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Integrated nutrient management in rice (*Oryza sativa*) – rice – cowpea (*Vigna unguiculata*) sequence under humid tropical Andaman Islands

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ABSTRACT

A field experiment was conducted during 1993–94, 1994–95 and 1995–96 to study the effects of integrated nutrient management in a rice (*Oryza sativa*) – rice – cowpea [*Vigna unguiculata* (L.) Walp.] sequence on crop productivity, soil fertility and economics. Combined use of 50% NPK + 50% poultry manure significantly increased the grain yield of first rice crop (74%) and second rice crop (79.8%) over the control. The effect of 50% NPK + 50% FYM and NPK dose alone was also comparable. Application of FYM and poultry manure alone or combined with 50% NPK had significant residual effect on the pod yield of cowpea. The pH and EC values did not change significantly. The highest increase in soil organic carbon (0.68%) was obtained from FYM application over initial value of 0.45%. The available N increased to 276 kg/ha under 50% NPK + 50% poultry manure treatment over initial value of 220 kg/ha. The application of poultry manure alone increased the available P (15 kg) and K (121 kg) over initial status, 11 and 112 kg/ha respectively. Highest net returns (Rs 23,083/ha) and benefit : cost ratio (1.67) were obtained from application of 50% NPK+ 50% poultry manure.

Key words : Integrated nutrient management, Rice–rice–cowpea sequence, Humid tropics

Rice– rice – cowpea crop sequence is one of the most profitable sequences in the humid tropical Andaman Islands (CARI, 1992). Nutrient management under such intensive cropping sequence to sustain the crop and soil productivity assumes greater importance, as the soil of these islands are nutritionally poor (Singh and Gajja, 1987). Increasing fertilizer prices and climatic constraints, i.e. heavy rainfall of over 3,000 mm per annum deter the resource poor island farmers from using the recommended levels of inorganic fertilizers. Hence it becomes imperative to judiciously utilize and integrate the locally available alternate sources of plant nutrition with inorganic ones. Information on these aspects is very much lacking under agroclimatic conditions of Andaman Islands. Therefore the present study was conducted to examine the effects of integrated nutrient management in rice–rice–cowpea sequence on crop productivity, soil fertility and economics.

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MATERIALS AND METHODS

The experiment was conducted in a fixed lay out at Bloomsdale Research Farm, CARI Port Blair, during 1993–94 to 1995–96. The soil was clay loam with pH 5.58, organic carbon 0.45%, available N 220 kg, P_2O_5 11 kg and K_2O 112 kg/ha. Eight treatments were laid out in 4 m x 2.5 m size net plots arranged in randomized block design with 4 replications. The treatments were: T_1, control (no fertilizer, no manure); T_2, N : P_2O_5 : K_2O @ 90 : 60 : 40 and 50 : 25 : 25 kg/ha for the first and second rice crops respectively (during 1993–94, a dose of 100 : 50 : 50, N : P_2O_5 : K_2O kg/ha was used in the second rice crop which was later reduced to 50 : 25 : 25 N : P_2O_5 : K_2O kg/ha); T_3, 100% N (T_2) through poultry manure (3.05% N); T_4, 50% NPK + 50% poultry manure; T_5, 100% N(T_2) through FYM (0.78%); T_6, 50% NPK + 50% FYM; T_7, 100% N (T_2) through *Gliricidia* leaf (2.94%); and T_8, 50% NPK + 50% *Gliricidia* leaf. The organic manures in both the rice crops were applied 15 days before transplanting. The inorganic fertilizers used were urea, single superphosphate and muriate of potash. Rice varieties 'Taichung-sen-yu' as first crop (May to September) and 'Mansarovar' as second crop (October to January) were transplanted at 15 cm x 10 cm and 20 cm x 10 cm respectively. After harvest of second rice, cowpea ('Pusa Komal') was sown at 30 cm x 10 cm spacing on residual soil fertility without any fertilizer application. The grain yield of rice was reported at 14% moisture and pod yield of cowpea was reported on fresh-weight basis. Soil samples (0–15 cm depth) collected after harvestof second rice in 1996 were analysed for available N ($KMnO_4$-N), P (Bray's P), K (NH_4OAC-K), organic carbon, pH and EC by standard procedures. The economic analysis of different treatments was done as per the prevailing prices of inputs used and crop produce. The total rainfall received during May–September, October–January and February–April were 231.8, 40.7 and 27.7 cm in 1993–94; 262.3, 20.4 and 6.1 cm in 1994–95; and 265.0, 93.6 and 9.1 cm in 1995–96 respectively.

RESULTS AND DISCUSSION

Growth and yield attributes of rice

The effect of organic manures alone (T_3, T_5 and T_7) on plant hight, panicles/m² and filled grains/panicle was similar (Table 1)

Table 1. Effect of manurial treatments on growth and yield attributes of rice in rice–rice–cowpea sequence (pooled mean of 3 years).

Treatments	First rice			Second rice		
	Plant height (cm)	Panicles/ m²	Filled grains/ panicle	Plant height (cm)	Panicles/ m²	Filled grains/ panicle
T_1	84.3	214	67	77.1	185	71
T_2	97.4	294	84	91.8	258	86
T_3	93.3	260	73	82.8	224	75
T_4	97.3	293	83	92.4	250	85
T_5	93.4	245	72	82.6	217	79
T_6	95.3	279	80	89.5	246	87
T_7	92.6	271	72	82.9	199	74
T_8	94.5	274	72	86.9	210	79
CD (P = 0.05)	2.8	25	9	1.9	17	8

Treatment details are given in Materials and Methods

among themselves and better than the control except for filled grains/panicle. Combined application of 50% NPK + 50% organic manure (T_4 and T_6) influenced the growth and yield attributes equally as NPK alone (T_2).

Grain and straw yield of rice

The grain and straw yields (Table 2) of both the rice crops obtained from combined application of 50% NPK + 50% poultry manure or FYM (T_4, T_6) were statistically comparable to the NPK dose alone (T_2). Application of organic manures alone (T_3, T_5 and T_7) gave equal rice yields among themselves. The highest increase in yield was obtained from combined use of 50% NPK + 50% poultry manure (74%). In second rice crop also, the treatment T_4 registered the highest increase in yield (79.8%) amongst the organic manure treatments. The overall improvement in growth and yield attributes due to the synergistic effects of combined use of NPK with organic manures was reflected in the increased grain yield. The results conform the findings of Raju *et al.* (1993).

Residual effect on cowpea pod yield

The differencesin pod yield due to various treatments applied in rice–rice were non-significant during the first year; however, from second year onwards the cumulative effect had significant influence on the pod yield. The pooled mean of 3 years revealed that treatments T_5, T_6, T_3, T_4 and T_8 (Table 3) resulted in significantly higher pod yield over the control. Gill and Meelu (1982) also reported significant residual effect of organic manure application in rice on succeeding crop.

Changes in soil fertility

The pH and EC values (Table 3) of the soil were not significantly influenced by the different treatments. The soil organic carbon increased by 51% under FYM application as compared to the initial value of 0.45%. The available N increased by 25% under T_4, available P (36%) and K (8%) under T_3. There was significant reduction in N, P and K status under control over initial values. The results corroboate the findings of Bhardwaj and Omanwar (1994).

Economics of rice–rice–cowpea sequence

The highest net returns (Rs 23,083/ha) and benefit : cost ratio (1.67) were obtained (Table 2) under treatment 50% NPK + 50% poultry manure (T_4), followed by treatment

Table 2. Effect of manurial treatments on yield of rice and economics of rice–rice–cowpea sequence (pooled mean of 3 years)

Treatments	Yield (q/ha)				Economics	
	First rice		Second rice		Net returns (Rs/ha)	Benefit : cost ratio
	Grain	Straw	Grain	Straw		
T_1	25.0	42.6	22.3	35.4	10,930	0.94
T_2	42.3	56.8	40.4	53.9	21,148	1.51
T_3	35.9	49.7	33.2	46.2	19,445	1.46
T_4	43.5	53.3	40.1	56.6	23,083	1.67
T_5	33.6	51.1	31.5	48.5	18,828	1.38
T_6	40.5	56.8	37.1	53.5	21,505	1.54
T_7	36.0	49.2	29.4	48.9	16,947	1.32
T_8	36.6	52.2	31.3	51.7	17,615	1.30
CD (P = 0.05)	4.4	7.0	5.7	3.9	2,711	0.20

Treatment details are given in Materials and Methods

Table 3. Effect of manurial treatments on changes in soil fertility(after harvest of second rice in 1995–96) and residual effect on pod yield of cowpea (pooled mean of 3 years)

Treatments	pH	EC dS/m	Organic carbon (%)	Available nutrients (kg/ha)			Pod yield (q/ha)
				N	P_2O_5	K_2O	
T_1	5.59	0.08	0.48	208	9	91	20.4
T_2	5.57	0.09	0.54	228	12	102	24.1
T_3	5.62	0.09	0.64	262	15	121	27.7
T_4	5.61	0.09	0.60	276	15	116	26.8
T_5	5.68	0.08	0.68	258	14	102	31.0
T_6	5.65	0.09	0.62	264	13	101	28.3
T_7	5.62	0.08	0.56	238	12	113	25.1
T_8	5.60	0.09	0.54	244	11	112	25.9
CD (P = 0.05)	NS	NS	0.14	10	1	13	5.2
Initial soil fertility	5.58	0.08	0.45	220	11	112	

Treatment details aregiven in Materials and Methods

T_6 and T_2. On an average, the treatment T_4 increased the net returns by 111 and 9% over the control (T_1) and T_2 respectively. Higher yields of the components crops of the sequence increased the total net returns.

It was concluded that in rice–rice–cowpea sequence under humid tropical Andaman Islands, integration of 50% NPK + 50% poultry manure or FYM was advantageous in sustaining the crop and soil productivity and obtaining higher net returns.

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