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EFFECT OF PHOSPHORUS AND POTASH LEVELS ALONE AND IN CONJUNCTION WITH FYM ON RICE- WHEAT CROPPING SYSTEM

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ABSTRACT

The effect of phosphorus and K alone and in combination of FYM on yield, nutrients uptake and physico-chemical properties of soil after ten crop seasons from 2003-2008 under rice - wheat cropping sequence was studied at crop production farm Nawabganj, Kanpur. Application of 60 kg P_2O_5 + 60 kg K_2O ha^{-1} in each kharif and rabi season produced maximum grain yield of rice and wheat crops. The average increases in grain yields through 100% P and K were 72.3 and 33.6 and 133.1 and 45.3% over control and 50% P and K in rice and wheat crop, respectively. On other hand, imbalanced use of P and K at higher levels could not enhance the yield potential of both crops markedly. The residual average responses of P and K levels in conjunction with 10 t FYM ha^{-1} on yield of both crops was observed 6.4 and 7.6 % more to that of fertilizer nutrients alone. Use of inorganic fertilizer nutrients with and without FYM significantly enhanced the available N, P, K and organic carbon content of the soil. Where N alone was applied (T_1) available P and K declined from the initial level of 15.60 and 278.0 kg ha^{-1} to 13.58 and 207.80 kg ha^{-1}, respectively. Application of P and K in various levels enhanced the uptake of these nutrients by both crops, the effect being more pronounced with balanced and integrated use of fertilizer nutrients along with judicious use of FYM.

Keywords: FYM, P and K levels, yields, nutrients uptake, available nutrients

INTRODUCTION

Rice –Wheat cropping system is most vital food security of our country. In general, the optimal soil physical environments for rice and wheat differ substantially. Puddling is synonymous with rice culture, which refers to the mechanical reduction of apparent specific volume of soil and impervious to water for decreasing percolation losses. Generally, puddling causes a massive or blocky and platy structure in the upper 10 to 20 cm of the soil (Ray and Gupta 2001). Although, these effects of puddling favour rice growth and development but the adversely affect the growth of wheat following rice. The cropping systems therefore, that include both rice and wheat, require special soil management practices and addition of organic manures/FYM along with optimum doses of fertilizer nutrients. Phosphorus is an important nutrient for normal growth and development of the plants. It plays an important role in energy transformation and metabolic processes in plants. It is known to be associated with nucleus formation, cell division and nitrogen fixation, fat and albumen formation and transfer of the heredity. Potassium helps in translocation of metabolites from vegetative parts to reproductive ones, increases plant resistance to drought and frost. Application of FYM, apart from increasing soil fertility, improves the soil physical condition (Salni *et al.* 2005). Moving productivity upward through fertilizers remains a wide-open option, since current intensity of fertilizer use is relatively low. Integrated nutrient management practices for rice-wheat cropping system are of supreme importance for sustainable crop production in the country. The production target can be meet by increasing yield to levels 2 to 2.5 time higher than current yields. Taking this in view, the present study was, therefore, undertaken to study the effect of P and K levels alone and in conjunction with FYM on rice wheat cropping system.

MATERIALS AND METHODS

A field experiment was conducted during 2003-04 to 2007-08 on a sandy clay loam soil of Crop Production Farm Nawabganj of C.S. Azad University of Agriculture and Technology, Kanpur located at 25^0 26^1 to 26^0 58^1 North latitude and 79^0 31^1 to 80^0 34^1 East longitude. The initial physico-chemical characteristics of experimental soil was pH 7.84, EC 0.26 $dSm^{-1,}$ organic carbon 2.5gkg^{-1}, CEC 11.98 c mol. (p+) Kg^{-1}, available N 232 kg ha^{-1}, available .P 15.6 kg ha^{-1} and available K-278 kg ha^{-1}. Treatments were T_{1-} P_0 K_0, T_{2-} P $_{60}$ K_0, T_{3-} P $_{90}$ K $_0$, T_4 -P_{30} K_{30}, T_5 -P_{60} K_{30}, T_6 -P_{60} K_{60}, T_{7-} P_0 K_{60} During each rabi season and T_{1-} P_0 K_0, T_{2-} P $_0$ $K_{60,}$ T_{3-} P $_0$ K $_{90}$, T_4 -P_{30} K_{30}, T_{5-} P_{30} K_{60}, T_6 -P_{60} K_{60}, T_{7-} P_{60} K_0 during each kharif season with and without 10 t FYM ha^{-1} of experiment in fixed layout. The nitrogen was applied @ 120 kg/ha equally to all treatments in both crop seasons. The recommended fertilizer doses for rice and wheat were 120:60:60 kg ha^{-1}. The experiment was laid out in split plot design with three replications. The FYM was mixed 15 days before transplanting of rice seedlings during kharif season only. Rice cultivar NDR-359 (21 days old seedlings) was transplanted in standing water in second week of July at spacing of 20x10cm. One third of N and full doses of P and K as per treatments were applied at the time of transplanting of rice. The remaining dose of nitrogen was broadcast in two equal splits after 3 and 6 weeks of transplanting. After harvest of rice crop, wheat (PBW-343) was sown during second week of November at a row spacing of 20cm in all the years. One-third of nitrogen and full doses of phosphorus and potash according to treatments were applied at the time of sowing. The remaining dose of nitrogen was top dressed in two equal splits after 21 and 40 days of sowing. The source of N, P and K were urea, DAP and MOP, respectively. Yields of both grain and straw were recorded on air-dry basis. Rice and wheat grain and straw were analyzed for N, P and K by adopting standard procedures (Jackson 1973). Soil samples (0-15 cm) were collected after harvest of wheat crop (2007-08) and analyzed for pH, org. carbon, N, P, K and other physico-chemical properties by adopting standard methods.

RESULTS AND DISCUSSION

Yield

It is obvious from the data (Table 1) that mean grain yield of rice due to various levels of phosphorus and potash varied from 35.27 to 60.76 q ha^{-1}. The maximum average grain yield of rice (60.76 q ha^{-1}) was noticed under the treatment 60 kg P_2O_5 + 60 kg K_2O ha^{-1} followed by T_5 T_7 T_4 and T_2. Lowest grain yield was recorded in the plot which was treated with 120 kg N ha^{-1}. Increasing levels of each P and K @ 30 and 60 kg ha^{-1} significantly increased the grain yield of rice. Application of phosphorus and potash (T_5) @ P_{30} and K_{60} respectively could not significantly differ from treatment (T_7) which received P_{60} K_0 along with. These trends of response were observed during all Kharif season (2003 to 2008). However, enhancing the dose of potash at recommended dose without phosphorus (T_3) could not significantly differ from that treatment which received 60 kg K_2O ha^{-1}, respectively during all the years (2003-2008). Although grain yield of rice under the influence of various treatments increased from initial year (2003) to final year of experiment (2008), yet nitrogen application @ 120 kg ha^{-1} alone showed negative trend on the grain yield of rice from first to last kharif season. It might be due to imbalanced availability of phosphorus and potash in that plot. It was also noticed that imbalanced use of fertilizer nutrients (120 kg N ha^{-1} alone) resulted in significant decrease in rice production over 100% recommended P and K doses. Khare and Dixit (2011), Sharma *et al.* (2006) and Sharma *et al.* (2012) also reported similar results.

Table 1: Impact of P and K levels alone and in conjunction with FYM on the grain yield (q ha^{-1}) of rice under rice-wheat cropping system

Treatments	2003-04	2004-05	2005-06	2006-07	2007-08	Mean
FYM (t ha^{-1})						
0	46.50	47.70	47.50	47.75	48.20	47.33
10	49.20	49.90	50.55	50.88	51.40	50.39
CD(P=0.05)	1.68	1.87	1.92	2.08	2.05	-
P and K (kg ha^{-1})						
T_1-P_oK_o	36.00	35.50	35.10	34.95	34.80	35.27
T_2-P_oK_{60}	40.50	40.90	41.20	41.40	41.50	41.10
T_3-P_oK_{90}	42.60	42.70	43.00	43.28	43.60	43.02
T_4-$P_{30}K_{30}$	44.90	45.20	45.45	45.80	46.00	45.47
T_5-$P_{30}K_{60}$	54.70	54.95	55.20	55.50	56.00	55.27
T_6-$P_{60}K_{60}$	60.00	60.30	60.80	61.20	61.50	60.76
T_7-$P_{60}K_0$	54.20	54.40	55.70	56.10	56.60	54.40
CD(P=0.05)	1.59	1.62	1.68	1.72	1.75	-

It is evident from the data (Table 2) that there was significant response of wheat crop to P and K application. The average grain yield of wheat crop during five years of experiment ranged from 22.96 to 53.53 q ha^{-1}.

Table 2: Impact of P and K levels alone and in conjunction with FYM on the grain yield of wheat (q ha^{-1}) under rice-wheat cropping system

Treatments	2003-04	2004-05	2005-06	2006-07	2007-08	Mean
FYM (t ha^{-1})						
0	37.45	37.80	38.15	38.49	38.85	38.15
10	40.30	40.70	40.95	41.38	41.95	41.06
CD(P=0.05)	1.42	1.48	1.65	1.78	1.902	-
P and K (kg ha^{-1})						
T_1-P_oK_o	23.60	23.38	23.00	22.60	22.25	22.96
T_2-$P_{60}K_o$	32.65	32.80	33.10	33.28	33.67	33.10
T_3-$P_{90}K_o$	33.85	34.20	34.55	34.80	35.20	34.52
T_4-$P_{30}K_{30}$	36.00	36.50	36.85	37.26	37.65	36.85
T_5-$P_{60}K_{30}$	48.20	48.85	49.37	49.82	50.28	49.30
T_6-$P_{60}K_{60}$	52.38	52.95	53.50	54.09	54.75	53.53
T_7-P_0K_{60}	47.00	47.45	47.95	48.40	48.93	47.95
CD(P=0.05)	1.33	1.43	1.50	1.62	1.73	-

The highest grain yield of wheat crop (53.53 q ha^{-1}) was recorded 60 kg P_2O_5 + 60 kg K_2O ha^{-1}. Increasing levels of each phosphorus and K markedly increased the yield of wheat crop. Application of 120 kg N ha^{-1} alone produced lowest average grain yield of wheat (22.96q ha^{-1}) during the period of experimentation. The average yield increases with 100% P and K (T_6) were 45.2 and 133.1% over 50% P and K (T_4) and 100% N alone, respectively. Singh *et al.* (2005) and Singh *et al.* (2013) also reported that integrated plant nutrition system is necessary for maintenance of soil fertility and of optimum plant nutrient supply to obtain a remarkable level for sustaining the productivity of rice-wheat crop under long term fertilizer use. The average grain yields of rice and wheat during 5 years cropping period varied from 49.20 to 51.40qha^{-1} and 40.30 to 41.95 qha^{-1}, respectively under the influence of application10 t FYM ha^{-1} along with various levels of phosphorus and potash. The results indicated that addition of 10 t FYM ha^{-1} in combination with various levels of fertilizer nutrients have more importance for sustaining rice-wheat production at maximum level. It might be due to improvement in availability of plant nutrients and manipulation of physical properties of rice soils. Bhatanagar *et al.* (1992), Yaduvanshi (2001) and Kumar *et al.* (2012) also reported similar results.

Uptake of nutrients

Application of phosphorus and K significantly increased the uptake of N, P and K by both rice and wheat as compared to 120 kg N ha^{-1} alone (T_1). The average values of nitrogen, phosphorus and potash uptake by rice and wheat crop varied from 64.70 to 130.10, 9.95 to 27.65 and 64.70 to 136.73 and 39.50 to 103.85, 8.50 to 28.86 and 47.20 to 120.35 kg ha^{-1}, respectively. Application of 60 kg P_2O_5 + 60 kg K_2O ha^{-1} gave maximum uptake of N, P and K by rice and wheat crops. The mean increase in uptake of NPK over control (T_1) with 50 and 100% recommended P and K (T_4 and T_6) were 40.9 and 101.6%, 83.9 and 177.8% and 74.4 and 111.3%, respectively by rice crop and 68.8 and 162.9%, 123.2 and 239.3 and 69.3 and 154.9%, respectively by wheat crop. Khare and Dixit (2011) also reported similar results. Application of 120 kg N ha^{-1} in combination with FYM significantly enhanced the uptake of N, P and K by rice and wheat crop. The of average increase in the uptake of P and K by rice and wheat crop due to integrated application of fertilizer nutrients alone varied from 13.8, 21.7 and 28.0 and 16.2, 27.0 and 16.0%, respectively. Application of FYM in conjunction with various levels of P and K also supplied secondary and micronutrients and its continued use could help in avoiding the deficiencies of these nutrients by improving soil fertility. Sharma *et al.* (2006), Sharma *et al.* (2012) and Singh *et al.* (2013) reported similar results.

Table 3: Impact of P and K levels alone and in conjunction with FYM on the nutrients uptake (kg ha^{-1}) by rice-wheat cropping system

Treatments	Rice			Wheat		
	Nitrogen	Phosphorus	Potash	Nitrogen	Phosphorus	Potash
FYM (t ha^{-1})						
0	90.20	20.50	98.67	69.55	12.40	98.67
10	102.68	24.95	126.30	80.87	15.95	126.30
CD (P=0.05)	2.521	1.620	2.617	1.956	1.510	2.232
P and K (kg ha^{-1})						
T_1-P_oK_o	64.70	9.95	64.70	39.50	8.50	47.20
T_2-P_0K_{60}	77.80	12.15	104.60	56.90	14.25	70.50
T_3-P_o K_{90}	82.95	13.80	109.86	61.45	17.50	74.90
T_4-$P_{30}K_{30}$	91.20	18.30	112.85	66.70	18.98	79.95
T_5-$P_{30}K_{60}$	116.95	22.78	125.67	92.40	25.95	109.80
T_6-$P_{60}K_{60}$	130.10	27.65	136.73	103.85	28.86	120.35
T_7-$P_{60}K_0$	113.50	24.90	116.90	88.96	23.60	106.40
CD (P=0.05)	2.257	1.321	2.431	1.856	1.182	2.125

Available nutrients

Continuous addition of 10 t FYM ha^{-1} in kharif season reduced the soil pH from initial level of 7.84 in 2002 to 7.48 in 2008 (Table 4). The decrease might be due to higher production of CO_2 and organic acids. The different levels of phosphorus and K with constant level of nitrogen in both rice and wheat crop also recorded decreasing trends than that of initial value. However, it ranged from 7.64 to 7.74 under the influence of various fertility levels but could not differ significantly. In general, continuous application of fertilizer nutrients alone and in conjunction with FYM markedly increased the content of soil organic carbon from initial level 2.5 to 3.9 g kg^{-1} (Table 4).

Table 4: Impact of P and K alone with FYM on the available nutrients, pH and organic carbon in the soil after rabi season crop

Treatments	Availability of Nutrients ($kg\ ha^{-1}$)			Org. C (%)	pH
	N	P	K		
FYM ($t\ ha^{-1}$)					
0	217.50	15.82	209.20	0.30	7.72
10	235.25	16.30	232.40	0.38	7.48
CD(P=0.05)	2.29	0.32	2.87	0.03	NS
P and K ($kg\ ha^{-1}$)					
T_1-P_oK_o	229.67	13.58	207.80	0.32	7.71
T_2-P_0K_{60}	225.38	16.28	213.95	0.38	7.73
T_3-P_0 K_{90}	222.79	17.67	221.70	0.34	7.70
T_4-$P_{30}K_{30}$	226.88	15.59	224.38	0.38	7.69
T_5-$P_{30}K_{60}$	227.42	17.30	22267	0.39	7.68
T_6-$P_{60}K_{60}$	223.69	16.72	230.75	0.38	7.64
T_7-$P_{60}K_0$	229.58	14.63	221.86	0.37	7.66
CD(P=0.05)	2.26	0.30	2.29	0.02	NS

Increasing level of P and K along with 120 kg N ha^{-1} without FYM enhanced significantly the organic carbon content in soil but application of 120 kg N ha^{-1} alone could not improve the content of organic carbon at a beneficial level. Yaduvanshi (2001) and Kumar *et al.* (2012) have also reported that organic carbon in the soil increased with the application of NPK with FYM or green manure.

Application of 10 t FYM ha^{-1} before 15 days of transplanting of paddy seedling in combination of fertilizer nutrients significantly enhanced the availability of nitrogen. Addition of FYM in conjunction with fertilizer nutrients increased 8.06% more available N than application of fertilizer nutrients alone in the soil. Yaduvanshi (2001) and Kumar *et al.* (2012) also reported increase in the available N content in the soil with the application of FYM. Continuous application of 60 kg P_2O_5 + 60 kg K_2O significantly enhanced available P from its initial status of 15.6 kg ha^{-1} to 16.72 kg ha^{-1}. Application of of phosphorus and K along with 10 t FYM ha^{-1} in kharif crop only significantly increased available P. The increase in available content in soil with FYM application might be due to greater mobilization of native soil-P, mineralization of organic-P and production of organic acids making soil P more available. Bhatnagar *et al.* (1992), Yaduvanshi (2001) and Kumar *et al.* (2012) also reported similar results. Increasing levels of K and P increased significantly available-K content of soil. The decrease in available-K content of the soil occurred under control from the initial value 278 to 207.8 kg ha^{-1}. The buildup of soil available K due to FYM addition might be due to the additional K applied through it. Similar findings were reported by Singh *et al.* (2005) and Kumat *et al.* (2012).

REFERENCES

Bhatnagar, V.K., Kundu, S. and Ved Prakash, K (1992) Effect of long term manuring and fertilization on soil physical properties under soybean-wheat cropping sequence. Indian *Journal of Agricultural Sciences* **62**, 212-214

Jackson, M.L. (1973) *Soil Chemical Analysis*, Prentice hall of India Pvt.Ltd., New Delhi.

Khare, D. and Dixit, H.C. (2011) Effect of potassium and zinc on yield, quality and uptake of nutrients in wheat. *Annals of Plant and Soil Research* **13**: 158-160.

Kumar, V., Kumar, T., Gupta, P.K., Singh, R.V., Singh, R.A., and Singh, S.B. (2012) Effect of pudding and organic sources of nutrients on productivity of rice-wheat cropping system in lowlands. *Annals of Plant and Soil Research* **14:** 95-100.

Ray S.S. and Gupta, R.P. (2001) Effect of green manuring and tillage practices on physical properties of puddled loan soil under Rice-Wheat cropping system. *Journal of the Indian Society of Soil Science* **49**: 670-678.

Salvi D, Santhy, P and Dhakshinamoorthy, M. (2005) Effect of inorganics alone and in combination with Farm Yard Manure on physical properties and productivity of Vertic Haplustepts under long term fertilization. *Journal of the Indian Society of Soil Science* **53**,302-307

Sharma, S.K., Tiwari, K.N. Jat M.L. Singh, V.K. and Shukla, A.K. (2006) Balanced and Integrated plant nutrient management for sustainable higher productivity Proc. of national seminar on soil testing for balanced and integrated use of fertilizers organized by division of *Soil Science and Agri. Chemistry. I.A.R.I., New Delhi* pp. 95-110

Sharma, Y.K., Singh, H., and Mandal, N. (2012) Effect of phosphorus and copper levels on yield and nutrients uptake by wheat. *Annals of Plant and Soil Research* **14**: 136-138.

Singh, G., Singh, S. and Singh, S.S. (2013) Integrated nutrient management in rice ans wheat crop in rice-wheat cropping system in lowlands. *Annals of Plant and Soil Research* **15***:* 1-4.

Singh, V.K., Dwivedi, B.S. and Shukla, A.K. (2005) Integrated nutrient management in transplanted Rice-Wheat system In: PDCSR annual report 2004-05, *Project Director of Cropping Systems Research, Modipuram*, India.

Yaduvanshi, N.P.S. (2001) Effect of Five Years of Rice-Wheat cropping and NPK Fertilizer use with and without organic and green manures on soil properties and crop yields in a reclaimed soidic soil. *Journal of the Indian Society Soil Science* **49**: 714-719.