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EFFECT OF NUTRIENT MANAGEMENT TECHNIQUES ON PHOSPHORUS AVAILABILITY IN BASMATI-WHEAT SYSTEM

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Abstract: The present research study was conducted with an objective to investigate the effect of nutrient management practices on availability of phosphorus in basmati-wheat sequence. To achieve these objectives, soil samples were taken from a long term fertilizer experiment which is in progress since *Rabi* 2006-07, at Research Farm of Department of Soil Science, Punjab Agricultural University Ludhiana after harvest of wheat crop in 2014. For this study ten treatments applied to wheat crop included unfertilized, recommended fertilizer (RF), integrated nutrient management [75 percent RF + 200 kg N ha^{-1} from FYM (INM1) and RF + 200 kg N ha^{-1} from FYM (INM2)] and N applied at 300 and 400 kg N ha^{-1} through FYM, vermicompost and rice straw compost. The results indicated that availability of phosphorus was maximum in treatments receiving organic manures while minimum in control plots. There occurred decrease in availability of phosphorus with depth. The results revealed that revealed that availability of phosphorus were generally more in organic system, followed by integrated nutrient management and chemical fertilizers alone.

Keywords: Basmati-wheat sequence, phosphorus, recommended fertilizers, integrated nutrient management, organic manures.

INTRODUCTION

Intensive agriculture involving high-yielding varieties of rice and wheat has led to removal of nutrients from the soil. Furthermore, imbalanced use of chemical fertilizers by farmers has deteriorated soil health. Improving and maintaining soil quality for sustaining agricultural production is the most importance issue these days. This challenge can be met through balanced use of chemical fertilizers and with use of organic sources along with inorganic fertilizers. Application of organic manures in conjunction with inorganic fertilizers significantly improves the availability of nutrients in soils. Integrated nutrient management entails the maintenance/adjustment of soil fertility to an optimum level for crop productivity to obtain maximum benefit from all possible sources of plant nutrients i.e. organic as well as inorganic in an integrated manner (Aulakh and Grant 2008). The use of organic farming with organic amendments to soil as nutrient inputs is increasing and it is an alternative agricultural

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practice for sustaining economically viable crop production with minimal environmental pollution (Padel *et al* 2009).

Rice-wheat is one of the major cropping systems in Punjab and it is highly nutrient exhaustive and therefore, its continuous practice has depleted inherent soil fertility, causing deficiency of several nutrients (Zia *et al* 1997). Since sustainability of the production system depends on the sustainable use of soil recourses, it is necessary to develop and adopt soil management technologies that increase soil organic matter contents and biological activities and improve soil physical conditions to keep lands productive on the sustainable basis. Prativa and Bhattarai (2011) observed that integration of organic manures with inorganic fertilizers was found significant in improving the soil phosphorus availability than the sole application of either of these nutrients. Application of organic manures alone and integrated nutrient management increased available N, P and K content of soil as compared to recommended fertilizer treated plots (Venkatakrishnan and Ravichandran 2012). Application of compost (12 and 24 t ha^{-1}) with and without chemical fertilizer (NPK for rice: 100-70-70 and wheat: 140-110-70 kg ha^{-1}) increased the available amount of all the major plant nutrients (N, P, K, Ca and Mg) and organic matter content of soil (Sarwar *et al* 2008). Barabde *et al* (2008) revealed that combined application of manure with inorganic fertilizer had improved the nutrient contents in soil. Presently, there is a great demand for organic foods but the potential availability of organic sources of nutrients is limited. Therefore, only limited area can be brought under organic farming. Integrated nutrient management on the other hand is a practical alternative that holds great promise for securing high productivity and sustainability of basmati-wheat system. Keeping in view point these facts, present study was undertaken to invesigate the influence of different fertilizer management practices on availability of phosphorus in basmati-wheat sequence.

METHODS AND MATERIALS

Soil samples used in this experiment were collected from an ongoing field experiment (since *Rabi* 2006-07) on basmati-wheat sequence, at Research Farm, Punjab Agricultural University, Ludhiana (30^{o} - 56´ N, 75^{o} - 52´E and 247 m above sea level) in 2013. Different physico-chemical properties of the experimental field were estimated using standard methodologies and these properties are summarized in Table 1. The experimental soil was sandy loam in texture and tested near neutral in pH, non-saline, low in organic carbon, available nitrogen and medium in Olsen P and exchangeable K at the time of start of experiment in 2006-07. The experiment was planned in RBD with ten treatments which are

listed in Table 2. Farmyard manure (FYM), vermicompost (VC) and rice straw compost (RSC) were applied to supply desired level of N. The organic sources were mixed in the soil with last ploughing before sowing of wheat. Whole of P, K and half of recommended N were

Table 1: Characteristics of experimental soil (2006-07)

Parameter	Value
Texture	Sandy-loam
pH (1:2 soil : water suspension)	7.5
EC (dsm^{-1}) (1:2 soil : water supernatant)	0.2
Organic carbon (%)	0.37
$CaCO_3$(%)	Nil
Available nitrogen (kg ha^{-1})	133.4
Available phosphorus (kg ha^{-1})	18.2
Available potassium (kg ha^{-1})	226

drilled at the time of sowing in chemical fertilizer and integrated nutrient management treatments. Remaining half dose was applied through chemical fertilizer and integrated nutrient management treatments was applied 5 days after first irrigation to wheat. While prior to basmati crop all plots except control and recommended fertilizer treatments were seeded to Sunhemp (*Crotolaria juncea*) green manure (GM) and raised for 8 weeks and incorporated one day before transplanting of basmati. In recommended fertilizer plots whole of phosphorus was applied at the time of puddling. Nitrogen was applied in two splits viz 3 and 6 weeks after transplanting. Standard management practices were followed for raising the crop and the crop was kept weed free manually.

Table 2: Details of treatments applied to basmati and wheat crop

Treatments	**Treatment acronym**	**Nutrient applied (kg ha^{-1}) to**	
		Basmati	Wheat
Control	Control	Nil	Nil
Recommended fertilizer	RF	40 N + 30 P_2O_5	120 N + 60 P_2O_5 + 30 K_2O
75 % RF + 200 kg N ha^{-1} through FYM	INM1	GM	90 N + 45 P_2O_5 + 22.5 K_2O + 200 N from FYM
RF + 200 kg N ha^{-1} through FYM	INM2	GM	RF + 200 N from FYM
300 kg N ha^{-1} through FYM	FYM 300 N	GM	300 N from FYM
400 kg N ha^{-1} through FYM	FYM 400 N	GM	400 N from FYM
300 kg N ha^{-1} through VC	VC 300 N	GM	300 N from VC
400 kg N ha^{-1} through VC	VC 400 N	GM	400 N from VC
300 kg N ha^{-1} through RSC	RSC 300 N	GM	300 N from RSC
400 kg N ha^{-1} through RSC	RSC 400 N	GM	400 N from RSC

Soil samples were collected with post-hole auger from 0-15, 15-30, 30-45, 45-60, 60-90 and 90-120 cm depths from three sites in each treatment plots before sowing of wheat in

2013. The samples collected from three sites in each plot were mixed thoroughly to obtain a representative soil sample. The soil samples were air dried, ground in a wooden pestle and mortar, and passed through a 2-mm plastic sieve and stored for further analysis.

Chemical analysis: Available phosphorus in soil samples was determined both by Olsen *et al* (1954) and Bray and Kurtz (1945) methods.

Statistical analysis: The data were analyzed statistically using analysis of variance technique (Narayanan and Adorisio 1983). The significance of the treatments on nutrient availability and soil chemical properties was tested using randomized block design (at 5% level of probability).

RESULTS AND DISCUSSION

Bray-P: Application of recommended fertilizer significantly increased Bray-P over control (Table 3). The increase in Bray-P in recommended fertilizer treatment compared to control may be due to addition of P through fertilizer in this treatment. Organic manure addition either alone or in combination with inorganic fertilizers significantly improved the phosphorus content over recommended fertilizer and control plots.

Table 3: Effect of different treatments on Bray-P (mg kg^{-1}) at different depths

Treatments	Depth (cm)					
	0-15	15-30	30-45	45-60	60-90	90-120
Control	11.4	9.4	6.3	3.3	2.3	1.5
RF	12.2	9.6	7.9	6.0	5.9	4.5
INM1	17.9	14.5	9.4	6.5	6.3	6.0
INM2	16. 2	15.2	9.5	10.5	8.2	6.9
FYM 300 N	21.9	18.9	13.6	16.9	11.0	9.6
FYM 400 N	22.8	21.2	18.3	19.0	12.1	7.2
VC 300 N	19.9	19.2	12.2	17.7	11.3	6.5
VC 400 N	20.1	19.8	12.8	18.2	11.6	6.0
RSC 300 N	18.3	17.2	12.2	12.9	9.6	6.4
RSC 400 N	18.7	18.8	14.9	12.4	7.0	5.7
CD (p=0.05)	1.5	1.1	1.0	1.5	1.1	1.0

Increase in phosphorus availability in INM1 and INM2 may be due to addition of organic P through FYM and the role of organic matter in providing organic anions competing with phosphate ions for adsorption, coating of the binding sites and formation of soluble phospho-humic complexes. Singh *et al* (2013) reported that available P in soil improved with combined use of fertilizers and manures as compared to 100% NPK due to solubilization of native P in the soil through release of organic acids from organic manures. Application of N through FYM, VC

and RSC at 300 or 400 kg N ha^{-1} significantly increased the Bray-P content over control and recommended fertilizer dose. Sharma *et al* (2009) reported that organic materials like FYM and VC when applied at 25 and 10 t ha^{-1}, respectively increased the available P content of soil as these organic manures produced nutrient complexing agents like humic and fulvic acids during their decomposition which enhanced the solubility and availability of phosphorus.

In subsurface layer (15-30 cm), Bray-P varied from 9.4 to 21.2 mg kg^{-1} and in subsequent layers it ranged between 2.3 and 19.0 mg kg^{-1}. The effect of treatments on Bray-P was significant up to 120 cm soil depth. Phosphorus content in soil decreased with depth in all treatments. This could be due to low organic matter status in sub soil and management practices like addition of fertilizers and FYM to surface soil. Gurumurthy *et al* (2009) also reported decrease in P content with increase in depth due to high organic matter status of surface layer as compare to deeper layers.

Olsen-P: Olsen-P in surface soil ranged between 13.0 in control plots and 23.1 mg kg^{-1} in plots receiving 400 kg N ha^{-1} from VC (Table 4). Application of recommended fertilizer and integrated nutrient management significantly increased the Olsen-P over control. Prativa and Bhattarai (2011) observed that integration of organic manures with inorganic fertilizers significantly improved the soil P availability than the sole application of either of these sources as integration of inorganic fertilizers with organic sources helped in the solubilization of fixed P to soluble form making it easily available to the plant.

Table 4: Effect of different treatments on Olsen-P (mg kg^{-1}) at different depths

Treatments	Depth (cm)					
	0-15	15-30	30-45	45-60	60-90	90-120
Control	13.0	12.4	12.1	11.8	11.6	10.8
RF	14.2	12.7	12.4	11.9	11.7	11.1
INM1	14.7	14.4	13.9	13.5	12.9	12.7
INM2	15.9	15.1	14.7	14.2	13.9	13.5
FYM 300 N	22.9	18.8	18.1	17.6	17.2	17.1
FYM 400 N	23.1	18.5	17.8	17.4	16.5	16.0
VC 300 N	24.5	23.9	22.6	22.4	22.0	20.6
VC 400 N	26.2	25.2	25.0	24.3	23.9	22.1
RSC 300 N	18.1	17.8	17.3	17.2	16.4	15.9
RSC 400 N	18.0	17.1	16.5	15.9	15.5	15.2
CD (p=0.05)	1.1	0.8	1.2	1.2	1.0	0.9

Application of N either through FYM, VC and RSC at 300 or 400 kg N ha^{-1} significantly increased Olsen-P over control and plots receiving recommended fertilizer dose. Aliasgharzadeh (1997) hypothesized that concentration of Olsen-P in organic treatments

increased due to increased microbial activity and possible mineralization of organic P. Olsen-P decreased with depth and and the effect was significant upto 120 cm depth. Concentration of Olsen-P ranged between 10.8 and 26.2 mg kg^{-1} at different depths.

CONCLUSION

Addition of organic manures to wheat crop resulted in higher availability of phosphorus followed by integrated nutrient management and chemical fertilizer treatment. Our results further investigated that the availability of phosphorus decreased with increase in depth.

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