Dosage: Suspension of one kg in 10 to 15 litre of water is sufficient for treating of seedlings for one acre.

Soil application: Mix 3-5 kg inoculant thoroughly with 50 kg finely powdered FYM. Broad cast this mixture at the time of last ploughing.

Phosphate Solubilizing Biofertilizers (PSB)

PSB can be used for all crops including paddy, millets, oilseeds, pulses and vegetables. Methods recommended for application are:

- Seed treatment
- Seedling dipping
- Soil application

Seed treatment: Same as described for *Rhizobium.*

Dosage: 10 kg medium size seeds such as groundnut, wheat, cotton, maize etc., may be treated with 200 g of inoculant, whereas 100 g per acre inoculant is enough for treatment of small size seeds.

Seedling dipping: This method is useful where the transplantation of seedlings are required. It is ideal for vegetable crops.

- Prepare the inoculant suspension in water in the ratio of 1:10.
- Dip the roots of seedlings in suspension and keep them immersed for about 5 minutes
- Take out the seedlings from the suspension and transplant as early as possible.

Dosage: Suspension of one kg in 10 to 15 litre of water for treating of seedlings for one acre.

Soil application: Mix 3-5 kg inoculant with 50 kg finely powdered FYM. Broad cast this mixture at the time of last ploughing.

Note : In case of PSB, best results are obtained when applied with well decomposed organic manure.

Tips for improving effectiveness of biofertilizers

- Biofertilizers should be stored in a cool place or at room temperature (25°C to 28°C for longer shelf life). The simplest method is to store in a pitcher containing wet paddy straw.
- Avoid direct contact with chemical fertilizers, insecticides and pesticides during storage or during application
- The storage and use of biofertilizers should be avoided in direct sunlight
- The inoculant should be used before the expiry date
- When fungicides and insecticides are to be used, apply fungicides before insecticides application. Apply biofertilizers after all other treatments. Give a gap of 24 h and double the dosage
- *Rhizobium / Bradyrhizobium* biofertilizer is specific to host plants, hence, only specific inoculant should be used for specific crop.

Scientists explaining the use of biofertilizer to farmers

Technology Transfer

The scientists at CRIDA have isolated and field tested efficient strains of biofertilizers of *Pseudomonas* (PSB) and *Bradyrhizobium* for dryland crops like sorghum, pigeonpea, groundnut through extensive farmer participatory trials. The institute has developed low cost production technology which can be adopted by non governmental organizations (NGO), small entrepreneurs and agricultural graduates trained through agri clinic schemes of the Government of India. Interested persons for training and technology transfer may contact the institute.

For further information contact:

Central Research Institute for Dryland Agriculture

P.O. Saidabad, Hyderabad-500 059. Ph.: 040-24530177, 24535336

BIRD-K, Zadcherla, Mahaboobnagar District, A.P.

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Biofertilizers in Rainfed Farming

NRSP
DFID Natural Resource System Programme

भाकृअनुप
ICAR

Central Research Institute for Dryland Agriculture

Santoshnagar, Hyderabad

Biofertilizers are low cost, renewable sources of plant nutrients which supplement chemical fertilizers. These are nothing but selected strains of beneficial soil microorganisms cultured in the laboratory and packed in a suitable carrier. They can be used either for seed treatment or soil application. Biofertilizers generate plant nutrients like nitrogen and phosphorous through their activities in the soil or rhizosphere and make available to plants in a gradual manner. Biofertilizers are gaining momentum recently due to the increasing emphasis on maintenance of soil health, minimize environmental pollution and cut down on the use of chemicals in agriculture. In rainfed agriculture, these inputs gain added importance in view of their low cost, as most of the farmers are small and marginal and can not afford to buy expensive chemical fertilizers. Biofertilizers are also ideal input for reducing the cost of cultivation and for practising organic farming.

Types of Biofertilizers

The following types of biofertilizers are available to the farmers in India.

- Nitrogen fixing biofertilizers eg. *Rhizobium, Bradyrhizobium, Azospirillum* and *Azotobacter.*
- Phosphorous solubilising biofertilizers (PSB) eg.*Bacillus, Pseudomonas* and *Aspergillus*
- Phosphate mobilizing biofertilizer eg. *Mycorrhiza*
- Plant growth promoting biofertilizers eg. *Pseudomonas*

How biofertilizers work?

- Biofertilizers fix atmospheric nitrogen in the soil and root nodules of legume crops and make it available to the plant.
- They solubilize the insoluble forms of phosphates like tricalcium, iron, and aluminium phosphates into available forms.
- They scavenge phosphate from soil layers.
- They produce hormones and anti metabolites which promote root growth.
- They decompose organic matter and help in mineralization in soil.
- When applied to seed or soil, biofertilizers increase the availability of nutrients and improve the yields by 10 to 25% without adversely affecting the soil and environment.

Application and use

While some biofertilizers can be used for all crops, some are crop specific. Depending on the biofertilizer, and the crop grown, different methods of application are adopted. In general, the performance of biofertilizers is more when used along with organic manures like compost. In rainfed farming, since moisture is limiting, best performance from biofertilizers can be realized when moisture conservation practices are adopted along with application of biofertilizers. The application methods for different biofertilizers are described below.

Rhizobium (Bradyrhizobium)

This biofertilizer is recommended for

- Pulse legumes such as bengal gram, red gram, pea, lentil, blackgram, greengram and cowpea
- Oilseed legumes like soybean and groundnut
- Fodder legumes like berseem and lucerne
- Tree legumes like *Acacia, Leucaena* and *Gliricidia*

The treatment of seeds with the slurry of *Rhizobium* inoculant is the most effective method of application.

- Prepare the slurry of required quantity of inoculant in sufficient water (generally 400-500 ml of water for 200 g inoculant). To prepare the slurry, boil 50 g gur in one litre of water and cool it.
- Pour this slurry over the heap of seeds to be treated. Mix the seeds thoroughly with hands. Now, spread the treated seeds over clean floor or on plastic sheet or on gunny bag and dry under shade.
- Sow the treated seeds as early as possible.

Application of Biofertilizer on seed

Dosage: 10 kg of normal size seeds such as moong, urd, arhar, cowpea, lentil and berseem may be treated with 200 g of *Rhizobium* inoculant by slurry method. Large size seeds such as groundnut, chickpea, soybean and pea, etc., require 400 to 500 g of inoculant for 10 to 12 kg of seeds. In case, the seeds are to be treated with fungicides, insecticides and bio agents, apply *Rhizobium* at the last. Apply *Rhizobium* 24 hr after treating with other chemicals.

Note: Best response for *Rhizobium* biofertilizer is realized when recommended level of phosphorous is applied to the legume crop.

Azospirillum

Azosprillum and *Azotobactor* can be used for most non leguminous annual and perennial crops. Sorghum, pearlmillet, maize and cotton are some examples. The methods of application are:

- Seed treatment
- Seedling dipping
- Soil application

Seed treatment: Same as described for *Rhizobium.*

Dosage: 10 kg medium size seeds such as wheat, cotton, maize etc., may be treated with 200 g of inoculant whereas, 100 g per acre inoculant is enough for treatment of very small size seeds such as mustard.

Seedling dipping: This method is useful where the transplantation of seedlings are required. It is ideal for vegetable crops. The method of application is:

- Prepare the suspension of required amount of inoculant in water in the ratio of 1:10.
- Dip the roots of seedlings in suspension and keep them immersed for about 5 minutes
- Take out the seedlings from the suspension and transplant as early as possible.

Chickpea seeds before (left) and after (right) treatment with biofertilizer