EVALUATION OF THE EFFICIENCY OF CERTAIN BIO-AGENT COMPOUNDS COMPARED WITH THE NEMATICIDE, CADUSAFOS AGAINST R00T - KNOT NEMATODE, *Meloidogyne incognita*

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ABSTRACT: The present study was conducted to evaluate the effectiveness of some bio-agent compounds, e. g., Sincocin, Nematoxin, Bio-Nematon, Nembecidin, and Bio-Nema comparing with the nematicide, cadusafos (10% G) against the root-knot nematode, *M. incognita* under laboratory and green house conditions. After one day exposure period, cadusafos and Nembecidin caused the lowest percentage of hatchability at double rate of application, while the highest percentage was at quarter rate of application of them, respectively. After 7 days, Nematoxin and Bio-Nematon were the most efficiency at double rate of application of them, respectively. Whereas the least efficiency was at quarter and double rate of application of Sincocin, respectively and quarter rate of application of Bionematon. In respect of the mortality of second stage juveniles, the highest mortality percentage after one day exposure period was at double rate of application of Nembecidin followed by cadusafos, while lowest one was at quarter rate of application of them. Similar trend were observed after 7 days of exposure period of the rest of the tested bio-agent compounds. However, Bio-Nema and Nematoxin were the most efficiency while the lowest ones were Bio-Nematon, Bio-Nema and Sincocin,. Regarding effect of application time and rate on the effectiveness of the tested bio-agent compounds against *M. incognita,* Nematoxin was the most efficiency where caused the highest percentage of reduction for the numbers of galls, J2s in soil and total number of eggs while treatment with Sincocin resulted the lowest one for the same parameters, this data when application time was after nematode infection. Treatment with Bio-Nematon resulted the highest percentage of reduction for the number of galls, J2s in soil and total number of eggs whereas treatment with Sincocin sighted the lowest ones for the same parameters, this when application time was before nematode infection. Treatment with Bio-Nema when applied before nematode infection increased the length of shoot, root and the fresh weight of shoot and root in addition of total number of leaves, whereas decreased the same parameters as a percentage when applied after nematode infection, this comparing with the control (inoculated untreated).

Keywords: Plant parasitic nematodes, bio-agent compounds, nematicides.

1. INTRODUCTION

The plant parasitic nematodes caused great economic losses to agricultural crops worldwide (**Sasser, 1979)** and are considered an economically important group of soil borne pathogens. Since nematodes are of great economic importance, much attention has been paid to their control. Root-knot nematodes *Meloidogyne incognita* (Kofoid & White) are serious pathogen of most crops causing quality defects that result in reduced crop value or crop rejection particularly in the warm climate. Root-knot nematodes cause annual losses of about 100 billion USD worldwide **(Brand *et al*., 2010**). Among various control measures, the use of nematicides has been found to be highly effective and reliable in controlling a wide range of

nematodes. On the other hand, chemical control is expensive and their residues persist in the environment for a longer period. Also, affects the beneficial soil microorganisms. Non fumigant nematicides costs are approximately 120- 220 $ / acre. All registered non fumigant nematicides are carbamates or organophosphates and 1, 3 – dichloropropene are second carcinogenic grade. All the three compounds are at the top of the "hit list" developed to implement the Food Quality Protection Act. Finally, development of natural resistance to nematicides by nematodes and the tendency to withdraw chemical pesticides/nematicides from the market led to the search for new methods of control. Hence, several biological control agents processing nematicidal properties were investigated as possible measures for controlling the nematode disease in various crops. Therefore, there is still need for alternatives and environmentally friendly compounds for effective nematode control. Certain safe procedures for nematode control have been developed based on bio-control agents and organic amendments, control plant parasitic nematode by reducing egg production of root – knot nematode which infects roots of several hosts **(Jatala *et al.*, 1985; Jatala 1986; Prakob *et al.*, 2007 and Shahnaz *et al.*, 2008).** Research on the possible mechanisms involved in biological control by bio-agents has led to several alternative explanations for successful bio control. Based on this background, greenhouse experiments aimed at substituting nematicides in controlling root-knot disease of okra plants induced by *Meloidogyne* spp. using of certain bio-agent compounds. The present work was carried out to evaluate five bio agent compounds namely, Bio--Nema, Bio-Nematon, Sincocin, Nematoxin and Nembecidin to testify their efficacy on eggs and larvae (J2) for *Meloidogyne* spp. *in vitro* as well as their effect on the pathogen root- knot nematode, *Meloidogyne incognita* and the host (okra plants) under greenhouse conditions to avoid the hazards of chemicals.

2. MATERIALS AND METHODS

2.1. The plant parasitic nematodes.

2.1.1. Root-knot nematode culture:

Culture of *Meloidogyne incognita* was maintained on eggplant plants (*Solanum melongena* cv. Black Beauty) growing in 20 cm diameter clay pots filled with steam sterilized soil comprised of 1 clay: 2 sand (v /v) . Infected plants were placed in a greenhouse at 25 ± 5 ºC and watered regularly. Two months later, infected roots were cut down into pieces and used as sources of inoculation for other healthy eggplant seedlings. By repeating this procedure, enough quantities of *M. incognita* inocula were obtained for other experiments. Mature egg- masses obtained from the source cultures were put in sterilized water in Petri-dishes for hatching of second stage juveniles (J_2s). The emerged J_2s were collected and refrigerated at 9^0C for the experimental use.

2.1.2. Hatchability of eggs and mortality of J_2s, *M. incognita* treatments:

For testing the nematicidal efficiency of tested bio-agent compounds, five rates of each bio-agent compound were prepared: 1/4, 1/2, 1, 2 and 4 rate of application. A volume of 10 ml from each rate was transferred to Petri-dishes. About1000 eggs or 300 newly hatched second juvenile stage larvae (J2s) of *M. incognita* were transferred to each Petri- dish. Three replicates were used per each rate and free distilled water served as controls. In case of the nematicide, cadusafos and a bio-agent compound, Nembecidin treatments, larval mortality count and egg hatchability were determined after 1 day, while the other compounds were obtained after 7 days, respectively. Percentages of mortality were corrected according to **Abbott (1925).**

Abbott's formula (% mortality) =

$$\frac{\text{Dead in treatment} - \text{Dead in control}}{100 - \text{Dead in control}} \times 100$$

2.1.3.Determination of nematode parameters:

Soil of each pot were soaked in a bucket half-full of tap water for 15 min. Nematode extraction was conducted by sieving through 200 and 400 mesh sieves **(Goodey, 1957).** Nematodes in the suspension were obtained from the 400 mesh and extracted for 72 hours by the modified Baerman trays technique **(Goody, 1963).** The final volume of extracted suspension was adjusted to about 50 ml. The nematodes were counted using Hawksley counting slide and light microscope. The number of galls or/and egg masses per each root system were counted using dissecting microscope. Regarding estimation of the average number of eggs per an eggmass, ten egg masses were selected randomly and put in a 1% NaOCl solution for 3 min. with shaking, then the suspension of eggs was sieved through 200 and 500 mesh sieves with gentle tap water to remove the debris by the first sieve and collected the released eggs by the second one (**Hussey and Barker, 1973),** average number of eggs per an egg mass was calculated.

2.2. Determination of plant parameters:-

Shoot & root length (cm), shoot & root fresh weights (gm.) and the number of leaves /plant were counted.

2.3. Bio-agent compounds and the nematicide used:

Five tested bio-agent compounds which not registed in Egypt as nematicides and a registed nematicide, cadusafos were illustrated in Table (1).

Table (1): The tested bio- agent compounds and the nematicide, cadusafos.

Commercial name	Essential components / Concentration	The rate of application
Bio-Nema	*Bacillus penetrans* ($32x10^3$ spores /g) Liquid	10 L / feddan
Bio-Nematon	*Paecilomyces Lilacinus* ($1x10^9$ CFU's/ml) - Liquid	2 L / feddan
Nematoxin	Plant extracts 25% - Liquid	1.5 L / feddan
Nembecidin.	*Azadirachtin* 0.03 % – EC.	1 L / feddan
Sincocin	Plant extracts of *Rhizopgora mangle , Rhus aromatic* (sumac), *Quercus falcate ,Opunita lindheimeria (Prickly Peasrcactus)*and (Magngrove) – Liquid.	0.4 L / feddan
Rugby (Common name: cadusafos)	S, S-di-sec-butyl O-ethyl phosphorodithioate (10 %) - Granules.	20kg / feddan

2.4. Green house experiments:

To study the effect of time and the rate of applications on the efficiency of the tested compounds against root-knot nematode, *M. incognita* on okra plants, the following conducted experiments. Five seeds of okra plants (*Hibiscus esculentus*, cv. Balady) were sowed in each pot then seedlings were thinned after ten days to one/pot. Four replicates were used for each treatment. Each pot was inoculated with about 2000 newly hatched second stage juveniles (J2s) of *M. incognita* by pipetting the inoculum suspension into 5 cm deep holes around the rhizosphere. Immediately after inoculation the holes and roots were covered with soil and watered. The proper amount of tested bio-agent compound was added to each procedures were carried out using clay pots (15 cm diameter). Soil was autoclaved before used in the experiment. Autoclaved soil was used as 1 kg/pot in all

pot according to the experimental aim. For testing the effect of application time and rate on the effectiveness of the bio-agent compounds and cadusafos (10% g) against *M. incognita*, The tested bio-agent compounds were used at three rates, R (Recommended rate); 1/2 R and 2 R. These tested compounds were applied one week after or before nematode inoculation. The plants were plucked after 45 days from inoculation. Numbers of galls, egg masses per root system and number of second stage larvae in the soils were counted. Average number of eggs per an egg mass was calculated. Also the plant growth parameters were determined; shoot & root length (cm), shoot & root fresh weights (gm.) and the number of leaves /plant were counted.

2.5. Statistical Analysis:

Obtained results were analyzed using proc. ANOVA in SAS Mean Separation which conducted using Duncan's multiple range tests in the same program.

3. RESULT AND DISCUSSION

3.1. Effectiveness of the tested bio-agent compounds on the hatchability of eggs and mortality of J_2s, *M. incognita.*

Data given in Table (2) revealed that, there were a highly difference in the eggs hatchability as affected by the tested bio-agent compounds, Nembecidin and the nematicide, cadusafos. After one day exposure period, the lowest percentages of hatchability were 21.7% and 19.1for cadusafos, and (4 rate of application) of Nembecidin respectively, while, the highest percentages were 43.8 and 40.1 % at (¼ rate of application) of each cadusafos and Nembecidin, respectively. 7 days after application, the lowest percentages were 20.9 and 37.9% at (4 rate of application) of Nematoxin and Bio-nema, respectively. Whereas, the highest percentages resulted in decreasing percentages of eggs hatchability. Data in Table (3) indicated that, the highest mortality percentage after one day exposure period were 89 and 83% at (4 rate of application) of each Nembecidin and cadusafos, respectively. While the lowest ones were 20 and 25% at (¼ rate of application) of each cadusafos and Nembecidin, respectively. Similar trend was observed after 7 days of exposure period of the rest of the tested bio-agent compounds. However, the highest mortality percentages were 96 and 53% at (4 rate of application) of Nematoxin and Bio-Nema, respectively, while the lowest ones at (1/4 rate of application) were 0.0, 9 and 9% of Bio-Nematon, bio-Nema and Sincocin, respectively. Increasing rates resulted in increasing mortality percentage. It could be concluded that the tested bio-agent compounds and cadusafos achieved double effect on the egg hatchability and mortality of J2s of *M. incognita.* The obtained results are supported in part by the findings of **Khanna and Kumar (2006),** which tested or evaluated some formulations such as Neem Jeevan, Neemark, Neem Gold, Achook and Kranti some leaf extracts against *M. incognita*, in terms of their effect on egg hatchability and juvenile mortality. They found that, significantly reduction in egg hatching and increasing in the mortality percentage of J2s of *M. incognita* at all the tested levels, in comparison with control. Also the nematicidal activity increased with the increase of the concentration and the exposure period of the nematode. The effect of Nembecidin may be due to its components such as, azadirachtin and other limonoids like meliantriol, salanin, nimbin and the most of other terpinoids in the ratio as it occurs in neem in nature. In respect of Bio-Nematon, there were multitude investigations interpreted the actions of *P. lilacinus* on plant parasitic nematodes as follow, **Jatala *et al.* (1985)** mentioned that, *P. lilacinus* caused substantial egg deformation in *M. incognita*, these deformed eggs never matured or hatched and killing juveniles and females of *M. incognita*. In the laboratory test this fungus infects eggs of *M. incognita* and destroys the embryos within 5 days because of simple penetration of the egg cuticle by individual hypha aided by mechanical and/or enzymatic activities **(Jatala 1986).** Also, *P. lilacinus* suppressed root- knot infections which

resulted in fewer galls developing in the root system **(Prakob *et al.*, 2007).** The serine protease produced by *P. lilacinus* might play a role in penetration of the fungus through the eggshell of the nematodes **(Bonants *et al.* 1995).** It is obvious that, *Paecilomyces lilacinus* is a cosmopolitan facultative pathogen of nematode juveniles and eggs (**Omaima *et al.*, 2012**). With regard to the bio-agent compound, Sincocin, no reports are available in literature illustrating the role of Sincocin in controlling plant parasitic nematodes. Although the compound had a considerable effect on the nematodes, the doses used in this trial are considered so high. In addition, the non-trend of the concentrations tested may be due to that Sincocin contains the plant growth regulator, cytokinin which may alter the susceptibility of the plant to nematode infection. Such alteration varied according to cytokin in concentration **(Nyczepir and Wood, 1988).** In relation to the bio- agent compound, Bio-Nema, Larvae of *Meloidogyne* spp. were readily infected with the endoparasite *Bacillus penetrans* by exposure to an aqueous suspension of spores from infected root-knot nematode females or by passage of larvae. Infection severely reduced motility of second-stage larvae or causes the death. Also**, Shahnaz *et al.*, (2008)** reported that, application of *Bacillus* spp. significantly reduced hatching juveniles of *M. javanica* and mortality percentage of juveniles was significantly increased with increasing of exposure period.

Table (2): Hatching percentage of *M. incognita* eggs as affected by different rates of the bio- agent compounds under laboratory conditions.

Exposure period	Treatment	Hatching %at different rates of application				
		1/4 Rate of application	1/2 Rate of application	Rate of application	2 Rate of application	4 Rate of application
1 day	Nembecidin	40.1	33.0	25.1	22.8	19.1
	cadusafos	43.8	36.2	30.7	26.3	21.7
7 days	Bio-Nema	50.6	56.4	56.4	40.2	37.9
	Bio-Nematon	76.2	69.0	56.37	54.3	48.1
	Sincocin	88.7	38.5	68.5	66.4	61.8
	Nematoxin	43.3	34.8	28.4	24.4	20.9

Table (3): Mortality percentage of *M. incognita* J2 as affected by different rates of the bio- agent compounds under laboratory conditions.

Exposure period	Treatment	Mortality% at different rates of application				
		1/4 Rate of application	1/2 Rate of application	Rate of application	2 Rate of application	4 Rate of application
1 day	Nembecidin	25	64	71	81	89
	cadusafos	20	36	54	69	83
7 days	Bio-Nema	9	25	40	55	53
	Bio-Nematon	0	1	5	13	26
	Sincocin	9	20	25	31	36
	Nematoxin	61	68	80	85	96

3.2. Greenhouse experiments.

3.2.1. Effect of application time and rate on the effectiveness of the tested bio-agent compounds against *M. incognita.*

Data given in Table (4) demonstrated the effect of the timing of application of the tested bio-agent compounds: Bio-Nema, Bio-Nematon, Sincocin, Nematoxin, Nembecidin and the chemical nematicide, cadusafos (G 10%) on the reproduction of nematode, *M. incognita*

infecting okra plants. Data illustrated that, all the tested compounds reduced number of galls, J2s in soil, number of eggs/ an eggmass, eggmasses and total number of eggs when applied before or after nematode inoculation. At the rate of application; treatment with Nematoxin when applied after nematode infection, caused the highest percentage of reduction for the numbers of galls, J2s in soil and total number of eggs (30.51, 38.20 and 30.10%, respectively), while treatment with Sincocin gave the lowest ones for the same parameters (1.81, 15.19 and 14.16%) respectively. On the other hand, treatment with Bio-Nematon when applied before nematode infection, gave the highest percentage of reduction for the number of galls, J2s in soil and total number of eggs (37.14, 55.83 and 48.40%) respectively, whereas treatment with Sincocin gave the lowest ones for the same parameters (29.99, 32.66 and 24.18%), respectively. Generally, application of the bio-agent compounds and the nematicide, cadusafos more effective when applied before nematode inoculate. With regard to the positive effect of the tested compounds comparing with their controls, on the growth of the infected okra plants with *M. incognita*, the data in Table (5) indicated that, treatment with Bio-Nema when applied before nematode infestation increased the length of shoot (7.9%), root (9.91%) and the fresh weight of shoot (22.48%) and root (16.44%) as well as total number of leaves (19.17%), in the while, increase comparing with the same comparative parameters with a percentage of 0.6, 1.29, 10.66, 0.34 and 0.0% respectively, when applied after nematode infestation. Also, data shown in Table (5) indicated that, there were a slightly differences among the bio-agent compounds on the growth parameters of okra plants within the same rate of application and in the same time. In contrast, the treatment with the nematicide, cadusafos, significantly increased the length of shoot (19.05%) and root (32.76%), fresh weight of shoot (59.94%) and root (57.53%) and number of leaves (37.5%) when applied before nematode infection, while the percentage of the same parameters increased about 13.69, 16.38, 49.86, 23.29 and 31.25%, respectively when applied after nematode infestation. However the present data are in agreement with **Walia *et al.* (1991),** who mentioned that, *Paecilomyces lilacinus* was applied either as a soil treatment 10 days before/after sowing as seed treatment or in different combinations to sandy soil planted with okra plants. Fungus aplication, in general, resulted in better top growth of okra, also, root galling was significantly reduced in all fungus treatments and proved better than carbofuran (1 kg a.i. /ha) in gall suppression. As mode of action of *Paecilomyces lilacinus* fungus, as observed by transmission electron microscopy, fungal hypha penetrated the *M. javanica* female cuticle directly **(Khan *et al.* 2006). Mahgoob and El-Tayeb (2010)** reported that, the nematicidal effect of the plant growth promoting bacteria (PGPB), *Paenibacillus polymyxa* UBF 15, *Bacillus megaterium* UBF 10 and *B. circulans* UBF 20 when applied two days before nematode-infestation was higher control compared with the application two days after infestation. **Farahat *et al.* (1993)** found that, the application of Sincocin after nematode inoculation significantly decreased numbers of the hatched juveniles and egg masses but without distinct trend. Double treatment of Sincocin gave the best results in reducing numbers of nematodes in soil. The addition of the compound one week after nematode inoculation resulted in a significant increase in shoot fresh and dry weights compared with the check, but without significant differences between concentrations. The failure of the high concentrations of Sincocin in reducing the numbersof nematodes may be due to cytokinin accumulation in plant roots may be justified by that cytokinin altered the resistant tomato cultivar, Y-91 to be susceptible to the root-knot nematode, *M. igcognita* **(Dropkin *et al.*, 1969).**

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Table (4): Effect of application time and the different rates of the tested bio - agent compounds on *M. incognita* infecting okra plants.

Treatment			Nematode parameters (number / plant / pot)				
Time	Compounds	Rate of application	No. of galls	No. of J_2s In soil	No. of eggmas	average eggs /an eggmas	Total No. of eggs
After	Bio-Nema	1	204.0d-g	7933.3b-e	163.5c-g	499.0c-h	81746.8
	Bio-Nematon		215.3cde	8806.5b-e	176.3bcd	516.5b-f	91059.8
	Sincocin		215.8cd	8807.5b-e	178.0bc	529.8a-d	94360.5
	Nematoxin		191.8g-j	6417.8b-g	150.0gj	505.5c-g	75848.5
	Nembecidin		200.8fgh	7389.5b-e	165.8c-f	488.5e-i	80952.8
	cadusafos		66.0o	1547.5ghi	42.00n	230.3p	9749.3
	Bio-Nema	1/2	213.5c-f	8556.8b-e	173.8bcd	520.8a-e	90523.3
	Bio-Nematon		219.0c	9243.8bcd	184.5b	531.8abc	98115.8
	Sincocin		240.0b	10345.8bc	184.5b	542.8ab	100183.3
	Nematoxin		213.5v-f	8045.0b-e	162.8d-g	501.3c-h	81718.8
	Nembecidin		213.5c-f	8442.0b-e	171.8b-e	497.3d-h	85556.0
	cadusafos		127.5m	3932.5d-r	70.0m	262.8p	18447.3
	Bio-Nema	2	183.3jk	5522.5b-i	142.8h-k	405.0mno	58009.0
	Bio-Nematon		205.0d-g	7263.0b-f	166.5c-f	515.3b-f	86323.3
	Sincocin		203.5d-g	7705.0b-e	163.0d-j	471.5hij	77304.0
	Nematoxin		182.0j-k	5478.0b-i	142.0ijk	382.5o	54389.0
	Nembecidin		185.8ijk	5708.0b-i	139.5jk	393.3no	54870.0
	cadusafos		29.3.0b	570.0h-i	15.8o	178.0q	2813.5
Before	Bio-Nema	1	173.5k	4587.0c-i	138.3jk	410.3mno	56719.8
	Bio-Nematon		195.3g-j	1839.3a	139.5jk	421.5lmn	58819.0
	Sincocin		201.5e-h	6957.5b-f	161.5d-g	516.0b-f	83343.0
	Nematoxin		197.5ghi	6603.0b-g	145.5hij	454.5jkl	66396.5
	Nembecidin		159.0g-j	7633.8b-e	146.5hij	456.0ijk	67008.0
	cadusafos		29.0p	799.0ghi	10.8o	178.5q	1939.0
	Bio-Nema	1/2	198.3ghi	6479.5b-g	139.0jk	431.0klm	60026.5
	Bio-Nematon		203.3d-g	8138.3b-e	146.0hij	483.8f-i	70882.3
	Sincocin		223.3c	8729.0b-e	167.8c-f	516.5d-f	86733.8
	Nematoxin		198.3ghi	8182.0b-e	145.5hij	494.0e-h	72079.5
	Nembecidin		199.ghi	8221.3b-e	157.3eh	503.8c-h	79438.8
	cadusafos		83.8n	992.0ghi	45.8n	243.0p	11167.0
	Bio-Nema	2	154.8l	3330.0e-i	122.0l	390.5no	47713.8
	Bio-Nematon		168.0ijk	4115.0d-i	130.5k	406.5mno	53095.5
	Sincocin		201.5e-h	6355.3b-h	155.3f-i	479.0g-i	74349.5
	Nematoxin		188.8hij	4125.0d-i	130.5kl	398.3mno	52024.0
	Nembecidin		186.3ijk	4152.3d-i	139.0jk	398.8mno	55435.8
	cadusafos		12.8u	237.5i	3.0o	113.8r	343.0
Control inoculated untreated			276.0a	10384.8b	198.6a	552.6a	109921.8

In each column, means not followed by the same letter differ significantly from one another at the 0.05 level.

Table (5): Effect of application time and the different rates of the tested bio- agent compounds on the growth of okra plants infected with *M. incognita*.

Treatment			Plant parameters / plant				
Time	Compounds	The rate of application	Length (cm)		Fresh weight (gm)		No. of. leaves
			Shoot	Root	Shoot	Root	
Before	Bio-Nema	1	45.3efg	25.3de	8..5 fgh	3.4 fg	14.3 fgh
	Bio-Nematon		44.5g-j	25.0def	8.5fgh	3.1g-h	14.3 fgh
	Sincocin		42.5 l-o	23.0 ghi	6.7 klm	2.8 j	13.3 hij
	Nematoxin		44.5 g-j	24.0 e-h	8.4 f-i	3.1 hij	13.3 hij
	Nembecidin		44.3 g-k	24.5 d-g	7.8 g-k	3.1 hij	13.0 h-k
	cadusafos		50.0 ab	30.8 a	11.1 bc	4.6 c	16.5 abc
	Bio-Nema	1/2	43.3 j-n	23.5 f-i	7.7 g-l	3.2 ghi	13.8 ghi
	Bio-Nematon		43.3j-n	23.0ghi	7.5h-m	3.1g-j	13.0h-k
	Sincocin		42.3mno	22.8hi	4.6lm	2.9ij	11.8k
	Nematoxin		43.8h-l	23.3ghi	6.9j-m	3.0ij	11.8k
	Nembecidin		43.3j-n	23.3ghi	6.9jm	2.9ij	13.3hij
	cadusafos		48.8bv	29.5a	8.4fgh	4.1d	16.0b-e
	Bio-Nema	2	46.3ef	25.3df	9.2def	3.7ef	15.0d-f
	Bio-Nematon		45.0fgh	25.0def	9.0efg	3.6ef	15.3d-f
	Sincocin		42.8l-o	23.3ghi	6.3m	3.0ij	13.3hij
	Nematoxin		45.3efg	25.5cde	8.6e-h	3.4fgh	15.0d-f
	Nembecidin		44.8ghi	25.0def	8.5fgh	3.5ef	14.8efg
	cadusafos		50.5A	31.0a	11.2ab	5.0b	17.8a
After	Bio-Nema	1	42.25mno	23.5fi	7.68g-l	2.93ij	12.0jk
	Bio-Nematon		42.25mno	23.25ghi	7.59h0m	2.92ij	12.25jk
	Sincocin		42.5l-o	23.25ghi	6.95j-m	2.92ij	12.25jk
	Nematoxin		43.25j-n	23.5f-i	7.90g-k	2.97ij	12.5ijk
	Nembecidin		43.0k-o	23.5f-i	7.89g-k	2.93ij	11.75k
	cadusafos		47.75cd	27.0bc	10.4bcd	3.85de	15.75cde
	Bio-Nema	1/2	42.25mno	23.0ghi	7.59h-m	2.92ij	12.0jk
	Bio-Nematon		42.25mno	22.25i	7.57h-m	2.92ij	12.0jk
	Sincocin		42.0no	23.0ghi	6.94j-m	2.92ij	12.25jk
	Nematoxin		43.25j-n	23.25ghi	7.76g-k	2.97ij	12.0jk
	Nembecidin		42.75l-o	23.5fi	7.44h-m	2.93ij	12.25jk
	cadusafos		46.5de	25.75cd	9.87cde	3.55ef	15.5df
	Bio-Nema	2	43.0k-o	24.0eh	8.13i-j	2.96ij	12.25jk
	Bio-Nematon		43.0k-o	23.25ghi	7.65g-l	2.95ij	12.5ijk
	Sincocin		42.5l-o	23.25ghi	7.10i-m	2.93ij	12.0jk
	Nematoxin		43.5j-n	24.0eh	8.28f-i	3.06hij	13.25hij
	Nembecidin		43.5im	24.0eh	8.28f-i	3.02ij	13.0h-k
	cadusafos		48.0c	27.75b	10.25bc	4.05d	16.25bcd
Control inoculated untreated			42.0o	32.2ghi	6.94j-m	2.92ij	12.0jk
Control uninoculated untreated			50.75a	30.0a	12.46a	5.45a	17.25ab

In each column, means not followed by the same letter differ significantly from one another at the 0.05 level.

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الملخص العربى

تقييم فاعلية بعض المركبات الحيوية مقارنة بمبيد الكادوسافوس ضد نيماتودا تعقد الجذور (ميلودوجينى إنكوجنيتا)

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أجريت هذه الدراسة بهدف إختبار فاعلية بعض المركبات الحيوية مثل بيونيما ، بيونيماتون ، نيماتوكسين ، نيمبسيدين وسينكوسين ، مقارنة بالمبيد النيماتودى كادوسافوس ضد نيماتودا تعقد الجذور ميلودوجينى إنكوجنيتا وذلك للحد من تأثيرها الضار على النبات بالإضافة إلى تحسن نمو النبات والحفاظ على البيئة ، وقد تم إجراء هذه الدراسة على مرحلتين كما يلى:

١- إختبارات معملية: أجريت تجربتين كالآتى:

أ- إختبار فاعلية هذه المركبات على فقس بيض نيماتودا تعقد الجذور ميلودوجينى إنكوجنيتا ، وفى هذه التجربة تم إستخدام خمس معدلات وهى: معدل التطبيق ، ربع معدل التطبيق ، نصف معدل التطبيق ، وضعف معدل التطبيق ، و ضعفى معدل التطبيق ، وذلك عن طريق إضافة كل معدل إلى معلق يحتوى على ١٠٠٠ بيضة نيماتودا ثم فحص البيض بعد يوم واحد لكل من مركب نيمبسيدين و مبيد كادوسافوس ، وبعد ٧أيام لكل من المركبات بيونيما ، بيونيماتون ، وسينكوسين و النيماتوكسين وذلك لتقدير نسبة فقس البيض ، وأظهرت النتائج مايلى:

١- بعد يوم واحد من المعاملة كانت أقل نسبة فقس هى ١٩,١ و ٢١,٧ % عند ضعفى المعدل المقترح وأعلى نسبة فقس كانت ٤٠,١ و ٤٣,٨ عند ربع معدل التطبيق من النيمبسيدين و كادوسافوس على التوالى٠

٢- بعد ٧ أيام من المعاملة كانت أقل نسبة ٢٠,٩ و ٣٧,٩ عند ضعفى معدل التطبيق لكل من النيماتوكسين و البيونيما على التوالى بينما كان أعلى معدل للفقس ٨٨,٧ و ٨٣,٥ % عند ربع و نصف معدل التطبيق معدل التطبيق لمركب السينكوسين على التوالى و ٧٦,٢ % عند ربع معدل التطبيق لمركب البيونيما.

ب- إختبار فاعلية هذه المركبات على موت الطور اليرقى الثانى لنيماتودا تعقد الجذور ميلودوجينى إنكوجنيتا.

فى هذه التجربة تم إختبار نفس المعدلات السابقة لنفس المركبات وفترات الفحص ولكن تم إضافة هذه المعدلات إلى معلق يحتوى على عدد ٣٠٠ يرقة نيماتودا وتم حساب نسبة الموت وكانت النتائج كالآتى:

١- بعد يوم من المعاملة كانت أعلى نسبة موت هى ٨٣,٨٩ % عند ضعفى معدل التطبيق وأقل نسبة موت هى ٢٠,٢٥ عند ربع معدل التطبيق لكل من مركب النيمبسيدين و مبيد كادوسافوس على التوالى.

٢- بعد ٧ أيام من المعاملة كانت نسبة الموت ٥٣ و ٩٦% عند ضعف معدل التطبيق لمركبى بيونيما و نيماتوكسين على التوالى بينما أقل نسبة موت كانت ٥,٥ و ٩ % عند ربع معدل التطبيق لكل من بيونيما و بيونيماتون على التوالى.

٢- إختبارات نصف حقلية تحت ظروف الصوبه.

فى هذه الإختبارات تم تقييم إختبار توقيت إضافة المركبات على فاعليتها ضد نيماتودا تعقد الجذور ميلودوجينى إنكوجنيتا.

فى هذه التجربة تم إختبار ٣ معدلات من كل مركب (نصف معدل التطبيق – معدل التطبيق – ضعف معدل التطبيق) وتم إضافتها مرة قبل عدوى النباتات بمدة أسبوع و مرة أخرى بعد عدوى النباتات بمدة أسبوع على مجموعتين مختلفتين من النباتات وكانت النتائج كالآتى:

١- عند إضافة المركبات بعد عدوى النباتات كانت أعلى نسبة خفض فى تعداد العقد الجذرية و الطور اليرقى الثانى فى التربة و العدد الكلى للبيض هى (٣٠,٥١ و ٣٨,٢٠ و ٣٠,١٠) على التوالى عند معدل التطبيق لمركب نيماتوكسين ، بينما كانت أقل نسبة خفض (٢١,٨١ و ١٥,١٩ و ١٤,١٦ %) لنفس مظاهر النشاط السابقه على التوالى عند معدل التطبيق لمركب السنكوسين.

٢- عند إضافة المركب قبل عدوى النباتات بالنيماتودا كانت أعلى نسبة خفض لتعداد العقد الجذرية ، الطور اليرقى الثانى فى التربه والعدد الكلى للبيض هى (٣٧,١٤ و ٥٥,٨٣ و ٤٨,٤٠ %) على التوالى عند معدل التطبيق لمركب البيونيما ، بينما كانت أقل نسبة خفض هى (٢٩,٩٩ و ٣٢,٦٦ و ٢٤,١٨ %) لنفس مظاهر النشاط السابقه على التوالى وذلك عند معدل التطبيق لمركب السينكوسين.

٣- مبيد كادوسافوس أعطى أعلى نسبة خفض على الإطلاق فى تعداد العقد الجذرية والطور اليرقى الثانى فى التربة والعدد الكلى للبيض (٨٩,٤٩ و ٩٢,٣٠ و ٩٨,٢٤ %) على التوالى عند إستخدام المعدل الموصى به قبل عدوى النباتات بالنيماتودا.

٤- أظهرت إضافة المركبات قبل العدوى بالنيماتودا زيادة ملحوظة فى طول المجموع الجذرى والخضرى وكذلك وزنها مقارنة بالنباتات المصابة والغير معاملة بالمركبات.