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IN VIVO EFFECTS OF SOME MICROBIAL INOCULANTS FOR THE SUSTAINABLE PRODUCTION OF SWEET POTATO

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Abstract

The transition from conventional to sustainable cultivation of sweet potato (Ipomoea batatas L.) triggers the need to identify efficient non-chemical inputs for plant protection and nutrition, as well as appropriate application methods. This study aimed to identify some beneficial microorganisms, bacteria and fungi, efficient in preventing sweet potatoes from pests and diseases. In vitro studies revealed the antifungal effects of a Romanian native Bacillus amyloliquefaciens strain in reducing the growth of Alternaria sp. and Fusarium spp., some common phytopathogens for sweet potato. Similar results were seen in Beauveria bassiana, which additionally express insecticidal potential. The shoot-immersion inoculation technique applied with these microorganisms on sweet potato, revealed comparative yields to the conventional production system, as well as pest and diseases management, only when the two beneficial microorganisms were inoculated as mixed treatment.

Key words*: Bacillus amyloliquefaciens, Beauveria bassiana, Ipomoea batatas.*

INTRODUCTION

The transition from conventional cultivation of sweet potato (*Ipomoea batatas* L.) to a sustainable agricultural system requires a redefinition of the phytosanitary strategies (Brunell et al., 2024) that can sustain crop productivity while ensuring good quality tubers, free from diseases and pest damage. Such shift aligns with the European Farm to Fork strategy and reveals high concern for consumers health and wellbeing and provides environmentally responsible yields (Yan et al., 2022; Țopa et al., 2025; Tüzel & Durdu, 2025). Replacing the chemical phytosanitary inputs with biologic means requires a comprehensive reassessment of plant health management practices, as well as consistent *in vitro* and *in vivo* studies (Puri et al., 2020; Rodríguez-Sabina et al., 2024; Bizjak-Johansson et al., 2025). The low-chemical strategies call for the identification of integrated, low impact solutions (Pandiyan et al., 2024; Dissanayaka et al., 2025; Sherzad et al., 2025) capable of preventing diseases and pest outbreaks without compromising agronomic performance.

This study aimed to identify some beneficial microorganisms, bacteria and fungi, efficient in preventing sweet potatoes from pests and diseases, while maintaining a high crop productivity.

MATERIALS AND METHODS

Microbial strains

Two microbial strains known for their *in vitro* biocontrol activity were selected to be tested in field trial as biologic phytosanitary treatments. One of the strains is *Bacillus amyloliquefaciens* BW (Sicuia et al., 2017; Boiu-Sicuia & Cornea, 2021) which showed *in vitro* antifungal activity against various plant pathogens, including fungi that could infect sweet potato. The other microbial strain is *Beauveria bassiana* an entomopathogenic fungi, with high potential in reducing pest populations and their attack (Cojanu et al., 2022).

These two biocontrol strains were prepared as agro-inoculants in concentrated solutions, at the USAMV of Bucharest, Faculty of Biotechnologies. The bacterial inoculum was prepared as 10^9 CFU/ml, while fungal inoculum as 10^8 spores/ml.

Field trials

The field experiments were conducted at the Research - Development Station for Field Crops on Sandy Soils (SCDCPN) Dăbuleni, Romania, under the pedo-climatic conditions of 2024 (Figure 1).

Figure 1. Sweet potato field crop - image from the experimental plot for biologic treatments evaluation

Planting material

ROK2 cultivar of sweet potato (*Ipomoea batatas* L.) was chosen, as it previously shown to be susceptible to specific field diseases. The shoots used as planting material in the field were locally produced at SCDCPN Dăbuleni.

Sweet potato shoots were produced in a double-protected greenhouse. Tubers were planted on March 20th, 2024, on raised beds, with an added substrate mixture of peat, sand and brown soil in equal parts. Shoots were harvested sequentially starting in early May, by cutting at 3-5 cm above the soil surface. Planting material was standardized to approximately 30 cm long shoots, with 6-7 nodes. After each harvest, N50 fertilization was applied, and optimal soil and air humidity was maintained in the greenhouse.

Field preparation and planting

Field preparations began on April 27th, 2024, and included disking, and NPK (15:15:15) fertilization at a rate of 533 kg/ha. The soil was ridged prior to planting using a Steyr tractor equipped with an MPB 4 rotary tiller. This equipment simultaneously modeled three ridges, covering them with plastic mulch film, while installing drip irrigation lines on top of each ridge under the foil. Planting was carried out on May 24th, 2024. When the soil temperature reached a constant minimum of 15ºC.

Experimental design

A single-factor experiment was performed on sandy soil with low fertility, under irrigated conditions. The experimental layout followed a randomized block design, in three replications. A total of 30 plants were monitored in each experimental variant.

Four experimental variants were established to evaluate the efficacy of biologic phytosanitary treatments compared to the conventional chemical treatments currently used at SCDCPN Dăbuleni:

- **V1 – Bacterial treatment** based on *Bacillus amyloliquefaciens*, diluted at 300 ml in 10 L of fresh dechlorinated water.
- **V2 – Fungal treatment** based on *Beauveria bassiana*, diluted at 170 ml in 10 L of water.
- **V3 – Biological mixt treatment** based on *B. amyloliquefaciens* and *B. bassiana* (150 ml + 85 ml in 10 L of water).
- **V4 – Chemical treatment** according to the phytosanitary technology conventional used at SCDCPN Dăbuleni.

Phytosanitary treatments administration

The biologic agro-inoculants were applied as single treatments in V1 to V3 experimental variants after planting time.

In the chemical treatment, V4 experimental variant, four applications of commercial pesticides were administrated during the vegetation season.

The first treatment was applied 20 days after planting, followed by three additional treatments at 14-days intervals. At first 0.2% Ortiva and 0.02% Karate Zeon were used. While in the second treatment 0.1% Teldor and 0.02% Cyperguard Max combination was applied.

The third treatment consisted in 0.2% Cabrio Top and 0.02% Laser 240 SC. While for the last treatment a combination of 0.2% Ortiva and 0.02% Karate Zeon was sprayed.

Field observations and Data Collection

The experimental objective was to assess the incidence and severity of pest and disease attacks and to identify the most effective phytosanitary treatment strategy for improving both yield quantity and quality.

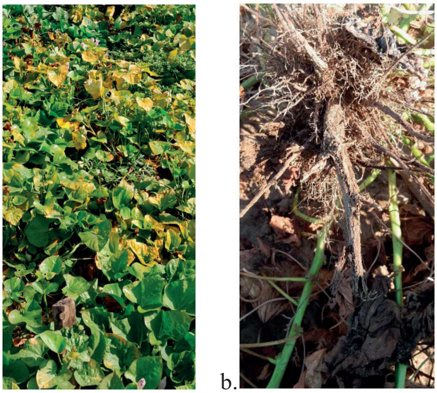
Pest and disease incidence and severity were evaluated by visual field observations. Phytopathogens identification was confirmed by microbiologic analyses on symptomatic plant tissues. For pest evaluation soil traps were installed to monitor epigeic arthropod fauna, while sticky yellow traps were used to capture the flying insects. The lab activities were performed at the Research-Development Institute for Plant Protection. The attack severity of pests and diseases infestation was calculated at the end of the growing season.

Sweet potato tuber yield was also recorded at the end of the experimental trial, for each experimental variant.

RESULTS AND DISCUSSIONS

Field observations regarding pests and diseases attack were made periodically. Biologic samples were collected and sent for laboratory analysis to detect the important pests and diseases.

According to the symptoms, the most problematic disease was vascular wilt, associated with leaf yellowing, veins browning, plant stunting and stem cracking (Figure 2).



a. b.

Figure 2. Vascular wilt of sweet potato:
a. leaf yellowing; b. detail of a cracked stem

Leaf blight also occurred (Figure 3), although causing less problems, compared to the vascular wilting.

Figure 3. Leaf spot of sweet potato

Laboratory analysis confirmed the presence of *Fusarium* spp. infections (Figure 4), as well as *Alternaria* spp. (Figure 5).

Figure 4. *Fusarium* sp. microconidia and mycelia

The isolated fusaria revealed cottony white colonies composed of hyaline, septate, filamentous mycelia, bearing single-celled ellipsoidal microconidia and one-septate fusiform conidia, both types having a slight curvature (Figure 4).

Previous studies on sweet potato also reported the occurrence of *Fusarium* stem rot from 2016 (Boiu-Sicuia et al., 2017; 2024).

Alternaria developed dematiaceous, septate, filamentous mycelia and obclavate multicellular conidia, with both transverse and longitudinal septa, often terminating in an elongated apical beak (Figure 5). This last aspect suggesting the pathogens involved are from the *Alternaria* section Porri (Woudenberg et al., 2014).

Figure 5. *Alternaria* sp. section Porri isolated from sweet potato

Phytosanitary field trials conducted on sweet potato demonstrated that the applied treatments were unable to fully suppress pathogen attacks. These plant pathogenic fungi persisted as the principal causal agents in sweet potato. The intensity, frequency, and severity of infection by the main pathogens exhibiting symptoms in 2024 were assessed (Table 1).

The poor performance of the biological treatment based on *B. amyloliquefaciens* BW under *in vitro* conditions is primarily considered due to the reduced adaptability of the bacterial strain to the sandy soil conditions of the region. This limitation was further accentuated by the fact that only a single treatment was applied at planting, whereas *Alternaria* spp. and *Fusarium* spp. typically exert their pathogenic attack later in the growing season. Additional hypotheses have also been proposed, such as the reduced compatibility between the host plant species and the bacterial strain, which may have hindered the expression of the antifungal properties demonstrated *in vitro* by BW.

Table 1. Phytosanitary issues in sweet potato grown under 2024 conditions

Analyzed parameter	Plant pathogen	Experimental variant			
		V1	V2	V3	V4
AF %	*Alternaria* spp.	12.0	14.0	6.0	6.0
	Fusarium spp.	14.0	12.0	6.0	4.0
AI %	*Alternaria* spp.	37.5	16.9	28.3	28.3
	Fusarium spp.	39.3	30.8	41.7	37.5
AS %	*Alternaria* spp.	4.5	2.4	1.7	1.7
	Fusarium spp.	5,50	3,70	2.5	1.5

Legend: AF % = attack frequency, AI % = attack intensity, AD % = attack severity.

Surveying pests attack and the damage they caused in sweet potato culture, it was determined that the most severe problems were associated with the larvae of the polyphagous moths *Spodoptera exigua* and *Helicoverpa* spp. The intensity, frequency, and severity of attack, caused by these pests in 2024 were assessed to evaluate the applied treatments (Table 2).

Table 2. Pests attack on sweet potato grown under 2024 conditions

Analyzed parameter	Pest	Experimental variant			
		V1	V2	V3	V4
AF %	*Spodoptera exigua*	8.0	12.0	8.0	10.0
	Helicoverpa sp.	12.0	8.0	12.0	6.0
AI %	*Spodoptera exigua*	50.0	30.8	31.3	24.0
	Helicoverpa sp.	37.5	16.9	28.3	28.3
AS %	*Spodoptera exigua*	4.0	3.7	2.5	2.4
	Helicoverpa sp.	4.5	1.4	3.8	1.7

Legend: AF % = attack frequency, AI % = attack intensity, AD % = attack severity.

Previous studies on sweet potato performed at the same location reported the presence of 50 arthropod species or genera in sweet potato crops (Iamandei et al., 2014), among which these two had a higher frequency. The yields obtained varied significantly depending on the experimental variant of phytosanitary treatment. The highest yield was recorded under the use of conventional cultivation technology, in which four phytosanitary treatments with synthetic chemical products were applied (Figure 6).

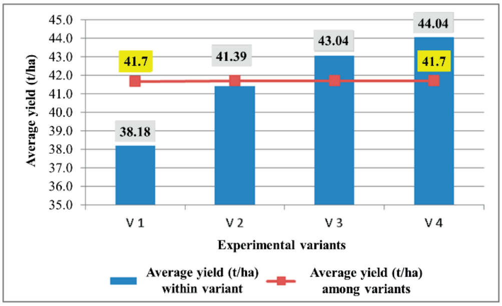


Figure 6. Average yield of sweet potato under different phytosanitary treatments

Although conventional phytosanitary technology revealed the highest tubers yield (44.04 t/ha), it is noteworthy that a single application, at planting time, of the mixed biological treatment based on *Bacillus amyloliquefaciens* and *Beauveria bassiana* biocontrol strains, ensured 43.04 t/ha, revealing an insignificant difference compared to the conventional technology used as control. However, single biological treatments applied only at planting are not competitive with conventional cultivation technology based on four complex chemical treatments applied during the growing season.

CONCLUSIONS

The results obtained in 2024 indicate that mixt biological treatments based on *Bacillus amyloliquefaciens* and *Beauveria bassiana* can be a promising phytosanitary approach to significantly reduce chemical inputs in sweet potato production system. However, some amendments are still required to mitigate the attack severity of *Fusarium* spp. and *Helicoverpa* sp. Therefore, further field trials are justified, and phytosanitary protection should be reinforced through the application of biological treatments not only at planting but also throughout the vegetation period.

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