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Research Communication

Influence of nutrient-management practices and microbial inoculants on productivity and profitability of lowland rice (*Oryza sativa*) in Eastern Himalayas

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ABSTRACT

A field study was conducted during the rainy (*kharif)* season of 2016 at Umiam, Barapani, Meghalaya, to find out the effect of different nutrient-management practices and microbial inoculants on yield-attributing characters, yield and profitability of lowland rice (*Oryza sativa* L.) in Eastern Himalayas. The experiment consisted of 12 treatment combinations including 3 nutrient-management practices, viz. 100% organic, 100% inorganic [recommended dose of fertilizer (RDF)] and integrated nutrient management (INM; 75% RDF + 25% FYM), in main plot and 4 microbial inoculation treatments, viz. control, *Azospirillum*, *Azospirillum* + phosphate-solubilizing bacteria (PSB), *Azospirillum* + PSB + zinc-solubilizing bacteria (ZnSB) in subplots. The experiment was laid out in a split-plot design with 3 replications. The yield-attributing characters, viz. tillers/m^2, panicle length and filled grains/panicle were the highest with INM treatment, followed by inorganic and organic nutrient-management practices. Similar trend was observed in case of 1,000-seed weight, but it was at par with the other nutrient-management practices. The highest grain yield (4.27 t/ha) was recorded in INM, followed by inorganic (4.08 t/ha) and organic (3.65 t/ha) nutrient-management practice. Among the microbial inoculants, the highest yield was recorded in *Azospirillum*+ PSB + ZnSB treatment, followed by *Azospirillum* + PSB and *Azospirillum* treatment. The highest cost of cultivation (₹28,829/ ha) was recorded under organic nutrient management, while net returns (₹48,615/ha) were maximum in INM practice with combined application of *Azospirillum*+ PSB + ZnSB. Thus, INM (75% RDF and 25% organic inputs, i.e. FYM) and microbial inoculants could be used for higher productivity and profitability of lowland rice in Eastern Himalayas.

Key words: Economics, Lowland rice, Microbial inoculants, Nutrient management, Yield

Rice is a staple food of more than 50% of the world's population and supplies 20 and 31% of total calories required by world and the Indian population, respectively. In India, rice accounts for 40% of the nation's food production and it is a staple food of around 65% total population. Rice-based production systems provide the main source of income and employment for more than 50 million households (Vaid *et al*., 2014). But the rice crop plants are able to use about 30–50% of the applied fertilizer N while more than 50% is lost from the soil-plant system through leaching, volatilization and denitrification (Tiwari *et al.,* 1998). With a view to reduce the losses and indiscriminate use of chemical fertilizers, substitution of a part of the chemical fertilizer by microbial inoculants is inevitable. Under the present situation, organic and microbial nutrient sources could be important components of the nutrient management in different agro ecosystems since they are good for the soil and cost-efficient (Das *et al*., 2014). In addition to supply of nutrients, these organic and microbial inoculants improve the physical condition and biological health of soil, which improves the availability of applied and native nutrients (Shahane *et al*., 2013; Meena *et al.,* 2014). Rose *et al.* (2014) in Vietnam also observed that the biofertilizer can replace between 23 and 52% of nitrogen fertilizer without loss of yield. Keeping this in view, the present study was undertaken to study the effect of nutrient-management practices and microbial inoculants on yield and profitability of lowland rice.

A field experiment was conducted during the rainy (*Kharif*) season of 2016 season at the research farm of ICAR Complex for NEH Region, Umiam, Barapani (25

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41'–21" N, 91 55'–25" E' 950 m above mean sea level), Meghalaya. The soil of the experiment site was sandy clay loam in texture, acidic (5.0) in nature and having low available N (252.98 kg/ha) and P (8.19 kg/ha), but high available K content and soil organic carbon (2.51%). The total rainfall received during the growing season was 1,622.6 mm. The experiment consisted of 12 treatment combinations and was laid out in a split-plot design with 3 replications. The treatments consisted of 3 main plot treatment, viz. 100% organic through FYM, 100% inorganic (recommended dose of fertilizer-RDF) and INM (75% RDF + 25% FYM), while in the subplot there were 4 treatments, viz. control, *Azospirillum*, *Azospirillum* + phosphate-solubilizing bacteria (PSB) and *Azospirillum* + PSB + zinc-solubilizing bacteria (ZnSB). A semi-dwarf, medium duration rice variety Shahsarang 1 was taken and transplanted on 19 July 2016, with plant spacing of 20 cm × 20 cm. Fertilizer N, P and K was applied through urea, single superphosphate and muriate of potash at the rate of 80 : 60 : 40 kg/ha, respectively for inorganic nutrient management. The nutrients in organic plots were applied through FYM and rock phosphate. In INM plots, it was applied through 75% RDF and 25% FYM. Microbial inoculants taken from ICAR-Indian Agricultural Research Institute, New Delhi, were applied as per the recommended doses and after dissolving in water and roots of the rice seedlings were dipped in the solution for 1 hr before transplanting. The observations on yield attributes, yield and economics were recorded as per the standard procedures.

The results showed that yield-attributing parameters, viz. tillers/m^2, panicle length and filled grains/panicle, were significantly influenced by different nutrient-management practices and microbial inoculants (Table 1). The yield-attributing parameters were the highest with INM, followed by inorganic and organic nutrient management at 30, 60, 90 days after transplanting (DAT) and at harvesting stage. Arif *et al.* (2014) also reported that, the maximum numbers of fertile tillers/hill produced when organic sources of nutrients were combined with 50% of the recommended dose of fertilizer. Among the microbial inoculants, the highest value of all the yield-attributing characters were observed in *Azospirillum*+ PSB + ZnSB treatment, followed by *Azospirillum* + PSB, *Azospirillum* and the control treatments. Yadav *et al.* (2015) reported significantly higher number of tillers of rice at all the stages owing to the inoculation of PSB. Filled grains/panicle were also found to be the highest in INM practice. A similar result showing higher percentage of filled grain/panicle was recorded under the INM practice over the control (Alagappan and Venkitaswamy, 2016). Number of panicles/m^2 were the highest (207) under INM and these were significantly higher than those recorded under organic treatment. The highest grain yield (4.27 t/ha) was recorded in INM, followed by inorganic (4.08 t/ha) and organic (3.65 t/ha) treatment and there was a yield advantage of 12% and 17% in inorganic and INM over organic management, respectively. The nutrient-management practices and microbial inoculants significantly influenced straw and biological yields, and showed the trends like the

Table 1. Effect of nutrient-management practices and microbial inoculants on yield attributes, yields and profitability of rice

Treatment	Effective tillers/m^2	Panicle length (cm)	Filled grains/ panicle	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	Cost of cultivation (× 10^3 ₹/ha)	Net returns (× 10^3 ₹/ha)	Benefit: cost ratio
Nutrient-management practices											
Organic*	206.5	20.8	113.3	23.4	3.65	5.69	9.34	39.13	28.8	31.7	1.10
Inorganic**	210.7	22.7	117.8	23.4	4.08	6.06	10.15	40.19	22.0	45.3	2.06
INM***	213.3	24.2	130.0	23.6	4.27	6.28	10.55	40.45	21.7	48.6	2.24
SEm±	2.04	0.27	2.19	0.23	0.08	0.09	0.16	0.42	–	–	–
CD (P=0.05)	8.02	1.11	8.64	NS	0.34	0.36	0.63	NS	–	–	–
Microbial inoculants											1.92
Control	137.0	22.0	109.2	23.2	3.72	5.62	9.34	39.83	24.1	37.3	1.55
Azospirillum	139.1	22.0	116.0	23.4	3.94	5.94	9.89	39.85	24.2	41.0	1.70
Azospirillum + PSB	142.5	22.9	120.7	23.4	4.10	6.17	10.27	39.88	24.2	43.2	1.78
Azospirillum + PSB + ZnSB	146.1	23.3	135.5	23.8	4.25	6.31	10.56	40.17	24.3	45.9	1.89
SEm±	0.89	0.31	2.28	0.26	0.05	0.10	0.11	0.25	–	–	–
CD (P=0.05)	2.63	0.95	6.78	NS	0.17	0.31	0.33	NS	–	–	–
Interaction	NS	NS	NS	NS	S	S	S	NS	–	–	–

*Organic, FYM and rock phosphate; **inorganic, 80 : 60 : 40 kg/ha N; P_2O_5: K_2O; ***INM, 75% mineral fertilization at RDF (80 : 60 : 40 kg/ha) + 25% FYM; INM, integrated nutrient management; PSB, phosphate-solubilizing bacteria; ZnSB, zinc-solubilizing bacteria; NS, non-significant grain yield. The highest cost of cultivation (₹28,829/ha) was recorded under organic nutrient management, while the highest net returns (₹48,615/ha) and benefit : cost ratio were observed in INM practice with combined application of *Azospirillum* + PSB + ZnSB. Shahane *et al.* (2013) also reported similar results. The interaction effects on grain and straw yields because of the nutrient-management practices and inoculation of microbial inoculants were found to be significant.

It was concluded that among different nutrient-management practices, adoption of INM including 75% RDF + 25% FYM was found to be the best for higher yield attributes and crop productivity. The INM was also proved better from the point of view of cost of cultivation and resulted in higher net returns and benefit : cost ratio. The combined inoculation with 3 microbial inoculants, viz. *Azospirillum* + PSB + ZnSB also resulted in higher productivity, net returns and benefit : cost ratio compared to control and single inoculation.

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