# MANAGEMENT OF THE NEMATODE *Ditylenchus destructor* THORNE, 1945 TO *Solanum tuberosum* L. CULTURE WITH THE APPLICATION OF *Bacillus cereus* var. *fluorescens* CNMN-BB-07 BACTERIA

Olesea GLIGA [*], Maria MELNIC[*], Ștefan RUSU[*], Valerina SLANINA[**]

[*] *Moldova State University, Institute of Zoology, Chisinau, Republic of Moldova*
[**] *Technical University of Moldova, Institute of Microbiology and Biotechnology, Chisinau, Republic of Moldova*
*Corresponding author: Olesea Gliga, Moldova State University, Institute of Zoology, 1 Academiei Str., MD2028, Chisinau, Republic of Moldova, phone: 022739809, e-mail: oleseagliga@gmail.com*

**Abstract.** For the first time in the Republic of Moldova, management research was conducted with the application strains of bacteria *Bacillus cereus* var. *fluorescens* CNMN-BB-07, of autochthonous origin, both *in vitro* and *in vivo* experiences to combat pests of the genus *Ditylenchus* - *D. destructor*, *D. dipsaci*, which parasitize potato tubers (*Solanum tuberosum* L.). *In vitro* testing demonstrated a lethal efficacy of 98.5 – 100% after 24-hours of exposure to the strain, taken in the initial concentration – 6 x $10^9$ cells/mL. The liquid culture (LC) of the tested strain, when diluted in proportions of: 1:50 (V2); 1:100 (V3) and 1:200 (V4), also, possess nematicidal activity. Thus, after 48 hours of exposure, the lethal effect was: 50%; 40% and 27.3%, respectively. *In vivo* testing in which seed potatoes infested with *D. destructor* (100% infestation) were treated by soaking in LC diluted 1:400 for 16 hours, resulted in a drastic reduction of infestation at harvest - down to 1-4%, compared to 40.42% in the untreated control. Additionally, the treatment with LC eliminated rot incidence (0%) both at harvest and during potato storage, and greatly reduced (just 10.4%) the attack of mole crickets (*Gryllotalpa gryllotalpa*). The given procedure represents an effective biological approach for combating phytoparasitic nematodes with a high growth-promoting effect on agricultural crops.

**Key words:** *Bacillus cereus* var. *fluorescens* CNMN-BB-07; cultural liquid; *Ditylenchus destructor*; lethal effectiveness; *Solanum tuberosum*; *Roko* variety.

## INTRODUCTION

Nematodes are known to be important plant pathogens that can cause serious damage to crops worldwide. Commonly used nematicides are chemical compounds, which have a major impact on the environment and human health, so researchers have tried to find antagonistic microorganisms for the biological control of nematodes.

Currently, in most countries (USA, India, Germany, France, Great Britain, Brazil, etc.), to combat nematode- parasitic species nematicidal biopreparations based on predatory fungi and parasitic bacteria from the genera *Arthrobotrys, Catenaria, Paecilomyces, Pasteuria, Pseudomonas, Rhizobium, Bacillus* etc. are developed and used [1, 10, 13, 26, 30].

Many fungi and bacteria have been reported to have nematicidal activities through the production of secondary metabolites. Various nematode - specific pathogenic bacteria, including *Pasteuria, Pseudomonas* and *Bacillus*, have been isolated from soil, host plants and nematodes for biological control of parasitic phytonematodes [3, 13, 14, 18]. These bacteria exert lethal action on nematodes by different mechanisms, including parasitism, toxin and enzyme production, etc. At the same time, these bacteria also perform anti-nematode activities by promoting plant growth and enhancing plant resistance against nematodes [5, 31].

*Bacillus* spp. can synthesize various molecules that are toxic to nematodes [10, 12, 18]. For example, *Bacillus thuringiensis* shows nematicidal activity towards *Meloidogyne incognita* and *Heterodera glycines* by producing crystal inclusions, a family of toxic proteins, effective against a wide range of insect species including nematodes [6, 14, 17]. According to the authors, *Bacillus* spp. are a potential source for pest biocontrol.

Understanding the mechanism of action of *Bacillus* spp. bacteria against phytopathogens is essential to sustain the biocontrol potential, for this reason, these mechanisms are studied by researchers. A review of specialized literature highlighted the significant biocontrol potential of *Bacillus* spp. combined with their ability to promote plant growth through various biological and biochemical mechanisms. Several studies have reported the different types of mechanisms employed by *Bacillus* spp. in controlling pathogens, including nematodes, fungi, and bacteria [1-5].

The nematicidal activity of the saprophytic bacterial species, researched by us, *Bacillus cereus* var. *fluorescens* CNMN-BB-07, of autochthonous origin from the Republic of Moldova, against the potato tuber nematode *Ditylenchus destructor,* has not previously been described in the scientific literature. It is also known that, according to international standards, seed potatoes must be free from nematode parasitic species harmful to this crop, including *Meloidogyne chitwoodi*, *Meloidogyne fallax* and *Ditylenchus destructor* (Standard for seed potatoes EAK OOH S-1).

According to several authors, Aerobic Endospore-Forming Bacteria (AEFB), - including most *Bacillus* and *Pseudomonas* species, are dominant components of the soil microbiota and act as antagonists to nematodes [15, 28]. Some of the best-known preparations with entomo- and phytopathogenic activity are obtained from bacteria of these genera, due to the secondary metabolites they secrete, such as: siderophores, antibiotics, volatile organic compounds, hydrogen cyanide (HCN), enzymes, and phytohormones [8, 9, 23, 26, 29]. These substances,

exert different actions on phytoparasitic nematodes by inducing parasitism, producing toxins, antibiotics, and enzymes, or by using the nematodes as a source of nutrition, etc. These actions lead to nematode mortality and a reduction in pest density. At the same time, these bacteria stimulate plant resistance mechanisms, and enhance plant development.

It is important to mention that some authors have detected the presence of antagonistic bacteria in the rhizosphere of *Solanum tuberosum* cultures, most of them being *Pseudomonas* spp. [11].

In the Republic of Moldova, researchers of the Institute of Genetics, Physiology and Plant Protection of Moldova State University have developed original technological procedures for the production of effective biological preparations, which were approved by the Interdepartmental Republican Council for the Approval of Phytosanitary Products and Fertilizers. Among them is preparation *Paurin*, obtained on the basis of the bacterium *Pseudomonas fluorescens* BKM CP 330 D, used to combat potato root rot caused by *Fusarium solani* and *Pectobacterium carotovorum* [32]. According to the State Register compiled by the State Center for Attestation and Approval of Phytosanitary Products and Fertilizers, two nematicidal preparations - BL No. 08-2-0129 and Rizoplan No. 08-2-243 are approved for use in biological control of phytoparasitic nematodes that form galls of the genus *Meloidogyne,* as well as other common vegetable crop pests (e.g., those affecting tomatoes and cucumbers) [7]. However, no nematicidal biopreparation are indicated for application to crops from the family Alliaceae, genus *Allium* (*A. sativum, A. cepa*) and *Solanaceae*, varieties *Solanum tuberosum* L., infested by species of migratory endoparasitic nematodes of the genus *Ditylenchus.*

Based on the above, in the Republic of Moldova for the first time, research was conducted to manage nematode infestations using *Bacillus cereus* var. *fluorescens* CNMN-BB-07, through both *in vitro* and *in vivo* experiments on the species of the genus *Ditylenchus (D. destructor, D. dipsaci)*, which parasitize Alliaceae crops and *Solanum tuberosum* L. varieties.

## MATERIALS AND METHODS

The investigations were carried out through *in vitro* and *in vivo* experiments during the years 2011-2021 at the Laboratory of Parasitology and Helminthology of the Institute of Zoology of the Moldova State University.

**Biological materials**

**Nematodes.** For *in vitro* experiments the nematode *Ditylenchus dipsaci* was extracted from infested garlic bulbs collected during the harvest period. Nematodes were isolated from plant tissue using the Baermann method, modified by Nesterov (1979), at 12-hour interval [25]. For the experiments, individual specimens of *D. dipsaci* and *D. destructor* (females, males, pre-imago larvae) were selected using a sterile entomological needle, in groups of 30 - 50 individuals per treatment variant.

**Bacterial Strain:** The strain of bacteria *Bacillus cereus* var. *fluorescens* from the family Bacillaceae, genus *Bacillus,* was isolated in 2005 from the fatty carbonate soil, loamy medium, with 3.5% humus content, in the Republic of Moldova. On 13.10.2014, the strain was deposited in the National Collection of Nonpathogenic Microorganisms (CNMN) at the same Institute. Method of obtaining liquid culture (LC): the given strain was cultivated on King B medium at a temperature of +27±1°C, for 48 hours. The resulting liquid culture (LC) was used to test the direct contact (*in vitro*) with the nematodes *D. destructor and D. dipsaci.*

***In vitro* Experiments**

*In vitro* testing was performed by the direct contact method (Kurt, 1973) of liquid culture (LC) of *Bacillus cereus* var. *fluorescens* (6 x $10^8$ cells/mL) with the parasitic nematode *Ditylenchus destructor* [16, 19]. The experiments were conducted at temperatures of +25…+27°C. Nematodes were maintained under these conditions at various time intervals: 18, 24, and 48 hours, as well as 5, 7, and 14 days. The testing was carried out in four experimental variants: V1, V2, V3, V4, and a control variant, M, as follows:

1. V1 – *D. destructor* exposed to undiluted live bacterial culture (LC);
2. V2 – *D. destructor* exposed to LC, diluted 1:50;
3. V3 – *D. destructor* exposed to LC, diluted 1:100;
4. V4 – *D. destructor* exposed to LC, diluted 1:200;
5. M1 – *D. destructor* exposed to distilled water (control).

At the end of the experiments, the efficacy of the treatment was assessed.

***In vivo* Experiments**

Under *in vivo* conditions, the bacterial strain *Bacillus cereus* var. *fluorescens* CNMN-BB-07 was tested in contact with seed potatoes (*Solanum tuberosum, Roko* variety) artificially infested with the phytoparasitic nematode *Ditylenchus destructor* Thorne, 1945.

A portion of the tubers, showing 100% infestation in the second stage of ditylenchosis, was treated by soaking in a liquid culture (LC) of *B. cereus* var. *fluorescens* CNMN-BB-07 ($6 \times 10^8$ cells/mL) at higher dilutions. Another portion of the infested tubers remained untreated, serving as the infested control (M1). Additionally, a batch of healthy, uninfested, and untreated tubers was included as a healthy control (M2).

The testing scheme was organized as follows:

1. V1 – Infested tubers treated with LC diluted 1:200; exposure time: 16 hours;
2. V2 – Infested tubers treated with LC diluted 1:400; exposure time: 16 hours;
3. M1 – Infested tubers, untreated (infested control);
4. M2 – Healthy, nematode-free tubers, untreated (healthy control).

Treatments were conducted at room temperature (+15 to +20 °C) using the soaking method, with an exposure duration of 16 hours (see Table 2).

The artificially infested seed tubers were obtained through a standardized inoculation method using a defined number of mature *D. destructor* individuals, ensuring 100% infestation prior to treatment [20, 21].

## RESULTS

### *In vitro* testing

The results of the *in vitro* experiments demonstrated that the nematodes exhibited an immediate reaction to the treatment, which takes the form of a spiral, which appeared within the first 20–60 minutes of contact. The lethal efficacy of *Bacillus cereus* var. *fluorescens* CNMN-BB-07 LC at its initial concentration of 6 x $10^9$ cells/mL (V1), reached 98.5 – 100% after 24 hours of exposure [19]. The liquid culture of the tested strain being diluted in proportions of: 1:50 (V2); 1:100 (V3) and 1:200 (V4), also possess nematicidal activity. Thus, at 48 hours of exposure, the lethal effect was: 50%, 40% and 27.3%, respectively (Fig. 1).

Mode of action on the nematode: complete destruction of internal organs and body deformation were observed (Fig. 2). In the mentioned images, it is clearly visible that, after 7-11 days of contact (Figure 2 A) initial tears appeared on the nematode's body, through which bacterial penetration it is clearly observed. Later, after 18-20 days (Fig. 2 B,C,D), in the place where the tears formed, some bubbles appear formed by the eliminated gases. In most cases, in females, pronounced pathological changes appear in its vulvar orifice regions, as well as the gonad with eggs inside the body. It was highlighted the fact that the decomposed homogeneous mass of the internal organs, formed as a result of the contact with the bacteria, is eliminated outside the body through the cuticle breaks. At the same time, the elimination of a gaseous substance was observed. It is known that species of aerobic antagonistic bacteria of the genus *Bacillus* produce a series of enzymes – such as transferases, hydrolases, and lipases – that break down starch, pectin, cellulose, fats, proteins. The results presented in Figure 2 demonstrate that the studied bacterial strain, in contact with nematodes *D. destructor*, *D. dipsaci*, exerted enzymatic activity, thanks to which the internal organs of the nematodes are subjected to hydrolysis processes.

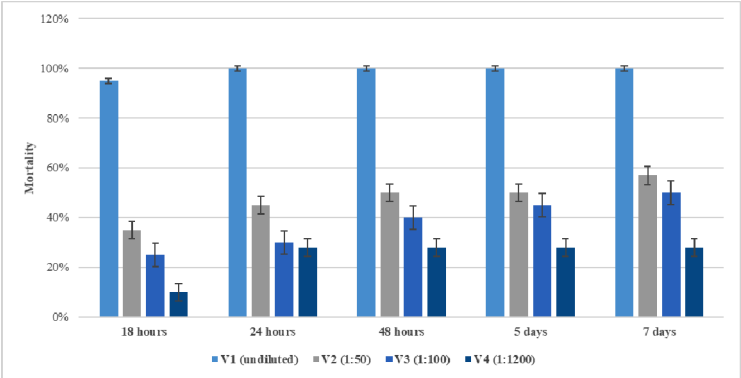


**Figure 1.** Contact effectiveness between *Bacillus cereus var. fluorescens* CNMN-BB-07 LC in different concentrations and the nematode *D. dipsaci* at different time intervals

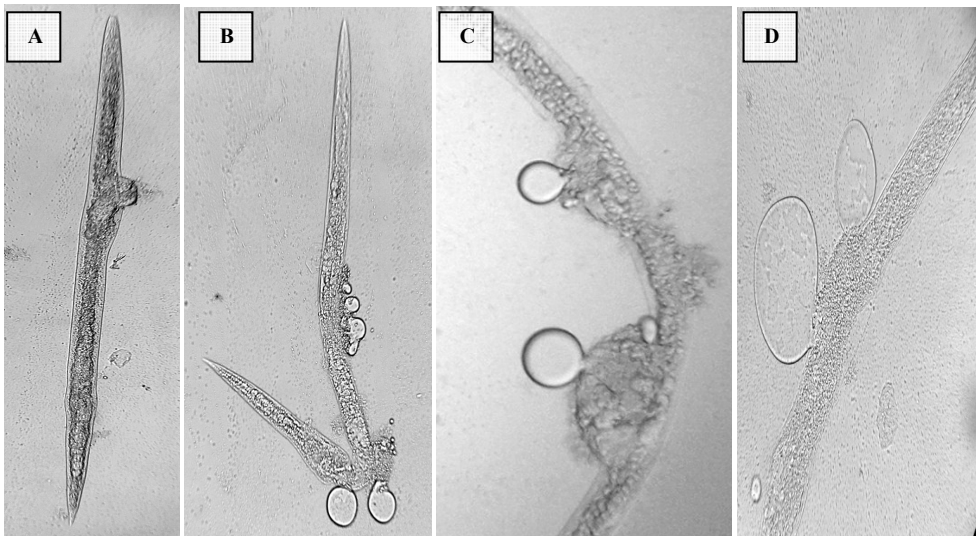


**Figure 2.** Pathologies caused by the nematode *Ditylenchus dipsaci* in contact with the Liquid Culture (without dilution) of the bacteria *Bacillus cereus* var. *fluorescens* CNMN-BB-07 in different periods of time – 7-20 day (**A** – after 7-11 days; **B, C, D** – after 18-20 days)

### *In vivo* testing

*In vivo* testing took place in field and vegetative experiments. The nematicidal action of the liquid culture of the bacterial strain - *Bacillus cereus* var. *fluorescens* CNMN-BB-07 was evaluated in contact with seed potatoes infested with species *Ditylenchus destructor* Thorne, 1945. The experimental tubers of the *Roko* variety, externally healthy, were calibrated first, according to the parameters: the diameter (d - cm) of the seed tubers in length and width, as well as the weight of each tuber (in grams) (Table 1).

As a result of the measurements, it was determined that the sizes of the seed tubers were approximately equal, in control lots: the diameter of a tuber varied between 54.9-63.2 cm × 80.0-118.9 cm, and the weight 72.8-84.07 grams/tuber. Similarly, in the experimental variants (V1 and V2), tuber diameters averaged between 58.5–62.3 mm × 80.0–103.2 mm, and weights ranged from 72.54 to 88.24 grams per tuber (Table 1).

After calibration, each experimental tuber was inoculated with a certain number of mature individuals of the species *Ditylenchus destructor* Thorne, 1945 [20, 21]. All seed potato tubers, both the inoculated and the healthy ones, destined for the experiments, were placed into specialized incubation vessels for a period of 30-35 days. During this period of time, *D. destructor* penetrated the tuber pulp, reproduced into the plant tissue, as well as the tubers sprouting, the size of the sprout had reached 0.7-1.0 cm (Fig. 3).

In field experiments (years 2015-2019), the *in vivo* contact between *B. cereus* var. *fluorescens* CNMN-BB-07 LC (6 x $10^8$ cells/mL) and seed potatoes inoculated with the nematode *D. destructor* was evaluated. The nematodes *D. destructor* were in the 2nd phase of ditylenchosis and the extent of the invasion was 100%.

It is important to note that in previous multi-year studies, conducted under both vegetative and field conditions, the living culture (LC) of *Bacillus cereus* var. *fluorescens* CNMN-BB-07 (6 × $10^8$ cells/mL), when applied at higher concentrations to treat infested seed potatoes, demonstrated strong nematicidal activity. It is necessary to mention that, in previous multi-year research, carried out in vegetative and field experiments, it was found that the LC of the *Bacillus cereus* var. *fluorescens* CNMN-BB-07 (6 x $10^8$ cells/mL) used to treat infested seed potatoes, being taken in higher concentrations. The undiluted and the diluted LC variants in small proportions, of 1:50, 1:100, respectively, causes a high lethal efficacy on the populations nematode *D. destructor*, reducing infestation of crops obtained from treated potatoes to 0%, but, in parallel, exerts a phytotoxic action on the development of tubers, as well as on crops.

The experimental potato tubers were planted in an open field, in soil free from *D. destructor* and *D. dipsaci* nematodes (Fig. 4). Plant development was monitored throughout the entire vegetation period.

The goal objective was to evaluate the growth-stimulating efficiency of various dilution ratios of the LC of *B. cereus* var. *fluorescens* CNMN-BB-07 LC on potato plants.

From the obtained data (Table 2) it was observed, that the LC of the *B. cereus* var. *fluorescens* CNMN-BB-07 in different concentrations exerted various actions on plant development, as well as tuber productivity.

**Table 1.** Average sizes of experimental seed potato tubers (*Roko* variety), evaluated before planting (field experiments)

| Control / Batch | *n* - Tubers | *d*- Diameter of tubers, cm | | | Weight, grams | |
|---|---|---|---|---|---|---|
| | | length | width | average | grams/tubers | average |
| Batch V1 | 20 | 5.5 - 7.9 | 4.5 - 6.5 | 6.75 × 5.4 | 58.5 - 103.2 | 88.24 |
| Batch V2 | 25 | 5.5 - 7.0 | 5.0 - 5.8 | 6.327 × 5.236 | 62.3 - 80.0 | 72.57 |
| Control M1 | 20 | 5.5 - 8.5 | 4.6 - 6.3 | 6.73 × 5.45 | 63.2 - 118.,9 | 84.07 |
| Control M2 | 20 | 5.7 - 6.6 | 4.5 - 6.5 | 6.145 × 5.436 | 54.9 - 103.8 | 72.8 |

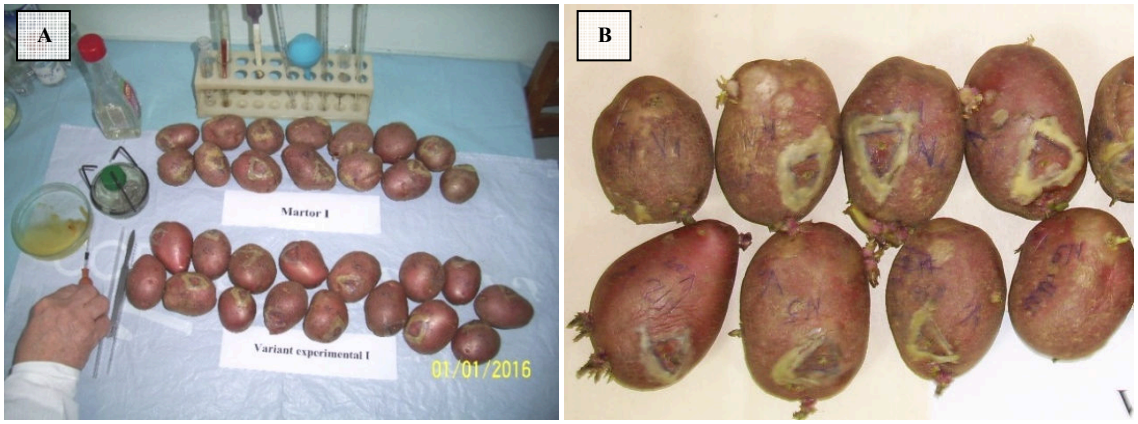


**Figure 3. A** - *Roko* seed potatoes, inoculated with *D. destructor*; **B** - after incubation, before processing with *Bacillus cereus* var. *fluorescens* LC and planting

In batch V1 (1:200) the preparation exhibited slight phytotoxicity, and the plants developed weaker, having a number of shouts per plant (n- average), plant height (h-average, cm), and tuber diameter (d-average, mm), were all lower compared to batch V2 (1:400), where potatoes tubers were treated with *Bacillus cereus* var. *fluorescens* CNMN-BB-07 LC in lower concentration. From the data presented in the table, we notice that the plants of variant V2 have an average height of approximately 12 cm greater and a number of shouts per plant 2 times higher, relative to the control plants M1.

Also, the LC of the researched bacteria, diluted in proportions of 1:400 (batch V2), possesses a major biological effectiveness against potato pathogens, showing a high nematicidal capacity. In this batch, enhanced plant development was highlighted, compared to all other experimental batches (V1, M1, M2).

At harvest, the number of tubers/nest, as well as the weight of tubers/nest, was on average 1.4 times higher in the experimental batch V2 (1:400), than in control batch M1 (infested, untreated) (Table 2, Fig. 5, 6).

The treatment with *B. cereus* var. *fluorescens* CNMN-BB-07, applied in a dilution of 1:400 (V2) led in parallel to a significant reduction (0%) of the manifestation of rots both at harvest and during post-harvest storage of potatoes. In addition, the incidence of mole cricket (*Gryllotalpa gryllotalpa*) damage was significantly reduced, reaching only 10.4%. We mention the fact that the harvest from batch M1, compared to V2 harvest, was highly attacked by rots (22.5%), as well as by mole crickets (40.3%). Data from table 2, indicate that 7.9% of the harvest obtained from batch M2 (healthy, untreated potatoes) is attacked by various bacterial and fungal infections, and 12.3% of the obtained tubers were damaged by mole crickets.

The extent of invasion by *D. destructor* in potatoes harvested from experimental batch V2, treated with *Bacillus cereus* LC decreased from 100%, before planting, to 1-4%, at harvest, while from batch M1, this was much higher, reaching the share of 40.42% [22].

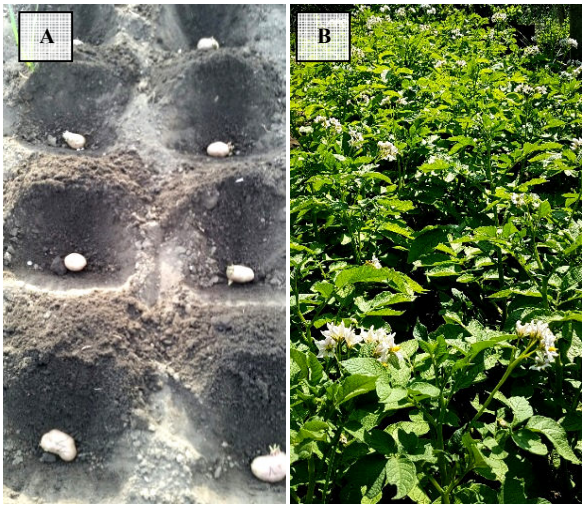


**Figure 4.** Experimental potatoes tubers: **A** - the process of planting; **B** - flowering-ripening phenophase.

**Table 2.** Evaluation of the treatment effectiveness of experimental seed potatoes *Roko* variety, infested with *Ditylenchus destructor*, in contact with the bacteria *Bacillus cereus* var. *fluorescens* CNMN-BB-07

| Batch | Dilution/ exposure time (hours) | Phase flowering - ripening | | Harvest | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *n*- sprouts | *h* - height plant (cm) | *n*- tubers/ nest | *d*-average /tubers (cm) | m/tubers (g) | *m*/tubers/ nest (g) | *Ditylenchus destructor* (%) | Rots (%) | Mole crickets (%) |
| V1 | 1:200/ 16 hours | 2.3 | 47.0 | 5.0 | 3.23/4.46 | 43.4 | 217.0 | 0 | 0 | 0 |
| V2 | 1:400/ 16 hours | 6.0 | 67.38 | 9.6 | 5.3/4.51 | 65.3 | 626.8 | 1 - 4 | 0 | 10.4 |
| M1 | inoculated, untreated | 3.5 | 55.6 | 7.0 | 3.72/4.63 | 48.4 | 377.52 | 40.42 | 22.5 | 40.3 |
| M2 | healthy, untreated | 4.4 | 62.36 | 8.7 | 5.0 x 3.8 | 58.3 | 508.2 | 0 | 7.9 | 12.3 |


**Figure 5.** Experimental potato harvests (tubers/plot), obtained from: **A** - batch V2 – inoculated, treated with *Bacillus cereus* (1:400), at an exposure of 16 hours; **B** - control batch M1 – inoculated with *D. destructor*, untreated.


**Figure 6**. Harvest of experimental potatoes variety *Roko*, tubers/nest: **A** - inoculated seed material, processed with *Bacillus* - batch V2; **B** - control batch M1, inoculated seed material, untreated.

## DISCUSSION

A major economic impact threat to *Solanum tuberosum* L. cultivation is potato tuber ditylenchosis, a disease caused by the nematode *Ditylenchus destructor* Thorne, 1945, which is among the most dangerous parasites of *Solanum tuberosum*. The phytonematode *D. destructor* parasitizes more than 90 species of higher plants, but the main host is potato tubers [29]. On a 1-to-5 scale of harmful potential, it ranks al level 5, being considered a species with a very high capacity of damage, especially during post-harvest storage. The main vector for the spread of this parasite is the seed potato tubers infested with *D. destructor* in phases 1-2 of ditylenchosis (when disease symptoms are not visibly detectable), intended for spring planting [20].

Promising results were obtained on the bacterial strain *Bacillus cereus* var. *fluorescens* CNMN-BB-07, of local origin. According to the results obtained *in vitro*, the lethal efficacy of its LC at initial concentration – 6 x $10^9$ cells/mL (V1) constituted 98.5 – 100% after 24 hours of exposure. LC of the tested strain being diluted in proportions of: 1:50 (V2); 1:100 (V3) and 1:200 (V4), also, possess nematicidal activity. Thus, 48 hours of exposure, the lethal effects were: 50%; 40% and 27.3%, respectively.

*In vivo* testing also demonstrated a high efficacy of bacteria *Bacillus cereus* var. *fluorescens* CNMN-BB-07.

The extent of invasion by *D. destructor* in harvested potatoes, variety *Roko*, obtained from the experimental batch V2, treated with LC of these bacteria in a dilution of 1:400 with water, for 16 hours decreased the invasion by *D. destructor* from 100%, before planting, up to 1-4%, at harvest, while from lot M1 (seed potatoes infested with *D. destructor*, untreated) the extent of the invasion was much higher, reaching 40.42% [22].

*In vivo* testing also demonstrated a high efficacy of the bacteria *Bacillus cereus* var. *fluorescens* CNMN-BB-07. The invasion extent by *D. destructor* in harvested potatoes, variety *Roko*, obtained from the experimental batch V2, treated with LC of these bacteria and water in a dilution of 1:400, for 16 hours decreased the invasion by *D. destructor* from 100%, before planting, up to 1-4%, at harvest, while from batch M1 (seed potatoes infested with *D. destructor*, untreated) the extent of the invasion was much higher, reaching a rate of 40.42%.

Some researches [2, 3] emphasize the importance of preserving and increase the antifungal activity of *Bacillus cereus* var. *fluorescens* CNMN-BB-07. According to these authors, the described method can be applied for the long-term preservation of microorganisms and their use as biological agents for the prevention and protection of crop plants from infection caused by phytopathogens.

Based on the data obtained, we conclude that the LC of *B. cereus* var. *fluorescens* CNMN-BB-07 exhibits not only nematicidal activity, but also a series of capabilities: it stimulates the seed potato germination, increases their growth, development and productivity. The researched strain also exerts bactericidal and antifungal activity, making it a promising plant growth-promoting agent with significant potential in the biological management of phytohelminths through microbiological technologies.

Similar research was also carried out by Mendoza *et al*. (2008) [24]. They investigated the *in vitro* activity of a *Bacillus firmus* strain, isolated from a bionematicide, against the nematodes *Radopholus similis*, *Meloidogyne incognita*, and *Ditylenchus dipsaci*. Their study demonstrated that treating plants with pure bacterial cells significantly reduced root gall formation and promoted plant growth.

The strain of bacteria *Bacillus cereus* var. *fluorescens CNMN-BB-07* synthesizes exometabolites with pronounced antimicrobial activity against phytopathogenic strains, making it valuable for agriculture due to its antagonistic properties. It demonstrates inhibition zones *in vitro* against the following phytopathogenic species: *Corinebacterium michiganense, Xantomonas campestris, Bacillus subtilis, Alternaria alternata, Fusarium solani, Fusarium oxysporum, Botrytis cinerea, Erwinia carotovora, Aspergillus niger* [3]. We mention the fact that their presence, as well as other pathogenic species

of microorganisms, was detected by some authors [27], in potato tubers of 4 varieties - *Desiree, Ostara, Dahlia,* and *Alka*, infested by *Ditylenchus destructor* at advanced stages of ditylenchosis, as follows - *Alternaria solani* (E et M) Jones et Grant, *A. alternata* (Fr.) Kreissler*, Botrytis cinerea* Pers. ex Pers., *Erwinia carotovora* pv. *atroseptica* (van Hall) Dye, *E. carotovora* pv. *carotovora* (Jones) Bergei et al. *Fusarium solani* var. *coeruleum* (Sacc.) Booth, *F. roseum* var. *graminearum* Sn. et H., *F. sambucinum* Fuckel, *F. roseum* var *avenaceum* Sn. et H, *F. oxysporum* (Schlecht) Sn. et H., *Phoma exigua* var. *foveata* Desm., *Rhizoctonia Solani* Kühn, *Sclerotinia sclerotiorum* (Lyb.) de By., *Verticillium albo-atrum* Reinke et Berth. Fungal species of the genus *Fusarium* were dominant among the pathogenic microorganisms detected (84.21%), consistently present not only in diseased potato tubers but also in the rhizosphere soil of agricultural plants, including potatoes. The species such as *F. sambucinum, F. solani* and *F. oxysporum* cause dry rot or fusariosis of tubers, a highly dangerous disease spread all over the world. In terms of harmfulness, *Fusarium* spp. ranks second place after phytophthorosis, caused by *Phytophthora infestans,* which is also considered the most serious disease in most countries [29].

According to our obtained data, the strain *Bacillus cereus* var. *fluorescens* CNMN-BB-07 possess the ability to reduce the degree of *Solanum tuberosum* tubers infestation with phytoparasitic nematodes of the genus *Ditylenchus* (*D. destructor, D. dipsaci*), as well as with phytopathogenic fungi of the genus *Fusarium (F. oxysporum, F. solani*). At the same time, it exerts a stimulating effect on the plant development and increases crop yields, through its ability to produce auxins, cytokinins, and gibberellins.

The process of biological treatment of seed potatoes against the nematode *Ditylenchus destructor*, which involves soaking the seed potato before planting in a solution containing *Bacillus cereus* var. *fluorescens* CNMN-BB-07 LC at a titer of 6 x $10^8$ cells/mL and water, diluted with water at a ratio of 1:400, for 16 hours, leads to the decrease of the invasion by 80-96% and increasing harvests by 1.7 times, compared to the untreated seed potato (control-M 1).

This procedure represents an effective biological method in combating phytoparasitic nematodes with a high stimulatory effect on agricultural crops and is currently implemented in agricultural households in the Republic of Moldova.

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