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INNOVATIVE BIOLOGICAL PRODUCTS IN ORGANIC BEAN GROWING TECHNOLOGY

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The application of microbiological products in agriculture is becoming more and more relevant nowadays in order to reduce the use of chemical products. These products have the potential to protect plants from diseases, pests, increase yields and improve quality and are friendly to the environment. The aim of the study was to evaluate the effect of the innovative biological product Sporeplus on bean growth and productivity, to evaluate the impact of the product on the prevalence of diseases. The study was carried out at Vytautas Magnus University Botanical Garden. Beans of 'Tiffany' and 'Bobas' varieties were studied by applying the microbiological product as a seed treatment and spraying the plants during vegetation with a product suspension. The highest average bean height was defined in both 'Bobas' (significantly) and 'Tiffany' (insignificantly) varieties sites, where bioproduct Sporeplus was applied for both seed treatment and for later plant spraying during vegetation. Significantly the highest average seed weight per plant was determined in beans of the 'Tiffany' variety, where the seed was treated by bioproduct and also the plants were sprayed with the microbiological product Sporeplus during the vegetation period as well. The average seed weight per plant of the 'Bobas' variety was also the highest (insignificantly) where both the seed and later the plants were treated with the microbiological product Sporeplus. The prevalence of bean rust (*Uromyces fabae*) was not significantly affected by the application of the microbiological product Sporeplus.

Keywords: bean, biocontrol, microbiological products, organic farming.

INTRODUCTION

The world, and the European Union in particular, is currently focusing on an agricultural policy that is orientated towards the green course. This policy has an important environmental significance, which makes the possibility to create organic, healthy products. One of the most important goals in organic farming is to increase plant productivity so that the cultivated plants are able to compete with weeds, diseases and pests (Ostergard, Jensen, 2004). The selection of intensive cultivation technologies in crop production reduces the biological activity of the soil. The application of various pesticides destroys the elements of diseases and pests, however at the same time damages soil microorganisms and pollutes the environment. When the biological activity of the soil decreases, plant residues contaminate the soil with the pests and pathogens, the microbiological processes of the soil are disrupted, the soil lacks oxygen, and excess moisture can occur. All these soil damages create unfavourable conditions for plant growth and development (Suojala, 2000). About 3,000 different species of microorganisms have been detected to inhabit in the soil, and most of them support soil fertility. The soil contains a variety of bacteria, fungi and other microorganisms that provide plants with nutrients. In addition, microorganisms are involved in humification processes (Dewar et al., 2006). Thus, in order to reduce soil damage, recommendations to consider alternatives to the application of microbiological products become more and more frequent. Microbiological products can improve the soil in which plants are grown. These products have the potential to protect plants from diseases, pests and increase the quantity and quality of the yield. Microbiological products can reduce soil degradation and agricultural production resources. They can be used in combination with mineral fertilizers. There is currently a large selection of microbiological products in the world whose market is constantly growing (Gomaa, 2012). The aim of the study was to evaluate the effect of the biological product Sporeplus on bean growth and productivity, to evaluate the impact of the product on the prevalence of diseases.

MATERIALS AND METHODS

The research was conducted in 2020 at Vytautas Magnus University Botanical Garden. A field experiment was performed with a purpose to determine the effect of the microbiological product Sporeplus on plant growth, productivity, and crop disease. Two varieties of beans 'Bobas' and 'Tiffany' were studied during the experiment. Methods of the application of microbiological product Sporeplus: 1. (K) - control variant, where the product was not applied at all, 2. (SA) - seeds were treated with Sporeplus 800 g t^{-1}, 3. (SA + A) - seeds were treated with Sporeplus 800 g t^{-1} and the plants were sprayed with Sporeplus 750 g ha^{-1} in BBCH 40-49 stage. The experiment was performed in four replicates.

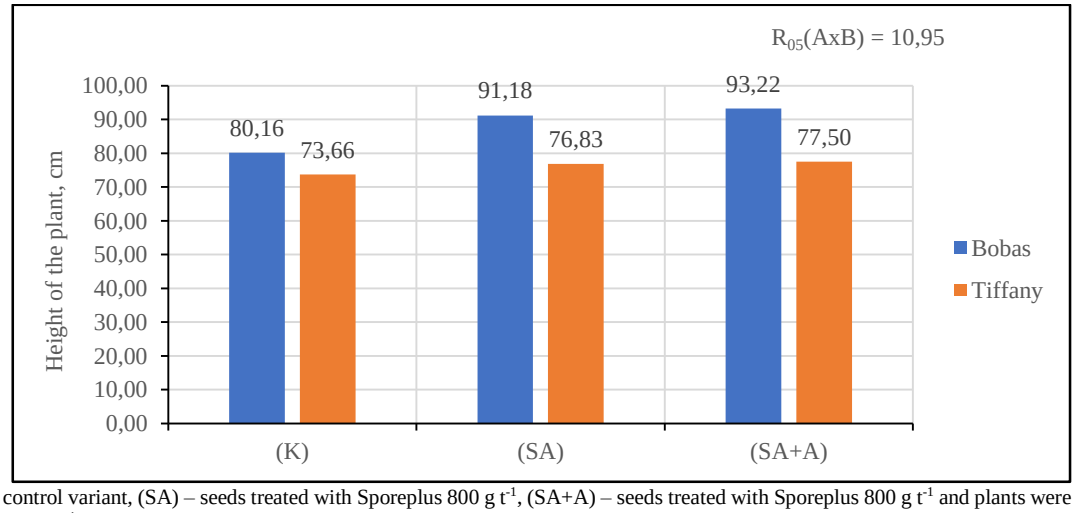
Soil type - *Calcari-Endohypogleyic Luvisol*. Soil granulometric composition according to Fere: sandy loam. The soil of high economic value dominates which is suitable for growing of main agricultural crops. The average soil productivity score in the area is 46.78. The thickness of the humus layer is 25 cm. The soil is slightly alkaline - pH-7.6.

Sporeplus is a microbiological product. It is a concentrated mixture of microorganisms consisting of the bacterial species *Bacillus licheniformis*, *Bacillus subtilis* and *Bacillus vallismortis*. The product can be used for pre-sowing treatment of plant seeds and for protection against fungal pathogens. This product can increase parameters of plant development and productivity. This mixture of bacteria can stimulate the production of hormones and improve the uptake of potassium and phosphorus by plants from the soil. This product can also reduce stress on plants during moisture deficiencies. According to the information provided by the manufacturer, the product may increase the resistance of plants to the following diseases: chocolate spot disease (*Botrytis cinerea*, *B. fabae*), brown rust (*Puccinia recondita*), Septoria nodorum blotch (*Septoria nodorum*), powdery mildew (*Blumeria graminis*), fusariosis (*Fusarium* spp.), cercosporiosis (*Cecospora* spp.), white mould (*Sclerotinia* spp.), verticillosis (*Verticilium* spp.), etc. This product acts against the pathogens in several ways: inhibits the germination of spores of the pathogen, disrupts the pathogen development cycle and prevents it from entering the plant. The prevalence of disease (%) was estimated according to the methodology described by Dabkevičius and Gaurilčikienė (2002). The height of the plant, weight of bean seeds were assessed applying the methodology described in the publication Scientific Methods for Innovative Agriculture and Forest Research (Sasnauskas et al., 2013).

Statistical analysis of the experimental data was performed by analysis of variance (ANOVA) using a SELEKCIJA software package.

RESULTS AND DISCUSSION

Height of the plant. According to the research data, the treatment of different varieties of beans with the biological product Sporeplus had a significant effect on plant height (80–89 BBCH) (Fig. 1). An analysis of the results of the studies shows that the height of the stems of different bean varieties was significantly higher in both variants where the biological product Sporeplus was applied. Comparing the influence of Sporeplus application on the height of bean varieties 'Bobas' and 'Tiffany', plants of variety 'Bobas' were significantly higher. The maximum plant height (13.06 cm) was significantly higher than in the control variant in sites, where beans 'Bobas' were processed in both ways of microbiological product Sporeplus application - seed treatment and sprayed during vegetation period. Also, in the sites where 'Bobas' beans were grown only treated with biological product as a seed treatment, the obtained result was significantly higher (11.02 cm) than in the control variant. The biological product also affected the growth of 'Tiffany' variety beans, however there were no significant differences in height compared to the control variant. Significant differences in stem height were determined between different bean varieties. The lowest plant height (73.66 cm) was obtained in 'Tiffany' variety sites non-sprayed with microbiological product Sporeplus. Meanwhile, in the sites of the 'Bobas' variety, in which microbiological product was not applied, the plants grew in 6.5 cm taller, nevertheless, this difference was insignificant. In beans of the 'Bobas' and 'Tiffany' varieties, where only the seeds were treated with the microbiological product Sporeplus, the average plant height was found to be 91.18 cm and 76.83 cm. The difference obtained was significant in beans of the variety 'Bobas'.

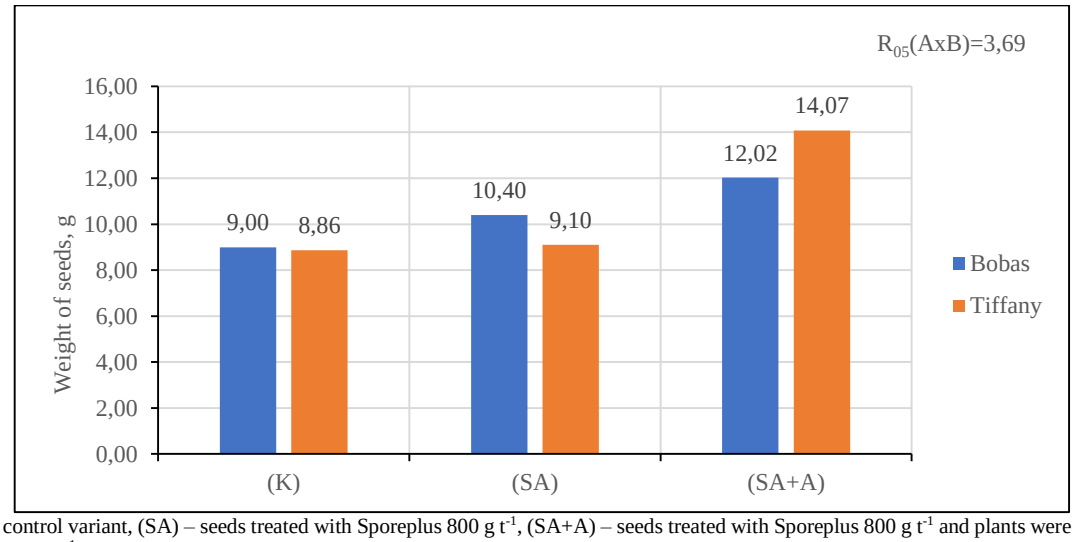


Note: (K) – control variant, (SA) – seeds treated with Sporeplus 800 g t^{-1}, (SA+A) – seeds treated with Sporeplus 800 g t^{-1} and plants were sprayed with Sporeplus 750 g ha^{-1}

Figure 1. Influence of biological product on the height of different varieties bean stems, cm

The highest average bean height was defined in both 'Bobas' (significantly) and 'Tiffany' (insignificantly) varieties sites, where bioproduct Sporeplus was applied for both seed treatment and for later plant spraying during vegetation period (93.22 cm and 77.50 cm respectively).

Weight of bean seeds. According to the research data, the treatment of different varieties of beans with the biological product Sporeplus had a significant effect on the average seed weight per plant (90-99 BBCH) (Fig. 2). Seed weight of different bean varieties was defined to be significantly higher in both variants where the biological product Sporeplus was applied. Comparing the influence of the biological product Sporeplus on the seed weight of bean varieties 'Bobas' and 'Tiffany', a higher seed weight was obtained in the sites where beans of the variety 'Tiffany' were grown.



Note: (K) – control variant, (SA) – seeds treated with Sporeplus 800 g t^{-1}, (SA+A) – seeds treated with Sporeplus 800 g t^{-1} and plants were sprayed with Sporeplus 750 g ha^{-1}

Figure 2. Influence of the biological product Sporeplus on seed weight of different varieties beans per plant, g

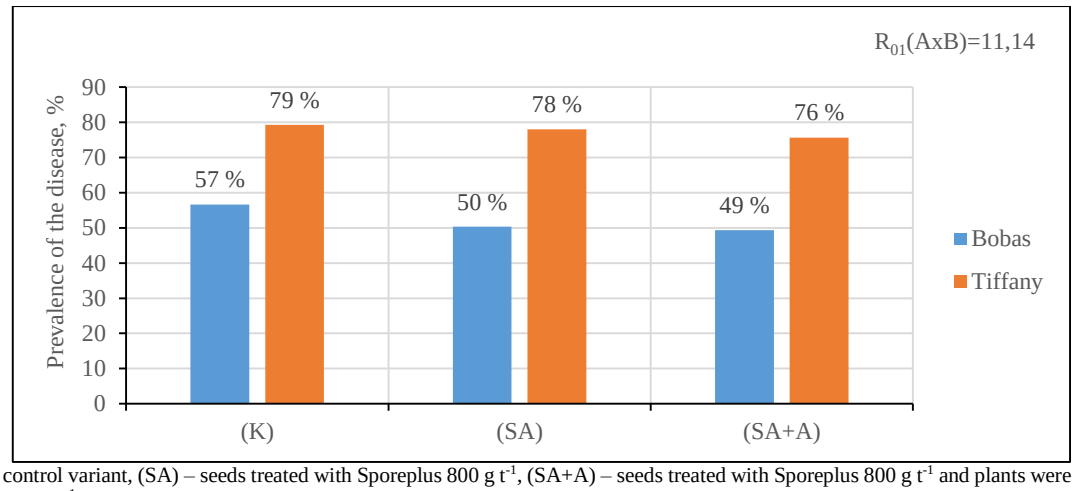
Summarizing the obtained results, it was determined that the maximum seed weight per plant of the variety 'Tiffany' beans was even in 5.21 g significantly higher compared to the control variant, when the beans were both seeds treated and sprayed with the microbiological product Sporeplus. The results obtained in the sites where only seeds of 'Bobas' and 'Tiffany' variety beans were treated with biological product did not differ significantly from the results obtained in the control variant. It is obvious that the biological product also influenced the growth of beans of 'Bobas' variety. It was defined that the average seed weight per plant was higher in 3.02 g in the sites where 'Bobas' variety beans were both seed treated and plants sprayed with the microbiological product Sporeplus. However, the result did not differ significantly from the results of the control variant.

The lowest average seed weight per plant was found in the control variant of 'Tiffany' variety beans - 9.00 g. In bean sites of 'Bobas' variety, in which microbiological product was not applied, an average of 8.86 g of seeds per plant was obtained. In the sites where the microbiological product Sporeplus was applied only as a seed treatment, the average weight of seeds of both 'Bobas' and 'Tiffany' varieties per plant was higher than in the control variant, although it did not differ significantly from the control.

Significantly the highest average seed weight per plant was determined in beans of the 'Tiffany' variety (14.07 g), where seeds were treated by bioproduct and also the plants were sprayed with the microbiological product Sporeplus during the vegetation period as well. The average seed weight per plant of the 'Bobas' variety (12.02 g) was also the highest where both the seed and later the plants were treated with the microbiological product Sporeplus. However, compared to the control variant, the difference was not significant.

Influence of biological product on disease prevalence in bean crop. In recent years, various diseases that can reduce seed yields have become more prevalent in bean crops. Bean rust (*Uromyces fabae*) is one of the most common diseases in bean crops. The rapid spread of rust in bean crops is affected by warm and humid weather or hot days and dewy nights. The spread of the disease is determined by the abundance of plant mediators – wartweeds (Brazaukienė, Semaškienė, 2006). Bean rust in bean crops can cause significant yield losses, which can be as high as 30% due to an outbreak when the disease pervades during pods ripening or before ripening stage (Deveikytė ir kt., 2020).

The research has shown that bean rust was more prevalent in 'Tiffany' variety beans. Meanwhile, there were significantly fewer plants damaged by bean rust in beans of the 'Bobas' variety (Fig. 3). The highest number (insignificantly) of the plants affected by bean rust were found in beans of the 'Tiffany' variety (even 79%), where the biological product Sporeplus was not applied.



Note: (K) – control variant, (SA) – seeds treated with Sporeplus 800 g t^{-1}, (SA+A) – seeds treated with Sporeplus 800 g t^{-1} and plants were sprayed with Sporeplus 750 g ha^{-1}

Figure 3. Influence of the biological product Sporeplus on the prevalence of bean rust, %

Meanwhile, 57% of plants were damaged by bean rust in beans of the 'Bobas' variety without the application of the biological product Sporeplus. Beans of the 'Tiffany' variety had a slightly lower incidence of bean rust when treated with the microbiological product Sporeplus, but no significant differences were defined compared to the control variant. A similar situation was observed in the bean sites of the 'Bobas' variety. 'Bobas' variety beans treated with the microbiological product Sporeplus also were less diseased by bean rust than untreated beans, however the differences were also insignificant. The disease of bean rust more damaged the beans of the 'Tiffany' variety. In all variants of the experiment the prevalence of bean rust in 'Bobas' variety beans was significantly lower than in 'Tiffany' variety beans. The prevalence of bean rust was not significantly affected by the application of the microbiological product Sporeplus neither in 'Bobas' nor in 'Tiffany' variety beans.

CONCLUSIONS

The highest average bean height was defined in both 'Bobas' (significantly) and 'Tiffany' (insignificantly) varieties sites, where bioproduct Sporeplus was applied for both seed treatment and for later plant spraying during vegetation. Significantly the highest average seed weight per plant was determined in beans of the 'Tiffany' variety, where the seed was treated by bioproduct and also the plants were sprayed with the microbiological product Sporeplus during the vegetation period as well. The average seed weight per plant of the 'Bobas' variety was also the highest (insignificantly) where both the seed and later the plants were treated with the microbiological product Sporeplus. The prevalence of bean rust (*Uromyces fabae*) was not significantly affected by the application of the microbiological product Sporeplus.

REFERENCES

1. Brazaukienė I.; Semaškienė R. 2006. *Lauko augalų ligos ir kenkėjai*. Mokslinis metodinis leidinys. Lietuvos žemdirbystės institutas, pp. 81-82. (In Lithuanian)
2. Dabkevičius Z.; Gaurilčikienė I. 2002. *Augalų ligų apskaitos rodikliai*. Žemės ūkio augalų kenkėjai, ligos ir jų apskaita, pp. 1-15 p. (In Lithuanian)
3. Deveikytė I., Semaškienė R., Sabeckis A. 2020. Lietuvos agrarinių ir miškų mokslų centras. Pupos. Integruotos kenksmingųjų organizmų kontrolės gairės. 3 p. [interaktyvus], [žiūrėta 2021-01-31]. Prieiga per internetą: https://www.lammc.lt/data/public/uploads/2020/05/d1_ikok_gaires_pupos.pdf (In Lithuanian)
4. Dewar A. M., May M. J., Waiwod I. P. 2006. A novel approach to the use of genetically modified herbicide tolerant crops for environmental benefit. *Biological Sciences: Proceedings of the Royal Society*, Vol. 270, pp. 35–340. https://doi.org/10.1098/rspb.2002.2248
5. Gomaa E. Z. 2012. Chitinase production by Bacillus thuringiensis and Bacillus licheniformis: their potential in antifungal biocontrol. *Journal of Microbiology*, Vol. 50, pp. 103-111. https://doi.org/10.1007/s12275-012-1343-y
6. Ostergar D. H., Jensen J. W. 2004. Characteristics of spring barley varieties for organic farming. *Genetic Variation for Plant Breeding*. Eucarpia, XVII, Tulln, pp. 483–484.
7. Sasnauskas A., Tilvikienė V., Mašalaitė R. 2013. *Mokslinės metodikos inovatyviems žemės ir miškų mokslų tyrimams*. Kaunas: Lututė, 2013. 447 p. (In Lithuanian)
8. Suojala T. 2000. Growth of and partitioning between shoot and storage root of carrot in northern climate. *Agricultural and Food Science in Finland*, Vol. 9, No. 1, pp. 49–59. https://doi.org/10.23986/afsci.5646