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Popular Article

Role of Biofertilizer Inoculants in Crop Productivity and Soil Fertility

M.Paramasivan[1], N. Senthil Kumar[2] and S. Jothimani[3]
[1&3]Agricultural College & Research Institute,
Tamil Nadu Agricultural University,
Killikulam – 628 252, Vallanad, Thoothukudi – Dt,
[2]Agricultural College & Research Institute, Kudumiyanmalai
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Bio-inoculants

Bio-inoculants are living organisms containing strains of specific bacteria, fungi, or algae which: - take nitrogen from the air and make it available to plants- reducing the need for nitrogen fertilizer. - make inorganic phosphate and micronutrients soluble and available to plants.

Soil microorganisms play an important role in the plant growth and development by various means viz. nitrogen fixation, phosphate solubilization, phytohormone production etc. Therefore, bio-inoculants for agriculture purpose i.e., bio-fertilizers could be a better alternative to chemical fertilizers for agricultural as well as environmental sustainability (Ritika and Uptal, 2014).

Commercialization of microbial inoculants

The commercialization of microbial inoculants popularly known as biofertilizers started in late seventies in India and currently they are being manufactured on a large scale. The journey of mass production of inoculants that started with Rhizobium, has now been diversified and various types of inoculants are commercially produced and utilized for nutrient mobilization and plant protection which play a key role in crop productivity. However, despite good potentiality of biofertilizer usage, the actual utilization is very low at about 2% of its potential. One of the initially introduced high potential biofertilizer, Rhizobium is losing the steam and is being gradually replaced by other inoculants such as phosphate solubilizing bacteria (PSB) (Jehangir *et al.*, 2017). With growing demand, many new inoculants are being launched and manufactured by the industry. Potash

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mobilizers, zinc solubilizers and consortia of biofertilizers are latest additions to the existing pool of biofertilizers manufactured in India.

Production of Biofertilizers in India

As per the latest compilation on mass production, India has about 225 biofertilizer production units with an installed production capacity of about 98,000 MT per annum. Against this, the actual production during the year 2010-11 was 37,997 MT. Out of various types of biofertilizers, PSB biofertilizers accounted for nearly 50% of total production and use. Remaining installed capacity is being used for the production of other microbial inoculants, mainly Trichoderma, Pseudomonas fluorescens, Metarhizium anisopliae, Beauveria bassiana and Verticillium, being traded as biopesticides. Share of biofertilizers to biopesticides in total production.

Types of Microbial Inoculants (Biofertilizers) in Market

Rhizobium was the first microbial inoculant, which was introduced as biofertilizer during early seventies with the introduction of soybean into the country. Azotobacter and Azospirillum were added to the list in mid- nineties. Phosphate solubilizing biofertilizer (PSB) was introduced in late nineties. During the same period, few more inoculants were added such as Acetobacter (or Gluconaceto bacter), Potash mobilizer (Frateuria aurantia and Bacillus sp.), Zinc solubilizers and lately consortia of microorganismscomprising a mixture of Azotobacter, Azospirillum, PSB and Pseudomonas fluorescens (Satyaprakash, 2017). Mono cultures although continue to dominate the market but mixed cultures are picking up fast and may surpass the single strain inoculants in next 5 to 7 years (Jnawali, 23015).

Methods of application of biofertilizer inoculants:

Rhizobium

Seed treatment has been found to be the suitable method of *Rhizobium* inoculation. Some adhesive is used to make proper contact between seeds and inoculants (bacteria). About 900 g soil base culture is sufficient to inoculate the seeds for an area of one hectare in case of legumes. A 10% jaggery (gur) solution is used as sticker for *Rhizobium* cells to seed. First, the solution is spread over the seeds and mixed to build up a thin coat over the seeds. After ascertaining the proper coating of slurry over the seeds, the inoculant is sprinkled over the seeds and the content is again mixed thoroughly. Then the content is dried in the shade by spreading thinly on a polythene sheet for at least overnight.

Azotobacter

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Field experiments carried out on *Azotobacter* indicated that this is suitable when inoculated with seeds or seedlings of crop plants like onion, aubergine, tomato and cabbage under different agro-climatic conditions. *Azotobacter* inoculation curtails the requirement for nitrogenous fertilizers by 10 to 20% under normal field conditions.

Azospirillum

Azospirillum inoculation helps to improve the vegetative growth of the plants, cutting back on nitrogenous fertilizers by 25–30%. So far, only four species of *Azospirillum* have been identified. They are *A. lipoferum*, *A. brasilense*, *A. amazonense* and *A. iraquense*. In Indian soils, *A. brasilense* and *A. oferum* are very common.

Acetobacter

Under field conditions, the yield of sugarcane increases after *Acetobacter* inoculation. Productions of auxins and antibiotic type substances have also been observed after its application.

Blue-green algae

The blue-green algae inoculum is applied after transplantation of rice crops in the main field. The inoculum required is 10 kg/ha. For higher nitrogen fixation, 3 to 4 t/ha of farmyard manure and 200 kg/ha of superphosphate are applied.

Azolla

Azolla is applied to the main field as a green manure crop and as a dual crop. As a green manure crop, *Azolla* is allowed to grow on the flooded fields for 2 to 3 weeks before transplanting. Later, water is drained and *Azolla* is incorporated by ploughing in. As a dual crop, 1000 to 5000 kg/ha of *Azolla* is applied to the soil one week after transplanting. When a thick mat forms, it is incorporated by trampling. The leftover *Azolla* develops again and is trampled in as a second crop. For better growth of *Azolla*, 25 to 50 kg/ha of superphosphate is applied and standing water of 5 to 10 cm is maintained continuously in the rice fields.

Frankia

Frankia inoculation enhances the growth, nodulation, nitrogenase activity of nodules and nodule dry weight of *Casuarina* and *Alnus* plants.

Biofertilizer inoculants in Abroad

In Brazil, Argentina and in other South American countries, successful results have been achieved with the re-inoculation of soybean, i.e., the yearly inoculation even in soils presenting well-established compatible rhizobial population from previous inoculations. This practice led to the

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commercialization of over 70 million doses of inoculants for soybean in Brazil in the last crop season. Estimates in Brazil are that re-inoculation increases soybean grain yield by 8% in average and by 6.8% to 14% in Argentina. In the USA, re-inoculation is traditionally not recommended, based on results from a former study showing that rhizobial populations as low as 10 cells/g would inhibit the nodule formation by inoculant strains. However, mean yield increases due to inoculation considering areas of traditional soybean cropping have been recently estimated at 1.67%, but could probably be higher if high N-fertilizer levels were not applied to the crops comprising the soybean agricultural systems. Amazingly, even the most recent studies on the quantification of soybean BNF in the USA take into consideration a large number of sites, soil fertility, and application of mineral N, but not the re-inoculation component. Certainly, the annual re-inoculation is responsible for the high contribution of BNF to the soybean N nutrition in Brazil, with values as high as 94% of the aboveground N accumulation, while in the USA these values range from 23 to 65%.

The acidic, saline, and low organic matter of the SSA soils, the average soybean yield is usually well below the world average. Therefore, in addition to the soybean genetic breeding, further studies have been carried out aiming at increasing yields. For example, in Ethiopia, searched for acid-tolerant rhizobia as strategy to increase soybean performance. A local isolate was able to improve soybean yield, indicating that search for indigenous or naturalized elite isolates might represent an interesting strategy to be adopted in other African countries. Impressive yield increases have also been observed by combining application of P-fertilizer and rhizobial inoculant in Nigeria, and along with other studies suggest that P is probably the main limiting factor to the BNF in Africa (Rahimi, 2014)

Conclusion

Biofertilizers can help solve the problem of feeding an increasing global population at a time when agriculture is facing various environmental stresses. It is important to realize the useful aspects of biofertilizers and implement its application to modern agricultural practices. However, the lack of awareness regarding improved protocols of biofertilizer applications to the field is one of the few reasons. Biofertilizers lead to soil enrichment and are suitable with long-term sustainability. Further, they pose no danger to the environment and can be substituted with chemical fertilizers. The application of bio-fertilizers can minimize the use of chemical fertilizers, decreasing environmental hazards, enhance soil structure and promote agriculture. They play a key role in maintaining long term soil fertility and sustainability by fixing insoluble P in the soil into forms available to plants,

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thus increasing their effectiveness and availability. Biofertilizers are the alternative sources to meet the nutrient requirement of crops. In Biofertilizers, beneficial bacteria are Azotobacter, Azospirillium, Rhizobium, Mycorrhizae which are very essential in crop production. Biofertilizer can also make plant resistant to unfavorable environmental stresses.

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