AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 03 Issue: 01 January 2022 Article No: 01

Role of Agriculturally Important Plant Associated Microorganisms in Sustainable Agriculture

Devendra Singh
Scientist, ICAR-Central Arid Zone Research Institute, Jodhpur

SUMMARY

Plant beneficial microorganisms are fundamental to different bio-geochemical process insoil viz. organic matter decomposition, carbon cycle, nitrogen cycle, phosphate solubilization and mobilization, nitrogen fixation and acquisition of micronutrients. Microorganisms also facilitate the crop plants to withstand various abiotic stresses viz. elevated temperature, elevated CO2, moisture stress, salinity stress and metal toxicity. Biofertilizers and biopestisides being major components of integrated nutrient and insect-pest management, and one of the key elements of sustainable agriculture, the application of beneficial microorganisms reduces the use of synthetic agro-chemicals, sustain the soil health, soil biodiversity and enhance the plant growth.

INTRODUCTION

Application of beneficial microorganisms as biofertilizers and biopesticides help in achieving the sufficient food for increasing human population in sustainable way and also help in alleviating adverse effect of agrochemicals on soil health. Besides, their activities also maintain the soil fertility and soil productivity and help in withstand the crop plant plants under adverse climatic conditions like rising temperature, moisture stress and greenhouses gases emissions (Wagg et al., 2014). Microorganism plays crucial role in plant nutrient cycling in rhizosphere. The huge decent variety of microbes gives an undiscovered chance of improving proficiency of crop production, adjusting to and alleviating environmental change impacts, along these lines accomplishing objectives of sustainable agriculture. In addition, agriculturally important microorganisms play the important role in sustainable agriculture through nutrient management, pest management, bioremediation and natural resources management.

Role of microbes in sustainable agriculture

Microbial inoculants are an attractive eco-friendly alternative to chemical fertilizers and pesticides. They exert beneficial effects on soil and plant health by different mechanisms:

Nutrient management and Biofertilizers

The efficient crop production depends on the nutrient status of the soil and is vital for sustainable agriculture. Chemical fertilizers are primarily used to increase the crop yield. However, their indiscriminate use has led to serious environmental consequences. The rise in the awareness of people about the adverse effects of chemical fertilizers is increasing the use of microbial inoculants as biofertilizers in organic farming and integrated farming systems.

Organic matter decomposition

Soil organic matter (SOM) decomposition is the biological transformation of complex organic matter into simple inorganic compounds. Decomposition of SOM results in stabilized organic matter which is further resistant to microbial decomposition and termed as humus. This humus plays crucial role in soil aggregates formation and improving water and nutrient holding capacity of soil. Soil organic matter is mainly derived from the plants residues. SOM decomposition is carried out by heterotrophic microorganism comprising soil bacteria, fungi, protozoa and actinomycetes. Cellulose, hemicelluloses and lignin are the major component of soil organic matter which are degraded comparatively slower than the other components like sugars, amino acids and lipids (Pérez et al. 2002). Earthworms also play an important role in the initial breakdown of organic residues

Nitrogen fixation

Biological nitrogen fixation (BNF) is the fixation of atmospheric nitrogen into ammonia. After photosynthesis, nitrogen fixation is the second most crucial process influencing plant growth and development. Only some prokaryotes, known as diazotrophs, have the ability to fix stable atmospheric nitrogen into reactive

nitrogen which can be easily taken up by plants. BNF contributes around 110 and 140 Tg per year of fixed nitrogen on land and ocean, respectively (Pajares and Ramos 2019).

Phosphorus solubilization and mobilization

Phosphorus (P) is one of the most essential and limiting mineral nutrient after nitrogen. It is a component of nucleic acids, enzymes, coenzymes, nucleotides and phospholipids. It constitute about 0.2% - 0.8% of plant's dry weight (Sharma et al. 2013). Availability of phosphorus for plant is limited mainly because of presence of P in insoluble form (about 95 to 99%). Plant growth promoting rhizobacteria (PGPR) are capable of solubilizing and mineralizing insoluble soil phosphorus, thereby enhances its availability for plant use (Alaylar et al. 2019).Extensive utilization of phosphorus solubilizing microorganisms in agriculture is a promising strategy to enhance plant uptake and reduce the use of chemical fertilizers that have negative impacts on the environment.

Potassium solubilization

Potassium (K) is the third major essential nutrient for plant growth after nitrogen and phosphorus. It plays vital role in protein synthesis, enzyme activity and photosynthesis.Deficiency of K in soil results in decreased crop yield and disease resistance. Although the potassium reserves in earth crust account for 2.1% to 2.3%, majority of it (about 90%) is insoluble silicate minerals which is unavailable for plants use (Xiao et al. 2017). Microorganisms such as bacteria, fungi and actinomycetes have remarkable ability to dissolve potassium from its mineral forms. Similar to P solubilizing bacteria, K solubilizing bacteria also produces organic and inorganic acids which solubilize potassium minerals either directly or indirectly by chelating mineral silicon ions to release K into solution. Therefore, use of KSB as biofertilizer in agriculture is a promising alternative to synthetic K fertilizers.

Biopesticides

Indiscriminate application of chemical pesticides, to tackle plant diseases, has affected the soil health, besides deleterious effect on non-target organisms and the environment. Microbial pesticides are promising options to avoid the deleterious effects of chemical pesticides and are gaining importance among the farmers and researchers. Biocontrol is defined as the application of living organism to control other plant detrimental organisms (Sporleder and Lacey 2013). Microorganisms having potential for disease suppression are referred as the microbial biological control agents (BCA). These biocontrol agents provide low cost, environmental friendly and sustainable alternative for hazardous synthetic chemical pesticides used in agriculture. Microbial biological control agents provide plant protection by producing allelochemicals such as antibiotics, biocidal volatiles and siderophores, inducing resistance or priming plants against pathogen infection by systemic acquired resistance (SAR) and induced systemic resistance (ISR), competition for limiting nutrients and directly killing the pathogen by hyperparasitism (Köhl et al. 2019).Bio-pesticides have the promising potential for the development of integrated pest management strategies.

CONCLUSION

Plant growth promoting microorganisms play the important role in sustainable agriculture. Plant growth promoting microorganisms maintain the soil health through organic matter degradation, biological nitrogen fixation, phosphorus solubilization, K-solubilization and biological control of insect-pest.

REFERENCES

Alaylar, B., Güllüce, M., Karadayi, M. and Isaoglu, M., 2019.Rapid detection of phosphate-solubilizing bacteria from agricultural areas in Erzurum. *Current microbiology*, *76*(7), pp.804-809.

Köhl, J., Kolnaar, R. and Ravensberg, W.J., 2019. Mode of action of microbial biological control agents against plant diseases: relevance beyond efficacy. *Frontiers in plant science*, *10*, p.845.

Pajares, S. and Ramos, R., 2019. Processes and microorganisms involved in the marine nitrogen cycle: knowledge and gaps. *Frontiers in Marine Science*, *6*, p.739.

Pérez, J., Munoz-Dorado, J., De la Rubia, T.D.L.R. and Martinez, J., 2002. Biodegradation and biological treatments of cellulose, hemicellulose and lignin: an overview. *International microbiology*, *5*(2), pp.53-63.

Sporleder, M. and Lacey, L.A., 2013. Biopesticides.

Wagg, C., Bender, S.F., Widmer, F. and Van Der Heijden, M.G., 2014. Soil biodiversity and soil community composition determine ecosystem multi functionality. *Proceedings of the National Academy of Sciences*, *111*(14), pp.5266-5270.

Xiao, F., 2017. Emerging poly-and perfluoroalkyl substances in the aquatic environment: A review of current literature. *Water research*, *124*, pp.482-495.