Indian J. Agron. **40** (3) : 349–352 (September 1995)

Nitrogen management in rice (*Oryza sativa*)-based food and fodder production system

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Received: April 1992

ABSTRACT

A field experiment was conducted during 1987–88 to 1988–89 to study the effect of 6 fodder crops along with wheat (*Triticum aestivum* L. emend. Fiori & Paol.)—common crop rotation used by the local farmers—on yield and nitrogen economy of succeeding rice crop (*Oryza sativa* L.). Six fodder crops were, viz. Egyptian clover (*Trifolium alexandrinum* L.), oat (*Avena sativa* L.), Indian clover (*Melilotus alba* Desr.), lucerne (*Medicago sativa* L.), barley (*Hordeum vulgare* L. sensu lato) and mustard (*Brassica campestris* L. var. Japan rape), along with wheat (grain) with recommended doses of fertilizers with an additional treatment of fallow in main plots during winter season. 'Jaya' rice was taken as succeeding rainy-season crop with 4 levels of nitrogen (0,40,80 and 120 kg N/ha) in subplots. The loamy soil was low in organic carbon and nitrogen. Among the various rice-based forage-cropping systems, the productivity of Egyptian clover–rice sequence was found maximum. This food–fodder cropping system also economized fertilizer N to the extent of 100 kg/ha with an additional amount of 20 kg P_2O_5/ha to legume component compared with to rice–wheat cropping system. Moreover, this system also improved the fertility status of soil.

Most of cereal crops are very exhaustive and put heavy demand on soil nutrients. However, forage crop particularly legumes find less priority in the existing cropping systems which otherwise enrich the soil by fixing atmospheric nitrogen and adding organic matter. Therefore, inclusion of such crop component in the existing cropping system would meet twin objectives of forage resources development and soil amelioration.

Nitrogen and P need also varies in relation to the preceeding crop (Malik *et al.*, 1984). However, research information on forage production with an accent on nitrogen economy in the existing cropping systems is meagre. Hence an experiment was carried out to evaluate rice-based cropping systems in terms of their feasibility and nitrogen economy.

MATERIALS AND METHODS

The experiment comprising 6 fodder crop, viz. Egyptian clover (*Trifolium alexandrinum* L.), oat (*Avena sativa* L.), Indian clover (*Melilotus alba* Desr.), lucerne (*Medicago sativa* L.), barley (*Hordeum vulgare* L. sensu lato) and mustard (*Brassica campestris* L. var. Japan rape) along with grain wheat (*Triticum aestivum* L. emend. Fiori & Paol.), was laid out with recommended doses of fertilizers with an addi-

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Table 1. Crop productivity in rice-based fodder production system

Fodder	Green-fodder yield (tonnes/ha)			Dry-matter yield (tonnes/ha)			Egyptian clover-equivalent yield (tonnes/ha)		
	1988	1989	Mean	1988	1989	Mean	1988	1989	Mean
Egyptian clover	61.8	72.4	67.1	8.83	11.9	10.4	61.8	72.4	67.1
Oat	47.0	24.5	35.8	14.54	6.0	10.3	44.3	19.6	32.0
Indian clover	26.0	32.7	29.4	8.26	5.6	6.43	24.8	32.8	28.8
Lucerne	21.5	20.5	21.0	6.01	5.1	5.6	21.5	16.7	19.1
Barley	30.7	21.4	26.1	13.88	6.1	10.0	26.8	17.1	22.0
Mustard	28.3	10.9	19.6	3.79	1.6	2.7	22.7	11.0	16.9
Fallow									
Wheat							25.4	36.5	31.0
CD (P = 0.05)	3.33	1.83		1.67	1.2		5.78	6.63	

Price of fodder (Rs/tonne): Egyptian clover, 300; oat, 250; Indian clover, 300; lucerne, 300; barley, 170; Indian mustard, 250
Price of wheat (Rs/tonne): Grain, 3,000; straw, 800

tional treatment of fallow in main plots during the winter season. Rice (*Oryza sativa* L.) was taken as a suceeding rainy-season crop with 4 levels of nitrogn (0, 40, 80 and 120 kg/ha) in subplots in split-plot design with 3 replications. The varieties included in the present investigation were 'IGFRI 99-1' of Egyptian clover, 'S 244' of lucerne, 'Kent' of oat, 'S 76' of Indian clover, 'Jyoti' of barley, 'Japan Rape' of mustard, 'Raj 1555' of wheat and 'Jaya' of rice.

The soil of the experimental field was loam in texture, having low organic carbon (0.49%), low available nitrogen (194.4 kg/ha) and medium available phoshorus (11.2 kg P_2O_5/ha). The recommended doses of fertilizers were given to preceeding winter-season crop and a basal dose of 60 kg P_2O_5/ha and 60 kg K_2O/ha and nitrogen as per treatments was given for succeeding rice crop. The rainfall received during 1987–88 and 1988–89 was 854.7 and 756.2 mm respectively.

RESULTS AND DISCUSSION

Yield of preceeding crops

The general crop of rice during rainy season of 1987 was taken. Among the winter-season crops, Egytian clover recorded maximum green-forage yields during 1988 and 1989. However, dry-matter production was highest in barley in 1988 whereas it was highest in Egyptian clover in 1989 because of higher tonnage production. The yields of different winter-season fodder and food crops were converted into Egyptian clover-yield equivalent for valid comparison (Table 1). It was maximum in Egyptian

Table 2. Grain and straw yields of rice as affected by preceding forage crops and nitrogen levels

Treatment	Grain yield (tonnes/ha)			Straw yield (tonnes/ha)		
	1988	1989	Mean	1988	1989	Mean
Cropping system						
Egyptian clover–rice	4.00	2.69	3.35	6.36	4.67	5.52
Oat–rice	3.74	2.50	3.12	5.75	4.40	5.01
Indian clover–rice	3.95	2.47	3.21	6.08	4.49	5.28
Lucerne–rice	3.72	2.00	2.86	5.88	3.96	4.92
Barley–rice	3.75	2.45	3.10	5.83	4.50	5.17
Mustard–rice	3.86	2.40	3.13	6.00	4.02	5.01
Fallow–rice	3.86	1.94	2.90	5.93	3.88	4.90
Wheat–rice	3.59	2.59	3.09	5.24	4.31	4.78
CD (P = 0.05)	NS	NS	NS	NS	NS	NS
N to rice (kg/ha)						
0	1.98	1.13	1.56	2.87	1.88	2.38
40	3.32	1.60	2.46	4.47	2.67	3.57
80	4.63	2.01	3.32	7.01	3.62	5.31
120	5.23	2.33	3.78	9.01	4.48	6.75
CD (P = 0.05)	0.21	2.18		0.46	3.43	

clover, followed by oat, wheat, Indian clover, barley, lucerne and mustard.

Effect of preceeding crops and fertilizer N on rice production

There was no significant variation in grain and straw yields of rice grown after different winter-season food or fodder crops. The grain and straw yields of rice in Egyptian clover—rice sequence were found maximum. It may be due to higher nitrogen fixation by Egyptian clover, which in turns showed greater carry-over effect on following rice crop. The lowest grain and straw yields of rice were obtained when the preceding crop was wheat (Table 2). Higher rice yields after leguminous crops could be attributed to biological fixation of N and addition of root biomass by legumes, resulting in improved physical and chemical properties of soil. All these resulted increased rice yield. However, wheat depleted the soil fertility and reduced the rice yield. Balyan and Seth (1985) also reported higher yields of crops grown in rotation with legumes.

The effect of higher level of nitrogen (120 kg/ha) was significant over other levels on rice yields, when grown after different preceding winter-season crops (Table 2). Considering both N and P nutrition in cropping system, it was found that Egyptian clover–rice sequence economized fertilizer nitrogen up to 100 kg/ha by applying an additional amount of 20 kg P_2O_5/ha to legume component compared with rice–wheat cropping system. In our study Egyptian clover–rice sequence recieved 140 kg N/ha and 140 kg P_2O_5/ha compared with wheat–rice sequence, 240 kg N/ha and 120 kg P_2O_5/ha. After 2 cycles of rice-based cropping system, the fertility status of the soil improved in 1989. The organic carbon increased to 0.53% and there was an increase in nitrogen by 163.7 kg/ha and phosphorus by 6.8 kg/ha over initial levels.

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