Biofertilizer Newsletter (BFNL) is a bi-annual publication under National Project on Organic Farming, Ministry of Agriculture, Government of India. BFNL is registered with Indian Scientific Documentation Centre. Scientific articles, extension news, results of field trials, information about recent events and review of books are especially welcome. Regarding articles, opinion expressed in BFNL is that of the author(s) and should not be attributed to this Centre. Acceptance of manuscripts for publication in BFNL shall automatically mean transfer of copyright to Biofertilizer Newsletter.
National Centre of Organic Farming, Ghaziabad and its seven Regional Centres at Ghaziabad (at HQ) Bangalore, Bhubaneshwar, Panchkula, Imphal, Jabalpur and Nagpur are presently playing major role in implementing the objectives of National Mission for Sustainable Agriculture in India. At present Indian agriculture production is declining due to non judicious use of synthetic fertilizers and chemicals. The soil organic carbon content of soil has reached critically low level. It is essential to improve the organic matter content in soil in order to improve soil carbon contents and other minerals required for high crop production. The use of organic products like biofertiliser, farm yard manure, compost, vermicompost and other organic input application to soil are recommended. Increasing soil organic carbon and soil fertility is primary concern. Application of biofertiliser like nitrogen fixing organisms, phosphorus solubilizing bacteria, potassium mobilizers, sulphur mobilizers and waste decomposers is not only increase soil health, fertility status but also promote crop growth by suppressing disease pathogens. Biofertilisers have a great potential in improving soil health conditions and sustainable agricultural production. Presently in the market solid and liquid carrier based different biofertilizer formulation products are available. Presently the liquid formulations of biofertiliser have been developed by various institute and organizations gaining more importance due to long shelf life and high population. Increase in crop growth and production is observed when applied these biofertiliser through seed or irrigation or soil application. It has been scientifically proven application of biofertiliser to soil has a beneficial to both crop plants and soil. Thus understanding the beneficial effects of biofertiliser microbial inoculants on different crops, identification of new fast growing strains, formulations of novel biofertiliser, and its application is subject of curiosity around the world. Thus government of India is making serious efforts to fill this gap by introducing new schemes and policies.

In the present issue article on NPK-LIQUID BIOFERTILIZER is continued article from previous issue is presented apart from this other columns are as usual.

I wish this edition will helpful to the researchers, scientists, administrators, farmers, industrialists and others to understand the importance of biofertilisers in agriculture.

Dr. Krishan Chandra
Chief-Editor
**Appeal to Readers**

Welcome readers – now you have opportunity to participate and be interactive with this publication.

All the time the readers are made to read whatever is published and there is no way to understand the level of satisfaction the readers come to attain after going through its contents on publication of an issue. We think that reader's views are quite important to consider. The news / information being disseminated through this publication should have a reflection from the readers to complete the process of communication and to enable the readers to communicate if they expect any special reference or material. The choice of the readers should always be kept in mind while making efforts to give latest news / information on the subject. Thus to make it interactive, more informative and readers friendly we think that creating this column is quite important.

We welcome the communication from our valued readers for this column. The communication may contain views of readers on importance of material published and its extent of advantages to them beside the material they think to be given consideration for publication in the issue. The feedback so received from the readers would not only be accommodated in this column but also it would be considered to assess it if found significant to further improve the quality of material to be published. The communication may also be information about a particular event, news or literature on biofertiliser in the locality of the readers which could turn advantageous to other readers. Thus an interaction could be established among the readers through this publication. This would also inspire the others readers to be interactive and share their views / information and news which we think would ultimately benefit the all the stake holders including farmers.

With this we again welcome the letters from the readers addressed to the editor. The readers must write their complete name and communication address, mobile no. and e-mail IDs while making communication with us for this column.
NPK-LIQUID BIOFERTILIZERS (Poly Culture)

Dr. Krishan Chandra
Director, National Centre of Organic Farming, Ghaziabad, India

Continued...
The comparative study of shelf life of Azospirillum, PSM and KSM in combined form in NPK liquid formulation source. Azospirillum retained maximum count i.e. $1 \times 10^8$ upto 12 month, whereas at 14 months, it reduced drastically and viable count is about $10^6$. Azotobacter ensures the shelf life is upto 12 months and retained the maximum bacteria $1 \times 10^8$. The PSM and KMB bacteria in liquid NPK retained their count upto $10^8$ upto 12 months. The survivability of potash and phosphorus is more. Rhizo(F) - Rhizobium fast grower Vigna uguiculata (Cowpea); Rhizo(S) - Rhizobium slow grower Glycine max (Soyabean). Slow grower Rhizobium retain count upto $10^8$ upto 8 months. Whereas, fast grower survive upto 3 months retain same count. However, it has not been considered as the maximum benefits in the field was noted up to one year of use, except with Rhizobium combination.

QUALITY CONTROL OF NPK-PRODUCT

5.1 Introduction
At present, there is insufficient knowledge and understanding of the responses of NPK liquid mixture culture standard so the author is maintaining $10^8$ cells of each type of bacteria in the formulation so as to perform under all conditions.

5.2 Cell count by optical density
The optical density of a bacterial suspension is generally correlated with the number of cells it contains. Optical density measurements are a simple and convenient estimate of cell numbers as they require but little manipulation and aseptic condition need not be observed.

Dilute 10 ml of the NPK fully grown culture to 10, 20, 40, 60 and 80% of its original concentration. Use NPK without grown broth to zero the instrument. Measure the light absorbed by each concentration with a spectrophotometer at a wavelength of 540 nm. Relate the different concentration to the actual cell count obtained with the Petroff-Hausser chamber by plotting the optical density (O.D.) against the total cell number. This method also has its limitations. It is best suited for initially clear media. Dead cell and contaminants contribute to the O.D. of the culture, as well as gum produced by the NPK - bacteria, undissolved salt or precipitate in the medium.

5.3 Determining the number of viable cells in a culture by plating methods
Make serial dilution of the NPK broth culture. Based on the total count, the number of viable cells will probably be around $1.0 \times 10^8$ cells/ml of each N, P, K bacteria. To achieve this concentration, set out 8 tubes each, containing 9 ml of sterile diluent (pH 6.8). One ml of broth culture is diluted in steps, tenfold each time ($10^{-1}$ through $10^8$).

Use a fresh pipette for each strain and for each dilution in the series. Begin with the highest dilution in the series. With the aid of the suction bulb, fill and empty the pipette by sucking in and out 5 times with the diluted culture, then transfer 1 ml aseptically to sterile Petri dish of respective medium. Open the Petri dish only sufficiently to allow the pipette to enter and deliver the sample. Flame the pipette briefly (but avoid overheat) by passing it through the Bunsen burner flame each time prior to successive removal of aliquots for replication (2 per dilution) from the
same tube. Similarly with the same pipette remove 1 ml aliquots in duplicated from the 10-7 and 10-6 dilutions into more Petri dishes.

**5.3.1 Pour plates method**

Pour 15-20 ml each in their respective medium (kept melted and equilibrated at 50°C in a water-bath) aseptically onto each of the cell suspensions in the Petri dishes. To disperse the cells evenly, gently move each Petri dish clockwise and and counterclockwise allowing an equal number of swirls in each direction. To further ensure uniform dispersion of the cells, move the Petri dish three times forward and backward, then to the left and right. Allow the agar to set, invert the dishes and incubate at 26°-28°C. Read the plates after 3-5 days. Prepare serial dilutions of N, P, K bacteria. Make pour plates with dilutions 10^{-8}, 10^{-7} and 10^{-6} in duplicates. Incubate the plates for 3-7 days, checking daily during the incubation. Count the colonies develop in the agar medium on the surface.

Multiply the average number of colonies by the dilution-factor. If the average number of colonies at 10^{-7} dilution is 30, then the original broth culture had a concentration of:

\[
\text{(number of colonies) x (dilution factor) x (vol. of inoculum)}
\]

\[
= 30 \times 10^7 \text{ cells per ml}
\]

\[
= 3.0 \times 10^8 \text{ cells per ml}
\]

**5.3.2 Spread-plate method**

A similar technique called the spread-plate method is also commonly used. Use the same serially diluted samples of NPK — product prepared for the pour plate method above. Begin with the 10-7 dilution and deliver 0.1 ml of the sample into each of 4 plates of each N,P,K bacteria previously dried at 37°C for about 2 hours. Using the same pipette, dispense 0.1 ml samples from the 10-6 and 10-5 dilutions, in that order. Prepare a glass spreader by bending a 20 cm glass rod of 4 mm diameter to the shape of a hockey stick, dip it in alcohol, and flame; then cool the spreader by touching it to the surface of a separate respective medium agar-plate. Lift the cover of each Petri-dish just enough to introduce the spreader and place it in position on the agar surface. Spread the sample evenly over the agar surface, sterilizing and cooling the spreader between samples. Incubate as before; calculate the number of viable cells as outlined for the pour plate method, adjusting for the smaller volume that was plated (0.1ml instead of 1.0 ml).

**5.3.3 Drop plate method**

Both of the above methods are lengthy and require a large number of Petri dishes. A variation known as the Miles and Misra drop plate method is more rapid and consumes less material. Use agar plates which are at least 3 days old or have been dried at 37°C for 2 hours. Radially mark off 8 equal sectors on the outside bottom of the Petri dish (pre sterilized with equal section divided Petri dishes are now available in market). Label 4 sectors for replications of one dilution and 4 for another, allowing two dilutions per plate.

**5.4 Gram stain of culture**

For quick testing of contamination in the broth media the gram staining is a useful common method to follow.

**SOLUTION FOR STAIN**  
(Vincent, 1970)

<table>
<thead>
<tr>
<th>Solution I</th>
<th>Crystal violet solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystal violet</td>
<td>10 g</td>
</tr>
<tr>
<td>Ammonium oxalate</td>
<td>4 g</td>
</tr>
<tr>
<td>Ethanol</td>
<td>100 ml</td>
</tr>
<tr>
<td>Water (distilled)</td>
<td>400 ml</td>
</tr>
</tbody>
</table>
Solution II: Iodine solution
- Iodine: 1g
- Potassium iodide: 2g
- Ethanol: 25 ml
- Water (distilled): 100 ml

Solution III: 95% Ethanol

Solution IV: Counter stain
- 2.5% Safranin (in C₂H₅OH) 10 ml
- Water (distilled): 100 ml

Carbol Fuchsin Stain
- Basic fuchsin: 1 g
- Ethanol: 10 ml
- 5% phenol solution: 100 ml

The fuchsin stain should be diluted 5-10 time with distilled water before use.

(All above chemicals are readily available in diluted form for ready to use)

DETERIORATION OF NPK-FORMULATION

There are many causes of deterioration of bacteria, because they have live components and complex proteins, such as crystal toxic and polyhedron NPK-formulation needs more attention otherwise it start deterioration at the different stages of production, storage and transport. The principal causes of deterioration are high temperature, length of time of exposure to causative factors, presence of free water (as opposed to molecularly bound water), adverse pH, enzymes (particularly proteases), surfactants and combinations of these factors. Some substances, e.g., certain sugars and amino acids, stimulate bacterial spores to germinate and lose their innate resistance to adverse factors. Some time elapses between stopping the production process and preservation by drying. Deterioration in fermenter liquors can be minimizes by cooling and lowering pH to a minimum of 6.0-6.9 to curb not only dissolution of the NPK-bacteria. However, it is recommended us of buffering at pH 6-6.5 by addition of food grade stabilizers, e.g., ascorbic acid, to simultaneously prevent growth of contaminant microorganisms. The above conditions established during stabilization and harvest allow stable shelf storage of NPK — microbes for 12-18 month to many years, depending on formulation type. Formulation counteracts most cases of deterioration by using a series of additive.

ADVANTAGES OF NPK-LIQUID BIOFERTILIZERS

Their advantages over conventional carrier based biofertilizers are listed below:

- Longer shelf life — up to 12 months.
- Better survival on the seed/soil.
- Cost and manpower savings on carrier materials, pulverization, neutralization, sterilization, handling, storage and transportation, etc.
- High populations can be maintained more than 10-8 cells /ml up to 12 months of each bacteria.
- Nil contamination.
- Superior in quality and performance minimum 10 times less dose required than carrier base 3 times less to liquid individual base product.
- Convenient of handling, storage and transportation.
- Quality control protocols are easy and quick.
- Easy to use by the farmer.
- High commercial revenues.
- Greater potential to compete with indigenous microbes.
- Export potential.

Azotobacter and Azospirillum cultures synthesize considerable amount of biologically active substances like vitamins, nicotinic acid, parthoghinic acid, indole acetic acid gibberellins. All these hormones/chemicals help plants in better germination, early emergence, and better root development. In NPK-formulation presence of these chemicals provide quick response within 5 days of use change in crop can be observed.
APPLICATION OF NPK-LIQUID BIOFERTILIZER

8.1 INTRODUCTION
Some beneficial organisms have been very effective in the laboratory only to fail at some stage in the field, even after development of a product for marketing. Common causes of this demise are poor stability of the product during storage prior to application, too little active material actually reaching the field target, and rapid degradation of the active material on the target. Formulation plays a vital role in helping to solve these problems and in making an organism effective in practice. However, this must be achieved in a cost-effective manner if the final product is to survive commercially.

In these the organism is carried in a liquid, normally water. Addition of surfactant and emulsifier to water forms drops of more even size than those of water alone, with consequently better controlled spray. Low volume is preferred in areas where water is scarce, because they reduce the volume and weight to be transported and the time needed for application. Higher volumes are aimed at providing complete wetting of a target surface. With microbial, results have varied but this may be due to a lack of attention to efficient application. Reduction of volume increases the need to optimize spray droplet size to maximize coverage of the target. Coverage is influenced by droplet viscosity, impaction and retention, and depends on several factors.

There are four ways of using Liquid Bio-Fertilizers

- Seed treatment
- Root dipping
- Soil application
- Dip irrigation

8.2 Seed Treatment
Seed Treatment is a most common method adopted for all types of inoculants. The seed treatment is effective for economic. For small quantity of seeds (up to 5 kgs quantity) the coating can be done in a plastic bag. For this purpose, a plastic bag having size (21"x 10") or big size can be used. The bag should be filled with 2 kg or more of seeds. The bag should be closed in such a way to trap the air as much as possible. The bag should be squeezed for 2 minutes or more until all the seed are uniformly wetted. Their bag is opened, inflated again and shake gently, stop shaking after each seed gets a uniform layer of culture coating. The bag is opened and the seed is dried under shade for 20-30 minutes. For large amount of seeds coating can be done in a bucket and inoculant can be mixed directly with hand. Seeds must be uniformly coated with NPK-liquid biofertilizer. This method will provide maximum number of each bacteria required for better result.

8.2.1 Pre-inoculated seed with NPK-microorganisms
Under this process the seed per-inoculated with NPK-inoculants. It is convenient to the grower to buy this seed ready to use.

Pre-inoculation of seed was initially undertaken using a process known as seed impregnation. The seed was moistened with a suspension of NPK-bacteria and then subjected to a vacuum. When the vacuum was withdrawn, bacteria were supposedly drawn into the seed through the micropyle and scratches on the seed coat. The process was disappointing in that the vacuum was effective in drawing NPK bacteria within the seed coat only a small percentage of treated seed and that few bacteria retained viability for any length of time during storage. The coating with of commercial lime (CaCO3) seed offered better prospects, using seed-coating techniques (Chandra 1995a). The lime neutralizes acid soil around the seed, and improves survival of applied bacteria prior. A number of commercial lime-coated seeds are currently not much available in India a number of beneficial effects have been reported with their use.

8.3 Root Dipping
For application of NPK-liquid biofertilizer on paddy transplanting / forest plants/vegetable crops this method is used. The required quantity of NPK-liquid
Biofertilizer has to be mixed with 5 — 10 ltr of water at one corner of the field and the roots of seedlings has be dipped for a minimum of half-an-hour before transplantation/raising of nursery.

8.4 Soil Application
NPK-liquid biofertilizer has to be used as a soil application. One liter of NPK-liquid biofertilizer 1000 kg of Cow dung/FYM along with ½ bag of rock phosphate if available. The mixture of NPK-liquid biofertilizer, Cow dung and rock phosphate have to be kept under any tree or under shade for overnight and maintain 50% moisture. Use the mixture as soil application in rows or during leveling of soil.

8.5 Dip Irrigation
NPK-liquid biofertilizer has to be mixed in water source (tank) @ 1.0 liter/200 liters of water. It is most effective method than soil treatment the bacteria reached near the root hence better result can be noted in the field. It was observed that is dip irrigation Nitrogen fixing, Phosphate solubilizing and Potash mobilizing bacteria multiply very fast. Their population became double in every 14-16 hours. Hence the efficiency of bacteria increased many fold provided soil should not be tonic.

In case of soil tonicity, manure is needed to neutralize the effect.

PHYSICAL LOSS
Microorganisms can be lost from target areas through action of wind and rain, physical abrasion or flowing water. Loss varies with type and properties of the formulation. The effects of drop size and liquid properties fluences retention. Sticker present in NPK product improve adherence of organisms to foliage and persistence during wind and rain (Chandra. 1995a). Effectiveness varies, from the delaying action of water-soluble material such as molasses, to the fastness of materials such as resins, which dry to become insoluble.

APPLICATION OF NPK
Biofertilizer : in Sugarcane

<table>
<thead>
<tr>
<th>Nitrogen level</th>
<th>Inoculated</th>
<th>Uninoculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>250kg/ha</td>
<td>146.43</td>
<td>132.97</td>
</tr>
<tr>
<td>300 kg/ha</td>
<td>156.75</td>
<td>145.70</td>
</tr>
<tr>
<td>350 kg/ha</td>
<td>156.73</td>
<td>149.07</td>
</tr>
<tr>
<td>400 kg/ha (control)</td>
<td>156.67</td>
<td>149.98</td>
</tr>
</tbody>
</table>

1 liter/acre of NPK-culture used. NPK-culture inoculated with the full dose of nitrogen fertilizers.

10.1 Application of Press mud with NPK Biofertilizer
Physically, press mud is soft, spongy, bulky (light weight) and amorphous blackish brown material.

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Composition before (%)</th>
<th>Composition After NPK-Biofertilizer inoculation at 21 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total solids</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Volatile solids</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>Ash (Non volatile solids)</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>C/N ratio</td>
<td>30:1</td>
<td>26:1</td>
</tr>
<tr>
<td>Cellulose</td>
<td>2.5</td>
<td>2.10</td>
</tr>
<tr>
<td>Hemicelluloses</td>
<td>27</td>
<td>22</td>
</tr>
<tr>
<td>Lignin</td>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>Organic carbon</td>
<td>24-27</td>
<td>26</td>
</tr>
<tr>
<td>Soluble</td>
<td>38</td>
<td>46</td>
</tr>
<tr>
<td>Wax (Benzene Extract)</td>
<td>10.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Proteins</td>
<td>7</td>
<td>8.10</td>
</tr>
<tr>
<td>Total Carbohydrates</td>
<td>2</td>
<td>3.50</td>
</tr>
</tbody>
</table>
The unidentified trace nutrients present in press mud would render fast multiplication of NPK-bacteria invaluable fertility value by complementing several physiological processes in plant and rhizobia microflora, providing sustained growth rate.

10.2 Application NPK Liquid Biofertilizer with micronutrients
Micronutrient-19.7 g of micronutrient mixture per kg of seed to supply 0.1% of Zn, Mn and Fe 0.05% of Cu, B and Mo had no adverse effect rather it add benefits to the plant, when treated with NPK-liquid.

FIELD OBSERVATION OF NPK-LIQUID BIOFERTILIZERS

11.1 Introduction
- Encourages early root development.
- PSM produced organic acids like malic, gloxalic, succinic, fumaric, citric, tartaric and alpha ketogutaric acid which hastens the maturity and thereby increases the ratio of grain to straw as well as the total yield.
- Increases the palatability of plants.
- Stimulates formation of fats, convertible starches and healthy seeds.
- Helps rapid cell development in plants and consequently increases resistance towards diseases.
- Increase micro nutrients in soil like Mn, Mg, Fe, Mo, B, Zn, Cu, etc., depends upon the nutrient presents in non available form.

11.2 Availability of Phosphorous Benefit
- Although the total amount of P the soil may be high, it is mainly present in forms unavailable to plants. The availability of applied P
to crop plants is adsorption, precipitation, or conversion to the organic forms. Organic P, predominantly phytic acid, may represent up to 80% of total soil P.

As a response to the low P availability, NPK-organisms have evolved different strategies to increase P uptake. Under P deficiency, plants may insurance root growth and root hair length or decrease root diameter thereby increasing root surface area. Plants & NPK-microorganisms release organic acids such as citrate, malate and oxalate, which increase solubility of inorganic P by leaching.

Use of NPK-Biofertilizer increase the microbial biomass can also represent a substantial sink for P added as fertilizer. Found that the same proportion of the added P was found in plants and the soil microbial biomass; indicating that biomass can compete with plants for P mineralisation /mobilization. Due to the high turnover rate of the microbial biomass, particularly in the rhizosphere, P stored in the biomass may become available to plants over time.

Adequate supplies of phosphate ensured by NPK-liquid, which ensures good root growth and production of flowers and fruit.

Phosphorous play an array of processes, including energy generation nucleic acid synthesis, respiration, membrane synthesis and stability, enzyme activation / inactivation, redox reaction, signaling, carbohydrate metabolism and nitrogen fixation. Phosphorus- (P) is unavailable because it rapidly forms insoluble complexes with cations, particularly aluminum and iron under acid conditions. Use of NPK-liquid reduced Phosphorus fixation by 70-80% in the soil.

### 11.3 Availability of Potassium Benefit

- Signs of potassium deficiency in the plant are readiness to wilt and the yellowing of the plant, falling of the leaves, 'leaf scorch' and poor development of fruit no such deficiency was noted with use of formulation.

- It is found that a major proportion of the potash in a plant resides in the straw or stem, whereas the major proportion of the nitrogen and phosphorus is in the berries and seed.

- Co- Potassium ions added to the soil appear to distribute themselves into about four locations: (1) dissolved in the soil solution; (2) in readily exchanged places on the soil particles; (3) in places on the soil particles that are only exchangeable with difficulty; (4) in non-exchangeable places on the soil particles. Some claim that these forms seek equilibrium between each other and that assimilation of potassium ions from the soil solution leads to rearrangement of the system. The leachability of potassium from soils appears to be related to the anion which accompanies the applied potash. However, NPK-liquid restrict the leachability of potassium and nitrogen.

- Plants can absorb nitrogen either in cationic (NH4 +) or in anionic (NO3) form. Suffered with severe stem lesions with continuous of N as NH 4+ unless K+ was added at
equivalent rates. Use of this NPK-liquid fulfill the requirement of K hence no deficiency was noted in the plants.

11.4 Availability of Nitrogen Benefit

- NPK- microorganisms play a key role in N mineralization. These microorganisms is capable of decomposing proteins into amino acids into NH4 (ammonification). Plants can take up NH4 and NO3 but nitrification occurs rapidly in most soils, therefore NO3 is the main N source of plants. The microbial biomass can also compete with plants for N.

- The density of free-living N2 fixers such as *Azospirillum* sp. *Azotobacter* sp. is increase in the rhizosphere than in the bulk soil. They contribute to N uptake by non-legumes in N deficient soils but due to the intense competition for root exudates in the rhizosphere, their contribution to N uptake is likely to be small, however NPK-liquid contains cell protectant which does not allow root exudates to effect the bacteria. A special case is endophytic N2 fixers in sugar cane. *Azospirillum* sp. With the help of this specific formulation enter the roots of sugar cane and colonise roots and stems where they are thought to fix substantial amounts of N.

11.5 Disease suppression in Rhizosphere

- Seed or root inoculation with NPK — Liquid biofertilizers can decrease root diseases. However, indirect effects have also been noted such as reducing the disease susceptibility of the plants.

- NPK — Liquid biofertilizers have been found to produce some antifungal, antibiotics which inhibits the growth some soil fungi like *Aspergillus, Fusarium, Curvularia* etc.

### FIELD APPLICATION OF LIQUID BIOFERTILIZER IN DIFFERENT CROPS

<table>
<thead>
<tr>
<th>Crop</th>
<th>Recommended Application of Biofertilizer to be applied</th>
<th>Quantity Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIELD CROPS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chickpea, peas, Groundnut</td>
<td>Rhizobium</td>
<td>Seed 200ml/acre</td>
</tr>
<tr>
<td>Soybean, beans Lentil, lucern, Berseem, green gram treatment Black gram, cowpea, pigeon pea treatment</td>
<td>Rhizobium</td>
<td>Seed 200ml/acre</td>
</tr>
<tr>
<td><strong>CEREALS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat, oat, barley Treatment</td>
<td>Azotobacter/Azospirillum</td>
<td>Seed 200ml/acre</td>
</tr>
<tr>
<td>Rice Treatment</td>
<td>Azospirillum</td>
<td>Seedling 200ml/acre</td>
</tr>
<tr>
<td><strong>OIL SEEDS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mustard, seasum Linseeds Treatment</td>
<td>Azotobacter</td>
<td>Seed 200ml/acre</td>
</tr>
<tr>
<td>Sunflower, castor Treatment</td>
<td>Azotobacter</td>
<td>Seed 200ml/acre</td>
</tr>
<tr>
<td><strong>MILLETS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearl millets, Finger millets, Kodo millet</td>
<td>Azotobacter</td>
<td>Seed 200ml/acre</td>
</tr>
<tr>
<td>Maize &amp; Sorghum Treatment</td>
<td>Azospirillum</td>
<td>Seed 200ml/acre</td>
</tr>
<tr>
<td><strong>FORAGE CROPS &amp; GRASSES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barmunda grass, Sudan grass, Napier Treatment</td>
<td>Azotobacter</td>
<td>Seed 200ml/acre</td>
</tr>
</tbody>
</table>
OTHER MISC. PLANTATION CROPS

<table>
<thead>
<tr>
<th>Crop</th>
<th>Microorganism</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>Azotobacter</td>
<td>Seedling 1000 ml/acre</td>
</tr>
<tr>
<td>Tea, Coffee</td>
<td>Azotobacter</td>
<td>Soil 1 L/acre</td>
</tr>
<tr>
<td>Rubber, Coconuts</td>
<td>Azotobacter</td>
<td>Soil 2-3 ml/Plant</td>
</tr>
</tbody>
</table>

AGRO-FORESTRY/FRUIT PLANTS

<table>
<thead>
<tr>
<th>Crop</th>
<th>Microorganism</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>All fruit/</td>
<td>Azotobacter</td>
<td>Soil 1.2 ml/plant</td>
</tr>
<tr>
<td>agroforestry (herb, shrubs,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>annuals nursery &amp; perennial)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>plants grown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>for fuel wood, gum, spice,</td>
<td>Rhizobium</td>
<td>1-2 ml/plant</td>
</tr>
<tr>
<td>leaves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>flowers, nuts &amp; seeds purpose</td>
<td>Azospirillum</td>
<td>2-3 ml/plant</td>
</tr>
<tr>
<td>Leguminous plants/ trees</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The formulation contains Azotobacter / Azospirillum / PSM / KSM in NPK — Liquid biofertilizers so the recommendation of Azotobacter/ Azospirillum culture means NPK — Liquid biofertilizers with these microbes.

*Rhizobium* is a crop specific so NPK — Liquid biofertilizers must contain *Rhizobium* along with P and K bacteria. So the recommendation of *Rhizobium* means PK— liquid biofertilizer with *Rhizobium* bacteria.

**DO’S AND DON'TS**

<table>
<thead>
<tr>
<th>Do</th>
<th>Don’ts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keep biofertilizer bottle away from direct</td>
<td>Don’t prick holes into the bottle</td>
</tr>
<tr>
<td>heat and sunlight. Store it in cool and dry</td>
<td>or puncture them.</td>
</tr>
<tr>
<td>place.</td>
<td></td>
</tr>
<tr>
<td>Sell only biofertilizer bottle which contain</td>
<td></td>
</tr>
<tr>
<td>batch number, the name of the crop, the</td>
<td></td>
</tr>
<tr>
<td>date of manu—facture and expiry period.</td>
<td></td>
</tr>
<tr>
<td>Don’t store biofertilizer bottle under heat</td>
<td></td>
</tr>
<tr>
<td>and sunlight.</td>
<td></td>
</tr>
<tr>
<td>Don’t sell biofertilizer bottle after their</td>
<td></td>
</tr>
<tr>
<td>expiry period is over.</td>
<td></td>
</tr>
</tbody>
</table>

**REFERENCES**


Government of India is promoting the use of NPK biofertilizer by giving subsidy under Paramparagat Krishi Vikas Yojana scheme
National and International Events

7th edition of BIOFACH INDIA together with INDIA ORGANIC in Kochi, Kerala during 5th to 7th November, 2015. BIOFACH INDIA together with INDIA ORGANIC concluded its seventh edition successfully once again, for the second time in Kochi, Kerala on 7th November, 2015. The three-day event witnessed an overwhelming response from 3345 B2B trade visitors which included more than eighty International Delegates. The event was inaugurated by Ms.Laxmi Rana, Chairperson – Uttarakhand Organic Commodity Board; Mr. Jörn Rohde, Consul General of the Federal Republic of Germany; Bangalore in the presence of Dr. A K Yadav, President – International Competence Centre of Organic Agriculture (ICCOA) and also recently appointed Advisor to the Organic Division - Agricultural and Processed Food Products Export Development Authority (APEDA); Dr.Tej Partap, Vice-Chancellor, SKUAST, Srinagar; Mr. Manoj Menon, Executive Director -International Competence Centre of Organic Agriculture (ICCOA) and also recently appointed Advisor to the Organic Division -IFOAM; Ms. Sonia Prashar, Managing Director – NuernbergMesse India; Mr Raj Sekhar Reddy, Managing Director - Sresta Natural Bio Products Pvt. Ltd, Hyderabad; Mr Tapan Ray, Managing Director & CEO - Nature Bio Foods Ltd and other National and International dignitaries. The event attended by 175 exhibitors comprised of five distinct components –Exhibition, International Conference, Buyer-Seller-Meetings, Organic Food Court and Consumer Connect initiative. The exhibitors included Private Stakeholders , State Pavilions, Government Boards as well as key Certification Bodies who exhibited a diverse range of food and non-food organic products. The participating States included Kerala, Karnataka, Himachal Pradesh, Sikkim, Uttarakhand, Andhra Pradesh, Assam and Madhya Pradesh.

17th International Conference on Organic Fruit Growing in Stuttgart, Germany from 15.02.2016 to 17.02.2016. “Ecofruit” is the continuation of the 16 previous meetings. It aims to bring together European researchers and consultants working on topics related to organic fruit growing. “Ecofruit” gives an opportunity to communicate and discuss latest results connected with organic fruit growing with regard to the improvement of the production system. The organizing committee consists of 17 people from different European countries engaged intensively in researching organic fruit growing for research stations or organic associations. The conference will take place in the Akademie Diözöse Rottenburg at the Tagungszentrum Hohenheim. The definitive programme with all contributions will be available at the end of the reviewing process at the end of the first week of February 2016. Further information : ecofruit.net: Ecofruit Homepage

The World of Organic Agriculture at BIOFACH 2016 The session on global organic farming and market trends will take place place from 4.30 pm to 5.45 pm, on February 10, 2016, in Room Istanbul (NCC East) at BIOFACH, NürnbergMesse, Nürnberg, Germany. At this session, the latest data on organic agriculture worldwide and market trends will be presented, and the 17th edition of “The World of Organic Agriculture”, the yearbook on global organic agriculture, will be launched.
Book Review

The Soil and Health : A Study of Organic Agriculture by Sir Albert Howard, Introduction by Wendell Berry Published by The University Press of Kentucky, Lexington, United States 356 pages; Price £30.72; - During his years as a scientist working for the British government in India, Sir Albert Howard conceived of and refined the principles of organic agriculture. Howard's The Soil and Health became a seminal and inspirational text in the organic movement soon after its publication in 1945. The Soil and Health argues that industrial agriculture, emergent in Howard's era and dominant today, disrupts the delicate balance of nature and irrevocably robs the soil of its fertility. Howard's classic treatise links the burgeoning health crises facing crops, livestock, and humanity to this radical degradation of the Earth's soil. His message—that we must respect and restore the health of the soil for the benefit of future generations—still resonates among those who are concerned about the effects of chemically enhanced agriculture.

Organic Farming : How to Raise, Certify, and Market Organic Crops and Livestock by Peter V. Fossel, Published by Voyageur Press Inc Stillwater, United States, 176 pages; Price £16.43 – Organic Farming is the seed you need to get your organic farm growing. This essential guidebook explains everything you need to know to begin and maintain a healthy, productive, and profitable organic farm, from organic certification to planting crops to marketing your produce. If you're thinking of starting an organic farm or making the transition to organics, you're in good company. The market for organic food increases every year, as does the number of organic producers: in the past two decades, the number of organic farms and businesses has more than tripled. And whether you're growing crops or raising animals, you'll need some helpful advice as you get started. Organic Farming can help--its pages are full of inspiring and educational wisdom from author Peter V. Fossel, who has farmed organically for more than 25 years. Find out how to farm without pesticides, how to find your way through the rules and regulations surrounding organic certification, and how to develop a marketing strategy. A list of resources also points the way to other books, websites, and organizations that focus on organic farming, including state standards. Organic Farming is the ideal practical handbook to fulfilling your dreams.

Organic Seed Production and Saving : The Wisdom of Plant Heritage by Bryan Connolly, Published by Chelsea Green Publishing Co, White River Junction, United States; 128 pages; Price £9.31 – This book has information on: Strengths and limitations of hybrid varieties Before you grow the seed (selecting varieties, saving seed and improving crops, intellectual property rights) Growing seed (pollination biology, harvesting, cleaning, storage, germination testing) Details on individual crops (amaranth, crucifers, beets and chard, lettuce, cucurbits, corn and small grains, nightshades, root veggies) Plus detailed appendices including more info on seed cleaning, seed companies, and more.

Natural Beekeeping : Organic Approaches to Modern Apiculture by Ross Conrad, Published by Chelsea Green Publishing Co, White River Junction, United States, 240 pages; Price £27.50 – The various chemicals used in beekeeping have, for the past decades, held Varroa Destructor, a mite, and other major pests at bay, but chemical-resistance is building and evolution threatens to overtake the best that laboratory chemists have to offer. In fact, there is evidence that chemical treatments are making the problem worse. "Natural Beekeeping" flips the script
on traditional approaches by proposing a program of selective breeding and natural hive management. Conrad brings together the best organic and natural approaches to keeping honeybees healthy and productive here in one book. Readers will learn about nontoxic methods of controlling mites, eliminating American foulbrood disease (without the use of antibiotics), breeding strategies, and many other tips and techniques for maintaining healthy hives. Conrad's reservoir of knowledge comes from years of experience and a far-flung community of fellow beekeepers who are all interested in ecologically sustainable apiculture. Specific concepts and detailed management techniques are covered in a matter-of-fact, easy to implement way. "Natural Beekeeping" describes opportunities for the seasoned professional to modify existing operations to improve the quality of hive products, increase profits, and eliminate the use of chemical treatments. Beginners will need no other book to guide them. Whether you are an experienced apiculturist looking for ideas to develop an Integrated Pest Management approach or someone who wants to sell honey at a premium price, this is the book you've been waiting for. (Courtesy: Book Depository.com)

Farming with Native Beneficial Insects: Ecological Pest Control Solutions by Eric Lee-Mader et al., Published by Storey Publishing, United States, 257 pages; Price £20.58 – This comprehensive guide shows you how to create a farm or garden habitat that will attract beneficial insects and thereby reduce crop damage from pests without the use of pesticides. Four experts from the Xerces Society, a world leader in conservation and environmental issues, discuss the ecology of native beneficial insects and show how you can conserve their presence on your land through conservation biocontrol - recognizing these insects and their habitat, reducing pesticide use, protecting existing habitat, and providing new habitat. Specific solutions and strategies include creating native plant field borders, mass insectary plantings, hedgerows, cover crops, buffer strips, beetle banks, and brush piles. Step-by-step illustrated instructions for these projects and more are accompanied by stunning full-color photography.”

Soil Fertility, Renewal and Preservation: Biodynamic Farming and Gardening by Ehrenfried E. Pfeiffer, Introduction by Lady Eve Balfour, Published by Lanthorn Press, Launceston, United Kingdom, 212 pages; Price £9.99 – Ways of working towards sustainable agriculture for our world have never been more important. This reissued edition of a classic biodynamic work from 1947 is as relevant now as when first published. The book covers all aspects of biodynamic agriculture, including ideas on forestry and market gardening, and includes chapters on evidence of scientific findings of the effect of biodynamic growing, and the effects of biodynamics on health. The book has been faithfully reproduced as originally published, but footnotes have been added to describe modern versions of methods referenced in the text. (Courtesy: Book Depository.com)

Compilation: Dr. V. Praveen Kumar