Progressive Research – An International Journal
Vol. 3 (Special Issue) : 496-501 (2008), ISSN : 0973-6417

Society for Scientific Development in Agriculture and Technology, Meerut (U.P.) INDIA

CONJOINT USE OF ORGANICS AND INORGANIC FERTILIZERS FOR SUSTAINING SOIL FERTILITY AND CROP PRODUCTIVITY IN CALCIORTHENTS UNDER RICE-WHEAT CROPPING SYSTEM

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ABSTRACT

The present investigation was under taken to assess the impact of conjoint use of organics and chemical fertilizers on crop productivity and fertility stat us of soils like pH, FC, Organic carbon available nutrients, N, P, K under rice-wheat cropping system. Field experiments were conducted during kharif and rabi season of l999-2000. At Pusa Farm of Rajendra Agricultural University, Pusa, Bihar, Samastipur in a split plot design with three replications. The treatments comprised five organic sources viz; dhaincha (GM), urd (GL), FYM, straw and weedy fallow and five levels of fertility i.e. control, 50% PK, 50% NPK, 100% PK and 100% NPK of recommended doses of fertilizers for rice crop and their residual effects were tested in wheat crop at normal dose of NPK (120 : 60 : 40 kg/ha N, P_2O_5, K_2O). The differences in soil reaction, organic carbon, available N, P and K were significantly influenced. However, no appreciable change in soil EC was observed. Soil organic carbon increased from initial value 0.5 l .10% to 0.593% due to the integrated impact of organics as well as inorganics in the post-harvest soil of wheat. A buildup of available NPK content with conjoint use of organic and inorganic fertilizers in the soil was apparently visualized which increased from 200.32 to 237. 78kg N/ha, 14.46 to 28.91 kg P_2O_5/ha and 96.18 to 124.01 kg K_2O/ha respectively. The impact of integrated nutrient management on soil pH was tremendous which caused a decline in soil pH from 8.50 to 8.20. The dhaincha (GM) + 100% NPK treatment combination produced the highest rice grain yield (53.24 q/ha) whereas the maximum grain yield of wheat (41.67 q/ha) were obtained under FYM + l 00% NPK treatment combination.

Key words : Integrated nutrient management, Organics, chemical fertilizers, sustainable crop production.

Continuous use of high analysis chemical fertilizer increased the crop yield during the initial years of the green revolution but, the sustainability of the productivity of the soil these days are being found to be at risk due to such practices (Vurmani, 1994). The decline in soil fertility and the resultant productivity are the matter of nutrient imbalance which has been recognized as one of the most important factors limiting crop yield (Nambiar & Ghost, 1984). Indiscriminate use of high analysis chemical fertilizer also resulted in the deficiency of nutrients other than the applied and caused decline in organic carbon (Singh *et.al.*, 1999). However, when organic manures, green manure, green legume, straw were applied in conjunction with chemical fertilizers for efficient growth of crops, decline in organic carbon was arrested and the gap between potential and the actual yields is bridged to a large extent. As we know that organic matter is the back bone for the sustainability of soil fertility y and productivity. Therefore, use of chemical fertilizer a lone may not keep pace with time in maintenance of soil health for sustaining the productivity. The problem of micro-nutrients also generally crops up with the use of high analysis fertilizer. The present study was under- taken to study the integrated management of organics and chemical fertilizers for sustaining crop productivity y and soil fertility in rice-wheat cropping system.

MATERIALS AND METHODS

A field experiment was conducted at Pusa Farm of Rajendra Agricultural University, Bihar, Samastipur during kharif-rabi season l999-2000, to study the integrated management of organic and inorganic fertilizers for sustaining soil fertile it and crop productivity in rice-wheat cropping system. The soil of the experiment l field was sandy loam in texture with pH 8.5 and calcareous in nature (-% $CaCO_3$ content). The organic carbon content of the surface soil was 0.51 percent with 9.30 dS/m EC, the available N. P_2O_5 and. K_2O contents were, 200.32, 14.46 and 96.18 kg/ha, respectively.

Soil samples were collected air dried and processed to pass through a 2mm sieve. Soil texture was determined by the international pipette method.

Table-1 : Influence of organic and inorganic fertilizer on the grain yield of rice and wheat in rice-wheat cropping system.

Inorganic fertilizer levels	Grain yield of rice (q/ha)						Grain yield of wheat (q/ha)					
	Organic sources						Organic sources					
	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean
Control	31.36	28.73	30.60	25.72	21.41	27.56	24.08	22.08	31.65	27.32	19.31	24.89
50% PK	34.29	31.92	33.58	27.29	25.60	30.54	24.56	23.87	33.18	27.68	21.31	26.12
50% NPK	44.07	36.76	43.48	34.66	30.86	38.04	30.78	29.31	38.53	35.91	25.71	32.05
100% PK	36.53	32.81	35.67	29.89	28.27	32.63	29.05	27.53	36.87	34.02	22.23	29.34
100 % NPK	53.24	43.29	52.57	40.65	34.94	44.94	36.19	35.24	41.67	39.27	29.34	36.34
Mean	39.90	34.70	39.26	31.64	28.22		28.93	27.61	36.38	32.84	25.58	
Source		S.Em.±			CD at 5%			S.Em.±			CD at 5%	
Organic manures (M)		0.89			2.90			0.43			1.40	
Inorganic fertilizers (S)		0.56			1.62			0.56			1.61	
Interaction (M×S)		1.44			NS			1.21			NS	

Table-2 : Influence of organic and inorganic fertilizer on the pH of post harvest soil in rice-wheat cropping system.

Inorganic fertilizer levels	pH of post harvest soil of rice						pH of post harvest soil of wheat					
	Organic sources						Organic sources					
	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean
Control	8.50	8.56	8.50	8.60	8.60	8.55	8.46	8.50	8.46	8.50	8.60	8.50
50% PK	8.50	8.53	8.50	8.60	8.60	8.54	8.46	8.46	8.43	8.46	8.60	8.48
50% NPK	8.39	8.50	8.39	8.50	8.53	8.46	8.36	8.36	8.30	8.33	8.50	8.37
100% PK	8.39	8.50	8.46	8.60	8.60	8.51	8.30	8.33	8.30	8.30	8.50	8.34
100 % NPK	8.30	8.39	8.36	8.39	8.50	8.39	8.23	8.26	8.20	8.23	8.39	8.26
Mean	8.42	8.50	8.44	8.54	8.56		8.36	8.38	8.34	8.36	8.52	
Source		S.Em.±			CD at 5%			S.Em.±			CD at 5%	
Organic manures (M)		0.025			0.081			0.015			0.048	
Inorganic fertilizers (S)		0.021			0.060			0.020			0.057	
Interaction (M×S)		0.048			NS			0.043			NS	

Soil pH was determined by liquid the electrical conductivity was determined using conductivity bridge, pH meter in 1:2.5 soils: water suspension and the electrical conductivity was measured by conductivity Bridge in the same soil water suspension. The organic carbon was determined by titrimetric method (Walkley and Black,1934) and available N content by alkaline permanganate method (Chopra and Kanwar, 1976).

The available-P was extracted by using 0.5M $NaHCO_3$ solution (pH 8.5) in (1 :20) soil: extractant suspension by shaking for 30 minutes (Olsen *et al.,*1954) and determination was done by the ascorbic acid procedure (Watanable and Olsen. 1965) using red, 660nm filter. Available K was extracted by neutral normal ammonium acetate extractant and estimated with the help of flame photometer as described by Jackson (1973).

The field experiment laid in split-plot design with three rep1ications consisted of treatments of organic like Dhaincha, Urd, FYM. Wheat straw and Weedy fallow in the main plots and treatments like No N PK, 50% PK. 50% N PK, 100% PK and 100% N PK at the rate of 120kg N, 60kg P205 and 40kg K2O/ha in sub-plots.

Dhaincha lopping (2.19% N, 0.42% P, 1.73% K), urd (2.33% N, 0.58% P, 1.17/K). FYM (1.25% N, 0.29% P, 0.68% K), wheat straw (0.54% N, 0.081% P, 1.08% K), weeds (0.39% N, 0. 1 8% P, 0.50% K) were incorporated into the soil three weeks before sowing of kharif rice (cv. Gautam) in fixed layout of the treatment's combinations. All plots received a uniform dose of N, P, K at the rate of 120, 60, 40kg/ha respectively for rabi wheat (cv. HUW-206). At the end

Table-3 : Influence of organic and inorganic fertilizer on the EC of post harvest soils in rice-wheat cropping system.

Inorganic fertilizer levels	EC (dS/m) of post harvest soil rice						EC (dS/m) of post harvest soil wheat					
	Organic sources						Organic sources					
	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean
Control	0.31	0.32	0.31	0.33	0.33	0.32	0.30	0.31	0.30	0.31	0.32	0.31
50% PK	0.30	0.31	0.31	0.32	0.33	0.31	0.29	0.30	0.29	0.29	0.32	0.30
50% NPK	0.29	0.31	0.30	031	0.32	0.30	0.28	0.29	0.29	0.29	0.30	0.29
100% PK	0.29	0.31	0.30	0.32	0.33	0.31	0.29	0.30	0.29	0.30	0.31	0.30
100% NPK	0.28	0.30	0.29	0.31	0.31	0.30	0.28	0.29	0.27	0.28	0.30	0.28
Mean	0.29	0.31	0.30	0.32	0.32		0.29	0.30	0.29	0.30	0.31	
Source		S.Em.±			CD at 5%			S.Em.±			CD at 5%	
Organic manures (M)		0.005			NS			0.010			NS	
Inorganic fertilizers (S)		0.006			NS			0.006			NS	
Interaction (M×S)		0.013			NS			0.015			NS	

Table-4 : Influence of organic and inorganic fertilizer on the organic carbon of post harvest soils in rice-wheat cropping system.

Inorganic fertilizer levels	Organic carbon (%) of post-harvest soil rice						Organic carbon (%) of post harvest soil wheat					
	Organic sources						Organic sources					
	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean
Control	0.530	0.510	0.537	0.540	0.447	0.513	0.510	0.500	0.513	0.513	0.430	0.493
50% PK	0.527	0.507	0.540	0.530	0.450	0.511	0.510	0.507	0.517	0.520	0.446	0.500
50% NPK	0.543	0.27	0.553	0.557	0.463	0.528	0.533	0.520	0.553	0.560	0.460	0.525
100% PK	0.533	0.523	0.543	0.560	0.460	0.524	0.513	0.510	0.517	0.530	0.450	0.504
100 % NPK	0.563	0.553	0.573	0.610	0.480	0.556	0.550	0.547	0.570	0.593	0.470	0.546
Mean	0.538	0.524	0.549	0.559	0.460		0.523	0.517	0.534	0.543	0.451	
Source		S.Em.±			CD at 5%			S.Em.±			CD at 5%	
Organic manures (M)		0.006			0.021			0.008			0.028	
Inorganic fertilizers (S)		0.008			NS			0.009			0.25	
Interaction (M×S)		0.017			NS			0.019			NS	

of each crop season grain and straw yield of kharif rice and rabi wheat were recorded.

RESULTS AND DISCUSSION

Grain yield of kharif rice and rabi wheat : The grain yield of rice increased with increasing levels of various fertilizer treatments over the control. Application of 100% recommended NPK + Dhaincha (GM) and 100% NPK + FYM produced the highest (Table-1) grain yield in rice and wheat, respectively. However, the lowest grain yield in both rice and wheat crops were recorded in weedy-fallow treatments in all the levels of NPK fertilizers all levels of the results further indicated that the additional residual advantage in using FYM and straw with chemical fertilizers was apparent as shown by the higher grain yield of wheat in FYM treatment. In both the cropping seasons, it was apparent that 50% NPK levels showed their superiority in grain yield even over 100% PK and other levels of fertilizer combinations. The higher yield in the NPK + FYM treatment may be due to the prolonged availability of plant nutrients. These results further indicated that about 25-30 per cent nutrient content in FYM could be absorbed by rice plant during the first crop. Consequently, accumulated N and other nutrients in soil were gradually mineralized and utilized by successive crop (Gaur *el. al.* 1984) similar results were also reported by Mandal and Mandal (1990). They observed that irrespective of the nutrient level combined application of FYM and NPK produced significantly higher yield than NPK alone. In other experiment in China, Li *et al.* (1986) concluded that INM

Table-5 : Influence of organic and inorganic fertilizer on the available nitrogen of post harvest soils in rice-wheat cropping system.

Inorganic fertilizer levels	Available N (kg/ha) of post harvest soil of rice						Available N (kg/ha) of post harvest soil of wheat					
	Organic sources						Organic sources					
	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean
Control	209.95	198.24	205.34	192.93	185.00	198.29	198.50	193.05	203.78	200.14	180.82	195.26
50% PK	212.45	200.08	207.80	195.98	186.86	200.63	200.96	198.69	210.52	205.23	181.20	199.32
50% NPK	222.56	209.65	212.63	200.62	189.38	206.97	206.75	202.70	223.36	212.75	185.01	206.11
100% PK	219.64	204.42	208.26	196.01	185.78	202.82	204.12	198.03	217.72	007.88	181.54	201.80
100 % NPK	230.07	220.84	225.94	214.60	198.02	217.90	220.02	213.07	237.78	224.87	188.49	216.85
Mean	218.93	206.64	212.00	200.03	189.01		206.07	201.11	218.52	210.17	183.41	
Source		S.Em.±			CD at 5%			S.Em.±			CD at 5%	
Organic manures (M)		1.88			6.16			2.45			7.98	
Inorganic fertilizers (S)		2.42			6.91			2.01			5.72	

Table-6 : Influence of organic and inorganic fertilizer on the available phosphorus of post harvest soils in rice-wheat cropping system.

Inorganic fertilizer levels	Available P_2O_5 (kg/ha) of post harvest soil of rice						Available P_2O_5 (kg/ha) of post harvest soil of wheat					
	Organic sources						Organic sources					
	Dhaincha (GM)	Urd (GL)	FYM	Stra w	Weedy fallow	Mean	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean
Control	16.92	15.12	16.23	13.02	12.82	14.83	14.01	13.86	16.00	12.35	10.08	13.28
50% PK	19.15	18.05	18.95	16.30	14.66	17.42	18.05	16.77	19.83	15.18	12.91	16.55
50% NPK	21.37	19.98	20.65	16.74	15.00	18.75	20.69	18.05	22.12	17.86	14.80	18.70
100% PK	24.96	21.01	21.70	18.32	17.47	20.69	23.02	20.98	25.56	19.89	17.05	21.30
100 % NPK	27.88	22.40	24.11	19.00	18.07	22.29	26.76	23.18	28.91	21.38	17.76	23.60
Mean	22.06	19.31	20.33	16.67	15.61		20.52	18.57	22.48	17.33	14.52	
Source		S.Em.±			CD at 5%			S.Em.±			CD at 5%	
Organic manures (M)		0.42			1.36			0.58			1.89	
Inorganic fertilizers (S)		0.45			1.30			0.33			0.95	
Interaction (M×S)		1.01			NS			0.88			NS	

was the most suitable approach for profitable crop production in sustained manner.

Soil reaction : The data reflecting the influence or organic sources and chemical fertilizer applied to the soil during last two crops on soil pH under rice-wheat cropping system are presented in Table-2. The results indicated that the minimum soil pH (8.30) was recorded under the dhaincha (GM) + 100% NPK treatment combination in the post-harvest soil of rice. While, the residual impact of FYM + 100% NPK treatment combination decreased the soil pH to 8.20 in post-harvest soil of wheat which clearly revealed that the decline pH by 0.3 unit from initial soil pH 8.50 to 8.20 in dhaincha (GM) or FYM with 100% NPK treatment combination was due to the removal of basic cations like, Ca, Mg and production of organic acids during decomposition of incorporated green manures, FYM and straw (Pattanayak *et. al*. 2001).

Electrical conductivity : The perusal of data (Table-3) of electrical conductivity in rice-wheat cropping system clearly demonstrated that impact of inorganic as well as organic sources in these crops were found statistically non-significant. Chaudhary *et al.* 91981) and Rokima (1985) also observed that very small changes or practically no influence on soil EC were found even after the continuous manuring and fertilization under rice-wheat cropping systems.

Organic carbon : Organic carbon content of the soil after rice-wheat sequence was significantly influenced by different nutrient management practices. Organic carbon content of surface soil (Table-4) increased significantly in both rice and wheat post-harvest soil. The conjoint application of organic and inorganic sources increased the organic carbon content from 0.447 to 0.610 per cent in rice and 0.430 to 0.593 per cent in wheat post-harvest soils. Highest buildup of organic carbon content (0.593%) was seen in of straw + 100 NPK treatment combination which followed by FYM (0.57%), dhaincha (0.55%), urd (0.547%) and weedy fallow (0.470%) and weedy fallow (0.40%) with 100% NPK treatment combination. The increase inorganic carbon content maybe attributed to the decomposition of organics and possibly due to the incorporation of larger root biomass in the soil because of better root growth. Sharma and Mitra (1991) also and their favorable residual effects on succeeding crop in rice-based cropping system.

Available nitrogen : Available nitrogen content of surface soil varied significantly with application of dhaincha (GM), urd (GL), FYM and straw in combination with fertilizer over control. The highest available nitrogen in surface soil (230.07 and 237.78 kg/ha) was recorded with incorporation of dhaincha (GM) in rice and FYM in wheat along with 100% NPK fertilizer after harvest of rice and wheat crops, respectively. Increase in available nitrogen with dhaincha (GM, FYM and urd (GL0 may be due to the direct addition of nitrogen through mineralization of GM, FYM and GL to the available pool of the soil.

During mineralization, decomposition of organic matter is accompanied by the release of appreciable quantities of CO_2. When CO_2 dissolved in water forms carbonic acids which is capable of weathering certain primary minerals. Similarly, the increase in available N due to application of organic materials again might be also attributed to the greater multiplication of microbes caused by the addition of organic materials for the conversion of organically bound N to inorganic from. Thus, the favorable soil condition under dhaincha (GM), FYM and urd (GL) addition might have helped in the mineralization of soil N leading to build up higher available N. Similar results were also reported by Gupta *et al.* (2000).

Available phosphorus : Incorporation of dhaincha (GM), FYM, urd (GL) and straw in combination with chemical fertilizer recorded significantly higher phosphorus content after harvest of rice soil as also shown by the results which indicated that available P content of soil increased significantly with dhaincha (GM), FYM and urd (GL) over straw and weedy fallow treatment in post harvested rice soils were found in the order:

FYM > dhaincha (GM)> Urd = Straw > Weedy fallow

The increased available P content of soil might be due to release of organic acids during decomposition of organics which in turn helped in releasing phosphorus. These results were in close conformity with the findings of Acharya *et al.* (1988). Badanur *et al.* (1990). Increase in available P with different organic manures application also be due to solubilization of the native P in the soil through release of various organic acids where increase in latule P occurs due to composition of cations like Ca^{2+} and Mg^{2+} when it is applied with inorganic fertilizers. The decomposition of organic matter is accompanied by the release of appreciable quantities of CO_2. It has been observed in calcareous soil that CO_2 production plays an important role in increasing the phosphate availability. The organic materials form a protective cover on Sequa oxide and this reduces the phosphate fixing capacity of the soil (Tandon, 1987).

Available Potassium : The available K content of rice and wheat post-harvest soil varied significantly from 86.52 to 114.07 kg/ha and 80.36 to 124.0 kg. ha respectively due to various levels of organics and inorganics combinations. Dhaincha (GM), FYM, urd (GL) and straw along with fertilizers recorded significantly higher amount of available K. the residual effect or organic sources on available K of wheat post-harvest soil were found in the order: FYM> straw > dhaincha (GM) > urd (GL)> weedy fallow. Increase unavailable potassium due to different organic manures like, dhaincha (GM) FYM, Urd (GL), straw application might be due to the direct addition of potassium to the available pool of the soil. The beneficial effect of different organic sources on the available K content may be ascribed to the reduction of fixation and release of K due to interaction of organic matter with clay besides the direct K addition to the available K pool of the soil. Similar results were found be many workers (Bharadwaj and Omanwar 1994). Thus, it may be concluded that integrations of chemical fertilizers with organic sources sustains not only the productivity of kharif rice and rabi wheat system but also the fertility of a soil.

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