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Integrated Phosphorus Management for Profitable Direct-Seeded Upland Rice Production in North-East India

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Abstract

Traditional transplanted rice production is not an economic business in Meghalaya. Hence, farmers are promoted to grow the direct seed rice organically. But the phosphorus deficiency is a major yield-limiting factor in direct-seeded upland production in Meghalaya. Hence, integrated phosphorus management must be taken into account for fetching a higher economic yield of upland rice in acidic soils of Meghalaya. Equal substitution of farmyard manure (FYM), vermicompost (VC), and poultry manure (PM) (FYM-25% + VC-25% + PM-25%) along with the Phosphorus Solubilising Bacteria is the economically feasible practice for sustainable upland rice production in Meghalaya under organic management.

Introduction

Rice (*Oryza sativa*) is the principal food crop for the populace of the North-Eastern region of India (Babu *et al.,* 2020). But the productivity of the rice in the NEH region is behind the national average of India (Yadav *et al.,* 2013[a]). There are several reasons for the low productivity of the rice in the NEH region of India. Out of which poor soil nutrients availability especially phosphorus (P) is of paramount importance. P is the second most important primary plant nutrient after N that plays a vital role in the functioning of nucleic acids (RNA and DNA). A major land chunk of the NEH region of India is acidic. Acidic soil has a higher level of Fe and Al oxides which provide strong P absorption capacity to the soil. Plants mainly absorb P dissolved in the soil solution as orthophosphate ions (HPO_4^{-2} and $H_2PO_4^{-1}$). Integrated nutrients management is an economical and sustainable approach for improving soil and enhancing crop productivity (Yadav *et al.,* 2013[b]). Due to climatic conditions, subsistence farming nature, and plenty of availability of organic manures the NEH region of India region has ample scope to improve crop productivity. Furthermore, the hilly tract of North-East where the soil is not much exposed to chemicals has a prosperous future in the direction of organic farming. Considering these points in view an integrated phosphorus management protocol has been developed for profitable upland rice production in the region without impairing the soil and environmental quality.

Suitable Ecology and Area for the Implication of Practice/ Protocol

The protocol is most suitable for rainfed lands of Meghalaya with good drainage provision. The average annual temperature of the targeted area could be around 20 °C for obtaining remunerative yields. In the border domain, the region with high rainfall with sub-tropical climate can be conducive for the growth of the crop.

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Soil

Well-drained soil with moderately acidic to neutral pH is most suitable. Sandy loam soil is the most desirable textural class. But it could be applied to clayey loam soil as well. Sufficient amounts of organic matter in soil could enhance fertility levels and increase yields.

Figure 1: Rice field at seedling stage

Figure 2: Land preparation for sowing rice

Land Preparation

The land should be once plowed with a power tiller followed by 2-3 times harrowing. Then after, field should be properly leveled and bunded.

Application of Organic Manures

Apart from the other recommended dose of fertilizers. The Recommend dose of the phosphorus should be applied through well-decomposed FYM, VC, PM in a 1:1:1 ratio along with biofertilizer consortia of PSB after final land preparation.

Sowing/ Direct Seeding

Suitable rice varieties like Bhalum-3 for Meghalaya should be selected for fetching good yield. The rice seeds should be directly sown by hand in continuous lines keeping a row spacing of 20 cm in June. Proper sowing distance must be maintained to ensure a uniform geometry of plant stand.

Thinning

Thinning (removal of plants) should be done after 7 DAS to ensure a proper plant to plant spacing of 10 cm.

Water Management

As Meghalaya enjoys a good amount of rainfall hence, timely drainage of excess water should be done for supplying adequate levels of oxygen to plant roots.

Weed Management

Regular hand weeding operations should be done thrice at an interval of 20 days, at 15, 35, and 55 DAS.

Harvesting and Threshing

Harvesting of crops depends on the type of variety grown and the time of the sowing. However, well managed and timely sown crop may be harvested during November. The harvested produce may be left in the field for five days to ensure proper sun-drying, after which threshing operations should be performed. Winnowing- the separation of grain from chaff should be done after threshing. After proper draying, the economic produced should be bagged and stored or send to the market.

Yield and Economics

Application of phosphorus in a balanced fashion e.g. 25% P through FYM + 25% P through VC + 25% P through PM along with solubilizing Bacteria mobilized the fixed phosphorus and increased nutrient uptake by the plant. It produced a grain yield of 4.97 t/ha and remunerative net returns of Rs. 1,01,186.00 /ha were obtained. A net B:C ratio of more than 1(1.95) was obtained indicating the profitability of the method.

Table 1: Yield and economics of direct seed rice under integrated phosphorus management protocol

Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (Rs./ha)	Net returns (Rs./ha)	B:C ratio
4.97	8.85	51,884.00	1,01,186.00	1.95

Conclusion

Integrated phosphorus management under organically grown directed seeded upland rice is the economically feasible option for profitable and sustainable rice production in North-East India especially in Meghalaya. As the prolonged application of organic manures in a balanced manner to the soil can go a long way in the sustenance of soil health, microbial diversity, obtaining higher yields, and generation of remunerative income by the farmers of North-Eastern Hill region.

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