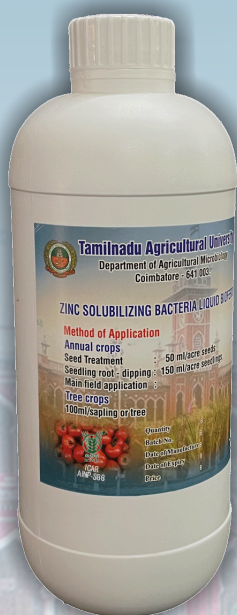


# Zinc Solubilizing Liquid Biofertilizer



## Salient Features



- ★ Produce 2-ketogluconic acid to solubilize insoluble Zn
- ★ Increases the soil available Zn up to 10 mg/kg
- ★ Ensures Zn availability throughout the cropping period
- ★ Enhance the Zn uptake by rice plant
- ★ Increase the availability of P and K contents of soil
- ★ Yield increase: Rice - 15-20%
- ★ Zn content in grains (25-30 mg/kg)
- ★ Improves ZnSO<sub>4</sub> use-efficiency
- ★ Suitable for rice, and other crops

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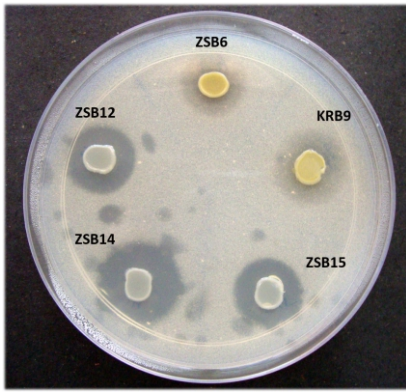
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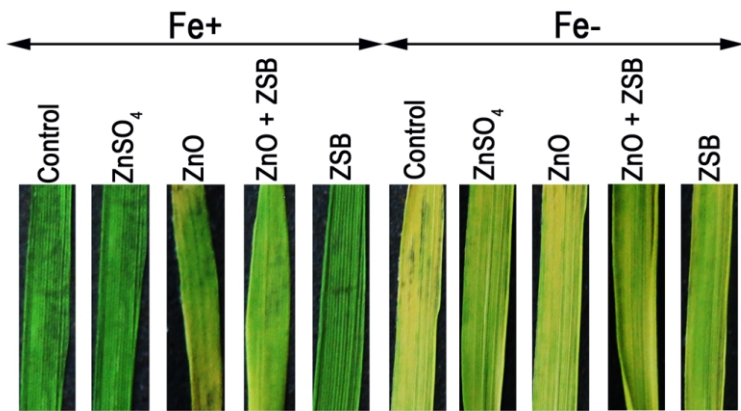
# Zn solubilizing bacterial strains



ZSB15 - *Pseudomonas chlororaphis*  
 MDU1 - *Pseudomonas gessardii*  
 ZSB14 - *Enterobacter cloacae*

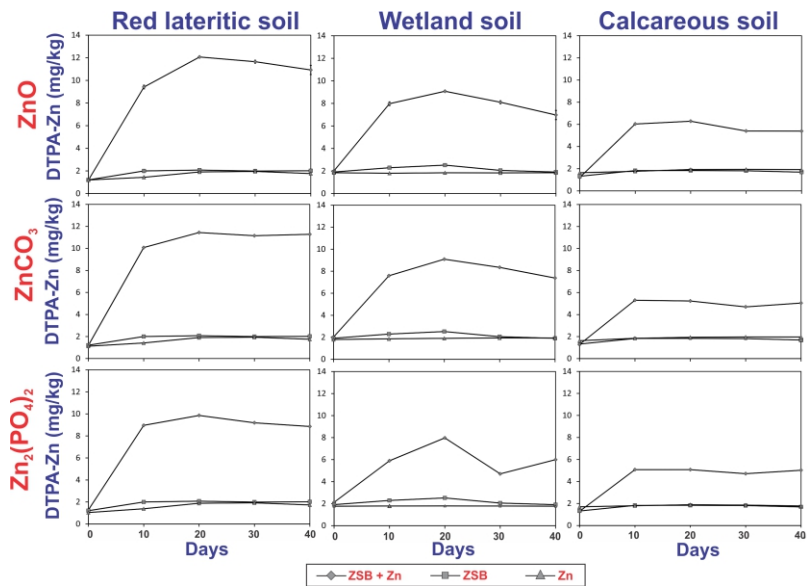
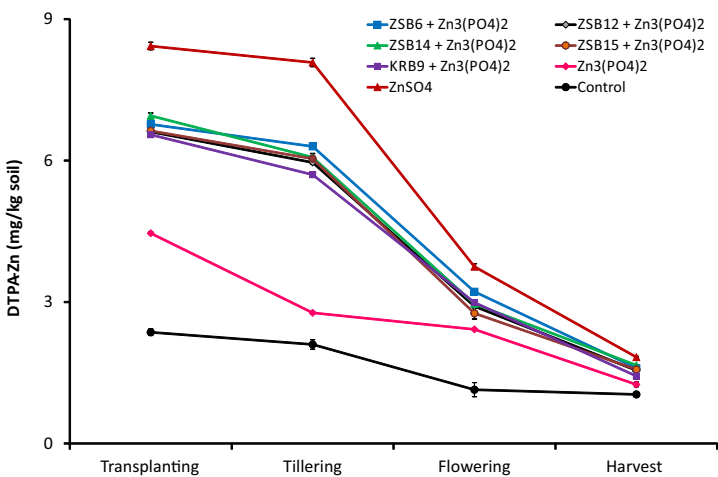
- Produce 2-ketogluconic acid
- Solubilize insoluble salts [ $ZnO$ ,  $Zn_2CO_3$ ,  $Zn_3(PO_4)_2$ ,  $Ca_3(PO_4)_2$ ,  $K_2SiO_3$ ]
- Plant-growth promotion [Growth hormones, siderophore production]

## ZSB - Rice Interactions



- Effective colonization (Quorum-sensing and Biofilm)
- Triggered by small molecules (Salicylic acid, yeast and Corynebacteria extracts)
- Modulates Zn transporters in rice (OsZIP1, OsZIP4, OsZIP5)
- Enhances rhizosphere biological attributes

## ZSB in Soils



- ZSB inoculation with Zn amendment (zinc phosphate) assured "Zn sufficient" condition throughout the cropping period of rice as that of zinc sulphate application.
- These strains ensure the Zn availability of three different soil types: red laterite, calcareous, and clayey soils.



## ZSB on Rice Yield increase

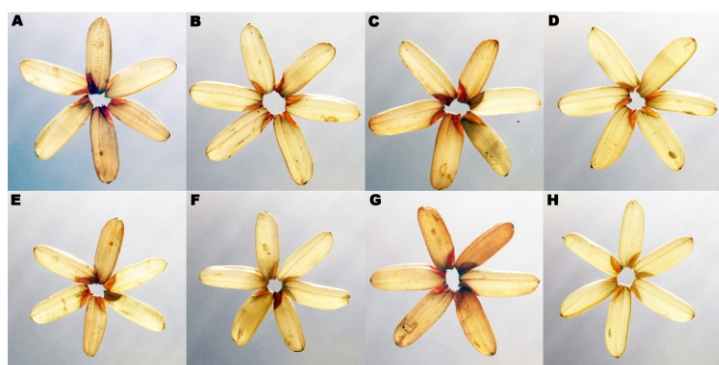
Particulars	I Year	II Year	III Year	IV Year
Trial Name	Exp. trials	MLTs	OFTs	OFTs (Large scale)
Cultivars	Co51	Co51, ADT45, ADT49	ADT46, ADT45, TPS3	Co51, White Ponni
No. of trials	2	3	3	4
Centres	CBE	CBE, TRY, ADT	ADT, MDU, KKM	BSR, TMV, ADT, KKM
Year	2015-16	2016-17	2017-18	2020-21

### Grain yield increase (%)

ZnSO <sub>4</sub>	19.55%	17.62%	10.44%	9.87%
ZSB inoculation with Zn amendment	22.84%	16.94%	18.62%	18.82%

- ZSB inoculation needs Zn amendments [Zn<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub> or ZnSO<sub>4</sub>] for significant impact on grain yield increase.
- ZSB inoculation ensures 16-18% yield increase.
- Fertilizer use efficiency of ZnSO<sub>4</sub> enhanced due to ZSB inoculation.

## ZSB on Zn fortification



Treatments	Grain zinc (mg/kg)	Phytic acid (g/kg)	Phytic acid /zinc molar ratio
ZSB6 + ZP	24.0 (±0.4) <sup>b</sup>	7.5 (±0.35) <sup>b</sup>	31.0 (± 1.2) <sup>b</sup>
ZSB12 + ZP	24.0 (±0.2) <sup>b</sup>	6.45 (±0.26) <sup>a</sup>	26.6 (± 0.6) <sup>a</sup>
ZSB14 + ZP	24.6 (±0.2) <sup>b</sup>	7.8 (±0.52) <sup>b</sup>	31.4 (± 1.9) <sup>b</sup>
ZSB15 + ZP	24.2 (±0.2) <sup>b</sup>	7.8 (±0.17) <sup>b</sup>	31.9 (± 1.0) <sup>b</sup>
KRB9 + ZP	24.4 (±0.3) <sup>b</sup>	6.9 (±0.05) <sup>a</sup>	28.0 (± 1.9) <sup>b</sup>
ZP	21.7 (±0.3) <sup>a</sup>	9.0 (±0.17) <sup>c</sup>	49.3 (± 1.5) <sup>d</sup>
ZnSO <sub>4</sub>	28.0 (±0.2) <sup>c</sup>	12.6 (±0.69) <sup>d</sup>	42.1 (± 3.0) <sup>c</sup>
Control	21.1 (±0.4) <sup>a</sup>	12.0 (±0.04) <sup>d</sup>	53.8 (± 2.9) <sup>d</sup>

ZP - Zinc phosphate

- ZSB inoculation with Zn amendment enhances grain-Zn of rice.
- ZSB inoculation reduces the Phytic acid/Zn ratio of rice grains better than ZnSO<sub>4</sub>

## Cost Benefits

Zn nutrition	Grain yield (kg/ha)				Mean Yield (kg/ha)	Additional yield (kg/ha)	Additional Cost involved (Rs)	Additional benefit (Rs)
	ADT	BSR	KKM	TMV				
RDF (STCR) + ZnSO <sub>4</sub> (12.5 kg/ha) + ZSB15	7565	4831	5402	7688	6371.50	478.25	Rs. 600	10168 + 350 = <b>10518</b>
RDF (STCR) + ZnSO <sub>4</sub> (25 kg/ha)	6942	4444	5020	7167	5893.25			

- ZSB inoculation with half-dose of ZnSO<sub>4</sub> (12.5 kg/ha) ensures additional yield increase of 478.5 kg/ha accounts for Rs. 10,518/- as additional income.

## Method of Application

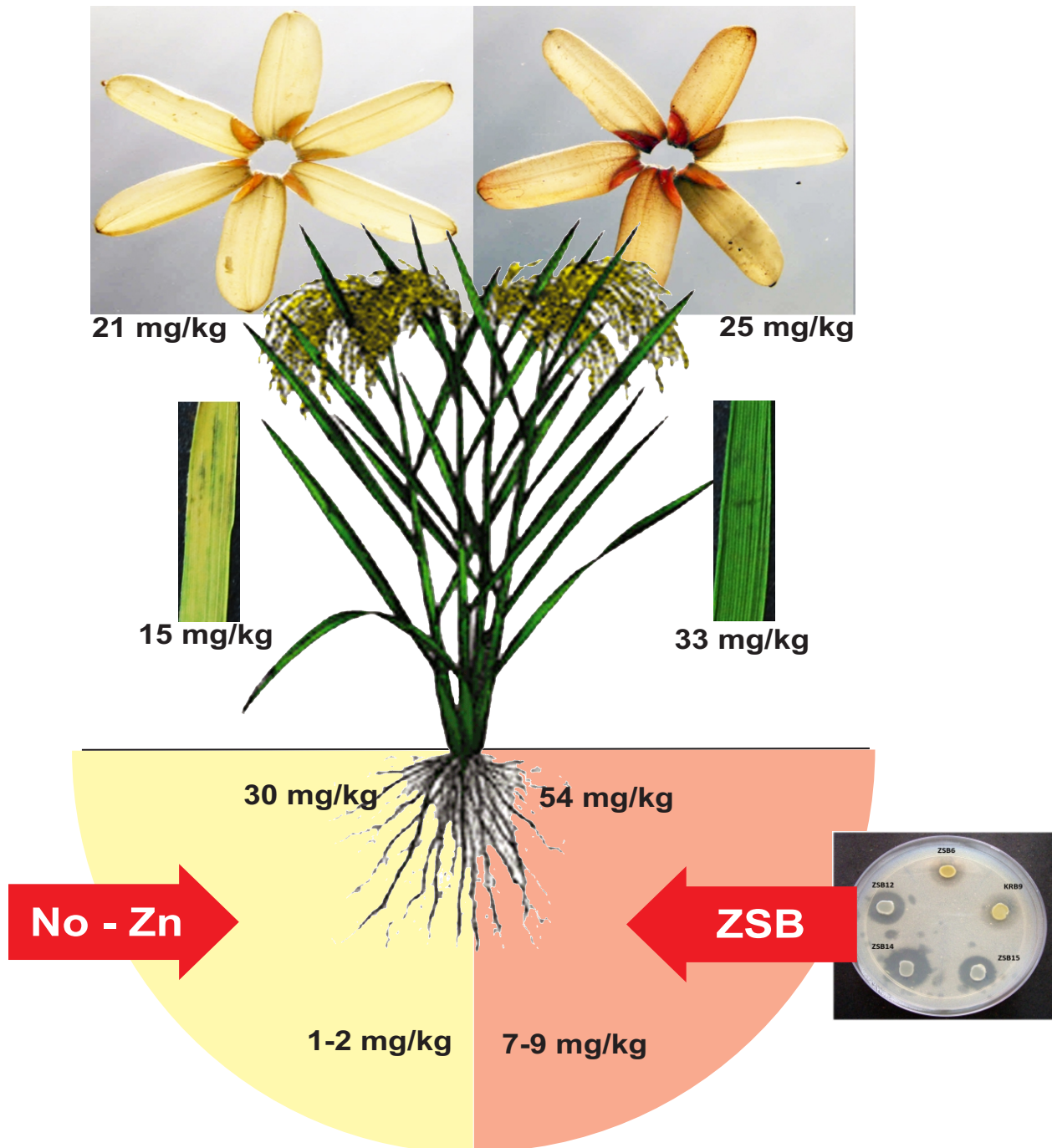
### Liquid biofertilizer:

- Seed treatment: 125 ml/ha of paddy seeds
- Seedling dip: 500 ml/ha of seedlings
- Soil application: 500 ml/ha

### Carrier-based biofertilizer:

- Seed treatment: 1 kg/ha of paddy seeds
- Seedling dip: 1 kg/ha of seedlings
- Soil application: 2 kg/ha

## Zinc solubilizing bacterial inoculation on rice



For more details, Contact us:

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