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Impact of Phosphorus Management in Lowland Paddy Cultivation under Hnahthial District of Mizoram, India

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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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 T_2 treatment with NPKat a rate of 40:60:40 kg $ha^{-1}$was found to give a better grain yield of 2.01 t/ha as compared to control (T_0) and T_1 treatment with a yield of 1.02 t/ha and 1.69 t/ha, respectively. Soil health was found to be enhanced with increase in soil physico-chemical properties like soil organic carbon (SOC) content, soil reaction (pH), available nitrogen (N), available phosphorus (P_2O_5) and available potassium (K_2O). Soil reaction (pH) and available phosphorus (P_2O_5) was found to increase in soil of paddy after harvest as compared to initial soil test result. Average value of soil pH, available phosphorus and potassium was found to increase from 5.12 to 6.26, 7.17 to 31.63 kg/ha and 119.2 to 167.15 kg/ha, respectively.

Keywords: Soil test; phosphorus; management; lowland paddy.

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1. INTRODUCTION

Phosphorus is one of the three major nutrients required in crop nutrition, the other twobeing nitrogen (N)and potassium (K). Phosphorus plays many vital roles in crop growth. Muralidharudu et al. [1] reported that for available P in Indian soils, 51 per cent of the districts are in low category, 40 per cent are medium and 9 per cent in the high P category. Nearly 78 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 increasedresponse to applied phosphorus. Paddy remains to 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% ofits rice requirement, Economic Survey Mizoram [2] 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 determine the effectiveness of different doses of phosphorus on soil physico-chemical properties and crop yield and its components.

2. MATERIALS AND METHODS

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. at an elevation of 1230m above mean sea level with a flat land topography. Textural class of the study area belongs to sandy clay loam soils. Location of the study area is given in Fig. 1. 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. 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} and organic manure at a rate of 2 ton/ha at each treatment. 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. 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, Global positioning system (GPS) based 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 Walkley and Black's [3] Wet Oxidation method as describe by Jackson [4] and expressed in percentage (%). The soil reaction (pH) of samples were measured in 1:2.5 soil: distilled water suspension by potentiometric method using glass electrode, Jackson [4]. Available nitrogen was determined by modified alkaline permanganate method of Subbiah and Asija [5] and available nitrogen content was determined by Micro-Kjeldahl method describe by Jackson [4]. It is expressed in $kgha^{-1}$.Available phosphorus was determined by the method as describe by Bray and Kurtz [6]. 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 [4]. It is expressed in $kgha^{-1}$.

3. RESULTS AND DISCUSSION

3.1 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. [7].

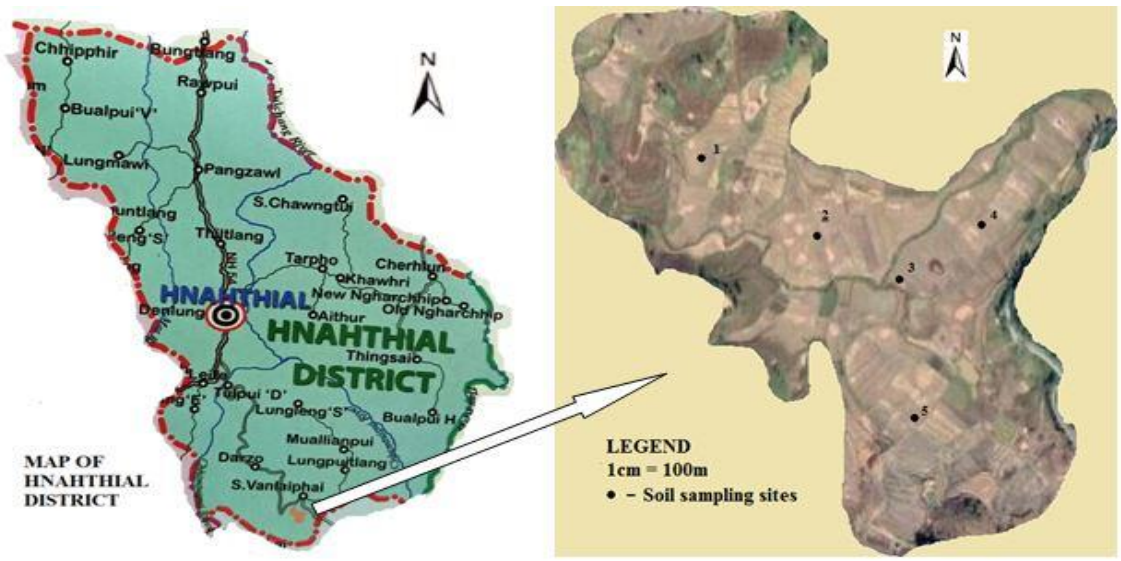

Fig. 1. Location of the study area and soil sampling sites

Table 1. Initial soil physico-chemical properties

GPS points at soil sampling sites	Sample No.	SOC (%)	pH	Avail. N ($Kgha^{-1}$)	P_2O_5 ($Kgha^{-1}$)	K_2O ($Kgha^{-1}$)
22°47'48.09''N 92°59'55.37''E	1	1.18	4.3	413	0.74	118.4
22°47'46.99''N 93°0'0.66''E	2	1.45	5.2	480.1	7.15	165.7
22°47'43.14''N 92°59'59.82''E	3	1.38	5.1	463	4.5	104.4
22°47'39.48''N 92°59'58.88''E	4	1.27	5.3	385.6	0.89	80.8
22°47'40.23''N 93°0'03.12''E	5	1.25	5.7	446.7	20.55	126.7
	Average	1.30	5.12	437.68	7.17	119.2
	SD	0.11	0.51	38.22	8.16	31.27
	CV (%)	8.26	10	8.73	120.55	26.24

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

GPS points at soil sampling sites	Sample No.	SOC (%)	pH	Avail. N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
22°47'48.09''N 92°59'55.37''E	1	1.27	6.5	435.6	33.96	27.86
22°47'46.99''N 93°0'0.66''E	2	1.27	6.4	435	27.70	114.2
22°47'43.14''N 92°59'59.82''E	3	1.23	6.3	424	40.21	136.5
22°47'39.48''N 92°59'58.88''E	4	1.36	5.9	457	32.17	337.1
22°47'40.23''N 93°0'03.12''E	5	1.18	6.2	296	24.13	220.1
	Average	1.26	6.26	409.52	31.63	167.15
	SD	0.07	0.23	64.57	6.14	117.08
	CV (%)	5.24	3.68	15.77	19.42	70.04

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

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, containing 18% of Calcium (Ca^{2+}) whichreplaces exchangeable H^+ ions from the soil solution. Similar finding was reported by Saunders [8]. Average available phosphorus content increases from initial (7.17 kg/ha) to after harvest soil sample of 31.63 kg/ha. This might be due to increase in soil pH and application of phosphatic fertilizers. As pH increases, activity of Fe and Al decreases, which reduces P adsorption/precipitation and increases solution P concentration, Havlin et al. [9].

3.2 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 [10] 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 [11]. The grain yield was different on all fertilizer treatment compared to T_0(Control). The highest average grain yield was in treatment ofT_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. [12] According to Dobermann and Fairhurst [13] 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. [14]. Marchner [15] 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 [16].

4. CONCLUSION

From the present study, it is confirmed that phosphorus deficiency was prevalent at the lowland rice cultivation sites due to repeated mono cropping of paddy. Highest grain yield (2.1 t ha^{-1}) was recorded by the treatment that received NPK at a rate of 40:60:40 kg $ha^{-1}$and 2 t ha^{-1} of organic manure. Soil health was also found to be improved after treatment with an average value of 1.26%, 6.26, 404.52 kg ha^{-1}, 31.63 kg ha^{-1} and 167.15 kg ha^{-1} for soil organic carbon, pH, available N, P and K, respectively. Most of the soil parameter are found to be in high and medium range. Therefore, it is suggested to go for the second crop after harvesting of paddy to make use of the residual soil nutrients and to promote crop diversification.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Muralidharudu Y, Sammi Reddy K, Mandal BN, SubbaRao A, Singh KN, Sonekar S. GIS Based Soil Fertility Maps of Different States of India. Indian Institute of Soil Science, Bhopal; 2011.
2. Economic Survey Mizoram, 2019 – 2020: Government of Mizoram, Planning and

Programme implementation Department (Research and Development Branch). 2020;40.
3. Black CA. Methods of soil analysis. Part II. American society of agronomy, Madison, Wisconsin, USA; 1965.
4. Jackson ML. Soil chemical analysis.Prentice Hall of India Pvt. Ltd., New Delhi; 1973.
5. Subbiah BV, Asija GL. A rapid procedure for determination of available nitrogen in soils.Current science. 1956;25:259-260.
6. Bray RH, Kurtz LT.Determination of total organic and available forms of phosphorus in soils. Soil Sci. Deenik J. Nitrogern mineralization potential in important agricultural soils of Hawaii.Soil and Crop Management 15, Cooperative extension service, University of Hawaii at Manoa. 1945; 59:39-46.
7. Hyvo¨nen R, Persson T, Andersson S, Olsson B, Agren GI, et al. Impact of long-term nitrogen addition on carbon stocks in trees and soils in northernEurope. Biogeochemistry. 2008;89:121–137.
8. Saunders WMH. The effect of different phosphate fertilisersonsoil pH and the consequent effect on phosphateretention. New Zealand Journal of Agricultural Research. 1958;1(5:675-682.
9. Havlin JL, Beaton JD, Tisdale SL, Nelson WL. Soil fertility and fertilizers.Seventh edition, PHI Learning (India) Pvt. Ltd; 1996.
10. Budiono R, PG, Soni P. Effect of new NPK fertilizer on lowland rice (*Oryza sativa* L.) growth. IOP Conf. Ser.: Earth Environ. Sc. 2019;293-303.
11. Fageria NK. The Use of Nutrients in Crop Plants.CRC Press. New York, USA; 2020.
12. Yoshida S. Fundamentals of Rice Crop. The International Rice Research Institute Philippines. 1981;17-30.
13. Dobermann A, Fairhurst T. Rice: Nutrient Disorders and Nutrient Management (Makati: International Rice Research Institute). 2000;191.
14. Totok ADH, Azis FN, Hidayat P, Susanti D, Riyanto A, Zheng SH. Path coefficient analysis on G39 x Ciherang and mentikwangi x G39 rice in F4 generation Agrivita. 2014;36(1):9.
15. Maschner H. Maschner's mineral nutrition of higher plants. 3rd Edition. Academic Press, London; 2012.
16. Hasan R. Phosphorus status of Indian soils. Better Crops International. 1996; 10(2):4-5.

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