# ЕФИКАСНОСТ НА НЯКОИ БИОИНСЕКТИЦИДИ СПРЯМО КАРТОФЕНИЯ МОЛЕЦ, *PHTHORIMAEA OPERCULELLA* ZELLER (LEPIDOPTERA: GELECHIIDAE) ПРИ ЛАБОРАТОРНИ УСЛОВИЯ

# EFFICACY OF SOME BIOINSECTICIDES AGAINST THE POTATO TUBER MOTH, *PHTHORIMAEA OPERCULELLA* ZELLER (LEPIDOPTERA: GELECHIIDAE) UNDER LABORATORY CONDITIONS

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**Резюме**

При лабораторни условия е изпитано овицидното и ларвицидното действие на три биоинсектицида – Дипел ВП, НимАзал Т/С и Трейсър 480 ЕК, спрямо картофения молец *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae). Биоинсектицидите бяха тествани в три концентрации – в регистрираната за други неприятели в България и в две по-ниски. Силен овициден ефект прояви само биоинсектицидът НимАзал Т/С. Препаратът във всички изпитани концентрации имаше значителен ефект в сравнение с контролата ($p \leq 0.05$). Яйцата, третирани с Трейсър 480 ЕК, се излюпиха на 24-ия час след третирането и в сравнение с контролата не бяха установени значими разлики.

Всички изпитани препарати показаха много добра ефикасност спрямо ларвите на *P. operculella*. Най-бърз инициален ефект беше регистриран при Трейсър 480 ЕК, следван от НимАзал Т/С и Дипел ВП. Ларвите, третирани с Трейсър 480 ЕК в концентрация 0.03%, загинаха на следващия ден и ефикасността достигна 100% на 3-тия ден след третирането. Третиранията с по-ниските концентрации от 0.025% и 0.01% достигнаха 100% ефикасност на 5-тия ден. Биоинсектицидът НимАзал Т/С в концентрация 0.3% показа 100% ефикасност на 7-мия ден след третирането. Най-бавно действие прояви Дипел ВП и ефикасност от 87.5% беше наблюдавана на 9-тия ден след третирането при концентрация от 0.15%.

**Abstract**

The ovicidal and larvicidal effect of three bioinsecticides – *Dipel DF, NeemAzal T/S* and *Tracer 480 SC* against the potato tuber moth, *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae) were tested under laboratory conditions. Bioinsecticides were tested at three concentrations – at the registered one for other pests in Bulgaria and at two lower ones. Only the *NeemAzal T/S* bioinsecticide showed strong ovicidal effect. The product in all tested concentrations had significant effects compared with the control ($p \leq 0.05$). The eggs treated with *Tracer 480 SC* hatched on the 24$^{th}$ hour after the treatment and no significant differences were observed compared with the control.

All tested products showed very good efficacy against the larvae of the *P. operculella*. The fastest initial larvicidal effect was registered for *Tracer 480 SC*, followed by *NeemAzal T/C* and *Dipel DF*. The larvae treated with *Tracer 480 SC* died on the following day and the efficacy reached 100% on the 3$^{rd}$ day after the treatment at a concentration of 0.03%. The treatments with lower concentrations of 0.025% and 0.01% reached 100% efficacy on the 5$^{th}$ day. The *NeemAzal T/S* bioinsecticide at a concentration of 0.3% showed 100% efficacy on the 7$^{th}$ day after the treatment. *Dipel DF* showed the slowest action and efficacy of 87.5% was observed on the 9$^{th}$ day after the treatment at a concentration of 0.15%.

**Ключови думи:** биоинсектициди, НимАзал Т/С, Трейсър 480 ЕК, Дипел ВП, *Phthorimaea operculella.*
**Key words:** bioinsecticides, *NeemAzal T/S*, *Tracer 480 SC*, *Dipel DF*, *Phthorimaea operculella.*

## INTRODUCTION

Potato, Solanum tuberosum L. is a crop of international importance. The potato tuber moth *Phthorimaea operculella* Zeller, is considered among the most important and destructive potato insect pest in both fields and storage (Ferreire *et al.,* 1994). Damage of the pest in suitable conditions in storage is more than in the field. The larvae of the pest cause severe damage to stored potatoes through mining into tubers and they get rot and become unsuitable for human consumption (Das, 1995).

In Bulgaria the pest was established for the first time in 1950 on potatoes in the region of Petrich (Stanev & Kaytazov, 1962). Since 2008 there has been an expansion in the distribution of the pest in the country, spreading in the regions of Kyustendil, Pernik, Samokov, Ihtiman, Pazardzhik, Plovdiv, Smolyan, Burgas, Blagoevgrad, Kardzhali, Balchik and Dobrich (Vaneva-Gancheva & Grigorova, 2010; Subchev *et al.,* 2013).

Conventional control methods against the potato tuber moth are not very successful because the larvae pass a most of their life inside the tubers (Haiba, 1994). The use of chemical pesticides to control *P. operculella* has resulted in harmful side effects such as health hazards from residues (Dikshit et al., 1985), reduction in populations of natural enemies (Shelton et al., 1981) and the development of insect resistance to pesticides (Haines, 1977; Llanderal-Cazares et al., 1996).

In recent years with development of the organic agriculture in our country has been increased interest in bioinsecticides as alternatives to chemical products. Bioinsecticides are an important component in modern plant protection, because they are selective and relatively safe for the environment and human health and at the same time effective measures for controlling many harmful pests, including the potato tuber moth (Stiener & Elliot, 1987; Stauffer & Rose, 1997; Miller & Uetz, 1998).

Botanicals are a promising source of pest control compounds. These have generated remarkable interest as potential sources of natural insect control agents. Over 2000 species of plants are known to possess different degrees of insecticidal activity (Jacobson, 1975).

Neem extracts have a wide range of effects against insect pests, including repellence, feeding and oviposition deterrence, toxicity, sterility and growth regulatory-activity (Jacobson, 1989; Schumutterer, 1990, 1995; Ascher, 1993).

The bacterial preparations based on *Bacillus thuringiensis* are widely used in organic farming. *B. thuringiensis* var. *kurstaki* causes the death of more than 200 species of the order Lepidoptera and is registered to control many insect pests on agricultural, forest and ornamental crops. These biopesticides have been assessed as safe for the environment and human health (Otvos et al., 2005).

The objective of this study is to examine the ovicidal and larvicidal effect of three organically-certified insecticides - NeemAzal T/S, Tracer 480 SC and Dipel DF on 1-2 days old eggs and on the first instar larvae of the potato tuber moth, *P. operculella*.

## MATERIALS AND METHODS

### *Phthorimaea operculella*

The population of potato tuber moth originated from the Institute of Tobacco and Tobacco Products - Markovo, kindly provided by the research assistant T. Vaneva-Gancheva. The population of the *P. operculella* was grown in the insectarium of department "Entomology" at the Institute of Soil Science, Agrotechnologies and Plant Protection – Sofia. The rearing is carried out at a temperature of 24-26°C, 60-80% relative humidity and photoperiod of 18: 6 h (L: D) by the methodology of Maharjan & Jung (2012).

### *Bioinsecticides*

NeemAzal T/S - containing 1% azadirachtin-A, as its active ingredient in the form of an emulsifiable concentrate, in concentrations of 0.1%, 0.25% and in the registered concentration at 0.3% against twospotted spider mite *Tetranychus urticae* Koch on vegetables.

Tracer 480 SC (480 g/l spinosad) – 0.01%, 0.025% and in the registered concentration at 0.03% against *Neodiprion sertifer* Geoffr.

Dipel DF (16 000 IU per 1 mg product of *Bacillus thuringiensis* var. *kurstaki*) - 0.05%, 0.1% and in the registered concentration at 0.15% against larvae of *Lobesia botrana* (Denis & Schiff.).

### *Bioassays*

The study was conducted in 2013 in the laboratory of department "Entomology" at the Institute of Soil Science, Agrotechnologies and Plant Protection – Sofia.

The ovicidal effect of NeemAzal T/S and Tracer 480 SC has been established on 1-2 days old eggs oviposited on filter paper. A piece of filter paper with 20 eggs was placed in a Petri-dish. The eggs were treated with tested products by dipping method

of Park et al. (2002). The treatments were conducted in four repetitions of 20 eggs in each repetition. The eggs were dipped for 20 seconds in different concentrations of tested bioinsecticides and the control was dipped in water. After drying for 20 minutes eggs were inserted in Petri dishes and subsequently covered. The number of hatched eggs was recorded on 24h and 48 h after the treatment.

The obtained data were statistically analyzed with the program StatSoft, ver. 10. Confidential probability, $P \leq 0.05$ (Student's t-test) is accepted as criterion for significant difference between treatments and the control.

The larvicidal effect of NeemAzal T/S, Tracer 480 SC and Dipel DF has been established on the first instar larvae of the potato tuber moth, *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae). The treatments with the bioinsecticides were carried out using the dipping method of Park *et al.* (2002). Potato slices (1 cm thickness) were dipped in the tested products for 20 seconds and the control was dipped in water. After drying for 20 minutes each slice was transferred to a Petri-dish and provided with 20 first instar larvae by fine hair brush. The treatments were conducted in four repetitions of 20 first instar larvae in each repetition. The number of surviving individuals was recorded on the 1st, 3rd, 5th, 7th and 9th days after the treatment. The efficacy was estimated according to Henderson and Tilton formula (1955).

## RESULTS AND DISCUSSION

### *Ovicidal effect*

The strong ovicidal effect showed only the bioinsecticide NeemAzal T/S. In all tested concentrations the product had significant ovicidal effects compared with the control ($p \leq 0.05$). The eggs treated with Tracer 480 SC hatched on the 24h after the treatments and no significant differences were observed compared with the control. Hatchability increased gradually as the concentrations decreased (Table 1).

The results obtained are similar to Shelke et al. (1987) which tested various vegetable extracts and oils for their ovicidal activity against *P. operculella.* They found that neem extract of the seeds of *Azadirachta indica* sprayed on eggs causes 91.67% inhibition of egg hatching at a concentration of 5%. Acording to other authors neem products acts as a repellent against phytophagous insects and also affects reproduction and development of pests preventing egg-laying of females and disrupts moulting of the larvae (Schumutterer, 1990; Mordue & Blackwell, 1993).

### *Larvicidal effect*

Results showed that Tracer 480 SC was the most efficient against the first instar larvae of potato tuber moth compared to NeemAzal T/S and Dipel DF. The larvae treated with Tracer 480 SC died on the following day and the efficacy reached 100% on the 3rd day after the treatment at concentration of 0.03%. The treatment with lower concentrations of 0.025% and 0.01% had 100% efficacy on the 5th day (Fig. 1).

The botanical insecticide NeemAzal T/S at concentration of 0.3% showed 100% efficacy on the 7th day after the treatment. In lower concentration of 0.25% the same product also had 100% efficacy but reached it on the 9th day, whereas at concentration of 0.1% had 87.5% efficacy on the 9th day (Fig. 1). Kroschel and Koch (1996) in their studies also established very high effectiveness of the water extract of neem of 93.8% against newly hatched larvae of potato tuber moth.

Dipel DF showed very good results against larvae of the potato tuber moth, but the action was very slow and maximum efficacy of 87.50% was observed on the 9th day after the treatment at concentration of 0.15% (Fig. 1). The efficacy of the other concentrations of 0.1% and 0.05%, was a little bit lower – 75% and 62.5%, respectively.

Kroschel and Koch (1996) in bioassays to control the potato tuber moth tested effect of the *Bacillus thuringiensis* when the potatoes were inoculated with eggs of the potato tuber moth after treatment and when the larvae were already in the tubers. They established that B. thuringiensis prevented the development of the larvae once eggs had hatched. With larvae already in tubers, the B. thuringiensis with fine sand mixture and dusted on tubers was extremely effective, with a success rate of 96%.

## CONCLUSIONS

1. The bioinsecticide NeemAzal T/S in all tested concentrations showed the strong ovicidal activity against *P. operculella,* while the eggs treated with Tracer 480 SC hatched on the 24h after the treatments.

2. The bioinsecticide Tracer 480 SC showed the fastest insecticidal action against first instar larvae of potato tuber moth on the next day after the treatment, followed by NeemAzal T/C and Dipel DF.

3. The products Tracer 480 SC at concentration of 0.03% and NeemAzal T/C - 0.3% showed 100% efficacy against first instar larvae of potato tuber moth on the 3rd and 7th day after the treatment, respectively. The slowest action showed Dipel DF with efficacy of 87.5% on the 9th day after the treatment.

**Table 1.** Ovicidal effect of bioinsecticides against egg stages of the potato tuber moth, *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae)

| Variants | 24h after the treatment | | 48h after the treatment | |
|---|---|---|---|---|
| | Number of hatched eggs (mean ± s.e.) | % hatched eggs | Number of hatched eggs (mean ± s.e.) | % hatched eggs |
| NeemAzal 0.3 % | 0±0* | 0 | 0±0* | 0 |
| NeemAzal 0.25 % | 0.25±0.25* | 1.25 | 0±0* | 0 |
| NeemAzal 0.1 % | 1±0.40* | 5 | 0±0* | 0 |
| Tracer 0.03 % | 7±1.29 | 35 | 8.75±0.47 | 43.75 |
| Tracer 0.025 % | 8.5±0.64 | 42.5 | 9.5±0.5 | 47.5 |
| Tracer 0.01 % | 9±0.57 | 45 | 10±0.40 | 50 |
| Control | 9.75±0.25 | 48.75 | 9.75±0.25 | 48.75 |

* means are significantly different (p≤0.05)

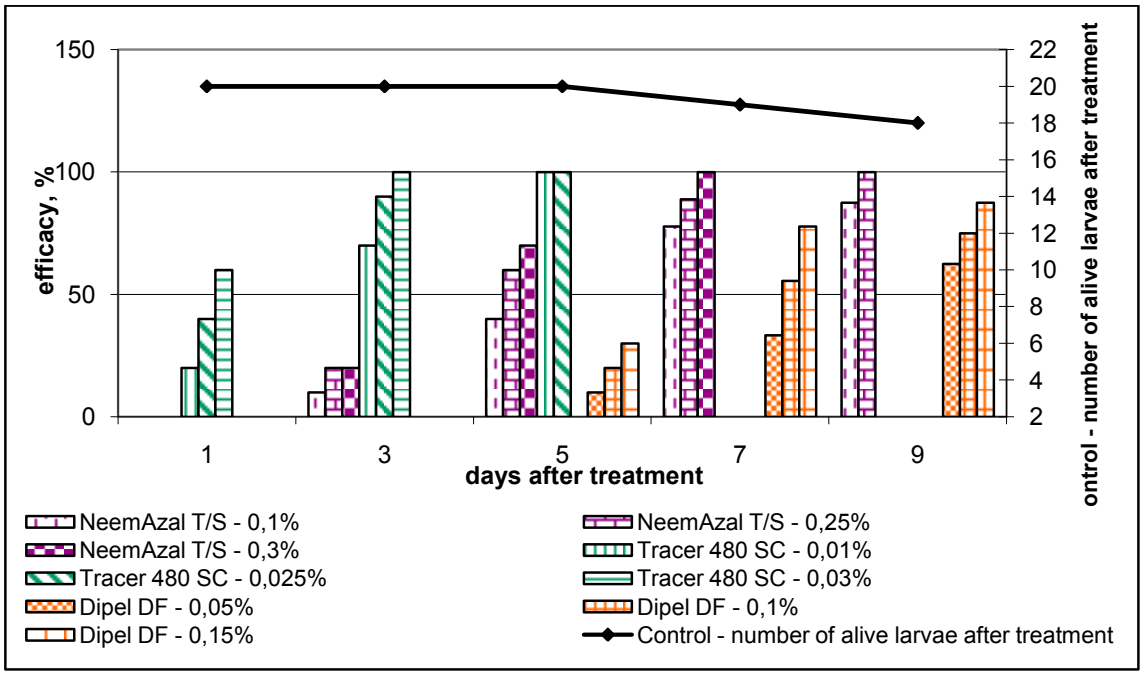


***Fig. 1.*** *Efficacy of bioinsecticides on the first instar larvae of the potato tuber moth, Phthorimaea operculella Zeller (Lepidoptera: Gelechiidae)*

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