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Effect of organics and inorganic fertility levels on productivity of rice (*Oryza sativa*) crop

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) season of 1995 and 1996 at Pusa, Bihar, to study the effect of organics and inorganic fertility levels on the productivity of rice (*Oryza sativa* L.) crop. Green-manuring with prickly sesban or *dhaincha* [*Sesbania cannabina* (Retz.) Pers.] gave significantly higher grain yield (47.70 and 40.40 q/ha), followed by biogas-slurry (37.16 and 39.30 q/ha) in 1995 and 1996 respectively over no organic manure (33.90 and 34.40 q/ha) and rice-straw incorporation (34.74 and 35.64 q/ha). Optimum fertility level (100, 60 and 40 kg/ha of N,P, and K) recorded significantly higher grain yield (43.25 and 44.38 q/ha) than lower doses (75% NPK and 50% NPK) in both the years. In the second year, the interaction between organics and inorganics was found significant and saved 50 and 25% NPK in *Sesbania cannabina* green-manure and biogas-slurry treatments respectively. Significantly higher NPK and protein contents were recorded with application of *dhaincha* green-manure and biogas-slurry application, while due to inorganic fertility it was unaffected. Total nutrient uptake (NPK kg/ha) was significantly influenced with *dhaincha* green-manure, biogas-slurry and higher fertility application in both the years.

Key words : Rice, Organic manures. Inorganic fertility levels, Rice yield, Nutrient content, Nutrient uptake.

Sustainability in production of rice can be assured through integration of organics and inorganics (Modgal *et al.*, 1995). Because of existence of such problems in North Indian condition, this study was conducted to determine the effect of organic manures with levels of inorganic fertilizers on rice crop productivity in agroclimatic zone I of North Bihar.

MATERIALS AND METHODS

The present experiment was conducted during rainy season of 1995 and 1996 at Pusa, Samastipur (Bihar). The soil was silty-clay loam, (Calciorthent soil), medium in organic carbon (0.56%), low in available N (242.63 kg/ha), medium in available P (24.62 kg/ha) and available K (114.6 kg/ha), and alkaline in nature (pH 8.5).

Treatments consisting of 4 organic manures, viz. no organic manures, *dhaincha* @ 14 tonnes/ha green biomass (60, 10.5 and 52 kg N,P, and K/ha), biogas-slurry @ 10 tonnes/ha (80, 31.5 and 97 kg N, P and K kg/ha) and rice straw @ 5 tonnes/ha + 2% urea (20, 5.25 and 61.5 kg N, P and K /ha) and 3 levels of fertilizers (50, 30 and 20; 75, 45 and 30; and 100, 60 and 40 kg N,P, and K/ha) were tried in randomized block design with 3 replications. Seeds of *dhaincha* green manure, biogas-slurry and rice straw were mixed in soil before 50 days of rice transplanting. Green biomass of *dhaincha* was burried *in situ* during the final field preparation. Half of N, whole P and K were applied at the time of puddling. Rest half N was applied in 2 equal splits, one-fourth at maximum tillering stage and one-fourth at panicle-initiation stage. The 'Sujata' ('IR 36' × 'Ramadja') rice variety was used for the experimental purpose (50 kg seed/ha) and transplanted at 15 cm × 15 cm distance using 2–3 seedlings/hill in mid-July. A thin layer of water (2–3 cm) was maintained during the initial stage of seedlings establishment. Thereafter the water was raised to 5 cm and attempts were made to maintain this level up to milk dough stage. Weeds were removed at 20 and 40 days after transplanting (DAT). Nitrogen, phosphorus and potassium contents in plant materials were determined by micro-Kjeldahl, vanadomolybdate yellow colour, flame photometer methods, respectively (Jackson, 1973). The per cent content of NPK were then multiplied by the total biomass produced for estimation of total nutrients uptake (kg/ha).

RESULTS AND DISCUSSION

Yield-contributing characters

Prickly sesban or *dhaincha* green manure recorded significantly higher number of panicles/m^2 than the other manurial treatments. Treatment of biogas-slurry also resulted significantly higher number of panicles than no organic manures and rice straw treatments. Likewise, the 100% fertility level recorded higher number of panicles/m^2 over the lower levels. The greater survival of tillers under these treatments could be other owing to continuous but controlled supply of nutrients throughout the crop growth period (Chaudhary and Thakuria, 1996). The panicle length was significantly influenced due to only green-manuring but fertility levels and other organic manures could not influence the length of panicle. Ear length is a stable character. The green-manure treatment resulted in the priming effect and made the fixed soil nutrients in available and thus resulted significantly more length of panicles (De Datta and Surjeet, 1981). An application of prickly sesban green-manure, biogas-slurry and 100, 60 and 40 kg N,P and K/ha recorded significantly more filled grains/panicle. There was no significant effect of organics and inorganics on the unfilled (sterile) grain of rice. The 1,000-grain weight was not influenced significantly due to different treatments (Table 1). In fact, 1,000-grain weight is a stable varietal character because the grain size is rigidly controlled by hull. Hence the grains cannot grow to a size greater than that permitted by the hull despite the favourable weather conditions and abundant nutrient supply (Yoshida, 1981).

Table 1. Yield-contributing characters of rice as influenced by different organic manures and inorganic fertilizers

Treatment	Panicles/ m^2		Panicle length (cm)		Filled grains/ panicle		Unifilled grains/panicle		Weight/ panicle (g)		1,000-grain weight (g)	
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
Organic manure												
No organic manures	205.50	208.60	21.03	21.27	86.62	88.18	19.00	20.14	2.0	2.0	22.43	22.72
Prickly sesban	248.64	250.40	23.60	23.74	98.10	103.10	20.80	21.88	2.3	2.3	23.10	23.40
Biogas slurry	225.80	228.00	22.60	22.87	90.78	91.28	19.44	20.44	2.1	2.1	22.60	23.00
Rice straw	210.70	212.30	22.04	22.30	88.04	88.96	20.00	20.10	2.0	2.0	22.50	22.80
CD (P = 0.05)	11.50	12.24	1.56	1.48	6.92	7.36	NS	NS	0.18	0.18	NS	NS
Fertility level (N : P : K kg/ha)												
50 : 30 : 20	195.40	198.64	21.00	21.80	83.90	85.10	19.28	20.23	2.0	2.0	22.26	22.56
75 : 45 : 30	220.70	222.80	21.86	22.60	90.78	94.88	19.50	20.25	2.0	2.0	22.65	22.95
100 : 60 : 40	238.50	240.60	22.98	23.00	96.80	101.00	20.80	21.48	2.2	2.2	22.95	23.25
CD (P = 0.05)	10.00	10.60	NS	NS	6.10	6.36	NS	NS	0.16	0.16	NS	NS

Total biomass and nutrients supplied by organic manures are given in Materials and Methods

Yield

Green-manuring increased the yield of rice over the recommended practice of applying nutrients (Table 2). This increase over only inorganic nutrients (100 : 60 : 40 N:P:K kg/ha) application was 13.80 and 14.00 q/ha in 1995 and 1996 respectively. The biogas-slurry treatment also recorded higher grain yield which was significantly lower than that obtained with green-manure but higher than only inorganic application and rice straw incorporation. Increase in yield due to application of green-manure and biogas-slurry might be due to addition of extra nutrients (60 : 10.50 : 52 and 80 : 31.50 : 97 N:P:K kg/ha respectively). Application of green-manure and biogas-slurry also exploits the fixed nutrients of soil in available form and regulates its supply to the crop through mineralization and prevents them from leaching and other losses (Hegde and Dwivedi, 1992; Verma *et al.*, 1995; Singh *et al.*, 1996). Application of rice straw could not show any significant influence on the rice yield. It was due to immobilization of N with high C : N ratio

Table 2. Effect of organic manures and inorganic fertilizers on the yield of rice crop (q/ha)

Treatment	Grain yield		Straw yield		Harvest index (%)	
	1995	1996	1995	1996	1995	1996
Organic manure						
No organic manures	33.90	34.40	54.17	54.80	38.0	38.0
Prickly sesban	47.70	48.40	64.30	66.00	43.0	43.0
Biogas slurry	37.16	39.30	57.20	57.55	40.0	40.0
Rice straw	34.74	35.64	54.60	54.96	39.0	40.0
CD (P = 0.05)	1.71	1.60	3.7	2.3	2.00	2.0
Fertility level (N:P:K kg/ha)						
50 : 30 : 20	31.77	32.78	48.00	49.00	40.0	40.0
75 : 45 : 30	40.12	41.15	58.40	58.90	40.0	40.0
100 : 60 : 40	43.25	44.38	64.67	66.00	40.0	41.0
CD (P = 0.05)	1.48	1.40	3.20	1.96	NS	NS

Total biomass and nutrients supplied by organic manures are given in Materials and Methods

Table 3. Effect of M × F interaction on grain yield (q/ha) of rice, 1996

Treatment	Fertility levels (N:P:K kg/ha)			
	50 : 30 : 20	75 : 45 : 30	100 : 60 : 40	Mean
Organic manure				
No organic manures	29.00	35.47	38.73	34.40
Prickly sesban	39.50	51.20	54.40	48.40
Biogas slurry	32.80	40.60	44.50	39.30
Rice straw	29.80	37.33	39.80	35.64
Mean	32.78	41.15	44.38	
CD (P = 0.05)		2.80		

Total biomass and nutrients supplied by organic manures are given in Materials and Methods

Table 4. NPK (%) and protein content (%) in grains and NPK content in straw of rice crop as influenced by the different organics and inorganics treatment

Treatment	1995							1996						
	Grain				Straw			Grain				Straw		
	N	P	K	Protein	N	P	K	N	P	K	Protein	N	P	K
Organic manure														
No organic manures	1.36	0.43	0.34	8.50	0.42	0.05	1.32	1.37	0.43	0.35	8.6	0.43	0.05	1.33
Prickly sesban	1.42	0.54	0.46	8.90	0.52	0.07	1.50	1.43	0.54	0.48	9.0	0.53	0.08	1.52
Biogas-slurry	1.38	0.50	0.40	8.60	0.44	0.05	1.45	1.38	0.50	0.40	8.8	0.45	0.06	1.45
Rice straw	1.36	0.45	0.40	8.50	0.44	0.05	1.37	1.36	0.45	0.40	8.5	0.44	0.05	1.38
CD (P=0.05)	0.02	0.03	0.03	0.060	0.02	0.008	0.01	0.02	0.02	0.03	0.08	0.02	0.006	0.01
Fertility level (N:P:K kg/ha)														
50 : 30 : 20	1.38	0.47	0.39	8.64	0.45	0.05	1.42	1.38	0.48	0.39	8.7	0.46	0.06	1.40
75 : 45 : 30	1.38	0.48	0.40	8.62	0.45	0.05	1.41	1.39	0.49	0.39	8.7	0.46	0.06	1.40
100 : 60 : 40	1.38	0.48	0.40	8.63	0.45	0.06	1.42	1.39	0.48	0.39	8.7	0.56	0.06	0.40
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Total biomass and nutrients supplied by organic manures are given in Materials and Methods

of rice straw. Effect of rice straw or any crop residue shows significant response when it is applied for long term (Khara, 1993).

Highest grain yield was recorded with the optimum fertility (100 % NPK) and was significantly superior to that obtained with lower levels.

The interaction effect of organic manures and fertility levels on grain yield indicated significant response during 1996 only. Green-manure in conjunction with 50% NPK recorded grain yield of rice at par with that obtained with optimum dose of NPK application (Table 3). Biogas-slurry with 75% also resulted at par grain to optimum dose of fertility. Thus by the application of *Sesbania* and biogas-slurry, the economy in NPK was noticed 50 and 25% respectively. The results confirm the findings of Hedge and Dwivedi (1992), Verma *et al.* (1995) and Singh *et al.* (1996), who also reported 50 and 25% saving of NPK with green-manure and farmyard manure respectively.

Similar trend in the yield of rice straw under different treatments was noticed as in the grain yield but interaction effect was found non-significant. Harvest index was significantly influenced only with green-manure treatment, whereas it remained unaffected by other organic and inorganic treatments. Kumar (1994) also reported similar results on harvest index of rice.

Nutrient content

Green-manure recorded significantly higher N, P and K contents in rice grain and straw by biogas-slurry, while no organic manure and rice-straw incorpo- ration showed significantly lower nutrients content. The fertility levels did not show significant influence on the nutrients contents in the grain and straw (Table 4). *Sesbania* being a fast-growing green-manure added higher green matter and hence the release of N, P and K could be more under this treatment. Application of

Table 5. Total nutrient uptake (kg/ha) by rice crop as affected by organic manures and inorganic fertilizers

Treatments	N		P		K	
	1995	1996	1995	1996	1995	1996
Organic manure						
No organic manures	66.20	67.20	16.50	16.88	71.00	73.00
Prickly sesban	98.60	99.72	27.30	27.63	116.00	118.00
Biogas-slurry	76.00	77.60	22.72	23.58	88.70	92.00
Rice straw	65.90	69.00	18.12	19.88	73.00	76.00
CD (P = 0.05)	3.68	3.90	1.45	1.24	3.37	3.86
Fertility level (N:P:K kg/ha)						
50 : 30 : 20	64.81	65.52	16.80	17.40	73.70	75.00
75 : 45 : 30	78.36	79.90	22.00	22.80	89.00	92.00
100 : 60 : 40	86.90	89.60	24.78	25.86	98.42	101.00
CD (P = 0.05)	3.70	3.37	1.26	1.07	2.92	3.33

Total biomass and nutrients supplied by organic manures are given in Materials and Methods

biogas-slurry as that of *Sesbania* acted similarly but at slower rate. Bindra and Thankur (1996) also reported similar results. Protein content in rice is mainly related to N content in grain and followed the trend of N content in grains with different treatments. Significantly higher protein content was obtained with green manure followed by other manurial treatments. Protein content increased slightly with increase in the fertility and noticed higher with 100% NPK which was recorded to be not significant.

Nutrient uptake

Green-manuring resulted significantly larger amount of total nutrient uptake than other organic manures (Table 5). The integrated use of biogas-slurry also recorded significantly higher total nutrient uptake than no organic and rice-straw incorporation treatments. The total nutrient uptake increased with increasing fertility levels due to production of higher amount of biomass. Optimum fertility level (100% NPK) recorded significantly higher nutrient uptake compared with lower rates of fertility levels. Furoc (1987) also reported similar finding with application of organic manures in rice crop.

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