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Results of a long-term trial with soil bacterial preparations (2016-2025)

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Éva Pénzes
Association of Hungarian Soil-Protective Bacterial Product Manufacturers and Distributors, Hungary

Correspondence: Dr. Éva Pénzes, Association of Hungarian Soil-Protective Bacterial Product Manufacturers and Distributors, Hungary, Tel +36-30-986-2440

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Introduction

Soil inoculant bacterial preparations belong to the category of yield-increasing biostimulants.[1] Their effects in stimulating plant growth[2] and development, increasing yield,[3] and improving quality parameters.[4,5] are well documented. To verify these effects, a joint study conducted by Nébih and the Hungarian Soil Protection Association examined soil bacterial treatments applied to field plots between 2016 and 2025. Products from different manufacturers were applied to the same experimental area and tested on different crops according to a crop rotation system. The study was carried out in two cycles.

In the first three-year cycle, 7 soil inoculant products were tested in corn, spring barley, and soybean. In 2019, a new site was established for a seven-year cycle with 6 microbiological preparations; the first crop was winter rapeseed, harvested in 2020. From 2020 onwards, the study continued with 4 products in winter wheat, with harvest in 2021, in 6 replications. In 2022, the third crop of the cycle was sunflower, tested with two new soil bacterial products (6 products in total) in 4 replications. In 2023, spring barley was tested with 6 products in 4 replications, in 2024 corn with 7 products in 4 replications, and in 2025 winter barley with 7 products in 4 replications. At sowing preparation, soil inoculant bacterial preparations were applied to all designated plots. After harvest, crop residues were treated with stubble-decomposing microbial preparations and then incorporated into the soil.

The aim was to compare the results of plots treated with microbiological preparations with those of the untreated and standard control plots.

Methods

Experimental method: a replicated randomized block design with small plots.

Experimental site: Baranya County, Szalánta Soil type: Ramann-type brown forest soil.

Plot size until 2018: 55–90 m²; as of 2019: 25–27.6 m². Number of replications: 4–6.

Number of treatments varying by year: 2 untreated controls + standard control + 7 or 4 or 6 treatments.

Standard control plot:+50 kg/ha of nitrogen applied as active ingredient in fertilizer form.

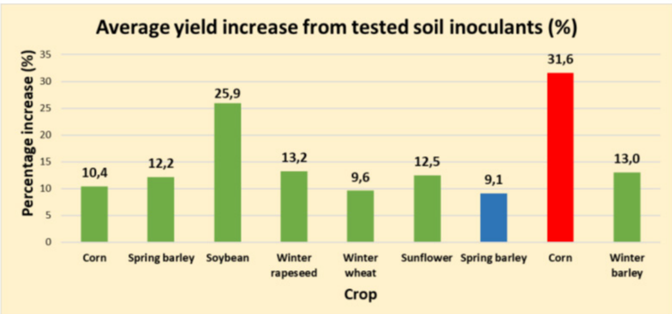
Experimental design: randomized block design.

The soil inoculant preparations were applied at rates ranging from 1–2 L/ha, although certain manufacturers recommend higher doses of 10–15 L/ha. In all treatments, the inoculant was diluted in 400 L/ha of water prior to field application. This corresponds to 0.0001–0.0015 L of inoculant per square metre, applied together with 0.04 L (0.4 dL) of water per square metre.

Parameters examined for all crop types: emergence rate, plant height, yield, and thousand-kernel weight Other examined parameters: number of ears, ear length, number of kernel rows per ear (corn), starch content (corn, spring barley), number of grains per ear (spring barley, winter wheat), number of pods, number of seeds per pod, number of nodules (soy-bean), moisture content (corn, spring barley, soybean), number of siliques, number of seeds per silique (winter rapeseed), crude protein content (spring barley, soybean), oil content (win-ter rapeseed), plant density (winter rapeseed , winter wheat), head diameter (sunflower).

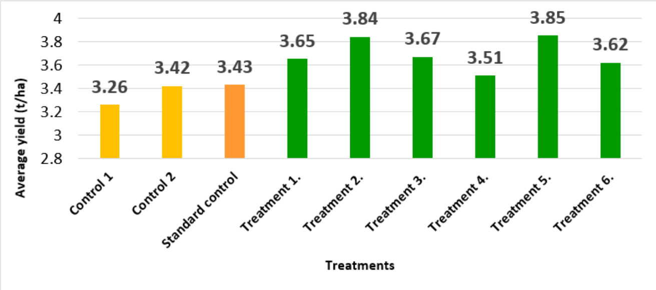
Results

During the long-term study of 10 years, in all experiments across 9 crop species, the average yields were higher compared to the untreated control plots. Across the 9 crops, the average yield increase was 15.28%. The highest value was observed in corn (31.6%), while the lowest was in spring barley (9.1%) (Graph 1).

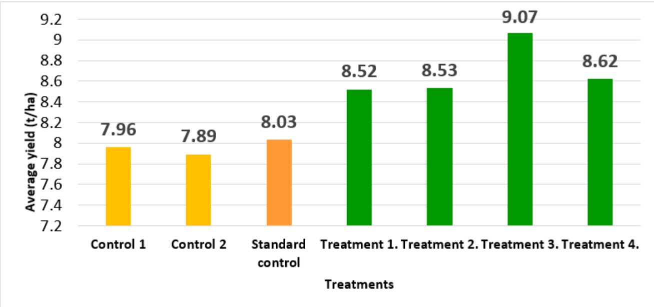


Graph 1 Effect of bacterial preparations on crop yield in different plant cultures.

Regarding average yield, significant differences compared to the control were observed in winter rapeseed and winter wheat crops (Graph 2 & 3).



Graph 2 Yield results of winter rapeseed in untreated control, standard control, and treated plots. Treatments 1, 3, and 6 are significant at P5%, treatments 2 and 5 are significant at P1%.



Graph 3 Yield results of winter wheat in untreated control, standard control, and treated plots. Treatment 3 is significant at P1%, treatment 4 is significant at P10%.

With one exception in 2025, the average yields of the plots treated with the micro-biological preparation exceeded those of the standard control (+50 kg/ha N) across all tes-ted crops (Table 1)(Figure 1).

Figure 1 Winter rapeseed, 14th November, 2019.

Table 1 Average yields of standard control and treated plots (2016–2025)

AVERAGE YIELD INCREASE (t/ha)																	
2016		2017		2018		2019-2020		2021		2022		2023		2024		2025	
CORN		SPRING BARLEY		SOYBEAN		WINTER RAPESEED		WINTER WHEAT		SUNFLOWER		SPRING BARLEY		CORN		WINTER BARLEY	
Standard control	*Treated area*	*Standard control*	*Treated area*	*Standard control*	*Treated area*	*Standard control*	*Treated area*	*Standard control*	*Treated area*	*Standard control*	*Treated area*	*Standard control*	*Treated area*	*Standard control*	*Treated area*	*Standard control*	*Treated area*
11,06	11,57	5,27	5,42	3,43	3,65	3,43	3,69	8,03	8,69	3,34	3,55	4,92	5,03	3,93	4,69	7,10	6,74

The quality parameters were significantly better compared to the control in the following crops. In spring barley (at the P5% level), crude protein content (%) was higher, and in winter rapeseed, oil content (%) was higher (at the P1% level). From 2020 onwards, quality parameters were no longer assessed.

Conclusions

As a result of the combined application of soil inoculant and stubble-decomposing microbial preparations, the average yields in all crop types exceeded those of the untreated control plots. The average yields of the treated plots also surpassed those of the standard control plots that received an additional 50 kg/ha of nitrogen. The yield-increasing effect of the soil inoculant bacterial preparations was confirmed during the study. On the treated plots, in most of the crop types, there were also significant differences in emergence rate and plant height compared to the control, and the measured parameters improved as a result of the treatment. The study showed that the bacterial preparations have a stimulating effect on plant development, growth, and performance. Regarding quality parameters, based on data collected up to 2020, crude protein content in spring barley and oil content in winter rapeseed were also significantly higher. Micro-biological preparations also improved the quality in certain crop species in the study.

The complete list of bacterial strains used in the trial is provided in Appendix A.

Acknowledgments

None.

Conflicts of interest

The authors declare no potential conflicts of interest.

References

1. Backer R, Rokem JS, Ilangumaran G, et al. Plant growth–promoting rhizobacteria: context, mechanisms of action, and roadmap to commercialization of biostimulants for sustainable agriculture. *Front Plant Sci.* 2018;9:1473.
2. Aquino JPA, Antunes JEL, Bonifácio A, et al. Plant growth–promoting bacteria improve growth and nitrogen metabolism in maize and sorghum. *Theor Exp Plant Physiol.* 2021;33:249–260.
3. Bhardwaj D, Ansari MW, Sahoo RK, et al. Biofertilizers function as key player in sustainable agriculture by improving soil fertility, plant tolerance and crop productivity. *Microb Cell Fact.* 2014;13(66):66.
4. Niu DD, Zheng Y, Zheng L, et al. Application of PSX biocontrol preparation confers root–knot nematode management and increased fruit quality in tomato under field conditions. *Biocontrol Sci Technol.* 2016;26(2):174–180.
5. Shakeri E, Modarres–Sanavy SAM, Amini Dehaghi M, et al. Improvement of yield, yield components and oil quality in sesame (*Sesamum indicum* L.) by N–fixing bacteria fertilizers and urea. *Arch Agron Soil Sci.* 2016;62:547–560.