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Balance sheet of soil nitrogen in wheat (*Triticum aestivum*)-based crop sequence

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ABSTRACT

A field experiment was conducted during 1992–94 at Pusa, Bihar, consisting of 7 rainy-season (*kharif*) crops, followed by wheat (*Triticum aestivum* L. emend. Fiori & Paol.). The crop sequence *dhaincha* [*Sesbania cannabinas* (Retz.) Pers.] (green manure)]–wheat showed a positive N-balance in soil. Fallow–wheat, blackgram (*Phaseolus mungo* L.)–wheat, groundnut (*Arachis hypogaea* L.)–wheat and sesame (*Sesamum indicum* L.)–wheat crop sequences also showed marginal, but positive N balance in soil at higher levels of nitrogen. However, sorghum [*Sorghum bicolor* (L.) Moench]–wheat, rice (*Oryza sativa* L.)–wheat and maize (*Zea mays* L.)–wheat sequences showed reduced available N status of soil, regardless of the level of nitrogen. The balance sheet of nitrogen, however, depicted the maximum gain of nitrogen in sorghum–wheat sequence, followed by maize–wheat, blackgram–wheat, groundnut–wheat and fallow–wheat sequences. The gain of nitrogen in balance sheet was more at lower levels of nitrogen.

Key words : Balance, Wheat, Soil nitrogen, Crop sequence

A need was felt to work out the balance sheet of nutrients in different cropping systems prevalent in north Bihar region. Various wheat-based cropping systems with emphasis on nitrogen, the key nutrient in crop production, formed the base for this investigation. An effort was made to quantify nitrogen-use pattern, depicting a balance sheet under various cropping systems.

MATERIALS AND METHODS

A field experiment was conducted during rainy (*kharif*) and winter (*rabi*) seasons for 1992–93 and 1993–94 at Rajendra Agricultural University, Pusa, Samastipur. Total rainfall during *kharif* 1992–93 was appreciably lower (452.9 mm) than the normal (1,062.2 mm), whereas during 1993–94 it was 1,027.6

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mm. On the other hand, the crop period during *rabi,* it received higher rainfall of 64.2 and 130.1 mm during 1992–93 and 1993–94 respectively than the normal (44.8 mm). The soil of the experimental plot was sandy loam having 245 and 288 kg available N/ha, 11.8 and 19.6 kg available P_2O_5/ha, 152 kg and 195 kg available K_2O/ha during first and second year, respectively, with pH of 8.2 and 8.4 during the corresponding years. The experiment was laid out in split-plot design replicated thrice with different *kharif* crops, i.e. rice, maize, blackgram, sesame, sorghum (fodder), *dhaincha* (GM) and groundnut including control in main plot and wheat superimposed with 4 levels of nitrogen (0,40,80 and 120 kg N/ha) in subplots during *kharif* and *rabi* seasons. As per Raghuwansi *et al.* (1991) nutrient balance in the soil was calculated as: Y-(X-a)-N, where Y, nutrient removal by crop; X, intial soil status of nutrient element; a, final soil status of nutrient element and N, nutrient added through fertilizers.

RESULTS AND DISCUSSION

Nitrogen balance in soil

Pooled data of balance sheet of N revealed that maximum increase in available N in soil was found in plot green-manured with *dhaincha* (C_4) during *kharif* season (Table1). The status of available N in green-manured plots increased 6–19 kg/ha, depending upon dose of N given to wheat crop. The results support the findings of Sadanand and Mahapatra (1973). Plots remaining fallow in *kharif* but getting either 80 kg N/ha (C_1N_2) or 120 kg N/ha (C_2N_3), groundnut plot getting 120 kg N/ha (C_3N_3) and sesame plots getting 80 kg N/ha (C_7N_2) or 120 kg N/ha (C_7N_3) in wheat also showed increased status of available N in the soil. However, plots sown with sorghum (fodder), maize and rice showed greater reduction in N status of soil irrespective of the doses of N applied to wheat. Further, regardless of crops taken during *kharif* seasons, there was definite trend that plot receiving higher dose of N either enriched more in N status, or if there was any loss in N status, the extent of loss was less at higher doses of N. The gain in N status of soil under green-manuring and blackgram can be explained on the basis of atmospheric N fixed in the photosynthetic apparatus of the leguminous crops, whereas reduction in N-status in plots having maize, rice and sorghum (fodder) during *kharif* can be attributed to very high biomass produced under these crops.

Nitrogen balance sheet also showed unaccountable N which was either taken up from soil in excess of that applied or vice-versa while the balance did not find proportionate exhibition in the balance sheet in the form of available N in soil. The crop sequence having green-manuring in *kharif* showed the maximum negative N balance revealing that nitrogen removed by the crops raised was far less than that applied in the field. However sorghum (fodder)–wheat and maize–wheat sequences showed the maximum gain of N, as the nutrient removed by them was much more than those applied. Blackgram–wheat, groundnut–wheat and fallow–wheat were the other sequences showing gain in N-balance sheet. The gain of N in terms of N uptake and N status of soil was more at the

Table 1. Balance of nitrogen in soil (Pooled)

Treatment	Initial N status	Nitrogen applied (kg/ha)			Nitrogen uptake (kg/ha)			Residual nitrogen after harvest of wheat	Changes in N status of soil	N balance
		Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total			
C_1N_0			0	0		116.25	116.25	255	–12	104.25
C_1N_1			80	80		176.81	176.81	260	–7	89.81
C_1N_2			160	160		212.27	212.27	268	1	53.27
C_1N_3			240	240		247.56	247.56	271	4	27
C_2N_0		40	0	40	46.79	125.62	172.41	265	–2	130.41
C_2N_1		40	80	120	46.79	192.18	238.97	268	1	119.97
C_2N_2		40	160	200	46.79	230.51	277.3	273	6	83.3
C_2N_3		40	240	280	46.79	259.12	305.91	276	9	34.9
C_3N_0		50	0	50	77.73	105.06	182.79	250	–17	155.79
C_3N_1		50	80	130	77.73	168.01	245.74	255	–12	103.74
C_3N_2		50	160	210	77.73	207.71	285.449	262	–5	70.4
C_3N_3		50	240	290	77.73	240.22	317.95	269	2	29.95
C_4N_0		295.8	0	295.8		169.89	169.89	273	6	–119.91
C_4N_1		295.8	80	375.8		223.48	234.8	277	10	–131.02
C_4N_2		295.8	160	455.8		272.76	272.76	283	16	–167.04
C_4N_3	26.70	295.8	240	535.8		274.17	274.17	286	19	–242.63
C_5N_0		200	0	200	274.03	87.62	361.65	248	–19	142.65
C_5N_1		200	80	280	274.03	149.39	423.42	252	–15	128.42
C_5N_2		200	160	360	274.03	186.78	460.81	261	–6	104.81
C_5N_3		200	240	440	274.03	220.43	494.46	265	–2	52.46
C_6N_0		160	0	160	151.55	67.84	219.39	244	–23	36.39
C_6N_1		160	80	240	151.55	105.75	257.3	247	–20	–2.7
C_6N_2		160	160	320	151.55	132.03	283.58	256	–11	–47.42
C_6N_3		160	240	400	151.55	154.23	305.78	261	–6	–100.22
C_7N_0		80	0	80	24.37	96.26	120.63	248	–19	21.63
C_7N_1		80	80	160	24.37	157.77	182.14	251	–16	6.14
C_7N_2		80	160	240	24.37	199.77	224.14	268	1	–14.86
C_7N_3		80	240	320	24.37	225.84	250.21	270	3	–65.79
C_8N_0		160	0	160	275	77.44	352.44	239	–28	164.44
C_8N_1		160	80	240	275	122.19	397.19	244	–23	134.19
C_8N_2		160	160	320	275	156.34	431.34	252	–15	96.34
C_8N_3		160	240	400	275	187.77	462.77	257	–10	52.77

CC_1, Fallow; C_2, blackgram; C_3, groundnut; C_4, *dhaincha* (GM); C_5, maize; C_6, rice; C_7, sesame; C_8, sorghum (fodder); N_0, control; N_1,40 kg N/ha; N_2,80 kg N/ha; N_3,120 kg N/ha control (0) level of N, which reduced with increase in the level of N up to 120 kg/N ha.

The unaccountable N might get an explanation in the well-established phenomenon that there is a continuous exchange of N from available to unavailable (fixed) pool and vice-versa. Besides, the transformation from the unavailable capacity factor to available intensity factor will be more if there will be derth and higher demand for available N in the rhizosphere. On the other hand, if the available N in soil is in excess of the crop need, the transformation of N to its unavailable form will be more (Russel, 1963). Roysharma and Singh (1969) also reported that application of N builds up soil N. High mobility of N and its rapid loss through leaching, volatilization and denitrification are the other factors to explain unaccountability of N in the balance sheet. Loss of N, in case of rice, in the balance sheet might be due to still high mobility of N under submerged condition.

Yield

Wheat followed by maize and sorghum (fodder) responded to N up to 120 kg N/ha. In case of the remaining 5 *kharif* crops, the response of wheat was noted only up to 80 kg N/ha.

It was further noted that irrespective of the levels of N the wheat crop preceded by green-manuring of *dhaincha* gave the highest grain yield. However, at N_0, it did differ significantly with wheat yield after fallow or blackgram. As the level of N was raised, the yield gap in wheat due to preceding crops narrowed. At N_{40} wheat after groundnut also become comparable with wheat after green-manuring. There was no further addition to this list at N_{80} but at N_{120} sesame and maize also acquired parity with green-manuring along with fallow, blackgram and groundnut. Thus at

Table 2. Yield of *kharif* as well as *rabi* wheat (pooled) as influenced by different treatments

Treatment (main/sub.)	Yield (q/ha)					
	Kharif		*Rabi* (wheat) at			
	Grain	Biomass	N_0	N_{40}	N_{80}	N_{120}
Fallow			21.6	32.1	37.9	41.8
Blackgram	9.04	33.24	23.1	34.4	40.5	43.6
Groundnut	12.71	48	19.9	31	37.5	41.2
Dhaincha (G.M.)	-	50.6	30.9	41.3	46.6	45.8
Maize	31.4	118	16.7	27.6	33.8	38.2
Rice	36.6	106.2	13.2	19.7	24.3	27.6
Sesame	5.9	32.5	18.6	29.4	35.8	39.4
Sorghum (Fodder)		97	15	23.1	28.8	33
	Main	Sub.	Sub. at main		Main at sub.	
CD (P=0.05)	10,14	1,26	4,05		10:46	

higher levels of N applied to wheat the effect of *kharif* cropping was less marked. The highest wheat gain yield (46.6 q/ha) was realized in green-manure. Wheat sequence at 80 kg N/ha. The findings are in agreement with those of Berison and Stanboliev (1970) and Roszak (1974), who reported higher yield of wheat after fallow and legumes than non-legumes. The crop sequences next in order after green-manuring–wheat in realizing higher wheat yields, were blackgram–wheat, fallow–wheat and groundnut-wheat. Wheat yields were lower after rice, sorghum (fodder), maize and sesame.

The higher biomass produced under maize, rice and sorghum (fodder) (Table1), thereby removing higher amount of N, might have been responsible for lower yields of the following wheat crop. Puddling in rice causing dispersal of soil particles and thereby deteriorating the soil structure might be the additional cause for still lower wheat yields after rice.

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