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EVALUATING THE POSSIBILITY OF USING INORGANIC, ORGANIC AND BIOFERTILIZERS IN THE CONTROL OF ROOT-KNOT NEMATODE, *MELOIDOGYNE INCOGNITA* INFECTING SWEET PEPPER PLANTS UNDER SEMI-FIELD CONDITIONS

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ABSTRACT: The present study was carried out at the experimental station and the Biological Laboratory of the Economic Entomology and Agricultural Zoology Department, Faculty of Agriculture, Menoufia University. The objective is to study the effect of Potassium silicate, Salicylic acid, Biofertilizer I-PHOS, Humic acid, NPK, and Fulvic acid on the population density of root-knot nematode, *M. incognita* infected sweet pepper plants cv. Top star under semi-field conditions compared with Oxamyl 24% L. The obtained results recorded that the highest reduction % in *M. incognita* juveniles in the soil was observed at oxamyl 85.2 %, followed by Humic acid at 69.6%, Salicylic acid, at 67.6%, Potassium silicate at 67.5%, and Fulvic acid 64.3%, while the biofertilizer I-PHOS recorded 61.1 % and NPK the treatment of registered the smallest decrease as 60.7%. As for reduction percentages of *M. incognita* females the highest reduction percentages were observed at oxamyl treatment 83.1 %, followed by Humic acid 53.4 %, while the least decrease percentages were recorded at the biofertilizer I-PHOS 22.2 %, and NPK 27.5 %. Meanwhile the treatments of Salicylic and Fulvic acids occupied intermediate status at 45.2 and 38.6 %. Regarding the reduction of *M. incognita* egg masses in the roots of pepper plants, the highest reduction % was observed at oxamyl at 80.6 %, followed by Humic acid at 52.1 % and Potassium silicate at 47.4%. In comparison, the lowest decrease % was recorded at the biofertilizer I-PHOS 18.9 %, and NPK 24.9 %. Meanwhile the treatments of Salicylic and Fulvic acids occupied intermediate status at 39.5 and 33.4%. As for reduction %, the highest reduction in root gall index was observed at oxamyl, Potassium silicate, and Humic acid at 50 %, followed by Salicylic and Fulvic acids at 33.3 %, while the least one recorded with biofertilizer I-PHOS and NPK 16.7%. The highest increase in plant height was 53.3% at Oxamyl, followed by 34.0 at Humic acid, and 28.5 and 21.8% at Potassium silicate and Salicylic acid, respectively. Meanwhile, it was just 9.2% at NPK. Additionally, Oxamyl showed the greatest increase in shoot weight at 61.6%, followed by Humic acid at 42.6, Potassium silicate, and Salicylic acid at 38.3 and 36.3%, respectively. In comparison, it was only 16.6 % at NPK. The study recommends the possibility of using humic acid, potassium silicate, salicylic acid, and fulvic acid to reduce the number of plant-parasitic nematodes while also increasing plant resistance to pests, particularly in soil.

Keywords: Biofertilizer, organic acids, *Meloidogyne*, biocontrol, pepper

INTRODUCTION

Sweet pepper (Capsicum annuum L.) belongs to the Solanaceae family and is one of Egypt's most important marketing and export vegetable crops, with 41,047 ha under cultivation and an annual production of 623,221 tons (FAO, 2022; Sood, 2023). It is distinguished from both tomatoes and potatoes by their high nutritional value because they contain antioxidants and vitamins C and A, which the body needs, especially in the winter season, to resist cold and influenza diseases and necessary for the synthesis of collagen, the body's primary structural protein that maintains the integrity of blood vessels, skin, and bones. Root-knot nematodes are considered one of the most important types of nematodes that infect peppers and cause a great loss in fruit production and significant economic losses (Manju and Sankari, 2015). *Meloidogyne*

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incognita infected pepper plants cause large root knots that damage the root system, weakening the root's ability to absorb water, salts, and nutrients and leading to yellowing, wilting, and gradual drying of the leaves from bottom to top, with stunted plants and a lack of yield (El-Shennawy and Abo Korah, 2021). The massive use of chemical pesticides led to much damage affecting humans, animals, plants, soil, and water, directly and indirectly, causing many diseases, especially those related to the respiratory and digestive systems, scientists turned to use alternative materials that are safe for humans, plants, and the environment (El-Deeb *et al.,* 2018 and Abo-Korah, 2022). Potassium silicate works to reduce transpiration rates and increase plant resistance to drought and soil salinity, as well as increase plant resistance to nematodes and activates the work of plant cells and the transport of proteins and carbohydrates (Rady *et al*. 2024). Salicylic acid plays the role of a natural plant hormone, meaning it stimulates plant growth and also stimulates acquired systemic resistance, increases the absorption of nutrients and increases the process of photosynthesis (He *et al.,* 2002). Bio-fertilizers (I-PHOS) are cheap sources of food for plants, and can be used as an alternative to mineral fertilizers. They secrete plant growth materials, which accelerates the growth rate of the plant (Bawa *et al.,* 2020). NPK contains a percentage of nitrogen to increase vegetative growth and maintain healthy leaves of various crops and plants to secure the leaves necessary for photosynthesis. It contains a percentage of potassium, that helps in the process of building proteins (Osman *et al*., 2021). Humic acid provides good nutrition for plants, which contributes to their healthy growth and avoids wilting and death. It increases their ability to resist nematodes and increases plant growth faster than usual. Humic acid also works to increase the percentage of chlorophyll (Abo-Korah and Moussa 2015, Al-Hazmi, and Javeed, 2015, Al-Hazmi, *et al*., 2019, and Seenivasan and Baidoo 2021). Fulvic acid facilitates the access of calcium, phosphorus, and magnesium, and transforms these elements from those that are not easily absorbed into forms that are easily absorbed in the roots to benefit from them (Abokorah and Fathalla, 2022). Given the tendency of scientists to use alternative materials to chemical nematicides due to their harmful effects on humans and the surrounding environment, this study aimed to use safe, effective, vital, and cheaper materials to achieve the best results against the root-knot nematode *Meloidogyne incognita* that infected the roots of pepper plants.

MATERIALS AND METHODS

The present studies were carried out at the experimental station and the Biological Laboratory of the Economic Entomology and Agricultural Zoology Department, Faculty of Agriculture, Menoufia University.

1- Nematode culture

Meloidogyne incognita larvae (J_2) were collected from pure culture reared on cotton *Gossypium barbadense* (Gallini) variety Giza 6 in the nematode laboratory of the entomology and zoology department of the faculty of agriculture, Menoufia University. Galled roots of cotton were washed in the water to clean them from the soil sticking to the roots, then the roots were cut into pieces of 1 cm long and stirred in sodium hypochlorite NaOCl (0.5%) for 3 minutes and shaken well in sterile water to free eggs from egg masses (Kerry and Bourne 2002). To obtain second-stage juveniles (J2), eggs were incubated in a modified Baermann funnel at 25 ± 1°C for 4 days, as described in the experimental infection procedure by Chuixu *et al*. (2013).

2- Preparation of treatments

Potassium silicate

Potassium silicate, [K_2SiO_3 (SiO_2 25% & K_2O 10%)] was applied as a foliar spray at 4000 ppm concentration. The application was done one week after planting the seedlings, then after one, two, and three months, according to (Abdel-Latif *et al.,* 2019).

Salicylic acid (SA)

Foliar application by SA (150 ppm) was adopted three weeks after planting and then monthly in the early morning till the end of the experiment (Hussien and Moussa, 2018).

Biofertilizer I-PHOS:

Potassium phosphate fertilizer, which is composed of 85% phosphorus and 15% potassium, was applied at a rate of 0.125 cm^3/plant.

Humic acid:

Humic acid treatments were prepared and mixed with experimental soil with concentration rates (1500 ppm).

NPK:

NPK fertilizer contains three essential nutrients needed for plant growth and overall plant health. These three essential nutrients include nitrogen (N), phosphorus (P), and potassium (K). NPK was applied as. (0.15 grams per plant), as soil drench around the roots (Nurul and Hidayati, 2022).

Fulvic acid:

Extraction of Fulvic acid was run according to the method as described by (Sanchez *et al.,* 2002). The compost samples were treated with either 0.5 N NaOH or 1.0 N KOH (Bidegain *et al.,* 2000). The obtained materials still contain impurities, which are purified as described by (Chen *et al.,* 1978). While the purification of Fulvic acid was completed according to the method described by (Kononva, 1966). It was applied at a concentration of 3000 ppm at a rate of 50 g per plant every two months (Hamzah and Saad, 2020).

3- Experimental preparation and design:

The experiment was conducted in a sweet pepper field (*Capsicum annum* L.) selected for this study during summer season from April, to June. At transplanting time, the treatments were arranged as a completely randomized block design. The experiment was done under felid conditions and each treatment consisted of (3) replicates. One seedling 30-day-old of a sweet pepper, *Capsicum annum* cultivar Top star was planted in a plastic pot 25 cm containing 3kg of sterilized clay-sand mixed soil (1:3 v/v). After seven days of seedlings adaptation, (1000 J_2 / 1 kg soil) of *Meloidogyne incognita* was added by pipette into three holes around each seedling. Treatments were applied solely or in combination immediately after infection with nematodes.

4- Sampling Procedures:

A hand trowel was used to collect soil samples from the area surrounding sweet pepper roots. The dried soil surfaces were removed, and samples were taken from the wetted rhizosphere region of the soil and transferred to the laboratory to extract nematodes and determine the population of each species, to identify nematode genera, particularly plant parasitic ones.

5- Nematode Extraction and Numeration:

Each soil sample was carefully mixed, and an aliquot of 250 cm3 was processed for nematode extraction according to methods described by Southey 1970. About 300-400 ml. of water was added to the soil in a glass beaker (1000 ml) and the mixture was agitated by fingers, after a few seconds the suspension was poured onto a 60-mesh sieve, and passing suspension was collected in another clean glass beaker. Materials caught on the 60-mesh sieve were discarded, while the collected suspension was then poured onto a 200-mesh sieve. Materials remaining on the sieve were thoroughly washed by a gentle stream of water into a 200 ml beaker. The resulting suspension containing nematodes was then transferred to a Modified Baermann pan fitted with soft tissue paper for the separation of active nematodes from debris and fine soil particles. After 72 hrs. nematode water suspension was collected and concentrated to 20 ml in a vial by using a 350-mesh sieve. An aliquant of 1 ml each of nematode suspensions was pipetted off, placed in a Hawksley counting slide, and examined using a stereomicroscope. Plant roots were rinsed in water, root-knot nematode females were counted with the help of a dissecting microscope, and the number of galls was rated as mentioned in Table (1). Egg masses were assessed by staining the roots with Phloxin-

B solution (0.15 g/l liter tap water) for 20 minutes according to (Daykin and Hussey 1985).

Rating scale levels of gall numbers were counted according to (Taylor & Sasser 1978) where:

No. of galls/ root	Gall index
0	0
1-2	1
3-10	2
11-30	3
31- 100	4
More than 100	5

6- Vegetative characters:

At the end of the experiments, plant height (cm), shoot weight (g), and root weight (g) were measured and determined. Increase or decrease in plant vegetative characters were computed according to the following formula:

Increase or decrease % =

Treatment – Control / Control x 100

7- Statistical analysis:

All obtained data were subjected to an ANOVA test using a computer program (Costat, 2008) to determine Duncan's multiple range test and the LSD 5% (least significant difference). In addition Abbott's formula was used to determine the increase percentages of vegetative characters.

Reduction percentages were counted according to Abbott's formula (1925).

Corrected mortality % =

$$(1 - \frac{\text{no. in Treatment after treatment}}{\text{no. in Control after treatment}}) * 100$$

RESULTS AND DISCUSSION

1- Effect of bio-fertilizers and Vydate on the population density of root-knot nematode, *M. incognita* infected pepper plants under semi-field conditions:

The results obtained in Table (1) show the average numbers of *M. incognita* juveniles/ 100 cm^3 soil, infected pepper plants under semi-field conditions, as influenced by some biofertilizers (Potassium silicate, Salicylic acid, Biofertilizer I-PHOS, Humic acid, NPK, and Fulvic acid) compared with the nematicide Oxamyl 24% L.

Statistical analysis of obtained data revealed that there were significant differences in the average numbers of *M. incognita* juveniles/ 100 cm^3 soil between the tested agents 30, 60, and 90 days after agent applications, compared to the control treatment. Furthermore, there were significant differences among the tested biofertilizers. The highest numbers of nematode juveniles were recorded with the treatment of NPK 907.3, followed by the treatment of Biofertilizer I-PHOS 894.7, while the least numbers were recorded with Oxamyl 24% L306.6 and Humic acid 683.0(LSD 5% = 9.0).

Table 1. Effect of bio-fertilizers and Vydate on the population density of root-knot nematode, *M. incognita* infected pepper plants cv. Top star under semi-field conditions.

Treatments	Aver. no. of *M. incognita* juveniles/ 100 cm^3 soil			
	Days post-treatments			
	30 Days	60 Days	90 Days	Overall mean
Potassium silicate	847.0^{e}	761.0^{e}	598.0^{f}	735.3 ^{f}
Salicylic acid (SA)	908.0^{d}	791.0^{d}	637.0^{e}	778.7 ^{e}
Bio fertilizer I-PHOS	953.0^{b}	901.0^{b}	830.0^{c}	894.7 ^{c}
Humic acid	829.0^{f}	657.0^{f}	563.0^{g}	683.0 ^{g}
NPK	957.0^{b}	902.0^{b}	863.0^{b}	907.3 ^{b}
Fulvic acid	921.0^{c}	809.0^{c}	701.0^{d}	810.3 ^{d}
Oxamyl 24% L	511.0^{g}	297.0^{g}	112.0^{h}	306.6 ^{h}
Control	1792.0^{a}	2473.0^{a}	3081.0^{a}	2448.7^{a}
LSD 5%	8.6	9.2	8.3	9.0

This means that each column followed by the same letter (s) is not significantly different at a 5% level

As for reduction percentages of *Meloidogyne incognita* infected pepper plants cv. Top star under semi-field conditions computed by Abbott's formula, results in Table (2) recorded that the highest reduction percentages in *M. incognita* juveniles in soil was observed at oxamyl treatment 85.2 %, followed by Humic acid 69.6, Salicylic acid, 67.6 Potassium silicate 67.5, and Fulvic acid 64.3, while the biofertilizer I-PHOS recorded 61.1 % and the treatment of NPK registered the least decrease as 60.7%.

Table 2. Reduction percentages of *Meloidogyne incognita* infected pepper plants cv. Top star under semi-field conditions as affected by some bio-fertilizers.

Treatments	Reduction %			
	30 Days	60 Days	90 Days	overall mean
Potassium silicate	52.7^{b}	69.2^{c}	80.6^{bc}	67.5^{c}
Salicylic acid (SA)	49.3^{c}	74.2^{b}	79.3^{c}	67.6^{c}
Bio fertilizer I-PHOS	46.8^{d}	63.5^{d}	73^{e}	61.1^{e}
Humic acid	53.7^{b}	73.4^{b}	81.7^{b}	69.6^{b}
NPK	46.6^{c}	63.5^{e}	72^{e}	60.7^{e}
Fulvic acid	48.6^{c}	67.3^{c}	77.2^{d}	64.3^{d}
Oxamyl 24% L	71.5^{a}	88.0^{a}	96.3^{a}	85.2^{a}
LSD 5%	1.7	1.9	1.5	1.8

Means in each column followed by the same letter (s) are not significantly different at 5% level

The obtained results in Table (3) show the average numbers of *M. incognita* females, egg-masses and root gall index in the roots of pepper plants cv. Top star, as influenced by some bio-fertilizers (Potassium silicate, Salicylic acid, Bio fertilizer I-PHOS, Humic acid, NPK and Fulvic acid) compared with the nematicide Oxamyl 24% L.

Statistical analysis of obtained data revealed that there were significant differences in the average numbers of *M. incognita* females, egg masses, and root gall index between the tested agents and control treatment.

In this direction, there were significant differences among the tested biofertilizers. The highest numbers of nematode females were recorded with the treatment of Biofertilizer I-PHOS 18.9, followed by the treatment of NPK 17.3, while the least juvenile numbers were recorded with Oxamyl 24% L 4.1 and Humic acid 11.3 (LSD 5% = 0.8).

In terms of egg masses, the highest number was recorded with the treatment of Biofertilizer I-PHOS 39.0, followed by the treatment of NPK 36.1, while the lowest juvenile numbers were recorded with Oxamyl 24% L 9.3 and Humic acid 23.0 (LSD 5% = 1.6).

Regarding to root gall index, the highest numbers were recorded with the treatments of Biofertilizer I-PHOS, NPK 17.3 and control registered 5 as root gall index, while the lowest index was recorded with Oxamyl 24% L 2 (LSD 5% = 0.6).

As for reduction percentages of *Meloidogyne incognita* females in the roots of pepper plants cv. Top star under semi-field conditions computed by Abbott's formula, results in Table (4) recorded that the highest reduction percentages in *M. incognita* females were observed at oxamyl treatment 83.1 %, followed by Humic acid 53.4 %, while the least decrease percentages were recorded at the treatments of biofertilizer I-PHOS 22.2 %, and NPK 27.5 %. Meanwhile the treatments of Salicylic acid and Fulvic acid occupied intermediate status as 45.2 and 38.6 (LSD 5% = 1.7).

As for reduction percentages of *Meloidogyne incognita* egg masses in the roots of pepper

plants cv. Top star under semi-field conditions computed by Abbott's formula, results in Table (4) recorded that the highest reduction percentages in *M. incognita* egg masses were observed at oxamyl treatment 80.6 %, followed by Humic acid 52.1 % and Potassium silicate 47.4%. In comparison, the lowest decrease percentages were recorded at the treatments of biofertilizer I-PHOS 18.9 %, and NPK 24.9 %. Meanwhile the treatments of Salicylic acid and Fulvic acid occupied intermediate status as 39.5 and 33.4 (LSD 5% = 1.6).

As for reduction percentages of root gall index in the roots of pepper plants cv. Top star under semi-field conditions, results in Table (4) recorded that the highest reduction percentages were observed at the treatments of oxamyl, Potassium silicate, and Humic acid 50 %, followed by Salicylic acid and Fulvic acid 33.3 %, while the least decrease percentages were recorded at the treatments of biofertilizer I-PHOS and NPK 16.7 %.

Table 3. Average numbers of *M. incognita* females, egg masses, and root gall index in the roots of pepper plants treated with some bio-fertilizers.

Treatments	Females / 5 g root	No egg-masses/ root	Root gall index
Potassium silicate	12.0 ^{f}	25.3 ^{f}	3.0^{d}
Salicylic acid (SA)	13.3 ^{e}	29.1^{e}	4.0 ^{c}
Biofertilizer I-PHOS	18.9 ^{b}	39.0 ^{b}	5.0 ^{a}
Humic acid	11.3 ^{f}	23.0 ^{g}	3.0 ^{c}
NPK	17.3 ^{c}	36.1^{c}	5.0 ^{a}
Fulvic acid	14.9^{d}	32.0 ^{d}	4.0 ^{b}
Oxamyl 24% L	4.1^{g}	9.3 ^{h}	2.0 ^{d}
Control	24.3^{a}	48.1^{a}	5.0 ^{a}
LSD 5%	0.8	1.6	0.6

Means in each column followed by the same letter (s) are not significant different at 5% level.

Table 4. Decrease percentages of *M. incognita* mature females, egg-masses and root gall index as influenced by some bio-fertilizers.

Treatments	Decrease percentages		
	Mature females	Egg-masses	Root gall index
Potassium silicate	50.6^{c}	47.4^{c}	50.0^{a}
Salicylic acid (SA)	45.2^{d}	39.5^{d}	33.3^{b}
Bio fertilizer I-PHOS	22.2^{g}	18.9^{g}	16.7^{c}
Humic acid	53.4^{b}	52.1^{b}	50.0^{a}
NPK	27.5^{f}	24.9^{f}	16.7^{c}
Fulvic acid	38.6^{e}	33.4^{e}	33.3^{b}
Oxamyl 24% L	83.1^{a}	80.6^{a}	50.0^{a}
LSD 5%	1.7	1.6	1.5

Means in each column followed by the same letter (s) are not significant different at 5% level.

2- Effect of bio-fertilizers and Vydate on some vegetative characters of pepper plants infected with root-knot nematode, *M. incognita* under semi-field conditions:

The obtained results in Table (5) show the average numbers of some vegetative characters (plant height, shoot weight, root weight) of pepper plants cv. Top star infected with root-knot nematode, *M incognita* , as influenced by the application of some bio-fertilizers (Potassium silicate, Salicylic acid, Biofertilizer I-PHOS, Humic acid, NPK and Fulvic acid) as well as the nematicide Oxamyl 24% L compared to control plants.

Statistical analysis of obtained data Table (5) revealed that there were significant differences in the average numbers of plant characters between the tested agents and control treatment.

As for plant height, the highest one was recorded with the treatment of Oxamyl 24% L 36.5 cm, followed by Humic acid 31.9 cm, and Potassium silicate 30.6 cm. The lowest heights were recorded with NPK 26.0 cm and salicylic acid 29.0 cm, compared to control 23.8 cm. (LSD 5% = 1.6). The highest increase percentages of plant height of pepper plants cv. Top star Table (6) as influenced by the application of some bio-fertilizers was recorded as 53.3 % at Oxamyl 24% L, followed by 34.0 at Humic acid, and were 28.5, 21.8 % at Potassium silicate& Salicylic acid treatments, while it was only 9.2 % at NPK treatment (LSD 5% = 1.0).

Statistical analysis of obtained data in Table (5) showed significant differences in the average numbers of shoot weight between the tested agents and control treatment.

As for shoot weight, the highest weight was recorded with the treatment of Oxamyl 24% L 40.9 g, followed by Humic acid 36.1 g, and Potassium silicate 35.0 g. The least weights were recorded with NPK 29.5 cm, compared to control 25.3 cm. (LSD 5% = 1.7). The highest increase percentages of shoot weight of pepper plants cv. Top star Table (6) as influenced by the application of some bio-fertilizers was recorded as 61.6 % at Oxamyl 24% L, followed by 42.6 at Humic acid. It was 38.3, 36.3 % at Potassium silicate& Salicylic acid treatments, while it was only 16.6 % at NPK treatment (LSD 5% = 1.5).

Statistical evaluation of the collected data (Table, 5) demonstrated that the average root weights of the tested agents and the control treatment differed significantly.

Table 5. Influence of bio-fertilizers and Vydate on some vegetative characters of pepper plants cv. Top star infested with *M. incognita*.

Treatments	Plant height/ plant (cm)	Shoot weight/ plant (g)	Root weight/plant (g)
Potassium silicate	30.6^{bc}	35.0^{bc}	7.8^{b}
Salicylic acid (SA)	29.0 ^{cd}	34.5 ^{cd}	7.1^{c}
Biofertilizer I-PHOS	27.3 ^{de}	30.0 ^{e}	6.0 ^{e}
Humic acid	31.9 ^{b}	36.1^{b}	8.1 ^{b}
NPK	26.0 ^{e}	29.5 ^{e}	5.9 ^{e}
Fulvic acid	28.5 ^{d}	33.1^{d}	6.5 ^{d}
Oxamyl 24% L	36.5 ^{a}	40.9 ^{a}	9.2 ^{a}
Control	23.8 ^{f}	25.3 ^{f}	5.0 ^{f}
LSD 5%	1.6	1.7	0.4

Means in each column followed by the same letter (s) are not significant different at 5% level.

As for root weight, the highest one was recorded with the treatment of Oxamyl 24% L 9.2 g, followed by Humic acid 8.1 g , and Potassium silicate 7.8 g . The least weights were recorded with NPK 9.5 g, compared to control 5.0 g (LSD 5% = 0.4). The highest increase percentages of root weight of pepper plants cv. Top star Table (6) as influenced by the application of some bio-fertilizers, the highest increase was recorded as 84.0 % at Oxamyl 24% L treatment, followed by 62.0 at Humic acid and were 56.0, 42.0 % at Potassium silicate& Salicylic acid treatments, while it was only 18.0 % at NPK treatment (LSD 5% = 1.9).

Table 6. Increase percentages of some vegetative characters of pepper plants cv. Top star as influenced by the application of some bio-fertilizers.

Treatments	Increase %		
	Plant height	Shoot weight	Root weight
Potassium silicate	28.5^{c}	38.3^{c}	56.0^{c}
Salicylic acid (SA)	21.8^{d}	36.3^{d}	42.0^{d}
Bio fertilizer I-PHOS	14.7^{f}	18.6^{f}	20.0^{f}
Humic acid	34.0^{b}	42.6^{b}	62.0^{b}
NPK	9.2^{g}	16.6^{g}	18.0^{g}
Fulvic acid	19.7^{e}	30.8^{e}	30.0^{e}
Oxamyl 24% L	53.3^{a}	61.6^{a}	84.0^{a}
LSD 5%	1.0	1.5	1.9

Means in each column followed by the same letter (s) are not significant different at 5% level.

The results obtained are in harmony with those conducted by Al-Hazmi, and Javeed (2015), Al-Hazmi *et al.* (2019). Hamzah and Saad (2020) and Samak and Abo-Korah (2021) reported the possibility of using biofertilizers and organic acids to decrease the population of plant parasitic nematodes. Furthermore, Biofertilizers (I-PHOS) secrete plant growth materials, which accelerates the growth rate of the plant (Bawa *et al.,* 2020). As for NPK increases vegetative growth and maintain healthy leaves of various crops and plants as well as helps in the process of building proteins (Osman *et al*., 2021). Humic acid increases the ability of plants to resist nematodes and increases plant growth faster than usual, and Fulvic acid facilitates the access of different elements to be easily absorbed in the roots and increases the resistance of plants to different pathogens (Abokorah and Fathalla 2022).

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تقييم إمكانية إستخدام الأسمدة العضوية وغير العضوية والحيوية في مكافحة نيماتودا تعقد الجذور (*Meloidogyne incognita*) التي تصيب نباتات الفلفل الحلو في ظروف شبه حقلية

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الملخص العربي

أجريت الدراسة الحالية بمحطة التجارب والمعمل البيولوجي لقسم الحشرات الاقتصادية والحيوان الزراعي بكلية الزراعة جامعة المنوفية لدراسة تأثير سيليكات البوتاسيوم وحمض الساليسيليك والسماد الحيوي I-PHOS وحمض الهيوميك و NPK وحمض الفولفيك على تعداد أطوار نيماتودا تعقد الجذور *M. incognita* التى تصيب نباتات الفلفل الحلو صنف Top star تحت الظروف الشبه حقلية مقارنة بالمبيد النيماتودى أوكساميل ٢٤٪. سجلت النتائج المتحصل عليها أن أعلى نسبة انخفاض في أعداد يرقات نيماتودا تعقد الجذور *M. incognita* في التربة مع مبيد أوكساميل ٨٥,٢٪ يليه حمض الهيوميك ٦٩,٦٪ وحمض الساليسيليك ٦٧,٦٪ وسليكات البوتاسيوم ٦٧,٥٪ وحمض الفولفيك ٦٤,٣٪ بينما سجلت معاملة السماد الحيوي I-PHOS ٦١,١ ٪ وسجلت معاملة NPK أقل نسبة انخفاض بلغت ٦٠,٧٪. أما بالنسبة لنسب انخفاض إناث *M. incognita* فقد سجلت أعلى نسب انخفاض عند معاملة الأوكساميل ٨٣,١٪ يليه حامض الهيوميك ٥٣,٤٪ بينما سجلت أقل نسب انخفاض مع السماد الحيوي I-PHOS ٢٢,٢ ٪ و NPK ٢٧,٥٪ ، في حين احتلت معاملات حمض الساليسيليك والفولفيك وضعاً متوسطاً حيث بلغت ٤٥,٢ و ٣٨,٦٪. أما بالنسبة لنسب انخفاض كتل بيض *M. incognita* في جذور نباتات الفلفل فقد سجلت أعلى نسب انخفاض مع مبيد الأوكساميل ٨٠,٦٪ يليه حامض الهيوميك ٥٢,١٪ وسيليكات البوتاسيوم ٤٧,٤٪ ، بينما سجلت أقل نسب انخفاض مع معاملة السماد الحيوي I-PHOS ١٨,٩ ٪ ومعاملة NPK ٢٤,٩ ٪. في حين احتلت معاملات حمض الساليسيليك وحمض الفولفيك وضعاً متوسطاً حيث بلغت ٤٥,٢ و ٣٨,٦٪. وفيما يتعلق بنسبة انخفاض كتل بيض *M. incognita* في جذور نباتات الفلفل فقد سجلت أعلى نسبة مع مبيد الأوكساميل ٨٠,٦٪ يليه حمض الهيوميك ٥٢,١٪ وسيليكات البوتاسيوم ٤٧,٤٪ ، بينما سجلت أقل نسبة انخفاض مع السماد الحيوي I-PHOS ١٨,٩ ٪ ومعاملة NPK ٢٤,٩ ٪ ، في حين احتلت معاملات حمض الساليسيليك وحمض الفولفيك وضعاً متوسطاً حيث بلغت ٣٩,٥ و ٣٣,٤٪. أما بالنسبة لنسبة الانخفاض فقد سجلت أعلى نسبة انخفاض في مؤشر تعقد الجذور مع الأوكساميل وسيليكات البوتاسيوم وحمض الهيوميك ٥٠٪ ، يليه حمض الساليسيليك وحمض الفولفيك ٣٣,٣٪ ، بينما سجلت أقل نسبة انخفاض مع السماد الحيوي I-PHOS ومعاملة NPK ١٦,٧ ٪. وسجلت أعلى نسبة زيادة في ارتفاع النبات مع مبيد أوكساميل ٥٣,٣٪ يليه حامض الهيوميك ٣٤,٠٪ و٢٨,٥٪ و٢١,٨٪ مع معاملتى سيليكات البوتاسيوم وحامض الساليسيليك ، بينما كانت فقط ٩,٢٪ مع NPK. في حين سجلت أعلى نسبة زيادة في وزن المجموع الخضري مع مبيد أوكساميل ٦١,٦٪ يليه حامض الهيوميك ٤٢,٦٪ و٣٨,٣٪ و٣٦,٣٪ عند سيليكات البوتاسيوم وحامض الساليسيليك بينما كانت ١٦,٦٪ مع معاملة NPK. يوصى البحث بإمكانية استخدام حامض الهيوميك وسيليكات البوتاسيوم و حمض الساليسيليك وحمض الفولفيك لتقليل أعداد النيماتودا المتطفلة على النبات بالاضافة الى رفع مستوى مقاومة النباتات للاصابة بالآفات وخاصة آفات التربة .

الكلمات المفتاحية: الأسمدة الحيوية، الأحماض العضوية، نيماتودا العقد الجذرية، المكافحة الحيوية، الفلفل