JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 40, No. 3/4 2000

EFFECT OF THE ALTERNATIVE HOST *STROPHOSOMA FABER* (HERBST) ON EFFICACY OF THE ENTOMOPATHOGENIC NEMATODE *STEINERNEMA GLASERI* IN CONTROL OF *AMPHIMALLON SOLSTITIALE* GRUBS IN THE SOIL

JOLANTA KOWALSKA

INSTITUTE OF PLANT PROTECTION, MICZURINA 20, 60-318 POZNAŃ, POLAND
e-mail: j.kowalska@ior.poznan.pl

Abstract. Larvae of June chafer (*Amphimallon solstitiale* L.) are important pests of the turf-grass. During a routine field collection of *A. solstitiale* grubs numerous larvae of a curculionid, *Strophosoma faber* were frequently observed in the soil. Both insects shared the same environment in the same season. Since entomopathogenic nematodes are considered as candidates for control of *A. solstitiale* it was decided to examine the effect of concurent presence of *S. faber* on the efficacy of *S. glaseri*. The laboratory test revealed that both insects were infected by *S. glaseri*. In conclusion, could be support the suggestion that *S. faber* is probably most susceptible for entomopa-thogenic nematodes and could become the alternative host for them.

Key words: *Amphimallon solstitiale*, *Steinernema glaseri*, alternative host, biological control

I. INTRODUCTION

Entomopathogenic nematodes could be an effective alternative to chemical insecticides in control of pest insects. They are among the leading biological insecticides commercially available worldwide (Georgis and Manweiller 1994).

The larvae of *Amphimallon solstitiale* L. feed on the roots of grasses causing death or making the turf lose after birds, which are searching for the insects. Control of larvae with chemical insecticides is difficult and often undesirable because of the public use of these fields. The use of the entomopathogenic nematodes seems to offer an attractive alternative to chemical control. The entomopathogenic nematode infection process consists of initial invasion of infective juveniles into the insect hemolymph followed by the release of a symbiotic bacterium. Insect mortality is due to both rapid bacterial growth (septicemia) and metabolites produced by the bacteria and the nematodes.

Scarab larvae, as major pests of turf-grass, pastures and ornamentals have been targeted as candidates for biological control using the entomopathogenic nematodes (Klein 1990). Tests field with steinernematid and heterorhabditid nematodes against scarab larvae have provided varied results. *Heterorhabditis bacteriophora* Poinar 1975 performs favorably compared to chemical insecticides when applied at the optimal temperature, soil type, irrigation interval, and thatch depth (Georgis and Gaugler 1991). *Steinernema glaseri* (Steiner 1929) has also provided effective control of scarab larvae (Klein 1990; Selvan et al. 1993 a;b). Similar results have been obtained in my earlier works (not published date) where *S. glaseri* proved to be the most virulent species among nematodes tested against third larval stage (L3) of *A. solstitiale*. However, the effectivenes of mass culture and storage of this species are strongly limited by many factors.

During a field collection of June chafer grubs numerous larvae of a curculionid *Strophosoma faber* (Herbst) (*Curculionidae*) were frequently observed at the same locations. Both insects shared the same soil niches and were present at densities of 6 and 40 larvae per m^2 of *A. solstitiale* and *S. faber*, respectively. The main objectives of this study were to examine if *S. faber* could play a role of an alternative host to entomopathogenic nematodes and if its presence in the soil could affect the nematode (*S. glaseri)* infectivity to scarab grubs.

II. MATERIALS AND METHODS

The experiments were conducted with infective juveniles of *S. glaseri* reared in last-instar larvae of *Galleria mellonella* at 25°C, according to Dutky et al. (1964). In the both tests described below the nematode infective juveniles (IJ) were applied in water suspension to the peat-moss surface at the rate of 100 IJs/cm^2. The larvae of *S. faber* and *A. solstitiale* (second larval stage L2) were collected in the field from the turf-grass and stored in the soil at room temperature.

Infectivity assay was carried out in plastic multi-well plates (20-mm diameter) half-filled with a peat-moss. Individual larvae of *A. solstitiale* and *S. faber* were placed separately into wells. Thirty larvae of each species were used. After nematode application plates were covered with lids and incubated at the room temperature. The mortality of experimental insects was checked daily for a period of 21 days. In the general infectivity test both nondiapausing (in spring-summer activity) and diapausing (in overwintering, months XI-III) larvae of *S. faber*, and only nondiapausing larvae of *A. solstitiale* were used.

The second bioassay was conducted in plastic pots (40 mm in diameter) half-filled with 50 ml of the peat. Two nondiapausing larvae, one of each insect species were placed together into individual pot. The insects were separated vertically with a copper mesh screen to avoid any potential wounding. The nematode suspension (1600 IJ/pot) in 1 ml water was applied to the peat-moss surface. The pots were placed at room temperature and checked daily.

III. RESULTS

Both insect species were infected and killed by *S. glaseri* (NC). Results of the infectivity test show that the nematode efficacy is related with particular physiological state of the insect. Mortality of non-, and diapausing larvae of *S. faber* was 100% and 66.4%, respectively (Figs. 1a, 1b). Also, the nematode efficacy is related with stage of development. The nematode infectivity to *A. solstitiale* tested separately with *S. glaseri* was 6.6% and 45% for second and third larval instar, respectively (Fig. 2).

The Fig. 3 demonstrates effects of *S. glaseri* on the mortality of *S. faber* and *A. solstitiale* second larvae placed together. The nematode caused 76.6 and 33.3% mortality of *S. faber* and *A. solstitiale*, respectively.

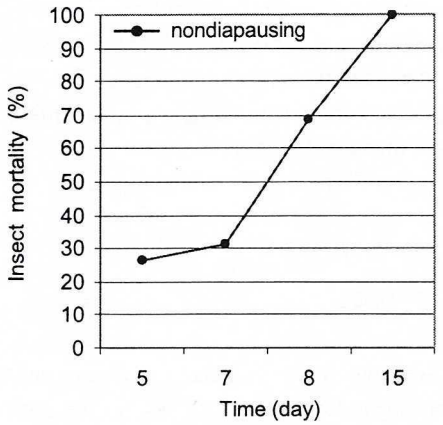

Fig. 1a. Mortality of nondiapausing larvae of *Strophosoma faber* in bioassay with *Steinernema glaseri*

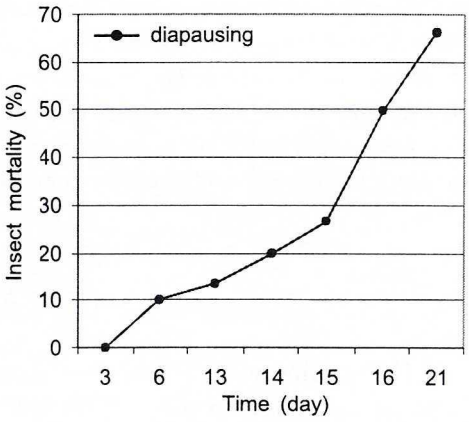

Fig. 1b. Mortality of diapausing larvae of *Strophosoma faber* in bioassay with *Steinernema glaseri*

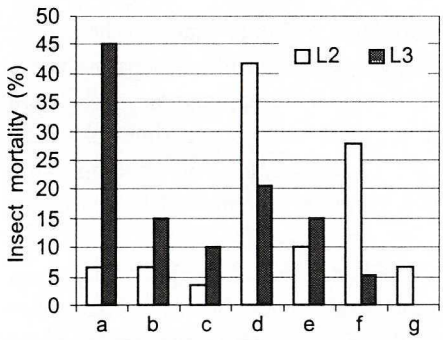

Fig. 2. Mortality of different stage development of *Amphimallon solstitiale* in bioassay with various species and isolates. a – *S. glaseri*, b – *S. arenarium*, c – ScP, d – *H. megidis* IZ#1, e – *H. megidis* Ehler's, f – *H. bacteriophora* Hp88, g – IZ#5

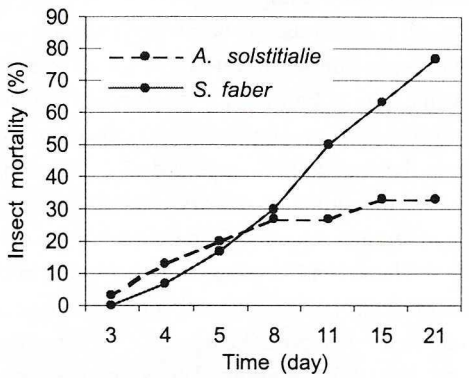

Fig.3. Mortality of nondiapausing larvae L2 of *Amphimallon solstitiale* and *Strophosoma faber* placed together into individual pot with *Steinernema glaseri*

VI. DISCUSSION

The most detailed research on the potential efficacy of entomopathogenic nematodes against white grub was conducted with Japanese beetle (*Popillia japonica*). Kushid et al. (1987) found that older grubs of *P. japonica* were more susceptible to nematode infection than younger stages. Data available in the literature indicate that L3 stage is more susceptible to infection than L2 stage. In the case of *A. solstitiale* this tendency is clearly confirmed by 6.6% mortality recorded in L2 and 45% in L3 grubs (Fig. 2). However, this situation was dramatically changed with the presence of *S. faber* in the soil when 33.3% of *A. solstitiale* L2 grubs were infected and killed by the nematode (Fig. 3). This is most likely caused by the ability of *S. glaseri* to reproduce in the body of dead *S. faber* larvae. The nematode juveniles

emerging from cadavers of *S. faber* apparently caused the mortality among *A. solstitialie*. Under field conditions, where density of the alternative host is higher than density of *A. solstitiale*, the population of *S. faber* can become a reservoir for new populations of *S. glaseri*. This situation is similar to observations of Sulistyanto and Ehlers (1995). Hay and Felon (1995) suggest that based on the infection behavior three subpopulations may be distinguished within the entomopathogenic nematode population. These are: a first group of individuals which initiate infection in unparasitized insects, a second group that invaded infected hosts only, and a third group of non-invaders. It is possible that the presence of alternative host-reservoir under field conditions can cause increase of the subpopulation of invaders. It is most likely that the increased mortality of *A. solstitiale* in the presence of *S. faber* could be due to this change. Bohan and Hominick (1995) suggest that previous contact of entomopathogenic nematodes with infected hosts improve their infectivity.

The infection level of *S. faber* is significantly higher than that of *A. solstitiale*. The low *S. glaseri* infectivity to *A. solstitiale* grubs observed in my research is similar to earlier data on infectivity to *P. japonica*. Scarab grubs are capable of preventing nematodes from entering their bodies. The most important factors limiting parasitization are special sieve plates that protect openings of the insect spiracles and dense hairs around the mouth and anal openings (Smits 1992).

The *S. glaseri* ability to infect larvae seems to be related with the insect physiological state. The infection level of *S. faber* nondiapausing, and diapausing larvae was clearly different and reached 100 and 66.4%, respectively (Fig. 1). It is similar to susceptibility of larvae of *Scarabaeidae*.

All studies reported in the literature demonstrate that entomopathogenic nematodes can be used without any risk for warm-blooded animals and plants (Boemare et al. 1996). Although Klein and Georgis (1992) reported reduction in numbers of mites and collembola one week after application of nematodes, the populations returned to their normal levels one month later. Therefore, entomopathogenic nematodes could be used safely and help to reduce the use of chemical insecticides against soil insects. This is particularly important to locations with special safety requirements, such as city parks and recreational areas.

Results of the presently reported study suggested that *S. faber* is clearly more susceptible to nematode infection than *A. solstitiale* grubs, it can support fast nematode reproduction and become a reservoir of new nematode population for more effective and extended control of the addressed pest.

V. LITERATURE

1. Boemare N., Laumond Ch., Mauleon H. 1996. The entomopathogenic nematode – bacterium complex: biology, life cycle and vertebrate safety. Biocontrol Science and Technology, 6: 333-345.
2. Bohan D., Hominick W. M. 1995. Examination of *Steinernema feltiae* infection interaction with *Galleria mellonella* host, using an infection model. Parasitology 111: 617-625.
3. Dutky S. R., Thompson J. V., Cantwell G. E. 1964. A technique for the mass propagation of the DD 136 nematode. J. Insect Pathol., 6: 417-422.
4. Georgis R., Manweiler S. A., 1994. Entomopathogenic nematodes: a developing biological control technology. Agricultural Zoology Reviews Andower, Intersept: 63-94.

5. Georgis R., Gaugler R. 1991. Predictability in biological control using entomopathogenic nematodes. J. Econ. Entomol., 84: 713-720.
6. Hay D., Felon J. S. 1995. A modified bionomial model that describes the infection dynamics of the entomopathogenic nematode *Steinernema feltiae*. Parasitology 111: 627-633.
7. Klein M. G., Georgis R. 1992. Persistence of control of Japanese beetle (*Coleoptera; Scarabaeidae*) larvae with Steinernematid and Heterorhabditid nematodes, J. Econ. Entomol., 85 (3): 727-730.
8. Klein M. G. 1990. Eficcacy against soil-inhibiting insect pests. pp.195-214. In "Entomopathogenic nematodes in Biological Control". (R. Gaugler, H. K. Kaya, eds.). CRC press, Boca Raton.
9. Kushid T., Mitsubashi J., Koizumi C., Mamiya Y. 1987. Newly found *Steinernema* sp. infecting injurious insects in soil. Recent Advances in Biological control of insect pest by entomogenous nematodes in Japan. Saga University, Japan: 71-80.
10. Selvan S., Gaugler R., Campell J. F. 1993a. Efficacy of entomopathogenic nematode strain agains *Popillia japonica* (*Coleoptera: Scarabaeidae*) larvae. J. Econ. Entomol., 86: 353-360.
11. Selvan S., Grewal P., Gaugler R., Tomalak M., 1993b, Evaluation of steinernematid nematodes against *Popillia japonica* (*Coleoptera: Scarabaeidae*) larvae: species, strains, and post-application rinse. J. Econ. Entomol.: 605-609.
12. Smits P. H., 1992. Control of white grubs, *Phylloperta horticola* and *Amphimallon solstitiale* in grass with heterorhabditid nematodes, pp. 229-235. In „Use of Pathogens in Scarab Pest Management", (Glare and Jackson, eds.).
13. Sulistyanto D., Ehlers R. 1995. Efficacy of the entomopathogenic nematodes *Heterorhabditis megidis* and *Heterorhabditis bacteriophora* for the control of grubs (*Phyllopertha horticola* and *Aphodius contami-natus*) in golf course turf. Biocontrol Science and Technology 6: 247-250.

Jolanta Kowalska

WPŁYW OBECNOŚCI GOSPODARZA ALTERNATYWNEGO *STROPHOSOMA FABER* (HERBST) NA SKUTECZNOŚĆ NICIENI OWADOBÓJCZYCH *STEINERNEMA GLASERI* ZASTOSOWANYCH W ZWALCZANIU PĘDRAKÓW *AMPHIMALLON SOLSTITIALE* L. W GLEBIE

STRESZCZENIE

Larwy guniaka czerwczyka (*Amphimallon solstitiale* L.) są szkodnikami terenów trawiastych i przyczyną poważnych szkód ekonomicznych. W trakcie dokonywania cyklicznych zbiorów pędraków tego szkodnika zaobserwowano licznie występujące w glebie larwy ryjkowca *Strophosoma faber* (Herbst). Oba gatunki zasiedlały w tym samym czasie tę samą niszę ekologiczną.

W związku z tym, że nicienie owadobójcze są rozważane jako czynnik biologicznego zwalczania guniaka czerwczyka, szkodnika występującego na zielonych terenach zurbanizowanych, podjęto decyzję o przeprowadzeniu testów laboratoryjnych, w trakcie których oceniono wpływ obecności konkurencyjnego gospodarza na skuteczność zastosowanych nicieni przeciwko innemu szkodnikowi. Stwierdzono, że oba gatunki są infekowane przez nicienie, choć zdecydowanie wyższy poziom śmiertelności zaobserwowano dla larw ryjkowca.

Można uznać, że *S. faber* jest bardziej wrażliwym owadem niż *A. solstitiale* na infekcje spowodowane przez nicienie owadobójcze. Tym samym może stać się dla nich gospodarzem alternatywnym i rezerwuarem dla następnych pokoleń larw infekcyjnych *S. glaseri.*