Zoology

Entomopathogenic Nematode *S. feltiae* for Biocontrol of Beet Moth *Gnorimoschema ocellatella* Boyd. (Lepidoptera: *Gelechiidae*)

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ABSTRACT. Efficacy of entomopathogenic nematode *Steinernama feltiae* in biocontrol of larvae of beet moth *Gnorimoschema ocellatella* Boyd. is studied. In the experiments carried out under different climatic conditions in June and August two different concentrations of nematode suspension 2000 and 4000 nem/ml water were used against harmful pests. Results of the study showed that in June after treating plants with suspension at the air temperature of 27-28^{0}C and relative humidity of 50-54% the pest larvae mortality was 63.2-83.6%, and in August, under the conditions of relatively high temperature of 32-34^{0}C and low relative humidity of 45-50% after treating with the same suspension the mortality reduced to 37.5-77%. *© 2014 Bull. Georg. Natl. Acad. Sci.*

Key words: entomopathogenic nematode, larvae, biological control, beet moth.

Beet mining moth is a harmful pest for beet. Moth larvae are especially dangerous because they cause damage for the entire life cycle. At first larvae skeletonize the mature leaves, and then feed on petioles and grown leaves. During the whole vegetation period two or even four generations of moth develop. In the second half of summer the harmfulness increases. Generally entomopathogens are considered to be ideal for pest management because of their specificity to pests and because of their lack of toxicity to humans or natural enemies of many crop pests.

Insect-pathogenic nematodes of the family *Steinernematidae* are known for decades as effective biological agents of insect pests. These nematodes can actively locate, infect and kill a wide range of insect species. Only the third-stage Juvenile can survive outside the insect host and move from one insects to another. Insect mortality, due to nematode infection, is caused by a symbiotic bacterium (*Xenorhabdus* spp.) [1]. However, when these biological control agents are taken into the field the range and degree to which they can be controlled is often greatly reduced. Application of beneficial nematodes are highlighted as arguably the most important fac-

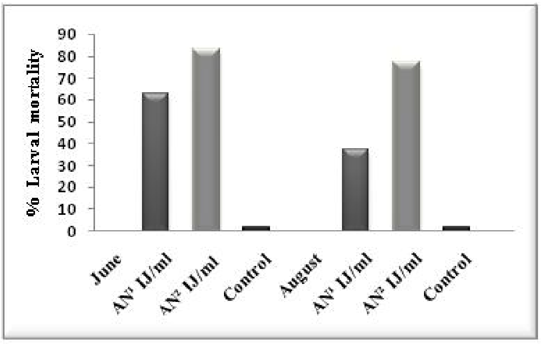

Fig. Mortality of beet moth larvae (%) in the areas treated with nematoda *Steinernema feltiae* suspension in June and August.

tors in determining the success of their application [2,3].

The focus of this work is to evaluate the infectiveness of *S. feltiae* against larvae of Beet moth in different climatic conditions of eastern Georgia.

Material and Method

Field experiments on biocontrol of beet moth larvae were carried out in Marneuli (south Georgia) in June and August, 2013. For observations 3 small private plots of beet crops of 10 m^2 were selected. Both experiments were carried out in 3 variants in 2 trial and 1 control plots.

Nematodes were cultured in last instar *Galleria mellonella* (Lepidoptera: Pyralidae) at 25^0C following the methods described by Dutky et al. [4]. All experiments were conducted with infective juveniles harvested between 2 and 3 weeks after their emergence from host cadavers.

Nematode suspension of two different concentrations with titres 2000 and 4000 IJ/ml was prepared. Both trial plots 1and 2 were treated with low and high concentration of nematode suspension, respectively, in both experiments. The control plot was treated with tap water.

The 1^{st} experiment was carried out in June at 27-28^0C and relative humidity of 50-54%. In the trial plot 1 pest larvae damaged 55% of 40 seedlings before treatement the area with suspension. The total number of larvae in 1 m^2 area was 170, i.e. 4.25 per plant, on average. In trial plot 2 larvae damaged 60% of 40 seedlings before treating with suspension. The total number of larvae was 175 per1 m^2, i.e. 4.37 per plant, on average.

The 2^{nd} experiment was carried out in August at a relatively high temperature 32-34 ^{0}C and low humidity of 45-50 %. In plot 1 the 61% of 40 seedlings were damaged by pest larvae before treating with small dose of the suspension. The total number of larvae in 1 m^2 area was 190, i.e. 4.75 per plant, on average. In plot 2– 62.5% of 40 seedlings were damaged before treating with high dose of suspension. The total number of larvae was 187 per 1 m^2, i.e. 4.67 per plant, on average.

Nematode suspension was sprayed in the trial plots in the evening after sunset. In the experiments a hand nozzle or a back pump with pressure of 3 bar and nozzle size of at least 0.5 mm without filters were used as equipment. Control of the treated plants and registration of the killed pests were fulfilled by the Abbott's method [5] on the 7^{th} day after spraying.

Results of the 1^{st} experiment

Number of damaged plants in the trial plot. In June, after 7 days of treating the plants with nematode suspension of low concentration in plot 1 the number of damaged plants decreased by 41%, and after using high concentration suspension the number of damaged plants decreased by 70.8% (Table 1).

Number of pest larvae in the trial plot. At first, the total number of larvae in plot 1 was 170, after spraying the suspension of low concentration it became 68, i.e. the number decreased by 60%. The number of live insects decreased by 85.3%; the number of killed insects was 43.

Analogously, in plot 2 the total number of larvae (175) after spraying the suspension of high concentration became 55, i.e. decreased by 60%, the number of live insects decreased by 94.8%; the number of killed insects was 46.

Number of pest larvae on one plant. After treating with suspension the number of pest larvae per 1 plant (4.25 on average) decreased by 60%, the number of live insects decreased by 85.3%; the number of killed insects was 1.08 on average.

Table 1. Bioefficacy of the nematode *S. feltiae* against beet moth larvae. Results of June experiments

Experimental objects	Trial plot 1 Low dose, 2000 IJ/ml			Trial plot 2 High dose, 4 000 IJ/ml		
	Before treating	After treating	Relative number of damaged objects*	Before treating	After treating	Relative number of damaged objects
Total number of plants	40	40	-	40	40	-
Number of damaged plants	22	13	41%	24	7	70.8%
Number of damaged plants, %	55%	32.5%	41%	60%	17.5%	70.8%
Number of insects in the experimental plants						
Total	170	68	60%	175	55	68.5%
Live	170	25	85.3%	175	9	94.8%
Dead	-	43	-	-	46	-
Number of insects on one plant						
Total	4.25	1.7	60%	4.37	1.35	68.5%
Live	4.25	0.62	85.3%	4.37	0.16	94.8%
Dead	-	1.08	-		1.19	-
Total mortality of insects, %	-	63.2%	-		83.6%	-

The number of larvae on one plant (4.37 on average) after treating with suspension decreased by 68.5%, the number of live insects decreased by 94.8%; the number of killed insects was 1.19 on average.

According to the data of the experiments carried out in June in plots 1 and 2, after applying low and high doses of the nematode suspension, 63.2% and 83.6% of mortality of beet moth larvae was recorded, respectively (Table 1).

In the control experiment, where tap water was used, the mortality of pests was insignificant (0.4%) (Fig.).

Results of the 2nd experiment

Number of damaged plants in the trial plot. The results of the experiments carried out in August showed that after treating the plants with nematode suspension in plot 1 the number of damaged plants decreased by 16.6%, and in plot 2 it decreased by 68% (Table 2).

Number of pest larvae in the trial plot. The initial number of larvae (190) after spraying the nematode suspension decreased to 144 in trial plot 1, i.e. it decreased by 24%. The number of live insects decreased by 50%. The number of killed insects was 54.

In plot 2 the initial number of larvae (187) decreased by 28.9% after treating, the number of live insects decreased by 84%. The number of killed insects was 103.

Number of pest larvae on one plant. The number of larvae on one plant was 4.75 on average; after spraying the suspension it decreased by 24%, the number of live insects decreased by 50%. The number of killed insects was 1.23 on average.

After spraying the high dose of suspension the number of larvae on one plant (4.67 on average) decreased by 28.9%, the number of live insects decreased by 84%, the number of killed insects was 2.57 on average (Table 2).

Thus, based on the data of the experiments the carried out in August (variants 1 and 2, AN_1-AN_2), 37.5% and 77% of mortality of beet moth larvae were recorded after using the low and high doses of suspension,respectively.

In the control plot, where tap water was used, the mortality of pests was insignificant (0.4%) (Fig.).

Table 2. Bioefficacy of the nematoda *S. feltiae* against beet moth larvae. Results of the August experiments

Experimental objects	Trial plot 1 Low dose, 2000 IJ/ml			Trial plot 2 High dose, 4 000 IJ/ml		
	Before treating	After treating	Relative number of damaged objects*	Before treating	After treating	Relative number of damaged objects
Total number of plants	40	40	-	40	40	-
Number of damaged plants	24	20	16.6%	25	8	68%
Number of damaged plants, %	60%	50%	16.6%	62.5%	20%	68%
Number of insects in the experimental plants						
Total	170	68	60%	175	55	68.5%
Live	170	25	85.3%	175	9	94.8%
Dead	-	43	-	-	46	-
Number of insects on one plant						
Total	4.75	3.60	24%	4.67	3.32	28.9%
Live	4.75	2.37	50%	4.67	0.75	84%
Dead	-	1.23	-	-	2.57	-
Total mortality of insects, %	-	37.5%	-		77%	-

*In both Tables, relative number of damaged objects is calculated by the formula $\frac{C_0 - AN_1}{C_0} \cdot 100\%$, where C_0 is a number of objects under experiments before treating, AN_1 and AN_2 – numbers of objects under experiments after treating with low and high doses of nematode suspension, respectively.

Conclusion

The data of the experiments carried out in summer months against larvae of beet moth *Gnorimoschema ocellatella* Boyd**.** showed that mortality of pests after 7 days of treating plants with nematode suspension of low and high concentration (2000 and 4000 nem/ml) was higher at relatively low temperature and high relative humidity. As is seen from Tables the pest mortality was 63.2-83.6% at 27-28 ^{0}C and relative humidity of 50-54% in June; in August, at 32-34 ^{0}C and 45-50% of humidity after treating with the same concentrations of suspension the mortality was lower 37.5-77%

It is clear that to reach the higher efficacy it is necessary to increase nematode suspension concentration and spray repeatedly with little time span and to irrigate additionally especially under hot climatic conditions. It should be noted that percentage of mortality of pests varied significantly during the mentioned period that was caused by both adiobatic factors and peculiarities of pest's biology.

Based on the results obtained, taking into consideration efficacy of entomopathogenic nematode *Steinernema feltiae* we think that their application for biocontrol of beet moth larvae is reasonable.

ენტომოლოგია

ენტომოპათოგენური ნემატოდა *S. feltiae* ჭარხლის ჩრჩილის - *Gnorimoschema ocellatella* Boyd. (Lepidoptera: *Gelechiidae*) ბიოკონტროლში

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შესწავლილია ენტომოპათოგენური ნემატოდის *Steinernama feltiae*-ს ეფექტურობა ჭარხლის ჩრჩილის *Gnorimoschema ocellatella* Boyd. მატლების ბიოკონტროლში. მავნე მწერის წინააღმდეგ განსხვავებულ კლიმატურ პირობებში ივნისში და აგვისტოში ჩატარებულ ცდებში გამოყენებული იყო ორი სხვადასხვა კონცენტრაციის მქონე ნემატოდური სუსპენზია 2000 და 4000 ნემ/მლ წყალი. ექსპერიმენტების შედეგებმა აჩვენეს, რომ სუსპენზიით მცენარეების დამუშავებიდან 7 დღის შემდეგ ივნისის თვეში 27-28^{0}C და 50-54% ფარდობითი ტენიანობის პირობებში მიღებული იყო მავნე მწერის მატლების სიკვდილიანობის 63.2 – 83.6%, ხოლო აგვისტოს თვეში შედარებით მაღალი 32-34^{0}C და დაბალი ფარდობითი ტენიანობის 45-50 პირობებში იგივე კონცენტრაციის ნემატოდური სუსპენზიის გამოყენების შედეგად მწერების სიკვდილიანობა შემცირდა და შეადგინა 37.5-77%.

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Received June, 2014