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From Editor's Desk

Dear Readers,

You are aware that present day agriculture aims to increase productivity along with long term maintenance of sustained yield, soil health and soil fertility. This could only be achieved when adequate crop nutrients are provided to the soil biologically. Biofertilisers are the product of efficient microbial organisms, which have proved immense potentialities in augmenting crop nutrients and facilitating increase metabolic activities for higher crop production.

This issue has attempted to report the response of rice genotypes to plant growth promoting Rhizobacteria (PGPR) which promote bioactive compounds through use of biofertilizer. Besides, there has been spectacular achievement in production of different biofertilizers in the country like *Azotobacter, Azospirillum, Rhizobium,* Phosphobacteria, BGA, Azolla as well as other inoculants like *Trichoderma, Metarhyzium, Bauveria* and *Verticillium* etc. Current production is about 38, 933 tones from 164 Biofertilizer production statistics besides has shown the growth of Biofertilizer during last 5 years which is unique. Maintenance of Biofertilizer quality is the paramount importance so as to get desired benefits of biofertilizers and this issue has reported an excellent article. Moreover, present issue has dealt research notes, news on conferences, workshops and trainings as well as book reviews on biofertilizers.

Hope the present issue will able to fulfill the expectations of our beloved readers.

Dr. R.N. Bisoyi
Editor

Response of rice genotypes to PGPR and manure in different cropping sequences at initial stage of organic farming in Indo-gangetic plains of eastern Utter Pradesh

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Abstract

Rice var. HUBR-2-1 (Sugandha) was found more responsive to PGPR (*Azotobacter chroococcum + Pseudomonas fluorescence + Aspergillus niger + Trichoderma harzianum*) in a field experiment conducted during kharif 2006 with 6 treatment of 3 rice varieties viz V_1 = HUBR-2-1 (Sugandha), V_2 = HUBR-1S (Sugandha selection-1) and V_3 = HUR-36 (Malviya Masoorie), and 2 levels (with and without) PGPR in 1st year of organic farming in cereal based cropping sequence, where, grain yield was quite low (19.79 qha^{-1}). In the 2nd experiment conducted in the same sequence during kharif 2007 with var. HUBR-2-1, the grain and straw yield increased to 29.47 and 51.33 qha$^{-1,}$ respectively, at the same level of FYM 24 tones ha^{-1} along with above combined inoculants of PGPR including *Azolla*. The 3rd experiment conducted with 2nd experiment in legume based cropping sequence at different level of FYM and PGPR. The grain yield 49.06 qha^{-1} of rice var. Sarju-52 obtained due to FYM 36 tones ha^{-1} + PGPR was significantly higher and 20.34% more over the same level of FYM without PGPR.

Introduction

The group of non-symbiotic beneficial soil microorganisms which enhance plant growth by suppressing diseases, fixing atmospheric nitrogen, solubilising phosphorous, iron and other nutrient, and by producing bioactive compounds that stimulate root proliferation are called Plant Growth Promoting Rhizobacteria (PGPR) (Kloepper et al 1980) and more recently, probiotic rhizobacteria (Haas and Keel, 2003). PGPR are being considered as the major biological input in organic farming systems.

India, the second leading producer of rice in the world after china produced around 93 million tones (2001-2002), where utter Pradesh accounts for about 42.32 million tones. It is grown in almost all region of the country to feed about 65% of the population as staple food. The demand for rice in the country is projected to 129 million tones by the year 2011-2012 which will require a production level of 3,124 Kg/ha with annual growth rate of 3.7% (Sunday Times of India, May 11, 2008, page 15). Though, it is difficult to achieve this target of rice production only through organic farming, but it has received a boost in the country because of high income potential through organic exports. In order to rapidly achieve the crop varieties adapted to organic farming, it is crucial to know plant genotypes potential for positive interactions with indigenous and introduced microflora as reported in rice (Engelhard et al 2000) and wheat (Mazzola et al 2004).

Cereal-cereal and legume-cereal are primarily existing as major cropping sequences in Indo-gangetic plains of eastern

Utter Pradesh, where, farmers grow rice either after wheat or any legume crop taken in rabi season. In this area, most of the researches have been done on rice for its cultivation in conventional as well as in integrated nutrients management system (INMS). Organic farming of any cereal and rice in particular is crucial in early stage of developing an organic farm, but it is manageable following the correct path of organic farming. Therefore, in the present study attempt has been made to find promising varieties and their interaction with different PGPR combinations in different cropping sequences suitable to initiate organic farming of rice through organic means in Indo-gangetic plains of eastern Utter Pradesh.

Materials and Methods

A field experiment was conducted at the Agricultural Research Farm, Institute of Agricultural Science, Banaras Hindu University, Varanasi in 2006. Mustard was raised to exhaust the soil of this field during rabi 2005-06. Green manuring of mungbean was done in summer to enrich the soil with organic matter (approximately 4.07 tones ha^{-1} having C/N ratio 18.7:1) before conducting experiment on organic rice. Initially, the soil of experimental field was sandy clay loam in texture with 40.83% water holding capacity and neutral in reaction (pH 7.25) with organic carbon at 4.95 g kg^{-1}.

To select the promising variety of rice for organic farming, an experiment was conducted with 6 treatment combinations of 3 popular rice varieties viz: V_1 = HUBR-2-1 (Sugandha), V_2 = HUBR-1S (Sugandha selection-1) and V_3 = HUR-36 (Malviya Masoorie), with and without inoculation of PGPR (*Azotobacter + Pseudomonas + Aspergillus + Trichoderma*) in 4 replication under factorial randomized block design (FRBD) during kharif 2006 at basal application of FYM 24 tones/ha in the green manured plots of each 5 x 4m. Transplanting of 3 seedlings of 25 days old was done as per treatment at 20x20 cm distance in last week of July. Proper irrigation and weeding was done whenever required. Extract of neem seed was sprayed to prevent the attack of Gundhi bug during grain filling stage. The crop was harvested in the last week of November.

The 2nd and 3rd experiment were conducted during kharif-2007 to find suitable dose of FYM and different combinations of PGPR on previously selected as well as on other popular varieties. The 2nd experiment was conducted after cultivation of wheat (in cereal based cropping sequence followed by green manuring of mungbean) with rice variety HUBR 2-1 found promising during 1st year of variety experiment. This experiment was comprising 8 treatment of various PGPR combinations as follows in 3 replications under RBD and basal application of FYM 24 tons ha^{-1}.

Treatments:

T_1 : Control (No FYM)
T_2 : 24 t FYM ha^{-1}
T_3 : 24 t FYM ha^{-1} + *Azotobacter*
T_4 : 24 t FYM ha^{-1} + *Azospirillum*
T_5 : 24 t FYM ha^{-1} + *Pseudomonas*
T_6 : 24 t FYM ha^{-1} + *Aspergillus*
T_7 :24 t FYM ha^{-1} + *Azotobacter* + *Azospirllum* + *Pseudomonas* + *Aspergillus*
T_8: 24 t FYM ha^{-1} + *Azotobacter* + *Azospirllum* + *Pseudomonas* + *Aspergillus* + *Azolla*

The 3rd experiment was conducted in the same season with rice var. Sarju-52 in legume (red gram) based cropping sequence followed by green manuring of dhaincha in summer 2007. This experiment consisted of 8 treatment with 4 levels of FYM (0,12, 24, 36 tons ha^{-1}) with and without inoculation of PGPR (*Azotobacter* + *Azospirillum* + *Pseudomonas* + *Aspergillus* + *Azolla*) in 3 replication of 5 x 4 m plots under RBD. Transplanting and other cultural practices were followed as in the case of 1st experiment. After harvesting, grain and straw yields were air dried and recorded in q ha^{-1}

Treatments:

T_1 : No FYM
T_2 : 12 t FYM/ ha
T_3 : 24 t FYM /ha
T_4 : 36 t FYM /ha

T_5 : No FYM + PGPR
T_6 : 12 t FYM/ ha + PGPR
T_7 : 24 t FYM /ha + PGPR
T_8 : 36 t FYM /ha + PGPR

Result and discussion

The yields were low in all the varieties of rice due to all treatment of organic manure or PGPR + organic manures during first year of organic farming. However, aromatic variety HUBR 2-1, locally known as Sugandha was found significantly more responsive, over other varieties. Similarly, significant increase in grain (16.16 qha^{-1}) and straw (43.01 qha^{-1}) yield of all varieties clearly indicated that the applied manure and PGPR were unable to supply sufficient nutrition required by the crop for full plant growth and grain yield (Table 1). Fast decomposing components of green manure and FYM supplied more nutrition during growth phase while, supply of nutrients decreased with decreasing rate of mineralization during grain filling stage. Hence, low grain yield was achieved even after more plant growth as it was seen by wide straw/grain ratio. This result supports the general view that organic farming of cereals, particularly rice, is not feasible at first year or initial stage of organic farming. However, the interaction effect significantly showed by PGPR x HUBR 2-1 with grain yield of 19.23 qha^{-1} over other interaction treatment supported the view of Macro *et al* (2006) that plant genotypes affects both the performance of root colonization by probiotic rhizobacteria and their beneficial activity.

In the second experiment during 2nd year of organic farming (kharif 2007), results have clearly shown that application of FYM as organic manure is worthless without application of PGPR (Table 2). Though, the grain (17.84 qha^{-1}) and straw (31.37) yield in treatment of 24 tones FYM was significantly higher over control (No FYM) treatment but its performance was significantly lesser than all the treatment of FYM applied either with single inoculant or with combined inoculants of PGPR. Among the free living nitrogen fixers, *Azospirillum* has shown significant superiority over *Azotobacter* in terms of grain and straw yield because of its microaerophilic nature and conducive condition in rice field as also reported by Dobbeaere *et al* (2003).

Table 1- Effect of PGPR on grain and straw yield of rice varieties in cereal based cropping sequence under organic farming system

Grain yield of rice varieties (q ha^{-1})				
	V_1	V_2	V_3	V_4
I_0	16.35	12.26	13.33	13.98
I_1	19.23	13.87	15.39	16.16
Mean	17.79	13.07	14.36	
		S.Edm +	C.D. at 5%	
Variety Inoculants		0.360	0.785	
V x I		0.832	1.813	
Interaction		1.441	3.141	
Straw yield of rice varieties (q ha^{-1})				
	V_1	V_2	V_3	V_4
I_0	48.75	39.34	31.60	39.90
I_1	50.89	43.75	34.40	43.01
Mean	49.82	41.55	33.00	
		S.Edm +	C.D. at 5%	
Variety Inoculants		0.355	0.774	
V x I		0.820	1.788	
Interaction		1.421	3.097	

Similarly, among the P-solubilizers, *Pseudomonas* proved significantly higher effectiveness with grain and straw yield of 27.08 and 48.91 q ha^{-1}, respectively over the *Aspergillus* treatment. Significant reduction in yield was observed when *Pseudomonas* and *Aspergillus* were applied together with *Azotobacter* and *Azospirillum* (T_7). *Pseudomonas fluorescence* is known as strong antifungal bioagent (Kumar *et al* 2006). The bioremediation of this antagonistic relationship of above two microbes was interesting finding of experiment, where, application of *Azolla* in addition to *Azotobacter*, *Azospirllum*, *Aspergillus* and *Pseudomonas* (T8) increased grain and straw yield maximum to 29.47 q/ha^{-1} and 52.33 q/ha^{-1}, respectively, over other treatments.

Increasing dose of FYM from 0,12,24 and 36 tones ha^{-1}) without PGPR in 3rd experiment of legume based cropping sequence on rice var. Sarju-52 were able to enhance grain and straw yield (Table 3) significantly higher over each of the preceding treatments. Similarly, PGPR treatments with each of the above FYM levels have also increased the yield significantly over the preceding inoculated treatments as well as over the respective treatments without PGPR. The maximum grain yield 49.06 qha^{-1} at application of FYM 36 tones ha^{-1}+ PGPR was 20.34% greater than the treatment of 36 tones FYM ha^{-1} alone. Hence, it may be conferred from all the above experiments that organic farming of rice is feasible even at early stage of developing organic farm. Rice varieties HUBR 2-1 and Sarju-2 were more responsive to PGPR and their organic cultivation could benefit legume based cropping system using combined inoculants (*Azotobacter* + *Azospirillum* + *Pseudomonas* + *Azolla*) at application of 1.5 times more FYM (36 tones ha^{-1}) than the general recommendation of 24 tones ha^{-1} in Indo-gangetic plains of Uttar Pradesh.

Table 2- Effect of PGPR on grain and straw yield of rice var. HUBR 2-1 under organic farming system and of rice var. Sarju-52 at different fertility levels of organic manures under organic farming system

Treatment	Rice var. HUBR 2-1 under organic farming system		Rice var. Sarju-52 at different fertility levels of organic manures	
	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	7.07	18.33	12.01	22.67
T_2	17.84	31.37	21.69	29.67
T_3	20.72	37.33	29.97	39.67
T_4	23.83	45.33	40.77	53.83
T_5	27.08	48.91	20.10	28.17
T_6	21.80	48.77	30.42	36.67
T_7	23.82	49.60	35.52	44.67
T_8	29.47	51.33	49.06	53.67
S.Edm	1.117	2.153	2.290	2.931
C.D. at 5%	2.396	4.617	4.913	6.288

Table 3- Effect of PGPR on grain and straw yield of rice (var. Sarju-52) at different fertility levels of organic manures under organic farming system

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	12.01	22.67
T_2	21.69	29.67
T_3	29.97	39.67
T_4	40.77	53.83
T_5	20.10	28.17
T_6	30.42	36.67
T_7	35.52	44.67
T_8	49.06	53.67
S.Edm C.D. at 5%	2.290 4.913	2.931 6.288

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Improvement of Biofertilizer Quality

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Introduction to AINP

The "All India Network Project on Biofertilizers" initiated by Indian Council of Agricultural Research in 2004 (replacing the AICRP on Biological Nitrogen Fixation) is a network project of 11 research institutes with a focus on enhancing productivity and supplementing a part of chemical fertilizer needs of crops through inoculation of Biofertilizers in legumes, cereals, millets, oilseeds, horticultural and plantation crops in diverse areas of India. Broad objectives of the AINP on BF were:

- To exploit the biodiversity of nitrogen fixers, phosphate solubilizers/mobilizers and plant growth promoting rhizobacteria (PGPR) for biofertilizer application in diverse cropping system
- To improve biofertilizer technology with particular reference to quality, carriers, consortia, delivery systems and testing methods.
- To expand biofertilizer research and application in drylands, mountainous regions, tribal areas and other under explored ecosystems.

To achieve the stated objectives strategy was divided into 5 major projects, namely : (a) Characterization of microbial diversity, (b) Formulation of mixed Biofertilizers and their testing in cropping systems, (c) Improvement of biofertilizer quality, (d) Extending BNF technologies to tribal, hill and mountain regions, NEH region and disadvantaged areas and (e) Research-Adoption-Impact continuum evaluation. The success achieved under AINP in "Improvement in Biofertilizer Quality" with focus on development of liquid Biofertilizer development is being presented here.

Liquid Inoculant Formulations (ANGRAU)

The widely used carrier based inoculants have a shorter shelf life of up to 6 months and are of poor quality. Liquid cultures containing cell protectants not only give high cell titer but also promote the formation of resting cells like cysts and spores which result in better resistance to abiotic stresses and high shelf life. Media supporting the growth of three Biofertilizer organisms viz *Rhizobium*, *Azospirillum* and P-solubilizing *Bacillus megaterium* (PSB) using different concentrations of cell protectants like arabinose, trehalose, glycerol, poly-vinyl-pyrolidone (PVP) were devised (LM1, LM2 and LM3). These were tested and compared with normal basal medium (control) and solid lignite base culture packs for different biofertilizer organisms like blackgram *Rhizobium* (strain RBG-314), *Azospirillum* (strain AZS-303) and *B. megaterium* (strain AMT-1001).

In case of *Rhizobium* the liquid medium LM3 maintained good titer (log 8.43 CFU/ml) even after 360 days whereas in normal liquid broth it had come down to a level of log 2.30 CFU/ml and in lignite to log 1.11 CFU/g (Fig. 1). In case of *Azospirillum* liquid medium LM2 maintained maximum population (log 8.64 CFU/ml) even after 360 days compared to log 3.57 CFU/ml in normal broth and log 2.99 CFU/g in lignite formulations. In case of PSB the liquid inoculant medium LM3 could maintain the maximum (log 8.02 CFU/ml) population until 360 days whereas the titer in normal broth came down to log 3.11 CFU/ml and in lignite to log 2.16 CFU/g. No contamination was observed until 360 days in any of the liquid inoculants.

The composition of the three successful media developed for three biofertilizer organisms are given in Table 1 below:

Fig 1 Population of *Rhizobium*, *Azospirillum* and PSB in different liquid inoculant formulations at 360 days.

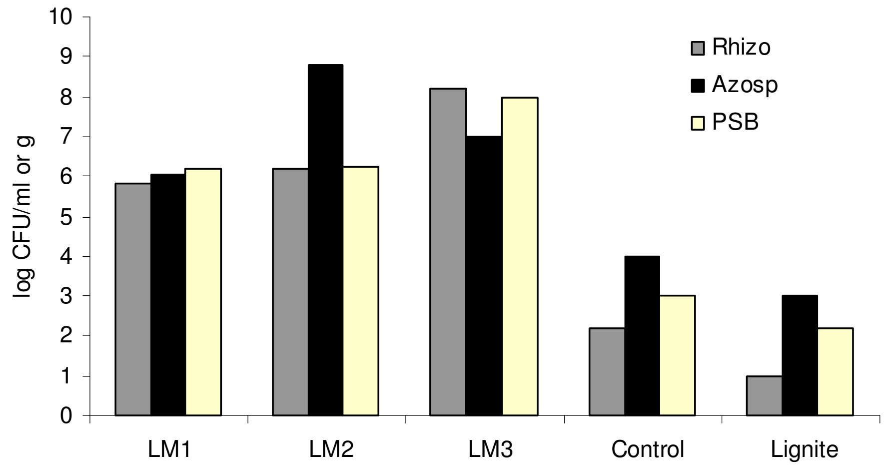

Table 1. Composition of Liquid biofertilizer media for Rhizobium, Azospirillum and PSB

Chemical	Gram per liter unless otherwise stated			Remarks
	Rhizobium (LM3)	*Azospirillum* (LM2)	PSB (LM3)	
Manitol	2.0	-	-	
K_2HPO_4	0.5	0.5	-	
$MgSO_4$ $7H_2O$	0.2	0.2	0.2	
NaCl	0.1	0.1	5.0	
Yeast Extract Powder	0.5	0.1	-	
Trehalose	2.0 mM	2.0 mM	2.0 mM	
Glycerol	4.0 ml	6.0 ml	8.0 ml	
PVP	20.0	10.0	15.0	Should be added at the end and vigorously mixed
Glucose	10 ml	10 ml	50 ml	Separately sterilized by preparing stock solution.
Arabinose	5 ml	10 ml	10 ml	Separately sterilized by preparing stock solution.
Fe-EDTA	200 μM	4.0 ml	-	Separately sterilized by preparing stock solution.
Malic acid	-	5.0	-	-
KOH	-	4.0	-	-
$CaCl_2$	-	0.2	0.10	-
Trace element soln.	-	2.0 ml	-	Separately sterilized by preparing stock solution and added before inoculation
$FeCl_3$	-	0.010	0.01	-
Peptone	-	-	5.0	-
Beef extract	-	-	3.0	-
NH_4Cl	-	-	0.5	-

(Abstracted from D.L.N. Rao edited "Biofertilizer Research Progress 2004-07", All India Network Project on Biofertilizers, Indian Institute of Soil Science, ICAR, Bhopal. Published with the kind consent of Dr. D.L.N. Rao, Network Coordinator)

Current Status of Biofertilizer Industry in India

Starting with *Rhizobium* and few hundred tones of production per annum, the biofertilizer industry has now grown well beyond imagination. Total production which was a mere 900 tons during 1989-90 has now increased to more than 20,000 tons. Incorporation of other inoculants such as *Trichoderma* and other biopesticides such as *Metarhyzium*, *Bauveria*, *Verticillium* etc has added to the sustainability of the industry. As per the information gathered by NCOF /RCOF's there are 164 biofertilizer units in the country. During the year 2007-08 details were available for 164 units, which indicate total installed production capacity of 67162.00 tones and actual production of 38932.689 tones. State wise production of different biofertilizers during the year 2007-08 is given in Table-1. State wise details of installed production capacity, total production of different Biofertilizers and total production of other (non-biofertilizer) inoculants are given in Table 2. State wise and unit wise production of different production units are given in Table 3.

Table 1 - Production of different Biofertilisers and other Microbial formulations in India during year 2007-08

Sr. No.	Name of Biofertiliser/ Inoculants	Production (in tones)
1.	*Azotobacter*	3360.854
2.	*Azospirillum*	2944.553
3.	*Rhizobium*	2825.893
4.	Phosphate solubilising Microorganism	10675.930
	Total Biofertilizers	**20111.050**
5.	Other Inoculants*	18821.639
	Grand Total (all inoculants)	**38932.689**

*Others include compost enrichers (*Trichoderma, Paceliomyces* etc.), PGPRs, BGA, etc.

Table 2 - State wise Biofertiliser Production (tones)

Sl. No.	Name of State	Biofertilizer Production during the year 2007-08						
		Azotobacter	Azospirillum	Rhizobium	PSB	Total BF	Other Inoculants *	Grand Total
1	Andhra Pradesh	566.454	519.697	874.154	2555.505	4515.81	65.164	4580.974
2	Assam	13.079	17.29	6.769	33.763	70.901	0	70.901
3	Bihar	0	0	0	0	20	0	20
4	Delhi	53.645	51.316	4.802	59.081	168.844	575.812	744.656
5	Gujarat	375.42	129.08	105.691	653.11	1263.301	32.18	1295.481
6	Goa	0	0	0	0	0	46.513	46.513
7	Haryana	2.02	0	1.49	5.38	8.89	0.01	8.9
8	Himachal Pradesh	12.25	15.01	13.7	15.25	56.21	0	56.21
9	Jharkhand	75	25	15	75	201.68	0	201.68
10	Kartnataka	353.318	691.407	102.929	1693.615	2841.269	5584.62	8425.889
11	Kerala	28.271	146.168	158.804	481.204	814.447	3743.392	4557.839
12	Madhya Pradesh	221.874	5.333	510.265	1147.395	1884.867	34.3	1919.167
13	Maharashtra	984.50	83.80	339.33	1078.78	2486.41	258.16	2744.57
14	Mizoram	0.72	0.67	0.89	1.3	3.58	0	3.58
15	Nagaland	3.82	1.6	2.14	6.42	13.98	0	13.98

Sl. No.	Name of State	Biofertilizer Production during the year 2007-08						
		Azotobacter	Azospirillum	Rhizobium	PSB	Total BF	Other Inoculants *	Grand Total
16	Orissa	152.38	39.02	33	55	331.94	13	344.94
17	Punjab	0	0	1.7	0	1.7	0	1.7
18	Pondicherry	10.34	77.701	67.51	315.735	471.286	1213.395	1684.681
19	Rajasthan	47.413	0	58.307	196.583	302.303	0	302.303
20	Tamilnadu	135.179	1000.125	330.111	2001.551	3466.966	7250.881	10717.847
21	Tripura	6.325	0	1.62	6.325	14.27	0	14.27
22	Uttar Pradesh	95.414	5.876	16.554	132.213	250.057	4.211	254.268
23	West Bengal	223.43	135.46	181.13	162.72	922.34	0	922.34
	Total	3360.854	2944.553	2825.893	10675.93	20111.05	18821.639	38932.689

* Other inoculants include compost enrichers (Trichoderma, Paceliomyces etc.), PGPRs, BGA, Azolla.

Table 3: State Wise Capacity and Production of Biofertilizer

S. No.	State	Installed Capacity	Total Biofertilizer Production (MT)	Other Inoculants (MT)*	Total Production (MT)
1	Andhra Pradesh	7025	4515.81	65.164	4580.97
2	Assam	290	70.901	0	70.90
3	Bihar	150	20	0	20.00
4	Delhi	1000	168.844	575.812	744.66
5	Gujarat	1850	1263.30	32.18	1295.48
6	Goa	150	0	46.513	46.51
7	Haryana	50	8.89	0.01	8.90
8	Himachal Pradesh	75	56.21	0	56.21
9	Jharkhand	220	201.68	0	201.68
10	Kartnataka	26425	2841.27	5584.62	8425.89
11	Kerala	5855	814.45	3743.39	4557.84
12	Madhya Pradesh	1725	1884.87	34.3	1919.17
13	Maharashtra	5775	2486.41	258.16	2744.57
14	Mizoram	25	3.58	0	3.58
15	Nagaland	150	13.98	0	13.98
16	Orissa	430	331.94	13	344.94
17	Punjab	2	2	0	1.70
18	Pondicherry	890	471.29	1213.40	1684.68
19	Rajasthan	800	302.30	0	302.30
20	Tamil nadu	12825	3466.97	7250.88	10717.85
21	Tripura	30	14.27	0	14.27
22	Uttar Pradesh	315	250.06	4	254.27
23	West Bengal	1105	922.34	0	922.34
	Total	**67162.00**	**20111.05**	**18821.639**	**38932.689**

* Others include compost enrichers (*Trichoderma, Paceliomyces* etc.), PGPRs, BGA, Azolla

Table 4 : State and Unit-wise Production of Biofertilisers in India 2007-2008

Organization Name	Capacity	AZOTO.	AZOSP.	RHIZ.	PSB	Total BF	Other Inoculants *	Total
Andhra Pradesh								
Bacterial Culture Production Lab., RSTL, Rajendra Nagar, Hyderabad	150	4.319	0.547	0.553	15.980	21.40	31.632	53.031
Mr. Krishan Rao, Krishna Agro Bioproducts Vrikshamitra 9/1/A-1 Road No. 16 IDA Nacharam, Hyderabad	3000	0	0	0	1865.00	1865.00	0	1865
Coromandal Fertilizers Ltd., Kakinada	150	0	0.572	0	0.847	1.42	0.692	2.111
The Pragathi Biofertlizers, Nellore	50	0	6.7	0	8.79	15.49	1.09	16.58
Agril. Research Station, Amravathi, Guntur	75	0	13.88	25.15	10.06	49.09	0	49.09
Sneha Biotech, Surampalli	50	0.281	0.281	0.321	0.562	1.445	0	1.445
Varsha Biosciences and Technology 17-1 - 382/SN/1/2 ,MNR Colony,Balaji Nagar, Hyderabad (A.P.)	75	2.129	4.892	0.13	34.927	42.078	0	42.078
Radar Biotech Vijay wara	150	0	15.5	0	21.5	37.000	25	62
Rovar Biotech Vijaywara	75	9.725	10.575	0	10.589	30.889	6.75	37.639
Prathista Industries Ltd. S. Lingotam (V) ,Chotuppal (M) Nalgonda (D) (A.P.)	3000	500	450	800	500	2250.000	0	2250
Sri Sai Agro Bio Lab. Cheerumpally, Vijaynagaram	250	50	16.75	48	87.25	202.000	0	202
Andhra Pradesh Total	**7025**	**566.454**	**519.697**	**874.154**	**2555.505**	**4515.81**	**65.164**	**4580.974**
Assam								
N.E.Green Tech P.Ltd, Anuradha Complex, Baraum Maidan, Guwahati, Assam	150	7.597	5.217	5.719	19	37.533	0	37.533
BVFC, Namrup, Dibruganj,	20	0.482	9.073	0.05	9.763	19.368	0	19.368
Orgaman R & D Division Nehru Park, T.R. Phukan Road, Jorhat	120	5	3	1	5	14.000	0	14
Assam Total	**290**	**13.079**	**17.29**	**6.769**	**33.763**	**70.901**	**0**	**70.901**
Bihar								
Association for social Economic Transforamtion, Baurani, Bihar	150	0	0	0	0	20.000	0	20
Bihar Total	**150**	**0**	**0**	**0**	**0**	**20.000**	**0**	**20**
Delhi								
International Panaacea Limited, E-34, Connaught Circus, New Delhi- 110 001	1000	53.645	51.316	4.802	59.081	168.844	575.812	744.656
Delhi Total	**1000**	**53.645**	**51.316**	**4.802**	**59.081**	**168.844**	**575.812**	**744.656**
Goa								
Cosme Biotech, Panaji,Goa	150	0	0	0	0	0.00	46.513	46.513
Goa Total	**150**	**0**	**0**	**0**	**0**	**0**	**46.513**	**46.513**

Organization Name	Capacity	AZOTO.	AZOSP.	RHIZ.	PSB	Total BF	Other Inoculants *	Total
				Gujarat				
Gujarat State Cooperative Marketing Fed. Ltd., Ahemdabad	250	0	94.13	45.461	0	139.591	0	139.591
Gujarat State Fertilizers & Chemicals Ltd., Vadodara	600	109.15	17.46	17.25	138.68	282.540	0	282.54
KRIBHCO- Hazira, Surat	750	175.5	5	25.75	400.4	606.650	30.8	637.45
CORDET Kalol, Gandhi Nagar	250	90.77	12.49	17.23	114.03	234.52	1.38	235.9
Gujarat Total	**1850**	**375.42**	**129.08**	**105.691**	**653.11**	**1263.30**	**32.18**	**1295.48**
				Haryana				
CCS Haryana Agriculture University, Hisar	50	2.02	0	1.49	5.38	8.89	0.01	8.90
Haryana Total	**50**	**2.02**	**0**	**1.49**	**5.38**	**8.89**	**0.01**	**8.90**
				Himchal Pradesh				
Sr. Analytical Chemist Laboratory, Shimla	75	12.25	15.01	13.7	15.25	56.21	0	56.21
Himchal Pradesh Total	**75**	**12.25**	**15.01**	**13.7**	**15.25**	**56.21**	**0**	**56.21**
				Karnataka				
University of Agril. Sciences, Department of Agril. Microbiology, College of Agriculture, Dharwad	50	0.728	4.487	0.789	5.19	11.19	7.24	18.43
West Coast Herbo Chem Ltd., 105/B, Industrial Suburb II Stage, III Cross, Goraguntepalya, Tmukur Road, Bangalore- 560 022	50	0	56.34	0	84.89	141.23	0	141.23
Rhizobium Production Lab., Kotnur, Gulbarga	50	0	0	0	0	0.00	10.56	10.56
K.C.D.C. Haralakunte, Madiwala Post, Bangalore	16000	2.755	2.62	8.05	7.09	20.52	2.185	22.70
Vital Plant Products, Gowrishankar Estate, Harihalli- 573 129, Via K. Hoskote, Alur TK, Hassan DT	1000	0	0	0	0	0.00	956.294	956.294
Kadur Agro, R.v. Vidyaniketan Post, Mylasandra, Bangalore	250	50	0	45	60.67	155.67	0	155.670
Rhizobium Prodn. Lab, Dharwad	25	0	0	0	0	0.00	8	8.00
Rhizobium Lab, Hebbal, Bangalore	75	1.3	0	2.59	7.14	11.03	0	11.03
Multiplex Biotech Pvt. Ltd., # 420-A, Peenya Indl. Area, Peenya Ist Stage, Bangalore- 58	825	87.375	43.3	21.5	287.175	439.35	271.931	711.281
M/s Agro Tech Agro India Ltd, Plot No. 1-D (Part-1), KIADB Industrial Area, Lokikere Road, Davanagere	250	0	0	0	0	0.00	158.9	158.900
Dutta Biofertilizers, Balki, Bidar	200	30	10	20	80.45	140.45	0	140.450
Madras Fertilizers Ltd, Bio Unit, Jigani, Bangalore	400	167.27	0	5	160	332.27	0	332.270

Organization Name	Capacity	AZOTO.	AZOSP.	RHIZ.	PSB	Total BF	Other Inoculants *	Total
Biopest Management Pvt, Ltd, Bantanala Village, Maralawadi Hobli, Kanakapura Tq. Bangalore Rural DT, Bangalore	1250	0	345.89	0	218.56	564.45	656.78	1221.230
Fertilie Agro Chem Ltd, H.O. #67, 1st Floor, West of Chord Road, Mahalaxmipuram, Bangalore- 86	500	0	0	0	0	0.00	467.44	467.440
Ganesha Agro Tech, 12th Main, RMV Extn. Bangalore	500	0	0	0	0	0.00	356.8	356.800
Karnataka Biofertilizers, Near Railway Bridge, Sindagi Road, Bijapur- 586 104	750	0	33.54	0	128.68	162.22	326.78	489.000
Karnataka Bio Organic Fertilizers, ambulinganahally, Davanaere, Karnataka	150	0	0	0	0	0.00	124.65	124.650
Krishi Samruddhi Agrotech, Dev Nagar, Old Jevargi Road, Gulbarga	400	0	0	0	0	0.00	233.56	233.560
M.Nayana Prabhu, Sri Venkatesh, Mudesaral, Mangalore, Dakshina Kannada	750	0	0	0	0	0.00	534.22	534.220
Poly Chemicals Industries Ashok Nagar, Nipani, Venkatarayappa Compound, Anjaneya Temple Road, Mahadevapura, Village- Bangalore- 48	600	0	0	0	0	0.00	438.45	438.450
Anshul Agro Chemicals, Bangalore	600	13.89	0	0	136.89	150.78	345.88	496.660
S.S. Bio Gold, # 374, 4th Main, P.J. Extension, Davanagere- 577 002	750	0	45.23	0	154.88	200.11	467.45	667.560
Chaitra Fertilizers & Chemicals (P) Ltd., No. E-1, Sri Krishna Complex, D. Banumaiah Circle, Mysore	1000	0	150	0	362	512.00	217.5	729.5
Karnataka Total	**26425**	**353.318**	**691.407**	**102.929**	**1693.615**	**2841.27**	**5584.62**	**8425.889**
Kerala								
M/s Agro Biotech Research Centre Ltd., Indl. Area, Poovanthuruthu P.O. Kottayam- 686 012, Kerala	575	2.371	21.694	0.044	38.4	62.51	379.009	441.518
Managing Director, High Range Bio Pesticides Pvt. Ltd. Udumbanoor, Thodupuzha, Idukki Dist.	200	2	4	2	60.8	68.80	88	156.8
Chief Sales Manager Biofertilizer Prodn. Unit, The Fertilizer & Chemicals Travancore, Eloor, Udgyogamandal	10	0	0	0	0	0.00	3.91	3.91
Plantrich Chemicals & Fertilizers Ltd., Industrial Estate, Manarcad P.O. Kottayam- 686 019,	1550	23.9	45.66	156.76	260.78	487.10	775.579	1262.679

Organization Name	Capacity	AZOTO.	AZOSP.	RHIZ.	PSB	Total BF	Other Inoculants	Total
The Managing Director Poabs Environtech (P) Ltd., Vilapisala (PO), Peyad, Trivendrum- 695 573, Kerala	510	0	12.727	0	1.332	14.06	416.452	430.511
Travancore Organic Fertilizer Company, Kangazha (PO), Kottayam- 686 541, Kerala	510	0	12.727	0	1.332	14.059	416.452	430.511
Biofertilizer Lab, Dist. Soil testing Lab, Pattambi, Palakkad	150	0	14.58	0	0	14.58	80	94.58
Deepa Farm Inputs (P) Ltd, Meppukkadu, Mulaynkeesh, Trivendrum, Kerala	600	0	0	0	37.89	37.89	539.78	577.67
Peremade Marketing Co-op, Society Ltd, No. z-240, Kumity Po, Thakkady, Idukki	500	0	0	0	0	0	234.89	234.89
Tiffco Fertilizers & Chemicals, Pudukkadu, Chengaloor, Trissur	500	0	0	0	34.78	34.78	349.56	384.34
High Range Fertilizers Biotech & Research Centre, Puliyanmala, Kattappana- 685 515, Kerala	750	0	34.78	0	45.89	80.67	459.76	540.43
Kerala Total	**5855**	**28.271**	**146.168**	**158.804**	**481.204**	**814.45**	**3743.392**	**4557.839**
Madhya Pradesh								
NFL-Vijaypur, Guna	150	64.389	0	13.955	124.215	202.559	0	202.559
Nafed Biofertilizer , Indore	500	37.44	0	287.74	412.62	737.80	0	737.8
Agri Business & Dev. Coop. Bhopal	50	6.03	0	14.19	45.3	65.52	0	65.52
The M.P. State Agro Ind. Dev. Corpn., Bhopal	500	37.125	2.33	137.71	348.32	525.49	0	525.485
JNKVV Jabalpur	100	13	0	21	52	86.00	0	86
MP Oil Seed Fed. Ltd. Dhar	150	13.49	0	33.07	121.93	168.49	0	168.49
Indore Biotech Input & Res. (P.) Ltd. Indore	275	50.4	3.003	2.6	43.01	99.01	34.3	133.313
Madhya Pradesh Total	**1725**	**221.874**	**5.333**	**510.265**	**1147.395**	**1884.87**	**34.3**	**1919.17**
Mizoram								
Biofertilizer Production Unit, Directorate of Agriculture, Neihbawith, Aizol, Mizoram	25	0.72	0.67	0.89	1.3	3.58	0	3.58
Mizoram Total	**25**	**0.72**	**0.67**	**0.89**	**1.3**	**3.58**	**0**	**3.58**
Maharashtra								
Arya Biochem Lab. Shivar, Amravati	50	1.8	0	1.5	1.8	5.10	0	5.1
Maharashtra Research and Development Center, 396, Sainik, Santosh Nagar, Bale, Solapur (M.S.)	150	1.803	0	13.111	13.657	28.57	2.36	30.931
Sahakar Maharishi Shankarrao Mohite Patil,Sahakari Sakhar Karkhane Ltd. Shankarnagar, Akluj (M.S.)	150	1.2	0	0	81.31	82.51	25.33	107.84
Deenee Chemicals Pvt. Ltd., 37/9, MIDC Road, Padoli, Chandrapur	150	3.387	0	8.766	42.569	54.722	0	54.722

Organization Name	Capacity	AZOTO.	AZOSP.	RHIZ.	PSB	Total BF	Other Inoculants *	Total
Sai Agrotech, Yavatmal	250	35	25	40	100	200.00	0	200
Krishi Vigyan Kendra, Sardanagar, Baramati, Pune	150	3.189	0	0.23	3.747	7.17	3.362	10.528
OM Agro Organic, A-76 MIDC, Yavatamal	250	40	35	60	120	255.00	0	255
Nilayam Bio-fertilizer Prod. Unit Plot No. 46/40, Mahad Colony Near ITI, Wardha	150	3.615	0	17.1	16.73	37.445	0	37.445
Vasundhara Agrotech, Walu, Aurangabad	15	0.25	0	0.1	2	2.35	8	10.35
Sangammer Bhag Sahakari Sakhar, Karkhana, Ahmednagar	25	2.23	0	0	2.214	4.44	9.308	13.752
Rajaram Bapu Patil Sahakari Sakhar, Karkhana, Rajaram Nagar, Sangli	75	7.049	0	0	7.251	14.30	31.041	45.341
M.S. Industries, Amravati	50	0.21	0.1	3.25	12.25	15.81	0.13	15.94
Krishak Bharti Coop Ltd. Lanja, Ratnagiri	150	24.95	6.5	22.07	68.15	121.67	2.13	123.8
Polchem Hygiene Lab, Pune	50	1.926	0	0	0.799	2.725	0	2.725
Envrionmental Protection Research Foundation, ' Arundhati' Vishrambag, Sangali (M.S.)	150	2.5	0	0.2	10.5	13.20	65	78.2
Pravara Agro Biotech, Sangamner, Ahmednagar	150	18.55	1	5	29	53.55	11	64.55
Choudhury Agrotech, Sri Devi Complex, Agyaram Devi Chowk, Subhas Road, Nagpur (M.S.)	50	12	0	4	15	31.00	0	31
Govinda Agro Tech Pvt. Ltd., Opposite Agyaram Devi Mandir, Bus Stand Road, Nagpur (M.S.)	150	30	0	30	52	112.00	0	112
Arun Biofertilisers Near MSEB, Power House Kurundwad, Tal-Shirol, Kolhapur	150	0	0	0	80	80.00	60	140
ELLORA Biotech, 20, Udyogmitra Industrial Estate, Chitegaon, Paithan, Aurangabad	150	30	0	28	72	130.00	0	130
Hindustan Antibiotics Ltd., Pimpri, Pune	25	9.183	0	0	9.716	18.899	0	18.899
Institute of Natural Organic Agriculture (INORA) , 11 B, Kulkarani Bungalow, Shikshak Nagar, Paud Road, Pune	200	22	5	11	76	114.00	8	122
Niranjan Biotech Pvt., Pune	50	0.25	0	0	0.25	0.50	0	0.5
Krishi Padvidhar Udyogic Ltd., Islampur	150	0	0	0	0	0.00	32.5	32.5
Kumar Krishi Mitra Bio Products(I) P Ltd., 917/17, 12 Ganeshwadi, Fergusan Road, Pune (M.S.)	2160	697.8	0	0	121.8	819.60	0	819.6
Kan Bioscience Pvt. Ltd., Pune	25	0.61	0	0	0.237	0.847	0	0.847
Santosh Biofertilizer Lab, Sawangi, Wardha	25	5	0	0	5	10.00	0	10.00
Durva Biotech, Somalwada, Wardha	25	0.5	0	0.3	9	9.80	0	9.8

Organization Name	Capacity	AZOTO.	AZOSP.	RHIZ.	PSB	Total BF	Other Inoculants	Total
Vaibhav Laxmi Biocontrol Lab, Wardha (M.S.)	50	3	0	7.5	8	18.50	0	18.50
Vidarbha Biotech, Yawatmal	50	8	0	5	13	26.00	0	26.00
Shree Jee Biotech, MIDC, Wardha	50	10	0	7	20	37.00	0	37
Harit Biocontrol Lab, Yawatmal	25	0.5	0.5	3	3	7.00	0	7.00
Microplex India 36 Mohata Market, Main Road, Wardha	300	5	0	50	52	107.00	0	107.00
Proothvi Biotech, Ambazari, Nagpur	25	0.5	2	2	5	9.50	0	9.50
Vishwadutt Minerals Pvt. Ltd, Nagpur	50	0.5	0	2.5	0.5	3.50	0	3.50
Ruchi Oyster	75	1.5	8.7	17.5	23.8	51.50	0	51.50
Nath Krupa Biocontrol Lab, Somalwada, Nagpur	25	0.5	0	0.2	0.5	1.20	0	1.20
Maharashtra Total	**5775.00**	**984.50**	**83.80**	**339.33**	**1078.78**	**2486.409**	**258.161**	**2744.570**
				Nagaland				
Biofertilizer Lab, Medziphema, Nagaland, Kohima	150	3.82	1.6	2.14	6.42	13.98	0	13.98
Nagaland Total	**150**	**3.82**	**1.6**	**2.14**	**6.42**	**13.980**	**0**	**13.98**
				Orissa				
Orissa A.I.C.Ltd., BBSR.	30	0	0	0	0	32.89	0	32.89
Bacteria Inoculation Lab, Sahid Nagar, Bhubaneshwar	50	0	0	0	0	19.65	0	19.65
State Biochemist, Orissa	50	2.38	4.02	13	15	34.40	0	34.40
Maa Kanak Biofertilizer, BBSR	300	150	35	20	40	245.00	13	258.00
Orissa Total	**430**	**152.38**	**39.02**	**33**	**55**	**331.94**	**13**	**344.94**
				West Bengal				
Deptt. of Agril. West Bengal	75	2.01	0.1	4.1	26.75	32.96	0	32.96
B.C.K.V.,LakeHall Campus,Kalyani	250	35.02	112.01	33.45	45	225.48	0	225.48
B.C.K.V.,Mohanpur	75	12.13	10	5.01	10	37.14	0	37.14
Nitrofix Laboratories, Kolkatta	175	0	0	0	0	143.00	0	143.00
Vivekand Instt. of Biotechnology, 24-Pargansa, Kolkatta	75	24	13.25	25.78	5.29	68.32	0	68.32
Excel Biotech Pvt. Ltd., 24-Paragansa, Kolkotta	80	0	0	0	0	76.60	0	76.60
Lila Agrotech	375	150.27	0.1	112.79	75.68	338.84	0	338.84
West Bengal Total	**1105**	**223.43**	**135.46**	**181.13**	**162.72**	**922.34**	**0.00**	**922.34**
				Jharkhand				
Birsa Agril, University, Ranchi	20	0	0	0	0	11.68	0	11.68
Swarnarekha Enterprises, Ranchi	200	75	25	15	75	190.00	0	190.00
Jharkhand Total	**220**	**75**	**25**	**15**	**75**	**201.68**	**0**	**201.68**
				Punjab				
Punjab Agriculture University, Ludhiana	2	0	0	1.7	0	1.70	0	1.70
Punjab Total	**2**	**0**	**0**	**1.7**	**0**	**1.70**	**0**	**1.7**
				Rajasthan				
Rhizobium Production Lab., Durgapura, Jaipur	50	3.898	0	12.698	17.157	33.75	0	33.75

Organization Name	Capacity	AZOTO.	AZOSP.	RHIZ.	PSB	Total BF	Other Inoculants *	Total
Nafed Biofertilizer SPL-80 RIICO Industrial Area Bharatpur (Rajasthan)	500	8.245	0	22.729	17.606	48.58	0	48.58
Jaipur Biofertilizer, J-71, Ashok Chowk, Adarsh Nagar, Jaipur- 302 004	250	35.27	0	22.88	161.82	219.97	0	219.97
Rajasthan Total	**800**	**47.413**	**0**	**58.307**	**196.583**	**302.303**	**0**	**302.303**
Tamil Nadu								
Monarch Biofertilizers & Res. Centre, No. 12, SIDCO Indl. Area, Thiramazhisai Chennai-602 107	10	1.54	0	0	1.865	3.41	10.69	14.095
Esvin Advance Technologies Limited, Esvin House, Perungudi, Chennai- 600 096	300	0.772	76.185	10.786	81.326	169.07	34.562	203.631
M/s Elbitec Innovations Ltd, 46 & 48, 2nd Floor, Masilamani Road, Balajinagar, Chennai	100	24.3	20.4	23.89	185.2	253.79	546.4	800.19
The Chief Manager-Bio Products, Madras Fertilizers Ltd., Manali, Chennai- 600 068	300	49.02	0	0	6.8	55.82	0	55.82
The Agricultural Chemist Biofertilizer Produ. Unit, Jamal Mohd. College Post Khajamalai Trichy-620 020, Tamil nadu	300	4.25	110.25	45.89	80.52	240.91	0	240.91
Dr. Y.Joe M/s Marygreen Agrotech (P) Ltd., Srisaibaba Street, Santosh Nagar, Kandanchavadi, Perugudi, Chennai- 600 096	250	0	0	0	0	0.00	145.55	145.55
Lakshmi Bio techs Shiva Shanti Gardens No. 30, Dowlath nagar, Cuddalore	250	0	0	0	0	0.00	168.34	168.34
M/s Rajashree Sugars & Chemicals Ltd., Theni Dist.- 625 562, Tamilnadu	30	8.35	0.042	0	9.39	17.78	7.7	25.482
The Agricultural Chemist Biofertilizer Prodn. Unit Seelanaickenpatty Salem- 636 201, Tamilnadu	400	0	148.6	53.78	110.12	312.50	0	312.5
The Agril. Chemist Biofertilizer Prodn. Unit Kudumianmalai- 622 104, Pudukottai Dist. (Tamilnadu)	300	0	173.65	36	113.38	323.03	0	323.03
The SIMA Cotton Dev & Res. Assn. "Shanmukha Manram", P.B.No. 3871, Race Course, Coimbutore- 641 018	100	0	2.77	0	2.77	5.54	0	5.54
M/s T. Stanes & Co. Ltd. 8/23-24, Race Course Rd, Coimbatore- 641 018	660	17	73.008	50	203.006	343.01	250.024	593.04
Agril. Chemist Biofertilizers Prodn. Unit, Ramanathapuram R.T.O. Office Road, Collectorate Post, Ramanathapuram	400	0	142.63	23.22	90.05	255.90	0	255.9

Organization Name	Capacity	AZOTO.	AZOSP.	RHIZ.	PSB	Total BF	Other Inoculants *	Total
Krishi Care Bio Inputs Plot No. 51, Madha Nagar, Main Raod, Madhanagar, Mouliwakkam, Chennai-	200	0	0	0	26.9	26.90	122.34	149.24
M/s Jeypee Biotechs 25, Chinniah School Street, Virudhunagar	75	18.6	21.6	32.36	84.6	157.16	38	195.16
M/s Green Peace Associates, 201, Mettur Road Erode- 638 001	250	0	0	0	0	0.00	178.67	178.67
Balaji Biotech Research Centre, Sathanur, Vazhur Post, Vandavasi Tq. Thiruvannamalai	250	0	0	0	0	0.00	203.78	203.78
Shristti Bioproducts Pvt. Ltd., 48, Ramar Koil Street, Ramnagar, Coimbatore	200	0	22	0	158.56	180.56	0	180.56
Forest Ranger Modern Nursery Range, Dharmapuri-5, T.N.	50	2	13	22.5	0	37.50	0	37.5
Srinivasa Marine Chemicals, 19, Veeran Street Tirumangalam, Madurai, DT	1000	0	0	0	0	0.00	967.98	967.98
Pasumai Agro Industries, #2, New Street, Valavachanur (PO), Chengam TK, Thiruvannamalai DT	550	0	0	0	0	0.00	489.8	489.8
Agriculture Chemist Biofertilizer Prodn. Unit, Dept. of Agriculture, Govt. of TamilNadu, Gundusalai Road, Sommandalam, Cuddalore- 607 001	300	0	0	0	0	0.00	274.5	274.5
Agriculture Chemist Biofertilizer Prodn. Unit, Dept. of Agriculture, Govt. of TamilNadu, Sakkottai, Thanjavur	300	0	140	31.56	111.76	283.32	0	283.32
Tamil Nadu Cooperative Sugar Federation Ltd., 474, Anna Salai, Periyar EVR Bldg., 5th Floor Nandanam, Chennai	400	0	0	0	70	70.00	150.8	220.8
OMEGA Ecotech Products India Pvt. Ltd. No.- 63-A, Bharathi Nagar Main Road, Bharathi Nagar, Ganapathy, Coimbatore	500	9.347	5.77	0.125	6.244	21.49	125.285	146.771
Innova Agrotech (P) Ltd., 2/527-1, East Street, Kulloorchanadai, Virudhunagar- 626 001	600	0	0	0	0	0.00	437.67	437.67
R. Sundar, 25, ChinniahSchool Street, Virudhunagar- 626 001	700	0	0	0	159.7	159.70	460.89	620.59
Krishicare Bioinputs Kamatch Nagar, Kundrathur Rd., Madhanandhapuram, Porur, Chennai- 600 116	500	0	0	0	25.75	25.75	284.56	310.31
Lakshmi Bio Techs, Tottapattu, Cuddalore	750	0	0	0	23.67	23.67	530.9	554.57

Organization Name	Capacity	AZOTO.	AZOSP.	RHIZ.	PSB	Total BF	Other Inoculants *	Total
Bio Lab, Bannari Amman Sugars Ltd., Alathukombai, Satyamangalam- 638 401, Erode, TN	1000	0	12.78	0	58.45	71.23	780.12	851.35
PL Agro Technolgies Ltd, Chennai- 600 034	50	0	0	0	0	0.00	38.45	38.45
M/s RamaKrishna, Bldg.No. 239, Annasalai, P.B. No. 703, Chennai-	250	0	0	0	20.65	20.65	124.64	145.29
M/s Arvee Biotech, 134, East Car Street, Chidambaram, Cuddalore	1500	0	37.44	0	370.84	408.28	879.23	1287.51
Tamil Nadu Total	**12825**	**135.179**	**1000.125**	**330.111**	**2001.551**	**3466.97**	**7250.881**	**10717.85**
Tripura								
Regional Biofertilizer Production Unit, Datta, A.D. Nagar, Tripura	30	6.325	0	1.62	6.325	14.27	0	14.27
Tripura Total	**30**	**6.325**	**0**	**1.62**	**6.325**	**14.27**	**0**	**14.27**
Uttar Pradesh								
Moti Lal Nehru Farmers Training Institute, Phulpur, Allahabad	150	78.046	0	0.025	96.98	175.05	4.211	179.26
Head, Soil Testing and Biofertilizer Production Lab, Etah (U.P.)	15	2.163	5.876	1.194	0	9.23	0	9.23
Dy. Director (Research), Departmental Agriculture Training & Testing Centre, Itawa	50	4.122	0	8.001	11.719	23.84	0	23.84
Head, Soil Testing Lab, Badaiu (U.P.)	50	5.416	0	4.736	10.324	20.48	0	20.48
Dy. Director Agriculture (Research), Departmental Agriculture Training & Testing Centre, Meerut	50	5.667	0	2.598	13.19	21.46	0	21.46
Uttar PradeshTotal	**315**	**95.414**	**5.876**	**16.554**	**132.213**	**250.06**	**4.211**	**254.27**
Pondicherry								
ROM Vijay Biotech No. 5, Cuddalore Main Road, Kanniakoil Pondicherry	150	10.34	34.54	65.63	280.77	391.28	845.22	1236.50
Perunthalivar Kamaraj Krishi Vigyan Kendra, Kurumbapet, Pondicherry	75	0	0	0	0	0.00	45.78	45.78
Green Tech Horti Consultancy Services C/o Mr. C.Ganeche 92- Nallavadu Road Abiga hekapakkam (PO), Pondicherry	500	0	34.89	0	26.77	61.66	267.89	329.55
M/s. Golulam Enterprises, No. 36, Sri Ram Nagar, Cuddalore Pondy Main Road, Kaniakoil Puducherry.	75	0	0.313	0	0.028	0.34	46.895	47.24
M/s PASIC, BF Prodn. Centre Agro House Agriculture Complex, Thattanchavady, Puducherry	90	0	7.958	1.88	8.167	18.005	7.61	25.615
Pondicherry Total	**890**	**10.34**	**77.701**	**67.51**	**315.735**	**471.29**	**1213.395**	**1684.681**
Grand Total	**67162.00**	**3360.85**	**2944.55**	**2825.89**	**10675.93**	**20111.05**	**18821.64**	**38932.689**

Growth in production of total Biofertilizers during last five years is given in Table 4.

Table 5 : Production of Biofertilizer in India during 2003-2004 to 2007-2008 (tonnes)

Sl. No.	Name of the State	Years				
		2003-2004	2004-2005	2005-2006	2006-2007	2007-08
	South Zone					
1	A & N Islands	0	0	0	0	0
2	Andhra Pradesh	205.00	2019.50	2246.43	4500.619	4515.81
3	Daman & Diu	0	0	0	0	0
4	Karnaraka	1083.40	1135.86	612	341.64	2841.269
5	Kerala	54.85	213.25	8.34	261.75	814.447
6	Lakshadweep	0	0	0	0	0
7	Pondicherry	22.62	0	7.78	1827.78	471.286
8	Tamil Nadu	1845.50	1564.94	2207.58	1770.29	3466.966
	Total	3211.37	4933.55	5082.13	8702.079	12109.778
	West Zone					
9	Chhatisgarh	86.95	0	0	0	0
10	Gujarat	1034.85	943.00	1371.60	1250.63	1263.301
11	Goa	0	0	0	3.5	0
12	Madhya Pradesh	1300.45	1333.94	823.07	1204.76	1884.867
13	Maharashtra	3035.00	3049.98	2098.96	2425.959	2486.41
14	Rajasthan	590.01	30.64	430.59	339.75	302.303
15	D & N Haveli	0	0	0	0	0
	Total	6047.26	5357.56	4724.22	5224.599	5936.88
	North Zone					
16	Delhi	0	1.36	1.23	0	168.844
17	Chandigarh	0	0	0	0	0
18	Haryana	22.54	20.16	23.48	30.22	8.89
19	Himachal Pradesh	9.48	10.30	9.59	0	56.21
20	Jammu & Kashmir	0	0	0	0	0
21	Punjab	2.95	0.37	2.27	2	1.7
22	Uttar Pradesh	115.98	130.27	486.30	212.78	250.057
23	Uttaranchal	0	0	0	0	0
	Total	150.95	162.46	522.87	245	485.701
	East Zone					
24	Bihar	0	15.00	41.00	36.9	20
25	Jharkhand	0	0	9.00	205.62	201.68
26	Orissa	59.31	32.62	65.97	280.54	331.94
27	West Bengal	226.53	74.296	194.60	1406.48	922.34
	Total	285.84	121.916	310.57	1929.54	1475.96
	North East Zone					
28	Arunachal Pradesh	0	0	0	0	0
29	Assam	88.50	25.20	107.60	8.465	70.901
30	Manipur	0	0	0	0	0
31	Meghalaya	0	0	0	0	0
32	Mizoram	1.14	0	0	1.68	3.58
33	Nagaland	8.03	0	17.03	10.65	13.98
34	Sikkim	0	0	0	0	0
35	Tripura	5.80	0	0	23.25	14.27
	Total	103.47	25.20	124.63	44.05	102.73
	Grand Total	**9798.89**	**10600.686**	**10764.42**	**16145.263**	**20111.05**

Data compiled is based on information received from State Govt/Regional Centres/NGOs/Pvt Production units

Research Notes

Bioformulation of *Burkholderia* sp. MSSP with a multispecies consortium for growth promotion of *Cajanus cajan* - The present work was undertaken to formulate an effective bioformulation using *Burkholderia* sp. strain MSSP, a known plant-growth-promoting rhizobacterium. MSSP was tagged with the reporter gene of green fluorescent protein (*gfp*) to monitor its population in cost-effective solid carriers, including sugarcane-bagasse, sawdust, cocoa peat, rice husk, wheat bran, charcoal, and rock phosphate, and paneer-whey as liquid carrier. Physical and chemical properties of different low-cost carrier materials were studied. The viability of the green fluorescent tagged variant of MSSP was estimated in different sterile carrier materials. Whey and wheat bran proved to be efficient carrier materials for the bioformulation. Sawdust, rock phosphate, rice husk, and cocoa peat were average, while charcoal and sugarcane-bagasse proved to be inferior carriers. The viability of strain MSSP was also assessed in wheat bran and whey-based consortium, having three other bacterial strains, namely *Sinorhizobium meliloti* PP3, *Rhizobium leguminosarum* Pcc, and *Bacillus* sp. strain B1. Presence of other plant-growth-promoting bacteria did not have any detrimental effect on the viability of MSSP. Efficiency of the wheat-bran-based multispecies consortium was studied on the growth of pigeonpea in field conditions. A considerable increase in plant biomass, nodule number and weight, and number of pods was recorded as compared with individual trials and with the control. (Source - Maheshwari, D.K.; Pandey, Piyush 2007 Canadian Journal of Microbiology, Volume 53, (2) : 213-222).

Synergistic effects of plant-growth promoting rhizobacteria and *Rhizobium* on nodulation and nitrogen fixation by pigeonpea (*Cajanus cajan*) – Plant-growth promoting rhizobacteria (PGPR), in conjuction with efficient *Rhizobium*, can affect the growth and nitrogen fixation in pigeonpea by inducing the occupancy of introduced *Rhizobium* in the nodules of the legume. This study assessed the effect of different plant-growth promoting rhizobacteria (*Azotobacter chroococcum,Azospirillum brasilense*, *Pseudomonas fluorescens*, *Pseudomonas putida* and *Bacillus cereus*) on pigeonpea (*Cajanus cajan* (L) Milsp.) cv. P-921 inoculated with *Rhizobium* sp. (AR-2–2□k). A glasshouse experiment was carried out with a sandy-loam soil in which the seeds were treated with *Rhizobium* alone or in combination with several PGPR isolates. It was monitored on the basis of nodulation, N_2 fixation, shoot biomass, total N content in shoot and legume grain yield. The competitive ability of the introduced *Rhizobium* strain was assessed by calculating nodule occupancy. The PGPR isolates used did not antagonize the introduced *Rhizobium* strain and the dual inoculation with either *Pseudomonas putida*, *P. fluorescens* or *Bacillus cereus* resulted in a significant increase in plant growth, nodulation and enzyme activity over *Rhizobium*-inoculated and uninoculated control plants. The nodule occupancy of the introduced *Rhizobium* strain increased from 50% (with *Rhizobium* alone) to 85% in the presence of *Pseudomonas putida*. This study enabled us to select an ideal combination of efficient *Rhizobium* strain and PGPR for pigeonpea grown in the semiarid tropics. (Source - Tilak, Ranganayaki, and Manoharachari 2006 European Journal of Soil Science, Volume 57 (1) , February 2006 , pp. 67-71).

Production of biofertilizers using baker's yeast effluent and their application to wheat and barley grown in north Sinai deserts - Effluent from the baker's yeast industry was experimented on as a culture medium for the growth and biomass production of diazotrophs. The effluent supported good growth of *Azotobacter chroococcum*, *Enterobacter agglomerans* and *Klebsiella pneuomoniae*, *Azospirillum brasilense*, *Bacillus polymyxa* and *Pseudomonas putida* and strongly proposed for biofertilizers production of associative diazotrophs. Slurry preparations containing natural polymers, e.g. Arabic gum (5%), pero-dextrin (20%), starch granules (10%) or gelatine (20%) were impregnated with cells of tested diazotrophs. With storage, entrapped cells of *B. polymyxa* were viable up to 160 days, while gradual decreases in *Azospirillum* numbers were recorded. Pero-dextrin, a by-product of the starch industry, was selected as the appropriate biocarrier accommodating diazotroph cells and maintaining prolonged survival rates and nitrogenase activity. Cell cultures of *A. brasilense*, *A. chroococcum*, *B. polymyxa*, *E. agglomerans* and *P. putida* were equally mixed and entrapped into pero-dextrin slurry biofertilizer formulation named as "BIOGRAMINA". Tested diazotrophs successfully survived (*ca.* 10^8 cfu ml^{-1}) in such formulation up to 6 months at both ambient and cold temperatures. The response of wheat and barley to "BIOGRAMINA" in the presence or absence of N fertilizers was evaluated in greenhouse and field trials. Highest total biological yields were recorded for inoculated plants simultaneously supplemented with rational N fertilizer dose. (Source Ali et al Archives of Agronomy and Soil Science, Volume 51, Issue 6 December 2005 , pages 589 – 604)

Development of multiple co-inoculants of different biofertilizers and their interaction with plants – The present investigation was undertaken to assess the feasibility and compatibility of different biofertilizers like *Rhizobium*, *Azotobacter*, *Azospirillum*, *Pseudomonas* and *Bacillus* as co-cultured multiple inoculant. The microbe-microbe interaction under cultural conditions, in charcoal-based carrier and with pigeonpea and mungbean plants was determined. Under cultural conditions, co-inoculation of *Azotobacter*, *Bacillus*, *Pseudomonas* and *Rhizobium* resulted in reduced growth of *Rhizobium*. A co-culture multiple inoculant in sterilized fine wood charcoal powder (200 g) of *Azotobacter*, *Azospirillum*, *Bacillus* and *Pseudomonas* containing more than 2×10^8 cells g^{-1} carrier was possible. However, the number of rhizobia reduced to less than 2×10^8 cells g^{-1} carrier, when co-cultured with *Rhizobium*. Inoculation of pigeonpea and mungbean seeds with multiple co-inoculant produced maximum nodule biomass, plant biomass and total soil N in case of pigeonpea and mungbean hosts. However, no beneficial effect of co-cultured multiple inoculants on nodule occupancy of pigeonpea or mungbean was observed. (Source – Suneja et al Archives of Agronomy and Soil Science, Volume 53, Issue 2 April 2007 , pages 221 – 230)

Crop improvement and root rot suppression by seed bacterization in chickpea - Field experiments were conducted at the Regional Research Station, CCS Haryana Agricultural University, Bawal, India, to evaluate the contribution of different bioinoculants in terms of nodule number, nodule biomass, root rot incidence and seed yield in chickpea. Nodule number and biomass were positively affected by the application of bioinoculants. Plant growth promoting rhizobacteria (PGPR) alone or in combination with bioinoculants reduced plant mortality and increased seed yield of the crop. Seed yield at 50% fertilizer dose (RF) plus all the three inoculants was at a maximum during all the three years of experimentation. (Source – Pathak et al Archives of Agronomy and Soil Science, Volume 53, Issue 3 June 2007 , pages 287 – 292)

Potential use of *Rhizobium* spp. to improve fitness of non-nitrogen-fixing plants - Plant-growth-promoting bacteria (PGPR) stimulate plant growth by producing and/or inducing the plant to release secondary metabolites facilitating the uptake of nutrients and/or inhibiting plant pathogenic organisms in the rhizosphere. Recently, legume bacteria (*Rhizobium spp.*) have been reported to act as PGPR. In this study, we investigated the potential use of legume bacteria as PGPR in nonlegumes by inoculating eight different rhizobial strains onto mixtures of six botanically different non-nitrogen-fixing plant species. Each seed mixture was inoculated before sowing with the same concentration of the respective rhizobial strain. The results showed that inoculation with certain rhizobial strains increased plant biomass. In a follow-up experiment, we investigated the importance of cell density of the rhizobial inoculant by inoculating seeds of one species (*Linum usitatissimum*) with only one rhizobial strain, but at different concentrations. A concentration of level 10^4 c.f.u. (colony-forming units) mL^{-1} proved to be the best for successful growth. A supplementary *in vitro* study investigating potential mechanisms behind the plant stimulatory effect of rhizobia found that some rhizobial strains have a capability to dissolve the fungal mycelium at the initial stage. These results demonstrate that certain rhizobial strains have interesting features that deserve further attention when evaluating and developing biological plant-protection systems and/or plant-stimulating agents. (Source – Hossain and Martinson Acta Agriculturae Scandinavica, Section B - Plant Soil Science, Volume 58, Issue 4 December 2008 , pages 352 – 358)

Effect of application of biofertilizers to soybean (*Glycine max*) and nitrogen to tobacco (*Nicotiana tabacum*) in soybean – tobacco cropping system - A field experiment was conducted during 2001–02 and 2002–03 at Jeelugumilli to find out the direct and residual effects of *Bradyrhizobium japonicum* and *Pseudomonas striata* inoculation on rainy season (*kharif*) soybean [*Glycine max* (L.) Merr.] cv 'JS 335' and of directly applied N in winter (*rabi*) season FCV tobacco (*Nicotiana tabacum* L.) cv 'Kanchan' in irrigated Alfisols of Andhra Pradesh. C*o*-inoculation of soybean with *Bradyrhizobium* + *Pseudomonas* recorded significantly higher growth, yield attributes and grain yield than their individual inoculation and no inoculation. Green-manuring *in situ* with sunnhemp [*Crotalaria juncea* (L.) Rotar & Joy] followed by tobacco recorded significantly higher tobacco green-leaf and cured-leaf yields, and grade index compared with other treatments. Combined inoculation of *Bradyrhizobium* and *Pseudomonas* to soybean increased the tobacco green leaf yield, cured leaf yield and grade index by 10.5, 7.7 and 13.2% respectively compared with no inoculation. Application of 130 kg N/ha recorded significantly higher green-leaf and cured-leaf yields, and grade index compared with that of 110 kg N/ha. Higher total N, nicotine, lower reducing sugars and sugar: nicotine ratio in X and L leaf positions were observed in sunnhemp–tobacco system, followed by soybean (co-inoculation) – tobacco system. Higher total N, nicotine, lower reducing sugars and sugar: nicotine ratio were recorded with 130 kg N/ha than with 110 kg N/ha. Soybean (co-inoculation) – tobacco system gave additional net returns of Rs 1,710/ha over sunnhemp–tobacco system (Rs 40,670/ha). Higher B: C ratio of 1.65 was obtained with sunnhemp – tobacco system. It was concluded that combined inoculation of *Bradyrhizobium* and *Pseudomonas* to soybean improved the growth and yield of soybean and increased the succeeding tobacco yields, and application of 130 kg N/ha would be needed for tobacco succeeding soybean. (Source – Krishna et al Indian Journal of Agronomy 2007, Volume : 52 (4)

Role of phosphate-solubilizing microorganisms in sustainable agriculture - A review - Compared with the other major nutrients, phosphorus is by far the least mobile and available to plants in most soil conditions. Although phosphorus is abundant in soils in both organic and inorganic forms, it is frequently a major or even the prime limiting factor for plant growth. The bioavailability of soil inorganic phosphorus in the rhizosphere varies considerably with plant species, nutritional status of soil and ambient soil conditions. To circumvent phosphorus deficiency, phosphate-solubilizing microorganisms (PSM) could play an important role in supplying phosphate to plants in a more environmentally-friendly and sustainable manner. The solubilization of phosphatic compounds by naturally abundant PSM is very common under in vitro conditions; the performance of PSM in situ has been contradictory. The variability in the performance has thus greatly hampered the large-scale application of PSM in sustainable agriculture. Numerous reasons have been suggested for this, but none of them have been conclusively investigated. Despite the variations in their performance, PSM are widely applied in agronomic practices in order to increase the productivity of crops while maintaining the health of soils. This review presents the results of studies on the utilization of PSM for direct application in agriculture under a wide range of agro-ecological conditions with a view to fostering sustainable agricultural intensification in developing countries of the tropics and subtropics. (Source - Khan et al India 2007Agron. Sustain. Dev. 27 : 29-43)

Microbial conversion of food wastes for biofertilizer production with thermophilic lipolytic microbes - Food waste is approximately one quarter of the total garbage in Taiwan. To investigate the feasibility of microbial conversion of food waste to multiple functional biofertilizer, food waste was mixed with bulking materials, inoculated with thermophilic and lipolytic microbes and incubated at 50 °C in a mechanical composter. Microbial inoculation enhanced the degradation of food wastes, increased the total nitrogen and the germination rate of alfalfa seed, shortened the maturity period and improved the quality of biofertilizer. In food waste inoculated with thermophilic and lipolytic *Brevibacillus borstelensis* SH168 for 28 days, total nitrogen increased from 2.01% to 2.10%, ash increased from 24.94% to 29.21%, crude fat decreased from 4.88% to 1.34% and the C/N ratio decreased from 18.02 to 17.65. Each gram of final product had a higher population of thermophilic microbes than mesophilic microbes. Microbial conversion of food waste to biofertilizer is a feasible and potential technology in the future to maintain the natural resources and to reduce the impact on environmental quality. (Source – Tsai et al Renewable Energy Volume 32, Issue 6, May 2007, Pages 904-910)

Alternatives to peat as a carrier for rhizobia inoculants: Solid and liquid formulations - Many of the microbial inoculants all over the world are based on solid peat formulations. This has been mostly true for well developed legume inoculants based on selected rhizobial strains, due to peat bacterial protection properties. Six carriers (bagasse, cork compost, attapulgite, sepiolite, perlite and amorphous silica) were evaluated as alternatives to peat. Compost from the cork industry and perlite were superior to peat in maintaining survival of different rhizospheric bacteria. Other tested materials were discarded as potential carriers for soybean rhizobia. Also, different liquid culture media have been assayed employing mannitol or glycerol as C sources. Some media maintained more than 10^9 cfu ml^{-1} of *Sinorhizobium* (*Ensifer*) *fredii* SMH12 or *Bradyrhizobium japonicum* USDA110 after 3 months of storage. Rhizobial survival on pre-inoculated seeds with both solid and liquid formulations previously cured for 15 days led to a higher bacterial numbers in comparison with recently made inoculants. An additional curing time of solid inoculants up to 120 days had a beneficial effect on rhizobial survival on seeds. The performance of different formulations of two highly effective soybean rhizobia strains was assayed under field conditions. Soybean inoculated with cork compost, perlite and liquid formulations produced seed yields that were not significantly different to those produced by peat-based inoculants. (Source – Albareda et al Soil Biology and Biochemistry Volume 40, Issue 11, November 2008, Pages 2771-2779).

Plant Root Associated Bacteria for Zinc Mobilization in Rice - The activity of Plant Growth Promoting Rhizobacteria (PGPR) to mobilize indigenous soil zinc (Zn) in rice (*Oryza sativa* L.) rhizosphere was observed in a net house micro plot experiment and compared with available form of chemical Zn source as Zn-EDTA. The PGPR application alleviated the deficiency symptoms of Zn and invariably increased the total biomass (23%), grain yield (65%) and harvest index as well as Zn concentration in the grain. The inoculation had a positive impact on root length (54%), root weight (74%), root volume (62%), root area (75%), shoot weight (23%), panicle emergence index (96%) and showed the highest Zn mobilization efficiency as compared with the un-inoculated control. The PGPR colonized rice plants were more efficient in acquiring Zn from either added or indigenous source, than non-colonized plants. Zinc mobilization by PGPR was also confirmed in liquid culture medium. It was concluded that, selected PGPR strains can serve as efficient solubilizer of Zn, allowing farmers to avoid the use of costly chemical

Zn fertilizer in rice crop. (Source – Tariq et al Pak. J. Bot., 39(1): 245-253, 2007.

Hypersaline Cyanobacterium: A Potential Biofertilizer for *Vigna mungo*. L (Black Gram) - The present study highlights the effect of interspecific competition between natural fertilizers, (cow dung), chemical fertilizer (urea), and biofertilizer (*Phormidium tenue, Bradyrhizobium* sp) on the overall growth performance and reproductive yield of *Vigna mungo* L. All the observations were done under the same experimental and environmental conditions. The differences in the growth parameters such as shoot length, root length, number of nodules, 100 grain weight, number of flowers, shoot and root weight were studied at different stages i.e., vegetative, flowering and pod forming. The biochemical constituents of leaf and seed were analyzed for chlorophyll, protein and total free amino acid content. (Source – Karthikeyan *et al* American-Eurasian Journal of Sustainable Agriculture, 2(1): 87-91, 2008)

Biofertilizer Quality Testing Kit

Scientists, world over are trying to develop quick methods for stimating bacterial populations in bioinoculants which can be used by quality control laboratories to check strain purity and inoculant quality. A quick biofertilizer testing kit, using genetic marker has been developed by the scientists at CCS, Haryana Agricultural University, Hisar under "All India Network Project on Biofertilizers". Strains of Azotobacter, Pseudomonas, Bacillus and Rhizobium were tagged with a genetic marker encoding for the enzyme ß-galactosudase and the end product was detected using chromogenic substrate. The amount of enzyme activity was correlated with the viable cell number to estimate the viable cell population in broth as well as charcoal based inoculants. This test can be performed either quantitatively in liquid cultures or qualitatively using filter paper discs. Viable cell population in liquid cultures can be estimated in 1 hour.

For estimation in cell number in charcoal based inoculants sample of bioinoculants (10 g) is suspended in 90 ml of water and shaken for 30 min on a magnetic stirrer. The suspension is filtered through Whatman filter paper. One ml filtrate is mixed with 1.4 ml of solution I and incubated at 37^0C till the development of yellow colour. Reaction is stopped by adding 2.0 ml solution II and the colour developed is read by using a spectrophotometer. This method has been standardized using bioinoculants of Azotobacter, Pseudomonas and Rhizobium. Viable cell population of 10^6 cells/g of charcoal can be estimated using this method.

(Source – D.L.N. Rao (Ed), Biofertilizer Research Progress 2004-2007, All India Network Project on Biofrtilizers, IISS, ICAR, Bhopal, M.P.)

Workshops, Conference and Training News

International Study Meeting on the Development and Utilization of Biofertilisers for Promoting Sustainable Agriculture & Green Productivity - Asian Productivity organization (APO) Japan, in collaboration with National Productivity Council India with financial support from the National Project on Organic Farming, Department of Agriculture and Cooperation, Ministry of Agriculture Govt. of India organized a study meeting on the Development and Utilization of Biofertilisers for Promoting Sustainable Agriculture & Green Productivity from 5th Nov. to 11th Nov. 2008 at India International Centre, New Delhi.

The objectives and the scope of study meeting were: (a) To review the current status & recent development in biofertiliser development and use. (b) To examine and analyze issues and challenges in promoting the development and use of biofertilisers and (c) To formulate strategies and recommendations for promoting biofertiliser development & use in member countries.

The study meeting was participated by twenty-Five participants from different countries of the Asia Pacific Region including 4 from India. The meeting was inugurted by The director General of Productivity Council of India. Dr. Muhammad Sayeed, Programme Officer, APO Japan delivered introductory speech.

Dr. Tong-Min-Sa Professor, Department of Agriculturral chemistry chung bwk National University Republic of Korea delivered a lecture on production & use of biofertilisers in Korea. Beside use of different species of Azospirillum, Azotobactor and PSB, Dr. Tong also discussed about the use of two microbes like *Burkholdaria* and *Methylobacterium* as potential future biofertiliser. The *Burkholdaria brasilemmes* is an endophyte of roots, stem and leaves of sugar plant. It is also isolated from the rice in Brazil. It can provide 31% of Rice plant-N from the atmosphere and its inoculation increased rice plant biomass by about 69% compared to control. It also showed phosphate solubilizing ability and produces hormones like IAA.

The other microbe, which is being used as biofertiliser in Korea is *Methylobacterium* which is aerobic & facultative methylotrophic & consist of 14 species. The association of *Methylobacterium* species with plants seems to rely on a symbiotic relationship between the bacterium & the plants host. Plants produce methanol, which is toxic & is used by *Methylobacterium* species as the sole source of carbon and energy. *Methylobacterium* species produce phytohormones (cytokinens & auxins) which are known to stimulate plant growth, fix atmospheric nitrogen or help plants to fight pathogens through induced systemic resistance to dehydration, freezing, UV and ionising radiation and elevated temperature. This species is known to metabolize a range of toxic chemicals such as methyl.

Dr. Shotaro Ando, Research leader, Forage production & Agro. Environment Research Team, National Institute of Livestock & Grassland Science (NILGS) National Agriculture & Food Research organization Japan, discussesd about Biofertiliser Production & use scenario in Japan. *Rhizobium*, *Azobactor* and Mycorrhizae (AM) are mainly used in Japan. A Biofertiliser namely "Mamezo" widely used in Japan, contains not only Bradyrhizobium but also Azospirillum. Mixed inoculation treatment of vegetable and soybean with this biofertiliser showed 35% increase in mature pods production.

Dr. A.K.Yadav Director, National Centre of Organic Farming Govt. of India, Ministry of Agriculture delivered a lecture on Quality Control, Policy initiatives & constraints in

Production Technology. Dr. Yadav in his Lecture highlighted history of biofertiliser in relation to production, uses and application of biofertiliser. He presented a quality control scenario prevailing in the country. He also spoke about the importance of liquid biofertiliser and discussed about the handling of biofertiliser technologies at different level right from the germplasm collection , production , quality control, storage to transportation to the farmers field.

Dr. Hyah' Taib Chairman of Myagri Group of companies, Malyarium presented a report on Biofertiliser Industry in Malaysia. Myagri Group of companies is producing mainly AM, *Trichoderma*, *Metarhizium* & compost. Dr. (Mrs) Dolly Wattal Dhar, Head, Microbiology IARI, New Delhi, delivered a lecture on Simple & cost effective Technology of Biofertiliser.

Total 13 countries presented their country status papers. Among the member countries of Asian Productivity Organization India is way ahead of other countries in biofertilizer production. Other leading countries are Philippines, Thailand & Malaysia. The scenario of biofertiliser production & use in remaining member countries are at a nascent stage. All the delegates from the participating countries expressed their concern regarding the quality of biofertilisers. Main constraints are mass sterilization of carrier material, viability of microbes during storage & transportation. The member delegates identify all these factors as the main bottle necks in harnessing this nobel technology for the benefits of Agricultural community. Members also advocated for regulation Act for quality control. Delegates from The Philippines suggested decentralisation of broth mixing units. In this system harvested broth is transported to different local mixing units where broth is mixed with the carrier material & distributed to the farmers. Presently this system is practiced in The Philippines.

Participants were segregated into 3 groups to finalize recommendation on: (a) Extension & dissemination of Information. (b) Production & quality control of biofertiliser and (c) Commercialization & making of biofertiliser. Groups recommended for adoption efficient fermentation technology and only sterile method of biofertiliser production. The second group suggested to discourage the production of mixed inoculum and suggested that inoculum should be prepared separately and should be mixed before application in the field. It also recommended for regulatory act for quality control & formulation of a standard and specialization for Asia Pacific Region. Such standards will help the member countries to export or import the product to other countries in the region. The third group recommended for transfer of technology among the member countries. They advocated that Govt. should stop the subsidy on product instead the fund should be given to develop the infrastructure like establishment of cold storage at the distribution points and refrigerated containers to transport the biofertilisers.

The study meeting was concluded by vote of thanks by programme officer of APO Dr Mohammad Sayeed, Japan, APO and Dr Raju K V R, Director, NPC, New Delhi, India.

The 12th Congress of the African Association for Biological Nitrogen Fixation - The 12th Congress of the African Association for Biological Nitrogen Fixation (AABNF2008) will be held on 15-18 December 2008 in Hammamet, Tunisia. The objective is to share experience and information, to evaluate the accomplished progress and to plan for an efficient exploitation of the biological nitrogen fixation systems in Africa. AABNF2008 is co-organized by the Centre of Biotechnology of Borj-Cédria and the Tunisian Association for Biotechnology. For more information, visit the web page of AABNF2008.

Book Review

Microbial Diversity By R.C. Ram, Asha Sinha, R.C. Ram, Asha Sinha Published by Daya Books, 2007, ISBN 817035448X, 9788170354482, 324 pages - The scope of microbiology has enlarged tremendously during last 25-30 years. The present volume deals about the microbial diversity comprising 25 reviews papers and research papers from outstanding scientists of India. This will related to plants and microbial diversity. It mainly includes fungal, bacterial and nematode diversity, mushrooms cultivation, bio-fertilizers, disease resistance, biological control, plant disease management, plant primary goal of preparing this volume fertility. The primary goal of preparing this volume is to present a balanced view of the diversity of issues that related to the microbial diversity and provide the fundamental infor-mation that will allow students and scientists to understand the complexities of those issues. This book is suitable for students of post-graduate, research scholars, senior research fellow and research associate in mycology, microbiology, plant pathology, plant bacterio-logy and plant protection. It will also be extremely useful to the teachers, instructors and scientists engaged in pursuit higher knowledge in this area.

Microbial Biotechnology: Fundamentals of Applied Microbiology By Alexander N. Glazer, Hiroshi Nikaido, Published by Cambridge University Press, 2007, ISBN 0521842107, 9780521842105, 554 pages - Knowledge in microbiology is growing exponentially through the determination of genomic sequences of hundreds of microorganisms and the invention of new technologies such as genomics, transcriptomics, and proteomics, to deal with this avalanche of information. These genomic data are now exploited in thousands of applications, ranging from those in medicine, agriculture, organic chemistry, public health, biomass conversion, to biomining. Microbial Biotechnology. Fundamentals of Applied Microbiology focuses on uses of major societal importance, enabling an in-depth analysis of these critically important applications. Some, such as wastewater treatment, have changed only modestly over time, others, such as directed molecular evolution, or 'green' chemistry, are as current as today's headlines. This fully revised second edition provides an exciting interdisciplinary journey through the rapidly changing landscape of discovery in microbial biotechnology. An ideal text for courses in applied microbiology and biotechnology courses, this book will also serve as an invaluable overview of recent advances in this field for professional life scientists and for the diverse community of other professionals with interests in biotechnology.

The Mycorrhizae: Diversity, Ecology and Applications By S.C. Sati (ed.) M. Tiwari (ed.) 2008, ISBN: 8170355168, 360p., Publisher: Daya Publishing House Price: $126.72 - Many plants benefit greatly from symbiotic relationship with soil fungi known as mycorrhizal fungi. These fungi live on and in the root systems of plants and provide nutrients to the plant in exchange for carbohydrates exuded by the plants. Some of the ecological uses of mycorrhizae include (i) enhancing plant growth and disease resistance, (ii) improving transplant success, (iii) building soil structure. (iv) reducing fertilizer dependency and (v) accelerating revegetation of degraded lands. While over 80 per cent of the Terrestrial Plants Show Mycorrhizal Association, the depth of its application towards industries seems to be under-exploited. Moreover, severe deforestation and land degradation have removed the host plants from the habitats giving way to loss of diversity of the mycorrhizal fungi. Particularly, this problem is acute in the tropical region of the world, where various natural calamities such as floods, landslides, fire, etc. in addition to the human exploitation of natural resources have degraded the major part of the ecosystems. Although, causes are known, strategies to rebuild the degraded systems remain bliss. There are many national and international journals that bring out the information about the mycorrhizal fungi and their symbiotic relationship with plants but the recent knowledge is almost in scattered state. This scattered information could be kept in a book to provide up-to-date information about mycorrhizal research especially being done in different corner of India. This book is a very selective monograph on mycorrhizae covering its different aspects. It is an excellent collection of 21 articles dealing with different disciplines of mycorrhizae and mycorrhizal research carried out by Indian scientists. In order to consummate the collective ideas on mycorrhizal association, its diversity and applications, a number of themes have been identified for this book, including (i) biodiversity and ecological issues on Mycorrhizal Association, (ii) physiology and molecular biology of plant-mycorrhizal fungal interactions, (iii) potential industrial applications. It is doubtless to say that this book would be very useful to all scientists, teachers, students and readers whosoever is interested on mycology and mycological literature.

Soil Sampling and Methods of Analysis, By Martin R. Carter, E. G. Gregorich, 2008, Published by CRC Press, ISBN 0849335868, 9780849335860, 1224 pages - Thoroughly updated and revised, this second edition of the bestselling Soil Sampling and Methods of Analysis presents several new chapters in the areas of biological and physical analysis and soil sampling. Reflecting the burgeoning interest in soil ecology, new contributions describe the growing number and assortment of new microbiological techniques, describe in-depth methods, and demonstrate new tools that characterize the dynamics and chemistry of soil organic matter and soil testing for plant nutrients. A completely new section devoted to soil water reviews up-to-date field- and laboratory-based methods for saturated and unsaturated soil hydraulic properties. Retaining the easy-to-follow, “cookbook” style of the original, this second edition provides a compilation of soil analytical techniques that are fast, straightforward, and relatively easy-to-use. Heavily referenced, peer-reviewed contributions from approximately 150 specialists make this a practical manual and resource handbook that describes a wide array of methods, both conventional and cutting-edge, for analyzing the chemical, biological, biochemical, and physical properties of many different soil types. Including several “primer” chapters that cover the overall principles and concepts behind the latest techniques, the book presents sufficient detail on the materials and procedures to characterize the potential and limitation of each method. It covers recent improvements in methodology, outlines current methods, and characterizes the best methods available for selecting the appropriate analysis technique. Promoting the research and practical application of findings in soil science, Soil Sampling and Methods of Analysis, Second Edition continues to be the most current, detailed, comprehensive tool for researchers and practitioners working with soil.

DO YOU KNOW?

On entire earth, annually 250 mt of N_2 is being fixed. Out of which 30 mt of Nitrogen is fixed by natural means, 50 mt is fixed by Industrial means & remaining 170mt of nitrogen is being fixed by some wonderful natural agencies. And these agencies are no one, but our tiny- tiny nitrogen fixers in soil. Isn’t it a wonder?