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4. Present Scenario of Bio fertilizer Use in Agriculture and Aquaculture

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4.1 Introduction:

India is regarded as one of the world's 12 mega-biodiversity countries. The population in India and the World is increasing day by day. It puts pressure on the agricultural lands and other resources to fulfil the need for food of this enormous population. In the case of Asia, it has been estimated that each 1% increment in crop productivity leads to a 0.48% reduction in the number of poor people (Thirtle *et al*., 2003); while, in India, 1% rise in agricultural value-added per hectare Poverty decreases by 0.4 percent in the short run and by 1.9 percent in the long run as a result of the indirect effects of lower food prices and higher wages. (Ravallion and Datt, 1996). Soils are losing calcium contents, and hence its biodiversity is critically affected.

As a result, the most difficult issue at the moment is increasing food production from rapidly shrinking per-capita agricultural land. (Bhattacharyya, 2009; Mazid and Khan, 2014). Despite the fact that India's production was remarkably high during the Green Revolution, poverty persists because it was concentrated primarily in favorable areas. To make agriculture sustainable, a well-balanced and reasonable use of nutrients that is both cost-effective and environmentally friendly must be implemented. Venkataraman and Shanmugasundaram, 1992; Mahdi et al., 2010); in that case, bio fertilizer could be a better option (Pindi and Satya Narayana, 2012; Borkar, 2015). Now, the Government of India has also taken a stride to harness the full potential of the available bio fertilizers by introducing them along with chemical fertilizers to the farmers (Ghosh, 2004).

Visualizing the economic burden and environmental cost of applying this considerable quantity of additional fertilizers, which can be met from biological sources like bio fertilizers, will significantly impact.

4.2 Bio fertilizer:

The term 'bio fertilizer,' also known as ‘micro inoculants' (Arora et al., 2010), was derived from a contraction of the term 'biological fertilizer,' with biological denoting the use of living organisms, that colonize in the rhizosphere, accompanying the interior of the plant and stimulating growth and enhance mineral nutrient accessibility and uptake by the host plant. (Vessey, 2003; Malusa *et al*., 2012; Malusa and Vassilev, 2014). It denotes all nutrient inputs and plant growth that are of biological origin that can improve soil fertility and crop productivity. They are known to not only improve yields and produce quality but also improve nutrient use efficiency. The use of cheap and eco-friendly inputs like bio fertilizers is vital for India, where most of the farming will continue to be in the hands of small farmers.

Nobbe and Hiltner performed the first trials on bio fertilizers on Rhizobia in 1895 and cultured 'Nitragin' in the laboratory. In India, N.V.Joshi, 1956 was the first to study legume 'Rhizobium'. Under the Ninth Year Plan, the Ministry of Agriculture initiated the actual effort to popularize and promote the input by setting up the National Project on Development and Use of Bio fertilizers (NPDB).

4.3 Nutrient Deficiency in Soil:

Roots primarily absorb the nutrients present in the aqueous environment. Besides Nitrogen, Phosphorus, Potassium (NPK); Sulphur, Zinc and Calcium are also required in reasonable quantities. Whereas other nutrients such as Iron, Boron etc. though needed in small amounts, their deficiency significantly impacts plant growth and life. Micronutrient deficiency due to Zn, Boron, Iron and Sulphur in soils is increasing day by day in India. Hence by application of secondary and micronutrients along with NPK nutrients can increase significant yields of production.

Role of Bio fertilizers:

a. Increase crop yield by 20-30%.
b. Replace chemicals nitrogen and phosphorus by 25 %.
c. Stimulate plant growth.
d. Activate soil biologically.
e. Restore natural fertility.
f. Provide protection against drought and some soil-borne diseases.

Method of Application of Bio fertilizers:

1. Seed treatment: Take both 200 gm of N bio fertilizer and Phosphoric in 300-400 ml of water and wait until mixed thoroughly. Finally, Mix this paste with 10 kg seeds & dry it in the shade. Sow immediately.

2. Seedling root dip: For vegetables, 1 kg each of two bio fertilizers mixed in water. Dip the roots of desired seedlings in this suspension for 30-40 min before transplanting. Whereas For paddy, make a bed in the field and fill it with water. Mix biofertilisers in water and dip the roots of seedlings for 8-10 hrs.

3. Soil treatment: Mix 4 kg each of biofertilisers in 200 kg of compost and leave it overnight. Apply this mixture to the soil at the time of sowing or planting. In plantation crops, apply this mixture near the root zone and cover it with soil.

Precautions while usage:

- Store bio fertilizer packets in a cool and dry place away from direct sunlight and heat.
- Use the right combination of biofertilisers.
- Rhizobium is crop-specific, so used in the specified crop.
- Do not mix with chemicals.
- While purchasing, ensure that each packet is provided with necessary information like name of the product, name of the crop for which intended, name and address of the manufacturer, date of manufacture, date of expiry, batch No and instructions for use.
- Use the packet before expiry, only on the specified crop, by the recommended method.

4.4 Bio Fertilizers Consumption in India:

Till 1997-98 strong correlation was found between fertilizer consumption and food grains production, which distorted this relationship. Most states are experiencing an increase in fertilizer consumption with a slower pace of crop productivity. Some states witness consumption of fertilizer picking up without any conspicuous gain on agricultural crop productivity.

The following types of microorganisms as bio fertilizers are available to the farmers in India:

- Nitrogen fixer, e.g. Rhizobium, Brady rhizobium, Azospirillum, Azotobacter, Acetobacter, Azolla and BGA.
- Phosphorus solubilizer, e.g. Bacillus, Pseudomonas and Aspergillus.
- Phosphate mobilizer, e.g. VA-mycorrhiza (VAM) like Glomus.
- K-solubilizer, e.g. Frateuria aurantia.
- Silicate solubilizer, e.g. Thiobacillus thiooxidans.
- Plant growth-promoting bio fertilizers, e.g. Pseudomonas sp. (Muraleedharan, 2010; Mishra and Arora, 2016).

Negative Impacts of Fertilizers:

a. Availability and cost:

- Demand is much higher than availability. It is estimated that by 2020, to achieve the targeted production of 321 million tonnes of food grain, the nutrient requirement will be 28.8 million tonnes, while their availability will be only 21.6 million tonnes being a deficit of about 7.2 million tones.

- Increasing costs are getting unaffordable for both small and marginal farmers.

b. Effect of Chemical fertilizers in soil and environment:

- Excessive and imbalanced use of inorganic fertilizers harms the soil causing a decrease in organic carbon, reduction in the microbial flora of soil, increasing acidity and alkalinity and hardening of soil, and reduction in species diversity.
- Excessive use of N-fertilizer is contaminating water bodies, thus affecting fish fauna and causing health hazards for human beings and animals.
- The production of chemical fertilizers adds to the pollution.

4.5 Present Scenario of Bio Fertilizers in India:

Despite the multiple advantages of bio fertilizers in agricultural production, several constraints at different levels, i.e. from the production unit to farmers' field, make it less prevalent in India. Now, the government of India is boosting the bio fertilizer industries by providing subsidies to a maximum of 20 lakh rupees and awarding a national productivity award to the efficient bio fertilizer production unit (Borkar, 2015). Agro Industries Corporation has the maximum production capacity, followed by State Agriculture Departments, National Bio fertilizers Development Centers, State Agricultural universities and private sectors (Pindi and Satya Narayana, 2012).

Generally, the activity of microorganisms are location and crop-specific so, strains selected for particular areas as well as crops should have good adaptability for this specific location and some qualities like competitive ability over other strains for nodulation of the host, N-fixing ability, potentiality to colonize and survive in adverse physical conditions (Panda, 2013). Some bio fertilizer production units do not have sufficient technically well-qualified microbiologists or skilled persons who can make available high-quality biofertilisers rather depend on more non-skilled labors working on a contract basis that leads to substandard bio fertilizers (Mahdi et al., 2010; Mathur et al., 2010; Motghare and Gauraha, 2012). In addition, the non-availability of good quality peat in India has also headed to the development of alternative carriers like lignite, charcoal, etc., which are mainly used unsterilized (Borkar, 2015; Panda, 2013). Most studies suggest that biofertilizers sold in markets are contaminated and have a low count of microorganisms. Generally, producers do not pay attention to the host-specific strains, and as a result, biofertilizers cannot express their potentiality (Mazid and Khan, 2014; Motghare and Gauraha, 2012).

Indian Standard Institute (ISI) specifications are recently available only for Rhizobium and Azotobacter; Azospirillum and phosphobacteria have been formulated. There is no regulatory action for the production of biofertilizers (Mazid and Khan, 2014).

4.6 Biofertilizers in Agriculture Vs Aquaculture:

Along with the increase in productivity, an eco-friendly, sustainable approach to agricultural practices is becoming increasingly necessary.

Excessive use of inorganic fertilizers is unsustainable or harmful for any farming practice from economic and ecological points of view has led to the use of various kinds of manure and, till recently, biofertilizers for fixing nitrogen solubilizing phosphates and decomposing/recycling carbon. Biofertilizers are live microbial cells such as cyanobacteria, nitrogen-fixing bacteria (such as Rhizobium, Azotobacter, and Azospirillum etc.) and phosphate-solubilizing bacteria (such as Bacillus etc.). These are positively active in enriching the ecological niche in which they are found with macro-nutrients like nitrogen and phosphorus, reorienting the in situ microbial ecology for human economic benefit. However, unlike agriculture, aquaculture practices call for a bio fertilizer with a conceptual difference.

Agriculture and the production of food by a man during civilization were probably the first human interventions that resulted in various specialized branches of food production. Aquaculture has emerged as one of the essential branches of food production. Sustained and enhanced productivity are the primary goals of aquaculture. Diseases have become an integral part of intensive aquaculture necessitating the use of chemicals, drugs, and antibiotics in health management. Although these measures produced enhanced productivity, continual use of chemicals and fertilizers are known to have deleterious effects on the environment and sustained productivity (World Health Organization antimicrobial resistance fact sheet 194, http://www.who.int/inf-fs/en/fact194.html). Biofertilizers (microbial interventions) were initiated to make aquatic production more sustainable and disease management measures more environmentally friendly. In aquaculture, this may be achieved by maintaining balanced populations of bacteria and using defined probiotics in several ways, such as enrichment of larval food, inclusion in the diet, or addition to the water, as a remediation agent. The use of antibiotics disturbs the microbiological balance of gut flora, eliminating most of the beneficial flora. The use of antibiotics is discouraged as it has led to drug-resistant bacteria, immune suppression in animals, harmful effects on the environment and concerns on food safety.

Moreover, aqua cultural products are sometimes banned due to the rejection of export consignments. Hence, the usage of probiotics is propagated to counter the effect of viral and bacterial infections in commercial aquaculture. It is reported that fish ingest only 20–30% antibiotics, and the remaining reaches the environment. Even the antibiotics ingested by aquatic animals may be excreted as such or as metabolites, harming animals and human consumers. Pathogens such as Vibrio’s and Aeromonads can develop resistance to antibiotics very quickly. So there is a need for an alternative health management strategy, which biofertilizers can accomplish. Charcoal-immobilized Azotobacter is recommendable as an aqua-bio fertilizer of better performance in low cost, eco-friendly, and sustainable aquaculture practice. However, the concept of biofertilizers in an aquatic system must be broad-based to ensure a tangible result/success.

It must be delivered for practice not simply as a technology but as a technology package. The organisms must serve as biofertilizers, detritus processors, fish food organisms, etc., ensuring a more substantial trophic base.

Such microorganisms, upon extended efforts, could also be supplementing as bioremediation/ bioaugmentors/bio ameliorators, bio filters, which is a single term that could be defined as probiotics.

4.7 Conclusion:

Biofertilizers, essential components of organic farming, play a vital role in maintaining long-term soil fertility and sustainability by fixing atmospheric di-nitrogen and mobilizing fixed macro and micronutrients in the soil into forms available to plants. Currently, there is a gap of ten million tons of plant nutrients between the removal of crops and supply through chemical fertilizers. In the context of both the cost and environmental impact of chemical fertilizers, excessive reliance on chemical fertilizers is not practicable in the long run because of the cost, both in domestic resources and foreign exchange involved in setting up fertilizer plants and sustaining the production. In this context, biofertilizers would be the viable option for farmers to increase productivity per unit area.

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