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Effect of system based phosphorus management on nutrients availability and enzymatic activities of soil under rainfed rice (*Oryza sativa* L.) - greengram (*Vigna radiata* L.) cropping system

Haramohan Rath, AK Verma and BB Panda

Abstract
The effect of System based phosphorus management on available nutrients and enzymatic activities of soil under rainfed rice-greengram cropping system was evaluated under medium land situation at ICAR-NRRI, Cuttack, Odisha. The experiment was carried out in both kharif and rabi season of the years 2019-20 and 2020-21. The experiment was laid out in a split plot design with three replication with treatments consisted of i) four nutrient management practices in rice *viz*. Recommended Dose of Fertilizer (RDF), RDF+ 25% additional phosphorus through FYM, RDF+ 25% additional phosphorus through fertilizer and RDF_{75} and ii) five nutrient management practices in greengram *viz*. Control (C), RDF, RDF+PSB Inoculation (RDF+ PSB), RDF+ Foliar spray of 2% DAP at flowering (RDF+ FS) and RDF+ PSB inoculation+ foliar spray of 2% DAP at flowering (RDF+PSB+FS). Effect of system based phosphorus management had significant effect on available nutrients and enzymatic activities of soil. Among the nutrient management practices in rice, the mean highest soil available nitrogen was recorded under RDF while the mean highest soil available phosphorus was recorded under RDF + 25% additional phosphorus though fertilizer. Among the sub plot treatments, significant difference in soil available phosphorus was observed in the second year. The mean highest and lowest soil available phosphorus was recorded under RDF and control respectively. With respect to acid and alkaline phosphatase activity of soil, the mean highest alkaline and acid phosphatase activities was recorded under RDF + 25% additional phosphorus through FYM, RDF + PSB +FS in nutrient management in rice and greengram respectively.

Keywords: System, phosphorus, management, *Oryza sativa* L., *Vigna radiata* L.

Introduction
Rice based cropping systems constitute an important food production systems with rice being the principal crop. Cereal-cereal system are the major cropping systems followed in irrigated ecology in India, while the land is kept fallow or rice is followed by pulse with very low yield under rainfed condition, resulting in low system productivity. Continuous mono cropping leads to exhaustion available soil nutrients from soil. The rising demands for food and uncertainties about climate change call for a paradigm shift in cropping pattern as the cereal-cereal system has been showing signs of fatigue with yield decline, negative nitrogen balance and reduced response to the applied mineral N (Duxbury *et al*., 2000; Ladha *et al*., 2003) [1, 6]. The major reasons for the yield decline are soil based and include inefficient use of fertilizer-N and a decline in the soil organic matter content.

Rice – greengram croppng system is a major croping system in Eastern India under rainfed situation. Greengram is the third most important pulse crop after pigeonpea and chickpea in India. It is widely used in cuisines of India and other South Asian countries. It is a short duration crop, tolerant to photoperiod, thermal variations and low soil moisture condition thus has scope for expansion in time and area during dry (rabi) season. It provides additional income, improves soil fertility and ensures efficient land utilization (Sharma & Sharma., 2004) [14]. It is grown both in kharif and rabi covering an area of 8.69 lakh hactares. However the productivity is low so the horizontal expansion of the system is less. Lower Productivity of greengram in Odisha contributes to low system yield. Neglected or sub optimal dose of fertilizer application to second crop (greengram) in dry season is one the reason that lower not only the yield of greengram but also the subsequent rice in next year and system as a whole. It also seriously affect the available nutrient status and enzymatic activities in soil. On the other hand, greengram shows good response to 20-60 kg P_2O_5/ha depending upon nutrient status of

soil, cropping system and moisture availability. Diversification of methods of fertilizer application in greengram like foliar spray of phosphorus (Ghosh, 2008) [3], bio-priming of greengram seed with PSB along with application of additional phosphorus to kharif crop (rice) during availability of soil moisture can be taken to increase the system productivity and to balance the soil nutrient status.

Materials and Methods

A field experiment was carried out at research farm, ICAR-National Rice Research Institute, Cuttack, Odisha, (20.45^{0}N, 85.93^0 E and 24 m above sea level) during both wet and *dry* seasons in 2019-20 and 2020-21 to assess the effect of system based phosphorus management in rainfed rice (*Oryza sativa* L.) - greengram (*Vigna radiata* L.) cropping system. The general climate of this region is dry moist, sub humid and the region receives 1300 –1500 millimetres and is received mostly during June-October (*Kharif* or Wet Season). Previously this area was under rice-maize-cow pea and rice-groundnut-cowpea before the start of current study. The experiment was laid out in split plot design with four main plot treatments (RDF, RDF+ 25% additional phosphorus through FYM, RDF+ 25% additional phosphorus through fertilizer and RDF$_{75}$). And five sub plot treatments (Control, RDF, RDF + PSB, RDF + FS, RDF + PSB + FS). The rice and greengram varieties taken are shahabhagidhan and virat respectively. The pre and post soil samples, (before the start of experiment and after each cropping year), were collected from root zone depth of 15 cm soil depth within each replication for analysis of available N, P, K and enzyme activities of soil. Soil for enzymatic analysis were taken fresh after end of each cropping year. The available N, P and K were determined by methods given by Subbiah and Asija (1956), Olsen *et al.*, (1954) and Muhr *et al*, (1965) [17, 12, 10] respectively. Similarly the acid and alkaline phosphatase activities were determined by method given by Tabatabai and Bremner (1969) [18]. The data recorded were tabulated and analysed statistically in split plot design as described by Gomez and Gomez (1984) [4].

Result and Discussion

Soil available nutrients

Critical analysis of data showed that among the nutrient management practices in rice, significant difference in soil available nitrogen and phosphorus were observed after the second year and mean data of experimentation (Table 1). The highest soil available nitrogen (217.48 kg ha^{-1}, 216.06 kg ha^{-1}) was recorded under RDF while the highest soil available phosphorus (16.66 kg ha^{-1}, 16.50 kg ha^{-1}) was recorded under RDF + 25% additional phosphorus through fertilizer. No significant difference in soil available potassium was observed. The lower available soil nitrogen RDF + 25% additional phosphorus through either FYM or fertilizer might be due to higher yield, which resulted in higher uptake by plant. However the same was not applied to phosphorus, since higher uptake was compensated by additional phosphorus application. (Siddaram *et al*. 2017; Singh *et al*., 2009; Malla Reddy and Devendra Reddy 2008) [15, 16, 8].

Among sub plot treatments, significant difference in soil available phosphorus was recorded after the second year. RDF recorded the highest soil available phosphorus while the lowest value was recorded under control. No significant difference in soil available nitrogen and phosphorus were observed with respect to nutrient management practices in greengram. Similar results were reported by Gangwar and Ram (2005) and Mongia *et al*., (1989) [2, 9].

Soil enzyme activity

Critical analysis of result indicated that the soil enzymatic activity was varied significantly by nutrient management in both rice and greengram but not by their interaction (Table 2). Among main plot treatments, the mean highest acid and alkaline phosphatase activity was recorded under RDF +25% additional phosphorus through FYM, which was at par with RDF +25% additional phosphorus through fertilizer but significantly higher than RDF and RDF$_{75}$. There also existed significant difference between RDF and RDF$_{75}$.

Among sub plot treatments, highest acid and alkaline phosphatase activity was recorded under RDF+ PSB inoculation +foliar spray of 2% DAP, which was at par with RDF+ PSB inoculation and RDF + foliar spray of 2% DAP at flowering but significantly higher than RDF which itself was significant over control.

Higher enzymatic activity under RDF+25% additional phosphorus through FYM in rice and RDF + PSB inoculation +Foliar spray of 2% DAP at flowering in greengram could be due to favourable effect of FYM and PSB inoculation on soil phosphorus and soil microbes. Similar findings were also recorded by Nakas *et al*., 1987, Li *et al*., 1997, Hays *et al*., 1999 and Sarawgi *et al*., 1999 [11, 7, 5, 13].

Table 1: Effect of system based phosphorus management on available soil nutrients (Kg ha^{-1}) under rice-greengram cropping system

Treatments	Available N			Available P			Available K		
	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean
Nutrient management in rice									
RDF	214.63	217.48	216.06	15.15	15.35	15.25	205.4	218.5	211.95
RDF+25% P (FYM)	208.23	211.99	210.11	16.41	16.42	16.41	201.2	213.0	207.08
RDF +25% P (FERT.)	210.32	214.19	212.26	16.34	16.66	16.50	200.7	211.5	206.11
RDF$_{75}$	202.59	201.81	202.20	14.54	14.23	14.39	195.5	204.0	199.77
S.Em	5.43	4.11	3.82	0.59	0.35	0.32	3.6	4.5	3.93
CD	NS	14.23	13.23	NS	1.21	1.12	NS	NS	NS
Nutrient management in greengram									
Control	205.70	201.02	203.36	15.40	13.42	14.41	192.0	202.7	197.35
RDF	216.18	224.02	220.01	16.23	16.66	16.45	211.4	227.3	219.34
RDF+PSB	199.43	208.86	204.15	15.35	16.02	15.69	198.5	208.1	203.27
RDF+FS	215.68	216.70	216.69	15.91	16.29	16.10	205.7	217.4	211.59
RDF+PSB+ FS	207.72	206.25	206.98	15.17	15.93	15.55	195.8	203.3	199.55

S.Em	8.18	6.43	5.54	0.62	0.78	0.48	7.3	8.8	7.97
CD	NS	NS	NS	NS	2.24	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS

DAS: Days After sowing, DAT: Days after Transplanting, RDF: Recommended Doses of Fertilizer, FYM: Farm Yard Manure, FERT: Fertilizer, PSB: Phosphorus Solubilising Bacteria, FS: Foliar spray of 2% DAP

Table 2: Effect of system based phosphorus management on soil enzymatic activities in rice-greengram crop ping system

Treatments	Alkaline phosphatase (µg pNP/g/h)			Acid phosphatase (µg pNP/g/h)		
	2019-20	2020-21	Mean	2019-20	2020-21	Mean
Nutrient management in rice						
RDF	8.19	8.00	8.10	29.84	29.87	29.85
RDF+25% P(FYM)	9.81	9.70	9.76	33.17	33.38	33.28
RDF +25% P (FERT.)	9.57	9.39	9.48	32.94	32.84	32.89
RDF_{75}	6.72	6.56	6.64	26.50	26.40	26.45
S.Em	0.33	0.37	0.33	0.86	0.64	0.65
CD	1.15	1.28	1.14	2.96	2.22	2.24
Nutrient management in greengram						
Control	6.60	6.41	6.50	23.20	22.91	23.05
RDF	8.59	8.46	8.52	31.25	31.06	31.16
RDF+PSB	9.27	9.08	9.17	32.65	33.24	32.95
RDF+FS	8.86	8.71	8.79	32.04	31.93	31.98
RDF+PSB+ FS	9.55	9.40	9.48	33.91	33.97	33.94
S.Em	0.25	0.29	0.25	0.76	0.98	0.82
CD	0.72	0.84	0.71	2.18	2.83	2.36
Interaction	NS	NS	NS	NS	NS	NS

DAS: Days After sowing, DAT: Days after Transplanting, RDF: Recommended Doses of Fertilizer, FYM: Farm Yard Manure, FERT: Fertilizer, PSB: Phosphorus Solubilizing Bacteria, FS: Foliar spray of 2% DAP

Conclusion

From this study, it was concluded that, among the nutrient management practices in rice, the highest available nitrogen was recorded under RDF in rice and while RDF+ 25% additional phosphorus through fertilizer recorded the highest available phosphorus after the second year and mean data of study. Among the nutrient management practices in greengram, the highest and lowest soil available phosphorus were recorded under RDF and control, respectively after the second year. The highest acid and alkaline phosphatase activities were recorded under RDF + 25% additional phosphorus through FYM and RDF + PSB inoculation + foliar application of 2% DAP at flowering with respect to nutrient management in rice and greengram respectively.

References

1. Duxbury JM, Abrol IP, Gupta RK, Bronson KF. Summary: Analysis of long-term soil fertility experiments with rice- wheat rotations in South Asia, 2000,vii–xxiip. In I.P.
2. Gangwar B, Ram B. Effect of crop diversification on productivity and profitability of rice (Oryza sativa)-wheat (Triticum aestivum) system. Indian J. Agric. Sci. 2005;75(7):435-438.
3. Ghosh MK, Joseph SA. Influence of biofertilizers, foliar application of DAP and sulphur sources on yield and yield attributes of summer green gram (Vigna radiate L. Wilczek). Legume Res. 2008;31:232-233.
4. Gomez KA, Gomez AA. Statistical procedures for agricultural research (2nd edition). John wiley and sons, *Wiley Inter Science Publications*, New York, USA, 1984,680.
5. Hays JE, Richardson AE, Simpson RJ. Phytase and acid phosphatase activities and extracts sfrom roots of pasture grass and legume seedlings. Australian Journal of Plant Physiology. 1999;26:801-809.
6. Ladha JK, Dawe D, Pathak H, Padre AT, Yadav RL, Bijay Singh *et al*. How extensive are yield declines in long-term rice-wheat experiments in Asia? Field Crops Res. 2003;81:159-180.
7. Li MG, Osaki M, Rao IM, Tandano T. Secretion of phytase from the roots of several species under phosphorus conditions. Plant and Soil. 1997;195:161-169.
8. Malla Reddy M, Devendra Reddy M. Integrated nutrient management for higher productivity and better soil health under rice based cropping system. The Andhra Agricultural Journal. 2008;55(3):267-272.
9. Mongia AD, Gangwar B, Shyam Singh V, Kumar BAK. Long term effect of fertilizers on important crops in Andaman and Nicobar Islands, Fertil. News. 1989;34(4):81-85.
10. Muhr GR, Datta NP, Sankarasubramoney H, Leley VK, Dunabha RL. Soil testing in India. 2nd ed, USAID – Mission to India, New Delhi, 1965.
11. Nakas JP, Gould WD, Klein DA. Orgin and expression of phosphatase activity in semi-arid grassland soil. Soil Biology and Biochemistry. 1987;19:13-18.
12. Olsen SR, Cole CL, Wetanabe PS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. United States Department of Agriculture, circular number, 1954,939.
13. Sarawagi SK, Tiwari PK, Tripathi RS. Uptake and balance sheet of nitrogen and Phosphorus in gram (*Cicer arietinum*) as influenced by phosphorus, biofertilizer and micronutrients under rainfed condition. Indian Journal of Agronomy. 1999;44(4):768-772.
14. Sharma SK, Sharma SN. Effect of cropping and nutrients applied to preceding crops on yield, nutrient uptake and economics of mungbean. Indian Journal of Pulses Research. 2004;17(2):138-142.
15. Siddaram MD, Santhosh GP, Shubha S, Gundappagol

RC, Umesh MR. Field Evaluation of Consortium of Azospirillum, PSB and AM Fungus on Yield parameters of Direct Seeded Rice. Environment & Ecology. 2017;35(2):1364-1367.
16. Singh RP, Singh PK, Singh AK. Effect of green manuring on physic-chemical properties of soil and productivity of rice. Oryza. 2009;46(2):120-123.
17. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soil. Current Science. 1956;25:259-260.
18. Tabatabai MA, Bremner JM. Use of P-nitrophenyl phosphate for assay of soil phosphatase activity. Soil Biology and Biochemistry. 1969;1:301-307.