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Role of bio fertilizers in crop production under rice-wheat cropping system

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ABSTRACT

Biofertilizers are the important component in rice-wheat cropping system. It play key role in the productivity and sustainability of soil while protecting the environment because these are cost effective, ecofriendly and renewable source of plant nutrients to supplement chemical fertilizers in rice-wheat cropping system.The role of biofertilizers in agriculture assumes special significance due to high cost of chemical fertilizers and their hazardous effect on soil health. These play an important role to improve nutrient supplies and their crop availability in the years to come. In rice-wheat cropping system azolla, azospirillum, PSB, mycorrhiza and azotobacter are mainly used. These are only option to improve the soil organic carbon for sustainance of soil quality and future agricultural productivity.

Keywords: Biofertilizer, Productivity, Organic Carbon, Renewable Source, Cropping System

INTRODUCTION

Agriculture plays a vital role in the survival of nation, thus maintain its quality and quantity is essential for feeding the population and the economic exports. In modern agriculture, use of continuous pesticides and chemical fertilizers decay of soil quality and fertility and might lead to collection of heavy metals in the plant tissues, affecting the fruit nutritional value and edibility (Farnia and Hasanpoor, 2015). Hence in the last few years many organic fertilizers have been introduce which helps to increase plant growth. A particular group of organic fertilizers includes outcomes based on plant

growth promoting microorganisms identified as biofertilizers. Also, fertilizers are as a nutrient supplement to plants and comprised mainly nitrogen, phosphorous and potassium and they also caused several health hazard. Researchers have also found biofertilizers as an excellent alternative of chemical fertilizers which provide nutrients through the action of nitrogen fixation, solubilising phosphorus and trigger plant growth through the synthesis of growth promoting essence (Sneha *et al.,* 2018).

In last century, the chemical fertilizers were used in agriculture extensively. Farmers were happy of getting increased yield as chemical fertilizers when applied to soil, provide nutrients to plants directly. But slowly chemical fertilizers started displaying their ill-effects such as maximum leaching of nutrient from soil, polluting of water basins due to excessive use of chemical fertilizers, it effects the beneficial microbes, residual effect causes diseases to the humans.Only focusing on crop yield is not sufficient as continuous application of chemical fertilizers have bad impact on soil health which will degrade the soil ecosystem in future. We should also concern with soil health and use the available resources effectively and efficiently without degrading soil health. The alternate use of chemical fertilizers arebiofertilizers which are ecofriendly in nature and without depleting the soil health provides nutrients to plants. The first commercial bio-fertilizer was developed as a Rhizobium culture in 1895 with the product nitragin in the United States. This bio fertilizer discovered by Nobbe and Hiltner. In India the use Rhizobium inoculants was initiated in 1920, but its systemetic production began after 1950 with gradual introducion of other bio-fertilizers. Biofertilizers are defined as the microorganisms which are capable for fixing atmosphiric nitrogen or converting insoluble phosphorus in the soil into available form to the plant.They are cost effective and renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture.They can be grouped in different ways based on their nature and functions.

The rice wheat rotation is the principal cropping system in south asian countries that occupies about 13.5 million hectares in the indo-gangetic plains, out of which, India occupies an area of around 10 million hectares. This cropping system is dominant in most Indians states such as Punjab, Haryana, Bihar, Madhya Pradesh and Uttar Pradesh and contributes to 75% of national food grain production.Thus, the rice-wheat cropping system is cornerstone of India food self-sufficiency. The environmental requirements for the growth and development of both rice and wheat crops are contrastingly different. Rice (*Oryza sativa)* grows best under stagnant water conditions, while wheat (*Triticum aestivum*) requires a well-pulverised soil with a proper balance of moisture, air and thermal regime. But in rice-wheat cropping system famers mostly used chemical fertilizers for enhance the crop yield but due to continuous use of chemicals quality of soil decline.

Thus, without using the chemicals, biofertilizers are one of the most effective method to increase the growth and yield of the crop. In rice field, *azospirillum* and *azolla* mostly used. *Azospirillum* solubilizes phosphorus and silicon to some extent required by rice. It also helps in drought tolerance when irrigation or rainfall is delayed. By adopting *azospirillum* application 30% of inorganic nitrogen usage can be reduced. Similarly,

azolla also help to fixing atmospheric nitrogen. It also provides nitrogen, potassium organic carbon to plants. It also helps to prevent the weed growth in rice field. *Mycorrhiza* also occurs naturally in low and upland rice. It mobilizes the phosphorus required by rice and also used in paddy nurseries in India. On the other hand, wheat is one of the major cereal crop and staple food for more than one-third of the world population. By using biofertilizers in the wheat crop yield also enhanced. Sharief et al., (1998) found that inoculation of wheat grains with mixture of *azospirillum* and *azotobacter* bacteria in the form of cerealine increased wheat weight, number of grains per spike, grain and straw yield.

ROLE OF BIOFERTILIZERS IN RICE-WHEAT CROPPING SYSTEM

- Application of biofertilizer applied to rice is regarded as direct effect to riceand residual effect to succeeding wheat. Similarly application of biofertilizer applied to wheat is regarded as direct effect to wheat and residual effect to succeeding rice. Both show cumulative effect (Ram *et al.,*2011).
- Application of biofertilizers results in increased mineral and water uptake, root development, vegetative growth, nitrogen fixation and other nutrient availability.
- Biofertilizers enhance the productivity of soil for example: *Azospirillum bacteria* thrive in root zone of rice and are capable of fixing more atmospheric nitrogen which is absorbed by plants. Root exudates of the crops provide nutrients for survive and multiplication of bacteria.
- Biofertilizers helps to improve yield, NPK uptake, grain quality, gross and net return of rice in rice-wheat cropping system.
- Biofertilizers containing living organisms which decompose organic matter and help in soil minerlization.
- Helps to improve the soil aeration.

TYPES OF BIOFERTILIZERS

Based on nature and function biofertilizers can be grouped as following:

Sr.no	Groups	Bio-agent
N_2 fixing Bio-fertilizers		
1.	Free living	*Azotobacter, Beijerinkia, Clostridium, Klebsiella, Anabaena, Nostoc*
2.	Symbiotic	*Rhizobium, Frankia, Anabaena azollae*
3.	Associative symbiotic	*Azosirillum*
P Solubilising Bio-fertilizers		
1.	Bacteria	*Bacillus megaterium var. phosphaticum, Bacillus subtilis Bacillus circulans, Pseudomonas striata*
2.	Fungi	*Penicillium sp, Aspergillus awamori*
P Mobilizing Bio-fertilizers		
1.	Arbuscular mycorrhiza	*Glomus sp.,Gigaspora sp.,Acaulospora sp., Scutellospora sp. & Sclerocystis sp*
2.	Ectomycorrhiza	*Laccaria sp., Pisolithus sp., Boletus sp., Amanita sp*

3.	Ericoid mycorrhizae	*Pezizella ericae*
4.	Orchid mycorrhiza	*Rhizoctonia solani*
Bio-fertilizers for Micro nutrients		
1.	Silicate and Zinc solubilizers	*Bacillus sp.*
Plant Growth Promoting Rhizobacteria (PGR)		
1.	Pseudomonas	*Pseudomonas fluorescens*

(Source: Jehangir *et al.,*2017)

BIOFERTILIZERS USED IN RICE-WHEAT CROPPING SYSTEM

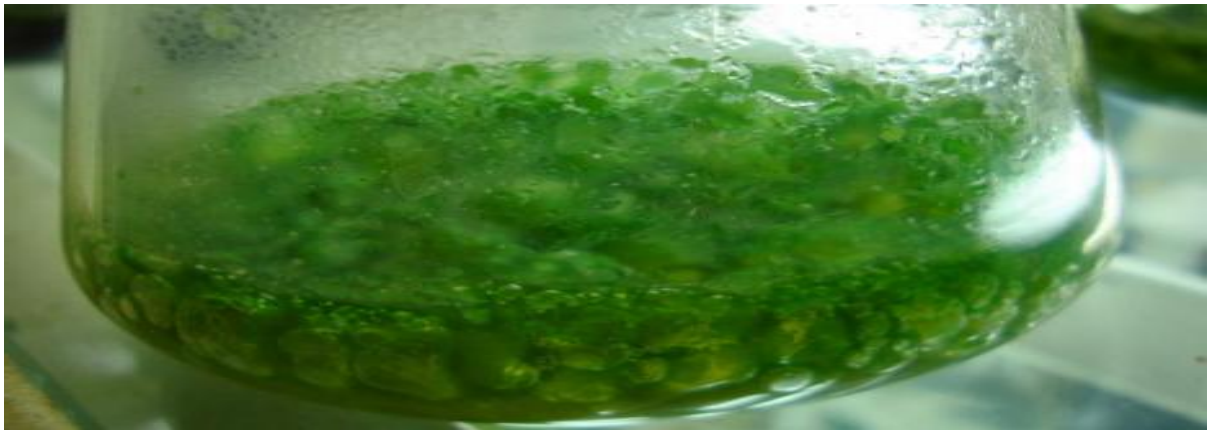
There are many types of biofertilizers used in different crops. Some are used in rice-wheat cropping system. These are as:

❖ **Biofertilizers used in rice:**

- **Azolla:**It is also known as duck weed. It is aquatic in nature and it fix the 30-40 kg N/ha.It takes 25-35 days to provide enough nitrogen for 4-6 t/ha in rice during the rainy season and 5-8 t/ha crop under irrigation during the dry season.

(Source: Agrifarming, 2019)

- **Blue green algae:** It is also known as Cyanobacteria**.** It is free living bacteria. It is fix the N 15-45 kg N/ha. It also maintains soil fertility and improves soil health. It contributes in the economic feasibility in paddy habitat, minimize cost and energy inputs (Mishra and Pabbi, 2004).



(Source: Indiamart.com)

- **Mycorrhiza:**It is symbiotic association between a fungus and plant.It provides nutrients to plants.Plant makes organic molecules such as sugar by photosynthesis

and supplies them to fungus and it supplies to the plants, water and nutrients such as phosphorus.

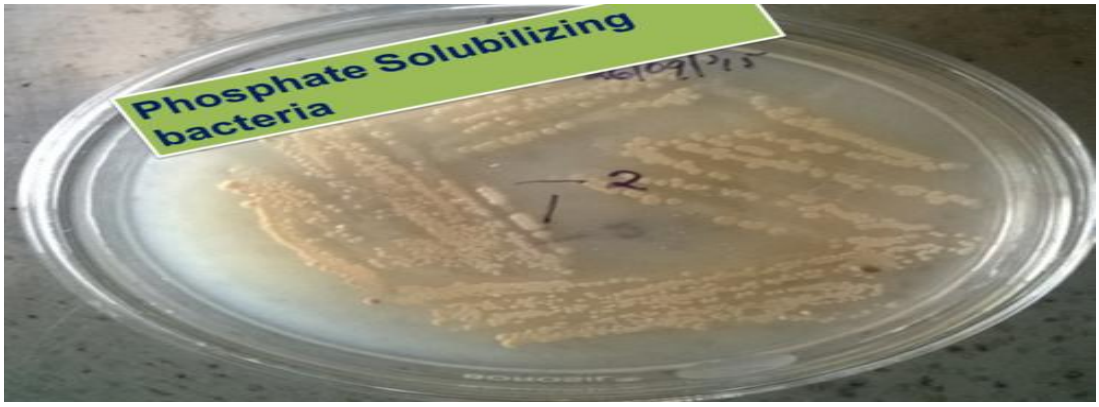
(Source: Indiamart.com)

BIOFERTILIZERS USED IN WHEAT:

- **Azotobacter:**It is non-symbiotic hetrotrophic bacteria which fix the atmospheric nitrogen an average of 20-30 kg N/ha. Azotobacter strains play a key role in the nitrogen cycle in nature that binds atmospheric nitrogen inaccessible to plants and releasing in the form of ammonium ions available to plants in the soil fixing an average 20 kg N/ha/year. It is able to grow at a pH range of 4.8-8.5 and fixes N at optimum pH of 7.0-7.5 (Kloepper*et al.,* 1989).

(Source: Indiamart.com)

- **PSB (Phosphate Solubilizing Bacteria):** It is beneficial bacteria which solubilize inorganic P from insoluble compounds. PSB can be used for all crops including paddy, millets, oilseeds, pulses and vegetables. It can be applied through seed treatment, seedling dipping and soil application.



(Source: Indiamart.com)

IMPORTANCE OF BIOFERTILIZERS

- **Increasing Yield**
  - Average increasing crop yield by 20 to 30%.
  - Algae based fertilizers have improved yields in rice at rates ranging between 10 and 45%.
- **Improving Soil Structure**
  - Use of microbial bio fertilizers improves the soil structure by influencing the aggregation of the soil particles.
  - Sustain soil health.
- **Better water relation**
  - Maintaining stomatal functioning and transpiration.
  - Increasing root length and development.
- **Lowering Production Costs**
  - Made from easily obtained organic materials such as rice husk, soil, bamboo, and vegetables etc.
  - Reduce the input expenses by replacing the cost of chemical fertilizers.
  - Replace 25-30% chemical fertilizers by use of biofertilizers and also reduce the economic cost of fertilizers.

TIPS FOR IMPROVING EFFECTIVENESS OF BIOFERTILIZERS

- Avoid direct contact with fertilizers, insecticides and pesticides during storage.
- Rhizobium/Bradyrhizobium biofertilizer is specific to host plants therefore, only specific inoculant should be used for specific crop.
- The storage and use of biofertilizers should be avoided in direct sunlight.
- For seed treatment, adequate adhesive should be used for better results.
- The inoculant should be used before the expiry date.
- Apply biofertilizers after all other treatments such as apply fungicides, insecticides etc and give a gap of 24 hour.
- It should be free from contaminating microorganisms.

CONSTRAINTS OF BIOFERTILIZERS

- **Production level constraints:** Due tounavailability of appropriate and efficient strains, unavailability of suitable carrier and mutation during fermentation effects the production.
- **Market level constraints:**Farmers are not aware, inadequate and inexperienced staff, lack of quality assurance, seasonal and unassured demand creates marketing problems,
- **Resource constraint:** Limited resource generation for biofertilizer production. Due to unavailability of resources biofertilizers are not produce on higher level.
- **Field level constraints:** Soil and climatic factors, native microbial population etc.

(Source: Rana *et al*., 2013)

CONCLUSION

It can be concluded that excessive use of chemical fertilizer cause soil deterioration, causes toxicity not only in grains and soil but also pollute the environment. But with application of various biofertilizer promotes crop yield, improves soil health as well as environment safely. On average 10-20% increased crop yield under different condition by using biofertilizers.It is also beneficial residue effect on soil and succeeding crop and also improves quality of food. Thus, biofertilizers play key role in productivity and sustainability of soil and protect the environment, eco-friendly, cost effective and renewable source of plant nutrients to supplement chemical fertilizers in sustainable rice-wheat cropping system.

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applied to the soil or plant directly to improve plant growth and yield. Free-living nitrogen-灰xing microorganisms contained in the biofertilizer increase plant growth by supplying the nitrogen nutrient element and phosphate-solubilizing bacteria, increasing the availability of the phosphorus nutrient element to the plant roots. In addition to nutrients microbes play an important role in plant growth promotion by the production of phytohormones (Panhwar et al. 2014a). The common phytohormone produced by the bacteria is indoleacetic acid, which promotes plant root growth. The vast root architecture help plants to absorb nutrients and water from the surroundings. The common bacteria genera used in biofertilizer preparation are Rhizobium, Burkholderia, Bacillus, Aspergillus, Pseudomonas, and Azotobactor, among others. These are also known as plant growth-promoting rhizobacteria (PGPR). Mycorrhiza biofertilizer is popular for management of the phosphorus nutrient in many vegetables, fruits, upland rice, and plantation crops (Naher et al. 2013a).

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