

## Feeding spice crops for quality produce

Soil micronutrient deficiencies drastically reduce the yield of spices. Hence, crop specific micronutrient formulations have been developed and commercialized for ginger, turmeric, black pepper and cardamom. Yield increase of 20-25% have been realized at farmers' fields. Plant growth promoting rhizobacteria (PGPR) have been extensively employed in agriculture for enhanced yield and disease suppression. The PGPR formulations have been developed for ginger, black pepper and seed spices. These PGPR formulations enhance growth besides being effective replacements for chemical fertilizers/fungicides. The delivery of PGPR through encapsulation has been a major breakthrough in biofertilizer industry. What makes this technology more exciting is that this encapsulation process can be used to deliver all kinds of agriculturally important microorganisms.

SPICES are grown mainly in red and laterite soils of South India, Western Ghats and North Eastern states where soils are highly weathered and low in nutrient status. Our productivity is found to be one of the lowest compared to other competing countries and the reason is mainly attributed to improper management. Under intensive management system, the productivity was higher compared to World production level.

In spices, quality of the produce, amount of oil, oleoresin, curcumin etc are more important as the export basket is mainly concentrating on value-added products of spices. In soils under spices deficiencies of micronutrients especially Zn, B and Mo are at its worst. Hence, there is an urgent need to develop micronutrient formulations that are crop specific in order to realize enhanced yield and quality.

### Micronutrient Formulations for Spices

Designer formulations of



Designer micronutrient formulations for promoting growth, yield and quality of cardamom, turmeric, ginger and cardamom

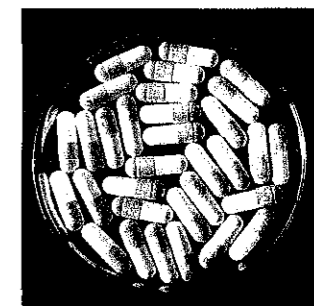
Due to excess use of high NPK fertilizers the soil has been rendered deficient in micronutrients, which is one of the major reasons why most of the crops do not flourish. Besides, low pH, P toxicity, limited use of micronutrients, and inadequate quantities of organic manures have worsened the situation. Systematic survey and analysis of more than 2.50 lakh soil samples in 20 states by All India Coordinated Research Project indicated deficiency of Zn to the extent of 49%, B by 33%, and 13, 7 and 4% of samples deficient in Fe, Mo, and Mn, respectively (<http://14.139.94.101/fertimeter/Soil%20Resources3.aspx>; accessed on 10/10/2014). This would reduce yield significantly and the extent and severity of deficiencies could, however, vary across soil types, agro-ecological zones and more importantly management and productivity of crops and cropping systems.

micronutrients have been developed for ginger, turmeric, black pepper and cardamom. These micronutrient mixtures are applied as foliar spray and increase 15-25% in yield. For black pepper foliar spray @ 5g per litre water should be done once during spike initiation with the onset of monsoon and another after two months. For cardamom foliar spray @ 5g per litre water should be given once during panicle initiation and another after three months. For ginger and turmeric foliar spray @ 5g per litre water once during 60 days after planting and another 90 days after planting is recommended. An important point to be kept in mind is that these mixtures should never be mixed with any other chemical pesticides during application.

An innate advantage of these mixtures is that they can also be used in organic agriculture and therefore are environment-friendly. While organic manures enhance soil

### Breakthrough in biofertilizer technology

The IISR has made a significant breakthrough in smart delivery of PGPR to crops in the field. Instead of the usual formulations like liquid, peat, granules, and freeze-dried powders, a PGPR encapsulating technique has been standardized, perfected and successfully demonstrated in experimental and farmers fields. It allows encapsulating the microbial strain in a nutritive shell or capsule and delivering them to the targeted site. The encapsulation process is simple, does not require sophisticated equipments and comes at low investment. Other advantages include reduced cost and easy handling and transport, no harmful byproducts, less requirement of inorganic and inert material, storage at normal temperature and more importantly, enhanced shelf life (18-24 months). Each capsule weighs just 1.0 g and in case of ginger only 200 capsules weighing just 200g are required for treating rhizomes required for 1.0 ha. Besides, this encapsulation technique can be used to deliver all agriculturally important microorganisms, viz. N fixers, nutrient solubilizers/ mobilizers, PGPR, Trichoderma, Burkholderia etc. Patent for this delivery process has been filed and published in Official Journal of the Indian Patent Office (issue 39, 2013; Patent Application no.3594/CHE/2013 dated 13/08/2013). Commercialization through prospective entrepreneurs is in progress at ICAR-IISR, Kozhikode, Kerala, India. Considering that presently no such commercial products are available in the Indian and world market, the encapsulating technique can be considered a watershed in biofertilizer industry.



PGPR *Bacillus amyloliquefaciens* IISR GRB 35 in gelatine capsules for ginger

microbial activity and therefore nutrient transformation/mobilization, these mixtures are guaranteed to enhance both yield and quality of the crop produce. The formulations for ginger and turmeric have already been commercialized to two agencies, viz. M/s HI-7 Agri Bio Solutions, #832, Sapthagiri Nilaya Vasanthanagar, Hessaraghatta Village, Bengaluru, Karnataka, India (Mobile: +91-7799247145, 8095890808) and M/s Natura Nursery and Agro Products, Indian Institute of Spices Research, Marikunnu P.O., Kozhikode (Calicut), Kerala, (Mobile: +91-9495083753).

### PGPR Formulations

About 100 PGPR strains isolated from different varieties of ginger and black pepper were first characterized for their morphological, biochemical,

Table 1 Effect of promising PGPR (GRB35 and GRB68) on sprouting, soft rot incidence and rhizome yield of ginger in the field (mean of six replications)

Treatment <sup>a</sup>	Sprouting (%)	Soft rot (%)	Yield(kg 3m <sup>-2</sup> )
GRB35	80.0	5.2	5.0
GRB68	80.0	7.3	4.3
IISR51	74.5	11.6	3.0
Streptomycin sulphate	73.0	18.5	2.3
Metalaxyl- Mancozeb	73.0	14.0	3.8
Control	73.0	25.1	2.2
LSD (P< 0.05)	5.4	3.9	0.9

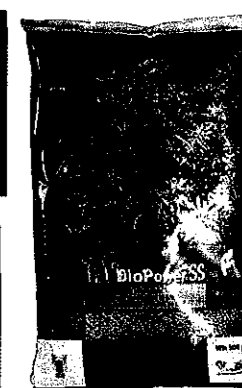
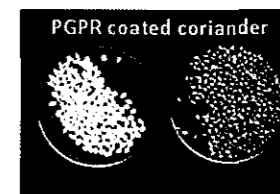
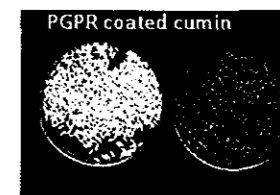
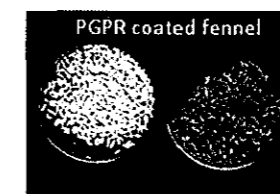
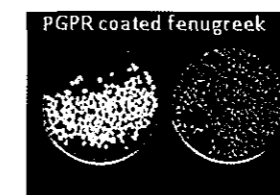
<sup>a</sup>GRB35-*Bacillus amyloliquefaciens*; GRB68-*Serratia marcescens*; IISR51- *Pseudomonas aeruginosa*; Streptomycin sulphate applied @ 1g L<sup>-1</sup> as seed treatment; Metalaxyl-Mancozeb applied @ 1.25g L<sup>-1</sup> as both seed treatment and soil drench

### Novel PGPR

A novel method for delivering PGPR (*Pseudomonas putida* FK 14 and *Microbacterium paraoxydans* FL 18) through seed coating of seed spices has been developed by ICAR-IISR. The technology is ecologically safe, provides enhanced nutrient mobilization and nutrient-use efficiency, increased growth, yield and protection against diseases.

The seed coating technology enhances seed quality, germination and viability during storage, increase shelf-life of seeds and reduces storage pest incidence. The seed coating process simplifies the sowing procedure, reduces seed rate

and thereby investment on seed. Demonstration of this technology was done in major seed spices-growing states of India through the centres of AICRP on Spices and it was found that the farmers are very convinced about the technology and have recorded a minimum of 10 % and maximum of 30% benefit in terms of yield. Talc-based formulations of both FK14 and F18 are now available at ICAR-IISR for commercialization.



PGPR coated fennel, fenugreek, cumin and coriander seeds

Talc-based formulation of PGPR for coating of seed spices



Talc based PGPR formulations for ginger and black pepper

and nutrient mobilization traits and disease suppressive traits *in vitro*. After a series of greenhouse and field experiments using the promising PGPR, two PGPR for ginger (IISR GRB 68- *Serratia marcescens* and IISR GRB 35- *Bacillus amyloliquefaciens*) and a consortium of PGPR for black pepper (IISR BRB 3 + BRB 13 + BRB23- *Micrococcus luteus*, *Enterobacter aerogenes*, *Micrococcus* sp.) are found to significantly enhance growth and yield as well as reduce disease incidence. Interestingly, the PGPR performs better than even chemical treatments (Table 1). Since *S. marcescens* is a human pathogen we did not use it further. Instead talc-based formulations using the remaining PGPR were developed and tested at farmers' fields

In black pepper, an Indian farmer from Karnataka was awarded the Best Farmer Award during 2013 for his production of 10 tonnes/ ha, whereas a Vietnam farmers was awarded by International Pepper Community for a relatively lower yield of 8 tonnes/ha.

with great success. These formulations are now ready for commercialization through prospective entrepreneurs.

For application to black pepper, 20g of the formulation is mixed in 1.0 litre water and 100ml is applied for nursery bags and 250ml is applied for each vine in the field. In the field, the formulation is applied twice a year in May/June and September/October. For application to ginger, suspend 100g of talc formulation in 10 litre of water and mix thoroughly. Soak 5kg of ginger rhizome bits (30g) in this suspension for one hour prior to planting. The remaining suspension can be sprayed on ginger bed after planting (at the rate of 1 litre/bed). A booster dose can be given as a soil application, after 30 days of planting, (100g talc formulation/10 litre water suspension can be drenched on ginger beds at the rate of 2 litre/ bed).

For further interaction, please write to:  
 Drs M Anandaraj, R Dinesh, V Srinivasan, S Hamza and YK Bini (Scientists), Indian Institute of Spices Research, Marikunnu PO, Kozhikode, Kerala 673 012, Kerala.

### INDIAN HORTICULTURE Subscription Order Form

To start a renew a subscription to Indian Horticulture fill in your name and address below:

Mail along with remittance by Money Order or Draft to: Business Manager, Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, Krishi Anusandhan Bhavan, Pusa, New Delhi 110 012.

Subscription for 6 issues: 1 year from: ..... onwards.

India: ₹125.00 Overseas: \$50.00

**SUBSCRIPTION**

**RENEWAL** (Subscription No. ....)

Name..... Name.....

(In Block Letters)..... (In Block Letters).....

Address..... Address.....

..... Pin code ..... Pin code .....

A total remittance of ..... is enclosed herewith.

**Attention readers:** • All disputes are subject to the exclusive jurisdiction of competent courts and forums in Delhi/New Delhi only. • The Council does not assume any responsibility for opinions offered by the authors in the articles and no material in any form can be reproduced without permission of the Council. • The Council is not responsible for any delay, whatsoever, in publication/delivery of the periodicals to the subscribers due to unforeseen circumstances or postal delay. • Readers are recommended to make appropriate enquiries before sending money, incurring expenses or entering into commitments in relation to any advertisement appearing in this publication. The Council does not vouch for any claims made by the advertisers of products and services. The publisher and the editor of the publication shall not be held liable for any consequences in the event of such claims not being honoured by the advertisers.