AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly e Newsletter
Volume 2 – Issue 1
Online ISSN: 2582-368X
www.agriallis.com

ROLE OF MICROBES IN THE SERVICE OF HUMANITY

Article Id: AL202036

Mousumi Malo
Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, West Bengal, India
Email: moubckv15@gmail.com

Microbes were the first form of life, originating almost four billion years ago and they will continue to inhabit our planet even long after disappearance of humans and other life forms. The invisible world of the microbes represents far greater evolutionary and metabolic diversity than the visible organisms familiar to us. They are the supreme waste recyclers and regenerators of the planet. Microbes are ubiquitous, and their activities sustain and influence the quality of all life on earth. Although we humans consider ourselves to be the stewards of planetary health, microbes are much more powerful agents, central actors and key stakeholders of influence, regulation and change of planetary activities and biological evolution. Microbes and their activities have pervasive, remarkably profound and generally positive effects on the functioning, and thus health and well being of human beings, the whole of the biological world, and indeed the entire surface of the planet and its atmosphere. Collectively and to a significant extent in partnership with the sun, they are the life support system of the biosphere. Plant associated microbes mediate acquisition of essential minerals including nitrogen (indeed without microbial mediated nitrogen fixation, there would not have been enough biomass production by plant, primary producers for the proliferation and evolution of animal consumers), protect against infections and produce hormone like compounds that promote plant growth. Some microbes carried by plants are toxic to animals and hence function as a plant defence against predators. The ability to recognize new opportunities of microbial activities in a timely manner, to accurately assess benefits and possible risks, and to take evidence based decisions on actions needed to facilitate their exploitation, is essential for knowledge based, bio-centric economies to be competitive and to progress significantly towards sustainable practices.

The concept of effective microorganisms

A unique approach for controlling the soil micro flora and for maximizing their beneficial effects has been developed by Professor Teruo Higa at University of Ryukyus in

Volume 2 – Issue 1
Online ISSN: 2582-368X
www.agriallis.com

Okinawa, Japan who is the innovator of the concept of effective microorganisms, a promising new technology. EM consists of mixed cultures of naturally occurring beneficial microorganisms that can be applied as inoculants to increase the microbial diversity of soils and plants. Research has shown that these EM cultures can improve soil health; growth, yield and quality of crops (Higa and Wididana, 1991). There is evidence that supports several theories concerning its action including a) suppression of plant pathogens and diseases b) enhanced nutrient availability c) stimulated plant growth (*i.e.* auxin mediated effects) and d) improved root surface-rhizosphere relationships (Higa and Wididana, 1991).

Using EM to improve soil health and performance

EM works by getting the natural processes to function, the way nature intended by stimulating biological activity in the soil. Using EM will not only add to the microbial population but also stimulate resident microbes. This stimulation can lead to increase the nitrogen fixation capacity directly through the increase of N fixing bacteria, and indirectly by increasing growth and activity of mycorrhiza, other fungus and earthworm. EM can enhance growth and improve soil health through:

- Enhancing fertiliser inputs
- Converting organic matter to plant nutrients
- Decomposing organic residues
- Recycling soil nutrients
- Breaking down fertiliser compounds
- Improving root structures
- Breaking down pollutants in the soil
- Increasing earthworm numbers
- Reducing compaction issues
- Building soil humus

Volume 2 – Issue 1
Online ISSN: 2582-368X
www.agriallis.com

Table No. 1. The role of microorganism in organic agriculture

Sl. No.	Group of microorganism	Kind and name
1.	Can fix Nitrogen a. Free living b. Living with other plants	a. Blue green algae (*Anabaena*, *Nostoc*); Bacteria (*Azotobacter*, *Azospirillum*) b. Blue green algae (*Azolla-Anabaena*); Bacteria (*Rhizobium* sp.)
2.	Solubilise Phosphate a. Free living b. Symbiosis	a. Bacteria (*Bacillus* sp., *Pseudomonas* sp.); Fungus (*Aspergillus* sp., *Penicillium* sp., *Fusarium oxysporum*) b. Fungus (Mycorrhizal fungi): Vesicular Arbuscular Mycorrhiza
3.	Decompose organic matter	*Trichoderma viride*, *Chaetomium abuanse*, *Myrothecium roridum*, *Aspergillus niger*, *Cellulomonas* sp., *Cytophaga* sp., *Bacillus* sp.
4.	Protect from insect pests	Virus (DNA viruses, RNA viruses); Bacteria (*Bacillus thuringiensis*); Fungus (*Entomophthora*, *Masospora*); Protozoa (*Nosema Locstae*, *N. bombycis*); Nematode (*Neosplectona*, *Carpocasae*)
5.	Can control weeds	*Cercospora rodmanoo*, *Celletortrichum glocoaporipeds*, *Punccinia chroudrillina*
6.	Antibiotic production a. Fungus b. Bacteria c. Insects	a. Cyclohexinide (*Streptomyces griseus*) Blasticidins (*S. griseochromogenes*) Polyozins (*S. cacaoi*) b. Streptomycin (*S. griseus*), Oxytetraccycline (*S. viridifaciens*) c. Tetranctin (*S. aureus*)
7.	Food for people and animals	Algae and Plankton (*Sprieulina*, *Nostoc*); Yeast; Mushroom (*Fusarium graminearum*, *Choetomium cellulolyticum*)

Microbes and biotechnology

Microorganisms are mostly microscopic small creatures which are placed in different groups such as bacteria, fungi, protozoa, micro algae and viruses. These organisms live in soil, water, food, animal intestines and other different environmental conditions.

a. Men use some of microbial diversity in the production of fermented foods such as bread, yogurt, and cheese.

b. Some soil microbes release nitrogen that plants need for growth and emit gases that maintain the critical composition of the earth's atmosphere.

Volume 2 – Issue 1
Online ISSN: 2582-368X
www.agriallis.com

c. Other microbes challenge the food supply by causing yield reducing diseases in food producing plants and animals.

d. In our bodies, different microbes help to digest food, ward off invasive organisms, and engage in skirmishing and pitching battles with the human immune system in give and take of the natural disease process.

e. Microbial biotechnology is an important area that promotes advances in food safety, food security; value added products, human nutrition and functional foods, plant and animal protection, and overall fundamental research in the agricultural sciences.

f. Microbial biotechnology, enabled by genome studies, will lead to breakthroughs such as improved vaccines and better disease diagnostic tools, improved microbial agents for biological control of plant and animal pests, modifications of plant and animal pathogens for reduced virulence, development of new industrial catalysts and fermentation organisms, and development of new microbial agents for bioremediation of soil and water contaminated by agricultural runoff.

Microbial biotechnology and its applications in agriculture

a. Natural fermentation
b. Bio-fertilizers
c. Bio-pesticides
d. Bio-herbicides
e. Bio-insecticides

Now increasing attention has been paid to the development of sustainable agriculture in which the high productivities of plants and animals are ensured using their natural adaptive potentials, with a minimal disturbance of the environment (Noble & Ruaysoongnern, 2010). It is our view that the most promising strategy to reach this goal is to substitute hazardous agrochemicals (mineral fertilizers, pesticides *etc*.) with environment friendly preparations of symbiotic microbes, which could improve the nutrition of crops and livestock, as well as their protection from biotic (pathogens, pests) and abiotic (including pollution and climatic change) stresses (Yang *et al*., 2009). At present, a wide spectrum of preparations of diverse microbial species may be used to enhance crop production (Andrews *et al*., 2010).

Volume 2 – Issue 1
Online ISSN: 2582-368X
www.agriallis.com

Conclusions

Global food demand is increasing rapidly especially more in developing nations where crop lands and resources hardly contribute to an efficient crop production needed to meet such an urgent demand for food. There is an urgent need to intensify agricultural production in a sustainable manner through the use of efficient agro-ecosystems which consider the entire bio-chemical diversity and their potential to mitigate the adverse impact of low soil fertility, abiotic stress, pathogens and pests (Timmusk *et al*., 2017). In this context, global food security issue will foster reliance on innovation, development, and delivery of technologies that lead to increased food production while ensuring sustainable intensification of agriculture. Microbial technology through the integration of beneficial microbes and micro biome interactions may represent a promising sustainable solution to improve agricultural production (Timmusk *et al*., 2017). For instance, advances in genomic, post genomic, biochemistry, ecology and symbiotic interactions of beneficial microbial strains have led to the development and commercialization of efficacious microbial products (bio-fertilizers, bio-stimulants, bio-pesticides, bio-herbicides and plant growth promoters *etc*.) with proven success to improve crops' yield and adaptation to environmental changes, and inputs of carbon and energy (Lindemann *et al*., 2016; Umesha *et al*., 2018).

References

Andrews, M., Hodge, S. and Raven, J. A. (2010). Positive plant microbial interactions. Annals of Applied Biology, 157, 317–320.

Higa, T. and Wididana, G. N. (1991). The concept and theories of Effective Microorganisms. p, 118-124. In J. F. Parr, S. B. Hornick and C. E. Whitman (ed.). Proceedings of the First International Conference on Kyusei Nature Farming. U.S. Department of Agriculture, Washington, D.C., USA.

Lindemann, S. R., Bernstein, H. C., Song, H. S., Fredrickson, J. K., Fields, M. W. and Shou, W. (2016). Engineering microbial consortia for controllable Outputs. *ISME J.*, 10, 2077–2084.

Noble, A. D. and Ruaysoongnern, S. (2010). The nature of sustainable agriculture. In Soil Microbiology and Sustainable Crop Production, pp. 1–25. Eds R. Dixon and E. Tilston. Berlin, Heidelberg, Germany: Springer Science and Business Media B.V.

Timmusk, S., Behers, L., Muthoni, J., Muraya, A. and Aronsson, A. C. (2017). Perspectives and challenges of microbial application for crop improvement. *Front. Plant Sci.* 8: 49.

Umesha, S., Singh, P. K. and Singh, R. P. (2018). "Microbial biotechnology and sustainable agriculture," in *Biotechnology for Sustainable Agriculture*, Chap 6 eds Singh R. L., Monda S., editors. (Sawston: Woodhead Publishing), 185–205.

Yang, J., Kloepper, J. W. and Ryu, C. M. (2009). Rhizosphere bacteria help plants tolerate abiotic stress. Trends in Plant Science, 14, 1–4.