatments (T)		1.59			1.63			1.36			0.78	
Period (P)		1.26			0.60			1.42			0.53	
P x T		N.S.			N.S.			N.S.			N.S.	

Table (4): Effect of seed soaking of four chickpea cultivars in each of chemical inducers and neem oil on pre--emergence damping-off incidence and survival plants (%) under artificially infection by *S. sclerotiorum* in greenhouse experiment.

Treatment	Concentration	Giza 1			Giza 2			Giza 195			Giza 531		
		Pre- %	Post - %	Survivals %	Pre- %	Post- %	Survivals %	Pre- %	Post- %	Survivals %	Pre- %	Post- %	Survivals %
Cobalt sulfate	0.5 mgL^{-1}	30	15	55	40	15	45	20	15	65	20	15	65
	1.0 mgL^{-1}	20	10	70	15	15	70	10	15	75	10	10	80
	2.0 mgL^{-1}	20	20	60	25	10	65	15	20	65	20	20	60
Salicylic acid	2.5mM	30	20	50	35	15	50	20	25	55	25	25	50
	5.0mM	15	20	65	25	10	65	15	20	65	15	20	65
	7.5mM	15	15	70	20	10	70	20	10	70	20	5	75
Ethephone	100 mgL^{-1}	35	25	40	40	25	35	30	20	50	30	30	40
	200 mgL^{-1}	35	30	35	30	30	40	35	25	40	30	20	50
	300 mgL^{-1}	35	25	40	40	15	45	30	25	45	30	20	50
Neem oil	2.5 ml L^{-1}	20	15	65	25	15	60	25	20	55	15	25	60
	5.0 ml L^{-1}	15	15	70	15	15	70	10	15	75	20	5	75
	7.5 ml L^{-1}	25	15	60	25	20	55	25	20	55	20	25	55
K_2HPO_4	5.0mM	30	10	70	20	10	70	15	15	70	15	10	75
	7.5mM	30	20	50	35	15	50	25	25	50	25	15	60
	10.0mM	25	10	65	25	25	50	30	10	60	25	25	50
Ascorbic acid	5.0 mM	30	15	55	40	20	40	20	25	55	25	20	55
	7.5 mM	30	5	65	25	20	55	20	20	60	25	20	55
	10.0 mM	20	10	70	20	10	70	15	15	70	15	15	70
Control		30	25	45	40	30	30	25	25	50	20	10	70
L.S.D. for:													
Treatment (T)			N.S.			N.S.			N.S.			N.S.	
Period (P)			1.53			2.12			1.82			1.56	
T xP			4.05			5.61			4.81			4.12	
Concentration (C)			N.S.			N.S.			N.S.			N.S.	
P x C			2.65			3.67			3.15			2.69	
T x C			N.S.			N.S.			N.S.			N.S.	
T x P x C			7.02			9.71			8.34			7.13	