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Status of organic carbon and total nitrogen under green manure and varying nitrogen levels in rice-wheat cropping system

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ABSTRACT

Significant increase in soil organic carbon and total nitrogen was observed by using bio-organic sources and bio-fertilizers in rice-wheat cropping system during the present investigations. It was observed that standard INM packages for paddy (N60 + GM + BGA) and wheat (N90 + *Azotobacter*) enhanced the paddy and wheat yield by 20 and 10 per cent respectively as compared to recommended doses (120 kg/ha) of chemical N. On an average most promising INM doses reflected positive nitrogen balance in soil after harvest of last rotation as +0.03 per cent organic carbon and +0.004 per cent total N with *Sesbania rostrata* as green manure and recommended dose N 120 kg/ha showed negative N balance as -0.02 per cent organic carbon and -0.001 per cent total N. In case of wheat *Azotobacter* with 90 kg N/ha gave sustainable nitrogen balance as +0.05 per cent organic carbon and +0.004 per cent total N as compared to recommended dose of N 120 kg/ha which showed negative nitrogen balance as -0.02 per cent organic carbon and -0.002 per cent total N. Application of biofertilizers and green manure alone or in combination with chemical N provided sustainable nitrogen balance after harvest of rice-wheat crop.

Keywords: Soil fertitlity; nitrogen; rice-wheat cropping system; INM

INTRODUCTION

Nitrogen nutrition most frequently limits the crop productivity. Chemical fertilizers being ecologically and economically expensive interest in exploitation of alternative or supplementary nitrogen sources have been renewed to encourage sustainable agriculture. Reducing the chemical nitrogen use while maintaining the native soil nitrogen resources and enhancing crop nitrogen output by biological nitrogen fixation systems is desirable from both environmental and economic perspectives. Green manuring by dhaincha is the most attractive and simplest alternative of organic nitrogen. This green manure provides roughly 40-80 kg N/ha sufficient to produce rice yield of 4-5 ton/ ha grains. The (blue green algae) BGA has been reported to enhance the seed yield through fixing the nitrogen from atmosphere (Dwivedi et al 2000). It also improves soil texture by addition of organic matter, vitamins and amino acids. *Azotobactor* increases crop yield primarily by fixing molecular nitrogen in soil but it is also reported to synthesize auxins, vitamins, growth substances and antifungal antibiotics which have beneficial effect of the inoculants on seed germination. The nutrient balance after harvest of crop mainly varies with the type of organic matter addition, sources of N fertilizers, soil organic carbon and total N contents. Therefore an attempt was made to study the variation on organic carbon, total N, available P_2O_5 and K_2O by the use of biological (BGA for paddy, *Azotobactor* for wheat), organic (dhaincha crop as green manure) and chemical N in rice-wheat crop rotation over two years and extracting nutrient balance after harvest of each crop.

MATERIAL and METHODS

The present investigations were conducted jointly at RATDC and KVK, Kotwa Farm, Azamgarh during 2007-08 and 2008-09 to evaluate the changes in soil chemical properties and their subsequent effect on rice-wheat cropping system. *Sesbania rostrata* was used as green manure and sown before paddy cultivation in the month of June at the seed rate of 75 kg/ha. Forty five days old *S rostrata* was ploughed in plots and was left for decomposition for one week. Twenty five days old seedlings of paddy var NDR-359 were transplanted after seven days of ploughing of green manure. Crop geometry was 20 x 15 cm. Soil based mixed BGA biofertilizers were inoculated in the plots after the seventh day of transplanting at the rate of 12.5 kg/ha under water logged condition. *Azotobactor/Azospirillum* was inoculated in wheat crop through seed treatment at the rate of 200 g culture per 15 kg of seed. Different levels of chemical N (urea 0, 30, 60, 90 and 120 kg/ha) were applied with or without green manure and biofertilizers. Phosphate was used as single super phosphate at the rate of 60 kg/ha while potash was used as muriate of potash at the rate of 40 kg/ha. Fifty per cent of total chemical N was applied at the time of transplanting of seedlings/sowing of seeds and 25 per cent at the time of flowering while recommended doses of P and K were used once at the time of transplanting/ sowing of seedlings/seeds. The per cent of organic carbon, available nitrogen, phosphorus and potash were analyzed thrice by using standard procedures and the data were subjected to statistical analysis.

RESULTS and DISCUSSION

Soil organic carbon and total N balance status with *Sesbania rostrata* as green manure in paddy

Soil organic carbon and total N were significantly influenced by the use of biofertilizer and green manure alone or in combination with chemical N. The effect of dhaincha (*S rostrata)* as green manure followed by BGA application proved to give best response in paddy than chemical fertilizers viz N 120 kg/ha and also induced sustainability. The increase was more pronounced after rice that declined after wheat crop. However it was more than the initial levels of the end of second year paddy harvest. The maximum increase in organic carbon and total N was observed in N60 + GM (dhaincha) + BGA treatment in paddy and N90 + AZB in wheat.

Wherever dhaincha was used as green manure (Table 1) the treatment N60 + GM + BGA yielded 0.03 per cent enhancement in organic carbon and 0.004 per cent enhancement in total N with 20 per cent higher grain yield of paddy as compared to treatment N 90 + BGA where only 0.01 per cent enhancement in organic carbon was recorded. It was interesting to note that the recommended chemical N dose (120 kg/ha) responded negative (by 0.001%) and organic carbon (by 0.02%) nitrogen and organic carbon balance (by 0.02% and 0.001% respectively) in paddy in 2007. Further same trend was found in repeated year 2008 as +0.07, -0.06, -0.01 per cent organic carbon and +0.001, 0.00 and 0.001 per cent in total N balance in the same respective treatments.

Soil organic carbon and total N balance status with *Azotobactor biofertilizer* in wheat

Azotobactor proved better for grain yield and nitrogen balance after harvest of wheat in comparison to chemical N doses. During 2007-08 at treatments N90 + AZB, 0.05 per cent enhancement in organic carbon and 0.004 per cent enhancement in total N as observed as compared to chemical fertilizer dose N 120 that responded in positive N balance with marginally higher grain yield of wheat while N120 alone showed negative organic carbon (0.04%) and total N balance (0.003%). In 2008-09, 0.04 per cent enhancement in organic carbon and 0.004 per cent enhancement in total N was observed in treatment N90 + AZB while N120 alone observed negative nutrient balance (0.01% in organic carbon and 0.001% in total N) while using dhaincha as green manure in previous paddy crop (Table 1). It was reflected that the BGA and AZB considerably improved organic carbon and total N after harvest of rice-wheat crop respectively. Perhaps increase in nutrient status was due to more mineralization and release of soil nutrients and/or due to left over residues of biofertilizers (Shinde 1981, Kanwar 1981). The findings that soil organic carbon and total N were positively influenced by the use of biofertilizers alone or in combination with chemical N are supported by the work of Mahapatra et al (1991).

Table 1. Effect of green manure (dhaincha) and biofertilizers on soil organic carbon and total nitrogen in rice-wheat cropping system

Treatment	Initial status 2007		After rice harvest 2007		After wheat harvest 2008		After rice harvest 2008		After wheat harvest 2009	
	OC	TN	OC	TN	OC	TN	OC	TN	OC	TN
N0	0.51	0.044	0.52	0.045	0.61	0.05	0.49	0.042	0.58	0.056
N30	0.5	0.043	0.53	0.044	0.62	0.05	0.63	0.055	0.64	0.058
N60	0.38	0.032	0.45	0.039	0.53	0.05	0.55	0.048	0.48	0.05
N90	0.45	0.038	0.53	0.046	0.5	0.04	0.57	0.049	0.46	0.052
N120	0.54	0.046	0.52	0.045	0.48	0.04	0.47	0.048	0.46	0.039
N0+GM/AZB	0.4	0.031	0.52	0.045	0.56	0.05	0.55	0.045	0.55	0.049
N30+GM/AZB	0.43	0.037	0.57	0.049	0.48	0.04	0.52	0.045	0.6	0.048
N60+GM/AZB	0.5	0.045	0.54	0.046	0.63	0.05	0.52	0.043	0.58	0.046
N90+GM/AZB	0.47	0.04	0.5	0.043	0.55	0.05	0.57	0.048	0.061	0.052
N120+GM/AZB	0.49	0.043	0.51	0.044	0.54	0.05	0.51	0.044	0.55	0.048
N0+BGA/AZB	0.48	0.041	0.5	0.041	0.54	0.05	0.46	0.039	0.49	0.044
N30+BGA/AZB	0.54	0.039	0.59	0.05	0.48	0.04	0.52	0.044	0.56	0.05
N60+BGA/AZB	0.44	0.038	0.55	0.047	0.55	0.05	0.58	0.05	0.61	0.054
N90+BGA/AZB	0.58	0.05	0.59	0.05	0.57	0.05	0.51	0.05	0.58	0.055
N120+BGA/AZB	0.45	0.039	0.54	0.046	0.72	0.05	0.56	0.043	0.56	0.046
N0+GM+BGA/AZB	0.45	0.038	0.6	0.052	0.47	0.04	0.5	0.048	0.54	0.058
N30+GM+BGA/AZB	0.54	0.046	0.62	0.053	0.47	0.04	0.6	0.043	0.62	0.064
N60+GM+BGA/AZB	0.44	0.037	0.47	0.041	0.61	0.05	0.54	0.047	0.51	0.055
N90+GM+BGA/AZB	0.38	0.032	0.7	0.06	0.54	0.05	0.56	0.048	0.6	0.064
N120+GM+BGA/AZB	0.42	0.036‘	0.63	0.045	0.55	0.05	0.64	0.055	0.65	0.066
$CD_{0.05}$	NS	NS	0.02	0.004	0.03	0.0005	0.02	0.004	0.05	0.009
pH range	7.0-8.0		7.7-8.0		7.5-7.8		7.5-7.8		7.5-7.8	
EC (ds/m) range	0.43-0.77		0.43-0.67		0.43 -0.77		0.43-0.70		0.40-48	

OC = organic carbon, TN = total nitrogen

Table 2: Effect of green manure and biofertilizers on grain yield and nutrient balance in rice-wheat

Treatment	Initial nutrient status				Grain yield	Nutrient balance			
	OC (%)	Total N (%)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)		OC (%)	Total N (%)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Paddy 2007									
N60 + GM + BGA	0.48	0.08	32.94	306.1	30.1	+0.02	0	+15.62	-144.6
N90 + BGA	5.2	0.07	29.32	321.1	22.8	-0.20	0	-15.92	-165.2
N120	0.59	0.08	20.58	317.3	22	-0.07	0	-4.75	-125.2
$CD_{0.05}$	-	-	-	-	1.7	-	-	-	-
Wheat 2007-08									
N90 + AZB	0.52	0.08	14.07	130.5	39.61	+0.03	0	-0.03	+94.3
N120	0.52	0.08	15.23	180.5	36.17	0	-0.02	-1.79	154.7
$CD_{0.05}$	-	-	-	-	1.44	-	-	-	-
Paddy 2008									
N60 + GM + BGA	0.56	0.07	14.63	186.9	28	+0.04	+0.002	+0.63	-28.23
N90 + BGA	0.56	0.07	15.83	225.1	23.8	+0.01	+0.001	+0.12	+28.77
N120	0.52	0.06	13.44	335.2	23.5	-0.02	0	+3.58	-179.33
$CD_{0.05}$	-	-	-	-	1.72	-	-	-	-
Wheat 2008-09									
N90 + AZB	0.51	0.06	15.44	152.13	35.68	+0.04	+0.003	+4.6	-0.93
N120	0.5	0.06	17.02	155.87	32.22	-0.02	-0.013	+1.02	+56.94
$CD_{0.05}$	-	-	-	-	1.6	-	-	-	-

CONCLUSION

It can be inferred that the fertility of the soil in relation to nitrogen in rice-wheat cropping system can be maintained by the use of green manure and biofertilizers sources of nitrogen along with chemical N that means that an integrated approach will help in maintaining nitrogen fertility of soil in a native way.

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