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# Productivity and economics of rice (*Oryza sativa*) through phosphorus management in North-East India

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Rice (*Oryza sativa* L.) is the staple food for more than half of the world's population. Rice accounts for 35–75% of the calorie intake by more than 3 billion people in Asia (Khush 2010). North-east India is characterized by high soil acidity, $Al^{+3}$ toxicity, heavy soils, uneven water distribution leading to scarcity during most parts of year (Das *et al.* 2016, Babu *et al.* 2020). Falleiro *et al.* (2013) commented on the impact of organic nutrient sources on improvement of soil chemical properties like cation exchange capacity and moderation of soil *p*H. The range of phosphorous use efficiency values for crops lies between 10-30% in the year of application (Malhi *et al.* 2002), which is very less compared to use efficiencies of N and K. Myint *et al.* (2010) stated of the twin benefits of increasing soil fertility and cost reduction by application of organic manures. The phosphorus deficiency is a major concern under direct seeded upland fields in soils of Assam contributing to low yield of rice as a large portion of applied chemical fertilizer get immobilized rapidly and becomes unavailable to the plants. The phosphate-solubilizing bacteria (PSB) increased the solubility of Al- and Ca-phosphate by secreting organic acids such as gluconic, oxalic and citric acids in the soil. Very little work has been done on upland rice cultivation on the hill terraces with organic nutrient sources to alleviate phosphorus deficiency. Hence, there is a need to compare the effect of different organic and inorganic combinations as nutrient sources in direct-seeded rice on hill terraces in Meghalaya. In this regard, an experiment was conducted to study the influence of phosphorus management practices on yield and economics of direct-seeded rice.

The experiment was conducted at research centre of ICAR- North-Eastern Hill region, Umiam (25°38' N and 91°53' E at an altitude of 950 m above mean sea level) during *kharif* 2019. The soil of the experimental plot was sandy-clay loam in texture with *p*H 4.2, high in organic carbon (1.62%) and available K (354 kg/ha), medium in available N (256 kg/ha) and low in available P (6.3 kg/ha). Eight treatments were arranged in randomized block design with three replications, viz. control plot with no P; 100% recommended dose of phosphorus (RDP), i.e. 60 kg $P_2O_5$/ha; 50% RDP + 50% through farmyard manure (FYM); 50% RDP + 50% through vermicompost (VC); 50% RDP + 50% through poultry manure (PM); 50% RDP + phosphorus solubilizing bacteria (PSB) + arbuscular mycorrhiza fungi (AMF); 75% RDP + PSB + AMF; 25% through FYM + 25% through VC + 25% through PM + PSB. Rice variety Bhalum 3 was directly hand sown using a seed rate of 25 kg/ha at 20 cm row spacing. The crop was fertilized with recommended dose of 80:60:40 kg of N, $P_2O_5$ and $K_2O$/ha. All the treatments were supplied with optimum doses of N and K, but P was given in accordance to the treatments supplementing it with other nutrient sources.

The yield attributes of the crop were determined using standard methods. The number of panicles from demarcated net plot area was counted at harvest stage and expressed as panicles/$m^2$. The total number of grains for the same 10 randomly selected panicles per unit plot area was counted and their average was recorded. The total numbers of filled grains along with number of unfilled grains were counted separately by a seed counter. The average value of filled grains per panicle was recorded. The weight of 1000-filled grains from the net plot area was taken separately. The produce was harvested in unit plot basis after maturity and then sun-dried for three days in the field. Then the total biomass or biological yield was recorded. After threshing, cleaning and drying the grain to a permissible moisture content of 14%, grain yield was calculated. Straw yield was derived by subtracting grain yield from the total biological yield. Harvest index was calculated by dividing economic yield with biological yield and expressing it in % values.

Economics of different treatments were estimated to determine the most cost-effective treatment among all. The net benefit: cost ratio was also worked out on the basis of total cost of production. Gross return (₹/ha) was calculated

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Table 1 Effect of nutrient management practices on yield and economics of direct-seeded rice

| Treatment | Panicles/ $m^2$ | Filled grains/ panicle | Test weight (g) | Grain yield (t/ha) | Straw yield (t/ha) | Cost of cultivation (× $10^3$ ₹/ha) | Net returns (× $10^3$ ₹/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|---|
| Control | 207 | 88 | 22.5 | 3.77 | 6.48 | 40.9 | 62.3 | 1.52 |
| 100% RDP | 234 | 111 | 23.7 | 4.57 | 8.02 | 44.7 | 96.6 | 2.15 |
| 50% RDP + 50% FYM | 227 | 106 | 23.4 | 4.49 | 7.69 | 50.9 | 78.7 | 1.55 |
| 50% RDP+ 50% VC | 227 | 107 | 23.5 | 4.50 | 7.72 | 49.4 | 83.1 | 1.68 |
| 50% RDP + 50% PM | 228 | 109 | 24.0 | 4.52 | 7.73 | 49.4 | 86.5 | 1.75 |
| 50% RDP + PSB + AMF | 224 | 103 | 23.3 | 4.46 | 7.66 | 43.8 | 71.8 | 1.64 |
| 75% RDP + PSB + AMF | 230 | 111 | 23.7 | 4.53 | 7.95 | 44.2 | 94.0 | 2.12 |
| 25% FYM + 25% VC + 25% PM + PSB | 243 | 121 | 24.4 | 4.97 | 8.85 | 51.9 | 101.2 | 1.95 |
| SEm± | 4.47 | 3.60 | 0.21 | 0.11 | 0.37 | … | 2.87 | 0.07 |
| LSD (P=0.05) | 13.07 | 10.83 | 0.61 | 0.32 | 1.10 | … | 8.62 | 0.21 |

RDP, Recommended dose of phosphorus; FYM, Farmyard manure; VC, Vermicompost; PM, Poultry manure; PSB, Phosphorus solubilizing bacteria; AMF, Arbuscular mycorrhizal fungi.

on the basis of grain and straw yield of rice and their present prices in the market (rice grain price: ₹ 15500/t; rice straw price: ₹ 2000/t). Net B:C ratio was obtained by dividing net returns obtained by cost of cultivation incurred.

Results showed that yield attributing characters, viz. panicles/$m^2$, filled grains/panicle and 1000 grain weight were significantly affected by phosphorus management practices (Table 1). The highest number of yield attributes along with grain yields were found to be the highest in 25% FYM + 25% Vermicompost + 25% Poultry manure + PSB (4.97 t/ha). Next to it was100% RDP (4.57 t/ha).

Similar results were also reported by Yadav *et al.* (2013). As revealed from soil test values, the soil is already poor in available N and P. So, no external addition of nutrients led to reduced yields as in control plot (Bamboriya *et al*. 2017). Organic manures also increase porosity and lead to more water retention in pore spaces which helps to increase yield. Chaffy grains are significantly reduced on adoption of integrated nutrient management (INM). It facilitates in better nutrient assimilation and a greater number of filled, healthy grains (Maragatham *et al*. 2010). The cost of cultivation was maximum in organically treated plot having a combination of all organic sources like FYM, VC, PM and PSB. FYM as it was needed to be applied in huge quantities owing to less concentration of nutrients in it. Vermicompost and poultry manure application along with half dose of RDP gave equal cost of cultivation in both the treatments. But, the net return for the organically treated plot was less than inorganic plot due to more cost of cultivation in the former. These results are in close conformity with the findings of Barik *et al.* (2006). Thus, it can be concluded that organically treated 25% FYM + 25% vermicompost + 25% poultry manure + PSB resulted in higher yield attributes and grain yield. But chemically treated 100% RDP proved to be the most cost-effective which was at par with organically treated plot. Therefore, organic nutrient management comprising of nutrient sources like FYM, vermicompost, etc. can be thought of as a viable option in North-East India.

## SUMMARY

A field experiment was planned and executed in randomized block design at Umiam during *kharif* 2019 to determine the grain yield and economics of upland direct-seeded rice (*Oryza sativa* L.) in North-Eastern Hill region under varying phosphorus management practices. The soil of the experimental plot was sandy-clay loam in texture with *p*H 4.2, high in organic carbon (1.62%) and available K (354 kg/ha), medium in available N (256 kg/ha) and low in available P (6.3 kg/ha). The plot managed with organic nutrient sources i.e. 25% FYM + 25% vermicompost + 25% poultry manure + PSB produced significantly higher number of yield attributes subsequently resulting in higher grain yields. This was followed by 100% RDP fertilized plot and 75% RDP+ PSB + AMF. In terms of economics, 100% RDP plot proved to be the most cost-effective owing to the less cost of fertilizers as compared to organic nutrient sources.

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## REFERENCES

Babu Subhash, Singh Raghavendra, Avasthe RK, Yadav G S, Mohapatra K P, Selvan T, Das Anup, Singh V K, Valente D and Petrosillo I. 2020. Soil carbon dynamics in Indian Himalayan intensified organic rice-based cropping sequences. *Ecological Indicators* **114**:106292 https://doi.org/10.1016/j.ecolind.2020.106292

Bamboriya S D, Bana R S, Pooniya V and Singh Y V. 2017. Effect of planting density and nitrogen management on micronutrient content, soil fertility and microbial properties in conservation agriculture based rainfed pearlmillet. *International Journal of Chemical Studies* **5**(4): 849–53.

Barik A K, Giri A K and Chattopadhyay G N. 2006. Effect of integrated plant nutrient management on growth, yield and production economics of wet season rice (*Oryza sativa*). *Indian Journal of Agricultural Sciences* **76(**11**)**: 657–60.

Das A, Babu Subhash, Yadav G S, Ansari M A, Singh R, Baishya L K, Rajkhowa D J and Ngachan S V. 2016. Status and strategies for pulses production for food and nutritional security in north-eastern region of India. *Indian Journal of Agronomy* **61**: 129–43.

Falleiro R M, Souza C M, Silva C S W, Sediyama C S, Silva A A and Fagundes J L. 2013. Influence of the preparation systems on the chemical and physical properties of the soil. *Brazilian Journal of Soil Science* **27**(6): 1097–1104.

Khush G S. 2010. What it will take to feed 5.0 billion rice consumers in 2030. *Plant Molecular Biology* **59**(1): 1-6.

Malhi S S, Brandt S A, Ulrich D, Lemke R and Gill K S.2002. Accumulation and distribution of nitrate–nitrogen and extractable phosphorus in the soil profile under various alternative cropping systems. *Journal of Plant Nutrition* **25**(11): 2499–2520.

Maragatham N, Martin G J and Poongodi T. 2010. Effect of Nitrogen sources on aerobic rice production under various rice soil eco systems. (In) *Proceedings of 19th World Congress of Soil Science, Soil Solutions for a Changing World*, 1–6 August, 2010*,* Brisbane, Australia, pp 13–16.

Myint A K, Yamakawa T, Kajihara Y and Zenmyo T. 2010. Application of different organic and mineral fertilizers on the growth, yield and nutrient accumulation of rice in a Japanese ordinary paddy field. *Science World Journal* **5**(2): 122–29.

Yadav G S, Datta M, Babu Subhash, Debnath C and Sarkar P K. 2013.Growth and productivity of lowland rice (*Oryza sativa*) as influenced by substitution of nitrogen fertilizer by organic sources. *Indian Journal of Agricultural Sciences* **83**(10): 1038–42.