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Effect of different nutrient management practices on soil available macronutrients (NPK) in rice-wheat cropping system

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Abstract
Rice-wheat system has played a major role for raising food grain production to make the country self-sufficient. However, its sustainability has been questioned in view of decline in crop yields and factor productivity of fertilizers. Soils of Trans-Gangetic Plains (representing Punjab and Haryana) and Upper Gangetic Plains (representing Delhi and Western UP) plain suffering from production fatigue manifesting in terms of declining soil organic matter, multi-nutrient deficiencies and diminishing factor productivity. The excess mining of nutrients by the crops is more than their replenishment with fertilizer. The field experiment under rice and wheat crop was established at CCS HAU, College of Agriculture, Kaul farm during 2021-22 and 2022-23. The experiment was planned in a split-plot design. The study included four main plot treatments and four sub plot treatments. The grain yield of wheat and rice was observed highest for 125% RDF, followed by 100% RDF, 75% RDF and lower in control under rice-wheat cropping system. Among main plot treatments, it was found that FYM+FYM showed lower grain yield of wheat and rice crop, followed by RDF (B)+GM, RS+RDF (B) and maximum was in RDF+RDF treatment. It was observed that the available nitrogen was increased by 5.19 to 16.6% in organic treatments, 7.5 to 16.2% in fertilizer treatments over the initial value of available nitrogen (138.57 kg ha^{-1}). The data revealed that organic carbon fraction increased where organic source was applied with RDF of N, P and K fertilizer.

Keywords: Rice-wheat system, available macronutrients, soil organic carbon, nutrient management

Introduction

Rice-wheat system has played a major role for raising food grain production to make the country self-sufficient. However, its sustainability has been questioned in view of decline in crop yields and factor productivity of fertilizers. Soils of Trans-Gangetic Plains (representing Punjab and Haryana) and Upper Gangetic Plains (representing Delhi and Western UP) plain suffering from production fatigue manifesting in terms of declining soil organic matter, multi-nutrient deficiencies and diminishing factor productivity. The excess mining of nutrients by the crops is more than their replenishment with fertilizer. The excess mining of nutrients by the crops is more than their replenishment with fertilizer. Even at moderate levels of production (6-8 t $ha^{-1}yr^{-1}$) RWCS removes 300-400 kg ha^{-1} of N + P_2O_5 + K_2O yr^{-1}, nutrient removal is much higher on farmer's field, where productivity is 10 t ha-1 yr-1 or more. In addition, large amount of secondary and micronutrients are also removed (Prasad and Nagarajan 2004) [7]. The quality of crop produce is deteriorated due to entry of chemical residues in the plants system and then food chain. Extra-mining of nutrients will have to be arrested to ensure sustenance of soil health, which is need of the hour to ensure food and nutritional security of the country. For efficient use of fertilizers, all nutrients must be applied in balanced proportions contextual to the particular crop/cropping system. The N: P_2O_5: K_2O (commonly referred to as NPK) consumption ratio (2018-19) of Haryana was 23.1:6.2:1 against ideal ratio of 4:2:1. Decline in the factor productivity of fertilizers year after year at the farmer's level is a common sight (Devraj *et al.*, 2020) [1]. The inadequate and imbalanced fertilizer use has caused widespread nutrient (N, P, K) deficiencies and deterioration in soil health in many parts of India. There is an urgent need to narrow down the NPK consumption ratio to sustain the crop productivity and restore the soil health.

Materials and Methods

Experimental site: The field trial was started at the CCSHAU Research farm, Rice Research Station, Kaul, located at 29°51ʺN latitude and 76°39ʺE longitude at the mean sea elevation of 254 m in north-west part of India. The soil was alkaline in nature with clay loam texture having medium organic carbon and available nitrogen while high phosphorus and potassium.

Experiment details: The study was conducted during the rice-wheat cropping systems of 2021-22 and 2022-23. Treatments were distributed in 14 m × 12 m plots with three replications in Split- split plot design. The study included four organic treatments (FYM+FYM, RS+RDF, RDF+GM and RDF+RDF) as main plot treatments and four fertilizer treatments (control, 75% RDF, 100% RDF and 125% RDF) as sub plot treatments. Nitrogen was applied in split dose as treatments wise. Phosphorus and potassium fertilizers were applied at the time of sowing in both crops. The farm yard manure (FYM) was applied in the treatment plots well before the sowing/transplanting of the crop. Treatment details for rice and wheat was given in table 1. The initial values of available N, P and K was 138.57, 25.88 and 298.89 kg ha^{-1} respectively.

Table 1: Treatment details of rice and wheat

	Main plot treatments		
Sr. No.		Wheat	Rice
1.	FYM+FYM	FYM @ 15 t ha^{-1}	FYM @ 15 t ha^{-1}
2.	RS+RDF (B)	Rice straw incorporation @ 6t ha^{-1} + HAU waste decomposer	RDF + Biofertilizer (*Azotobacter* + PSB)
3.	RDF (B)+GM	RDF + Biofertilizer (*Azotobacter* + PSB)	Green manuring (Dhaincha)
4.	RDF+RDF	RDF	RDF
	Sub plot treatments		
1.	75% RDF	75% RDF	75% RDF
2.	100% RDF	100% RDF	100% RDF
3.	125% RDF	125% RDF	125% RDF
4.	Control	Control	Control

Soil Sampling & Analysis

After the harvest of each Crops, soil samples were collected for available N, P and K content in soil. The soil samples were air-dried and grinded in wooden pestle-mortar and pass through 2 mm sieve. The available N in soil was analyzed by Kjeldhal-distillation method (Subbiah and Asija 1956). Available P in soil samples was extracted by 0.5M sodium bicarbonate (pH 8.5) with activated charcoal and P concentration of extract calorimetrically measured at 660 nm by using spectrophotometer (Olsen *et al.,* 1954) [6]. Available K in soil was extracted by 1N neutral NH4OAC and determined with the help of flame photometer (Jackson, 1973) [2].

Statistical Analysis

The data of each treatment related to soil samples were analyzed in split-split plot design. The critical difference (CD) was used to compare the effect of the treatment at $p<0.05$ using OPSTAT software (Sheoran *et al*., 1998) [10].

Results

The value of soil pH decreased from 8.3 (initial) to 7.97 (Rice) and EC increased from 0.22 to 0.24 dS m^{-1} after one year of experiment (table 1). Among different sub-plots treatments non-significant effect of nutrients were found on soil EC and pH. The interaction of main treatments and sub treatments on soil pH and EC were also non-significant.

The highest (0.46%) soil organic carbon was observed in FYM+FYM treatment, followed by RS+RDF (B), RDF (B)+GM and least was observed in RDF+RDF (0.40) in one year of experiment. The practices of nutrients management in organic and inorganic treatments increased soil organic carbon upto 24% from its initial value (0.41%).

Table 2: Effect of different nutrient management practices on soil EC, pH and soil OC in rice-wheat cropping system

Treatments	Soil EC (dS m^{-1})	Soil pH	Soil OC (%)
FYM+FYM	0.24	7.97	0.46
RS+RDF (B)	0.23	7.98	0.43
RDF (B)+GM	0.23	7.99	0.44
RDF+RDF	0.22	8.02	0.40
S.Em±	0.00	0.006	0.002
CD (p=0.05) (S)	NS	NS	0.007
Sub plot (T)			
75% RDF	0.23	8.00	0.43
100% RDF	0.24	7.99	0.43
125% RDF	0.24	7.98	0.43
Control	0.23	8.00	0.42
S.Em±	0.00	0.003	0.003
CD (p=0.05) (T)	NS	NS	0.008
CD (p=0.05) (S*T)	NS	NS	NS

Available macronutrients

It was observed that the available nitrogen was increased by 5.19 to 16.6% in organic treatments, 7.5 to 16.2% in fertilizer treatments over the initial value of available nitrogen (138.57 kg ha^{-1}) (table 2). The highest available P was observed in RDF+RDF (31.11 kg ha^{-1}) and 125% RDF (31.28 kg ha^{-1}) treatments, followed by RS+RDF (B) and 100% RDF treatments and least was observed in RDF (B)+GM and control (30.36 kg ha^{-1}) in rice-wheat cropping system. Available potassium was found to be increased significantly from its initial value of 298.89 kg ha^{-1} to 316.29 kg ha^{-1} (125% RDF) after one year of experiment.

Table 3: Effect of different nutrient management practices on soil available N, P and K (kg ha^{-1}) in rice-wheat cropping system

Treatments	Soil available N (kg ha^{-1})	Soil available P (kg ha^{-1})	Soil available K (kg ha^{-1})
FYM+FYM	151.73	30.22	313.41
RS+RDF (B)	155.96	31.43	313.75
RDF (B)+GM	154.28	30.4	315.08
RDF+RDF	154.44	31.11	311.57
S.Em±	0.832	0.141	0.616
CD (p=0.05) (S)	2.88	0.486	2.131
Sub plot (T)			
75% RDF	153.18	30.6	312.88
100% RDF	155.07	30.92	314.26
125% RDF	156.72	31.28	316.29
Control	151.44	30.36	310.37
S.Em±	0.59	0.117	0.549
CD (p=0.05) (T)	1.7	0.34	1.58
CD (p=0.05) (S*T)	S	S	S

Discussion

The available macronutrients of soil were found more in treatments where organic sources were applied as compare to control. This is due to fact that during the decomposition of organic matter, biological and chemical reactions were enhanced which results into release of bounded nutrients into soluble form. Among different sub-plots, the availability of macronutrients of soil were increased as the application of inorganic fertilizers were increase from 75% RDF to 125 RDF. This might be due to direct application of inorganic form of nutrients, resultant into increase in availability of nutrients in soil. Similar results were reported by Singh *et al.* (2007) [11] and Urkurkar *et al*. (2010) [13], Satyanarayana and Janawade, (2009) [8] and Meena *et al*. (2008) [5], Kumar *et al.* (2020) [4], Sharma *et al*. (2023) [9] and Kumar *et al.* (2012) [3]. Also in case of phosphorus and potassium, the organic matter reacts with sesquioxides which make them inactive giving ample quantity of available phosphorus for plants (Urkurkar *et al*. 2010) [13].

Conclusion

The experiment highlights the complex interplay between different nutrient management practices and their impact on soil properties and nutrient dynamics. The results underscore the potential of integrated nutrient management strategies to improve soil health and support sustainable crop production in rice-wheat cropping systems.

References

1. Raj DRS, Antil S, Garg R, Dahiya DS, Arora VK, Yadav SS, *et al*. Impact of Intensive Cropping Systems on Crop Productivity and Changes in Soil Fertility. Indian Journal of Fertilisers. 2020;16(10):988-996.
2. Jackson ML. Soil chemical analysis. Prentice Hall of Englewood Cliffs, New Jersey, USA; c1973.
3. Kumar S, Dahiya R, Kumar P, Jhorar BS, Phogat VK. Long-term effect of organic materials and fertilizers on soil properties in pearl millet-wheat cropping system. Indian Journal of Agricultural Research. 2012;46(2):161-166.
4. Kumar V, Goyal V, Dey P. Impact of STCR based long term integrated management practices on soil chemical properties and yield attributing parameters of wheat and pearl millet in semi-arid North-West India. International Journal of Chemical Studies. 2020;8:1320-1328.
5. Meena MC, Patel KP, Singh D, Dwivedi BS. Long-term effect of sewage sludge and farmyard manure on grain yields and availability of zinc and iron under pearl millet (Pennisetum glaucum)-Indian mustard (*Brassica juncea*) cropping sequence. The Indian Journal of Agricultural Sciences. 2008;78(12):1028-1032.
6. Olsen SR, Cole VC, Watanbe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Circulation from United States Department of Agriculture, 939. USDA, Washington, D.C.; c1954.
7. Prasad R, Nagarajan S. Rice-wheat cropping system-food security and sustainability. Current Science-Bangalore. 2004;87:1334-1335.
8. Satyanarayana R, Janawade AD. Influence of integrated nutrient management practices on physicochemical properties of cotton growing soils. Journal of Cotton Research and Development. 2009;23(1):60-63.
9. Sharma J, Goyal V, Bhardwaj KK. Coupling effect of nitrogen application rates and irrigation levels improves concentration of nutrients in soil profile in Sandy loam soil of cotton growing areas. Journal of Cotton Research. 2023;37(2):207-212.
10. Sheoran OP, Tonk DS, Kaushik LS, Hasija RC, Pannu RS. Statistical Software Package for Agricultural Research Workers. Recent Advances in Information Theory, Statistics and Computer Applications by DS Hooda and RC Hasija Department of Mathematics Statistics, CCS HAU, Hisar; c1998. p. 139-143.
11. Singh G, Jalota SK, Singh Y. Manuring and residue management effects on physical properties of a soil under the rice–wheat system in Punjab, India. Soil and Tillage Research. 2007;94(1):229-238.
12. Subbiah BV, Asija CL. A rapid procedure for the estimation of available nitrogen in soil. Current Science. 1956;25:172-194.
13. Urkurkar JS, Alok T, Shrikant C, Bajpai RK. Influence of long-term use of inorganic and organic manures on soil fertility and sustainable productivity of rice (*Oryza sativa*) and wheat (Triticum aestivum) in Inceptisols. Indian Journal of Agricultural Sciences. 2010;80(3):208-212.