

نظرة على استخدام النيماتودا الممرضة للحشرات فى مكافحة سوسة المخزن وسوسة والأرز

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الملخص العربى

أجريت هذه الدراسة بمعامل قسم الحشرات الإقتصادية والحيوان الزراعى بكلية الزراعة . جامعة المنوفية . شبيبن الكوم لمكافحة سوسة الحبوب وسوسة الأرز باستخدام النيماتودا الممرضة. اثبتت النتائج ان اكبر نسبة موت مصححة Corrected mortality من الأطوار الكاملة لسوسة الحبوب تم تسجيلها مع التركيز ٣٠٠٠ يرقة نيماتودية من جنس *Steinernema feltiae* حيث اعطت ٩٣.٥٥ % ، أما بالنسبة للنوع النيماتودى *Heterorhabditis bacteriophora* فقد تم تسجيل اكبر نسبة موت مصححة مع التركيز ١٠٠٠ يرقة نيماتودية مسجلا ٦٤.٥٢ % . وبالنسبة الى سوسة الارز فقد اثبتت النتائج ان اعلى نسبة موت مصححة من الاطوار الكاملة لسوسة الارز كانت مع التركيز ان ١٠٠٠ ، ٢٠٠٠ يرقة نيماتودية من النوع *Steinernema feltiae* معطية ٨٩.١٩ % ، اما بالنسبة لنوع النيماتودا *Heterorhabditis bacteriophora* فقد تم تسجيل اعلى نسبة موت من الاطوار الكاملة لسوسة الارز مع التركيز ٣٠٠٠ يرقة نيماتودية وصلت الى ٨٢.٣٥ %.

PROSPECT FOR THE USE OF ENTOMOPATHOGENIC NEMATODES IN THE GRANARY AND RICE WEEVILS CONTROL

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ABSTRACT: *Experiments were conducted at the laboratories of the Economic Entomology and Agricultural Zoology Department , Faculty of Agriculture, Menoufiya University, Shebin Elkom , Egypt to evaluate the possibility of using entomopathogenic nematodes, Heterorhabditis bacteriophora and Steinernema feltiae in the control of granary and rice weevils under laboratory conditions. Results indicated that the highest average of corrected mortality of Sitophilus granaries adult stages was recorded with the treatment of 3000 infective juveniles giving 93.55 % , while the highest average of corrected mortality of the S. granaries adult stages was registered with the treatment of 1000 infective juveniles of H. bacteriophora giving 64.52 % . As for the toxic effect of S. feltiae on S. oryzae adult stages, the highest averages of corrected mortality was registered with the treatments of 1000 and 2000 infective juveniles of S. feltiae giving 89.19 % , while the highest average of corrected mortality of the adult stages of S. oryzae was registered with the treatment of 3000 infective juveniles of H. bacteriophora giving 82.35 % . It could be concluded that the use of H. bacteriophora and S. feltiae in the control of stored insect products i.e. the rice weevil, Sitophilus oryzae , and the granary weevil, Sitophilus granaries registered good results , but it needs more studies.*

Key words: *Entomopathogenic nematodes, granary weevil, Sitophilus granaries, rice weevil, Sitophilus oryzae, biological control*

INTRODUCTION

In recent years it have seen an increase attention for non-chemical methods of stored-product protection, including biological control of stored-product pests (Arbogast, 1984; Brower *et al.*, 1996; Schoeller *et al.*, 1997; Adler, 1998; Cox & Wilkin, 1998; Schoeller, 1998). Entomopathogenic nematodes have not been previously tested against stored-product insects in environments such as empty grain bins or food processing and warehouse facilities, but their effectiveness at finding and infecting hosts in other cryptic habitats has been demonstrated. The use of entomopathogenic nematodes in the control of store product insects is a new field . Recently, there are a few articles were published in this direction i.e. Ramos-

Rodriguez, *et al.*, (2007) who reported that persistence of stored-product insects in hidden refuge and their subsequent movement into stored commodities resulting in product infestation contributes to their pest status and represents a potential target for biological control agents.. In laboratory bioassays, *Steinernema riobrave* reduced survival of red flour beetle, *Tribolium castaneum*, larvae, pupae and adults from $77.9 \pm 3.2\%$ in the controls to $27.4 \pm 2.5\%$ in treatments. Shahina and Salma (2009) tested seven Pakistani strains of entomopathogenic nematodes belonging to the genera *Steinernema* and *Heterorhabditis* against last instar and adult stages of the pulse beetle, *Callosobruchus chinensis*. Athanassiou, *et al.*, (2010) examined the insecticidal effect of *Heterorhabditis*

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bacteriophora Poinar , *Steinernema carpocapsae* (Weiser), and *Steinernema feltiae* (Filipjev) against Mediterranean flour moth, *Ephesia kuehniella* (Zeller) larvae, lesser grain borer, *Rhyzopertha dominica* (F.) adults, rice weevil, *Sitophilus oryzae* (L.) adults, and confused flour beetle, *Tribolium confusum* Jacquelin du Val adults and larvae under laboratory conditions in wheat, *Triticum aestivum* L. Laznik, and Trdan, (2010) tested the efficacy of three strains (B30, B49 in 3162) of *Steinernema feltiae* to control adults of rice weevil (*Sitophilus oryzae*). Shahina, and Salma (2010) tested the virulence of 7 indigenous entomophilic nematodes viz., *Steinernema pakistanense* (Ham 10 strain), *S. asiaticum* (211 strain), *S. abbasi* (507 strain), *S. siamkayai* (157 strain), *S. feltiae* (A05 strains), *Heterorhabditis bacteriophora* (1743 strain) and *H. indica* (HAM-64 strain) against the adult and pupa of rice weevils (*S. oryzae*) in laboratory bioassays. Shrestha and Gyun (2010) reported that the two entomopathogenic bacteria, *Photorhabdus temperata* sub sp. *temperata* (Ptt) and *Xenorhabdus nematophila* (Xn), are symbiotically associated with the nematodes, *H. megidis* and *Steinernema carpocapsae*, respectively, and found that a significant difference in pathogenicity was observed between these two bacteria against the red flour beetle, *Tribolium castaneum*, in which Ptt exhibited more than six times higher pathogenicity than Xn. Recently in Egypt Sweelam *et al.*, (2010) controlled red palm weevil, *Rhynchophorus ferrugineus* Oliver by entomopathogenic nematode species.

From these points of view, this research was conducted to throw a light on the possibility of using entomopathogenic nematodes, *Heterorhabditis bacteriophora* and *Steinernema feltiae* in the control of granary and rice weevils.

MATERIALS AND METHODS

Experiments were conducted at the laboratories of the Economic Entomology and Agricultural Zoology Department , Faculty of Agriculture, Menoufiya University, Shebin Elkom , Egypt.

Rearing of entomopathogenic nematodes:

Two species of entomopathogenic nematodes: *Heterorhabditis bacteriophora* Poinar (Nematoda: Heterorhabditidae), and *Steinernema feltiae* (Filipjev) (Nematoda: Steinernematidae) were extracted from the soil of the mango trees of the Experimental Station of the Faculty of Agriculture Shebin El-Kom, Minoufiya University. The greater wax moth, *Galleria melonella* were used for culturing of both entomopathogenic nematodes. They were starved for 2 hours before being infect with nematodes. Modified white traps (White, 1927) were used in large numbers to obtain sufficient numbers of nematodes for the present experiments. Collected nematodes were stored in plastic tubes (50 ml) in a refrigerator adjusted to 10 °C temperature until used.

Tested insects :

Granary weevil , *Sitophilus granaries* L. and Rice weevil *S. oryzae*, L. adult stages were obtained from a naturally infested wheat and rice grains stored in plastic bags under laboratory conditions.

Application of nematodes on the stored insects:

Adult stages of previous insects were exposed to different concentrations of 50, 100, 500, 1000 and 2000 IJs (Infective juveniles) of *Heterorhabditis bacteriophora* and *Steinernema feltiae* nematodes to determine their effects against granary and rice weevils.

Ten adult stages of each insect species, were kept in Petri dishes, each 5-cm diameter containing 2 moist filter papers where insects were put between them, and exposed to entomopathogenic nematodes. Every nematode concentration was sprayed on the insects as 5 ml distilled water containing nematodes. At control treatment, insects were sprayed with 5 ml distilled water without nematodes. Each treatment was replicated three times. Mortality was checked after 24, 48, 72, 96 hours for all

concentrations of the two tested nematode species, and percentage of mortality was calculated for each nematode species at different concentrations using Abbott's

formula (1925). Mortality percentage was corrected by Schneider-Orelli's formula (Püntener W., 1981).

$$\text{Corrected mortality \%} = \frac{(\text{Mortality \% in treated plot} - \text{Mortality \% in control plot})}{100 - \text{Mortality \% in control plot}} \times 100$$

RESULTS AND DISCUSSION

Results in Table (1) show the effect of different doses of entomopathogenic nematode, *Steinernema feltiae* on the mortality percentages of the adult stages of the Granary weevil, *Sitophilus granaries*, under laboratory conditions. The highest average mean of corrected mortality of the adult stages of Granary weevil, *S. granaries* was recorded with the treatment of 3000 infective juveniles of entomopathogenic nematode, *S. feltiae* giving 93.55 %, followed by the treatment of 500 infective juveniles of *S. feltiae* nematode as 67.74%, and the treatment of 2000 infective juveniles of *S. feltiae* nematode , 64.52 %, while the least mean averages of the corrected mortality of the adult stages of insects were recorded with the treatment of 1000 infective juveniles of entomopathogenic nematode, *S. feltiae* nematode which was calculated as 48.39%, and the treatment of 100 infective juveniles recorded 54.84 % as overall averages.

Results in Table (2) show the effect of different doses of entomopathogenic nematode, *Heterorhabditis bacteriophora* on the mortality percentages of the adult stages of the Granary weevil, *Sitophilus granaries*, under laboratory conditions. Results indicated that the highest averages of corrected mortality of the adult stages of

Granary weevil, *S. granaries* was registered with the treatment of 1000 infective juveniles of entomopathogenic nematode, *H. bacteriophora* giving 64.52 % , followed by the treatment of 2000 infective juveniles of *H. bacteriophora* nematode as 54.52 % , while the least averages of the corrected mortality of the adult stages of insects were recorded with the treatment of 100 infective juveniles of entomopathogenic nematode, *H. bacteriophora* nematode which was calculated as 38.71 % , followed by the treatment of 500 and 3000 infective juveniles which recorded 48.39 % as overall averages.

As for the toxic effect of the entomopathogenic nematode, *Steinernema feltiae* on the adult stages of the Rice weevil, *Sitophilus oryzae*, results in Table (3) indicated that the highest averages of corrected mortality of the adult stages of *S. oryzae* was registered with the treatments of 1000 and 2000 infective juveniles of entomopathogenic nematode, *S. feltiae* giving 89.19 % , followed by the treatments of 3000 and 500 infective juveniles of *S. feltiae* nematode as 83.78 and 81.08 % , respectively , while the least averages of the corrected mortality of the adult stages of insects was recorded with the treatment of 100 infective juveniles which was calculated as 62.16 % , as overall averages.

Table (1): Mortality percentages of adult stages of granary weevil, *S granaries* as affected by *S. feltiae* nematode under laboratory conditions (25 ± 5 °C & 65% RH).

Concentration of nematode juveniles	Mortality percentages %					Corrected mortality
	24 h	48 h	72 h	96 h	Mean	
100	20	60	80	100	65	54.84
500	50	70	80	100	75	67.74

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1000	40	40	70	90	60	48.39
2000	50	60	80	100	72.5	64.52
3000	90	90	100	100	95	93.55
Control	10	20	30	30	22.5	-

Table (2): Mortality percentages of adult stages of granary weevil, *Sitophilus granaries* as affected by *H. bacteriophora* nematode under laboratory conditions (25 ± 5 °C & 65% RH)

Concentration of nematode juveniles	Mortality percentages					Corrected mortality
	24 h	48 h	72 h	96 h	Mean	
100	20	40	50	100	52.5	38.71
500	30	30	80	100	60	48.39
1000	30	70	90	100	72.5	64.52
2000	40	50	80	90	65	54.84
3000	30	60	50	100	60	48.39
Control	20	20	20	30	22.5	-

Table (3): Mortality percentages of adult stages of rice weevil, *S. oryzae* as affected by *Steinernema feltiae* nematode under laboratory conditions (25 ± 5 °C & 65% RH)

Concentration of nematode juveniles	Mortality percentages					Corrected mortality
	24 h	48 h	72 h	96 h	Mean	
100	20	80	80	80	65	62.16
500	40	90	100	100	82.5	81.08
1000	60	100	100	100	90	89.19
2000	60	100	100	100	90	89.19
3000	60	80	100	100	85	83.78
Control	0	10	10	10	7.5	-

Moreover, results in Table (4) show the effect of different doses of entomopathogenic nematode, *Heterorhabditis bacteriophora* against the adult stages of Rice weevil, *Sitophilus oryzae*, under laboratory conditions. Results indicated that the highest averages of corrected mortality of the adult stages of *S. oryzae* was registered with the treatment of 3000 infective juveniles of entomopathogenic nematode, *H. bacteriophora* giving 82.35 % , followed by the treatment of 500 infective juveniles of *H. bacteriophora* nematode as 58.82 % , and the treatment of 2000 infective juveniles of the entomopathogenic nematode, *H. bacteriophora* nematode , 52.94 % , while the least averages of the corrected mortality of the adult stages of insects were recorded with the treatments of 100 and 1000 infective juveniles of entomopathogenic nematode, *H. bacteriophora* nematode which was calculated as 41.18 and 47.82 % , as overall

averages. The obtained results are in harmony with those obtained by Ramos-Rodriguez, *et al.*, (2007), Shahina and Salma (2009), Athanassiou, *et al.*, (2010), Shahina, and Salma (2010) , and Shrestha and Kim Yong Gyun (2010) who used entomopathogenic nematodes, *Heterorhabditis bacteriophora* and *Steinernema feltiae* in the control of the rice weevil, *Sitophilus oryzae* , the red flour beetle, *Tribolium castaneum* , the lesser grain borer, *Rhyzopertha dominica* (F.), the Mediterranean flour moth, *Ephestia kuehniella* (Zeller) , and the pulse beetle, *Callosobruchus chinensis* (L.).

It could be concluded that the use of entomopathogenic nematodes, *Heterorhabditis bacteriophora* and *Steinernema feltiae* in the control of stored insect products i.e. the rice weevil, *Sitophilus oryzae* , and the granary weevil, *Sitophilus granaries* registered good results , but it needs more studies.

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Table (4): Mortality percentages of adult stages of rice weevil, *Sitophilus oryzae* as affected by *H. bacteriophora* nematode under laboratory conditions (25 ± 5 °C & 65% RH).

Concentration of nematode juveniles	Mortality percentages					Corrected mortality
	24 h	48 h	72 h	96 h	Mean	
100	0	60	60	80	50	41.18
500	40	60	80	80	65	58.82
1000	0	60	60	100	55	47.06
2000	40	60	60	80	60	52.94
3000	40	100	100	100	85	82.35
Control	0	20	20	20	15	-

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