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Effect of green manuring on physico-chemical properties of soil and productivity of rice

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ABSTRACT

Studies on the the effect of green manuring with Dhaincha (Sesbania aculeata) and Sunnhemp (Crotalaria juncea) on physico-chemical properties of soil, nitrogen uptake and productivity of rice indicated that soil pH, organic carbon, available N, available P_2O_5, available K_2O and nitrogen uptake recorded before transplanting, at 20 transplanting and after harvest of rice were affected significantly due to methods of green manuring and nitrogen levels. Soil pH was significantly higher in summer fallow as compared to rest of the methods of green manuring. Organic carbon, available N, P_2O_5, K_2O and nitrogen uptake were higher in Sesbania green manuring at 60 days after sowing. which was at par with Crotalaria green manuring at 60 days after sowing. Summer fallow recorded significantly lowest indices of these physico-chemical properties of soil. Application of N beyond 75 kg ha^{-1} did not produce significant differences. Nitrogen uptake increased significantly with increase in nitrogen level from 0 to 150 kg ha^{-1}. The number of panicle m^{-2}, grains panicle^{-1}, 1000 grain weight, grain and straw yield of rice were significantly significantly higher under green manuring of Sesbania at 60 days after sowing followed by Crotalaria green manuring at 60 days after sowing.

Key words: *Green manure, Sesbania, crotalaria, soil property, rice productivity*

Green manuring plays a pivotal role in minimizing the ill effects of intensive rice-wheat cropping system. Role of green manuring in improving soil fertility and crop productivity is well established. Soil productivity is maintained when chemical fertilizers are used judiciously along with green manuring. Green manuring not only helps in augmenting the soil nutrient supply system but also improves the physical and chemical conditions of the soil. Incorporation of *Sesbania* (Dhaincha) and *Crotalaria* (Sunnhemp) could add about 60-80 kg N ha^{-1} and also increased the yield of rice and succeeding wheat crops (Kolar *et al.*, 1993, Bindra and Thakur, 1994). *Sesbania* and *Crotalaria* after decomposition increase the humus, available nitrogen content and lower C : N ratio (Bindra and Thakur, 1994). These green manures improve the soil structure, texture, aeration, permeability and also protect the soil from leaching of nutrients. Decomposed materials of *Sesbania* and *Crotalaria* also serve as chelating compound and help in increasing the availability of nutrients. Therefore, a study was undertaken to find out the effect of green manuring with *Sesbania* and *Crotalaria* on physico-chemical properties of soil and productivity of rice.

MATERIALS AND METHODS

A field experiment was conducted during the wet seasons of 2003 and 2004 at Faizabad in silty loam soil with 15 treatment combinations comprising 5 treatments of green manuring *viz*., green manuring with *Sesbania* incorporated at 45 DAS; green manuring with *Sesbania* incorporated at 60 DAS; green manuring with *Crotalaria* incorporated at 45 DAS; green manuring with *Crotalaria* incorporated at 60 DAS and summer fallow in main plot and 3 Nitrogen level viz. 0 kg, 75 kg and 150 kg ha^{-1} in sub plot in a split plot design with three replications. A fertilizer dose of 20 kg N and 40 kg P_2O_5 ha^{-1} was applied through Urea and SSP as basal in green manured plots. Seeds of *Sesbania* (Cv ND-Ses-4) and *Crotalaria* (ND-Crota-1) were sown in 43 cm apart rows. Remaining plots were left fallow throughout the growing period of *Sesbania* and *Crotalaria*. The green manure crops were irrigated as and when needed *Sesbania* and *Crotalaria* crops were incorporated in the field at 45 and 60 DAS and was

allowed for proper decomposition for 15 days. 30 days old seedlings of rice Sarjoo-52 were transplanted with 3-seedlings hill^{-1} at 20 x 10 cm spacing. Nitrogen was given as per treatment along with 60 kg P_2O_5 and 40 kg K_2O ha^{-1} in rice. Chemical analyses were done as per standard procedure.

RESULTS AND DISCUSSION

Significantly higher reduction in soil pH was recorded at 20 DAT of rice due to incorporation of *Sesbania* at 45 and 60 DAS (Table 1). Maximum soil pH was recorded in summer fallow (8.86). The sap of *Sesbania* leaves having pH value of 4.0 exerted a marked influence in neutralizing the high pH of alkali soil. However, application of chemical nitrogen fertilizer had no significant effect on soil pH. Organic carbon content at 20 DAT was higher (0.45%) with S*esbania* green manuring (GM) at 60 DAS and the minimum was recorded in summer fallow (0.32 %). Increase in organic matter content could be due to addition of green manure and interaction between manure and nitrogen levels at different stages of plant growth (Kolar *et al.,* 1993 and Singh *et al.,* 1994) also reported similar results. Incorporation of *Sesbania* at different stages increased the N, P_2O_5 and K_2O availability more than *Crotalaria*. Incorporation of *Sesbania* (GM) at 45 and 60 DAS recorded significantly higher nutrient availability over green manuring by *Crotalaria* at 45 DAS and summer fallow (Table 1).

Increase in nitrogen level increased the organic carbon, available N, P_2O_{-5} and K_2O content significantly. Similar finding were also reported by Yaduvansi, 2003 and Gill *et al.,* 1994. Higher P_2O_{-5} availability was due to mineralization of nutrients in soil and solublization of inorganic compound of soil through increased microbial population (Zoysa *et al.,* 1990). The extensive root system of green manure crops improved the physical condition of the soil and liberated CO_2 and organic acids which help in dissolving native potassium in soil and ithus ncreasing the availability of potassium (Swarup, 1991, Dudhan *et al.,* 2004). Incorporation of *Sesbania* GM at 60 DAS recorded significantly higher N uptake (184.5 ha^{-1}) as compared to green manuring of *Sesbania* at 45 DAS (166.5 kg ha^{-1}) and summer fallow (125.99 kg ha^{-1}). The application of 150 kg N ha^{-1} recorded higher nitrogen uptake (135.47 kg ha^{-1}) which was at par with the application of 75 kg N ha^{-1} (Table 2). The increased uptake of nitrogen might be due to mineralization of N added by green manure crops and its rapid decomposition after incorporation of green manure crops (Pandey, 2003; Mahapatra and Sharma, 1996 and Mahapatra and Sharma, 2003).

Table 1. Comparative performance of green manuring of *Sesbania, Crotalaria* and Nitrogen levels on soil pH, organic carbon and available N at different stages of rice (pooled data for 2003 and 2004)

Treatments	Soil pH			Organic carbon (%)			Available N (kg ha^{1})		
	Before transplanting	20 DAT	After harvest	Before transplanting	20 DAT	After harvest	Before transplanting	20 DAT	After harvest
Methods of green manuring									
45 DAS *Sesbania*	9.08	8.32	8.72	0.35	0.38	0.36	123.26	166.51	124.03
60 DAS *Sesbania*	9.06	8.30	8.80	0.41	0.45	0.42	143.51	184.52	144.78
45 DAS *Crotalaria*	9.12	8.42	8.80	0.34	0.36	0.35	120.48	166.11	123.28
60 DAS *Crotalaria*	9.07	8.33	8.71	0.41	0.43	0.41	141.36	183.16	141.96
Summer fallow	9.19	8.86	9.12	0.32	0.32	0.33	112.47	125.99	113.27
SEm ±	0.026	0.105	0.181	0.002	0.002	0.003	3.2013	3.495	2.875
CD (P=0.05)	0.085	0.343	0.265	0.009	0.008	0.010	10.440	11.400	9.376
Nitrogen levels									
0 kg ha^{-1}	9.09	8.44	8.79	0.35	0.36	0.35	121.44	149.97	123.05
75 kg ha^{-1}	9.09	8.45	8.85	0.37	0.38	0.38	129.99	171.18	131.27
150 kg ha^{-1}	9.13	8.45	8.85	0.38	0.39	0.39	133.22	174.62	134.08
SEm ±	0.029	0.058	0.037	0.004	0.004	0.003	3.091	2.371	3.461
CD (P=0.05)	0.087	0.173	0.110	0.012	0.010	0.011	9.119	6.995	10.210

DAS = Days after sowing, DAT= Days after transplanting

Significantly, higher number of grains panicle^{-1} (210.6) and 1000 grain weight (25.0 g) were recorded with *Sesbania* GM at 60 DAS followed by *Sesbania* GM at 45 DAS (Table 3). *Sesbania* GM proved to be better than *Crotalaria* as it produced both higher biomass and higher number of root nodules which tend to fasten decomposition and ultimately more nitrogen favoured which increased the yield attributes. Application of nitrogen at 150 kg N ha^{-1} significantly increased the number of panicle, grains panicle-^{1} and 1000 grain weight. The highest grain yield (4.38 t ha^{-1}) was obtained with *Sesbania* GM at 60 DAS but it was at par with *Crotalaria* GM at 60 DAS (4.24 t ha^{-1}). Straw yield also followed similar trend (5.38 t ha^{-1}). Pandey (2003) also reported that higher biomass and root nodules production in green manuring crop at 60 DAS, helped more N fixation, increase in humus content and narrow down the C:N ratio and increased the uptake

Table 2. Comparative performance of green manuring of *Sesbania, Crotalaria* and Nitrogen levels on available P_2O_5 (kg ha^{-1}), K_2O (kg ha^{-1}) and Nitrogen uptake (kg ha^{-1}) at different stages of rice (pooled data for 2003 and 2004).

Treatments	Available P_2O_5 (kg ha^{-1})			Available K_2O (kg ha^{-1})			Nitrogen uptake (kg ha^{-1})
Methods of green manuring							
45 DAS *Sesbania*	27.58	30.84	28.31	157.40	166.43	145.96	166.51
60 DAS *Sesbania*	32.57	36.18	33.04	148.33	163.33	141.60	184.51
45 DAS *Crotalaria*	26.63	29.97	27.64	142.29	154.28	131.63	166.11
60 DAS *Crotalaria*	31.00	33.65	31.94	143.58	157.62	132.83	183.16
Summer fallow	22.17	22.36	23.01	151.11	161.13	140.17	125.99
SEm ±	0.699	0.599	0.708	2.905	1.746	2.28	3.49
CD (P=0.05)	2.282	1.954	2.310	9.474	5.690	7.44	11.40
Nitrogen levels							
0 kg ha^{-1}	25.01	27.55	25.61	147.71	159.40	136.89	112.15
75 kg ha^{-1}	28.90	31.65	29.90	148.30	160.04	137.27	130.34
150 kg ha^{-1}	30.06	32.59	30.85	149.62	162.21	141.12	135.47
SEm ±	0.695	0.773	0.699	4.280	4.68	3.669	2.371
CD (P=0.05)	2.051	2.282	2.063	12.626	13.81	10.82	6.99

DAS= Days after sowing

Table 3. Comparative performance of green manuring of *Sesbania, Crotalaria* and Nitrogen levels on yield attributes and yield of rice (pooled data for 2003 and 2004).

Treatments	Panicles m^{-2}	No. of grains panicle^{-1}	1000 grain weight (g)	Yield (t ha^{-1})	
				Grain	Straw
Methods of green manuring					
45 DAS *Sesbania*	637.5	198.56	24.30	4.08	5.12
60 DAS *Sesbania*	728.0	210.67	25.03	4.38	5.38
45 DAS *Crotalaria*	568.0	193.67	22.90	3.97	4.88
60 DAS *Crotalaria*	670.0	206.33	24.20	4.24	5.23
Summer fallow	528.5	190.00	22.60	3.81	4.69
Sem ±	10.0	3.10	0.36	0.028	0.026
CD (P=0.05)	32.5	10.12	1.20	0.085	0.079
Nitrogen levels					
0 kg ha^{-1}	536.0	186.47	22.56	3.78	4.65
75 kg ha^{-1}	657.0	204.33	24.20	4.19	5.15
150 kg ha^{-1}	687.5	208.73	24.60	4.32	5.32
Sem ±	15.5	5.13	0.60	0.099	0.033
CD (P=0.05)	46.0	15.15	1.79	0.293	0.112

DAS= Days after sowing

of nitrogen.

Conclusively, organic carbon, available N, P_2O_5 and K_2O, nitrogen uptake and yield of rice were higher in *Sesbania* green manuring at 60 days after sowing followed by *Crotalaria* green manuring at 60 days after sowing. Summer fallow recorded lowest indices of physico-chemical properties of soil, nitrogen uptake and yield of rice. Increase in nitrogen level from 0 to 150 kg ha^{-1} significantly increased the soil pH, organic carbon, available N, P_2O_5, and K_2O. However, application of N beyond 75 kg ha^{-1} did not produce significant differences. Nitrogen uptake, yield attributes and yield of rice increased significantly with increase in nitrogen level from 0 to 150 kg ha^{-1}.

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