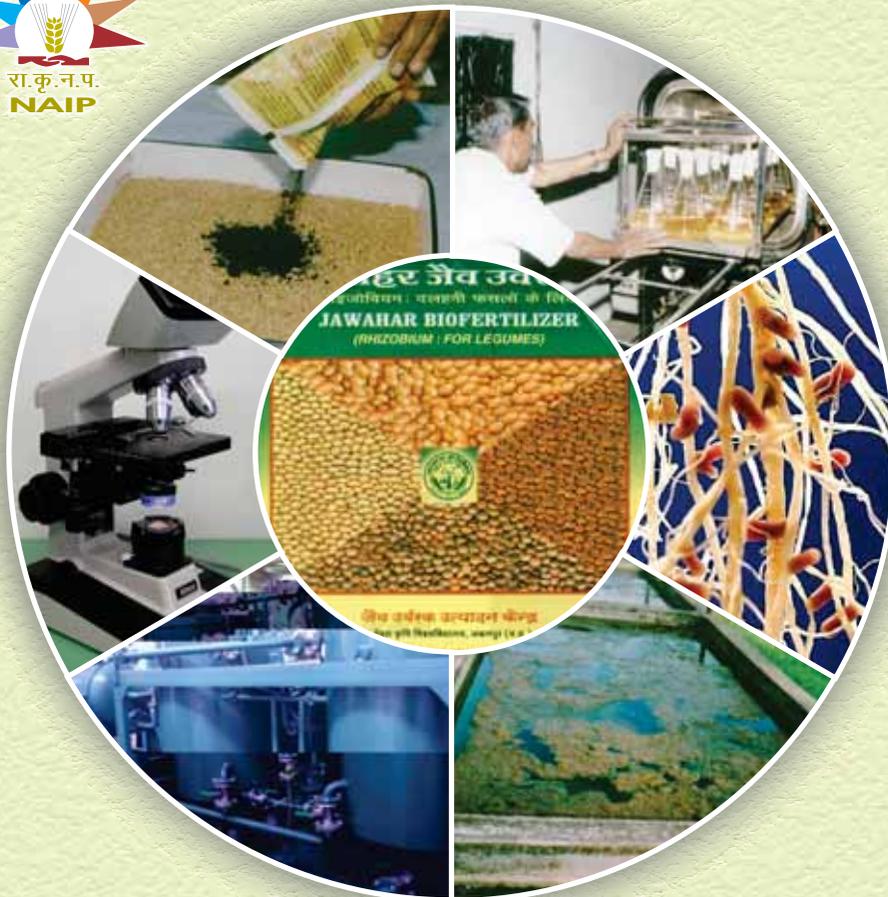


OPPORTUNITIES FOR BIOFERTILIZER INDUSTRY



Business Planning and Development Unit
National Agricultural Innovation Project
Jawaharlal Nehru Agricultural University
Jabalpur 482004 (Madhya Pradesh)

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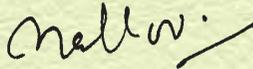


Prof. Gautam Kalloo
Vice Chancellor

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. It is the largest economic sector and plays a significant role in the overall socio-economic development of India. Despite India is one of the most prominent producers of so many food crops, the population is growing faster than its ability to produce staple foods of rice and wheat. However, in view to raise the productivity, entire dependence on chemical fertilizers would also mean imbalanced nutrition to crops, loss in soil health, possibilities of water contamination and burden on the fiscal system. Therefore, Integrated Plant Nutrient Management (IPNM) should be followed for sustainable agriculture with food security incorporating the use of biofertilizers and bio-pesticides.

The commercial production unit of biofertilizer has been established in the Vishwavidyalaya in 1976. Since then the unit has gained a reputation for supplying qualitative biofertilizers and now it is working as a branch of Business Planning and Development (BPD) unit in JNKVV sponsored by National Agricultural Innovation Project (NAIP) of ICAR funded by World Bank in the year 2009. Agripreneurs are being provided incubation services for BPD unit at JNKVV campus with the help of R&D facilities, technologies and knowledge available in the University. The present publication exhibited the necessary information on biofertilizers which ascertains to provide guidance to stakeholders in promoting biofertilizer business and the users in farming community.

Endeavour made by the team of BPD unit in compiling the information for benefit of the entrepreneurs and the farming community is in fact appreciable.


(Gautam Kalloo)

Foreword



Jawaharlal Nehru Krishi Vishwavidyalaya
Jabalpur 482004 (M.P.)



Preface



Dr. S.K. Rao

Principal Investigator, BPD Unit &
Director Farms

The green revolution brought impressive gains in food production but with insufficient concern for sustainability. In India, use of fossil fuel based chemical fertilizers is the matter of involvement of high inputs, a burden to the small hold farmers. Entire dependence on chemical fertilizers in crop production also threatens for disproportionate supplement of nutrients to crops and deterioration of soil health. Proportionate application of green inputs viz., biofertilizers and biopesticides is the spontaneous answer to alleviate to problem. However, it is difficult to estimate the total size of green inputs market in India because of its diversity in terms of products and also due to the nature of it being unorganized market.

Production of Jawahar Biofertilizers by the Biofertilizer Production Center, JNKVV, Jabalpur fulfil a substantial demand in Madhya Pradesh. The production unit manufactures a number of biofertilizers using beneficial microorganisms like *Rhizobium*, *Azotobacter*, *Azospirillum*, phosphate solubilising bacteria, *Trichoderma*, blue green algae, enriched bio-organics from EM cultures. Jawahar *Rhizobium* cultures are crop specific to various legumes under different cross inoculation groups.

This publication is prepared by the Business Planning and Development unit, JNKVV where biofertilizer technologies are available. Details of business support services and guidelines in this context are given in this booklet.

We hope that this booklet will help entrepreneurs in understanding the opportunities available in the Vishwavidyalaya for benefit of farming community and sustainable agriculture with food security.

S. K. Rao
(S.K. Rao)

**Jawaharlal Nehru Krishi Vishwavidyalaya
Jabalpur 482004 (M.P.)**



Business Planning and Development Unit

Business Planning and Development Unit is set up under National Agricultural Innovation Project (NAIP) in collaboration with Indian Council of Agricultural Research (ICAR), New Delhi at Jawaharlal Nehru Agricultural University (JNAU), Jabalpur to facilitate commercialization of the innovative agrotechnologies through agri-business development thereby benefitting the farmers.

Objectives

- Promotion of market responsive products and technologies through effective entrepreneurship development.
- Promotion of public private partnership for commercialization of technologies.
- Human Resource Development for entrepreneurship promotion.

Commercialization of Technology



Business Support Services of BPD-JNAU

BPD-JNAU is offering membership to individual entrepreneurs, cooperative societies, companies and other agribusiness ventures. By becoming a member of the BPD unit, seed production organizations/ companies/ societies/ individual can avail various business development services from JNAU, Jabalpur.

As a seed production and marketing organization they can get immense benefit by becoming a member. Besides priority access to breeder seeds of improved varieties on the basis of availability a host of other services would be provided on payment basis.

Business Incubation Services are being provided by the BPD Unit for agribusiness ventures in seed sector. All the services would be provided to the entrepreneurs against the payment of requisite fees.

Biofertilizer Ventures

JNKVV is having strong research base and developed technologies in Biofertilizers. Entrepreneurs can avail these technologies and produce high quality Biofertilizers to fulfill the increasing demand from farmers.

Support Services

- | Access to information on bio-fertilizers
- | Training program at JNKVV on Biofertilizers production technologies
- | Access to microbial mother cultures
- | Field visits by scientists
- | Access to programs and exhibitions conducted by BPD
- | Business plan preparation

Biofertilizers are defined as preparations containing living cells or latent cells of efficient strains of microorganisms that help crop plants' uptake of nutrients by their interactions in the rhizosphere when applied through seed or soil. They accelerate certain microbial processes in the soil which augment the extent of availability of nutrients in a form easily assimilated by plants. Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances. Biofertilizers can be expected to reduce the use of chemical fertilizers and pesticides. Bio-fertilizers are eco-friendly organic agro-input and more cost effective than chemical fertilizers. Bio-fertilizers like *Rhizobium*, *Azotobacter*, *Azospirillum* and blue green algae (BGA) are in use since long time ago.

Very often microorganisms are not as efficient in natural surroundings as one would expect them to be and therefore artificially multiplied cultures of efficient selected microorganisms play a vital role in accelerating the microbial processes in soil. Therefore, application of biofertilizers is recommended every year.

Benefits

- Microbial function is in long duration causing improvement of the soil fertility. It maintains the natural habitat of the soil.
- It increases crop yield by 20-30%, replaces chemical nitrogen and phosphorus by 25%, and stimulates plant growth. Hence it is supplementary to chemical fertilizers.
- It can also provide protection against drought and some soil-borne diseases.
- Biofertilizers are cost effective relative to chemical fertilizers. They have lower manufacturing costs especially regarding nitrogen and phosphorus use.
- It is environmentally friendly in that it not only prevents damaging the natural source but also helps to some extent cleanse the plant from precipitated chemical fertilizer.
- Organic fertilizers have been known to improve biodiversity (soil life) and long-term productivity of soil, and may prove a large depository for excess carbon dioxide.
- Organic nutrients increase the abundance of soil organisms such as fungal mycorrhiza, which aid plants in absorbing nutrients.
- Secrete certain growth promoting substances.
- Improve soil structure (porosity) and water holding capacity.
- Enhance seed germination.
- Increase soil fertility and fertilizer use efficiency and ultimately the yield of crops.

Precautions in handling and use of Biofertilizers

Introduction

The term 'Biofertilizer' itself denotes that, it is a 'Live Fertilizer'. The quality of biofertilizers demands in-depth the study of microbial characteristics, effective, consistency, precautions and limitations not only at laboratory and production level but at field level too.

- Store the packets of biofertilizers in cold place, away from direct sun or hot wind.
- Biofertilizers are very specific to be effective to the particular crop(s), please apply as recommended.
- Tear open the packets of biofertilizers only just before use, apply entire packet of biofertilizer in one application.
- Treat the seeds (seed coating) or seedling (dipping) under shade only.
- Avoid direct contact of chemical fertilizers and pesticides.
- In case of seed treatment with pesticides is essential, treat the seeds first with the pesticides followed by treatment of biofertilizer at the rate 2-3 time more of recommended dosage.
- Good quality biofertilizer is identified with the moisture content of 30-40%, as envisaged by formation of a clod in the fist, which breaks from a slight touch.
- For convenience in application of biofertilizers, in case of soil application, admix recommended dose of biofertilizer with 50 kg pulverized soil or 25 kg FYM and broadcast.
- Every biofertilizer responds better if soil is enriched with sufficient quantity of available phosphorus (apply superphosphate), organic matter (apply FYM), soil of neutral pH (apply lime).
- To obtain best effect, treatment with biofertilizers is advised 3-4 hour before sowing.

Source of availability

In-charge
Biofertilizer Production Centre
Jawaharlal Nehru Krishi Vishwa Vidyalaya
Adhartal, Jabalpur 482004, Madhya Pradesh
Phone: 0761-2681031, 2681119, 2681021
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Technologies available for Biofertilizer Industries

Technologies

Biofertilizer Production Centre (BPC) at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is working under ICAR initiated Revolving Fund since 1976. The centre has been launched to meet out heavy demand of various biofertilizers amongst farmers and small-scale cultivators of Madhya Pradesh as tabulated.

The biofertilizers produced by BPC are recognized as the best of its quality. It is the worthy outcome of recent and valuable researches in the field of microbiology under laboratory and field experimentations conducted by expertise hands. The products are supplied to the customers after various feedback microbiological qualitative / quantitative tests of the representative samples. It is supplied to the customers and the farmers as least cost input products.

Types of Biofertilizers produced

1. Jawahar *Rhizobium* Biofertilizer for legumes (separately for each type of cross inoculation group)
2. Jawahar *Azotobacter* Biofertilizer for non-legumes
3. Jawahar *Azospirillum* Biofertilizer for non-legumes
4. Jawahar Phosphate Solubilizing Biofertilizer for all crops
5. Jawahar BGA Biofertilizer for paddy crop
6. Jawahar *Trichoderma* for all crops (as BCA)
7. Jawahar Enriched Bio-organics for all crops

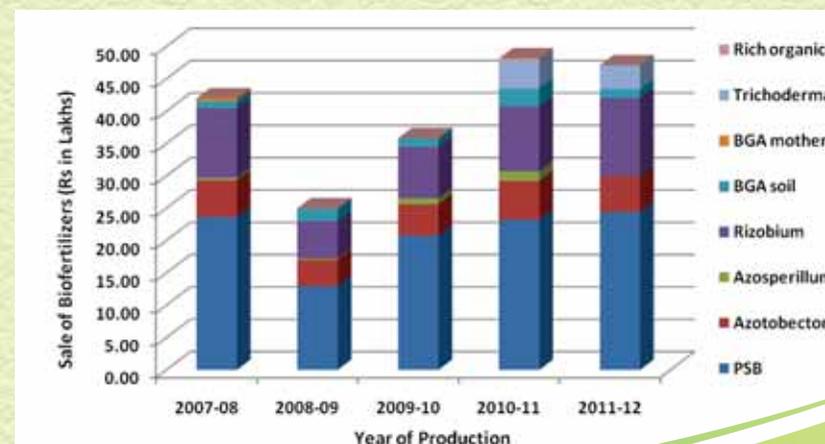
Purchasers (Agencies purchasing biofertilizers from BPC)

1. Farmer Welfare & Agriculture Development Department
2. MP State Marketing Society Federation Corp.
3. Krishi Vigyan Kendras, JNKVV
4. Research Stations, JNKVV
5. Farms, JNKVV
6. Farmers directly

Crop	Rhizobium	Azotobacter / Azospirillum	PSB	Total
Cereals	-	24,609	24,609	49,218
Pulses	4,593	-	13,779	17,372
Oil seeds	4,430	-	13,290	17,720
Fruits and vegetables	-	632	632	1,264
Total	9,023 (45.11)	25,241 (126.20)	52,310 (209.20)	86,574 (380.51)

- *Rhizobium*, *Azotobacter*, *Azospirillum* each 200 g and PSB 250 g per packet.
- Figures in parenthesis are million packets.

Biofertilizer Production (Pkts.) and Sell During Last Five Years (2007-012)



Soybean root nodules, each containing billions of *Rhizobium* bacteria

Rhizobia are soil bacteria that fix nitrogen (diazotrophs) after becoming established inside root nodules of legumes. Rhizobia require a plant host; they cannot independently fix nitrogen. All rhizobia that could form nodules on roots of certain legume types have been collectively taken as a species, i.e. cross-inoculation groups. This system of classification has provided a workable basis for the agricultural practice of legume inoculation. Under this scheme, seven species are generally recognized. Due to host specificity, rhizobial cell can penetrate the roots of the specific leguminous plants only and form nodules. Atmospheric nitrogen is fixed by rhizobia within the nodules.

JNKVV is producing different *Rhizobium* cultures for the different leguminous crops like gram, pigeonpea, mung, urid, pea, soybean, lentil, etc. Each *Rhizobium* culture is useful only for the crop mentioned on the packet. This culture should be applied by seed treatment only



Advantages

- The effective strain used in Jawahar *Rhizobium* culture increases the healthy nodulation and thereby nitrogen fixation (about 40 to 50 kg/ha).
- About 15 to 20% increase of crop yield can be achieved with the use of this culture.
- The residues of pulses (legume crops) left in the soil after harvesting the crop are also advantageous to the subsequent crops to be sown.

Dose

Seed Treatment (for one acre): 200 g / 10-15 kg seeds with light sprinkling of water.

Packing

200 g

Jawahar Azotobacter Culture

Azotobacter is a genus of free-living diazotrophic bacteria whose resting stage is a cyst. It is primarily found in neutral to alkaline soils, in aquatic environments, and on some plants. It has several metabolic capabilities, including atmospheric nitrogen fixation. *Azotobacter* spp. have the highest metabolic rate of any organisms. Therefore, soil-dwelling diazotrophs such as *Azotobacter* are especially useful in gauging the health and virility of the ground.

Azotobacter cultures are useful for the cereals and cash crops viz. wheat, paddy, bajra, jowar, maize, mustard, cotton, cumin, banana, sugarcane, tobacco, castor, vegetables etc., as well as horticultural crops.



Advantages

- The effective strain used in *Azotobacter* culture fixes about 20 to 25 kg atmospheric nitrogen per hectare.
- Certain growth promoting substances released by these cultures are useful for increasing the seed germination, plant growth and ultimately the yield.
- In certain condition they also exhibit anti-fungal activities and thereby fungal diseases may be controlled indirectly.
- About 10 to 15% increase of crop yield can be achieved with the use of these cultures.

Dose

- Seed treatment (for one acre): 200 g (1 pkt)/ 10-15 kg seeds with light sprinkling of water.
- Seedling root treatment (for one acre): 2-4 pkts culture per 15 litre water, deep the roots for 30 min before transplanting.
- Soil application (for one acre): 8-10 pkts culture admixed with 50 kg pulverized soil or 25 kg FYM and broadcast. The soil-culture mixture may be applied to soil near the roots of standing crop may be done.

Packing

200 g

Jawahar *Azospirillum* Culture

The cells of *Azospirillum* remain in association with the roots and fix part of the atmospheric nitrogen. Jawahar *Azospirillum* culture is useful for the cereals and cash crops viz. wheat, paddy, bajra, jowar, maize, mustard, cotton, banana, sugarcane, tobacco, vegetables, and horticultural crops etc.



Advantages

- The effective strain used in *Azospirillum* culture fixes about 15 to 20 kg N/ha.
- Certain growth promoting substances released by these cultures are useful for increasing the seed germination, plant growth and ultimately the yield.
- In certain condition, anti-fungal activities exhibited by this culture indirectly controls fungal diseases.
- Crop yield about 10 to 15% is increased with the use of this culture.

Dose

- Seed treatment (for one acre): 200 g (1 pkt)/ 10-15 kg seeds with light sprinkling of water.
- Seedling root treatment (for one acre): 2-4 pkts culture per 15 litre water, deep the roots for 30 min before transplanting.
- Soil application (for one acre): 8-10 pkts culture admixed with 50 kg pulverized soil or FYM and broadcast. This mixture can be applied to soil near the roots of standing crop.

Packing

200 g

Jawahar Phosphate Solubilizing Bacteria

Most of the cultivable soil being alkaline in nature contains less available phosphorus. Due to higher concentration of calcium, whenever phosphatic fertilizers are applied in such soil, the large quantity of it gets fixed as tri-calcium phosphate as it is water insoluble and hence becomes unavailable to the crop. Certain soil microorganisms have inherent capacity to dissolve part of the fixed phosphorus and make it available to the crop by secreting certain organic acids. Jawahar PSB culture are useful for all the crops i.e. cereals, cash crops, leguminous crops, horticultural crops, vegetables, etc.



Advantages

- The effective strain of PSB increase the level of available P_2O_5 in soil through its solubilization 30 to 40% of phosphate deposit.
- With the increase in available P_2O_5 level, overall plant growth can be increased.
- In certain condition they also exhibit anti-fungal activities and thereby fungal diseases may be controlled indirectly.
- About 10 to 15% increase of crop yield can be achieved with the use of this culture.

Dose

- Seed treatment (for one acre): 250 g (1 pkt)/ 10-15 kg seeds with light sprinkling of water.
- Seedling root treatment (for one acre): 2-4 pkts (0.5-1 kg) culture per 15 litre water, deep the roots for 30 min before transplanting.
- Soil application (for one acre): 4-8 pkts (1-2 kg) culture admixed with 50 kg pulverized soil or 25 kg FYM and broadcast. This mixture can be applied to soil near the roots of standing crop.

Packing

250 g

Trichoderma is a genus of fungi that is present in all soils. Many species in this genus can be characterized as opportunistic avirulent plant symbionts.

Several strains of *Trichoderma* have been developed as biocontrol agents against fungal diseases of plants. The various mechanisms include antibiosis, myco-parasitism, inducing host-plant resistance, and competition. Most important biocontrol agent is from the species *T. viride*. The biocontrol agent generally grows in its natural habitat on seed and root surfaces, and so affects root disease in particular, but can also be effective against foliar diseases.



Trichoderma viride woolly growth



Advantages

1. **Disease Control:** *Trichoderma* is a potent biocontrol agent and used extensively for disease control. It has been used successfully against various pathogenic fungi belonging to various genera, viz. *Fusarium*, *Phytophthora*, *Scelerotia*.
2. **Plant Growth Promoter:** *Trichoderma* strains solubilize phosphates and micronutrients. Its application increases the number of deep roots, thereby increasing the plant's ability to resist drought.
3. **Biochemical Elicitors of Disease Resistance:** *Trichoderma* strains are known to induce resistance in plants. The compounds produced by *Trichoderma* induce resistance in plants. These compounds also induce ethylene production, hypersensitive responses and other defence related reactions in plant cultivates.
4. **Bioremediation:** *Trichoderma* strains play an important role in the bioremediation of soil that are contaminated with pesticides and herbicides. They have the ability to degrade a wide range of insecticides: organochlorines, organophosphates and carbamates.

Dose

- Seed treatment (for one acre): 250 g / 10-15 kg seeds with light sprinkling of water.
- Soil application (for one acre): 1-2 kg (4-8 pkts)/acre is mixed with 50 kg pulverized soil or FYM or compost and broadcast. This mixture can be applied to soil near the roots of standing crop.

Packing

250 g

Jawahar Enriched Bio-organics

Jawahar Enriched Bio-organics (Rich Organics) contains well-matured organic matter and growth promoting substances of biological origin. It contains major, minor and trace elements available in a form that facilitates its entry into the plant system in totality like chelated nutrients. It has free living nitrogen fixing and phosphate solubilizing microorganisms to benefit plants. It contains bio-stimulants that boost up plant vigour / vegetative growth, flowering, fruiting and yield of crop as targeted by the producer.

Advantages

1. Improves soil structure and better tilth.
2. Better soil aeration and water percolation, reducing soil erosion.
3. Increases water and nutrient holding capacity.
4. Provides reserve plant nutrients.
5. Helps in supply of growth promoting substances.
6. Contributes to better taste and flavor of produce.
7. Provides PSM, root nodule bacteria, nitrobacter, etc.
8. Prevents nutrient loss and improves fertilizer usage efficiency.
9. Minimizes the toxic effect of chemical fertilizers, while complementing the use of chemical fertilizers.
10. Serves as major food source for microbial population thus keeping the soil alive.
11. It is weed free and pathogen free.
12. Prevents micro-nutrient deficiencies in plants.
13. Better root and tiller growth, maintain plant health, vigour and green colour.
14. Increases crop yield by 20-40%, with the increase of grain yield 10-30%
15. It is unique natural organic manure.
16. The rate of application is very less 1/10th as that recommended for ordinary organic matter / compost.
17. Direct Manurial value of rich organics is about 400% better than normal cow-dung.
18. Rich organics is almost a complete balanced plant food.

How to apply?

- Rich Organics should be mixed well into the top 20-25 cm layer of soil. This is the area where active growth and development of roots take place.

When to apply ?

- Normally, it should be applied at the time of soil / land preparation.
- However, inter-row application can also be done. In case of perennials (like fruit trees), Aug, Sept. (after monsoon rains) is the best time to apply Rich Organics.
- Rich Organics creates the right kind of conditions for faster germination and establishment of the root system. Hence, the application of Rich Organics is done prior to seed sowing or raising of seedling / transplanting will have remarkably good results.
- Ideally Rich Organics is recommended to apply every year.

How much to apply – the Dosage

Cash crops : 0.5 to 2.0 tonnes per acre.
Perennial plants : 5 to 10 kg per plant.
Ornamental plants : 0.5 to 1.0 kg per plant.
Nurseries and lawns : 2 to 3 kg per square metre.
For Forests Plants like teak, pines, etc.: 5 - 10 kg. per plant, after rains.
However, the dosages may vary based on the fertility status of the soils. Rich Organics gives best response to light textured soils poor in organic matter and microbe content to reap rich dividends. Admix Rich Organics with adequate quantity of soil and apply before last ploughing.

Packing

1 kg

Technologies



Jawahar BGA Culture

Blue Green Algae, in symbiotic association with water fern belonging to *Azolla* species, fixes atmospheric nitrogen in the soil. *Nostoc* and *Anabaena* are the two popular species of blue green algae. Jawahar BGA culture incorporates cyanobacteria *Anabaena* in major. It can contribute over 100 kg of nitrogen per hectare per crop like paddy under low land conditions. Hence algae is an excellent association to supply nitrogen in low lying areas.

Blue-green algae are actually a type of bacteria that is known as cyanobacteria. In their aquatic habitat, cyanobacteria are equipped to use the sun's energy to manufacture their own food through photosynthesis. Cyanobacteria tend to proliferate in large population in very slow moving or still fresh water at appropriate conditions of temperature and nutrient availability. This explosive growth is popularly referred to as a bloom.

Cyanobacteria are one of the few microorganisms that can convert inert atmospheric nitrogen into a usable form, such as nitrate or ammonia. The production of rice has benefited from the fertilization capability of this microorganism.

A composite culture of BGA having heterocystous *Nostoc*, *Anabaena*, *Aulosira* etc. is cultured as primary inoculum in trays, polythene lined pots, and cemented pits. Later it is supplied for mass multiplication in the field for application as soil based culture to the rice growing field at the rate of 10 kg/ha (4 kg/acre).

Advantages

1. Cheap source of nutrients, nitrogen 20-30 kg/ha.
2. Suppliers of micronutrients.
3. Supplier of organic matter.
4. Counteracting the negative impact of chemical fertilizers.
5. Secretion of growth hormones.
6. Improves soil health by increasing water holding capacity, nutrient status particularly for nitrogen, organic carbon, and micronutrients.
7. It increases crop yield by 10-20%.

How to apply BGA culture

1. Jawahar BGA culture is applied within 7 days of paddy transplantation, as BGA grows well in presence of vegetation like paddy. The field should contain 8-10 cm of stagnant water (80-100% moisture). BGA soil based culture should be broadcasted @ 10 kg/ha (4 kg/acre).
2. Blooms of BGA flourish better when the field receives application of superphosphate at recommended dose or at least one third of the recommended dose.
3. After broadcasting of BGA culture, the water in the field should be stagnant upto 8-10 cm without disturbance or flowing for next 10-15

days, compact soil surface is better in this context.

4. On appearance of green algae, spray 0.05% of copper sulphate solution.
5. On infestation of insects, spray malathion or nuvan (@ 1 ml/litre), accordingly.
6. To achieve better crop growth, application of one third recommended dose of nitrogen (as urea) is advised.
7. The field receives BGA culture inoculation continuously for 3-4 years, need not require BGA culture for coming years.
8. Soils highly acidic are advised to amend with lime, as GBA thrives well in condition of neutral soil reaction (around pH 7).

Dose

- Broadcast (for one acre): 4-8 kg (2-4 pkts)/acre
- For even application, mix the culture with 10-15 kg pulverized soil or FYM per acre area and broadcast.

Packing

2 kg (soil based BGA culture)

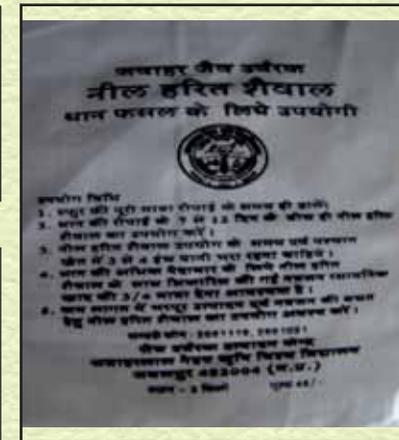
Technologies



Bloom of blue green algae flakes in pit



Powdered blue green algae flakes



Future Thrust for Commercial Production of Bio-control Agents

Future Thrust

Following is a list of microbial biocontrol agents with its target pests and pathogens. The culture production centre aims to produce these biocultures commercially in near future.

S. No.	Name of microorganism	Type	Target organisms	Mode of action
1.	<i>Trichoderma</i> sp. (<i>T. viride</i> , <i>T. harzianum</i> , <i>T. hamatum</i>)	Fungus	Soil borne pathogenic fungus	Eroding cell wall by degrading enzymes
2.	<i>Beauveria bassiana</i>	Fungus	Thrips, whiteflies, aphids and different beetles	Causing white muscardine disease
3.	<i>Metarrhizium anisopliae</i>	Fungus	white grubs, brown leaf hoppers of paddy, pyrilla of sugarcane, green semi looper, citrus mealybugs, tobacco cutworms and many more	Causing green muscardine disease
4.	<i>Nomureae rileyi</i>	Fungus	Aphids, root aphids (on grape vines), thrips, mealy bugs, jassids, leaf hoppers, whiteflies, leaf rollers, leaf miners, cutworms, chaffer beetles (scarabids), etc.	Gradually paralyzing and thus killing
5.	<i>Verticillium</i> sp. (<i>V. lecanii</i> , <i>V. chlamyosporium</i>)	Fungus	Mealybugs, mites and aphids.	Pathogenesis and consumption of internal organs of the insects
6.	<i>Paecilomyces lilacinus</i>	Fungus	Root-knot and cyst nematodes and their eggs	Entrance by secreting enzymes proteases and chitinase, followed by aggressive pathogenesis

Future Thrust for Commercial Production of Bio-control Agents

Future Thrust

S. No.	Name of microorganism	Type	Target organisms	Mode of action
7.	<i>Hisutella thompsnii</i>	Fungus	Insects and nematodes	Host mortality appears to result from invasion of tissue by the fungal hyphae, while no toxicogenic activity.
8.	VA mycorrhiza	Endo-mycorrhiza (root associated fungus)	P / Zn solubilization in soil and sugar-water / mineral exchange	Both physical and chemical
9.	<i>Bacillus subtilis</i>	Bacteria (Gram-positive)	Fruit rot fungal diseases caused by <i>Monilinia fructicola</i> , <i>Botrytis cinerea</i> , <i>Glomerella cingulata</i> . Some strains produce insect toxins	Peptide antibiotics (Iturin) against fungus and insects.
10.	<i>Pseudomonas fluorescens</i>	Bacteria (Gram-negative)	It cures plant diseases like damping off, scab, root and stem rot and blights caused by <i>Fusarium</i> or <i>Pythium</i> and some phytophagous nematodes. It also helps plants absorb phosphorous and works as catalyst for <i>Trichoderma viride</i> .	It is antagonistic to foliar or rhizosphere bacteria and fungi through the production of siderophores and antibiotics
11.	<i>Ampelomyces quisqualis</i>	Fungus	Although it is specific to powdery mildews, but has an extremely broad host range of important plant pathogens. It has been recorded on more than 64 species in the genera <i>Brasilomyces</i> , <i>Erysiphe</i> , <i>Leveillula</i> , <i>Microsphaera</i> , <i>Phyllactinia</i> , <i>Podosphaera</i> , <i>Sphaerotheca</i> , and <i>Uncinula</i> .	The mycoparasite directly its reproductive bodies, pycnidial formation begins and the infected cells soon die. Secondary cycles of infection result from conidia released during subsequent rain events.

Future Thrust for Commercial Production of Bio-control Agents

Future Thrust

S. No.	Name of microorganism	Type	Target organisms	Mode of action
12.	Nuclear polyhedrosis virus (NPV)	Baculovirus	Predominantly moths and butterflies which susceptible to contraction.	The virus is ingested by the feeding larva and the protective protein matrix is dissolved in the alkaline insect midgut, releasing the virus particles. These pass through the peritrophic membrane and invade midgut cells by fusion with the microvilli. The virus particles invade the cell nuclei, where they are uncoated and replicated. The feeding caterpillars that become pale and start dying within 2-5 days in the characteristic "head down" position, hanging on only with their abdominal pro_legs.
13.	Entomopathogenic nematodes (EPNs)	Simple roundworm	More than 90% of insects, including many pest species, have at least one stage (specially larval or pupal) of their lifecycle in the soil.	The nematodes enter the insect host through body openings. They multiply within the host and release a symbiotic bacterium carrying in their intestines whose toxin kills the host by blood poisoning. More than one generation of nematodes may develop in dead host insect in the media. The infective juveniles then exit the dead body and search for new hosts to infect
14.	<i>Bacillus thuringiensis</i>	Bacteria (Gram-positive)	Cry toxins of the bacteria have specific activities against insect species of the orders Lepidoptera (moths and butterflies), Diptera (flies and mosquitoes), Coleoptera (beetles), hymenoptera (wasps, bees, ants and sawflies) and nematodes.	Once the bacteria or its endospores are ingested by insects or larvae and the toxins are solubilized, it forms pores in the midgut epithelium. The infected host losses its appetite and die due to starvation.



Jawaharlal Nehru Agricultural University Business Planning and Development Unit Membership Form

Organization Name: _____

Organization Category: Individual/SHG/NGO/Start-Ups/Cooperative/
Producer Companies/Pvt Ltd / Public Ltd. / MNCs

Major products/business area: _____

Contact Name: _____

Address: _____

City: _____ State: _____ PIN Code: _____

Phone: _____ Fax: _____

Email: _____

Website address: _____

Areas of interest for collaboration and business support services: _____

Membership Fee:

Categories	A	B	C
Entrepreneur profile	SHGs, Individual Farmers who wants to start their business ventures	Cooperatives, NGOs, Start-ups	Public/Private Limited/Multinational companies
Membership Fees (Rs.)	2,000	10,000	50,000
Renewal Fees	1,000	5,000	10,000
2nd year onwards (Rs.)			

Payment Mode: Bank Demand Draft in favor of "BPD-JNKV R/F Account" payable at Jabalpur

Payment Details: DD No. : _____ Date of Issue: _____

Issuing Bank: _____

Please return this form to:

Dr. S.K. Rao

Principal Investigator, BPD Unit & Director Farms
Directorate of Farms

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Tele-fax: 0761-2681021

E-mail: s.k.rao@bpd-jnkvv.org

Website: www.bpd-jnkvv.org ; www.jnkvv.nic.in

Membership

Privileges of Membership

Membership

Categories	A	B	C
Entrepreneur profile	SHG's, Individual Farmers who want to start their business ventures	Cooperatives, NGO's Start-ups	Public/Private Limited/Multinational companies
Membership Fees	2,000	10,000	50,000
Renewal fees after from second year onwards (Rs.)	1,000	5,000	10,000
Services			
Technology Information Brochure	Free	Free	Free
Meeting with Scientists	Eligible	Eligible	Eligible
Promotion of products and services of the member in the events participated by BPD	Yes	Yes	Yes
Promotion through BPD website	Contact details	One page	One page and display of company logo in the homepage of the website
Invitation for attending events conducted by BPD unit	Yes		
Discount in training programmes	Not Applicable	Applicable once in a year	Application in all training programmes conducted by BPD
Access to breeder seeds	Improved varieties of field crops and vegetables		
Access to parent lines of hybrids	Not Applicable	Not Applicable	Not Applicable
Business Plan Preparation/Consulting Services	Will be provided with a fee which will be decided case to case basis.		

Terms and Conditions:

1. Membership fees have to be paid by Demand Draft only.
2. Services to be provided to members may be revised and would be informed to the members.
3. If there are disputes related to any particular term or condition will be sought first through mutual discussion. Any controversy, claim, or dispute arising will be settled the legal jurisdiction of Jabalpur only.



For further details, please contact

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