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Effect of FYM and Fertilizers Nutrition on Production Potential, Nutrients Uptake and Soil Properties under Rice-Wheat Cropping System

VINOD KUMAR KANAUJIA*
Chandra Shekhar Azad University of Agriculture and Technology, Kanpur,Uttar Pradesh, India

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ABSTRACT

A field experiment was conducted during the Kharif and Rabi seasons of 2001-2005 in regular crop sequence at Crop Research Station, Nawabganj, CSA University of Agriculture & Technology, Kanpur in order to find out the effect of farm yard manure (FYM) and NPK levels in rice-wheat cropping system. One level of FYM (10 t ha^{-1}) and one level of N (120 kg ha^{-1}),three levels of P (0, 30, 60 kg ha^{-1}), four levels of K (0, 30, 60, 90 kg ha^{-1}) were tested. The grain yield of rice and wheat crops were increased at levels of FYM (10 t ha^{-1}) and NPK (120, 60, 60 kg h a^{-1}). The application of FYM with 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha-^{1} gave significantly highest yield of rice and wheat crops. The application of NPK fertilizers with FYM were found increased in their uptake. The application of NPK fertilizers with FYM was found improvements in physio-chemical properties of soil like soil ph, organic carbon and available NPK.

Keywords: *FYM, Nutrients uptake, Rice- Wheat Cropping system, Physio-chemical properties, Tillage,*

INTRODUCTION

Rice-Wheat cropping system is most vital cropping system of Indian subcontinent. Rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L.) are the two most important energy giving food globally (Singh *at al.*, 2011 and Meena *at al.*, 2013). Rice and wheat grown sequentially in an annual rotation (Singh and Singh, 2009) constitute a rice-wheat cropping system (RWCS) and in a system occupy nearly 13.5 million hectares area in the Indo-GangeticPlains (IGP) of South Asia. Integrated nutrient management practices for rice-wheat cropping system are of supreme importance for sustainable crop production in country (Singh and Kumar, 2009). The cropping systems therefore, that include both rice and wheat, require special soil management practices like tillage and addition of FYM/ organic manures along with optimum doses of fertilizer nutrients. Application of FYM, apart from increasing soil fertility, improves the soil physical condition. Tillage practices cause a decrease in bulk density and increase in total porosity along with hydraulic conduction (Prasad 2008).

MATERIALS AND METHODS

A field experiment was conducted during the Kharif and Rabi seasons of 2001-2005 in regular crop sequence at Crop Research Station, Nawabganj, C. S. A. University Of Agriculture & Technology, Kanpur located at $25^0$26' to 26^0 58' North latitude and 79^0 31' to 80^0 34' East longitude. The experimental soil had soil pH-7.8(1:25)soil water ratio, EC (0.26 Dsm^{-1}), Organic carbon (0.25 g kg^{-1}), C.E.C (11.98 C mole $[P^+]kg^{-1}$), Total N (0.52 g kg^{-1}), Available N (232 kg ha^{-1}), Available P_2O_5 (15.6 kg ha^{-1}), Available K_2O (278 kg ha^{-1}) and sand, slit, clay % 54.98, 19.32, 26.25 and sandy loam in texture. The studied comprising with seven treatments vizT_1-100% N, T_2-100% NP, T_3-100% N+150% K, T_4-100% N+50% PK , T_5-100% NK+50% P, T_6-100% NPK, T_7-100% NP with/without FYM@10 t ha^{-1} during each kharif season andvizT_1-100% N, T_2-100% NP, T_3-100% N+150% P, T_4-100% N+50% PK , T_5-100% NP+50% K, T_6-100% NPK, T_7-100% NK during each rabi season experiment in fixed layout. The recommended dose of fertilizer for rice and wheat were 120, 60, 60 kg ha^{1}.The experiment was laid out in a split plot design with three replications. The FYM was incorporate in soil before 15 days transplanting of rice only. Rice cvNDR-359 was transplantedon first fortnight of July at spacing 20x10 cm. In each crop seasons after harvest of rice, wheat cv PBW-343 was sown first fortnight of November at a row spacing 20 cm during experimental periods. One third of N and full doses of P & K as per treatments were applied at the time of transplanting/sowing in both crops. The remaining dose of nitrogen was top dressed in two equal split doses after 3 and 6 weeks in paddy and at 21, 40 days in wheat. The source of N, P and K were Urea, DAP and MOP, respectively. The grain yields of both crops were recorded on air-dry basis. The grain of both crops was analyzed for NPK by standard procedures. Crops were harvested at maturity and yield data were collected. After harvesting of wheat crop, soil sample were taken from each plots and analyzed for different parameters via pH, org. carbon, NPK and other physio-chemical properties of soil through standard methods.

RESULT AND DISCUSSION

Response of fertilizer nutrients

It is obvious from the data shown in table 1 that mean grain yield of rice to various levels of phosphorus and potash in combination with nitrogen @ 120 Kg ha^{-1} from 2001- 02 to 2005-06 varied from 35.27 to 60.76 q ha^{-1}. The maximum average grain of rice (60.76 q ha^{-1}) was noticed under the treatment $N_{120,}$ P_{60} and K_{60} Kg ha^{-1} (T_6)followed by T_5, T_7, T_4 and T_2. Lowest grain

***Corresponding Author Email :** fathervinod@gmail.com

yield was recorded in the plot which was treated with nitrogen @ 120 Kg ha^{-1}. Increasing the levels of phosphorus and potash @ 30 and 60 Kg ha^{-1} along with nitrogen @ 120 Kg ha^{-1} significantly increased the grain yield of rice. Application of phosphors, potash and nitrogen (T_5) @ P_{30}, K_{60} and N_{120} Kg ha^{-1}, respectively could not significantly differ from treatment (T_7) which received P_{60}, K_0 alongwith N_{120} Kg ha^{-1}. These trends of response were observed during all kharif season (2001-05). However, enhancing the dose of potash in combination with nitrogen at recommended dose without phosphorus (T_3) could not significantly differ from that treatment which received potash and nitrogen only @ 60 and 120 Kg ha^{-1} respectively, during from all the experimental years (2001-05). Although grain yield of rice under the influence of various treatments increased from initial year (2001) to final year of experiment (2005), yet nitrogen application @ 120 Kg ha^{-1} alone showed negative trend on the grain yield of rice from first to last kharif season. In might be due to imbalanced availability of phosphorus and potash in that plot. It was also noticed that imbalanced use of fertilizer nutrients N_{120} Kg ha^{-1}(T_1) alone resulted in significant decreasing the rice production over 100% recommended NPK (T_6). Integrated plant nutrient supply system is and approach which adopts plant nutrition to rice based cropping system and particularly yield target reported by Aulakh and Grant *(2008) and* Sharma *et al.* (2006).

It is evident from the data presented in table 2& 4 that there was significant effect of wheat crop to N, P and K. The average grain yield of wheat crop during five year of experiment ranged from 22.96 to 53.53 q ha^{-1}. The highest grain yield of wheat crop (53.53 q ha^{-1}) was recorded in that plot, which was treated with N_{120}, P_{60} and K_{60} (T_6), increasing the levels of each phosphorus and potash markedly increased the yield of wheat crop. Application of nitrogen @ 120 Kg ha^{-1} alone responded lowest average grain yield of wheat (22.96 q ha^{-1}) during the period of experimentation. The average yield response percentage of 100% P and K in combination with N @ 120 Kg ha^{-1} (T_6) were 45.26 and 133.14 over to 50% P and K along with N_{120} (T_4) and 100% N alone, respectively. Timsing and Corner (2001) and Singh *et al.* (2005)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. Intensive rice-wheat cropping with N only input is a short lived phenomenon and it is verified by relatively higher P and K fertilizer use efficiencies and lower nitrogen use efficiency.

Table 1: Effect of treatments on grain yield of rice

Treatments	Grain yield (q ha^{-1})					
Main plots	2001-02	2002-03	2003-04	2004-05	2005-06	Mean
Without FYM (W_o)	46.50	47.70	47.50	47.75	48.20	47.33
With FYM (W_1)	49.20	49.90	50.55	50.58	51.40	50.39
CD-(P=0.05)	1.68	1.87	1.92	2.08	2.05	-
T_1-N_{120} P_0 K_0	36.00	35.50	35.10	34.95	34.80	35.27
T_2-N_{120} P_0 K_{60}	40.50	40.90	41.20	41.40	41.50	41.10
T_3-N_{120} P_0 K_{90}	42.60	42.70	43.00	43.28	43.60	43.02
T_4-N_{120} P_{30} K_{30}	44.90	45.20	45.45	45.80	46.00	45.47
T_5-N_{120} P_{30} K_{60}	54.70	54.95	55.20	55.50	56.00	55.27
T_6-N_{120} P_{60} K_{60}	60.00	60.30	60.80	61.20	61.50	60.76
T_7-N_{120} 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	-

Response of Farm Yard Manure

The average grain yields of rice and wheat during five years cropping period varied from 49.20 to 51.40 q ha^{-1}, respectively under the influence of Farm Yard Manure application @ 10 t ha^{-1} along with various levels of phosphorus and potash in addition with nitrogen 120 Kg ha^{-1}. The percentage of yield response due to FYM application in conjunction with different levels of fertilizer nutrient over that obtained under various levels of fertilizer nutrient alone ranged from 5.80 to 6.85 with general mean 6.46 and 7.34 to 7.98 with general mean 7.63 in rice and wheat, respectively. The results indicated that addition of FYM @ 10 t 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 stupendous improvement in concomitant availability of plant nutrients and manipulation of physical properties of rice soil. Bhatnagar *et al.* (1992) and Yaduvanshi (2001) also reported that long term use of inorganic fertilizer with organic manure /FYM significantly enhanced the available N, P and K along with improvement of physical properties of soil, resulting maximum grain yield of rice and wheat crops.

Uptake of nutrients by Rice and Wheat

It is palpable from the data depicted in table 3 and table 4 that application of phosphorus and potash in various levels along with nitrogen @ 120 Kg ha^{-1} significantly increased the uptake of nitrogen, phosphorus and potash by both rice and wheat crop as compared to N_{120} Kg ha^{-1}(T_1). The average values of nitrogen, phosphorus and potash uptake by rice and wheat crop during five years of experimentation varied from 64.70 to 130.10, 9.95 to 27.65 and 64.70 to 136.73 and 39.50 to 103.85, 8.5 to 28.86 and 47.20 to 120.35 Kg ha^{-1}, respectively.Application of

Table 2: Effect of treatments on grain yield wheat

Treatments	Grain yield (q ha^{-1})					
Main plots	2001-02	2002-03	2003-04	2004-05	2005-06	Mean
Without FYM (W_o)	37.45	37.80	38.15	38.49	38.85	38.15
With FYM (W_1)	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	-
T_1-N_{120} P_0 K_0	23.60	23.38	23.00	22.60	22.25	22.96
T_2-N_{120} P_{60} K_0	32.65	32.80	33.10	33.28	33.67	33.10
T_3-N_{120} P_{90} K_0	33.85	34.20	34.55	34.80	35.20	34.52
T_4-N_{120} P_{30} K_{30}	36.00	36.50	36.85	37.26	37.65	36.85
T_5-N_{120} P_{60} K_{30}	48.20	48.85	49.37	49.82	50.28	49.30
T_6-N_{120} P_{60} K_{60}	52.38	52.95	53.50	54.09	54.75	53.53
T_7-N_{120} P_0 K_{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	-

100% recommended doses of NPK @ 120:60:60 Kg ha^{-1} during five years response, maximum uptake of N, P and K by rice and wheat crops. The mean increase in uptake of NPK over nitrogen @ 120 Kg ha^{-1} alone (T_1) with 50% and 100% recommended P and K in addition with 100% N (T_4 and T_6) were determined 40.95 and 101.64%, 83.92 and 177.88% and 74.42 and 111.33%, respectively by rice crop and 68.86 and 162.91%, 123.29 and 239.33 and 69.38 and 154.97%, respectively wheat crop. Application of inorganic fertilizers in varying levels along with N @ 120 Kg ha^{-1} in combination with FYM significantly enhanced the uptake of N, P and K by rice and wheat crops during 2001 to 2005-06. The percentage of average increase in the uptake of N, P and K by rice and wheat crops due to integrated application of fertilizer nutrients alone varied from 13.83, 21.70 and 28.00 and 16.18, 27.02 and 16.04, respectively during five years of experimentation. Application of FYM in conjunction with various levels of N, P and K also supplied secondary and micronutrients and its continued use could help in avoiding the deficiencies of these nutrients by improving soil health, which in recent years have become key factor in reducing the response of crops to NPK through in organic fertilizers. Farmers are themselves realizing that due to declining soil health they have to apply much more fertilizer to obtain sustainable rice-wheat production (Sharma *et al.*, 2006).

Table 3: Effect of treatments on nutrients uptake of rice

Treatments	Average Nutrients uptake (Kg ha^{-1})		
Main plots	N	P	K
Without FYM (W_o)	90.20	20.50	98.67
With FYM (W_1)	102.68	24.95	126.30
CD-(P=0.05)	2.521	1.620	2.617
T_1-N_{120} P_0 K_0	64.70	9.95	64.70
T_2-N_{120} P_0 K_{60}	77.80	12.15	104.60
T_3-N_{120} P_0 K_{90}	82.95	13.80	109.86
T_4-N_{120} P_{30} K_{30}	91.20	18.30	112.85
T_5-N_{120} P_{30} K_{60}	116.95	22.78	125.67
T_6-N_{120} P_{60} K_{60}	130.10	27.65	136.73
T_7-N_{120} P_{60} K_0	113.50	24.90	116.90
CD- (P=0.05)	2.257	1.321	2.431

Response on soil properties

Soil pH

Continuous addition of Farm Yard Manure @ 10 t ha^{-1} in kharif season during five years reduced the soil pH from initial level of 7.84 in 2001 to 7.48 in 2005-06 (Table 5).The decrease might be due to higher production of CO_2 and organic acids. The different levels of phosphorus and potash with constant level of nitrogen in both rice and wheat crops in five years experimentation 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 by statistical scrutiny of data.

Table 4: Effect of treatments on nutrients uptake of wheat

Treatments	Average Nutrients uptake (Kg ha^{-1})		
Main plots	N	P	K
Without FYM (W_o)	69.15	12.40	98.67
With FYM (W_1)	80.87	15.95	126.30
CD-(P=0.05)	1.956	1.510	2.232
T_1-N_{120} P_0 K_0	39.50	8.50	47.20
T_2-N_{120} P_{60} K_0	56.90	14.25	70.50
T_3-N_{120} P_{90} K_0	61.45	17.50	74.90
T_4-N_{120} P_{30} K_{30}	66.70	18.98	79.95
T_5-N_{120} P_{60} K_{30}	92.40	25.95	109.80
T_6-N_{120} P_{60} K_{60}	103.85	28.86	120.35
T_7-N_{120} P_0 K_{60}	88.96	23.60	106.40
CD- (P=0.05)	1.856	1.182	2.125

Organic carbon

In general, continuous application of fertilizer nutrients alone and in conjunction with FYM markedly increased the content of soil organic carbon from initial level 0.25 to 0.39 g Kg^{-1} (Table 5). However, increasing the level of P and K along with N @ 120 Kg ha^{-1} without FYM enhanced significantly the organic carbon content in soil but application of N @ 120 Kg ha^{-1} alone in both kharif and rabi season could not improve the content of organic carbon at a beneficial level. The maximum increase organic carbon content (0.39 g Kg^{-1}) have been determined in that plot which received N_{120}, P_{30} and K_{60} in kharif and N_{120}, P_{60} and K_{30} Kg ha^{-1} in Rabi season, respectively duringfive years of the experimentation. Yaduvanshi (2001) have also reported that organic carbon in the soil increased with the application of NPK with FYM or green manure.

Table 5: Effect of treatment on NPK availability, Organic carbon and pH

Main plot treatments.		Availability of nutrients (Kgha^{-1})			Org. C(g Kg^{-1})	pH
		N	P	K		
W_o-without FYM		217.50	15.82	209.20	0.30	7.72
W_1-with FYM		235.25	16.30	232.40	0.38	7.48
CD-(P=0.05)		2.295	0.324	2.876	0.030	NS
Sub plot treatments.		-	-	-	-	-
Kharif	Rabi					
T_1-N_{120} P_0 K_0	T_1-N_{120} P_0 K_0	229.67	13.58	207.80	0.32	7.71
T_2-N_{120} P_0 K_{60}	T_2-N_{120} P_{60} K_0	225.38	16.28	213.95	0.38	7.73
T_3-N_{120} P_0 K_{90}	T_3-N_{120} P_{90} K_0	222.79	17.67	221.70	0.34	7.70
T_4-N_{120} P_{30} K_{30}	T_4-N_{120} P_{30} K_{30}	226.88	15.59	224.38	0.38	7.69
T_5-N_{120} P_{30} K_{60}	T_5-N_{120} P_{60} K_{30}	227.42	17.30	222.67	0.39	7.68
T_6-N_{120} P_{60} K_{60}	T_6-N_{120} P_{60} K_{60}	223.69	16.72	230.75	0.38	7.64
T_7-N_{120} P_{60} K_0	T_7-N_{120} P_0 K_{60}	229.58	14.63	221.86	0.37	7.66
CD- (P=0.05)	-	2.262	0.301	2.296	0.020	NS

Available Nitrogen

The data on available N after the harvest of 10 crops in rotation are depicted in Table 5. Continuous cropping for five years markedly increased the available N with the use of fertilizer N @ 120 Kg ha^{-1} in both the kharif and rabi season alone. The available N varied from 222.79 to 229.67 Kg ha^{-1} during last wheat crop in experimental site. However, the lowest available N content (222.79 Kg ha^{-1}) was observed in that plot which received NPK (120:0:90 Kg ha^{-1}) in kharif and (120:90:0 Kg ha^{-1}) in rabi crop during five years Rice-Wheat crop rotation. Application of FYM @ 10 t 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 in various levels in kharif crop only increased 8.06% more available N than application of fertilizer nutrients alone in the soil. Yaduvanshi (2001) also reported increase in the available N content in the soil with the application of FYM.

Available phosphorus

Continuous application of 100% NPK (T_6) significantly enhanced available P from its initial status of 15.6 to 16.72 Kg

ha^{-1}. Increasing the level of phosphorus up to 90 Kg ha^{-1} in both kharif and rabi crops the available P increased, significantly, beyond this could not enhanced markedly. Application of various levels of phosphorus with different levels of potash and fixed N @ 120 Kg ha^{-1} in Rice-Wheat cropping system during five years along with FYM 10 t 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 soil-P, mineralization of organic-P and production of organic acids making soil P more available. Bhatnagar *et al.* (1992) and Yaduvanshi (2001)also reported similar results. After ten crops harvested in rice-wheat rotation the available P decreased from initial level 15.6 to 13.58 Kg ha^{-1} in nitrogen alone treated plot. This was because of enhanced dry matter production and consequent higher uptake of P by both the crops.

Available potassium

The data on available K after the harvest of ten crops in rotation are depicted in table 5. Continuous cropping for five years available K significantly declined under nitrogen alone and nitrogen with various levels of P over different levels of K treated plots. Increasing levels of K (0, 30, 60 and 90 Kg ha^{-1}) with nitrogen and phosphorus increased significantly available K content of soil. The decrease in available K content of the soil occurred under N treatment from the initial value 278 to 207.80 Kg ha^{-1}. The buildup of soil available K due to FYM addition might be due to the additional K applied through it. The solublising action of certain organic acids produced during FYM decomposition and its greater ability to hold K in the available form. Similar findings were earlier reported by *Singh et al.* (2005) and Timsing and Corner (2001).

CONCLUSION

It was concluded thatthe application of FYM with 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} gave significantly highest yield of rice and wheat crops. The application of NPK fertilizers with FYM was found improvements in physio-chemical properties of soil like soil pH, organic carbon and available NPK.

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