J. Agric. Sci. Mansoura Univ., 30 (5): 2853 - 2863, 2005

EFFECT OF CERTAIN MINERAL SALTS, ORGANIC ACIDS, AMINO ACIDS AND GROWTH REGULATORS ON REPRODUCTION OF *Meloidogyne javanica* INFECTING SUNFLOWER

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ABSTRACT

Effect of Na_2HPO_4, NaH_2PO_4, K_2HPO_4 and KH_2PO_4, ascorbic, salicylic and citric, lysine and thiamin, indol acetic acid, giberllin, and pix, was tested on juvenile(j_2) mortality and reproduction of *M. javanica* and the growth of sunflower in vitro and greenhouse. In vitro, 1,250, 2,500 and 5,000 ppm, of those compounds and Rugby, a nematicide, showed a positive correlation between concentration and juvenile mortality. Rugby was the superior with 100% juvenile mortality, followed by citric acid, 92.7%, then ascorbic acid, 78.9%, and pix, 70.5%, while Na_2HPO_4 and NaH_2PO_4 gave, 21.2 and 22.6%,j_2 mortality respectively, at 5,000 ppm.

In greenhouse test, higher shoot dry weights were obtained from the treated than the non-treated plants with the highest shoot weight from plants treated with indol acetic acid, 16.67 gm, and the lowest, 10.0 gm, and 6.0 gm, Na_2HPO_4 and the control treatments, respectively. At 1,000 ppm the highest shoot dry weight, 19.33 gm, from plants treated with indol acetic acid or gibberllin and the lowest, 8.67 gm, was detected with thiamine treated plants. Root dry weights from most treatments did not differ, significantly, than that from the non-treated plants with highest, 8.0 gm, from indol acetic acid at 1,000 ppm and the lowest, 4.0 gm, from lysine at 1,000 ppm or salicylic acid at 2,000 ppm.. Root weights of the control plants ranged from 4 to 5.67 gm

Most treatments reduced reproduction of *M.javanica*, where the lowest reproductive factor, Rf = 0, was found with K_2HPO_4, KH_2PO_4, citric acid, gibberellin or pix treated plants at 1,000 or 2,000 ppm, while ascorbic acid gave a zero Rf at 2,000 but not at 1,000 ppm. The highest Rf values were from plants treated with thiamine, 1.98, or ascorbic acid, 1.88, at 1,000 ppm, and it was 1.69 from thiamine at 2,000 ppm. The Rf values from the non-treated plants ranged from 1.94 and 1.78.

Regarding to chemical analyses a positive relationship between concentration of the used chemicals and amounts of sugar and phenolic, but not amino acid contents was observed. Amounts of total sugars ranged from 0.579 to 4.04 mg/gm while amounts of reducing sugars were from 0.229 to 1.246 mg/gmThe highest amount of total phenols, 18.635 mg/gm was found in plants treated with KH_2PO_4 at 1,000 ppm while the lowest, 6.63 mg/gm was from plants treated with NaH_2PO_4 at the same concentration. Amounts of the total amino acids ranged from 0.008 to 0.386 mg/gm from plants treated with KH_2PO_4 at 2,000 ppm or pix at 1,000 ppm, respectively.

Keywords: Mineral salts, organic acids, amino acids, growth regulators, *Meloidogyne javanica*, sunflower.

INTRODUCTION

Sunflower is an important oil crop in Egypt where its cultivation is encouraged to overcome the shortage of oil production. Egypt's total cultivated area of sunflower reached 32,367 feddan (feddan = 4,200 m^2) in 2004 concentrated in El-Behira, Beni-Suef, Fayoym, Minia and Assiut

governorates. Sunflower is a subject to infection by several pathogens that attack almost all the parts of the plant, from roots to the flower. Nematode problems were reported frequently on sunflower and some of those problems were caused by root-knot nematodes, *Meloidogyne* spp and reniform nematode, *Rotylenchulus reniformis* (Khalil *et al.* 2004).

Crop rotation, nematicides and developing nematode-resistant cultivars are recommended strategies to control nematode problems (Rodriguez-Kabana *et al.* 1992). Unfortunately, these strategies are faced with some constrains that oppose their complete application. Those constrains motivated investigators to find applicable alternative strategies for controlling nematode problems. These strategies include the use of plant extracts and debris as soil and plant amendments (Nagesh *et al.*1997). Also, some growth regulators and resistance inducers were evaluated against some genera of plant parasitic nematodes (Osman *et al.* 1984 and Nandi *et al.* 2000).

Some of these substances showed high efficiency in controlling nematodes, for examples plant debris reduced the reproduction of *R. reniformis* by 82.91- 86.76% compared to the non-treated control (Khalil *et al.* 2004). Another example was the positive effect of the growth regulator cycocel in reducing the reproduction of *Tylenchorhynchus microdorus* and enhancing the growth and oil content of flax (Osman *et al.* 1984). Moreover, some amino acids reduced the reproduction of *M. incognita* when they were used in treating, seeds or seedlings of soybean. Also, promising results were obtained when some amino acids were used with soybean against *M. incognita* (Osman and Viglierchio 1981).

Several other investigations focused on the use of some compounds such as salicylic acid and some salts as inducers of resistance against nematodes. Salicylic and jasmonic acids were effective against *M. incognita* in tomato when they were used as soil drench and/or spraying the plants (Mahgoob and Zaghlool 2002).

The objective of the present investigation was to evaluate the effect of some mineral salts, organic acids, amino acids and growth regulators on reproduction of *M. javanica* on sunflower. Moreover, the growth of sunflower and some chemical contents in the healthy and infected plants were also determined .

MATERIALS AND METHODS

Effect of some mineral salts, organic acids, amino acids and growth regulators, as the used chemicals, was tested on the mortality of *M. javanica* in vitro and on its reproduction, and the growth parameters of sunflower under greenhouse conditions. The used chemicals were as follows: Mineral salts: disodium hydrogen orthrophosphate (Na_2HPO_4), sodium dihydrogen orthrophosphate (NaH_2PO_4), dipotassium hydrogen orthrophosphate (K_2HPO_4) and potassium dihydrogen orthrophosphate(KH_2PO_4),

Organic acids: ascorbic, salicylic and citric, Amino acids: lysine and thiamin, and Growth regulators: indol acetic acid, gibberellin, and pix. Also,Rugby was used as a recommended nematicide.

Effect of the used chemicals on the mortality of the second stage juveniles (j_2)of *M. javanica in vitro*:

Certain amounts from each of the used chemicals were weighted to create the concentrations of 1,250, 2,500 and 5,000ppm of each of the used chemicals when added to five ml of double distilled water. The weight for each concentration was added in eight-ml sterilized glass bottles containing 500 second stage juveniles of *M. javanica* in five ml double distilled water. Each treatment was replicated four times and four non-treated bottles, containing five ml distilled water and 500 second stage juveniles, served as control.

After 48 hours one hundred juveniles was examined using a research microscope where the number of dead or alive juveniles was counted. Percentage of juvenile mortality was calculated as follows: number of dead juveniles divided by the total number of examined juveniles (=100 juveniles) x 100.

Effect of soaking sunflower seed in the used chemicals on reproduction of *M. javanica* and growth of sunflower in greenhouse:

Seeds of sunflower hybrid. aroflower were soaked for five hours in 1,000 or 2,000 ppm of Na_2HPO_4, NaH_2PO_4, K_2HPO_4, KH_2PO_4, ascorbic acid, salicylic acid, citric acid, indol acetic acid, gibberellin, and pix, lysine or thiamine. Also, Rugby as a recommended nematicide was used as a separate treatment using the aforementioned concentrations and period of seed soaking. Each treatment was replicated three times with three pots planted with seeds soaked in water to serve as control. Each plastic pot, 20-cm-diam., was filled with autoclaved sandy loam soil, about 2kg, and planted with five seeds of sunflower, hybrid aroflower, thinned to three after germination. Each pot was infested with 1,500 second-stage juveniles. Pots were randomly arranged on a greenhouse bench at 25±2°c, and watered as needed. Forty-five days after soil infestation, the experiment was terminated and dry root and shoot weights, number of galls per root system and total count of nematodes per pot were recorded for each treatment. Also, the reproductive factor (Rf) which is the result of dividing the final count of nematode by the initial number used in soil infestation. Data were statistically analyzed using the L.S.D technique.

Chemical analyses:

Preparation of root extracts:

A representative samples each of one gram were obtained from fresh roots of all treatments at the end of the experiment. Such samples were cut into small pieces and immediately plunged into 95% boiling ethanol for 10 minutes to kill the tissues. The extraction was then resumed in a soxhelt apparatus using 75% ethyl alcohol as an extractant until the perolate was colorless, (about 8-10 hrs). Alcoholic extractions were filtrated and evaporated to near dryness on mild water bath, 60°C. the dried residue was re-dissolved in 5 ml of 50% isopropanol. These extracts were then used for determination of sugars, phenols and amino acids contents as follows:

Determination of sugars:

Total and reducing sugars were determined spectrophotometerically by picric acid method described by Thomas and Dutcher (1924). The sugar contents were calculated as mg glucose/ gm fresh weight of roots. Values were obtained from a standard curve prepared for glucose. The color density was recorded by using spectrophotometer in the presence of a blank at wave length of 540 nm.

Determination of phenolic compounds:

Phenolic compounds were determined using the colorimetric method of Folin-Denis reagent described by Snell and Snell (1953). The color intensity was recorded using spectrophotometer in the presence of a blank (containing all reagents without the extracts) at the wave length of 560 nm. The concentrations of free and total phenols were calculated as mg caticol/gm fresh weigh. Values were obtained from standard curve constructed for caticol in an identical way.

Determination of amino acids:

The total free amino acids were determined as mg leucine/gm fresh weight by modified colorimetric ninhydrin method that was used by Rason (1959). The color density was immediately recorded using spectrophotometer in the presence of a blank at the wavelength 570 nm. Values were obtained from standard curve prepared for leucine.

RESULTS

In vitro, concentrations of 1,250, 2,500 and 5,000ppm of each of the used chemicals were tested for their effect on juvenile mortality of *M. javanica*. Data show that all the tested chemicals increased the mortality percentage at all concentrations, compared to the non-treated control. Also, a positive relationship between the concentration and juvenile mortality percentage was observed for all compounds (Table1).The nematicide Rugby, at recommended dose, showed a perfect effect as with a 100% of juvenile mortality at the tested concentrations. Among the used chemicals, citric acid was the most effective that giving 92.7% juvenile mortality then ascorbic acid, 78.9%, and pix, 70.5%, while Na_2HPO_4 and NaH_2PO_4 were the least effective, with values of 21.2 and 22.6%, respectively, (Table1). At concentration of 2,500 ppm, ascorbic acid was the most effective, 61.3%, followed by citric acid, 53.2%, while thiamine, 11.1%, K_2HPO_4, 11.4%, and lysine, 11.6%, were the least.

When the least concentration, 1,250 ppm, was used, the highest percentage of juvenile mortality was obtained with citric acid, 33.4%, ascorbic acid, 32.2%, and pix, 32.1%, while the lowest values were detected with thiamine, 5.2%, and K_2HPO_4, 7.2%, (Table 1). The juvenile mortality was 100% for rugby and 2.4, 1.9 and 2.2% for the non-treated control at 1,250, 2,500, and 5,000ppm, respectively, (Table 1).

Table 1: Effect of certain mineral salts, organic acids, amino acids and growth regulators on the mortality of the second stage juveniles of *M. javanica*.

Treatment	Juvenile mortality (%)		
	1,250 ppm	2,500 ppm	5,000 ppm
Na_2HPO_4	10.4	16.3	21.2
NaH_2PO_4	8.4	12.3	22.6
K_2HPO_4	7.2	11.4	23.5
KH_2PO_4	9.4	13.5	25.6
Ascorbic acid	32.2	61.3	78.9
Salicylic acid	31.6	43.5	68.4
Citric acid	33.4	53.2	92.7
Lysine	8.4	11.6	25.8
Thiamine	5.2	11.1	16.3
Indol acetic acid	21.5	31.4	56.8
gibberellin	25.3	42.6	61.2
Pix	32.1	45.4	70.5
Rugby	100	100	100
Non-treated (control)	2.2	1.9	2.4
LSD 0.05	1.32	0.35	0.76

In greenhouse, all the tested chemicals increased shoot weights compared to the non-treated control at the same concentrations of 1,000 and 2,000 ppm. At 1,000 ppm concentration, the highest shoot weights were detected with gibberellin treated plants, 19.33gm, indol acetic acid, 19.33 gm, or pix, 17 gm, and the lowest onces were found with thiamine treated plants, 8.67 gm, Na_2HPO_4, 9 gm, or salicylic acid, 9 gm, while it was 5 gm. in the non-treated plants (Table. 2). When the 2,000 ppm concentration was used, some treatments gave higher shoot weights and some other treatments gave lower shoot weights compared to 1,000 ppm showing indefinite trend regarding to the effect of concentration of the used treatments on the shoot weights (Tables. 2 and 3). The highest shoot weights were found with indol acetic acid treated plants, 16.67 gm, citric acid, 15.67 gm, and gibberellin or pix, 15.33 gm, while the lowest shoot weights 10.0, 11.0 and 11.33 gm were from plants treated with Na_2HPO_4, thiamine and Rugby, respectively, (Table. 3). The shoot weight of the non-treated plants was 6.0 gm (Table. 3).

Regarding to root weights, data show that most treatments did not differ significantly on their effect on root weigh compared to the non-treated plants (Tables 2 and 3). The highest root weights were from plants treated with indol acetic acid, 8.0gm and pix, 7.33 gm when they were used at 1,000 ppm, while it was from plants treated with indol acetic acid, 7.33 gm at 2,000 ppm (Tables 2 and 3). The lowest root weight was 4.0 gm from plants treated with lysine at 1,000 ppm or salicylic acid at 2,000 ppm, while the root weights of the non-treated plants 4 and 5.67 gm for 1,000 and 2,000 ppm, respectively, (Tables 2 and 3).

The numbers of root galls varied significantly among the used treatments showing a clear negative correlation between the numbers of galls and the concentration of the used chemicals (Tables 2 and 3). The most

effective treatments were K_2HPO_4, KH_2PO_4 and citric acid as the treated plants showed no galling at 1,000 or 2,000 ppm, while the plants that treated with gibberellin or pix showed no galling at 2,000 ppm and 3.33 and 2.33, respectively, when used at 1,000 ppm (Tables 2 and 3). The highest numbers of galls were in the care of plants treated with thiamine, 246.33, and ascorbic acid, 244.0 at 1,000 ppm, while they were on planted treated with thiamine, 43.67, and NaH_2PO_4, 33.33, at 2,000 ppm (Tables 2 and 3). The numbers of galls from plants treated with the nematicide Rugby were 28.33 and 11.33 when it was used at 1,000 and 2,000 ppm, respectively, while they were 211.0 and 171.0 at 1,000 and 2,000 ppm, respectively, (Tables 2 and 3).

Table 2: Effect of certain mineral salts, organic acids, amino acids and growth regulators at 1,000 ppm on the reproduction of *M. javanica* and growth of sunflower

Treatment	Shoot Wt. gm	Root Wt. gm	N. galls per root system	Rf
Na_2HPO_4	9.00	4.33	54.33	0.77
NaH_2PO_4	9.67	4.33	63.67	1.12
K_2HPO_4	11.00	4.33	0.00	0.00
KH_2PO_4	11.67	5.67	0.00	0.00
Ascorbic acid	13.00	5.67	244.00	1.88
Salicylic acid	9.00	4.67	119.00	1.44
Citric acid	16.33	6.00	0.00	0.00
Lysine	10.67	4.00	54.67	0.66
Thiamine	8.67	5.00	246.33	1.98
Indol acetic acid	19.33	8.00	23.33	0.28
Gibberellin	19.33	6.33	3.33	0.00
Pix	17.00	7.33	2.33	0.00
Rugby	15.33	6.00	28.33	0.72
Non-treated (control)	5.00	4.00	211.00	1.94
LSD 0.05	2.22	1.77	87.00	0.44

Reproduction of *M. javanica* was recorded as the reproductive factor which is final nematode count, eggs, juveniles and developmental stages, per pot divided by the initial population (Pf/Pi). Data show that most treatments were effective in reducing reproduction of *M. javanica* on the roots of sunflower with a negative correlation between the used concentrations and the values of Rf. A zero Rf was observed when plants were treated with either of the two concentrations of K_2HPO_4, KH_2PO_4, citric acid, gibberellin and pix, while ascorbic acid gave a zero Rf at 2,000 ppm but not at 1,000 ppm (Tables 2 and 3). The highest Rf values were from plants treated with thiamine, 1.98, and ascorbic acid, 1.88, at 1,000 ppm, while it was from plants treated with thiamine at 2,000 ppm. The Rf values from the non-treated plants were 1.94 and 1.78 at 1,000 and 2,000 ppm, respectively, (Tables 2 and 3).

Table. 3: Effect of certain mineral salts, organic acids, amino acids and growth regulators at 2,000 ppm on the reproduction of *M. javanica* and growth of sunflower

Treatment	Shoot Wt. gm	Root Wt. gm	N. galls per root system	Rf
Na_2HPO_4	10.00	5.33	26.00	0.59
NaH_2PO_4	11.67	5.00	33.33	0.64
K_2HPO_4	11.67	5.67	0.00	0.00
KH_2PO_4	13.67	5.67	0.00	0.00
Ascorbic acid	13.00	5.00	12.67	0.00
Salicylic acid	11.67	4.00	17.00	0.11
Citric acid	15.67	6.00	0.00	0.00
Lysine	13.00	5.33	11.33	0.16
Thiamine	11.00	5.00	43.67	1.69
Indol acetic acid	16.67	7.33	4.00	0.01
Gibberellin	15.33	5.67	0.00	0.00
Pix	15.33	4.67	0.00	0.00
Rugby	11.33	4.33	11.33	0.07
Non-treated (control)	6.00	5.67	171.00	1.78
LSD 0.05	2.61	1.34	27.74	0.24

Effect of the tested chemicals on the phenolic, sugar and total amino acids was determined. Regarding to the sugars content, the obtained data show a positive correlation between the amounts of total or reducing sugars and the concentration of the used compounds (Table 4). Amounts of total sugars ranged from 0.579 mg/gm for plants treated with pix at 1,000 ppm to 4.04 mg/gm for plant treated with citric acid at 2,000 ppm while amounts of reducing sugars were ranged between 0.229 to 1.246 mg/gm for plants treated with KH_2PO_4 at 1000 ppm or K_2HPO_4 at 1,000 ppm, respectively, (Table 4).

Amounts of total phenols increased by increasing the concentration of the used chemicals, except for K_2HPO_4 treatment that showed an opposite trend, while amounts of free phenols did not show certain trend with regard to the concentration of the used compounds. The highest amount of total phenols, 18.635 mg/gm, was found in plants treated with KH_2PO_4 at 1,000 ppm while the lowest, 6.630 mg/gm, was from plants treated with NaH_2PO_4 at the same concentration. Amounts of total phenols in plants treated with the nematicide Rugby were 11.02 and 10.66 mg/gm, when it was used at 1,000 and

2,000 ppm, respectively, while it was 11.67 mg/gm from non-treated plants (Table 4). The highest amount of free phenols, 15.82 mg/gm, was from plants treated with K_2HPO_4 at 1,000 ppm while the lowest, 1.430 mg/gm, was from plants treated with lysine at the same concentration. Also, amounts of free phenols were 8.050 and 8.577 mg/gm when plants were treated with Rugby at 1,000 and 2,000 ppm, respectively, while it was 3.890 mg/gm in the non-treated plants (Table 4).

Table 4: Effect of certain mineral salts, organic acids, amino acids and growth regulators at 1,000 and 2,000 ppm on some chemical components of sunflower, hybrid arflower.

Treatment	Concentration (mg/g)				
	Total sugars	Reducing sugars	Total phenols	Free phenols	Total amino acids
Na_2HPO_4-a	1.483	0.308	12.150	3.020	0.149
Na_2HPO_4-b	2.036	0.415	8.610	4.110	0.068
NaH_2PO_4-a	1.356	0.345	6.630	2.310	0.186
NaH_2PO_4-b	2.123	0.396	8.030	5.220	0.091
K_2HPO_4-a	1.920	1.246	16.480	15.820	0.111
K_2HPO_4-b	2.595	0.317	16.553	12.753	0.055
KH_2PO_4-a	1.206	0.229	18.635	7.920	0.030
KH_2PO_4-b	1.556	0.301	18.267	7.426	0.008
Ascorbic-a	1.492	0.310	14.90	3.140	0.158
Ascorbic-b	2.127	0.405	9.15	3.900	0.075
Salicylic-a	1.429	0.389	9.013	2.520	0.177
Salicylic-b	2.214	0.413	8.756	6.370	0.113
Citric-a	2.401	0.283	10.345	6.230	0.166
Citric-b	4.040	0.365	9.727	9.008	0.071
Lysine-a	2.413	0.444	13.47	1.430	0.072
Lysine-b	2.754	0.579	8.43	2.180	0.052
Thiamine-a	1.587	0.413	10.59	4.946	0.202
Thiamine-b	2.183	0.452	9.87	7.865	0.065
IAA-a	1.770	0.349	10.135	1.900	0.117
IAA-b	2.151	0.405	10.04	7.426	0.037
Gibberellin-a	1.080	0.384	10.927	2.430	0.123
Gibberellin-b	2.031	0.563	10.88	3.934	0.043
Pix-a	0.579	0.333	12.091	8.683	0.386
Pix-b	1.849	0.484	13.243	8.041	0.137
Rugbby-a	0.809	0.00	11.02	8.050	0.435
Rugbby-b	1.833	0.00	10.66	8.577	0.278
Non-treated (control)	1.516	0.325	11.67	3.890	0.007

a: 1,000ppm
b: 2,000ppm

Unlike sugar and total phenols contents, total amino acids amounts were decreased by increasing the concentration of the used compounds (Table 4). The highest amount of total amino acids, 0.386 mg/gm, was determined with pix treated plants at 1,000 ppm while the lowest, 0.008 mg/gm, was in plants treated with KH_2PO_4 at 2,000 ppm (Table 4). Amounts of total amino acids from plants treated with the Rugby were 0.435 and 0.278 mg/gm at 1,000 and 2,000 ppm, respectively, while it was 0.007 mg/gm from the non-treated plants (Table 4).

DISCUSSION

The nematoxic effect of some of the used chemicals was tested under in vitro and greenhouse conditions is an approach for a safe strategy to minimize nematode problems. As a preliminary test, three concentrations of

the used chemicals caused mortality of the second stage juveniles proving different degrees of nematicidal effect in vitro. This result confirms similar results of some of the used chemicals on tomato (Ali, 2004). The positive relationship between the used concentrations and juvenile mortality was an indicator to use those chemicals in greenhouse at higher rates with *M. javanica* than those were used with other nematode genera (Osman *et al.* 1984). This positive relationship could be attributed to the increase of the active ingredient that has the nematoxic effect by increasing the concentration.

In greenhouse experiments, all the used chemicals increased shoot weights while their effect on root weights was fluctuated compared to the non-treated control. The increase of these two growth parameters could be due to that some of the used treatments are growth promoters (gibberellin, indol acetic acid and pix) and others are sources for nutritional elements such as phosphorus, potassium and sodium. Ascorbic, salicylic and citric acids may have direct or indirect role in this respect. Our results disagree with those published by Al-Sayed and Montasser (1986) who reported a negative effect of ascorbic acid on the growth of tomato. This could be due to we used different concentrations and host plants which may respond differently to the used chemicals. On the other hand, root weights from most treatments did not differ significantly than that from the non-treated control. This could be explained as the roots are the infection court of *M. javanica* so that most nutrients were depleted and the used treatment did not find the suitable medium to act properly with plant cells.

Most of the tested chemicals reduced reproduction of the *M. javanica* on sunflower proving their potentiality in controlling this serious pest. This effect against *M. javanica* could be attributed to the role of the used compounds in induction of plant resistance as reported in several studies (Zinovieva *et al.* 1995 and 1998). Since some of the used chemicals are growth regulators they may enhance some metabolic cycles and pathways that cause accumulation of some metabolites that resist pathogenic organisms. Since lysine reduced nematode reproduction while thiamine did not, one may conclude that they have different roles against *M. javanica* although both of them are amino acids. This kind of specification could be due to the difference in their chemical construction that could be responsible for electing resistance against *M. javanica*.

The increase in sugars by increasing the concentration of the used chemicals could be due to enhancing the metabolism and accumulation of metabolites that contain sugars. Another possibility is that the increase of concentration gave higher nematode suppression and consequently less consumption of nutrient including sugars.

The increased of free phenols by increasing the concentrations of the applied compounds could be attributed to the increase of the plant defense against the invading nematode. Our results confirm this as most treatments that gave low Rf values had high levels of free phenols and this is attributed to the fact that phenolic compounds play appositive role against plant pathogens (Mahgoob and Zaghlool 2002)

The decrease in the total amino acids by increasing concentrations of the used compounds could be attributed to lower infection and consequently lower replenish of proteins from the plant cell that adjacent to the infected ones (Nandi *et al.* 2003)

Our results give an approach to control *M. javanica* in sunflower using compounds that are safer than nematicides. These results should be considered when designing an integrated pest management program for root-knot nematodes or other nematode pathogens in sunflowers and other crops.

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تأثيـــر بعض الأملاح المعدنية و الأحماض العضوية و الأحماض الأمينية و كذلك مـــنظمات الـــنمو علـــى نيماتودا تعقد الجذور (النوع جافانيكا) التى تصيب عباد الشمس

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تـم دراســة تأثير بعض الأملاح المعدنية (فوسفات الصوديوم والبوتاسيوم الأحادية و الثنائية) و الأحمــاض العــضوية (السلــسليك،الأسكوربيك والستريك) و الأحماض الأمينية (الليثين و الثايمين) و كذلك مــنظمات الــنمو (الأندول اسيتيك اسيد و الجبرلين و البيكس) على موت يرقات نيماتودا تعقد الجذور تحت ظــروف المعمــل و كذلك تكاثرها و نمو عباد الشمس تحت ظروف الصوبة و كذلك تأثيرها على المحتوى الكيماوي (سكريات –فينولات– أحماض أمينية) لجذور نباتات عباد الشمس السليمة و المصابة .

تحــت ظــروف المعمــل و جدت علاقة طردية بين التركيزات ١٢٥٠ ، ٢٥٠٠، ٥٠٠٠ جزء في الملــيون و نــسبة موت اليرقات، و قد كان مبيد الراجبى أكثر كفاءة معطيا ١٠٠% موت لليرقات ثم حمض الستريك (٩٢,٧%) ويلية حمض الأسكوربيك (٧٨,٩%) بينما أعطى البيكس (٧٠,٥%)،في حين أعطت كلا من فوسفات الصوديوم الأحادية و الثنائية ٢٢,٦ ، ٢١,٢% على التوالي عند ٥٠٠٠ جزء فى المليون.

وتحت ظروف الصوبة أوضحت النتائج المتحصل عليها ما يلي:

١- كان الوزن الجاف للمجموع الخضري أعلى فى النباتات المعاملة عنة فى غير المعاملة حيث بلغ اعلاة (١٩,٣٣ جــم) فــي النباتات المعاملة بالأندول اسيتيك اسيد والجبريللين و أقلة (٨,٦٧ جم) فى النباتات المعاملــة بالثيامــين عــند تركيــز ١٠٠٠ جزء في المليون و كذلك بلغا اعلاة ١٦,٦٧جم) فى النباتات المعاملــة بالأندول اسيتيك اسيد و اقلة ١٠ جم فى النباتات المعاملة بفوسفات الصوديوم الثنائية عند تركيز ٢٠٠٠جزء فى المليون بينما تراوحت بين ٥ جم ،٦٠ جم فى النباتات غير المعاملة.

٢- لــم تختلف أوزان الجذور الجافة في النباتات المأخوذة من معظم المعاملات عنها في غير المعاملة حيث كــان أعلاهــا(٨جــم) في النباتات المعاملة بالأندول اسيتيك اسيد وأقلها (٤ جم) في النباتات المعاملة بالليثــين عند تركيز ١٠٠٠ جزء في المليون بينما كانت اعلاها ٧,٣٣ جم فى النباتات المعاملة بالأندول اسيتيك اسيد و اقلها ٤ جم فى النباتات المعاملة بالسلسيك عند تركيز ٢٠٠٠ جزء فى المليون و تراوحت بين ٤ جم و ٥,٦٧جم فى النباتات غيرالمعاملة .

٣- قللــت معظــم المعــاملات تكاثر النيماتودا حيث كان أقلها (معدل التكاثر= صفر) فى النباتات المعاملة بفوسفات البوتاسيوم الأحادية و الثنائية و حمض الستريك و الجبرلين و البيكس عند استخدامها بتركيزات ١٠٠٠او ٢٠٠٠ جزء في المليون.

٤- بالنــسبة للتحلــيلات الكيميائــية فقد و جدت علاقة طردية بين تركيز المواد المستخدمة و المحتوى من الــسكريات و الفينــولات و لكــن ليس بالنسبة للأحماض الأمينية . و تراوحت نسبة السكريات الكلية من ٠,٥٧٩الــى ٤,٠٤ملجــم/ جــم جذور بينما تراوحت من ٠.٢٢٩الى ١,٢٤٦ ملجم/ جم جذور بالنسبة للسكريات المختزلة. و أعطت النباتات المعاملة بفوسفات البوتاسيوم الأحادية أعلى كمية فينولات كلية (١٨,٦٣٥ ملجم/ جم جذور) عند تركيز ١٠٠٠ جزء فى المليون بينما اقلها كان ٦,٦٣ ملجم/ جم جذور مــن النــباتات المعاملــة بفوسفات الصوديوم الأحادية عند استخداء نفس التركيز بالإضافة إلى ذلك فقد تراوحت كميات الأحماض الأمينية الكلية ما بين ٠,٠٠٨ الى ٠,٣٨٦ ملجم/ جم جذور.