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Zinc Solubilizing Biofertilizer for North-East Region of India

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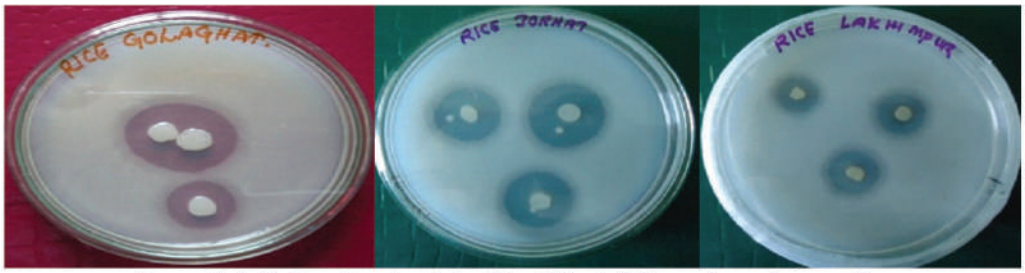
Background

Zinc (Zn) deficiency is a substantial global public health and nutritional problem affecting nearly one-third of world population. In South and Southeast Asia, over half a billion people are estimated to be at risk from inadequate Zn intake. In India, zinc is now considered the fourth most important yield-limiting nutrient after, nitrogen, phosphorus and potassium, respectively which accounts10 Mha are considered Zn deficient. Among the cereals, rice is a special case and 70% of the crop is produced in flooded soils in the paddy system with half of all lowland rice soils prone to Zn deficiency. Rice grain Zn concentrations may be as low as 15.9 and as high as 58.4 mg kg^{-1} depending upon the genotype, and within a single genotype, the grain Zn concentration may vary from 8 to 47mg kg^{-1} depending on soil Zn status.For controlling grain Zn concentrations in rice cultivation, the native soil Zn status and its bioavailability is the dominant factor, followed by genotype and fertilizer. Zn deficiency is often caused not by low total soil Zn contents but by low bioavailability of Zn. Inherently low Zn status in soil is aggravated by submerged conditions; consequently low land rice is more susceptible to Zn deficiency than other cereals. During flooding or inundation (anaerobic conditions),plant available Zn decreases as a result of the formation of insoluble compounds like $ZnCO_3$ in calcareous and ZnS in acidic soils. Because of the above factors, even the application of Zn fertilizers the Zn use efficiency hardly exceeds 2% by rice and the remaining part get fixed in soil. Improving the processes by which Zn moves from the soil into the plant and eventually into the edible part of the grain has the potential to mitigate problems associated with Zn deficiency in rice cultivation. An additional, sustainable tool to improve Zn loading in rice grain could be the exploitation of Zn solubilizing bacteria. ICAR-All India Network Project on Soil Biodiversity-Biofertilizers (AINP-SBB) has developed Zn solubilizing biofertilizer technology for North East Region of India especially for rice in Zn deficient (<0.6ppm) sites. Potential strains were isolated after intensive screening of native isolates from rhizosphere of rice and toria in North East Region, and currently being used for mass production of biofertilizers. Performances of the biofertilizers were evaluated on rice in NEH regions. Zn solubilizing biofertilizers can replace the inorganic Zn sulphate by 100%and saved chemical fertilizer significantly. During last 3 years, about 100 farmers have been benefitted and 10 KVK officers were trained to intensify use of this technology. State agriculture department and KVKs have adopted this technology and documented in the package of practices.

Zn Solubilizing Biofertilizerin North Eastern Region of India

AINP on Soil Biodiversity-Biofertilizers at Assam Agricultural University has been engaged in screening and evaluation of efficient Zn solubilizing bacteria (ZSB) from the rhizospheres of different crops grown in NER. Four prospective Zn solubilizing bacteria (PSB) *viz*; *Pseudomonas aeruginosa* (MW301141), *Burkholderia ambifaria* (MW301144), B*urkholderia seminalis* (MW301140) and *Bacillus paramycoides* (MW301142) from rhizosphere of rice were isolated, screened and evaluated on Modified Pikovskaya'smedia.It was reported that the isolated bacteria could solubilize the insoluble ZnO over 70% in 30 days.



Zn solubilizing bacteriain Modified Pikovskaya's media containing ZnO in place of TCP (1% as Zn).

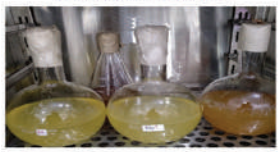
Procedure of Zn solubilizing biofertilizer preparation

Step I : Mass multiplication of Zn Solubilizing Bacteria (ZSB) in modified Pikovskaya's broth by inoculating the mother culture @1.0 % (mL). Allowed the ZSB to grow for 5-7 days in incubator shaker/BOD incubator at 30±1^{0}C.

Mother Cultures

Step II: The carrier material (compost+charcoal,50:50) is powdered to a fine powder so as to pass through 212 micron IS sieve. The mixed carrier material is sterilized in an autoclave to eliminate the contaminants for three consecutive days at 24h of interval.

Step III: The sterilized carrier material is spread in a clean, dry, sterile metallic or plastic tray.The full grown (population approx 10^9cell/mL) ZSB culture is added to the sterilized carrier and mixed well by manual (by wearing sterile gloves). The culture suspension is added to a level of 40- 50% WHC of the carrier materials.Curingis done by spreading the inoculant on a clean floor/polythene sheet/ trays with polythene covering for 2 -3 hours at room temperature before packaging. Packaging of ZSB biofertilizer is carried out in polythene bags (thickness 50-75 micron) and sealed with electric sealer.



Growth of ZSB in broth

Step IV : Each packet is marked with the name of the manufacturer, name of the product, strain number, the crop to which recommended, method of inoculation, date of manufacture, batch number, date of expiry, price, full address of the manufacturer and storage instructions etc.

Mixed with sterilized carrier materials

Step V : The packet is stored in a cool place away from the heat or direct sunlight.The population of inoculant in the carrier inoculant packet is determined at 15 days interval till its application. There should be more than 10^9 cells / g of inoculant at the time of preparation and10^7 cells/g on dry weight basis before expiry date.

Benefits of ZSB inoculants

- ZSB commonly used in Zn deficient sites of rice growing areas of NER.
- Replaces the 100% of inorganic Zn sulphate in integrated nutrient management.
- Increases average grain Zn content upto 29.73 ppm paddy.
- Increases DTPA - Zn in soil after harvest of paddy upto 0.963 ppm in Zn deficient sites.
- Secretes growth promoting and antibiotic like substances
- Ideal source of releasing inorganic complex Zn from soil in organic agriculture.

Packaging and Sealing

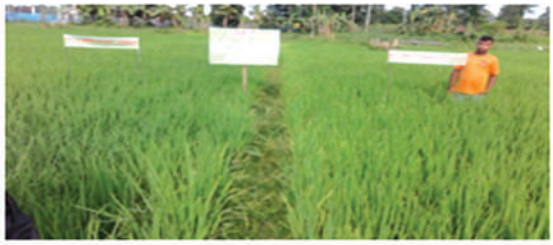
Strategies for application of ZSB biofertilizers

This biofertilizer can be applied to rice through seedling root dip treatment.In transplanted rice, ZSB along is generally used as root dip treatment. In this method small size bed is prepared in a corner of the paddy field. To transplant one bigha of land, 500gm each of ZSB biofertilizer is mixed with 10-15kg compost and just sufficient quantity of water in the bed. Uprooted rice seedlings are dipped in the bed for 8-12 hours before transplanting.

Effect of Zn solubilizing bacteria in rice conducted at different KVKs.

Crop	Application and crop response
Rice	At KVK, Nalbari 1. Recommended NPK + Zn solubilizing Bacteria (3.5kg/ha): Yield 4.82 t/ha 2. Recommended NPK@ 40:20:20 kg/ha + $ZnSO_4$ @ 25kg/ha: Yield 4.87 t/ha

At KVK, Sonitpur
1.Recommended NPK + Zn solubilizing Bacteria (3.5kg/ha): Yield 4.91 t/ha
2.Recommended NPK@ 40:20:20 kg/ha + $ZnSO_4$ @ 25kg/ha: Yield 5.11t/ha



At KVK, Golaghat
1.Recommended NPK + Zn solubilizing Bacteria (3.5kg/ha): Yield 3.10 t/ha
2.Recommended NPK@ 40:20:20 kg/ha + $ZnSO_4$ @ 25kg/ha: Yield 3.56 t/ha

At KVK, Nagaon
1. Recommended NPK + Zn solubilizing Bacteria (3.5kg/ha): Yield 5.31 t/ha
2. Recommended NPK@ 40:20:20 kg/ha + $ZnSO_4$ @ 25kg/ha: Yield 5.45 t/ha

At KVK Lakhimpur
1.Recommended NPK + Zn solubilizing Bacteria (3.5kg/ha): Yield 3.91 t/ha
2.Recommended NPK@ 40:20:20 kg/ha + $ZnSO_4$ @ 25kg/ha: Yield 3.86 t/ha

Trainings / package of practices/recommendations

Farmers benefitted (2017-2020)	About 100 farmers of NEH regions and 10 KVK officers were trained.
Technology transfer	1.Technology transferred to KVKs and State Agriculture Department, Assam.
Package of practices	Package of practices developed and recommended to farmers of NEH regions. Published by AAU, Jorhat & State Agriculture Department, Assam as follows: • Package of practices for Kharif crops of Assam, 2019 • Package of practices for selected crops of Assam,2019

Package of Practices for *Kharif* Crops of Assam 2019

Published jointly by

Assam Agricultural University, Jorhat
&
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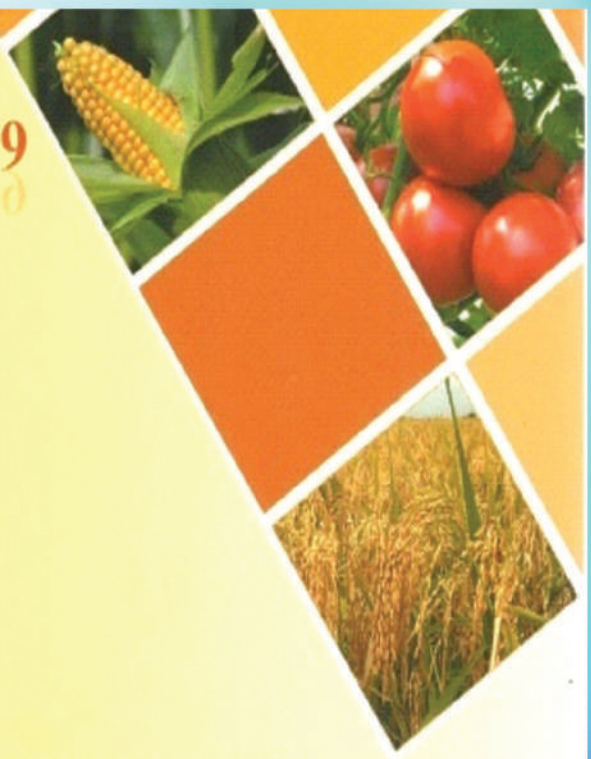

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PACKAGE OF PRACTICES FOR SELECTED CROPS OF ASSAM

Developed under Assam Agribusiness and Rural Transformation Project (APART)

ASSAM AGRICULTURAL UNIVERSITY
JORHAT - 785013

The information given in the document is based on the experiments carried out at the AINP Centre-Department of Soil Science, Assam Agricultural University (AAU). Jorhat, Assam. For training, demonstration and other enquiries please contact Principal Investigator, AINP on Soil Biodiversity-Biofertilizers, AAU, Jorhat-13, Assam.

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