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Microbial plant breeding– prospects and applications in agriculture

Visalakshi Chandra C, Hanume Gowda K, Pradeepika Chintha, Senthil Sankar

[1]ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala-695 017.

visalakshi.ctcri@gmail.com

Microbial plant breeding/ Microbe-assisted plant breeding (MAPB) is an emerging area in agriculture that leverages the intricate interaction between plants and their associated microbiomes to enhance crop productivity, resilience, and health. Instead of focusing solely on plant genetics, this approach also considers the role of beneficial microbes as pivotal contributors to plant development and health, in improving plant traits, including growth, disease resistance, and nutrient uptake. This method uses microbial products such as biostimulants, biopesticides, and fertilizers that are made from naturally existing microbes or their metabolites to promote increased production through faster growth and better health. The use of molecular markers facilitates the discovery of desirable features more quickly and allows for the selection of superior plant types by introducing microbial aid into conventional breeding procedures. Additionally, microbes are essential for advancing conventional breeding initiatives. They can help to speed up the identification of desired features and aid in the selection of superior plant types by facilitating the expression of molecular markers. Incorporating microbial support into breeding procedures not only improves efficiency but also leads to the development of crops that are more resilient and productive.

Requirements for Microbial Breeding?

To utilise this cutting-edge approach, there are a few requirements such as understanding microbial interaction mechanisms; improving culture collections, developing synthetic communities, Identification of molecular markers linked to external traits and conducting field trials for trait validation are pivotal (Kroll et al., 2017).

Steps involved in microbial breeding

Identification of target traits, Isolation, and screening of microbes Beneficial microbes are isolated from the rhizosphere or plant tissues and screened for traits that promote plant growth or resistance to stresses. These beneficial microbes are then used as bioinoculants which are products containing live microorganisms that are applied to seeds, soil, or plants to improve crop performance.

Microbial Community Management

Once the bioinoculants are applied, it is essential to add organic matter, compost, or specific nutrients to the soil to encourage the growth of beneficial microbes. Crop Rotation, Intercropping, and conservation tillage are practised to promote a diverse microbial community in the soil and reduce soil disturbance to preserve the natural microbial communities that contribute to soil health and plant productivity.

Symbiotic Breeding

Plant breeding programs can focus on selecting plants with a high affinity for beneficial microbes, such as mycorrhizal fungi or nitrogen-fixing bacteria, enhancing the symbiotic relationship for improved crop performance.

Manipulation of the Plant Microbiome

Through the use of microbial consortia, synthetic communities of microbes can be engineered and introduced to the plant to confer specific benefits, such as drought resistance or improved nutrient efficiency. The use of DNA sequencing to analyze the entire microbial community associated with a plant, allows breeders to understand which microbes are present and how they contribute to plant health and productivity.

Evaluation of plant performance

The evaluation of plant performance, to assess the impact of microbial interactions on desired traits is assessed followed by breeding and selection.

Benefits of Microbial Plant Breeding

It is anticipated that conventional plant breeding methods will be combined with microbial plant breeding to produce crop varieties that collaborate well with their microbial partners. Beneficial microorganisms reduce the need for chemical pesticides and fertilizers by assisting plants in accessing nutrients and by outcompeting or inhibiting diseases. Microbes can help plants absorb more water and deal with environmental stressors like salinity and drought. By boosting natural processes and lowering dependency on artificial inputs, microbial plant breeding promotes more environmentally friendly agricultural techniques. Crops may need assistance from microbial plant breeding to adjust to new climatic factors like rising temperatures, droughts, and altering insect pressures. By connecting genetics, environment, and microbial populations, microbial plant breeding opens the door to more focused and informed (Wille et al., 2019).

Applications in Agriculture

Rhizobium bacteria that fix nitrogen in symbiosis with legumes (like soybeans, peas, and lentils) are an established example of microbial plant breeding. Beneficial microbes that can enhance nitrogen use efficiency in non-legume crops like wheat, maize, and rice can be introduced. Microbial inoculants can be developed for a variety of horticultural crops to improve yield and resistance to diseases. Advanced genomic and microbiome analysis tools will enable more precise manipulation of microbial communities for crop improvement.

Challenges

Microbial communities are complex and dynamic, making it difficult to predict how they will interact with plants in different environments. Soil type, climate, and farming practices influence microbial communities' composition and function, which can complicate the consistent application of microbial plant breeding techniques. Regulatory hurdles and public acceptance challenges are related to introducing new microbial products in agriculture.

References

- Berryish, 2024. Microbe-Assisted Plant Breeding: A Paradigm Shift for Sustainable Agriculture.Biotica Research Today 6(3), 110-112.
- Kroll, S., Agler, M.T., Kemen, E., 2017. Genomic dissection of host-microbe and microbe-microbe interactions for advanced plant breeding. Current Opinion in Plant Biology 36, 71-78. DOI: https://doi.org/10.1016/j. pbi.2017.01.004.
- Wille, L., Messmer, M.M., Studer, B., Hohmann, P., 2019. Insights to plant-microbe interactions provide opportunities to improve resistance breeding against root diseases in grain legumes. Plant, Cell & Environment 42(1), 20-40. DOI: https://doi. org/10.1111/pce.13214.