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OSMO-PROTECT

The European Congress of Life Sciences EUROBIOTECH

KRAKÓW 2026

OSMO-PROTECT: the potential for supporting crops under conditions of variable soil moisture and salinity using microorganisms

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Drought and salinisation are among the greatest challenges facing agriculture. Meanwhile, flooding and waterlogging significantly alter the microbiome, resulting in substantial crop losses. It is estimated that 10–12% of the world's agricultural land is affected by excessive moisture and/or poor soil drainage. Extreme weather events have a significant impact on plants, soil fauna and flora, which in turn influence the global biogeochemical cycle and ecosystem services such as crop yields in agricultural systems. Climate change affects all aspects, including the economy, energy, ecosystems and water resources. Droughts and floods have a wide range of social and economic consequences, and their impact on agriculture is linked to supply chain disruptions. Microorganisms are the main components of biopreparations, such as microbial fertilisers and biostimulants, and they can improve plant health under stressful conditions directly and indirectly. Their presence in the soil can increase water retention and reduce salt toxicity. The availability of microbial preparations is growing rapidly.

This report aims to determine the potential of using methods incorporating microbial preparations to mitigate the effects of extreme soil moisture and salinity fluctuations in agriculture.

Table 1. Examples of microorganisms that support plants under **drought** conditions

Microorganisms	Effect	Testing plant
Cladosporium cladosporioides (fungi)	increase in plant biomass; increase in relative water content; increase in soluble sugar content; increase in soluble protein content; increase in proline content; increase in antioxidant enzyme activity	*Nicotiana benthamiana*
Tobamovirus sp. (virus)	increase in plant osmolite content; increase in antioxidant enzyme activity and gene expression	*Nicotiana benthamiana*
Gluconacetobacter diazotrophicus (bacteria)	increase in plant biomass; higher gas exchange rates; higher yield; positive regulation of certain defence genes	*Oryza sativa*
Pseudomonas sp. (LTGT-11-2Z) (bacteria)	production of siderophores; production of EPS; increased activity of 1-aminocyclopropane-1-carboxylate deaminase (ACC); improved plant health and hydration	*Triticum aestivum*
Microbacterium sp. (3J1) (bacteria)	higher relative water content; higher fresh and dry plant weight; increased intracellular trehalose concentration; increased content of sugars such as trehalose, melibiose, fructose and glucose	*Capsicum annuum*
Pseudomonas spp. (E102 , E141) (bacteria)	greater fresh above-ground and root biomass; greater number of leaves; greater plant growth	*Phoenix dactylifera*
Bacillus megaterium (TG1-E1) (bacteria)	increased production of ethanolamine, which is a precursor to glycine, betaine and proline	*Solanum lycopersicum*
Bacillus oraz *Pseudomonas* (bacteria)	improved growth of soyabean seedlings	*Glycine max*
Pseudomonas spp. (M25, N33) (bacteria)	significant increase in water content and elasticity of plant cell walls; increased formation of new leaves; increased growth and photosynthetic capacity	*Eucalyptus grandis*
Rhizophagus irregularis (fungi)	increased chicory growth; higher percentage of inulin	*Cichorium intybus* L.
Pseudomonas fluorescens (bacteria)	increased fresh and dry plant weight	*Catharanthus roseus*
Bacillus sp. (bacteria)	increased plant biomass, increased water-holding capacity, improved stability of soil aggregates	*Zea mays*

Table 2. Examples of microorganisms that support plants under **salt stress**

Microorganisms	Effect	Testing plant
Bacillus subtilis (bacteria)	production of ACC deaminase, auxins, biofilm formation	wheat, tomato, rice
Pseudomonas fluorescens (bacteria)	synthesis of siderophores and phytohormones, phosphorus solubilisation	tomato, cucumber, rice
Azospirillum brasilense (bacteria)	production of IAA, nitrogen fixation, improved water uptake	maize, wheat, rice
Enterobacter cloacae (bacteria)	production of ACC deaminase, nitrogen fixation, improved root growth	tomato, radish, cabbage
Halomonas spp. (bacteria)	salt tolerance, production of osmoprotectants	alfalfa, rice, barley
Rhizobium leguminosarum (bacteria)	nitrogen fixation, symbiosis with legumes	peas, alfalfa, soya
Paenibacillus polymyxa (bacteria)	phosphate solubilisation, production of cytokinins and IAA	wheat, tomato, radish

Figure 1. Photographs from the project implementation: A) Laboratory work; B) bioreactor cultures; C) the finished prototype; D) a field trial with winter wheat.

At the Institute of Soil Science and Plant Cultivation - State Research Institute, we are carrying out the OSMO-PROTECT project, through which we have developed two biopreparations that positively affect three test plant species.
The biostimulating and osmoprotective effects of both prototypes have been confirmed under drought conditions.
The prototypes using the natural properties of soil bacteria to support the soil and plants.

The research was developed as part of project No. LIDER14/0250/2023 entitled „*Development of an innovative osmoprotective microbial preparation for the support and protection of crop plants under osmotic stress conditions caused by variable soil moisture and salinity*" funded by the National Centre for Research and Development (NCBR).