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EFFECT OF ORGANIC SOURCES AND CHEMICAL FERTILIZERS ON YIELD AND FORMS OF NITROGEN IN CALCIORTHENTS UNDER RICE-WHEAT CROPPING SYSTEM

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ABSTRACT

The present investigation was undertaken to assess the impact of conjoint use of organic and chemical fertilizers on nutrient content in rice crop and on different forms of inorganic-N (NO_3^- and NH_4^-) as well as total-N content in post-harvest soil of rice under rice-wheat cropping system. A field experiment was conducted during 1999-2000 (kharif) at North Chhaunia Farm of Rajendra Agricultural University, Bihar, Pusa (Samastipur). The treatments comprised of five organics *viz*., dhaincha. (GM), urd (GL), FYM, straw and weedy fallow with five levels of fertility *i.e.,* control, 50% PK, 50% NPK, 100% PK and 100% NPK of recommended doses of fertilizers for rice crop. The results indicated that organic and inorganic nutrient sources when applied alone or in combinations increased the nutrient content in rice crop as well inorganic-N (NO_3^- and NH_4^-) and total-N content in post-harvest soil of rice as compared to weedy fallow and unfertilized control treatments. Green manuring by dhaincha increased the nutrient content at its maximum level in rice crop which was followed by FYM, urd (GL) and straw at all the levels of chemical fertilizers. Superiority of different organic sources with respect to inorganic forms (NO_3^- and NH_4^+) of N were observed as follows: GM > GL > FYM > Straw > Weedy fallow. However, total-N content was found maximum as 0.0603% with FYM + 100% NPK treatment combination. This trend was followed by GM, GL, Straw and Weedy fallow, respectively.

Key words : Organic sources, nutrient content, forms of N, rice-wheat system.

Studies conducted in India has conclusively indicated that neither inorganic nor organic manures alone were conducive to crop productivity and soil health but their integrated use may be helpful in sustaining the productivity of soil and crop yield under intensive cropping system practicing regions.

In addition, the chemical fertilizers are becoming expensive over the years. Therefore, the importance of organic manures such as dhaincha green manuring, urd green legume, farm yard manure, straw is gaining prominence. Soil changes are associated with the application of organic manures (Katyal *et al.,* 2002).

Rice-wheat cropping system is one of the most important cropping systems in India. However, it is general observation that wheat yield is low in post rice soils in comparison to post upland crops. Among different reasons of low yield of wheat, unfavourable chemical environment created by cyclic oxidation-reduction of soils, seems to be an important one. Under such situation organic matter seems to be a key factor in improving overall productivity of this cropping system. The addition of organic manures along with chemical fertilizer is known to stimulate mineralization and immobilization, thereby affecting the Jevels of different inorganic (NO_3^- and NH_4^+) and total-N fractions in the soil.

In the study of soil nutrient crop inter relationship, it is imperative to identify the forms of N like NO_3^-, NH_4^+ -N and total-N contributing towards availability of nitrogen for rice crop under a particular set of soil and environmental conditions. Fertilizers-N management in soil amended with different organic sources are governed by N transformations following application of organic and inorganic. materials. The present investigation was undertaken to study the integrated effect of organics and chemical fertilizers on nutrient contents of rice and wheat crop, as well as forms the NO_3^-, NH_4^- and total-N contents of the post-harvest soil of rice crop (Vipin, 2003).

MATERIALS AND METHODS

A field experiment was conducted at the University Farm, Pusa, Bihar in kharif of 1999-2000 on Chawania Sandy Loam Soil. The soil (0-15cm) had the following characteristics i.e., pH 8.5, organic carbon (OC) 0.51%, EC 0.30 dSm^{-1}, available N (alkaline $KMnO_4$) 200.32 kg ha^{-1}, Olsen P 14.46 kg ha^{-1}, 1N NH_4OAC K 96.18 kg

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

Inorganic fertilizer level	N-content (%) rice grain						N-content (%) rice straw					
	Organic sources						Organic sources					
	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean	Dhainch a (GM)	Urd (GL)	FYM	Stra w	Weedy fallow	Mean
Control	0.953	0.910	0.980	0.900	0.880	0.924	0.630	0.590	0.600	0.556	0.480	0.571
50% PK	0.930	0.870	0.990	0.906	0.873	0.913	0.630	0.600	0.610	0.556	0.516	0.582
50% NPK	1.150	1.103	1.120	1.063	1.013	1.090	0.633	0.610	0.630	0.586	0.530	0.598
100% PK	0.913	0.893	0.903	0.916	0.866	0.898	0.600	0.592	0.610	0.520	0.456	0.555
100% PK	1250	1.180	1.170	1.100	1.050	1.150	0.650	0.613	0.640	0.593	0.560	0.611
Mean	1.040	0.990	1.032	0.977	0.936		0.628	0.600	0.618	0.563	0.508	
Source		S.Em.±		CD at 5%			S.Em.±		CD at 5%			
Organic manures (M)		0.013		0.041			0.006		0.0021			
Inorganic fertilizers (S)		0.012		0.033			0.006		0.019			
Interaction (M×S)		0.026		NS			0.015		NS			

Table-2 : Influence of organic and inorganic fertilizer on phosphorus content of rice crop in rice-wheat cropping system.

Inorganic fertilizer level	P-uptake (%) of rice grain						P-uptake (%) of rice straw					
	Organic sources						Organic sources					
	Dhain cha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean	Dhainc ha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean
Control	0.196	0.193	0.193	0.186	0.170	0.188	0.100	0.093	0.096	0.086	0.086	0.092
50% PK	0.203	0.198	0.200	0.189	0.173	0.193	0.106	0.100	0.106	0.093	0.090	0.099
50% NPK	0.222	0.210	0.220	0.200	0.190	0.208	0.119	0.113	0.116	0.110	0.100	0.112
100% PK	0.230	0.213	0.223	0.190	0.185	0.214	0.126	0.116	0.126	0.113	0.106	0.117
100 % PK	0.243	0.223	0.236	0.210	0.206	0.224	0.133	0.123	0.130	0.116	0.112	0.123
Mean	0.218	0.207	0.214	0.195	0.185		0.117	0.109	0.115	0.104	0.099	
Source			S.Em.±		CD at 5%			S.Em.±		CD at 5%		
Organic manures (M)			0.004		0.015			0.0021		0.0067		
Inorganic fertilizers (S)			0.003		0.009			0.0016		0.0047		
Interaction (M×S)			0.008		NS			0.0039		NS		

ha^{-1} and total N as 0.0478%. The experiment was conducted in a split plot design with five sources of organics namely Dhaincha green manure (GM), Urd green legume (GL), Farm yard manure (FYM), Straw and Weedy fallow in the main treatment and five levels of chemical fertilizers namely, Control, 50% PK, 50% NPK, 100% PK and 100% NPK, respectively in sub-plot treatment. The treatments were replicated thrice. The recommended N, P_2O_5 and K_2O doses were 120, 60 and 40 kg/ha applied through urea, single super phosphate and muriate of potash, respectively, to each rice and wheat crop. Half of N and whole P and K were applied at the time of transplanting of rice and sowing of wheat and remaining half N was applied in two equal valves at tillering and flowering stages. The biomass yields of dhaincha (GM) and urd (GL) at 55 days old stage were recorded and incorporated into the soil before 15 days of transplanting whereas, FYM and straw were incorporated 30 days before transplanting. N, P and K contents in grain and straw of rice and wheat, dhaincha (GM), urd (GL), FYM, straw and weeds biomass were estimated (Jackson, 1973). Composite surface soil sample (0-15cm) from each plot were collected after rice crop in rice-wheat system.

Inorganic forms of N (Nitrate-N and Ammonical-N) and total-N were determined in post-harvest soils of rice crop. The nitrate-N in soil was estimated calorimetrically by phenol disulphonic acid method (Jackson, 1973). However, ammonical-N was estimated with acidified NaCl solution method. Whereas, total-N was determined by the modified kjeldahl method as described by Jackson (1973).

Nutrients Content in Rice Crop

Nitrogen content : The different treatments consisting

Table-3 : Influence of organic and inorganic sources on potassium content of rice in rice-wheat cropping system.

Inorganic fertilizer level	K-content (%) of rice grain						K-content (%) of rice straw					
	Organic sources						Organic sources					
	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean	Dhaincha (GM)	Urd (GL)	FYM	Straw	Weedy fallow	Mean
Control	0.276	0.253	0.270	0.263	0.240	0.261	1.430	1.240	1.410	1.320	1.220	1.324
50% PK	0.293	0.253	0.286	0.276	0.246	0.271	1.470	1.380	1.410	1.420	1.240	1.398
50% NPK	0.306	0.280	0.303	0.290	0.250	0.286	1.580	1.420	1.523	1.480	1.270	1.455
100% PK	0.320	0.286	0.313	0.313	0.253	0.297	1.690	1.500	1.640	1.550	1.370	1.550
50% NPK	0.323	0.313	0.320	0.319	0.263	0.308	1.830	1.600	1.790	1.630	1.410	1.652
Mean	0.304	0.277	0.298	0.292	0.250		1.600	1.428	1.568	1.480	1.302	
Source			S.Em.±		CD at 5%			S.Em.±		CD at 5%		
Organic manures (M)			0.005		0.017			0.029		0.094		
Inorganic fertilizers (S)			0.004		0.0013			0.021		0.061		
Interaction (M×S)			0.010		NS			0.051		NS		

Table-4 : Influence of organic and inorganic fertilizers on NH_4^+ - N content in post harvest soils rice after rice.

Inorganic fertilizer level	NH_4^+ - N(ppm) in post harvest soil of rice					
	Organic sources					
	Dhaincha (GM)	Urd (GL	FYM	Straw	Weedy fallow	Mean
Control	52.41	41.53	44.72	37.34	35.45	42.29
50% PK	54.53	44.62	47.79	38.62	35.67	44.25
50% NPK	57.83	54.56	56.33	51.87	45.32	53.18
100% PK	55.54	47.63	50.25	45.18	37.82	47.28
50% NPK	78.63	70.92	76.88	64.31	55.57	69.26
Mean	59.79	51.85	55.19	47.46	41.96	
Source	S.Em.±				CD at 5%	
Organic manures (M)	0.803				2.619	
Inorganic fertilizers (S)	0.723				2.066	
Interaction (M×S)	1.654				4.884	

of organic and inorganic nitrogen and their combinations were found to increase the N content in grain and straw over control (Table-1). Addition of dhaincha (GM), urd (GL), FYM and straw increased N-content in grain and straw of rice crop than weedy fallow treatment. Higher N content (1.250% and 0.640%) were recorded in the rice grain and straw, respectively, under dhaincha (GM) treatment. It was further observed that the N-content in rice grain and straw increased from 0.924% & 0.571% (control) to 1.090% & 0.998% and 1.150% & 0.611 due to 50% and 100% NPK treatments, respectively. However, integration of organics with inorganic fertilizers also increased the N content of rice grain and straw. It was recorded the highest value (1.250% & 0.650%) under dhaincha (GM) + 100% NPK treatment combinations. It might happen because of different organic sources attributed to slow and continuous supply of N throughout the crop growth (Gupta, 1998).

Phosphorus content : Addition of different organic sources increased P content IN rice grain and straw a from 0.1857% and 0.099% (weedy fallow) to 0. 195% & 104% 0.207% and 0.109% 0.214 % 0.115% and 0.218%. 0.117% due to straw, urd (GL), FYM and dhaincha (GM) treatments, respectively (Table-2). Incremental doses of chemical fertilizers further enhanced P content in rice grain and straw and found higher value (0.224% & 0.123%) with 100% NPK : treatments, whereas, the highest P content in rice grain and straw (0.243% 0.133%,respectively) were recorded under dhaincha (GM) + 100% NPK combinations. This may happen because of the release of organic acids during decomposition of different organic matter which increased availability of P in the root zone profile of the soil (Debnath and Hajra, 1972 and Nagrajan *et al.,* 1986).

Potassium content : K content in rice grain and straw ranged from 0.240 % to 0.323% and 1.220% 1.830% as influenced by different treatment combinations (Table-3). The effectiveness of different organic sources was found in the following order: GM > F YM > straw > GL > weedy fallow, while among the different levels of inorganic fertilizers, 100% NPK recorded higher K-content (0.308 and 1.652%) in rice grain as well as in straw which was followed by 100% PK, 50% NPK, 50% PK and control. Increase in K content with progressive increase in the supply of chemical fertilizers to crops was seen because of higher availability of these nutrients which ultimately resulted in higher content of nutrients (Santhy *et al.,* 1998).

Inorganic forms of nitrogen

Nitrate-N : A perusal of data in table indicated that NO_3^- - N in post-harvest rice soil varied from 15.37 to 24.02 mg kg^{-1} because of the integrated effect of different treatments combinations. The different organic sources exhibited the significant impact on the NO_3^-N content in the post-harvest soil after rice. The higher NO_3^- N (21.08 mg kg^{-1}), was recorded with dhaincha (GM) treatment which was followed by urd (GL), weedy fallow, FYM, and straw treatments, respectively. Similarly, increasing levels of chemical fertilizers also increased NO_3^- N content significantly over control in the following order : 100% NPK (21.18 mg kg^{-1}) > 50% NPK (18.69 mg kg^{-1}) = 100% PK (17.83 mg kg^{-1}) = 50% PK (17.54 mg kg^{-1}) = control (17.06 mg kg^{-1}). Thus, these results indicated that addition of dhaincha (GM), urd (GL) treatments consistently increased NO_3^-N content might be happened due to mineralization NO_3^-N by addition of tender leaves of green manure and green legume crop having lower C/N ratio. Addition of straw and FYM to soil, decreased NO_3^-N content in soil when compared with green manure and green legume incorporations. These results further inferred that the immobilization of NO_3^-N with straw and FYM incorporation might be due to higher C/N ratio of straw and FYM. A low buildup of NO_3^-N in soil even with higher dose of fertilizer application might be occurred because of easy NO_3^-N immobilization in presence of more organic matter, incomplete nitrification of applied fertilizer or loss of NO_3^-N due to gentrification and leaching under flooded reduced condition in rice soils. This view was in line with the observation made by Prasad and Rakima (1991).

Ammonical-N : A small and consistent increasing trend in NH_4^+-N fraction (Table-4) was observed in the following decreasing order: dhaincha (59.79 mg kg^{-1}) > FYM (55.19 mg kg^{-1}) > urd (51.85 mg kg^{-1}) > straw (47.46 mg kg^{-1}) > weedy fallow (41.46 mg kg^{-1}). Similarly, the application of chemical fertilizers also increased the NH,-N content which was recorded higher at 100% NPK level (69.26 mg kg^{-1}), followed by 50% NPK (53.18 mg kg^{-1}), 100% PK (47.28 mg kg^{-1}), 50% PK (44.25 mg kg^{-1}) and control (42.29 mg kg^{-1}). The interaction effects due to conjoint use of organics and inorganic on NH_4^+-N content of soil were also found significant and recorded the highest NH_4^- N content (78.63 mg kg^{-1}) under dhaincha (GM) + 100% NPK treatment combination. Application of these integrated treatments resulted in higher accumulation of organic matter. The subsequent decomposition and mineralization of the organic matter might have contribution in the accumulation of higher NH_4^+-N content over the other treatments (Basumatary and Talukdar, 1998).

Total-N content : Total-N content in post-harvest soil of rice significantly increased due to the impact of different organics (Table 4). The higher total-N (0.0525%) was recorded with FYM treatment followed by dhaincha (GM) (0.0515%), urd (0.0495%), straw (0.0488%) and weedy fallow (0.0460%) treatments. This significantly increased further due to application of various levels of chemical fertilizers in the following order: 100% NPK (0.0558%) > 50% NPK (0.0497%) = 100% PK (0.0481%) = 50% PK (0.0476%) = control (0.0471%). However, effectiveness of conjoint use of different organic sources with inorganic fertilizers on total-N content in post harvest soil of rice was recorded highest as 0.0603% when 100% NPK were used in, conjunction with FYM treatment. Purnanik *et al.* (1978) also observed that continuous application of FYM for more than 8 years increased the total-N content of the soil.

NO_3^-N : Addition of dhaincha green manuring and urd (GL) consistently increased NO_3^-N irrespective of FYM and straw treatments (Table 4). This might be due to mineralization of green manure and green legume having low C/N ratio. Soil NO_3^-N) in different treatments varied from 16.75 mg kg? in control + weedy fallow combination to 24.02 mg kg^{-1} in the treatment of 100% NPK + dhaincha (GM) combination. NO_3^-N increased with the application of increasing doses of chemical fertilizer alone, or in combination with GM and GL. As low build up of NO_3^-N in soil with FYM and straw incorporation or even with high dose of fertilizer application might be because of little nitrification under anaerobic conditions in submerged soil. Losses of NO_3^-N due to denitrification and leaching under flooded conditions in rice soils could be the other reasons of low

NO_3^-N buildup in soil. These results are in conformity with the findings of (Vipin, 2003).

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