Efficiency of three formulated entomopathogenic nematodes against onion thrips, *Thrips tabaci* under aquaculture system

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ABSTRACT

Entomopathogenic nematodes (EPN) proved to be efficient control agents against thrips under soil stages. However, few studies were reported on foliar application of EPNs against the feeding stages which cause the initial infestation. Therefore, the aim of this study was to evaluate the efficacy of three formulated parasitic nematodes, two native and an adapted exotic species, against the onion thrips, *Thrips tabaci* L., under green house conditions in aquaculture. The nematode species were *in vivo* produced using larvae of the greater wax moth. Nematodes were formulated using mixed polymer based on calcium alginate and their viability was tested before each application. The experiment was done inside the greenhouse on onion plants heavily infested with onion thrips, *T. tabasi*. Population density of the pest was estimated before and after spraying with the tested bioformulated EPNs. EPNs species caused significantly higher mortality than control treatment in different developmental stages of *T. tabaci*. In general the three formulated nematodes, BA1, BA2 and OBIII had significantly better shelf-lives than the control. Data showed that *S. carpocapsae* BA2, was the most commonly applied species for control of foliar pests. They are ideal candidates for pest insects that are encountered on the surface soil when they descend from foliage. The market of EPNs-based biopesticides has faced great success in relation to few marketing failures during the past two decades. Due to the rapid increase in EPNs production technology, their prices become more compatible to other insect control strategies. Therefore, the development of simple; cheap and innovative formulations should not only target increasing EPNs performance but also enhancing storage ability and application methods

Key words: Thrips; entomopathogenic nematodes; formulation; acquaculture; alginate

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INTRODUCTION

Due to their relative small size and high reproductive rate, the onion thrips (OT), *Thrips tabaci* consider a serious cosmopolitan pest attacking wide range of economically important crops including field and greenhouse crops. This pest can cause more than 50% yield reduction (Kashkouli *et al.* 2014). It can damage plants directly by feeding on their different parts and indirectly by transmitting plant viral diseases such as tomato spotted wilt virus (Jones, 2005).

For many years and due to the rapid development of the thrips resistance to chemical insecticides, the hidden life habits and short life cycle of *T. tabaci* population (Maniania *et al.*, 2003), biocontrol means have been considered. One of the most promising bio-control agents is the entomopathogenic nematodes (EPNs) (Hussein *et al.*, 2018), which can successfully attack pests in different habitats including soils as well as on canopy (Tradan *et al.*, 2009; Nouh and Hussein, 2014; Hussein *et al.*, 2015). EPNs have strong pathogenic effect against a variety of soil inhabiting insects and their life cycle consists of an egg, four juvenile stages, and an adult (Boemare *et al.*, 1996). The 3rd stage infective juvenile (IJ) carries pathogenic bacteria inside its gut, which is the main responsible about killing host pest by septicemia (Kaya and Gaugler, 1993; Abdel Rahman and Hussein, 2007). Members of Heterorhabditidae and Steinernematidae proved to be efficient control agents against thrips soil stages (Ebssa *et al.* 2001). However, few studies were reported on foliar application of EPNs against the feeding stages which cause the initial infestation (Chyzik *et al.*, 1996). Therefore, the aim of this study was to evaluate the efficacy of three formulated entomopathogenic nematodes, two native and an adapted exotic species, against the onion thrips, *Thrips tabaci* L., under aquaculture system in greenhouse conditions.

MATERIALS AND METHODS

Nematodes Culture

Three EPNs *Heterorhabditis bacteriophora* (BA1) and *Steinernema carpocapsae* (BA2), two native isolates of EPNs (Hussein and Abou El-Sooud, 2006) and an exotic commercial species, *S. feltiae*, was used. The three nematode species were *in vivo* produced using larvae of the greater wax moth, *Galleria mellonella* L. (Lepidoptera: Pyralidae) according to Metwally *et al.*, (2012). Nematodes were stored at 7°C in a cold room until used (<3 mo). Nematodes were formulated using mixed polymer consists mainly from calcium alginate according to Hussein and Abdel-Aty (2012) and their viability was tested before each application by dissolving a pinch (~10 mg) of each formulated nematode into water and observing nematode shape and mobility under a light microscope. Healthy nematodes were opaque in color and S-shaped with oscillating movements. Dead or unhealthy nematodes were translucent, straight, and lacked movement. The product was used if viability was >50% and discarded if <50% viable.

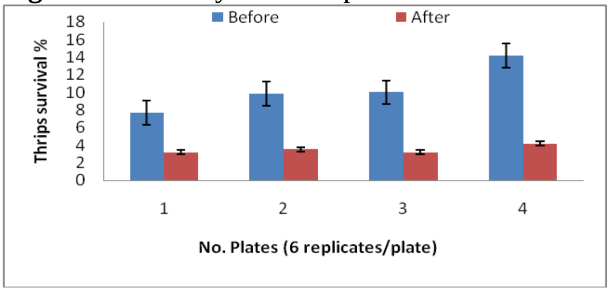
Insects and greenhouse plots

This experiment was conducted at "El-Bustan Farm", Alexandria Desert Road; the first commercial farm adopted the aquaponic system in Egypt. Water circulates from tanks hosting schools of fleshy Nile tilapia through hydroponic trays which grow vegetables including cucumber, basil, lettuce, kale, peppers, tomatoes watercress and onion on floating foam beds with run-off flushed out to irrigate olive trees planted around the farm. The experiment was done inside the greenhouse on onion plants heavily infested with onion thrips, *T. tabasi*. Population density of the pest was estimated before and after spraying with a concentration of 2×10^4 IJs/Plant of 3 formulated EPNs. For each nematode species 6 plates were sprayed each plate carries 36 pots of onion plants. Control plates were sprayed with nematode suspension in only water. Three days later, No. of pests in each plate was counted and % mortality was calculated.

RESULTS

Overall, all EPNs species caused significantly higher mortality than control treatment in different developmental stages of *T. tabaci*.. In general and as represented in Figs. 1-3. Formulated nematodes, BA1, BA2 and OBIII had significantly better shelf-lives than the control although the test was done in mid-summer at high temperature.

Fig. 1. Efficiency of encapsulated *Steinernema*

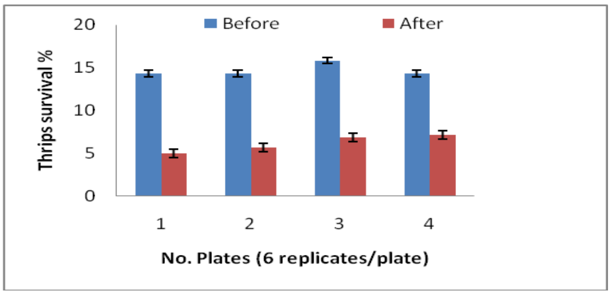


carpocapsae BA2 in controlling *Thrips tabasi* infested onion in greenhouse

As data recorded the proportion of adult emergence in the control was relatively high since control received only water. However, all EPNs strains tested caused significantly higher mortality than natural mortality in the control ($P < 0.001$). Significant differences in thrips mortality were observed between the tested EPNs strains, with highest mortality recorded in the BA2 and OBIII and lowest in the BA1 treatments, respectively (Figs. 1-3).

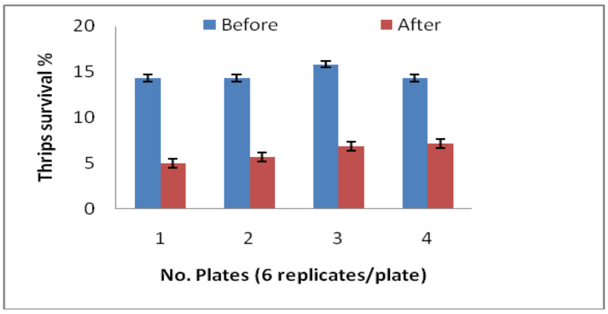
In case of the native *H. bacteriophora* BA1, the mean average no. of onion thrips recorded was 9.21insect/plant reduced to 5.1insect/plant after application of formulated heterorhabtid nematodes (Fig. 1). Also, In case of the native *S. carpocapsae* BA2, the mean average no. of onion thrips recorded was 10.42 insect/plant reduced to 3.5insect/plant after application of formulated steinernematid nematodes (Fig. 2).

Fig.2. Efficiency of encapsulated *Steinernema feltiae OBIII* in controlling *Thrips tabasi* infested onion in greenhouse



Meanwhile, when the exotic formulated *S. feltiae* OBIII nematodes were applied to onion pots infested with mean average no. of onion thrips recorded was 14.71insect/plant, thrips were reduced to mean average no. of 6.17insect/plant (Fig. 3).

Fig.3. Efficiency of encapsulated *Heterorhabditis bacteriophora* BA1 in controlling *Thrips tabasi* infested onion in greenhouse



DISCUSSION

The date obtained in the present study agreed with that of Saleh *et al.* (2015) which showed that *S. carpocapsae* BA2, was the most commonly applied species for control of foliar and other above-ground pests. Due to its ambusher host-finding strategy, they are ideal candidates for pest insects that are encountered on the surface soil when they descend from foliage.

The progression in EPN formulation for foliar application has been greatly noticed during this decade. Hussein and Abdel-Aty (2012) reported improved storage ability of two native Egyptian strains of EPNs *H. bacteriophora* and *S. carpocapsae* specifically and pathogenicity as well. Control of *Cydia pomonella* L. (Lepidoptera: Tortricidae) was improved in the laboratory using *H. zealandica* formulated with a superabsorbent starch hydrogel (de Waal *et al.*, 2013) and in the field enhanced the survival and pathogencity against pear orchards pests.

The same as well for *Plutella xylostella* L. (Lepidoptera: Plutellidae) which was significantly controlled on cabbage foliage using *S. carpocapsae* in an appropriate formulation (Schroer *et al.*, 2005) and on watercress (Hussein *et al.*, 2015). Our data were similar to that recorded by Navon *et al.*, (2002), who improved the shelf life and the efficiency of EPNs against some insect pests at room temperature and in greenhouse tests. Nematodes were successfully encapsulated in an alginate polymer. Moreover, a polymer based on an alginate used to develop innovative methods for EPN delivery (Hiltbold *et al.*, 2012). Our data is strongly supported by Kaya and Nelsen (1985). Capsules of *S. feltiae* and *H. heliothidis* in an alginate based polymer were still able to attack *Spodoptera exigua* Hübner (Lepidoptera: Noctuidae) and no obvious reduction in their survival or their potency during the formulation process.

The market of EPNs-based biopesticides has faced great success in relation to few marketing failures during the past two decades. Due to the rapid increase in EPNs production technology, their prices become more compatible to other insect control strategies (McMullen and Stock, 2014). Therefore, the development of simple; cheap and innovative formulations should not only target increasing EPNs performance but also enhancing storage ability and application methods.

REFERENCES

Abdel Rhman, R.A. and Hussein, Mona A. (2007). Effect of different infection rates in *Galleria mellonella* larvae on the quality of the produced *Heterorhabditis* juveniles. *Egyptian Journal of Biological Pest Control* **17**(2): 91-97.

Boemare, N., Laumond, C., and Mauleon, H. 1996. The entomopathogenic nematode–bacterium complex: biology, life cycle, and vertebrate safety. *Biocontrol Science and Technology,* **6**:333–345.

Chyzik, R., Glazer, J., and Klein, M. 1996. Virulence and efficacy of different entomopathogenic nematode species against western flower thrips (*Frankliniella occidentalis*). *Phytoparasitica* **24**: 103– 110.

De Waal, J. Y., Malan, A. P., & Addison, M. F. 2013. Effect of humidity and a superabsorbent polymer formulation on the efficacy of *Heterorhabditis zealandica* (Rhabditida: Heterorhabditidae) to control codling moth, *Cydia pomonella* (L.) (Lepidoptera: Tortricidae). *Biocontrol Science and Technology,* **23**(1): 62–78.

Ebssa, L., Borgemeister, C., Berndt, O., Poehling, H.M. 2001. Efficacy of entomopathogenic nematodes against Soil-Dwelling life Stages of western flower thrips, *Frankliniella occidentalis* (Thysanoptera: Thripidae). *Journal of Invertebrate Pathology*, **78**:119–127.

Hiltpold, I., Hibbard, B. E., French, D. W., and Turlings, T. C. J. 2012. Capsules containing entomopathogenic nematodes as a Trojan horse approach to control the western corn rootworm. *Plant and Soil,* **358**: 11–25.

Hussein, M.A. and Abdel Aty, M. A. 2012. Formulation of two native entomopathogenic nematodes at room temperature. *Journal of Biopesticides,* **5** *(Supplementary):* 23-27.

Hussein, Mona. A. and A. B Abou El- Sooud 2006. Isolation and characterization of two Heterorhabditids and one Steinernematid nematodes from Egypt. *International Journal of Nematology,* **16**(1):7-12.

Hussein, M.A.; Metwally, H. M. and El-Raoaaf M.A. 2015. Foliar Application of Native Bio-Formulated Entomopathogenic Nematodes against Diamondback Moth in Aquaponic Agriculture. *Research Journal of Pharmaceutical, Biological and Chemical sciences.* **6**(6): 1030-1035.

Hussein MA, El-Rahman RA, El-Boraey H, Hilmy M. And Attya E 2018. The Impact of Cu Ion, Two Novel Schi Base Ligands and their Copper (II) Complexes on the Biological Activity of the Entomopathogenic Nematodes. *Microbial Bioactives*, **1**(2), 046-050.

Jones, D. R. 2005. Plant viruses transmitted by thrips. *Europian Journal of Plant Pathology*, **113**: 119-157.

Kashkouli, M.; Khajehali, J., and Poorjavad, N. 2014. Impact of entomopathogenic nematodes on *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) life stages in the laboratory and under semi-field conditions. *Journal of Biopestcides,* **7**(1):77-84.

Kaya, H. K., and Nelsen, C. E. 198). Encapsulation of steinernematid and heterorhabditid nematodes with calcium alginate: A new approach for insect control and other applications. *Environmental Entomology,* **14**(5): 572–574.

Kaya, H. K. and Gaugler, R. 1993. Entomopathogenic nematodes. *Annual Review of Entomology,***38**:181-206.

Maniania, N.K., Sithanantham, S., Ekesi, S., Ampong-Nyarko, K., Baumg artner, J., Ohr, B.L. and Matoka, C.M. 2003. A field trial of the entomogenous fungus Metarrhizium anisopliae for control of onion thrips, *Thrips tabaci*. *Crop Protection,* **22**:553–559.

McMullen, J. G., and Stock, S. P. 2014. *In vivo* and *in vitro* rearing of entomopathogenic nematodes (Steinernematidae and Heterorhabditidae). *Journal of Visualized Experiments,* **91**: e52096.

Metwally, H. M.; Hafez, G.A.; Hussein, M. A.; Hussein, M.A.; Salem, H.A. and Saleh, M.E. 2012. Low Cost Artificial Diet for Rearing the Greater Wax Moth, *Galleria mellonella* L. (Lepidoptera: Pyralidae) as a Host for Entomopathogenic Nematodes. *Egyptian Journal of Biological Pest Control,* **22** (1): 15-17.

Navon, A., Nagalakshmi, V. K., Levski, S., Salame, L., and Glazer, I. 2002. Effectiveness of entomopathogenic nematodes in an alginate gel formulation against lepidopterous pests. *Biocontrol Science and Technology,* **12**(6): 737–746.

Nouh, G. and Hussein, Mona A. 2014. Virulence of *Heterorhabditis bacteriophora* (Rhabditida: Heterorhabditidae) Produced *in vitro* Against *Galleria mellonella* (Lepidoptera: Pyralidae). *Research Journal of Pharmaceutical, Biological and Chemical Sciences,* **5**(3): 1385-93.

Saleh, M.E.; Hussein, Mona, A.; Gehan A. Hafez; M.A.Hussein; H.A. Salem and Hala M. S. Metwally 2015. Foliar application of entomopathogenic nematodes (Nematoda: Steinernematidae : Heterorhabditidae) for controlling *Spodoptera littoralis* and *Agrotis ipsilon* (Lepidoptera: Noctuidae) on corn (*Zea mays*). *Advances in Applied Agricultural Science,* **1**(1): 50-61.

Schroer, S., Ziermann, D., and Ehlers, R. U. 2005. Mode of action of a surfactant–polymer formulation to support performance of the entomopathogenic nematode *Steinernema carpocapsae* for control of diamondback moth larvae (*Plutella xylostella*). *Biocontrol Science and Technology,* **15**(6): 601–613.

Tradan S, Vidrih M, Andjus L, and Laznik Ž. 2009. Activity of four entomopathogenic nematode species against different developmental stages of Colorado potato beetle, *Leptinotarsa decemlineata* (Coleoptera, Chrysomelidae). *Helminthologia,* **46**:14–20.

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