Indian Journal of Agronomy **46** (1) : 12–16 (March 2001)

Nutrient management in semi-deep water (30–50 cm) rice (*Oryza sativa*) and its effect on succeeding lentil (*Lens culinaris*) crop

G. SINGH, L.J. WADE[1], B.B. SINGH[2], R.K. SINGH[3] AND V.P. SINGH[4]

Crop Research Station, Narendra Deva University of Agriculture and Technology, Ghaghraghat, Bahraich, Uttar Pradesh 271 901

Received : May 2000

ABSTRACT

An integrated use of farmyard manure with fertilizer gave significantly maximum average grain yield (3.34 tonnes/ha) of rice (*Oryza sativa* L.) and (1.02 tonnes/ha) of lentil (*Lens culinaris* Medikus) during 1995–98. Application of neem cake-coated urea + P and K to rice resulted in significantly higher yields and uptake of nutrients by rice and succeeding lentil compared with rest of the treatments except integrated use of both, and farmyard manure alone for lentil yield. Soil fertility (N, P and organic carbon) was improved significantly with FYM used either alone or in combination with fertilizer over that of initial soil status. Potassium content in soil was reduced in all treatments.

Key words : Nutrient management, Transplanted rice, Lentil, Semi-deep water, Carry-over effect

The poor productivity of rice in semi-deep water situation was attributed to low recovery of applied nitrogen due to its losses by way of denitrification, ammonia volatilzation, leaching and runoff or immobilization. Nitrogen-use efficiency in rainfed lowlands may be improved with application of slow-release nitrogen fertilizers like neem cake-coated urea (Singh and Singh, 1994). Addition of zinc with nitrogen further enhanced the productivity of rice owing to its synergistic effect on availability of nutrients.

Incorporation of farmyard manure alone or in combination with inorganic fertilizers improves the productivity of rice, sustains soil health and economizes fertilizers need (Tripathi and Chaubey, 1996). Studies conducted so far in nutrient management under rainfed lowlands is confined to only its direct effect on crop. Since meagre information is available on residual effect

Present address : [1,4]International Rice Research Institute, Manila, Philippines, [3]IRRI-Representative, C 18, New Friends Coloney New Delhi 110 065, [2]Department of Crop Physiology, N.D.U.A.T., Kumarganj, Faizabad, Uttar Pradesh 224 001

of rice succeeding crop, the present experiment was undertaken to find out the direct and residual effects of nutrient-management practices on transplanted rice and succeeding lentil.

MATERIALS AND METHODS

A field experiment was conducted in wet season (June–November) and dry season (December–April) during 1995–98 at the Crop Research Station, Ghaghraghat, Narendra Deva University of Agriculture and Technology, in collaboration with International Rice Research Institute, Philippines, in semi-deep water (30–50 cm) depth. The soil was sandy-loam with pH 7.8, organic carbon 0.50, available N 248, P_2O_5 21.86, K_2O 167.5 kg/ha and bulk density 1.54/cm^2. The experiment was conducted with first 6 treatments (T_1 to T_6) replicated thrice in 1995, while 7 treatments (T_1 to T_7) replicated 4 times in 1996 and 1997 in randomized block design. Treatments were: T_1 control (no NPK); T_2, PK (40+40 kg/ha); T_3, NPK (80+40+40 kg/ha); T_4, NPK+$ZnSO_4$ (80+40+40+25 kg/ha); T_5, neem cake-coated urea (N)+PK (80+40+40 kg/ha); T_6, farmyard manure (80 kg N/ha) @ 16 tonnes/ha; and T_7, integrated use (half FYM 40 kg N/ha @ 8 tonnes/ha FYM) + half NPK (40+20+20 kg/ha). Nitrogen was applied in 3 splits, i.e. 50% N as basal + 25% N at tillering (35 days of transplanting) + 25% N at panicle-initiation stage (85 days after transplanting). Total quantity of phosphorus, potassium and zinc sulphate was applied before transplanting. Farmyard manure was applied 25 days before rice planting.

Thirtyfive days old seedlings of variety 'Jalpriya' was transplanted on 24 July 1995 and 26 July 1996 and 1997 at 20 cm × 10 cm spacing. Rice was harvested in the third week of November in all years. To study the residual effect of fertilizer applied to rice, 'PL 406' lentil was sown in lines 20 cm apart with 50 kg seed/ha without tillage in the first week of December in all years. Lentil was fertilized with nitrogen @ 10 kg/ha and top-dressed 55 days after lentil germination in all treatments except the control and PK treatments. Grain and straw samples of rice and lentil drawn in each season were processed and analysed for N, P and K. Initial and post-harvest soil samples collected from 0–20 cm depth were analysed for bulk density, pH, organic carbon, available N, P and K by using standard laboratory procedures.

Water started accumulating in the plot on 9 September 1995, 4 September 1996 and 20 August 1997 and reached at maximum level of 39 cm in 1995, 45 cm in 1996 and 37 cm in 1997. The stagnation of water in the field was 26 days in 1995, 33 days in 1996 and 38 days in 1997 and remained in the range of 30–50 cm depth.

RESULTS AND DISCUSSION

Yields

Combined use of farmyard manure and fertilizers gave significantly higher mean grain yield of rice and succeeding lentil crop over rest of the treatments except farmyard manure alone treatment which gave significantly higher grain yield of succeeding lentil crop over rest of the treatments. The higher yield of both crops with this treatment was owing to significant

Table 1. Yields, nutrients uptake by rice and lentil, and soil fertility status as influenced by different nutrient-management practices in semi-deep water (30–50 cm) depth (average data of 3 years data)

Treatment	Yield (tonnes/ha)				Total uptake of NPK (kg/ha)						Available nutrient (kg/ha)			Organic carbon (%)	Bulk density (g/cm^2)
	Rice		Lentil		Rice			Lentil			N	P_2O_5	K_2O		
	Grain	Straw	Grain	Straw	N	P	K	N	P	K					
T_1	1.51	2.90	0.32	0.32	33.2	13.3	41.4	18.4	1.9	3.5	229	18.1	122.5	0.42	1.54
T_2	1.89	3.72	0.37	0.40	41.8	16.1	52.4	25.8	2.7	4.7	226	20.4	130.9	0.42	1.54
T_3	2.96	5.82	0.78	0.70	62.7	24.0	81.0	48.3	5.5	9.0	238	20.3	126.3	0.46	1.54
T_4	3.07	6.09	0.81	0.73	65.4	24.4	85.5	52.5	6.0	10.2	246	21.3	127.2	0.47	1.53
T_5	3.18	6.22	0.92	0.78	67.4	24.5	87.7	56.0	6.6	11.0	243	22.0	133.3	0.49	1.52
T_6	2.36	4.76	1.00	0.71	59.5	20.2	74.9	61.3	7.1	11.6	269	24.3	145.2	0.51	1.48
T_7	3.34	6.50	1.02	0.81	69.8	25.9	91.6	59.0	7.0	11.6	266	26.1	147.2	0.51	1.49
CD (P = 0.05)	0.07	0.09	0.03	0.04	2.1	0.5	2.3	2.4	1.1	0.6	04	0.7	7.0	0.01	0.01
Initial soil status											248	21.9	167.5	0.50	1.54

Details of treatments are given in text

improvement in yields attributes of both crops (Tables 1, 2), owing to adequate availability of nutrients. Sumathy *et al.* (1999) reported the similar results. The lower yields of rice in farmyard manure alone treatment was because of poor availability of nutrients owing to immobilization of soil nitrogen.

Among the inorganic fertilizer treatments, application of neem cake-coated urea + P and K resulted in significantly higher grain yield of rice and succeeding lentil over rest of the treatments, because of slow releasing and nitrification-inhibition action of neem cake which maintained synchronizing supply of nitrogen with crop demand resulted better growth and yield attributes and yield. Singh and Singh (1994) also reported similar result. Addition of zinc with N, P, K gave significantly higher grain yield of rice and succeeding lentil crop because of improvement in availability of nutrients owing to its synergistic effect with nitrogen. Khanda *et al.* (1997 reported similar results.

Nutrient uptake

The uptake of N, P and K by rice was the highest with integrated use of both; however, lentil depleted higher N, P and K with FYM alone treatment applied to preceding rice. This was probably due to improvement of soil environment (physical and chemical) which encourages root proliferation and in turns drew more nutrient from large area of greater depth. Similar findings were reported by Mishra and Sharma (1997). The use of neem cake-coated urea + P and K resulted significantly higher removal of nutrients by both crops than NPK, NPK+$ZnSO_4$, PK, FYM and no NPK because of higher yield with this treatment.

Soil fertility

The magnitude of residual available nitrogen and phosphorus, and organic

Table 2. Yield attributes of rice and lentil as affected by integrated nutrient management in shallow rainfed lowlands average data of 3 years

Treatment	Rice						Lentil			
	Panicles/ m^2	Panicle length (cm)	Panicle weight (g)	Grains/ panicle	Grain weight/ panicle (g)	1,000-grain weight (g)	Plants/ m^2	Pods/ plant	Seed yield/ plant (g)	1,000-seed weight (g)
T_1	134	22.2	2.90	103	2.32	20.3	180	40	0.31	15.3
T_2	143	24.0	3.02	123	2.41	21.7	189	47	0.38	16.1
T_3	235	25.9	3.35	160	2.45	25.0	192	50	0.40	17.5
T_4	249	26.3	3.51	169	2.68	25.7	195	52	0.42	18.1
T_5	264	27.2	3.68	181	2.81	26.4	201	54	0.43	18.7
T_6	166	24.3	3.25	126	2.49	24.8	208	59	0.47	20.1
T_7	275	27.4	3.80	190	2.93	26.9	210	61	0.49	20.4
CD (P=0.05)	10	0.8	0.15	08	0.17	0.7	06	04	0.03	0.4

Details of treatments are given in text

carbon in soil was significantly improved with farmyard manure applied either alone or in combination with inorganic fertilizers than its initial soil status (Table 1). This was due to mineralization of farmyard manure which improved the available N, P and organic carbon in soil. These results are in close conformity with those of Mishra and Sharma (1997) and Mandal and Chettri (1998). Content of potassium was reduced in all nutrient-management practices, might be due to higher depletion of K by crop and insufficient addition of potassium through fertilizer. Integrated use of farmyard manure with inorganic fertilizers reduced the bulk density significantly than its initial soil status because of better soil aggregate and higher macro-pore space. Bellakki *et al.* (1998) also reported lower bulk density with organic manures application.

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