CONSUMER-SAFE FRUIT AND VEGETABLES OR PROTECTING CROPS FROM DISEASE - ARE THESE MUTUALLY EXCLUSIVE

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BIOSAFEFOOD PROJECT

The main objective of the BioSafeFood project is to develop and introduce new, safe biopreparations for fruit and vegetable production to protect them against the most important fungal diseases and to develop new technologies (protection programmes) using these agents.

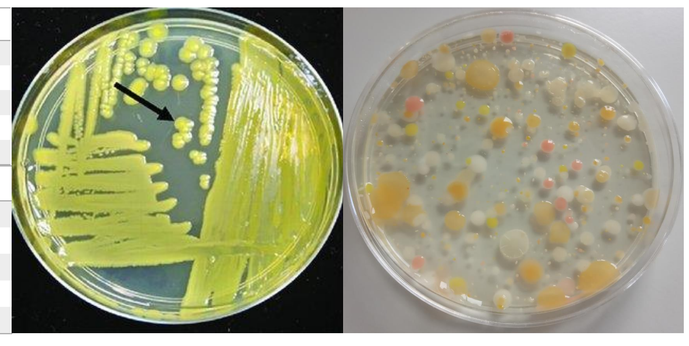
One of the main goals of agriculture in highly developed countries is to reduce the use of chemical pesticides by implementing eco-friendly production systems. The widespread adoption and implementation of these systems allow for restoring environmental balance and utilizing its natural resistance against pests and other harmful factors that limit the efficiency of crop production. In society, there is a growing expectation for the development of the methods alternative to chemical approaches. One of the solutions to reduce the chemical impact of agriculture is the application of bioproducts – plant protection agents based on microorganisms that enable plant defense against diseases while also ensuring the production of consumer-safe fruits and vegetables with reduced residues of chemical pesticides.

LABORATORY STUDIES

During the 2018 season, more than 2000 bacterial isolates from the environment of different plants were screened for their antagonistic properties against fungal pathogens. Based on the results, the most active isolates were selected under laboratory conditions and formulations were developed for testing under field conditions.

ANIm and Percentage Similarity	
Isolate T16/8	*
Pantoea agglomerans DSM3493^T	**98.67**
Pantoea allii LMG24248^T	84.16
Pantoea ananatis LMG2665^T	83.97
Pantoea vagans LMG24199^T	91.91

ANIm and Percentage Similarity	
Isolate T14/15	*
Pantoea agglomerans DSM3493^T	84.00
Pantoea allii LMG24248^T	**99.04**
Pantoea ananatis LMG2665^T	89.20
Pantoea vagans LMG24199^T	84.11



In our research, we show the potential of new isolates from the genus *Pantoea* as a new bioproduct for both crop protection and biostimulation. The genus *Pantoea* contains several plant pathogens, as well as biocontrol agents effective against a range of fungal diseases such as, for example, white mold, gray mold, alternariosis, anthracnose, brown rot, bull's eye rot, powdery mildew, and blue mold, as well as bacterial diseases such as, for example, fire blight or soft rot, affecting cultivated plants during the vegetation period and throughout the storage of harvest.

Bacterial strains have been tested for safety:

- toxicity for human safety (OPPTS 885.3200)
  does not show toxicity/acute pathogenicity
- phytotoxicity to non-target crops
  does not show phytotoxicity

FILED STUDIES

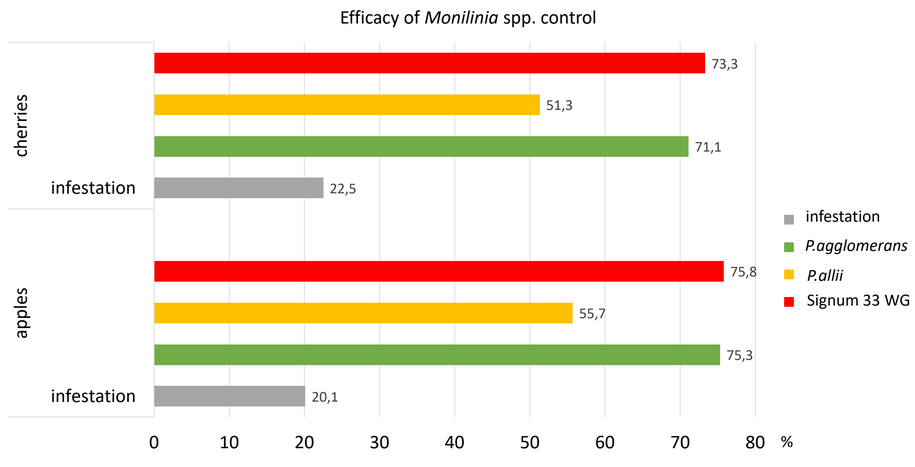
During the seasons 2019 - 2021, experiments were conducted on plantations: grapevine, blueberry, strawberry, raspberry, carrot, cabbage and celery as well as apple, pear and cherry orchards. Protective treatments were carried out with biopreparations by using them alone throughout the season or in programmes with chemical fungicides.

Due to the multiplicity of results, the key findings from the experiments are presented below.

Monilinia spp.

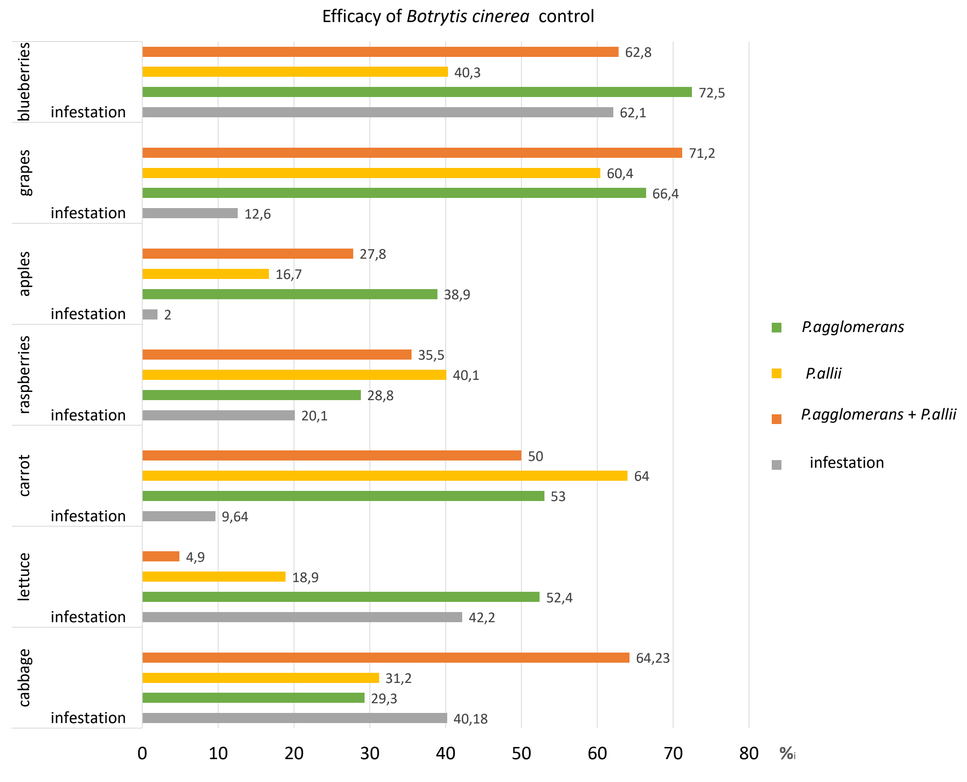
Brown rot of apples, known as moniliosis, is a disease caused by fungi of the *Monilinia* genus. This disease affects both pome fruit trees like apple trees and stone fruit trees. It particularly affects plums and apricots. The disease has two forms: a summer form that occurs in orchards and the second one – which becomes evident during storage. The harm caused by the disease lies in the rotting of the fruits.

The assessment of the effectiveness of *P.agglomerans* and *P.allii* strains in reducing moniliosis was conducted in field experiments on apples and cherries. A water suspension containing bioproducts with strains were at a concentration of 10^7 CFU/ml. The efficacy of *P.agglomerans* test preparation was similar to that of the standard fungicide applied three times per season.



Botrytis cinerea

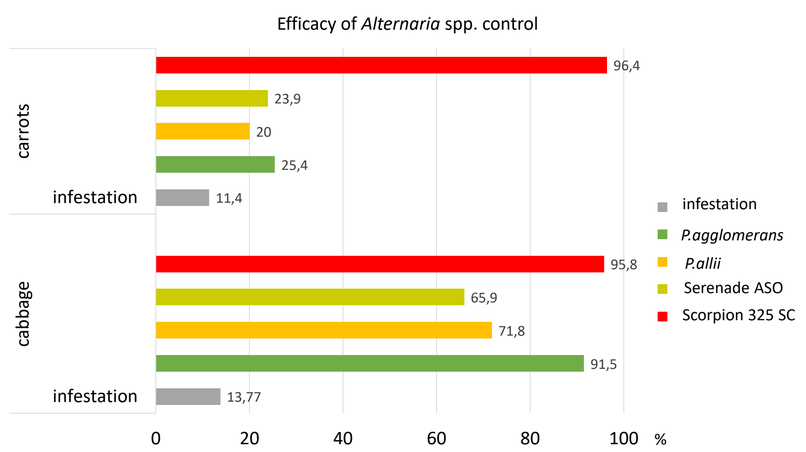
Gray mold caused by the fungus *Botrytis cinerea* attacks numerous plant species, and it can occur throughout the entire vegetation period, affecting all of their above-ground parts. The disease-causing agent affects agricultural, fruit-bearing, and ornamental plants. Berry plants, in particular, are highly susceptible to infections. The pathogen can cause damage even during the germination phase of plants, leading to damping-off and the death of young seedlings. Gray mold also affects vegetables during storage. The disease's progression is facilitated by low light levels, plant weakening due to other diseases, as well as calcium and potassium deficiency in the soil. The assessment of the effectiveness of *Pantoea* strains was conducted in field experiments on cabbage, lettuce, carrot, apples, grapes, blueberries, raspberries, strawberries. For spraying, suspensions were used containing: one of the strains, or mixture both, each treatment at a concentration of 10^7 (CFU/ml).



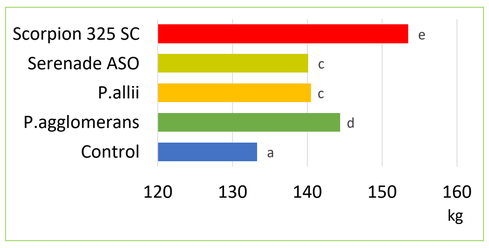
Alternaria spp.

Alternariosis diseases constitute a group of leaf, stem, and to a lesser extent, fruit diseases caused by fungi belonging to the Alternaria spp. genus. These microorganisms are widely spread in major cultivation regions of onions, cabbage vegetables, leeks, carrots, potatoes, and tomatoes. Infections caused by *Alternaria* spp. spores can lead to significant losses in the quality and quantity of harvested crops and contribute to their poorer storage.

The assessment of the effectiveness of *P.agglomerans* and *P.allii* strains in reducing alternariosis was conducted in field experiments on cabbage and carrots. The experiment conducted on cabbage growing in an experimental field was set up in a randomized block design with 4 replications and 2 rows of plants per rows (20 plants per plot). It included 6 combinations. For spraying, suspensions were used containing: one - *Pantoea agglomerans* strain, and the other - *Pantoea allii* strain, each at a concentration of 10^7 (CFU/ml).



The influence of the tested formulations on the yield of cabbage



CONCLUSIONS

The results of the above-mentioned experiments show that new strains of bacteria belonging to the *Pantoea* spp., have a significantly broader spectrum of activity than the currently known and used strains. The utilization of these strains could offer a solution to the inconveniences posed by the known methods in comprehensively protecting various plant species, including vegetables, fruits, and ornamental plants, against simultaneous attacks by different fungal and/or bacterial diseases. Scientific knowledge on biocontrol agents should be developed to ensure that alternatives are available when new strategies are required because of consumer pressure or just because the fruit and vegetables industry cannot use the current methods any longer. Ideally, BCAs should positively contribute to ecosystem services, such as improving soil fertility and biodiversity for succeeding agricultural production.

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