Streszczenie rozprawy doktorskiej w języku angielskim

The Influence of Biopreparations on Plant Health, Selected Morphological Traits, and Yield of Strawberry (*Fragaria x ananassa* Duchesne) Cultivated Under Organic Farming Conditions

Strawberries are a crop of significant economic importance, particularly in Poland, one of the leading producers of this fruit within the European Union and the foremost in organic strawberry production. Current EU agricultural policies aim to reduce the use of chemical plant protection products and synthetic fertilizers, which supports the development of non-chemical crop protection methods, including those based on biopreparations.

The objective of this study was to evaluate the effects of newly developed biopreparations – based on beneficial microorganisms and plant extracts – on strawberry fruit yield, incidence of fungal diseases (gray mold, leather rot, and anthracnose), plant biometric traits, as well as the economic viability of their application and their influence on the content of macro- and micronutrients and heavy metals in the fruit.

The research was conducted between 2020 and 2022 on a certified organic field at the Agricultural Experimental Station of IUNG-PIB in Grabów nad Wisłą. The strawberry trial, covering a total area of 2,300 m^2, was divided into two treatment groups: irrigated and non-irrigated. Five biopreparation combinations (K2-K6) containing strains of *Bacillus spp.* and various plant extracts were applied, and three strawberry cultivars – 'Honeoye', 'Rumba', and 'Vibrant' – were included in the experiment.

The tested cultivars responded differently to the applied biopreparations, both in terms of yield and susceptibility to fungal pathogens. 'Honeoye' showed the most positive response, with a notable increase in yield and the highest resistance to *Colletotrichum acutatum*, the causal agent of anthracnose. The highest yield increase in the 2021 season (on average by 33%) was observed following the application of the K4 formulation, which contained bacterial strains *Bacillus* sp. AF75BC and *Bacillus subtilis* AF75AB2 on carrier contained dry humic acids, mustard, rapeseed oil and clove oil in micronized dolomite, as well as *Bacillus* sp. Sp116AC*, *Bacillus* sp. Sp115AD, humic acids and yeast culture filtrate in micronized dolomite.

The effectiveness of the biopreparations in reducing the incidence of fungal disease in strawberry fruit depended on the cultivar and weather conditions during the growing season. In 2020, the K6 preparation combination effectively limited the occurrence of gray mold (*Botrytis cinerea*) on strawberry fruit. In the cultivar 'Vibrant', a reduction in fruit infection caused by the pathogen responsible for leather rot (*Phytophthora cactorum)* was noted, particularly after treatment with the K3 combination. In 2021, a reduction in disease symptoms ranging from 26% to 30% compared to the control was observed after applying combinations K2, K3, and K6.

Most of the biopreparation combinations used (with the exception of K2 in 2021) promoted an increase in the number of crowns per plant compared to the control, indirectly indicating the stimulatory effect of these preparations on strawberry plant growth and development.

The results suggest that the effectiveness of biopreparations may have been influenced by the presence or absence of irrigation. The K3 combination proved to deliver consistent economic benefits across all tested cultivars and under both irrigated and non-irrigated conditions, highlighting its broad applicability. The K4 combination showed high economic effectiveness specially under non-irrigated conditions, supporting its recommendation for use in such cultivation systems.

The microbial biopreparations applied also influenced the chemical composition of strawberry fruit, including dry matter content and the levels of nitrogen, iron, manganese, copper, zinc, cadmium, and lead. These effects were cultivar-dependent. However, no significant changes were noted in the calcium, magnesium, or sodium content of the fruit. None of the tested samples exceeded permissible levels for heavy metals. Significant differences in the concentration of elements- N, Mn, Na, Mg, Ca, K, P-and heavy metals - Cu, Zn, Pb, Cd - were found among the cultivars. The 'Honeoye' cultivar had lower levels of Na, K, P, Mg, Mn, and Fe in its fruit compared to the others. In contrast, 'Vibrant' showed higher concentrations of Mg, Zn, Mn, Pb, Cd and Ca. Meanwhile, the 'Rumba' cultivar exhibited the lowest levels of heavy metals (Cu, Zn, Pb) and calcium, but the highest content of total nitrogen, K, P, and Na. No uniform pattern in the effects of biopreparations was observed, underscoring the complexity of interactions between cultivar, biopreparation, and environmental conditions.

Overall, the results indicate that the use of biopreparations containing beneficial microorganisms and plant extracts can have a positive impact on yield and economic performance of organic strawberry production. However, the choice of preparation should take into account both the cultivar and cultivation conditions (presence or absence of irrigation). Biopreparations show potential for improving fruit quality in organic farming systems, but their use requires careful adaptation to specific growing conditions and cultivar characteristics.

Keywords: biopreparations, organic farming, fungal pathogens, microbial biofertilizers, macronutrients, micronutrients, heavy metals, economic efficiency, profitability index, strawberry, yield

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