

## Original Research Article

# Response of Transplanted Rice (*Oryza sativa*, L.) to Soil Inoculation of Azospirillum and Phosphate Soluble Bacteria under Medium Deep Black Soils

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## ABSTRACT

The field experiment was conducted at Agricultural Research Station, Gangavathi, Karnataka during the rainy season of 2016 and 2017 to evaluate the effect of *Azospirillum brasilensis* and Phosphate soluble bacteria as a supplement of fertilizer nitrogen and phosphorous in transplanted rice. The treatments include soil application of various combinations of different doses of inorganic fertilizers, Azospirillum and phosphate soluble bacteria (PSB), brown manuring and paddy straw. The experiment was tried in RBD design with three replications. The mean data revealed that application of 100% NPK recorded significantly higher grain yield (57.89q/ha) than all other treatments except soil application of Azospirillum +PSB @3.5kg /ha each with 75%NPK(55.47q/ha) indicating the beneficial effect of Azospirillum and PSB on grain yield of rice. Grain yield parameters like the number of panicles per unit area, panicle and test weight were improved with soil application of Azospirillum+PSB each @3.5kg/ha. The mean economics revealed that 100%NPK registered higher net returns (Rs77373/ha) and BC ratio (2.54) than other treatments but remained on par with soil application of Azospirillum+PSB each @3.5kg/ha with 75%NPK with a net returns of (Rs 73713/ha) and bc ratio of 2.46. The results thus indicated that soil application of Azospirillum and PSB @ 3.5kg each/ha along with 75% NPK can supplement 25% of NPK in transplanted rice and also economically viable technology.

## Keywords

Azospirillum,  
PSB,  
Biofertilizers,  
Diancha, Paddy  
straw, Nitrogen  
fixing

## Introduction

Rice is the staple food crop of India, grown over an area of 43.44 mha with a production of 112.4mt and with a productivity of 2.7t/ha (Anon., 2016). Tungabhadra project (TBP) in Karnataka state is an important rice belt covering 0.25mha. Farmers in the command area have been growing rice as a mono-cropping with intensive use of inorganic

fertilizers for several years. This is particularly true concerning nitrogen fertilizer wherein application rates often exceed 250 kg/ha. In recent years the cost of inorganic fertilizers has been escalating resulting in less profit for the farmers and continuous use of chemical fertilizers alone are known to have a deleterious effect on soil microflora and lead to environmental pollution. Hence there is a need to optimize N and P application and

exploit eco friendly alternate sources of N and P and adoption of integrated nutrient management practices for sustainable production of rice. Biofertilizers like *Azospirillum* are known to fix atmospheric N and supplement additional N to rice. Similarly, PSB is known to solubilize the unavailable/ insoluble soil phosphorous to available Phosphorus that plant can make use of the use of these biofertilizers as a supplement to fertilizer N and P in rice have been reported by Rodrigues *et al.*, (2008), Ninopaul Meynard Banayo *et al.*, (2012) and Abd EL-Lattief (2016). In the present investigation, a study was undertaken to evaluate the effect of *Azospirillum brasilense* and phosphate solubilizing bacteria (PSB) in supplementing NPK fertilizers in transplanted rice.

## Materials and Methods

A field experiment was conducted at the Agricultural Research Station, Gangavati, Karnataka during the rainy season of 2016 and 2017. The soil of the experimental site was medium-deep black clay in texture, neutral to alkaline in reaction ( $pH$  8.1 to 8.3), and low in electrical conductivity(0.40 to 0.65dS/m). The soil was low in alkaline  $KMnO_4-N$  ( $225\text{ kg ha}^{-1}$ ), high in Olsen's- $P_2O_5$  ( $81.5\text{ kg ha}^{-1}$ ) and high in  $NH_4OAc$  extractable  $K_2O$  ( $410\text{ kg ha}^{-1}$ ) in the surface 0-20cm depth. Seven treatments consisting of  $T_1$ : Recommended 100%NPK (200:100:100 kg N,  $P_2O_5$  &  $K_2O/ha$ ),  $T_2$ :*Azospirillum* +Phosphate solubilizing bacteria (PSB) each @3.5kg/ha + 75%NPK,  $T_3$ :*Azospirillum* +PSB each @3.5kg/ha+ brown manuring diancha + 75%NPK,  $T_4$ : *Azospirillum*+PSB each @3.5kg/ha+ brown manuring diancha + paddy straw @2.0t/ha+75%NPK, $T_5$ : *Azospirillum*+PSB each @3.5kg/ha+ brown manuring diancha + paddy straw @2.0t/ha+50%NPK,  $T_6$ : *Azospirillum*+PSB each @3.5kg/ha, seed and soil application

+FYM 5.0t/ha + 50%NPK and  $T_7$ :No NPK absolute control were tried in randomized block design with four replications. GGV-05-01 variety of medium duration rice was used. Thirty days aged seedlings were transplanted on well puddle soil at a spacing of 20 x15 cm on 5<sup>th</sup> September and August 23<sup>rd</sup> during 2016 and 2017 respectively. In the case of brown manuring, Daincha was sown in between rice lines and incorporated into the soil after one month by spraying diancha with 2,4-D sodium salt. Similarly, paddy straw was manually incorporated into the puddled soil before transplanting. The recommended plant protection measures were followed. Observations on yield and yield parameters were recorded, soil analysis for N, P and K were carried out, statistically analyzed and presented.

## Results and Discussions

### Effect on grain yield

During 2016 the recommended NPK (RDF) recorded significantly higher grain yield (51.19q/ha) than no NPK control (35.75q/ha) and *Azospirillum*+PSB each @3.5kg/ha+ brown manuring diancha + paddy straw @2.0t/ha+50%NPK.However it remained on par with other treatments including soil application *Azospirillum* +PSB each @3.5kg/ha with 75%NPK (51.13q/ha), *Azospirillum* + PSB each @3.5kg/ha + brown manuring diancha + 75%NPK, *Azospirillum* + PSB each @3.5kg/ha + brown manuring diancha + paddy straw @2.0t/ha+75%NPK, and *Azospirillum*+PSB each @3.5kg/ha, seed and soil application +FYM 5.0t/ha + 50%NPK. Absolute control with no application of NPK recorded the lowest grain yield (35.75q/ha). Similarly, during 2017 100%NPK recorded significantly higher grain yield (64.60q/ha) than other treatments but remained on par with an application of *Azospirillum* +PSB

@3.5kg /ha each with 75% NPK (59.80q/ha). The two year mean data revealed that application of 100%NPK recorded significantly higher grain yield(57.89q/ha) than all other treatments mainly due to higher amounts of N, P and K applied. However, it remained on par with Azospirillum +PSB @3.5kg /ha each with 75% NPK (55.47q/ha) indicating that grain yields on par with 100%NPK can be maintained by soil application of Azospirillum and PSB with 75%NPK only resulting in 25% saving in NPK.

Azospirillum is a symbiotic bacteria that thrive well in the root zone of rice plants and capable of fixing atmospheric nitrogen. In the present study, the higher grain yield observed with Azospirillum application might be associated with improved soil nitrogen due to fixing of nitrogen and made available for plant uptake. Rodrigues *et al.*, (2008) reported that inoculation of rice plants with azospirillum has been found to cause significant increases in growth and yield which is equivalent to the application of 15-20 kg N/ha. Similarly, Abd El-Lattief *et al.*, (2016) reported that inoculation with Azospirillum or Azatobacter may improve the growth and yield of rice due to supplementing the growing plants with fixed nitrogen and growth-promoting substances. The results of the present study are also in agreement with Ine'S Garcia de Salmone *et al.*, (2010), Ine's Garcia de Salmone *et al.*, (2012), Nino Paul Meynard Banayo *et al.*, (2012), Zhihua Bao *et al.*, (2013) and Nayara F S Garcia *et al.*, (2016) who reported increased grain yield of rice, harvest index and N accumulation with inoculation of *Azospirillum brasilensis*.

The higher grain yields observed with biofertilizers is also due to the action of PSB which might have solubilized the native unavailable soil phosphorus and made

available for plant absorption leading to increased grain yield. These results are in agreement with Esmail Bakhshandeh *et al.*, (2017) who reported improved rice plant growth and uptake of P in rice with inoculation of phosphate solubilizing bacteria.

Grain yield in rice is mainly determined by the number of panicles per unit area, panicle weight, number of filled spikelets per panicle and test weight. Significantly more number of panicles per square meter(381no/sqm) had mainly contributed to increased grain yields in the case of RDF. Similarly, in the case of soil application of Azospirillum+PSB each @3.5kg/ha with 75%RDF in addition to more number of panicles per square meter, other yield parameters like higher panicle weight and test weight have also contributed for increased grain yields. This indicated growth promoting nature of the above biofertilizers. Earlier Esmail Bakhshandeh *et al.*, (2017) and Nilima Dash *et al.*, (2017) reported increased growth parameters of rice due to inoculation of Phosphate solubilizing bacteria.

### **Economics**

The economics revealed that during 2016 the net returns were significantly higher in the case of Azospirillum+PSB @3.5kg/ha with 75%RDF (Rs64407/ha) which however remained on par with 100%NPK. While during 2017 it was significantly higher in the case of 100%NPK followed by Azospirillum+PSB @3.5kg/ha with 75% NPK. The mean data revealed that 100%NPK recorded significantly higher net returns(Rs77373/ha) than all other treatments except Azospirillum+PSB @3.5kg/ha with 75%NPK(Rs 73713/ha) wherein it remained on par indicating the economic sustainability of Azospirillum and PSB. Similarly, the bc ratio during 2016 was significantly higher

with Azospirillum+PSB @3.5kg/ha with 75% NPK followed by 100%NPK. While during 2017 it was higher with 100%NPK followed by Azospirillum+PSB @3.5kg/ha with 75% NPK. The mean data revealed that 100%NPK (2.54) and soil application of Azospirillum +

PSB each @3.5kg/ha with 75% NPK (2.46) recorded significantly higher bc ratio than all other treatments indicating economic profitability of use of Azospirillum and PSB in rice in comparison with 100%NPK.

**Table.1** Grain yield and yield parameters of transplanted rice as influenced by soil application of Azospirillum and Phosphate solubilizing bacteria

Treatments	Grain yield(q/ha)			Panicles/ sqm	Panicle weight(g)	Grains/ panicle	Test weight(g)
	2016	2017	Mean				
T1	51.19	64.60	57.89	381	2.18	132	14.91
T2	51.13	59.80	55.47	379	2.30	126	15.63
T3	48.69	53.11	50.90	343	2.18	144	14.55
T4	49.06	51.54	50.30	373	2.21	143	15.18
T5	43.94	52.48	48.21	369	2.13	128	15.53
T6	50.81	53.85	52.33	374	2.13	141	14.50
T7	35.75	29.89	32.82	303	1.57	114	13.44
SEm	1.16	1.40	0.94	10.7	0.08	5.21	0.25
CD(0.05)	3.41	4.13	2.84	31.3	0.25	15.35	0.74

**Table.2** Soil available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O and Economics of transplanted rice as influenced by soil application of Azospirillum and Phosphate solubilizing bacteria

Treatments				Net Returns (Rs/ha)			benefit-cost ratio		
	Av.N (kg/ha)	Av.P <sub>2</sub> O <sub>5</sub> (kg/ha)	Exc.K <sub>2</sub> O (kg/ha)	2016	2017	mean	2016	2017	mean
T1	141.3	45.3	330.8	62776	91970	77373	2.25	2.83	2.54
T2	184.31	44.9	351.5	64407	83019	73713	2.32	2.71	2.46
T3	202.65	39.7	343.2	57650	66858	62253	2.15	2.33	2.24
T4	199.13	54.2	389.0	55479	60979	58229	2.04	2.15	2.09
T5	166.2	51.7	366.8	46549	65116	55832	1.92	2.28	2.10
T6	169.3	38.4	356.7	64077	68009	66043	2.26	2.34	2.30
T7	137.0	35.5	325.1	39777	26802	33289	2.02	1.68	1.85
SEm	6.30	3.88	13.8	2546	3014	1785	0.05	0.06	0.04
CD(0.05)	18.54	11.42	NS	7490	8866	5252	0.16	0.19	0.11

Av.N: Available nitrogen, Av.P<sub>2</sub>O<sub>5</sub>: Available P<sub>2</sub>O<sub>5</sub>, Exc.K<sub>2</sub>O: Exchangeable K<sub>2</sub>O

**Soil NPK**

The available soil N was significantly higher in the case of Azospirillum+PSB @ 3.5kg/ha each+Daincha brown manuring (202.65 kg/ha) as compared to other

treatments but remained on par with Azospirillum+PSB@ 3.5kg/ha+Daincha brown manuring+paddy straw@2t/ha with 75% NPK and Azospirillum +PSB @3.5kg/ha with 75% NPK. The high soil available N was mainly attributed to the

fixation of atmospheric N in the root zone of rice plants by the Azospirillum.

The available soil P<sub>2</sub>O<sub>5</sub> was significantly higher in the case of Azospirillum + PSB@3.5kg/ha+Daincha brown manuring (54.2 kg/ha) with 75% NPK which however remained on par with Azospirillum+PSB @3.5kg/ha with 75%NPK. Here also the higher soil available P was mainly attributed to the action of phosphate solubilizing bacteria in transforming the unavailable fixed P into available form enriching the available soil P. The soil exchangeable K<sub>2</sub>O did not differ significantly among the treatments.

The two-year data thus indicated that treatment of soil application of Azospirillum +PSB @3.5kg/ha along with 75%NPK recorded on par grain yield with recommended NPK and can supplement NPK fertilizers to an extent of 25% in transplanted rice.

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