



AGRI MAGAZINE

(International E-Magazine for Agricultural Articles)

Volume: 03, Issue: 03 (March, 2026)

Available online at <http://www.agrimagazine.in>

© Agri Magazine, ISSN: 3048-8656

Effect of Microbial Consortia on Maize Production

*Gajveer Meena¹, Pravin Dalavi¹ and Dr. S.K. Raina²

¹Ph.D. (Scholar), Sher-e-kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar-190025, J&K, India

²Professor, Sher-e-kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar-190025, J&K, India

*Corresponding Author's email: gajveermeena98@gmail.com

Zea mays, often known as maize, is said to have originated from a wild grass in central Mexico 7000 years ago. Native Americans improved maize to become a more nutritious food source. Maize is found all over the world, with the top three producing nations being the United States, China and Brazil. It comprises roughly 72% starch, 10% protein, and 4% fat, providing 365 Kcal/100 g of energy. A wide range of food and commercial items, such as starch, sweeteners, oil, drinks, glue, industrial alcohol and fuel ethanol can be produced from maize. About 40% of the maize produced in the United States is now used to produce fuel, a huge rise over the previous ten years. Although maize output has increased globally over time, human consumption of the grain has stayed relatively constant. The majority of the production increase is believed to have coincided with a rise in the usage of maize as animal feed. But many people still use maize as a staple diet, particularly in Africa.

Globally, Maize is known as queen of cereals because of its higher genetic yield potential among the cereals. Every part of the maize plant has economic value (the grain, leaves, stalk, tassel, and cob) and all are used to produce a large variety of food and non-food products. It is the most versatile crop and is grown in more than 166 countries across the globe, including tropical, subtropical and temperate regions, from sea level to 3000 m above mean sea level. It is cultivated in nearly 205 million ha with a production of 1210 million tonnes and productivity of 5878 kg/ha all over the world, having wider diversity of soil, climate, biodiversity and management practices (FAOSTAT, 2021). India produced 33.62 million tonnes in an area of 10.04 million hectares in 2021-22, where in kharif 2022-23, maize production was 23.10 million tonnes in an area of 9.68 million hectares (agricoop.nic.in). United State of America (USA) is the largest producer of maize contributing 32 per cent of the global production and is regarded as the diver of the US economy. During 2022-23, maize was grown in 1.21 lakh hectare with a production of 36.24 lakh tonnes in Maharashtra (Daubenfeld *et al.*, 2025).

In order to achieve sustainable agriculture, biofertilizers are becoming more and more important as a viable substitute for dangerous chemical fertilisers. In order to preserve long-term soil fertility and increase crop output, which is crucial for supplying the world's growing food demand, biofertilizers are used. Crop plants can interact with microbes to improve their defences, development, and growth. The needed nutrients for optimum crop growth include nitrogen, phosphorous, potassium, zinc, and silica; nevertheless, these nutrients are normally present in complex or insoluble forms. They become soluble and accessible to the plants thanks to certain bacteria. In this overview, the prospective microorganisms, their mode of operation, and their impact on crops are reviewed. Biofertilizers are a fantastic alternative to pricey and damaging chemical fertilisers since they are affordable, non-toxic and environmentally benign. We can better grasp the value of microorganisms in agriculture and

how to use them as biofertilizers for sustainable crop development using the knowledge we have gathered from this review (Nosheen *et al.*, 2021).

Characteristics of Vertisols and Their Impact on Maize

Physical Constraints

Chemical Constraints

Biological Status

Physical Properties of Vertisols

Key Characteristics:

- **Texture:**

- ✓ Very high clay content (30-70%)
- ✓ Dominated by smectites clays

- **Structure:**

- ✓ Strong angular blocky or prismatic structure
- ✓ Surface may show gilgai microrelief (uneven mounds and depressions)

- **Shrink–Swelling properties:**

- ✓ Wide cracks (up to 60 cm or more) in dry season
- ✓ Soil swells and becomes plastic when wet

- **Bulk Density:**

- ✓ Moderate to high (1.3-1.6 Mg/m³)

- **Porosity & Permeability:**

- ✓ Low permeability (slow infiltration)
- ✓ Poor internal drainage

- **Water Holding Capacity:**

- ✓ Very high (due to clay content)
- ✓ But water availability may be limited due to strong adsorption

- **Consistency:**

- ✓ Sticky and plastic when wet
- ✓ Hard and cloddy when dry

Implication: Difficult to till; timing of cultivation is very critical.

Chemical Properties of Vertisols

Key Characteristics:

- **Soil pH:**

- ✓ Neutral to alkaline (pH 7.0-8.5)

- **Cation Exchange Capacity (CEC):**

- ✓ Very high (40–60 cmol(+)/kg)
- ✓ Due to presence of smectite clay minerals

- **Base Saturation:**

- ✓ High (>80%)
- ✓ Dominated by Ca²⁺ and Mg²⁺

- **Organic Matter:**

- ✓ Low to moderate

- **Nutrient Status:**

- ✓ Nitrogen (N): Low
- ✓ Phosphorus (P): Low to medium (fixation occurs)
- ✓ Potassium (K): High (due to clay minerals)
- ✓ Micronutrients: Often deficient in Zn, Fe, and S

- **Calcium Carbonate:**

- Often present in a sufficient amount in black soil (calcareous nature)

Implication: Fertility is moderate but nutrient management (especially N & P) is essential.

Biological Properties of Vertisols

Key Characteristics:

- **Microbial Activity:**

- ✓ Moderate but influenced by moisture conditions

- ✓ Activity decreases during dry cracking phase
- **Soil Enzymes:**
- ✓ Enzyme activities (dehydrogenase, phosphatase and alkaline phosphates) fluctuate with wetting–drying cycles
- **Organic Carbon:**
- ✓ Generally low → limits microbial biomass
- **Soil Fauna:**
- ✓ Earthworms and microbes present in soil and play a key role in nutrient cycling but affected by poor aeration
- **Aeration:**
- ✓ Poor during wet conditions → anaerobic zones may form

Microbial Consortia: Concept and Components

- **Definition of microbial consortia** Microbial consortium has emerged as a promising approach for sustainable agriculture. A microbial consortium comprises a community of microorganisms, including bacteria, fungi and other microorganisms, that work collaboratively to provide essential functions to the ecosystem. Each component of the microbial consortium plays a specific role in the ecosystem, and their interaction with each other and the environment is crucial to their function. (PSB+KSB = Consortia I), (PSB+KSB+ZnSB= Consortia II).
- **Common components:**

Azospirillum (Nitrogen fixation)

Azospirillum is one of the most studied plant growth-promoting bacteria (PGPB), it represents a common model for plant bacterial interactions. While *Azospirillum brasilense* is the species that is most widely known, at least 22 species, including 17 firmly validated species, have been identified, isolated from agricultural soils as well as habitats as diverse as contaminated soils, fermented products, sulphide springs and microbial fuel cells (Cassan *et al.*, 2020).

PSB (Phosphate solubilization): Phosphate Solubilizing Bacteria (PSB) play an important role in improving soil phosphorus availability. They convert insoluble forms of phosphorus into soluble forms by secreting organic acids and enzymes, making it easily accessible to plants. PSB enhances nutrient uptake, root development, and overall crop growth. Additionally, their use reduces dependence on chemical phosphorus fertilizers and promotes sustainable soil fertility.

KSB / ZnSB (nutrient mobilization): Potassium Solubilizing Bacteria (KSB) play a key role in mobilizing unavailable forms of potassium in soil by releasing organic acids that dissolve mineral-bound K. This increases potassium availability for plant uptake, improving enzyme activation, water regulation, and stress tolerance. KSB also enhances soil fertility and supports better crop growth. Their application helps reduce dependence on chemical potassium fertilizers and promotes sustainable nutrient management. (Fridrich *et al.*, 1991).

Zinc Solubilizing Bacteria (ZnSB): help convert insoluble zinc compounds into plant-available forms through acidification and chelation processes. This improves zinc uptake, which is essential for enzyme activity, chlorophyll formation, and growth regulation. ZnSB contributes to correcting zinc deficiency in soils and enhances crop yield and quality.

Synergistic interactions: Synergistic interactions in microbial consortia enhance nutrient availability by combining the functions of different beneficial microbes, leading to improved nutrient solubilization and uptake. (Saleem *et al.*, 2021).

Mechanisms of Microbial Consortia in Maize Production

Nutrient Availability

- Biological nitrogen fixation
- Solubilization of phosphorus and potassium
- Increase the availability of all macro and micro nutrient to the plant

Plant Growth Promotion

- Production of phytohormones (IAA, GA)

- Root growth enhancement

Soil Health Improvement

- Increase in soil organic carbon
- Enhanced enzyme activity
- Regulate the nutrient cycling

Stress Mitigation

- Better tolerance to moisture stress and poor aeration in Vertisols and increase water holding capacity

Effect on Growth and Yield of Maize

- Increase in plant height, leaf area index
- Improvement in yield attributes (cob length, grains/cob)
- Grain and stover yield enhancement
- Increase chlorophyll content
- Comparative performance

Effect on Soil Properties

Chemical Properties

- Available N, P, K improvement
- Increase the availability of micronutrient (Fe, Mn, Cu and Zn)
- pH stabilization

Biological Properties

- Microbial biomass carbon
- Enzyme activities:
 - ✓ Dehydrogenase
 - ✓ Phosphatase
 - ✓ Urease

Integration with Nutrient Management

- Microbial consortia + reduced chemical fertilizers
- Role in Integrated Nutrient Management (INM)
- Compatibility with organic amendments (FYM, compost, biochar)

Economic Analysis: It also improves the benefit–cost (B:C) ratio compared to sole fertilizer use. Thus, consortia treatment is an economically efficient and sustainable option for maize cultivation.

Constraints and Limitations

Constraints of microbial consortia include variable field performance due to soil type, climate, and microbial survival.

Future Prospects

Future prospects of microbial consortia are promising due to their potential to enhance nutrient use efficiency and reduce dependence on chemical fertilizers.

Conclusion

Microbial consortia (PSB, KSB, ZnSB, and *Azospirillum*) play a crucial role in enhancing nutrient availability, soil health, and maize productivity, especially in Vertisols. Their synergistic action improves plant growth, yield, and nutrient use efficiency while reducing dependence on chemical fertilizers. Additionally, consortia-based approaches are economically beneficial and environmentally sustainable. Hence, adoption of microbial consortia is a promising strategy for sustainable maize production.

References

1. Cassan F., Coniglio, A. Lopez, G. Molina, R. Nievas, S. and Mora, V. (2020) Everything you must know about *Azospirillum* and its impact on agriculture and beyond. *Biology and Fertility of Soils*, **56**:461–479.

2. Daubenfeld, T., Lauenstein, L., & Carrasco, D. (2025). Limits to growth in global crop yield? Insights from data mining of the FAOSTAT database from 1961 to 2023. *agriRxiv*, (2025), 20250585560.
3. FAOSTAT, 2021. Food and agriculture organization of the united nation, Rome, Italy. <https://www.fao.org/faostat/en/#data/QCL/visualize>.
4. Friedrich, S. N. P., Platonova, G. I., Karavaiko, E., stichel and Glombitza, F., (1991). Chemical and microbiological solubilization of silicates. *Acta. Biotech*, **11**: 187-196.
5. Nosheen, S., Ajmal, I., Song, Y. (2021) Microbes as Biofertilizers, a Potential Approach for Sustainable Crop Production. *Sustainability*, **13**(4):1868.
6. Saleem, M., Nawaz, F., Hussain, M. B., & Ikram, R. M. (2021). Comparative effects of individual and consortia plant growth promoting bacteria on physiological and enzymatic mechanisms to confer drought tolerance in maize (*Zea mays* L.). *Journal of Soil Science and Plant Nutrition*, **21**(4), 3461-3476.