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Organic and inorganic sources of fertilizers for sustained productivity in rice (*Oryza sativa*)–wheat (*Triticum aestivum*) sequence on humid hilly soils of Sikkim

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ABSTRACT

A field experiment was carried out during 1990–91 to 1992–93 to study the influence of nitrogen economization in rice (*Oryza sativa* L.)–wheat crop sequence. An application of 60 kg N/ha produced significantly more grain and straw yields of rice 11.65 and 26.03% and wheat 32.31 and 34.80% over no nitrogen, whereas significantly higher grain and straw yields of rice 5.90 and 6.36% and of wheat 13.73 and 14.06% were obtained with the application of farmyard manure 10 tonnes/ha over no application. All the yield-attributing characters of rice, i.e plant height, length of panicle and number of grains/panicle were increased the straw and grain yield of both the crops up to 90 kg N/ha but there was no significant difference in 60 kg and 90 kg N/ha.

Rice–wheat system is the most prominent double cropping system in India which has continuously been expanding in recent years. This system covers more than 6.4 million/ha (Hobbs *et al.*, 1987). Depending on the ecological, edaphic and biotic conditions of Sikkim rice–wheat is the new thrust in double cropping in the state . In the Sikkim production of rice (1257.1 kg/ha) and wheat (1532.92 kg/ha) production during 1991–92 was low in comparison to other states. Therefore, new crop sequence for balanced cropping systems with organic manure as farmyard manure and inorganic fertilizer as nitrogen were tested to increase the cereal production of north-eastern hilly region.

MATERIALS AND METHODS

The present study was carried out at Research Farm, Tadong, Gangtok, at 1,350 m mean sea-level extends 27–28° N and 88–89° E during 1990–91 to 1992–93. Treatments consisting of 4 levels of N (0, 30, 60 and 90 kg/ha) combined with 3 levels of farmyard manure (0 and 20 tonnes/ha) for both the crops in sequence. The experiment was conducted in a permanent lay out at a fixed location in randomized block design with 3 replications .The soil was sandy loam having pH (< 5.5), low in organic carbon (0.69%), low in available phosphorus (3.20-4.0 kg/ha) and rich in available potassium (174.5–186.8 kg/ha), Nitrogen was applied twice, half dose of N as urea broadcasting at the time of transplanting or sowing remaining half dose was applied at 30 days after sowing or transplanting for both the crops. The FYM was thoroughly mixed into the

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Table 1. Effect of nitrogen and FYM on yield attributes of rice in rice–wheat rotation

Treatment	Plant height (cm)			Panicle length (cm)			Grain/panicle		
	1990	1991	1992	1990	1991	1992	1990	1991	1992
N (kg/ha)									
0	90.0	94.3	70.8	23.6	23.7	22.8	144.0	152.2	135.7
30	91.6	100.3	71.1	24.3	25.6	24.5	151.8	157.1	143.9
60	94.8	103.8	72.9	24.8	26.4	25.3	157.0	162.6	152.5
90	97.7	103.2	76.4	25.6	26.5	25.8	106.3	163.6	154.6
CD (P = 0.05)	3.7	2.8	3.6	1.1	0.8	0.4	4.7	3.5	2.2
0	92.5	99.1	53.67	23.5	24.4	23.5	148.5	154.0	144.4
10	93.7	100.2	72.7	24.6	25.9	24.8	153.8	159.5	146.9
20	95.1	110.3	74.2	25.5	26.3	25.6	157.5	161.3	148.7
CD (P = 0.05)	NS	NS	NS	1.2	0.9	0.5	5.4	4.0	2.5

soil at the time of land preparation.

The test cultivar 'DR92' of rice was transplanted at 25 cm lines and 20 cm plants apart and wheat ('Sonalika') was sown 25 cm lines. The wheat crop was irrigated at tillering, late jointing and milk stages from the natural resources of irrigation water. The total rainfall received in the rainy (*kharif*) and winter (*rabi*) seasons were 2,069.4 and 313.1 mm during 1990–91, 2,162.7 and 234.2 mm during 1991–92 and 1,801.3 and 422.3 mm during 1992–93 respectively.

RESULTS AND DISCUSSION

Plant height, length of panicle and grains/panicle were significantly higher with 60 kg N/ha than the control and the result was at par with 90 kg N/ha. The yield attributes of wheat were not taken into consideration, Moreover, significantly higher rice grain (52.7 and 65.2 q/ha) and straw (110.9 and 137.4 q/ha) yields were obtained by 60 kg N/ha compared with the control and the effect was at par with 90 kg N/ha during 1990 and 1991, whereas in 1992, the treatment consisted application of 90 kg N/ha gave significantly higher rice-grain yield (42.19 q/ha) and straw (82.8 q/ha) yield over 60 kg N/ha and the control. This might be due to cummulative effect of organic and inorganic fertilizers coupled with equally distributed rains during the crop-growth period. Similar findings were reported by Rai *et al.* (1990). The NPK and FYM application increased soil nutrients P, K and Ca, but only FYM application increased organic carbon content. The results confirm the finding of Soni and Sikarwar (1991) for rice–wheat sequence. The yield of both the crops increased with increasing rates of NPK with FYM than without it.

Application of FYM @ 20 tonnes/ha recorded highest grain yield and straw yield compared with the control, but a significant difference was not observed between the 10 tones FYM/ha and 20 tonnes FYM/ha during the 3 consecutive years

Grain and straw yields of wheat in the rice–wheat sequence was significantly higher under 60 kg N/ha than those under the control and were at par with application of 30 and 90 kg N/ha in all the 3 years. Under

Table 2. Effect of nitrogen and FYM on productivity of rice and wheat sequence

Treatment	Rice yield (q/ha)						Wheat yield (q/ha)					
	Grain			Straw			Grain			Straw		
	1990	1991	1992	1990	1991	1992	1990–91	1991–92	1992–93	1990–91	1991–92	1992–93
Nitrogen (kg/ha)												
0	43.3	57.9	37.1	84.6	103.1	73.9	17.9	16.9	14.8	52.6	46.1	43.5
30	49.5	60.4	38.2	96.2	123.4	78.7	20.3	20.0	19.9	61.2	60.5	57.7
60	52.7	63.2	38.5	110.9	137.4	81.4	22.9	20.8	21.0	66.7	62.3	62.7
90	54.9	64.1	42.1	124.8	146.4	82.8	23.4	21.3	21.6	69.5	62.9	63.7
CD (P=0.05)	2.7	5.9	4.8	14.3	13.4	9.8	4.3	2.5	3.2	14.1	6.9	8.7
FYM (tonnes/ha)												
0	47.2	57.8	35.6	96.8	118.9	73.6	18.9	17.4	16.8	54.8	50.0	48.7
10	49.5	61.0	38.5	104.6	126.3	76.8	20.6	20.0	19.0	62.1	56.6	56.4
20	53.6	65.5	42.8	110.9	137.5	87.3	23.9	21.4	21.5	70.6	67.2	65.5
CD (P=0.05)	6.8	6.8	5.2	NS	15.5	10.0	4.8	3.2	4.6	15.0	7.9	10.8

10 tonnes FYM/ha significantly higher wheat grain yield and straw yield were observed than under the control but there was no significant difference between 10 and 20 tonnes FYM/ha. The results are in agreement of Mandal and Sarkar (1987), Mandal *et al.* (1991) and Sharma and Mittra (1989) reported that residual effect of application of 60 kg N/ha +10 tonnes FYM/ha is the economic dose for getting maximum yield in high rainfall area of Sikkim.

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