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**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 in 32-34$^0$C and low relative humidity in 45-50% after treating with the same suspension the mortality reduced to 37.5-77%.

Key words: *entomopathogenic nematodes, 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 mature leaves, and then feed on petioles and grown leaves. During the whole vegetation period from two to four generations of moth developed. In the second half of summer harmfulness increases.

Generally entomopathegens 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 factor in determining the success of their appliation [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 $25^0$C 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 nem/ml was prepared. Both trial plots 1 and 2 were treated with suspension of 2000 nem/ml and 4000 nem/ml concentrations, respectively, in both experiments. The control plot was treated with tap water.

The 1st experiment was carried out in June at 27-$28^0$C 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 ones on one 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 2nd 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 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 treated plants and registration of killed pests was fulfilled by the Abbott's method [5] on 7th days after spraying.

**Results of the 1st 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 plot**. At first, the total number of larvae in the 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 the 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.

Accordingly, 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 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 2$^{nd}$ 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.

In variant 2, 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 experiments, 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.).

**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 63.83.6% 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 noticed that percentage of mortality of pests varied significantly during the mentioned period that was caused by both abiotic factors and peculiarities of pest's biology.

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

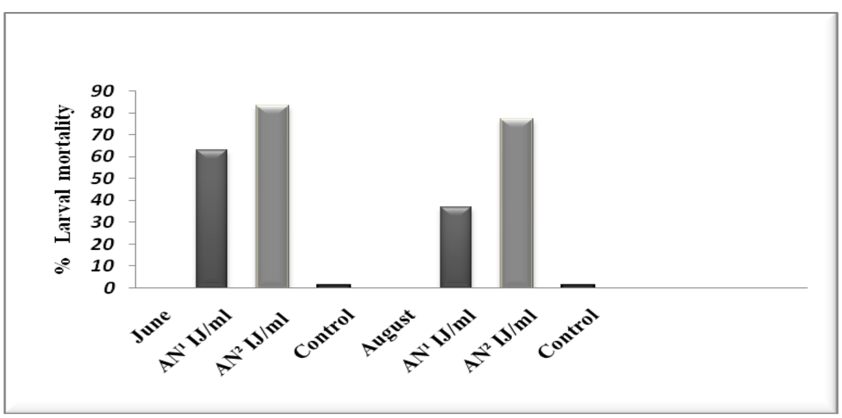

Fig. Mortality of beet moth larvae in % in the areas treated with nematoda *Steinernema feltiae* suspension in June and August.

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

| Experimental objects | Trial plot 1<br>Low dose, 2000 nem/ml | | | Trial plot 2<br>High dose, 4 000 nem/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% | - |

*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.

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

| Experimental objects | Trial plot 1<br>Low dose, 2000 nem/ml | | | Trial plot 2<br>High dose, 4 000 nem/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 | 190 | 144 | 24% | 187 | 133 | 28.9% |
| Live | 190 | 95 | 50% | 187 | 30 | 84% |
| Dead | - | 54 | - | - | 103 | - |
| 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% | - |

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