Original Research Article
Impact of phosphorus management in lowland paddy cultivation under Hnahthial District of Mizoram, India

Abstract:

Rice is the first most important crop in the Northeast region of India grown under rainfed lowland soils. Due to continuous cultivation, plateauing of yield was observed with the occurrence of phosphorus deficiency in the soils, based on soil test result. A field level demonstration on management of phosphorus and other important soil nutrient was conducted based on soil test result in lowland paddy fields of South Vanlaiphai village under Hnahthial District of Mizoram covering 17 ha. It was observed that with the application of different sources of NPK, crop yield and soil health was found to be enhanced. This technology was found to be beneficial and suitable for lowland paddy soils, where plateauing of yield was observed with phosphorus deficiency.

Keywords: Soil test, phosphorus, management, lowland paddy

Introduction:

Phosphorus is one of the three major nutrients required in crop nutrition, the other two being nitrogen (N) and potassium (K). Phosphorus plays many vital roles in crop growth. Hasan (1996) reported that for available P in Indian soils, 49.3 per cent of the districts are in low category, 48.8 per cent are medium and 1.9 per cent in the high P category. Nearly 98 per cent of the soils in India are in need of phosphorus for better crop productivity. The response of crops to phosphorus application may differ with the crop ecosystem. The requirement of phosphorus by rice is not as high as that of nitrogen but deciding its dose, time and method of application is very much essential for increased response to applied phosphorus. Paddy remainsto be the principal food crop and the staple food of the people of Mizoram. The minimum rice requirement of the state per year is estimated to be about 1,80,000 MT, the present rice production is only 59,605 MT per year which could meet only 33.11% of its rice requirement, Economic Survey Mizoram (2019-20), with the productivity of 1.68 MT/ha. There is so much need to increase productivity by applying the right dose of deficient nutrient, keeping this in mind the present study aims to improve the quality of soil with increasing yield.

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Comment [12]: present a less general objective.

Materials & Method:

The study was under frontline demonstration (FLD) programme of KVK Lunglei, Mizoram carried out during 2021 conducted at South Vanlaiphai village covering paddy cultivation area of 17 ha. Plateauing of yield was observed in paddy due to continuous cultivation and absence of nutrients inputs. Paddy was sown in the month of June, transplanted in the month of July and harvested in the month of November. Soil samples were collected from the location and deficiency of Phosphorus was observed in the soils, initial soil test result is given in Table 1. Based on soil test results, treatments were given as T_0- Control, T_1- Recommended dose of fertilizers (RDF) of N:P:K (40:20:40) kg ha^{-1},T_2- 40:60:40 kg ha^{-1}. Nutrients were applied in two split doses. Half dose of N and P source of nutrient was applied during puddling and panicle initiation stage. K nutrient was applied during panicle initiation stage and milking stage.

Comment [13]: Do not reference a table that is in another topic.

Comment [14]: Include maps and photos that demonstrate the position and setting of the survey.

Nutrients were applied in the forms of urea, single super phosphate and muriate of potash (MOP). Yield and yield attributing data was recorded for different treatments.

To determine soil physico-chemical properties, soil samples were collected before transplanting of paddy and after harvesting of paddy, soil sampling was done at a depth of 15-20cm. The soil samples were air dried at room temperature. Soil samples before chemical analysis was screened through a 2mm sieve. The total organic carbon (TOC) content of finely ground sample was determined by Walkely and Black's Wet Oxidation method as describe by Jackson (1973) and expressed in percentage (%). The soil reaction of samples were measured in 1:2.5 soil: distilled water suspension by potentiometric method using glass electrode, Jackson (1973).Available nitrogen was determined by modified alkaline permanganate method of Subbiah and Asija (1956) and available nitrogen content was determined by Micro-Kjeldahl Method describe by Jackson (1973). It is expressed in kg ha^{-1}.Available phosphorus was determined by the method as describe by Bray and Kurtz (1945). It is expressed in $Kgha^{-1}$.Available potassium was extracted with neutral normal ammonium acetate and the content of potassium in the solution was estimate d by Flame photometer (Jackson, 1973). It is expressed in kg ha^{-1}.

Result & Discussion:

Characteristics of soil

The initial soil physico-chemical properties indicated that soil organic carbon is mostly in a high range from 1.18% to 1.45% (Table 1). Soil reaction is within the range of 4.3 to 5.7 (Table 1), which is strongly acid to moderately acid. Available soil nitrogen is mostly in a medium range from 413 to 480.10 $kgha^{-1}$. Available Phosphorus (P_2O_5) is mostly in a low range from 0.74 to 20.55 kg $ha^{-1}$and available Potassium (K_2O) is in a low to medium range from 80.8 to 165.7 kg ha^{-1}.

Increase in soil organic carbon (SOC) was observed from initial soil sample to soil after paddy harvest (Table 1 and Table 2). This may be because of the application of organic manure and chemical fertilizer as it can improve soil aggregation, soil water retention, and reduce bulk density of the soil, promoting crop growth and the return of more root residues to the soil, Hyvo¨nen *et. al*., (2008)

Table 1: Initial soil physico-chemical properties

Sample No.	**SOC (%)**	**pH**	**Avail. N ($Kgha^{-1}$)**	**P_2O_5 ($Kgha^{-1}$)**	**K_2O ($Kgha^{-1}$)**
1	1.18	4.3	413	0.74	118.4
2	1.45	5.2	480.1	7.15	165.7
3	1.38	5.1	463	4.5	104.4
4	1.27	5.3	385.6	0.89	80.8
5	1.25	5.7	446.7	20.55	126.7

Increase in soil reaction from initial soil sample as compared to soil after harvest. This is attributed to application of single super phosphate (SSP) as a phosphorus source, which contains 18% of Calcium. Where replacement of exchangeable H^+ ions by Ca^{2+} ions from the fertilizers (SSP) takes place. Similar finding was reported by Saunders (1958). Increase in phosphorus availability increase from initial soil sample (Table 1) to after harvest soil sample (Table 2). This might be due to increase in soil pH. As pH increases, activity of Fe and Al decreases, which reduces P adsorption/precipitation and increases solution P concentration, Havlin *et. al.*(2011).

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Table 2: Effect of nutrient application on soil physico-chemical properties after paddy harvest

Sample No.	SOC (%)	pH	Avail. N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
1	1.27	6.5	435.6	33.96	27.86
2	1.27	6.4	435	27.70	114.2
3	1.23	6.3	424	40.21	136.5
4	1.36	5.9	457	32.17	337.1
5	1.18	6.2	296	24.13	220.1

Table 3: Effect on yield of paddy and yield attributing factors

Treatments	Grain yield (t/ha)	No. of effective tillers	Test weight (gm)	Pannicle length (cm)
T_0	1.02	6	22	25.6
T_1	1.69	8	26.5	26.06
T_2	2.1	11	29.6	29.2

Yield components:

Yield components that were influenced by fertilizer treatment were the number of effective tillers, panicle length, test weight of seed and productivity. Fageria (2009) stated that increase in 1000 grain weight may due to increase in N–absorption by the plant and advanced photosynthetic rates. Large amounts of phosphorus derived mainly from that accumulated in leaves before the flowering stage begins may aid in increasing the 1,000 grains weight (Yoshida, 1981) The grain yield was different on all fertilizer treatment compared to T_0 (Control). The highest average grain yield was in treatment of T_2 - with NPK ratio of 40:60:40 kg/ha. This showed that the nutrient adequacy of N, P and K had an important role in improving rice yield, Budiono *et al.* 2019. According to Dobermann and Fairhurst (2000) for every ton of rice produced it took about 17.4 kg N, 2.6 kg P, and 14.5 kg K. The higher the yield obtained, the greater of the nutrients needed and vice versa. The increase in NPK fertilizer rate may have increased the grain yields which may be due to the adequate supply of nutrients to the crops to produce higher panicle numbers associated with higher percentage of productive tillers. Further, the increase in NPK rate may aid in higher spikelet sterility thus contributing to higher rate of grain filling that may increase yields. Number of effective tillers and panicle length was found to be much higher in treatments T_1 (8 and 26.06 cm) and T_2 (11 and 29.2 cm) than in control T_0 (6 and 25.6 cm). This illustrates that N and P provides an important role in the formation of panicles. The number of panicles shows the number of vegetative tillers that were productive tillers. The large number of panicles plays a large role in production because it had a high direct effect on yield, *Totok et al.,* 2014. Marchner (2012) had noted the positive roles of adequate P supply in stimulating healthy root growth which helps plants in better utilization of water and nutrients thereby promoting strong stem and foliage development, production of a large number of flowers and early fruit set.

Conclusion:

The content of this paper highlight that the importance of soil testing in identifying the nutrient deficiency specifically phosphorus in continued cultivation of lowland paddy soils. Recommended dose of different source of fertilizers have synergistic effect on soil health and crop yield components. Applying Phosphorus in the form of single super phosphate have impact on increasing the soil pH due to its calcium content 18%. Addition of organic manure and fertilizers improves soil organic carbon by promoting crop growth and the return of more root residues to the soils. Nitrogen and phosphorus plays an important role in increasing 1000 grain weight and total grain yield. Adequate P supply have a positive effect on development of healthy root system which help in better utilization of water and nutrients.

Comment [16]: the conclusion is obvious. be more specific and present highlights found in the survey.

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Comment [17]: update references

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