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Comparison between the Effectiveness of Certain Insecticides and Entomopathogenic Nematodes Against Tortoise Beetle, *Cassida vittata* (Vill.) in Sugar Beet Fields and Their Side Effects on *Coccinella undecimpunctata*

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ABSTRACT

The tortoise beetle, *Cassida vittata* (Vill.) (Coleoptera: Chrysomelidae), is considered the most serious pest on Sugar beet, *Beta vulgaris* L. (Chenopodiaceae), in Egypt. Field evaluation of eight insecticides: chlorantraniliprole, thiamethoxam, lufenuron, methomyl, carbosulfan, chlorpyrifos, spinetoram and abamectin comparing with two strains of entomopathogenic nematodes, (EPNs): *Heterorhabditis bacteriophora* (H88) and *Steinernema carpocapsae* (S2) against larvae and adults of the *C. vittata* and their side effects on *Coccinella undecimpunctata* was the main goal of this wark, inhabiting sugar beet fields during 2017 and 2018 sugar beet growing seasons at a field in Biyala, Kafr El Sheikh Governorate, Egypt. Data obtained revealed that chlorpyrifos, carbosulfan and thiamethoxam were the most efficient compounds against larvae and adults of *C. vittata*. However, chlorantraniliprole, spinetoram, abamectin and methomyl demonstrated a moderate toxic effect. Moreover, lufenuron was nontoxic. Also, data showed that a low effect of entomopathogenic nematodes against *C. vittata* and safe on *C. undecimpunctata*. Whereas, all tested insecticides significantly reduced the population of *C. undecimpunctata* except lufenuron.

INTRODUCTION

Sugar beet, *Beta vulgaris* L. (Chenopodiaceae), is one of the most important economic crops in Egypt and one of the main sources for producing sugar rank with sugarcane, as it represents more than 50% of total sugar production in Egypt. Also, the sugar beet crop consumes less irrigation water and the planting period is short compared to the sugarcane crop. The sugar beet crop is attacked by many insect pests, the most important of which is the tortoise beetle, *Cassida vittata* (Vill.), (Coleoptera: Chrysomelidae), has become a notorious pest of sugar beet in Egypt within the past decade (Mahmoud *et al.*, 1973; Youssef, 1994 and Saleh *et al.*, 2009). Larvae and adults of *C. vittata* are leaf feeders. Crop loss occurs due to leaf-feeding and a reduction in sugar content of infested plants (Aly *et al.*, 1993 and Al-Habshy, 2013).

El-khouly and Omar (2002) found that the profenofos, carbosulfan were the most efficient compounds against eggs, larvae, pupae and adults of the tortoise beetle *C. vittata*. However, chlorfenapyr, demonstrates had a moderate toxic effect. But unfortunately, profenofos, carbosulfan and Chlortenapyr were more toxic effects on the associated predators *Coccinella undecimpunctata*.

Control of *C. vittata* by conventional insecticides was the main tool for combating such pests but repeated applications of insecticides on sugar beet and other crops induced many problems, including toxic and persistent environmental residue, development of pesticide-resistant strains of pests and destruction of non-target organisms particularly beneficial natural enemies.

On the other hand, the entomopathogenic nematodes (EPNs) were pathogenic to a large number of insect pests attacking many important crops in the world **(**Poinar Jr, 1990).

In this study, the efficacy of the tested insecticides and (EPNs) against *C. vittata* and their side effects on *C. undecimpunctata* were evaluated in sugar beet fields for two seasons (2017 and 2018).

MATERIALS AND METHODS

The insecticides Used:

Eight commercial insecticide formulations belonging to eight active ingredients that are available in Egypt were used in this study. These formulations are shown in Table (1).

Entomopathogenic Nematodes (EPNs):

Entomopathogenic nematodes, *Heterorhabditis bacteriophora* (H88) and *Steinernema carpocapsae* (S2) used in this study were obtained from Zoology Department, Faculty of Agriculture, Cairo, Al-Azhar University. These strains were not previously exposed to any pesticides and stored at 15 ^{o}C as aqueous suspensions in 250 ml culture flasks.

Table 1: The tested insecticide formulations.

Chemical Group	Common name	Trade name	Concentration and formulation.	Source	Rate fed.$^{-1}$	Recommended concentration in 200 L water as ppm
Avermectin	Abamectin	Vertimec	1.8%EC	Syngenta co.	80ml	7.2
Benzoylurea	Lufenuron	Match	5%EC	Syngenta co.	160 ml	40
Carbamate	Methomyl	Lannate	90%SP	DuPont USA co.	300gm	1350
	Carbosulfan	Marshal	25%WP	DuPchem co.	800gm	1000
Diamide	Chlorantraniliprole	Coragen	20%SC	DuPont USA co.	60ml	60
Neonicotinoid	Thiamethoxam	Actara	25%WG	Syngenta co.	40gm	50
Organophosphorus	Chlorpyrifos	Dorasil	48%EC	KZ co.	1000ml	2400
Spinosyn	Spinetoram	Radiant	12%SC	Dow AgroSciences co.	100ml	60

Experiments:

Experiments were conducted during 2017 and 2018 sugar beet growing seasons in Biyala, Kafr El Sheikh Governorate, Egypt. The cultivated sugar beet variety was Hosam. Normal agriculture practices were done.

1-Effects of Insecticides on *Cassida vittata*:

The present work was carried out in the private field in Biyala, Kafr El-Sheikh Governorate during two successive growing sugar beet seasons, 2017 and 2018. Treatments were distributed in a complete randomized block design with four replicates for each treatment. The area of each replicate was 1/100 of feddan (42m^2) and four replicates were used as the untreated control. All agricultural processes were carried out as usual. All tested insecticides were diluted with irrigation water. The final volume of spray solution was 200 liters per feddan (4200m^2). A knapsack sprayer (CP3) equipped with one nozzle was used, where spraying was directed to the lower surface, of sugar beet leaves as possible. Movable barriers made of muslin were placed between treatments to avoid contaminations.

2-Effects of Entomopathogenic Nematodes on *Cassida vittata*:

Seven treatments including control were used in a complete randomized block design were used. Each treatment has been divided into four plots (replicates). The area of each plot was 42 m^2 (6 x 7 m^2). Nematode suspensions of *S. carpocapsae* and *H. bacteriophora* were prepared at concentrations of (1000, 2000 and 4000 infective juveniles ml^{-1}) and applied to sugar beet plants. Sugar beet plants were sprayed with nematode suspension an hour before the sunset using a back sprayer.

Estimation of the number of *C. vittata* and *C. undecimpunctata* by chosen randomly five sugar beet plants from each replicate (20 plants per treatment) before and after 3, 7 and 14 days of spraying.

3- Analysis of Data:

Reduction percentages in the populations of studied insects were estimated according to Henderson and Tilton (1955) as follows:

$$\text{Reduction \%} = 100\left(1-\frac{\text{B x A}^{-}}{\text{A x B}^{-}}\right)$$

Where:

B =No. of individuals in treated samples after spray.

B =No. of individuals in treated samples before spray.

A =No. of individuals in control samples after spray.

A =No. of individuals in control samples before spray.

The significance of various treatments was evaluated by LSD test range test ($p < 0.01$) (Snedecor & Cochran, 1980). Data were subjected to statistical analyses using a software package CoStat® Statistical Software (2005) a product of Cohort Software, Monterey, California.

Statistical analysis was made to show if there were significant differences between treatments or not at ($p < 0.01$) according to Duncan (1955).

RESULTS AND DISCUSSION

1- Evaluation of Conventional Insecticides Effectiveness on the *Cassida vittata* under Field Conditions:

The effect of the insecticides on the reduction in the sugar beet infestation caused by sugar beet beetle *C. vittata* were summarized and discussed as follows:

Data presented in Table (2) showed that the numbers of *C. vittata* larvae and adults per five sugar beet plants during 2017 sugar beet season. It is clear that the infestation with sugar beet beetle started with few numbers of 1st and 2nd instar larvae from the first march and slightly increased gradually till the end of season. Also, all insecticide treatments high significant decreased the population of *C. vittata* except Lufenuron and methomyl were non-significant compared to the untreated check as the general mean number of *C. vittata* larvae and adult per five sugar beet plant in treated plots ranged between 4.25 and 18.59 larvae and adult, whereas it reached to 18.15 larvae and adult in untreated plots.

Comparing the efficiency of the tested insecticidal against *C. vittata*, the data presented in Table (2) revealed that spraying of carbosulfan was the most effective insecticidal treatment-induced 92.55% reduction in population, while the lufenuron was the least effective with a percent reduction of -1.32% comparing the different insecticidal against sugar beet beetle infestation. Based on the general mean reduction in sugar beet beetle infestation of these tested compounds could be arranged descendingly as the following: carbosulfan (92.55%), chlorpyrifos (85.39%), thiamethoxam (58.42%), chlorantraniliprole (49.71%), spintoram (49.20%), methomyl (21.37%), abamectin (19.71%) and lufenuron (-1.32%) reduction in a larval and adult population.

With regard to 2018 sugar beet season, Data presented in Table (3) showed a similar trend of results as in 2017 season, but the effect of tested insecticides against sugar beet beetle was relatively less than the first season, the general mean number of *C. vittata* larvae and adult per five sugar beet plant in treated plots ranged between 6.06 and 20.41 larvae and adult, while it reached to 23.97 larvae and adult in the untreated plots.

Table 2: Average numbers and percent infestation reduction of larvae and adults on five sugar beet plants of *Cassida vittata* before and after applying the tested insecticides at Kafr El-Sheikh Governorate (2017 sugar beet season).

Treatments	Average numbers (Percent infestation reduction)											
	Larva					Adult					Total	General means
	No. before spray	After 3 days	After 7 days	After 14 days	Mean	No. before spray	After 3 days	After 7 days	After 14 days	mean		
Spinetoram Radiant 12%SC	12.75	4.75 (67.57)	9.25 (55.71)	19.50 (39.59)	11.56c (54.29)	7.50	4.00 (68.52)	10.50 (35.48)	16.25 (28.44)	9.56b (44.11)	84.50	10.56b (49.20)
Chlorantraniliprole Coragen 20%SC	13.00	6.25 (58.16)	10.5 (50.70)	21.25 (35.44)	12.75bc (48.10)	10.25	7.50 (56.82)	10.50 (52.72)	17.25 (44.42)	11.37b (51.32)	96.50	12.06b (49.71)
Abamectin Vertimec 1.8 EC	9.50	8.75 (19.83)	13.5 (13.26)	18.50 (23.09)	12.56bc (18.73)	8.00	9.75 (28.07)	16.00 (7.69)	18.25 (24.66)	13.00b (20.144)	102.25	12.78b (19.43)
Lufenuron Match EC 5%	11.50	13.75 (-4.07)	18.75 (0.48)	31.00 (-6.47)	18.75a (-3.35)	9.50	17.25 (-7.16)	19.75 (4.05)	27.25 (5.26)	18.43a (0.72)	148.75	18.59a (-1.32)
Thiamethoxam Actara 25WG	12.75	4.5 (69.28)	9.75 (53.32)	13.75 (57.41)	10.18c (60.00)	11.00	7.25 (61.10)	8.00 (66.43)	19.00 (42.95)	11.31b (56.83)	86.00	10.75b (58.42)
Chlorpyrifos Dorasil48%EC	10.00	2.00 (82.59)	2.50 (84.74)	1.50 (94.08)	4.00d (87.14)	10.50	2.50 (85.95)	4.75 (79.12)	4.50 (85.85)	5.56c (83.64)	38.25	4.78c (85.39)
Methomyl Lannate 90%SP	13.00	12.50 (16.31)	15.75 (26.05)	19.25 (41.52)	15.12b (27.96)	9.75	13.75 (16.77)	19.25 (8.88)	24.00 (18.70)	16.68a (14.78)	127.25	15.90a (21.37)
Carbosulfan Marshal25%WP	12.50	1.25 (91.30)	1.00 (95.12)	1.75 (94.47)	4.12d (93.63)	11.25	2.25 (88.20)	1.75 (92.82)	2.25 (93.39)	4.37c (91.47)	34.00	4.25c (92.55)
Control	11.75	13.5 (0.00)	19.25 (0.00)	29.75 (0.00)	18.56a (0.00)	9.00	15.25 (0.00)	19.50 (0.00)	27.25 (0.00)	17.75a (0.00)	145.25	18.15a (0.00)

Data followed by the same letters are not significantly different at the 1% level by Duncan (1955).

Table 3: Average numbers and percent infestation reduction of larvae and adults on five sugar beet plants of *Cassida vittata* before and after applying the tested insecticides at Kafr El-Sheikh Governorate (2018 sugar beet season).

Treatments	Average numbers (Percent infestation reduction)										Total	General means
	Larva					Adult						
	No. before spray	After 3 days	After 7 days	After 14 days	Mean	No. before spray	After 3 days	After 7 days	After 14 days	Mean		
Spinetoram Radiant 12%SC	15.00	8.75 (50.91)	10.25 (47.02)	14.50 (39.91)	12.13bc (45.95)	23.00	12.00 (45.68)	16.50 (47.27)	15.75 (48.34)	16.81b (50.10)	115.75	14.47c (48.02)
Chlorantraniliprole Coragen 20%SC	13.25	6.75 (57.13)	9.25 (45.88)	11.25 (47.22)	10.13cd (50.08)	18.75	11.50 (46.72)	8.00 (68.64)	14.25 (42.67)	13.13c (52.68)	93.00	11.63d (51.38)
Abamectin Vertimec 1.8 EC	13.50	11.75 (26.76)	11.75 (32.52)	16.75 (22.87)	13.44b (27.39)	18.50	16.75 (21.35)	15.00 (40.40)	18.75 (23.54)	17.25b (28.43)	122.75	15.34c (27.91)
Lufenuron Match EC 5%	16.25	18.25 (5.50)	18.75 (10.54)	27.25 (-4.24)	20.13a (3.93)	17.50	20.25 (-0.52)	23.75 (0.24)	21.25 (8.40)	20.69b (2.71)	163.25	20.41b (3.32)
Thiamethoxam Actara 25WG	15.25	6.50 (64.13)	5.75 (70.77)	6.00 (75.54)	8.38d (70.15)	19.50	7.00 (68.82)	5.75 (78.33)	9.00 (65.18)	10.31cd (70.77)	74.75	9.34e (70.46)
Chlorpyrifos Dorasil48%EC	15.75	2.75 (85.31)	2.50 (87.69)	3.50 (86.19)	6.13e (86.40)	19.50	5.25 (76.61)	2.50 (90.58)	5.75 (77.76)	8.25d (81.65)	57.50	7.19f (84.02)
Methomyl Lannate 90%SP	13.50	10.25 (36.11)	13.00 (25.34)	18.00 (17.12	13.69b (26.19)	20.50	16.50 (30.08)	19.50 30.08)	21.25 (21.80)	19.44b (27.32)	132.50	16.56c (26.76)
Carbosulfan Marshal25%WP	13.50	1.50 (90.65)	1.50 (91.39)	2.25 (89.64)	4.69e (90.56)	21.25	3.25 (86.71)	2.00 (93.08)	3.25 (88.46)	7.44d (89.42)	48.50	6.06f (89.99)
Control	17.25	20.50 (0.00)	22.25 (0.00)	27.75 (0.00)	21.94a (0.00)	21.50	24.75 (0.00)	29.25 (0.00)	28.50 (0.00)	26.00a (0.00)	191.75	23.97a (0.00)

Data followed by the same letters are not significantly different at the 1% level by Duncan (1955).

Our results are in agreement with data obtained by Bassyouny and Bleih (1996) who found that carbosulfan and profenofos were the best compounds in reducing the adults of *C. vittata*. El-Khouly (1998) stated that profenofos was the most effective insecticide against the immature stages of tortoise beetle, *C. vittata*. They added that a successful reduction in the adult population was also recorded by spraying infested sugar beet plants with profenofos and carbosulfan. Abo El-Naga (2004) found that Selecrone was the most effective insecticide followed by Marshal as they induced high initial and long residual effect against both adults and larvae of *C. vittata*. Abdou (2009) found that carbosulfan was the most effective against *C. vittata* compared with the other four compounds where carbosulfan caused an 82.3% decrease in the adult population. The efficiency of tested compounds can be arranged as follows: Marshal > Achook > Bancol > Pymetozine > Alkanz. Shaheen *et al.* (2011) found profenofos and carbosulfan were the most efficient compounds against larvae and adults of *C. vittata.* However, spintoram demonstrated a moderate toxic effect.

On the other hand, Abo El-Ftooh *et al.* (2013) evaluated the efficacy of the three pesticides (spinetoram, acetamiprid and chlorpyrifos) for reducing the population density of beetle. They found that the spintoram was more toxic against tortoise beetle, *C. vittata* (Larvae and Adults) through two seasons.

2- Efficiency of Entomopathogenic Nematodes (EPNs) on Controlling *Cassida vittata*:

Tow strain of (EPNs) *Heterorhabditis bacteriophora* (H88) and *Steinernema carpocapsae* (S2) were prepared as a suspension in three concentrations (1000, 2000 and 4000 IJs ml^{-1}) to controlling *C. vittata*.

Data in Table (4) revealed that all treatments were non significantly decreased the population of *C. vittata* except the treated with *S. carpocapsae* at (1000 and 4000 IJs ml^{-1}) compared to the untreated check during 2017 season as the general mean number of *C. vittata* larvae and adult per five sugar beet plant in treated plots ranged between 17.75 and 13.59 larvae and adult, whereas it reached 18.50 larvae and adult in untreated plots.

Regarding the effect of sprays with *S. carpocapsae* at (4000 IJs ml^{-1}) induced the highest effect representing 26.82% reduction in population. Whereas the lowest effect of 4.05 % was obtained in the case of *H. bacteriophora* at (1000 IJs ml^{-1}). The rest treatments could be arranged descendingly as follows in Table (4). *S. carpocapsae* at (4000 IJs ml^{-1}) 26.8% followed by *H. bacteriophora* at (4000 IJs ml^{-1}) 16.15%, *S. carpocapsae* at (2000 IJs ml^{-1}) 11.78%, *S. carpocapsae* at (1000 IJs ml^{-1}) 7.26%, *H. bacteriophora* at (2000 IJs ml^{-1}) 6.99% *H. bacteriophora* at (1000IJs ml^{-1}) 4.05% reduction.

With regard to 2018 sugar beet season, Data presented in Table (5) showed a similar trend of results as in 2017 season.

Saleh *et al*. (2009) they tested four EPNs of the genera *Heterorhabditis* and *Steinernema* for their ability to control the beet beetle *C. vittata*. In the laboratory, they found the all-tested nematodes succeeded in invading and developing in all insect stages in variable extents depending on nematode species, concentration and exposure time. To our knowledge, this is the first report on the efficiency of EPNs against the sugar beet beetle, *C. vittata*. No literature citations were found on the effect of EPNs on *C. vittata*. They found that the single application of *S. carpocapsae* S2 in the field killed 65% of the larvae, 92% of the pupae and 57.3% of the adults of *C. vittata* within a week.

Table 4: Average numbers and percent infestation reduction of larvae and adult on five sugar beet plants of *Cassida vittata* before and after applying the tested EPNs at Kafr El-Sheikh Governorate (2017 sugar beet season).

Treatments	Average numbers (Percent infestation reduction)										Total	General means
	Larva					Adult						
	No. before spray	After 3 days	After 7 days	After 14 days	mean	No. before spray	After 3 days	After 7 days	After 14 days	Mean		
S. carpocapsae at 1000 IJs ml-1	8.50	7.50 (23.20)	13.50 (3.06)	21.25 (1.26)	12.69b (9.17)	7.75	12.75 (2.91)	16.75 (0.25)	22.50 (12.90)	14.94bc (5.35)	110.50	13.81b (7.26)
S. carpocapsae at 2000 IJs ml-1	10.00	9.25 (19.49)	14.00 (14.55)	25.25 (0.27)	14.63ab (11.44)	9.75	16.50 (0.13)	18.50 (12.43)	24.75 (23.85)	17.38ab (12.13)	128.00	16.00ab (11.78)
S. carpocapsae at 4000 IJs ml-1	9.75	6.25 (44.21)	14.25 (10.79)	23.75 (3.79)	13.50b (19.60)	9.25	9.50 (39.39)	11.75 (41.37)	24.25 (21.35)	13.69c (34.04)	108.75	13.59b (26.82)
H. bacteriophora at 1000 IJs ml-1	8.00	8.50 (7.52)	13.00 (0.81)	23.00 (-13.55)	13.13b (-1.74)	10.25	16.75 (3.56)	21.75 (1.06)	26.00 (23.90)	18.69a (9.44)	127.25	15.91ab (4.05)
H. bacteriophora at 2000 IJs ml-1	9.00	7.75 (25.05)	14.25 (3.35)	21.75 (4.55)	13.19b (10.99)	8.75	16.00 (-7.92)	20.25 (-6.81)	22.25 (23.71)	16.81abc (3.00)	120.00	15.00ab (6.99)
H. bacteriophora at 4000 IJs ml-1	11.50	11.00 (16.75)	16.75 (11.10)	26.00 (10.71)	16.31ab (12.85)	11.50	16.75 (14.04)	20.75 (16.72)	27.75 (27.61)	19.19a (19.46)	142.00	17.75a (16.15)
Control	11.75	13.50 (0.00)	19.25 (0.00)	29.75 (0.00)	18.56a (0.00)	9.00	15.25 (0.00)	19.50 (0.00)	30.00 (0.00)	18.44ab (0.00)	148.00	18.50a (0.00)

Data followed by the same letters are not significantly different at the 1% level by Duncan (1955).

Table 5: Average numbers and percent infestation reduction of larvae and adults on five sugar beet plants of *Cassida vittata* before and after applying the tested EPNs at Kafr El-Sheikh Governorate (2018 sugar beet season).

Treatments	Average numbers (Percent infestation reduction)										Total	General means
	Larva					Adult						
	No. before spray	After 3 days	After 7 days	After 14 days	mean	No. before spray	After 3 days	After 7 days	After 14 days	Mean		
S. carpocapsae at 1000 IJs ml-1	16.00	16.25 (14.54)	19.25 (6.72)	23.75 (7.73)	18.81a (9.66)	17.75	20.25 (0.90)	22.50 (6.83)	24.50 (-4.13)	21.25ab (1.20)	160.25	20.03b (5.43)
S. carpocapsae at 2000 IJs ml-1	15.25	14.75 (18.61)	20.00 (-1.68)	23.75 (3.19))	18.44a (6.71)	19.25	19.25 (13.13)	22.25 (15.04)	19.50 (23.58)	20.06ab (17.25)	154.00	19.25b (11.98)
S. carpocapsae at 4000 IJs ml-1	13.75	7.00 (57.16)	10.75 (39.39)	21.25 (3.93)	13.19b (33.49)	16.00	10.00 (45.71)	18.50 (15.01)	16.75 (21.03)	15.31b (27.25)	114.00	14.25c (30.37)
H. bacteriophora at 1000 IJs ml-1	16.50	19.50 (0.55)	20.25 (4.85)	25.00 (5.81)	20.31a (3.74)	17.50	17.00 (15.61)	20.75 (12.84)	23.75 (-2.38)	19.75ab (8.69)	160.25	20.03b (6.22)
H. bacteriophora at 2000 IJs ml-1	15.50	16.50 (10.42)	19.50 (2.46)	26.50 (-6.28)	19.50a (2.20)	20.00	24.25 (-5.33)	23.00 (15.47)	23.00 (13.25)	22.56a (7.80)	168.25	21.03b (5.00)
H. bacteriophora at 4000 IJs ml-1	14.25	16.00 (5.52)	21.25 (15.61)	24.25 (-5.78)	18.94a (-5.29)	19.75	20.50 (9.83)	20.75 (22.77)	22.50 (14.06)	20.88ab (15.55)	159.25	19.91b (5.13)
Control	17.25	20.50 (0.00)	22.25 (0.00)	27.75 (0.00)	21.94a (0.00)	21.50	24.75 (0.00)	29.25 (0.00)	28.50 (0.00)	26.00a (0.00)	191.75	23.97a (0.00)

Data followed by the same letters are not significantly different at the 1% level by Duncan (1955).

3- The Side Effect of The Tested Insecticides against *Coccinella undecimpunctata*:

The results presented in Table (6) revealed that during 2017 season the population density of *C. undecimpunctata* decreased high significantly in all insecticide treatments except lufenuron compared to untreated plots. The mean number of *C. undecimpunctata* in treated plots ranged between 2.81 and 11.94 individuals per five sugar beet plants, whereas it was 9.5 individuals in untreated plots. Also, data in Table (6) indicated that all insecticides were more toxic on *C. undecimpunctata* except lufenuron compared to untreated plots. The present of reduction could be arranged descendingly as follows chlorpyrifos (89.72%), methomyl (78.07%), thiamethoxam (59.47%), abamectin (27.42%), spintoram (24.17%), carbosulfan (23.77%), chlorantraniliprole (11.90%), and lufenuron (-15.81%) reduction in adult population. With regard to 2018 sugar beet season,

Data presented in Table (7) showed a similar trend of results as in 2017 sugar beet season.

The high toxicity of methomyl and chlorpyrifos-methyl formulations for this insect has been observed by Youn *et al.* (2003) who stated that some of the ladybird beetles are susceptible to chemical insecticides chlorpyrifos and pirmicarb at the recommended rates.

On the contrary to our results regarding methomyl, the selectivity of carbamates may be associated with changes in the acetylcholinestase enzyme in the body of predators and parasitoids or to the higher speed with which the acetylcholinestase enzyme catalyzes the hydrolysis of the neurotransmitter acetylcholine in insects, compared to the speed in pests (Silver *et al.*, 1995). The selectivity of the carbamates may also be associated with their higher metabolization rate by beneficial insects than by pests by P450-depending monooxygenase enzymes (Brattsten *et al.*, 1986).

Table 6: Average numbers and percent infestation reduction of an adult on five sugar beet plant of *Coccinella undecimpunctata* before and after applying the tested insecticides at Kafr El-Sheikh Governorate (2017 sugar beet season).

Treatments	Average numbers						percent infestation reduction			
	No. before spray	After 3 days	After 7 days	After 14 days	Total	Mean	After 3 days	After 7 days	After 14 days	Mean
Spintoram Radiant 12%SC	5.75	4.00	7.25	4.75	21.75	5.44b	51.61	6.17	14.73	24.17
Chlorantraniliprole Coragen 20%SC	4.50	3.75	4.50	5.75	18.50	4.63b	42.03	25.58	-31.90	11.90
Abamectin Vertimec 1.8 EC	6.25	5.00	4.25	6.75	22.25	5.56b	44.35	49.40	-11.48	27.42
Lufenuron Match EC 5%	9.25	12.75	11.50	14.25	47.75	11.94a	4.11	7.48	-59.02	-15.81
Thiamethoxam Actara 25WG	5.00	0.50	2.50	3.75	11.75	2.94b	93.04	62.79	22.58	59.47
Chlorpyrifos Dorasil48%EC	8.50	0.00	0.75	2.00	11.25	2.81b	100.00	93.43	75.71	89.72
Methomyl Lannate 90%SP	11.00	0.00	1.75	5.75	18.50	4.63b	100.00	88.16	46.04	78.07
Carbosulfan Marshal25%WP	3.75	1.00	4.00	4.75	13.50	3.38b	81.45	20.62	-30.75	23.77
Control	8.00	11.50	10.75	7.75	38.00	9.50a	0.00	0.00	0.00	0.00

Data followed by the same letters are not significantly different at the 1% level by Duncan (1955).

Table 7: Average numbers and percent infestation reduction of an adult on five sugar beet plant of *Coccinella undecimpunctata* before and after applying the tested insecticides at Kafr El-Sheikh Governorate (2018 sugar beet season).

Treatments	Average numbers						percent infestation reduction			
	No. before spray	After 3 days	After 7 days	After 14 days	Total	Mean	After 3 days	After 7 days	After 14 days	Mean
Spintoram Radiant12%SC	9.75	8.25	7.25	9.50	34.75	8.69b	21.77	-1.21	22.99	14.52
Chlorantraniliprole Coragen 20%SC	7.75	6.00	3.50	8.50	25.75	6.44bc	28.42	38.53	13.32	26.76
Abamectin Vertimec 1.8 EC	5.25	5.50	4.00	5.00	19.75	4.94cd	3.14	-3.70	24.73	8.06
Lufenuron Match EC 5%	9.00	8.75	10.00	9.25	37.00	9.25b	10.12	-51.23	18.77	-7.45
Thiamethoxam Actara 25WG	4.25	0.00	0.50	0.75	5.50	1.38d	100.00	83.99	86.05	90.01
Chlorpyrifos Dorasil48%EC	6.00	0.00	0.25	2.00	8.25	2.06d	100.00	94.33	73.66	89.33
Methomyl Lannate 90%SP	11.25	0.50	6.50	9.00	27.25	6.81bc	95.89	21.36	36.77	51.34
Carbosulfan Marshal25%WP	9.25	0.25	0.50	3.00	13.00	3.25cd	97.50	92.64	74.37	88.17
Control	12.25	13.25	9.00	15.50	50.00	12.50a	0.00	0.00	0.00	0.00

Data followed by the same letters are not significantly different at the 1% level by Duncan (1955).

4- The Side Effect of The Entomopathogenic Nematodes (EPNs) against *Coccinella undecimpunctata:*

Data presented in Table (8) show the during seasons 2017 all treatments were non significantly decreased the population of *C. undecimpunctata*. The mean number of *C. undecimpunctata* in treated plots season 2017ranged between 6.38and 8.81 individuals per five sugar beet plant, whereas it was 9.50 individuals in untreated plots. While the reduction percentages ranged between 5.55 and 18.37 % in season 2017. With regard to 2018 sugar beet season,

Data presented in Table (9) showed a similar trend of results as in 2017 season. Garriga *et al.* (2019) found that the EPNs persistence only half of the nematodes applied were still alive after seven hours. The three EPNs proved to be harmless to the natural enemies tested, with the discontinuous contact that a plant pot experiment involves. These results showed good compatibility between the natural enemies and EPNs tested, which should be confirmed in field conditions.

Table 8: Average numbers and percent infestation reduction of larvae on five sugar beet plant of *Coccinella undecimpunctata* before and after applying the tested EPNs at Kafr El-Sheikh Governorate (2017 sugar beet season).

Treatments	Average numbers						percent infestation reduction			
	No. before spray	After 3 days	After 7 days	After 14 days	Total	Mean	After 3 days	After 7 days	After 14 days	Mean
S. carpocapsae at 1000 IJs ml^{-1}	7.75	10.75	9.75	7.00	35.25	8.81a	3.51	6.38	6.76	5.55
S. carpocapsae at 2000 IJs ml^{-1}	5.75	8.00	6.75	5.00	25.50	6.38a	3.21	12.64	10.24	8.70
S. carpocapsae at 4000 IJs ml^{-1}	8.25	10.25	8.50	6.75	33.75	8.44a	13.57	23.33	15.54	17.48
H. bacteriophora at 1000 IJs ml^{-1}	6.00	6.50	8.00	6.25	26.75	6.69a	24.64	0.78	-7.53	5.96
H. bacteriophora at 2000 IJs ml^{-1}	6.75	8.00	8.50	5.75	29.00	7.25a	17.55	6.29	12.07	11.97
H. bacteriophora at 4000 IJs ml^{-1}	7.00	8.25	7.00	6.00	28.25	7.06a	18.01	25.58	11.52	18.37
Control	8.00	11.50	10.75	7.75	38.00	9.50a	0.00	0.00	0.00	0.00

Data followed by the same letters are not significantly different at the 1% level by Duncan (1955).

Table 9: Average numbers and percent infestation reduction of larvae on five sugar beet plant of *Coccinella undecimpunctata* before and after applying the tested EPNs at Kafr El-Sheikh Governorate (2018 sugar beet season).

Treatments	Average numbers						percent infestation reduction			
	No. before spray	After 3 days	After 7 days	After 14 days	Total	Mean	After 3 days	After 7 days	After 14 days	Mean
S. carpocapsae at 1000 IJs ml^{-1}	7.00	6.50	4.50	7.50	25.50	6.38a	14.15	12.50	15.32	13.99
S. carpocapsae at 2000 IJs ml^{-1}	8.75	9.25	6.25	8.25	32.50	8.13a	2.26	2.78	25.48	10.18
S. carpocapsae at 4000 IJs ml^{-1}	9.00	8.00	6.00	6.75	29.75	7.44a	17.82	9.26	40.73	22.60
H. bacteriophora at 1000 IJs ml^{-1}	10.50	9.00	7.00	12.75	39.25	9.81a	20.75	9.26	4.03	11.35
H. bacteriophora at 2000 IJs ml^{-1}	12.00	9.75	7.75	11.50	41.00	10.25a	24.88	12.09	24.26	20.41
H. bacteriophora at 4000 IJs ml^{-1}	9.75	10.25	6.50	9.50	36.00	9.00a	2.81	9.26	22.99	11.69
Control	12.25	13.25	9.00	15.50	50.00	12.50a	0.00	0.00	0.00	0.00

Data followed by the same letters are not significantly different at the 1% level by Duncan (1955).

Entomopathogenic nematodes have been proven effective in controlling some foliar pests (Trdan *et al*., 2007; Laznik *et al*., 2010 and Laznik *et al*., 2011), but they do have some negative properties. Among these, the wide spectrum of their efficacy includes a negative influence on beneficial organisms (Hazir *et al*., 2004). Up to now, the studies on the non-target effects of entomopathogenic nematodes were performed on various species of non-target organisms, and a large range - from complete harmlessness to pronounced harmful effect - was established (Bathon, 1996 and Farag, 2002). The results of some field trials show a moderate influence of entomopathogenic nematodes on non-target arthropods or even the absence of such an effect (Georgis *et al*., 1991). Bathon (1996) reports that mortality can be observed among the non-target organisms, but the influence of these agents should be temporary and local and so only a part of the population is under attack. Georgis *et al*. (1991) demonstrated a negligible influence of entomopathogenic nematodes on non-target organisms if they are used only in short-term pest control.

Farag (2002) reports high mortality of the larvae of *Coccinella undecimpunctata* Linnaeus caused by *Heterorhabditis taysearae* and *Steinernema carpocapsae* strain S2 in a laboratory assay, so the author does not recommend the use of entomopathogenic nematodes when these predators are present on the plants in a high number. Likewise, *H. bacteriophora* Poinar and *S. carpocapsae* (Weiser) species were – under laboratory conditions – very harmful to the following predators: *Coleomegilla maculata* [De Geer], *Olla v-nigrum* [Mulsant], *Harmonia axyridis* [Pallas] and *Coccinella septempunctata* L.

On the other side Shapiro-Ilan and Cottrell (2005) found the lady beetles to be substantially less susceptible to nematode infection compared with a known susceptible insect - the black cutworm (*Agrotis ipsilon* Hüfnagel).

REFERENCES

Abdou, G. Y. (2009). Use of some relatively safe compounds for controlling of the tortoise beetle, *Cassida vittata* (Vill.) in sugar beet crop. *Research Journal of Agriculture and Biological Sciences,* 5 (1):24-28.

Abo El-Ftooh, A.A.; I.M.A Gohar and M. S. Saleh (2013). Effect of some pesticides, sugar beet cultivars and their interaction on population density of tortoise beetle *cassida vittata* (vill.) and some characters of sugar beet cultivars at Nubaryia and Damanhour region. *Egyptian Journal of Agricultural Research,* (1):128-139.

Abo El-Naga, A. M. M. (2004). Ecological studies and integrated control of the sugar beet beetle, *Cassida vittata* (Vill.). *Master Science Thesis, Faculty Agricultural Tanta University,* 129 pp.

Al-Habshy, A.Z.N. (2013). The economic injury level of *Cassida vittata* (Vill.) on sugar beet plants. *Egypt Academic Journal Biological Sciences,A.Entomology,* 6(2): 159-168.

Aly, F.A.; M.M.A. Mahgoub; S. I. El-Deib and M.A. El-Hamaky (1993). Ecological studies on the tortoise beetle, *Cassida vittata* (Vill.) and the efficacy of certain chemicals in controlling this insect in sugar beet plants. *Journal Agricultural Science Mansoura University Egypt,* 18(6):1813-1824.

Bassyouny, A. M. and S. B. Bleih (1996). Sowing dates, seasonal fluctuations and chemical control against the main insects attacking sugar beet. *Alexandria Sciences Exchange, Egypt,* 17 (3): 283 - 296.

Bathon, H. (1996). Impact of entomopathogenic nematodes on non-target hosts. *Biocontrol Science and Technology,* 6: 421-434.

Brattsten, L.B.; J.R. Holyoke; J.R. Leeper and K.F. Raffa (1986). Insecticide resistance. challenge to pest management and basic research. *Sciences,* 231: 1255-1260.

CoStat Statistical Software (2005). CoHort version 6.3, Monterey, CA.

Duncan, D. B. (1955). Multiple Range and Multiple F test. *Biometrics,* 11: 1-42.

El-khouly, M. I. and B. A. Omar (2002). The efficiency of some insecticides on tortoise beetle, *Cassida vittata* Vill. inhabiting sugar beet fields. *Egyptian Journal of*

Agricultural Research, 80(2):697-708.

El-Khouly, M. I. I. (1998). Ecological studies and control of the tortoise beetle, *Cassida vittata* (Vill.) in sugar beet ecosystem. *Doctor of Philosophy Thesis, Faculty Agricultural, Al-Azhar Univ., Egypt*, 183 pp.

Farag, N. A. (2002). Impact of two entomopathogenic nematodes on the ladybird, Coccinella undecimpunctata and its pray, Aphis fabae. *Annals of Agricultural Sciences (Cairo). Faculty of Agricultural, Ain Shams Univercity, Cairo, Egypt*, 47: 431-443

Garriga, A.; A. Morton; D. García-López and F. García-del-Pino (2019). Compatibility of entomopathogenic nematodes with natural enemies for horticultural pest control. *Biological Control*, 138, 104050.

Georgis, R.; H. K. Kaya and R. Gaugler (1991). Effect of steinernematid and heterorhabditid nematodes (Rhabditida: Steinernematidae and Heterorhabditidae) on nontarget arthropods. *Environmental Entomology*, 20: 815-822

Hazir, S.; H. K. Kaya; S. P. Stock and N. Keskin (2004). Entomopathogenic nematodes (Steinernematidae and Heterorhabditidae) for biological control of soil pests. *Turkish Journal of Biology*, 27: 181-202

Henderson, C.F. and Tilton, E.W. (1955). Test with acaricides against the brown wheat mite. *Journal Economic Entomology*, 48: 157 Duncan, D.B.

Laznik, Ž.; Tóth T.; Lakatos T.; Vidrih M. and Trdan S. (2010). Control of the Colorado potato beetle (Leptinotarsa decemlineata [Say]) on potato under field conditions: acomparison of the efficacy of foliar application of two strains of Steinernema feltiae (Filipjev) and spraying with thiametoxam. *Journal of Plant Diseases and Protection*, 117: 129-135

Laznik, Ž.; Žnidarčič D. and S. Trdan (2011). Control of *Trialeurodes vaporariorum* (Westwood) adults on glasshouse-grown cucumbers in four different growth substrates: an efficacy comparison of foliar application of *Steinernema feltiae* (Filipjev) and spraying with thiamethoxam. *Turkish Journal of Agriculture and Forestry*, 35 (in press)

Mahmoud, A.; M.A. Assem; K.H. Youssef; A.A. Meshour and G.A.L. El-Imam (1973). Studies on the main pests by using some recent insecticides. *Abstracts of the 4th vegetable research conference, Alexandria University, Alexandria*, 2-4 September, 1973, p 60.

Poinar, GO Jr (1990). Biology and taxonomy of *Steinernematidae* and *Heterorhabditidae*. In: Gaugler R, Kaya HK (eds) Entomopathogenic nematodes in biological control. *CRC, Boca Raton*, pp. 23–61.

Saleh, M. M. E.; K. A. A. Draz; M. A. Mansour; M. A. Hussein and M. F. M. Zawrah (2009). Controlling the sugar beet beetle *Cassida vittata* with entomopathogenic nematodes. *Journal Pest Sciences*, 82: 289–294.

Shaheen, F. A. H.; A. A. A. Said; E. A. H. Sherief and H. A. M. Fouad (2011). Effect of certain insecticides against sugar beet beetle *cassida vittata* (vill.) (Coleoptera:Chrysomelidae) inhabiting sugar beet fields. *Journal Plant Protection and Pathological Mansoura University*, 2 (6): 597 – 607.

Shapiro-Ilan, D.I. and T. E. Cottrell (2005). Susceptibility of lady beetles (Coleoptera: Coccinellidae) to entomopathogenic nematodes. *Journal of Invertebrate Pathology*, 89: 150-156.

Silver, A.R.J.; H.F. Emden and M. Battersby (1995). A biochemical mechanism of resistance to pirimicarb in two glasshouse clones of *Aphis gossypii*. *Pesticide Sciences*, 43: 21-29.

Snedecor, G. W. and W.G. Cochran (1980). Statistical Methods. 7th Ed. The Iowa State

University Press. Ames, Iowa, U.S.A., pp. 507.

Trdan, S.; D. Žnidarčič and M. Vidrih (2007). Control of *Frankliniella occidentalis* on glasshouse-grown cucumbers: an efficacy comparison of foliar application of *Steinernema feltiae* and spraying with abamectin. *Russian Journal of Nematology*, 15: 25-34

Youn, Y.N.; M.J. Seo; J.G. Shin; C. Jang and Y.M. Yu (2003). Toxicity of greenhouse pesticides to multicolored Asian lady beetles, *Harmonia axyridis*. *Biological Control*, 28: 164-170.

Youssef, A.E. (1994). Studies on certain insects attacking sugar beet. *Doctor of Philosophy thesis Faculty of Agriculture, Tanta University, Kafr El-Sheikh.*

ARABIC SUMMARY

مقارنة بين فعالية بعض المبيدات الحشرية والنيماتودا الممرضة للحشرات على خنفساء البنجر السلحفائية كاسيدا فيتاتا فى حقول بنجر السكر وتأثيراتها الجانبية على حشرة أبو العيد

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تعتبر خنفساء البنجر السلحفائية كاسيدا فيتاتا من أخطر الآفات التى تصيب محصول بنجر السكر فى مصر. والهدف الرئيسى لهذة الدراسة هو التقييم الحقلى لفاعلية ثمانية مبيدات حشرية: الكلورانترانيليبرول والثياميثوكسام واللوفينيورون والميثوميل والكاربوسلفان وسبينتورام واباميكتين بالمقارنة مع سلالتين من النيماتواد الممرضة للحشرات (شتينرنيما كاربوكابسا و هيتيروهابيدات باكتيروفورا) ضد اليرقات والطور الكامل لخنفساء البنجر السلحفائية وتأثيراتها الجانبية على حشرة أبو العيد كوسينيلا أونديسمبنكتاتا المصاحبة لتلك الآفة فى حقول بنجر السكر خلال موسمي 2017-2018 م فى مركز بيلا محافظة كفر الشيخ مصر. حيث أظهرت النتائج التى تم الحصول عليها أن الكلوربيروفوس والكاربوسلفان والثياميثوكسام أكثر المبيدات تأثيراً على اليرقات والطور الكامل لخنفساء البنجر السلحفائية. كما وجد أن هذه المبيدات: الكلورانترانيلبرول وسبينتورام واباميكتين وميثوميل كان لها تأثير متوسط على تلك الآفة. وعلى العكس لم يكن لمبيد اللوفينيورون أى تأثير على هذه الآفة. كما أشارت النتائج أيضاً الي أن النيماتودا الممرضة للحشرات كان لها تأثير منخفض جداً على خنفساء البنجر السلحفائية فى حين كانت آمنة على أبو العيد. ومن ناحية اخري كل المبيدات المختبرة كان لها تأثر معنوى جداً في خفض تعداد حشرة أبو العيد ماعدا مبيد اللوفينيورن لم يكن لة تأثير معنوي.