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Efficacy of the entomopathogenic nematodes and their based-product on some species of mealybugs (Hemiptera: Pseudococcidae) in Egypt

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ABSTRACT

The infectivity of three Egyptian Heterorhabditid nematode species *Heterorhabditis bacteriophora* (Poinar), *Heterorhabditis indica* (Poinar) and *Heterorhabditis baujardi* (Poinar) (Rhabditida : Heterorhabdilidae) and one imported Steinernematid species, *Steinernema abbasi* (Elawad) (Rhabditida: Steinernematidea) were evaluated against preadult of the citrus mealybug *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) and adult of Egyptian mealybug *Icerya aegyptiaca* (Douglas) (Hemiptera: Monophlebidae) under laboratory conditions. Also, laboratory and semifield evaluation of the efficiency of entomopathogenic nematodes (EPN) alone or mixed with wax remover Oleyl-polypeptide, against adults and nymphs of the mealybug *Ferrisia virgata* (Cockerell) (Hemiptera: Pseudococcidae) were carried out. Nematode reproduction in their cadavers were detected. Moreover, the effect of *Steinernema carpocapsae* alone or with medical additive (Docusate Sodium) comparing with Super Misrona oil were studied on the grape mealybug, *Planococcus ficus* (Signoret) . Three methods of formulation of Egyptian entomopathogenic nematodes were tested for their effectiveness on *H. bacteriophora* and *S. carpocapsae*. These formulations are water-dispersible granules (WDG), Calcium alginate geland infected cadavers. The infectivity of the formulated nematodes was tested against *I. aegyptiaca* adults.

Keywords: entomopathogenic nematodes, mealybugs , Egypt

INTRODUCTION

EPN in the families steinernematidae and heterorhabditidae possess tremendous potential as alternatives to chemicals and are the only biological control agents which have the capacity to actively search and infect insect larvae in the soil. The infective juvenile (IJs) of EPN is microscopic organism having 0.5 to 1.5 mm long depending on species. IJs enter through the insect's natural body openings, the mouth, anus or spiracles and then penetrate into the blood cavity from the gut. Heterorhabditis species can also penetrate the insect with a special tooth. Once in the insect's blood, infective juvenile releases a highly specialized symbiotic bacterium (*Xenorhabdus* spp. in *Steinernema*, *Photorhabdus* spp. in Heterorhabditis). The symbiotic bacteria multiply and rapidly kill the insect within a day or two. The bacteria then convert the insect into suitable food for the nematodes and produce a range of antibiotics and antifeedants that preserve the dead insect from putrefaction while the nematodes feed and reproduce in it. From a medium-sized insect cadaver 100,000 to 300,000 IJs are produced which leave the decaying cadaver in 7-10 days and seek out new insect pest hosts. Nematodes have been applied successfully against soil inhabiting insects (as soil application) as well as above-ground insects (foliar spray) in cryptic habitats. They possess many good attributes such as wide host spectrum, active host seeking killing the host within 48 h, easy mass production, long-term efficacy, easy application, compatibility with most chemicals, and are environmentally safe. However, the pathogenicity, host searching behavior, and survivability of different nematode species are varied making them suitable in biological control programs.

However, control potential of these nematodes depends on efficient production, a reliable and stable formulation, storage, and shipping which allowing successful introductions into markets. Such commercial nematode products, however, are not often available to Egyptian farmers and crop producers due to their highly importation cost. Also, most of the imported products are formulations of nematode species isolated from cold climate regions that don't tolerate the worm Egyptian climate. Unavailability of commercial nematode products and other biocontrol agent formulations in Egypt often results in excessive and ill-timed applications of toxic chemical pesticides. Hence (Abdel-Rahman *et al*, 2011) formulate Egyptian EPN in alginate gel, water dispersible granules (WDG) and infected cadavers. WDG nematode based-product and infected cadavers gained approximately good infectivity against *Icerya aegyptiaca* adults.

Mealybugs are commonly found in all temperate and tropical regions of the world. The citrus mealy bug, *P. citri* are serious pests of their host tree species. The striped mealybug, *Ferrisia virgata* (Cockerell) (Hemiptera, Pseudococcidae) is one of the most important pest attacking many different host plants, belongs to several plant families, it infests mulberry, fig, guava , pear, apple, grape, and olive in Egypt. This mealybug mainly attacks the foliage, sucks a great amount of plant sap for its protein requirement and secrets honeydew. Many of these species are covered with white wax and have a distinct fringe of waxy filaments around the circumference of their bodies. The grape mealybug, *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae) is one of the most common mealybugs. It attacks grape vine, citrus, cotton, mango and banana. This insect has two forms, a root form that attacks the roots of its host and an aerial form that attacks the leaves, twigs and the base of fruits. Some studies have reported that entomopathogenic nematodes kill Homoptera and Heteroptera insects including aphids, spittlebugs, squash bugs, and triatomid bugs. But no comparative studies have been conducted on the susceptibility of any Homoptera or Heteroptera insects to various strains and species of entomopathogenic nematodes. Also, a few natural enemies are currently recommended for control of citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) and *Icerya aegyptiaca* (Douglas) (Hemiptera: Monophlebidae). So, efforts are currently underway in Egypt to identify and evaluate entomopathogenic nematodes of the families Heterorhabditidae and Steinernematidae as a promising biological control agents of mealybugs.

RESULTS

1. Efficy of entomopathogenic nematodes on Pseudococcidae:

Since a few natural enemies are currently recommended for control of citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) and *P. ficus*, efforts are currently underway in Egypt to identify and evaluate indigenous entomopathogenic nematodes as possible biological control agent for this pest (Abdel-Rahman *et al*, 2008). Mangoud *et al.* (2009) studied the effect of different natural control agents (Biofly, NeemAzal and Super Mesrona oil) comparing with entomopathogenic nematodes on the grape mealybug, *P. ficus* and its predator *Cryptolaemus montrouzieri* (Mulsant) (Coleoptera: Coccinellidea) under laboratory conditions. The potency of the tested compounds and nematodes were varied tremendously due to the nature of the tested compounds, the used concentration and the tested stage. As a general trend, data proved that at any of the tested compound the higher the concentration, the higher was the rate of mortality and vice versa.

2. Enhancement effect of a wax remover as an additive to EPN for controlling mealybugs:

The need for successful foliar application of the EPN for controlling mealybugs, which always give poor results become critical. This problem was faced by the addition of a wax remover to the EPN at the time of application in the field to remove the wax layer of the mealybugs. This facilitate, increase their penetration and reduce the time of penetration of the mealybugs and consequently protect them from the heat and ultraviolet radiation (Abdel-Rahman *et al*, 2010). In the laboratory, the effeciency of EPN alone increased with increasing infection dose. Also, the effeciency of EPN increased by mixing with Oleyl- polypeptide. The rank of the efficiency of the tested materials in laboratory against the nymphs were Malathion and nematodes mixed with Oleyl-polypeptide, then Super Misrona and finally nematodes only, while, the efficiency of the same tested materials against adults were ordered as follow: nematodes mixed with Oleyl-polypeptide, Malathion, nematodes only then Super Misrona. In semifield, the mortality percentages of nymphs were more than that of adults when adding Oleyl-polypeptide with nematode. Malathion scored the highest mortality against adults and nymphs of *F. virgata*. The rank of the efficiency of the tested materials for nymphs was Malathion followed by the mineral oil, then nematodes mixed with Oleyl-polypeptide and finally nematodes only. The rank of the efficiency for adults was slightly differed from nymphs, where, the efficiency of the nematodes mixed with Oleyl-polypeptide was greater than that of mineral oil.

Abdel-Rahman and Mangoud (2010) studied the effect of Egyptian nematode, *S. carpocapsae* alone or with medical additive (Oleyl-polypeptide) comparing with Super Misrona oil on the grape mealybug, *P.lanococcus ficus* . In the first season (2008), the treatments with Egyptian nematode) alone gave moderate percent reduction on the population of adult females and nymphs of *P. ficus* when comparing with Super Misrona oil, which gave also moderate or highly percent reduction after 1st, 2nd and 3rd weeks before and after pruning. The data in the second season (2009) gave similar results to those obtained in the first year (2008). Mixing Egyptian nematode with Oleyl-polypeptide gave highly percent reduction on the population of adult females and nymphs of *P. ficus.* Super Misrona oil mixed with Oleyl-polypeptide gave highly percent reduction after the 1st, 2nd and 3rd weeks before and after pruning. It can be concluded that mixing the EPN and mineral oils with ear wax remover (Oleyl-polypeptide) increasing the effectiveness against the mealybug and could be used in Integrated Pest Management Programs "IPM" on the grape mealybug, *P. ficus*, which becoming very dangerous pest on grape vine plants, especially in organic farms that exporting fruits to Europe and America.

3. Efficy of entomopathogenic nematodes on true mealybug:

Abdel-Rahman *et al.* (2008) evaluated three Egyptian Heterorhabditid nematode species *Heterorhabditis bacteriophora* (Poinar) (Rhabditida: Heterorhabdilidae), *Heterorhabditis indica* (Poinar) and *Heterorhabditis baujardi* (Poinar) and one imported Steinernematid species *Steinernema abbasi* (Elawad) (Rhabditida: Steinernematidea) against adult of Egyptian mealybug *I. aegyptiaca* under laboratory conditions. Doses of 100, 200 and 400 infective juveniles (IJs) nematodes were applied to the *I. aegyptiaca*. *S. abbasi* sp. achieved the highest mortality (76%) against *P. citri* at dose 1000IJs followed by *H. indica*, *H. bacteriophora* and *H. baujardi* respectively. The differences between the tested species were obvious. *S. abbasi* recorded the lowest infectivity at the dose 100IJs (0%), followed by *H. bacteriophora* and together with each other scored the lowest infectivity at dose 400IJs (38%). *H. indica* achieved the highest mortality rate at dose 400IJs (100%) followed by *H. baujardi* (90 %) which also recorded the highest infectivity at dose 100IJs (70%).

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ARABIC SUMMARY

فعالية النيماتودا الممرضة للحشرات و منتجاتها على عدة أنواع من البق الدقيقي فى مصر

رندا محمد عبد الرحمن و مها عبد الرازق وإيفون عبد الله و أشرف عبد السلام هندى
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تم تقييم التأثير السمي لأربعة أنواع من النيماتودا الممرضة للحشرات معمليا، ثلاثة أنواع *Heterorahaditis bacteriophora Heterorahaditis indica* and *Heterorahaditis baujardi*) مـن عائلـة (Heterorhabditidae) والنوع الرابع *Steinernema abbasi* من عائلة (Steinernematidae) ضد نوعين من البق الدقيقي هما بق الموالح الدقيقى (*Planococcus citri*) ، والبق الدقيقى المصرى (*Icerya aegyptiaca*). أيضا تم دراسة تأثير التطبيق المعملي و النصف لحقلي للنيماتودا الممرضة للحشرات علي الأطوار البالغة والحوريات لحشرة البق الدقيقي فيريزيا فرجاتا كنموذج للبق الدقيقى، منفردة ومخلوطة بمذيب الشمع للحشرة (أوليل عديد الببتيدات) وقد أظهرت النتائج أن فعالية النيماتودا تزيد بدرجة كبيرة عند إضافة مزيب الشمع، كذلك فإن هذا البحث هو الأول الذى رصد حدوث تكاثر فى الحوريات. كذلك تم دارسة فعالية النيماتودا (*Steinernema carpocapsae*) منفردة أو خلطا بالمركب الطبي أوليل بوليبيبتيد مقارنة بفعالية الزيت المعدني الخفيف منفردا أو خلط اباأوليل بوليبيبتيد علي بق العنب الدقيقي. تم دراسة ثلاثة طرق لتصييغ النيماتودا لعمل منتج تجارى من النيماتودا و إختبار مدى كفاءتهم على الطور البالغ للبق الدقيقى المصرى. هذة المنتجات هى الحبيبات الذائبة فى الماء و جل الكالسيوم ألجينات و جثث الحشرات المعدية بالنيماتودا.