

Biofertilizers and Methods of Application of Microbial Inoculants

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Biofertilizers are microbial inoculants or carrier-based preparations containing living or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing and cellulose decomposing microorganisms intended for seed or soil application and designed to improve soil fertility and plant growth by increasing the number and biological activity of beneficial microorganisms in the soil.

The advantage of application of biofertilizers /microbial inoculants to seed, soil or compost pit is to accelerate certain microbial processes increase the number and biological / metabolic activity of useful microorganisms that to augment the extent of availability of nutrients in the available forms which can be easily assimilated by plants. The need for the use of Biofertilizers has arisen primarily due to two reasons i.e. though chemical fertilizers increase crop productivity and production, but increased / intensive use of chemical fertilizers has caused serious concern of soil texture, soil fertility and other environmental problems, use of Biofertilizers is both economical as well as environment friendly it is not harm to ecosystem. Therefore, the Biofertilizers can't replace chemical fertilizers but supplement to Chemical fertilizers so an integrated approach of applying both chemical fertilizers and Biofertilizers is the best way of integrated nutrient supply in agriculture.

Biofertilizers, thus include i) Symbiotic nitrogen fixers *Rhizobium* sp. ii) non-symbiotic, free living nitrogen fixers *Azotobacter*, *Azospirillum* etc. iii) BGA- inoculants *Azolla-Anabaena*, iv) Phosphate solubilizing microorganisms (PSM) *Bacillus Pseudomonas*, *Penicillium Aspergillus* etc. v) Mycorrhiza vi) Cellulolytic microorganisms and Organic fertilizers. Organic fertilizers (manure, compost, vermicompost) are also considered as Biofertilizers, which are rendered in available forms due to the interactions of microorganisms or their association with plants.

Advantages of Biofertilizers

- Renewable source of nutrients
- Sustain soil health
- Supplement chemical fertilizers.

- Replace 25-30% chemical fertilizers
- PSB can provide 12-20 kg P₂O₅/ha/season
- Mycorrhiza can provide adequate P
- Increase the grain yields by 10-40%.
- Decompose plant residues, and stabilize C:N ratio of soil
- Improve texture, structure and water holding capacity of soil
- No adverse effect on plant growth and soil fertility.
- Stimulates plant growth by secreting growth hormones.
- Secrete fungistatic and antibiotic-like substances
- Solubilize and mobilize nutrients
- Eco-friendly, non-pollutants and cost-effective method

Methods of Application of Biofertilizers

Carrier based microbial inoculations are applied mainly three different methods.

- i. Seed treatment or seed inoculation
- ii. Seedling root dip
- iii. Main field application

Seed treatment or seed inoculation

One packet of inoculants is mixed with 200ml of rice gruel to make slurry, (or clamping material or Jiggery solution). The required for an acre are mixed in the slurry so as to have uniform coating of the inoculants over the seed and shade dried for 30 min. the shade dried seeds should be sown within 24 hrs. one packet of the inoculants (200 g) sufficient for to treat 10 Kgs of seeds.

Seedling root dip

This method is used for the transplanting crops. Two packets of inoculants are mixed in liters of water. The root portion of the seedlings required for an acre is dipped for 5-10 min and then transplanted.

Main field application

Four packets of inoculants are mixed with 20 Kg of FYM and then broadcast in one acre of field just before transplanting

Rhizobium: for all legumes, Rhizobium is applied as seed inoculants

Azospirillum/ Azotobacter: in the transplanted crops *Azospirillum* is inoculated through seed, seedling root dip and soil application methods. For direct sown crops, *Azospirillum* is applied through seed treatment and soil application.

Phosphobacteria: Inoculated through seed, seedling roots dip and main field application. The recommended dosage of *Azospirillum* is adopted for PSB inoculation. For combined application, both the biofertilizers as per the recommendation are mixed before using.

Method of application:

Point to remember: Bacterial inoculants should be mixed with insecticides, fungicides, herbicides and fertilizers; seed treatment with bacterial inoculants is to be last when seeds are treated with fungicides.

Application methodologies for AZOLLA biofertilizers

1. **Mechanical broadcasting:** Broad cast the dried BGA inoculant over the standing water in the field @10-20 kg/ha-1, 3-4 days after rice seedling transplanting.
2. **Half saturation technique:** Azolla is introduced @ an inoculum density of 0.5 kg fresh weight Azolla / m². Once Azolla has fully covered the area, half of the Azolla is transferred to new area of similar size.
3. **Dual cropping:** Seven days after transplanting, inoculate fresh Azolla @ 0.5-1.0

kg ha In 15- 20 days Azolla forms mat. Drain excess water and Azolla is mixed in soil.. On an average, one crop of Azolla produces 30 kg N ha Yield increase is equivalent to that of 30 kg of chemical fertilizers. Provides 60 kg N as green manure and 90 kg N and twice-dual cropping 90kg N.

Application methodologies for VAM biofertilizers

For transplanted crops like chilies, tomatoes, etc., VAM can be applied @ 2kg/Sq.m nursery bed and pre-colonized seedlings can be transplanted to the main field after 30 days.

For tree seedlings, raised in polythene bags, application of 25g/polybag (with 5 kg substrate) is recommended.

For perennial trees, and plantation crops like coconut, areca nut, pepper and grapes etc., one kg of VAM may be mixed with 10 kg FYM and the mixture may be applied around each tree.

Precaution for using bio-fertilizer

- Bio-fertilizer packets need to be stored in cool and dry place.
- Keep away from direct sunlight and heat.
- Right combinations of bio-fertilizers have to be used.
- Some bio-fertilizers are crop specific, it should be use for the specified crop only.
- Other chemicals should not be mixed with the bio-fertilizers.
- The packet has to be used before its expiry.

Table 1: Microbial Inoculants for Nitrogen fixation: field application methods of Bio-fertilizer in different crops

Crops	Recommended Bio-fertilizers for Nitrogen	Method of application	Quantity required /ha of each Bio-fertilizers	Time of application
Agriculture Crops				
Pulses				
Chickpea, Pea, Ground nut, Soyabeans, Beans	<i>Rhizobium</i>	Seed treatment	1.0-2.0kg	Sowing time
Lentil, Lucern, Berseem, Green Gram, Balck Gram, Cowpea, Pigeon pea, Guar	<i>Rhizobium</i>	Seed treatment	0.4-0.6kg	Sowing time
Cereals				
Wheat, Oat, Barley	<i>Azotobacter</i>	Seed treatment	1.0-2.0kg	Sowing time
Rice	<i>Azospirillum</i>	Seed treatment	2.0-3.0kg	Transplantation time
	<i>Blue Green algae</i>	Broad casting	10kg	After one week of transplanting
	<i>Azolla</i>	Dual crop	500-1000kg	After one week of transplanting

Oil Seeds				
Sunflower and castor	<i>Azotobacter</i>	Seed treatment	0.5-0.8kg	Sowing time
Mustard, Kusum, Sesamum, Linseed	<i>Azotobacter</i>	Seed treatment	0.2kg	Sowing time
Millets				
Perl Millets, Finger millets, Kodo millet	<i>Azospirillum</i>	Seed treatment	0.2kg	Sowing time
Maize and Sorghum	<i>Azospirillum/Azotobacter</i>	Seed treatment	0.4-0.6kg	Sowing time
Forage Crops				
Barmuda grass, Sudan grass, Napier grass, Guinea grass, Star grass, Rhodo grass	<i>Azospirillum</i>	Seed treatment	0.8-1.0kg	Sowing time
Fibre Crops				
Cotton	<i>Azotobacter</i>	Seed treatment	0.6-1.0 kg	Sowing time
Jute	<i>Azotobacter</i>	Seed treatment	0.8-1.0 kg	Sowing time
Sunhemp	<i>Rhizobium</i>	Seed treatment	0.8-1.0 kg	Sowing time
Sunflower and Castor	<i>Azotobacter</i>	Seed treatment	0.5-0.8 kg	Sowing time
Sugar Crops				
Sugarcane	<i>Azospirillum/Azotobacter/Acetobacter</i>	Soil/set treatment	4.0-5.0 kg	Sowing time
Sugarbeats	<i>Azotobacter</i>	Seed treatment	2.0-3.0 kg	Sowing time

Source: Millennium Biofertilizer Guide, Compiled by Rajnesh Jain, Delhi

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