

## Soil fertility and yield as influenced by different legume-wheat (*Triticum aestivum*) sequences

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### ABSTRACT

An experiment was conducted during 1993-95 at Ranchi on sandy loam soil low in available N and P, and medium in available K. The experiment comprised of 4 legumes, viz. soybean [*Glycine max* (L.) Merr.], blackgram (*Phaseolus mungo* L.), cowpea [*Vigna unguiculata* (L.) Walp.] and stylo (*Stylosanthes hamata* L.) and 1 cereal, i.e. rice (*Oryza sativa* L.) in *kharif* and followed by 5 levels of N in wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.] in *rabi* with, viz. 0, 25, 50, 75 and 100 kg N/ha. The results revealed that in blackgram plots, the soil organic carbon, available N, P and K were higher in 0-15 cm soil layer over their initial status after 2 cycles of rotation. The available soil N, P and K in other legume plots were also higher compared with rice-wheat sequence. Application of 75 kg N/ha to succeeding wheat after legume augmented available N and K in soil. The yield of wheat was markedly higher after blackgram compared with wheat after other legumes and rice. However, stylo-wheat system recorded the maximum wheat equivalent yield (WEY), being higher over other cropping systems. The yield of wheat and WEY increased with increasing level of N up to 75 kg/ha.

**Key words :** Soil fertility, Yield, Legume-wheat sequence

Crops differ in their physical and chemical effect on the media in which they are grown, and continuous growing of exhaustive crops impairs the soil fertility. Inclusion of legume in a crop sequence not only takes care of soil health but also gives more yield and helps to save chemical fertilizers. Moreover, fertility build-up in soil through biological sources is considered more beneficial than inorganic sources. Legumes in cropping system had beneficial

effects on succeeding crops (Palaniappan *et al.*, 1976) improved the available N in soil (Newaj and Yadav, 1994). The present experiment was therefore planned to assess the beneficial effects of legumes on productivity of succeeding wheat and their effect on soil fertility.

### MATERIALS AND METHODS

The experiment was conducted during 1993-94 and 1994-95 at Ranchi. The

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treatments comprising 4 legumes, viz. 'Brag' soybean (*Glycine max*) 'Gomati' cowpea (*Vigna unguiculata*), 'T 9' blackgram (*Phaseolus mungo*), 'Verano' Stylo (*Stylosanthes hamata*), and 1 cereal 'Brown Gora' rice (*Oryza sativa*) in *kharif* as main plots and 5 levels of N (0, 25, 50, 75 and 100 kg/ha) in wheat (*Triticum aestivum*) cv. 'UP 262' in *rabi* season as subplots were tested in a split-plot design with 3 replications.

The soil was sandy loam in texture, low in organic carbon (0.42%), available N (230 kg/ha), and medium in available P (15.2 kg/ha) and K (180.0 kg/ha) with pH 6.1. *Kharif* crops received recommended dose of fertilizers. In wheat, N was applied as per treatments in 3 splits (25% basal, 50% at crown root initiation and 25% at flag leaf initiation). The recommended dose of P and K was applied at sowing.

## RESULTS AND DISCUSSION

### Organic carbon

Legumes in general and blackgram in particular added higher biomass in soil system but the same was depleted after the harvest of wheat (Table 1). The maximum value of organic carbon was recorded after blackgram in both the years. Since the crops were raised without addition of organic manure, a general decrease in organic carbon was noticed.

### Available soil N

Soil maintained higher available N than initial level at the harvest of *kharif* and *rabi* crops except at harvest of wheat after rice (Table 1). There was, however, decrease in available N after wheat in all the crop

sequences. Blackgram-wheat sequence recorded markedly higher available soil N after each crop during 2 seasons over other crop sequences. It appeared that N added by legumes was utilized by succeeding wheat resulting in reduced available N status of soil after the harvest of wheat in various rotations.

### Available soil P

A general reduction in available soil P was noticed after the harvest of legumes and wheat, except in first year. This might be due to higher rate of P fixation in red acidic soils. As the cropping sequences advanced, a general buildup in available soil P was observed, and was maintained till the completion of 2 sequences. The external application of P to crops in general and legumes in particular in different seasons enriched the soil with available P (Ahlawat *et al.*, 1981). Blackgram-wheat maintained higher soil available P than other sequences.

### Available soil K

A less quantity of K application to *kharif* legumes and its losses under high rainfall conditions might be the reasons for low soil K status after the harvest of legumes. The same was further decreased after the harvest of wheat, because cereals are more efficient in K extraction from soil than legumes. However, a fairly good enhancement in available K was recorded to its initial status due to continuous application of K in all the crops. Sequences having legumes left behind more K in soil than cereal sequence. This might be due to legumes inefficiency to harvest K as compared to cereals (Prasad and Kerketta, 1991).

**Table 1.** Influence of cropping sequences and N on soil fertility parameters

Treatment	Organic carbon (%)				Available N (kg/ha)				Available P (kg/ha)				Available K (kg/ha)			
	1993-94		1994-95		1993-94		1994-95		1993-94		1994-95		1993-94		1994-95	
	AHK	AHR	AHK	AHR	AHK	AHR	AHK	AHR	AHK	AHR	AHK	AHR	AHK	AHR	AHK	AHR
<i>Crop sequences</i>																
Soybean-wheat	0.42	0.38	0.46	0.40	244	242	283	271	12.4	6.6	14.1	12.9	153	149	192	187
Cowpea-wheat	0.43	0.30	0.47	0.41	246	243	287	274	15.3	8.9	16.0	15.5	158	155	196	192
Blackgram-wheat	0.44	0.40	0.49	0.43	256	250	302	282	17.6	9.7	18.4	18.5	165	161	208	202
Stylo-wheat	0.40	0.33	0.47	0.37	241	236	281	267	12.2	5.9	13.9	13.0	150	150	145	186
Rice-wheat	0.33	0.31	0.39	0.30	240	230	280	262	11.7	5.4	11.8	10.9	146	141	18	180
CD (P = 0.05)		0.40	0.05	0.09		1.8	1.7	2.1		0.14	0.16	0.94		2.1	1.4	2.6
<i>N (kg/ha)</i>																
0		0.33	0.43	0.38		234	282	263		13.5	21.9	21.0		146	190	183
25		0.35	0.45	0.38		236	284	266		9.6	17.7	17.0		148	192	185
50		0.37	0.45	0.39		239	286	269		6.7	14.2	13.6		149	194	188
75		0.38	0.48	0.41		245	288	278		4.2	11.3	10.7		153	186	192
100		0.38	0.48	0.41		247	291	280		2.3	9.2	8.5		155	198	194
CD (P = 0.05)		0.01	0.03	0.01		1.6	2.8	2.5		0.24	0.27	1.30		2.9	3.3	3.4

Initial soil organic carbon, 0.42%; available N, P and K, 230, 15.2 and 180 kg/ha respectively; AHK, after harvest of *kharif* crop, and AHR, after harvest of *rabi* crop

### Effect of N

A general decrease in soil organic carbon and available N was noticed after the harvest of wheat, but was further maintained by legumes. Increasing N levels increased the biomass production and incorporation of organic matter in form of leaves and roots which led to increase in organic matter and N status of the soil. In absence of N, low biomass harvesting resulted in higher quantity of P in the soil. The maximum P fixation of acid soils might have resulted in reduced available soil-P (Grewal and Singh, 1989). Increasing the rate of N increased the available soil K. This might be due to higher root biomass production under high fertility conditions. A slight increase in available K after completion of 2 years sequence after harvest of wheat in comparison to initial level was possibly due to higher K extraction

by wheat and as a result, it left over less K in soil.

The yield of succeeding wheat was positively and significantly correlated to organic carbon, available N, P and K status of soil. These parameters accounted for 95.7 and 96.8% contribution towards wheat yield during 1993-94 and 1994-95 respectively. The yield of wheat grown after legumes revealed that application of 75 kg N/ha to succeeding wheat was optimum, since its yield at 100 kg N/ha happened to be static. Similar contribution of legumes to succeeding cereal was also reported by Srivastava and Srivastava (1993).

### Wheat and wheat equivalent yields

Based on 2 seasons, wheat after blackgram recorded markedly higher yield over wheat after other legumes and rice

**Table 2.** Wheat and wheat equivalent yields as influenced by legume-wheat sequences and N levels

Treatment	Wheat yield (q/ha)			Wheat equivalent yield (q/ha)		
	1993-94	1994-95	Mean	1993-94	1994-95	Mean
<i>Crop sequence</i>						
Soybean-wheat	24.13	22.20	23.16	52.30	46.16	49.23
Cowpea-wheat	26.30	24.28	25.29	46.37	40.00	43.18
Blackgram-wheat	31.98	30.66	31.32	54.86	50.66	52.76
Stylo-wheat	25.26	23.04	24.15	72.44	64.95	68.69
Rice-wheat	22.45	20.28	31.36	40.85	35.10	37.97
CD (P = 0.05)	2.84	2.95	4.23	2.86	3.71	4.90
<i>N (kg/ha)</i>						
0	16.98	15.08	16.03	44.06	38.91	41.48
25	22.38	20.98	21.68	49.54	44.11	46.82
50	26.87	24.90	25.88	54.16	41.88	51.02
75	31.03	28.92	29.97	58.54	52.11	55.32
100	32.86	30.57	31.71	60.53	53.87	57.20
CD (P = 0.05)	2.21	1.82	2.53	2.24	1.77	2.56

(Table 2). There was marked increase in wheat yield with each increment of N up to 75 kg N/ha. The total production in terms of wheat equivalent yield clearly demonstrated the superiority of legume-wheat sequences as compared to rice-wheat sequence. Among legumes, pasture legume (stylo) gave higher wheat equivalent yield owing to maximum biomass production (Prasad and Kerketta, 1991). Increasing levels of N increased the wheat equivalent yield up to 75 kg N/ha.

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