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Original research

Evaluation the effectiveness of some pesticides against root-knot nematode on eggplant

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Abstract:

Meloidogyne incognita, a root-knot nematode that seriously damages agricultural plants, badly infects eggplant plants. In order to improve the active ingredient's distribution to the target nematode, farmers must apply chemical nematicides, either with or without adjuvants. The direct impact of nematicides and insecticides (Cadusafos, Furdan, Gupter, Mocap, Oxamyl, Malathion, and Methomyl) was examined in a recent study at the tested doses caused significant reduction in nematode root galls, egg-masses, eggs per 1g root and number of larvae / 250 g of soil compared to untreated inoculated control. Gupter had the most nematicidal impact on the development of root galls, egg-masses and eggs per g root, recording reduction percentages of 91.40, 91.28, and 96.34 in these variables. recording reduction percentages of 91.40, 91.28, and 96.34 in these variables. recording 91.40, 91.28 and 96.34 reduction percentages in these parameters, respectively.While cadusafos gave the highest nematicidal reduces the quantity of juveniles in the soil as a result by 94.39 %. As opposed to that,Malathion proved to be the lowest effective compound. Gupter gave the highest value in both fresh and dry root weight (19.06 g/ root) and (3.93 g/ root), respectively. While the smallest fresh root weight was obtained by Malathion (16.89 g/ root), while the smallest root dry weight was obtained by Oxamyl and Cadusafos, which gave the same value (3.38 g/ root).

Key words: Chemical control, nematicides, insectiside (Cadusafos, Furdan, Gupter, Mocap, Oxamyl, Malathion and Methomyl), *Meloidogyne* spp.

1- Introduction

Nematodes are the most prevalent animals that live in soil. Nematodes that parasitize plants greatly reduce the value of agricultural crops worldwide.. Root-knot nematodes Pathogens of several different crops called *Meloidogyne* spp. are significant economically**. Badwi and Abu-Gharbieh (2000**) used Furadan 10%G, Mocap 20%L and Vydate 24%L, compared with Methyl bromide (MeBr) against *Meloidogyne javanica* on tomato. They found that (MeBr) was the most effective where it reduced the average over all nematode parameters by 70.5% and increase the average follage weight by 86% followed respectively by the nematicide furdan (36.9, 31.9%),

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Mocap (27.1, 25.98%), while Vydate was least effective (15.5, 16.5%). **Shafiq and khan, 2001)**, showed that higher concentration of malathion (2000 Mg/ml) gave the best defence against root-knot nematodes is phorate, carbofuran, endosulphon, methyl parathion, and benfurocarb are placed after that. Plants treated with phorat 100 mg/ml concentration showed the greatest improvement in plant development and the suppression of nematode multiplication and root galling, followed by carbofuran, malathion, endosulphon, methyl parathion, and benfurocarb.

This study's goal is to examine the impact of nematicides and insecticides (Cadusafos, Furdan, Gupter, Mocap, Oxamyl, Malathion and Methomyl) in controlling the root-knot parasite *Meloidogyne incognita* inficting eggplant plants grown in greenhouse-like surroundings.

2- Materials and Methods

2.1. Nematode vaccine:

Meloidogyne incognita (Kofoid & White) chitwood eggs, a root-knot nematode, were found infesting the roots of *Solanum*. (*Solanum nigrum* L.) which came from the El-Nubaria district of the El-Beheira Governorate. Using running water, galls roots were removed from the adherent soil particles and cut into small pieces. They were then homogenised in a blender for 10 seconds in a 0.5% sodium hypochlorite (NaOCl) solution to dissolve the gelathineous matrix and remove any remaining nematode eggs from the mass matrix (Hussey and Barker, 1973). The suspension was run through two sieves, one of 200 mesh and the other of 400 mesh. To remove any leftovers before inoculation, eggs were then rinsed under a moderate stream of running water. These eggs were incubated in Petry dishes at 25°C while being placed on cotton tissues submerged in distilled water. We gathered young hatchlings.

2.2.Inoculation of Root-knot nematodes in the greenhouse for evaluating the tested chemicals:

In plastic containers with a 15-cm top diameter and 1.5 kg of sandy loam soil, experiments were carried out after being steam sterilised for five hours at 135°C. Four replications of a randomised complete block design were used for the experiment. A 4-week-old cultivar (seedling) of aubergine with four to six true leaves was placed in each pot. On the day of transplanting, 1,000 newly hatched J2 of *M. incognita* were suspended in water and applied to each plant. The inoculum was pipetted into three triangular-shaped holes that were each 0.5 cm in diameter, 5 cm deep, and 2 cm from the crown area. Two days after the inoculation, nematicides were used (Alam *et al*., 2022).

2.3.The tested nematicides and insecticides:

Five nematicides—Furdan, Oxamyl, Gupter, Mocap, and Cadusafos—and two insecticides—Methomyl and Malathion—were tested against *M. incognita* on eggplant plants(super classic) in a pot experiment to compare their effectiveness. The soil was treated with nematicides and insecticides at the approved rates. based on formulated forms after two days from inoculation with nematodes. Oxamyl, Furdan and Cadusafos were applied at the rate of 0.12 g/kg soil, Gupter and Mocap were applied at the rate of 0.14 g/kg, methomyl 0.12 g/kg soil and malathion 0.2 ml/kg soil.

2.4.Effect of the tested nematicides and insecticides against *M. incognita* infecting eggplant plants:

Plants were carefully removed after 60 days of chemical application, and any soil particles stuck to the roots were completely rinsed under running water. In addition to shoot length, the fresh and dry weights of the shoots and roots were calculated. Additionally, in treated and untreated pots,

the egg masses, number of galls per root system, number of eggs per g root, and number of juveniles per 250 g soil were compared.

2.5.Statistical analysis:

The data were subjected to the analysis of variance using SAS software **(SAS,2000)** Means of significant variance were separated using Duncan's multiple range test at 5% probability level (**Duncan, 1955**).

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The reduction of nematode parameters was calculated according to **Raddy *et al.* (2013)**:

$$\%\text{Reduction} = \frac{\text{Control} - \text{Treatment}}{\text{Control}} \text{x100}$$

3.Results and Discussion

Results of the efficacy of five nematicides; Cadusafos, Furdan, Gupter, Mocap, Oxamyl, and two insecticides; Malathion and Methomyl against root-knot nematode, *M. incognita* on eggplant plants under greenhouse conditions were presented in Tables (1 and 2) and Figs. (1 and 2). Also, their effect on growth parameters of eggplant plants were shown in Tables 3 and 4.

Data in Table 1 demonstrated that in comparison to the inoculation control group that wasn't treated, all of the tested nematicides and insecticides considerably (p 0.05) decreased the amount of galls. The two most successful treatments, furdan (0.12 g/kg soil) and malathion (0.2 g/kg soil), decreased galls by 95.33 and 93.36%, respectively. With the exception of Malathion, Furdan was the treatment that was the most successful. However, Oxamyl (0.12 g/kg soil) and Mocap (0.14 g/kg soil) had most little activities, reducing the number of galls by 84.52 and 86.97%, respectively. However, compared to Furdan, Methomyl and Gupter did not differ much. In terms of reducing the amount of galls, methomyl and gupter were classified between the greatest and lowest treatments, 91.40 and 90.66%.

Data concerning egg-masses revealed that, all the tested compounds compared to the inoculation control group that wasn't treated, caused a considerable decrease in the amount of egg masses. (Table 1 and Fig. 1). The highest activity was obtained by Furdan (95.91%) with significant differences compared with all treatments, followed by Malathion (93.64%) with significant differences compared with rest treatments. Conversely, Oxamyl was the lowest treatment, which reduced number of egg-masses by 83.83 %. Methomyl and Gupter did not differ significantly from oxamyl, they decreased the quantity of egg masses by 90.37% and 91.28% respectively.

The results in Table (2) and Fig. (2) demonstrated that, when compared to the untreated inoculation control, all of the investigated chemicals had a significant (p 0.05) impact on lowering the number of eggs per 1g root. Gupter had the best results (96.34%), and there were substantial disparities between her results and those of the other treatments. Malathion .Contrarily, it was the least successful therapy, reducing the number of eggs per g of root by 86.1%. Oxamyl, mocap, and cadusafos reduced the number of eggs per g of root by 92.81, 92.75, and 92%, respectively, with no discernible variations between them. Insignificantly different from methomyl, which decreased the number of eggs per g root by 90.11%, furdan lowered the number of eggs per 1g root by 90.65%.

Table (1): Effect of certain nematicides and insecticides on the number of galls and egg-mass formation on eggplant plants infected with *M. incognita* in greenhouse-like surroundings.

Treatments	Dosage rate g or ml/kg	Mean of galls/ root system	Reduction (%)	Egg-mass / root system	Reduction (%)
Untreated inoculated control	-	407.0^{a}	-	367.0^{a}	-
Cadusafos 10% G	0.12g	45.0^{cd}	88.94	40.0^{d}	89.10
Furdan 10% G	0.12g	19.0^{f}	95.33	15.0^{g}	95.91
Gupter 10% G	0.14g	35.0^{cd}	91.40	32.0^{e}	91.28
Mocap 15% G	0.14g	53.0^{bc}	86.97	49.0^{c}	86.84
Oxamyl 24% SL	0.12ml	63.0^{b}	84.52	59.33^{b}	83.83
Malathion	0.2ml	27.0^{ef}	93.36	23.33^{f}	93.64
Methomyl	0.12ml	38.0^{ed}	90.66	35.33^{ed}	90.37

Each column's values followed By the same letter (s), there is little different according to Duncan multiple range test at 0.05 level.

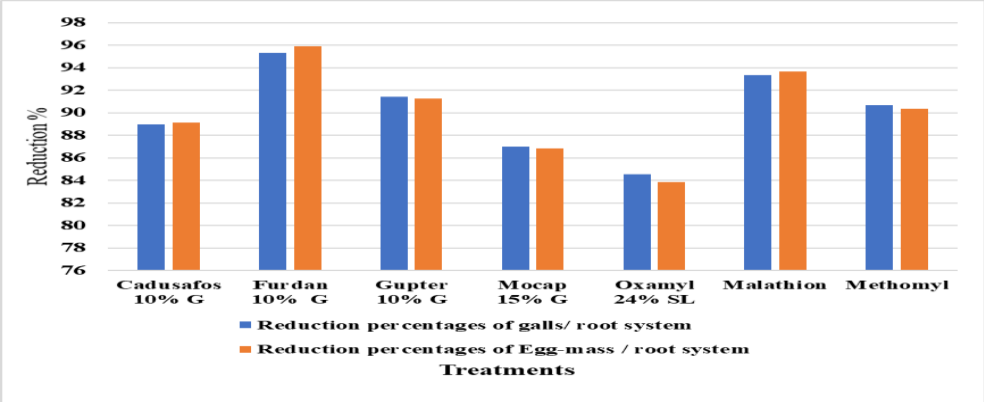

Figure (1): Reduction percentages of galls and eggmasses on roots of *M. incognita* infecting eggplant plants as affected by five nematicides; Cadusafos, Furdan, Gupter, Mocap, Oxamyl, and two insecticides; Malathion and Methomyl, under greenhouse conditions.

The same table's findings also show that, in comparison to the untreated inoculation control, all of the investigated chemicals significantly (p 0.05) decreased the quantity of juveniles in their second stage (j2) in the soil. Cadusafos (94.39%) and Gupter (93.9%) had the highest effects, with no discernible difference between them. Malathion, on the other hand, was the least successful treatment, which reduced J_2 by 85%. Methomyl and mocap were significantly equal in effectiveness with percent reduction of 88.18 and 87.1%, respectively. Furdan was ranked between the heights and the lowest treatments, as it reduced number of $J_2$by 93%.

Overall, compared to the untreated inoculation control, all examined nematicides and insecticides significantly reduced nematode root galls, egg-masses, eggs per 1g root, and number of larvae / 250 g of soil. Gupter had the greatest nematicidal impact on the development of root galls, egg

masses, and eggs per g root. In contrast, cadusafos had the greatest nematicidal impact on the quantity of juveniles per 250 g of soil. Malathion, on the other hand, turned out to be the least effective substance.

Table (2): Effect of certain nematicides and insecticides on number of eggs/g root and 2nd juvenile's on eggplant plants infected with *M. incognita* in greenhouse-like surroundings.

Treatments	Dosage rate g or ml /kg	Eggs/ g root	Reduction (%)	Mean juvenils 2nd / 250 g of soil	Reduction (%)
Untreated inoculated control	-	556.67[a]	-	601[a]	-
Cadusafos 10% G	0.12g	44[ed]	92	33.66[f]	94.39
Furdan 10% G	0.12g	51[cd]	90.65	42[e]	93
Gupter 10% G	0.14g	20.33[f]	96.34	36.66[ef]	93.9
Mocap 15% G	0.14g	40.33[e]	92.75	72.66[d]	87.1
Oxamyl 24% SL	0.12ml	40[e]	92.81	82[c]	86.35
Malathion	0.2ml	77.33[b]	86.1	90[b]	85
Methomyl	0.12ml	55[c]	90.11	71[d]	88.18

Each column's values followed By the same letter (s), there is little different according to Duncan multiple range test at 0.05 level.

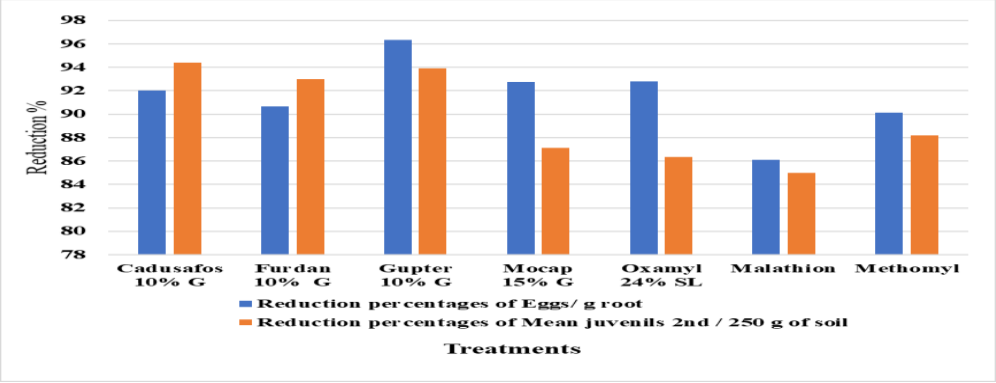

Figure (2): Reduction percentages of eggs/1g root and juvenile in soil on roots of *M. incognita* infecting eggplant plants as affected by five nematicides; Cadusafos, Furdan, Gupter, Mocap, Oxamyl, and two insecticides; Malathion and Methomyl, in greenhouse-like surroundings.

B. Effect of certain nematicides and insecticides on shoots and root system of eggplant plants infected with *M. incognita*:

Data in Fig. 3 and Table 3 indicated that every tested nematicides and insecticides with the exception of Gupter (56.4 g/plant) and Cadusafos (53.86 g/plant), which were equal to non-inoculated control in terms of significance, the shoot fresh weight increased significantly (p 0.05) when compared to untreated (inoculated control) (23.43 g/plant). However, Mocap displayed the lowest fresh shoot weight (48.5 g/plant), with no discernible difference from other treatments.

The same results were obtained with shoot dry weight, all treatments increased shoot dry weight significantly ($p \leq 0.05$) compared to untreated (inoculated control), (8.70 g/ plant), but in

a smaller way ($p \leq 0.05$) compared to non-inoculated control (14.86 g/ plant), except Gupter (14.56g/ plant) and Cadusafos (14.12g / plant) equal significantly with non-inoculated control. Additionally, all treatments significantly (p 0.05) increased shoot length in comparison to the untreated (inoculated control), but less significantly (p 0.05) in comparison to the non-inoculated control (65.00 cm/ shoot), with the exception of Gupter (63.00cm/ shoot) and Cadusafos (61.33cm/ shoot) which were equally significantly greater than the non-inoculated control. The lowest shoot dry weight (11.91) and shoot length (49.00 cm / plant) were obtained from Malathion treatment.

Table (3): Effect of some nematicides and insecticides on length of the shoot, fresh and dry shoot weights of eggplant plants infected with *M. incognita* in greenhouse-like surroundings.

Treatments	dosage rate g or ml /kg	Shoot fresh weight (g)	Shoot dry weight (g)	Shoot length (cm)
Untreated inoculated control	0	23.43^{c}	8.70^{c}	37.66^{e}
Non-inoculated control	0	$58,66^{a}$	14.86^{a}	65.0^{a}
Cadusafos 10% G	0.12g	53.86^{ab}	14.12^{a}	61.33^{ab}
Furdan 10% G	0.12g	50.66^{b}	12.68^{b}	58.33^{bc}
Gupter 10% G	0.14g	56.4^{a}	14.56^{a}	63.0^{ab}
Mocap 15% G	0.14g	48.5^{b}	12.90^{b}	54.0^{cd}
Oxamyl 24% SL	0.12ml	48.63^{b}	12.50^{b}	52.66^{d}
Malathion	0.2ml	49.80^{b}	11.91^{b}	49.0^{d}
Methomyl	0.12ml	49.70^{b}	12.56^{b}	51.33^{d}

Each column's values followed by the same letter (s), there is little different according to Duncan multiple range test at 0.05 level.

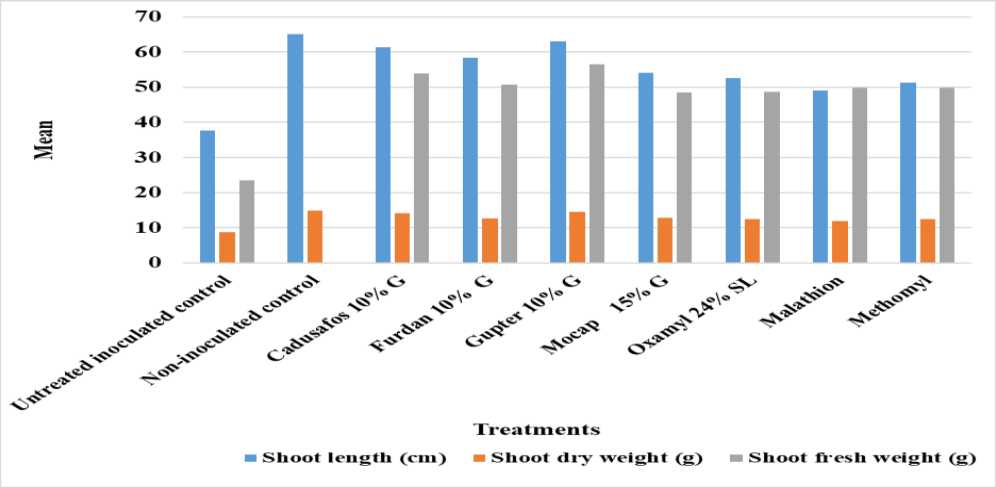

Figure (3): Impact of nematicides; Cadusafos, Furdan, Gupter, Mocap, Oxamyl, and two insecticides; Malathion and Methomyl, on length of the shoot, fresh and dry shoot weights of eggplant plants infected with *M. incognita* in greenhouse-like surroundings.

Table (4) and Figure (4) display the effects of several nematicides and insecticides on the fresh and dry root weights of eggplants. When compared to the untreated, inoculation control, the fresh and dry root weights of eggplants were all considerably (p 0.05) enhanced by all of the tested nematicides and insecticides. In terms of both dry and fresh root weight, Gupter provided the highest value (19.06 g/ root) and (3.93 g/ root) respectively, without significant differences compared to non-inoculated control (20.56 g/ root) and (3.98 g/ root) respectively. On the other hand, the lowest root fresh weight was obtained by Malathion (16.89 g/ root), While nematicides Oxamyl and Cadusafos produced the lowest root dry weight (3.38 g/ root), respectively.

Table (4): Effect of some nematicides and insecticides on root fresh and dry weights on eggplant plants infected with *M. incognita* in greenhouse-like surroundings.

Treatments	Dosage rate g or ml/ kg	Root fresh weight (g)	Root dry weight (g)
Untreated inoculated control	0.0	10.16^{d}	2.24^{c}
Untreated inoculated control	0.0	20.56^{a}	3.98^{a}
Cadusafos 10% G	0.12g	17.5^{bc}	3.38^{b}
Furdan 10% G	0.12g	18.56^{abc}	3.74^{ab}
Gupter 10% G	0.14g	19.6^{ab}	3.93^{ab}
Mocap 15% G	0.14g	18.46^{abc}	3.71^{ab}
Oxamyl 24% SL	0.12 ml	17.33^{c}	3.38^{b}
Malathion	0.2ml	16.89^{c}	3.71^{ab}
Methomyl	0.12ml	17.51^{bc}	3.71^{ab}

Each column's values followed By the same letter (s), there is little different according to Duncan multiple range test at 0.05 level.

According to observations made by numerous researchers, the results of this portion of the study showed that all of the tested chemicals significantly reduced agricultural productivity and nematode reproduction (P>0.05) when compared to untreated plants (**Reddy *et al.*, 2002; Eissa *et al.*, 2007; Meher *et al.*, 2010 ; Radwan *et al.*, 2012).** The findings of this study are consistent with those of other researchers **(Giannakou *et al.*, 2005; Russo, *et al.*, 2003; Singh, 2006 and Saad *et al.*, 2011; Kesba ,2011); Saad *et al.*, 2012**), they showed that Gupter was effective against RKN *M. incognita*. Also, **Radwan *et al.*, (2012)** confirmed that gupter was the most effective treatment against the root-knot nematode population compared with four granular nematicides namely, cadusafos, carbofuran, ethoprop and oxamyl. Also, all treatments increased the plant growth indices. Furthermore **Ibrahim *et al.*, (2010)** found that gupter (Nemathorin 10% G) and methomyl (Vertemic1.8% EC) improved the weights of fresh tomatoes and the lengths of the shoots and roots. In the current experiment, Cadusafos came in second place for suppressing M. incognita, ahead of Mocap and Oxamyl. These outcomes are validated by those of **Soltani *et al.*,** (**2013)** and **El-Kholy and Anany (2010)**.

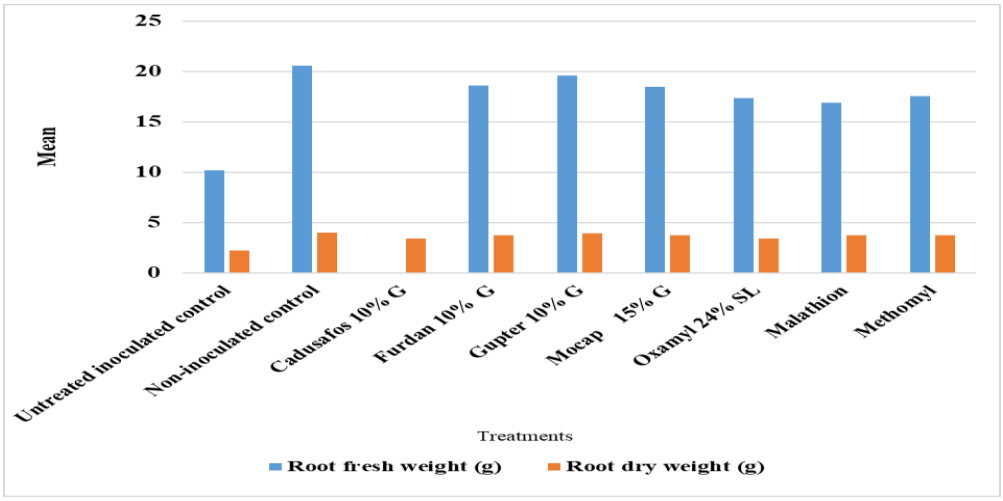

Figure (4): Impact of nematicides; Cadusafos, Furdan, Gupter, Mocap, Oxamyl, and two insecticides; Malathion and Methomyl, on M. incognita-infected eggplant plants grown in greenhouses, both fresh and dry root weights.

Also, **Raddy *et al.*, (2013)** discovered that the use of Cadusafos resulted in the greatest decrease in nematode infection. It decreased the populations of galls, J2 in the soil, root developmental stages, egg masses, and finally nematodes by 96.49, 94.57, 90, 98.56, and 99.6%, respectively. Contrarily, oxamyl provided some nematode control but cadusafos did not adequately control nematodes. This difference may be explained by the nematicide's failure to do so even at relatively high soil concentrations. **(Giannakou *et al.*, 2005)**. Also, **Khalil (2013)** showed that oxamyl and gupter recorded the highest reduction in nematode population 91.20 & 76.63%, respectively. In the present study application of malathion was the lowest effective treatment against the root-knot nematode population. This result was supported by those obtained by **Bindra** and **Kaushal (1971)** who found that malathion controlled the nematode poorly.

Conclusion

As for the effect five nematicides; Cadusafos, Furdan, Gupter, Mocap, Oxamyl, and two insecticides; Malathion and Methomyl to combat the root-knot nematode, *M. incognita* on eggplant plants in greenhouse-like surroundings.. Results indicated that all tested compounds caused significant ($p \leq 0.05$) effect in reducing the number of galls, egg-masses, eggs per 1g root and number of second stage juveniles (j_2) compared to untreated inoculated control

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