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Effect of lime, organic and inorganic nutrients on wheat (*Triticum aestivum*) – soybean (*Glycine max*) cropping system in acidic red soils

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ABSTRACT

A field experiment was carried out during 1988–89, 1989–90 and 1990–92 to study the direct effect of lime, organic and inorgnic nutrients on wheat (*Triticum aestivum* L. emend. Fiori & Paol.) and its carry-over effect on soybean [*Glycine max* (L.) Merr.]. Lime (1.25 tonnes/ha), FYM (4 tonnes/ha) and boron (10 kg/ha) in combination with 60 kg N + 30 kg P_2O_5 + 20 kg K_2O/ha resulted in the highest yield of wheat (29.3 q/ha). A significant residual effect was also observed for soybean (23.4 q/ha) with application of 30 kg N + 60 kg P_2O_5 + 30 kg K_2O/ha. The direct and the carry-over effects of lime and organic manure along with inorganic nutrients application significantly increased the uptake of N, P and K by both the crops in the cropping system.

Key words: Wheat – soybean cropping, Lime, Nutrients, Acidic red soil

Wheat–soybean system is gaining popularity in the soybean-growing areas of the country. In recent years, wheat harvest/ha multiplied many times, resulting in severe soil depletion by way of removal of essential nutrients. Soybean, unlike other legumes, having higher N content, requires higher amount of nitrogen. Our fertilizer recommendations so far are mostly macronutrient-oriented and single crop based, lacking in basic requirement of balanced nutrition. In such a system, effect of fertilizers must be assessed well because the crops grown in fixed cropping sequence behave differently than grown in individually (Dixit *et al.*, 1993). Hence an experiment was conducted to study the effect of lime, organic and inorganic nutrients on wheat–soybean cropping system in acidic red soils.

MATERIALS AND METHODS

The field experiment was conducted at Semiliguda during 1988–89, 1989–90 and 1990–91. The soil was acidic (pH 5.8) and sandy loam, with organic carbon 0.61%, total N 0.059%, available P_2O_5 17.08 kg/ha, available K_2O 142 kg/ha and available boron 0.3 mg/kg soil. The experiment was laid out in randomized block design, replicated 4 times. The treatments consisted of T_1, 80 kg

Table 1. Effect of different treatments of fertilizer management on yield (q/ha) of wheat–soybean cropping system

Treatment	Grain yield of wheat (q/ha)				Seed yield of soybean (q/ha)				Wheat-equivalent yield (q/ha)			
	Y_1	Y_2	Y_3	Mean	Y_1	Y_2	Y_3	Mean	Y_1	Y_2	Y_3	Mean
T_1	27.9	27.1	29.8	28.3	24.8	19.2	20.1	21.3	72.5	61.7	66.0	66.7
T_2	28.7	27.5	30.3	28.8	24.9	20.4	21.4	22.3	73.5	64.2	68.8	68.8
T_3	29.4	27.6	30.3	29.1	25.8	20.9	21.9	22.9	75.8	65.2	69.7	70.2
T_4	29.8	27.7	30.5	29.3	25.8	21.7	22.7	23.	76.2	66.8	71.4	71.5
T_5	29.5	26.3	28.9	28.2	23.8	17.1	17.9	19.6	72.3	57.1	61.1	63.5
T_6	16.0	25.0	27.5	22.8	22.9	12.9	13.5	16.5	57.2	48.2	51.8	52.4
T_7	21.3	22.6	24.8	22.9	20.4	10.2	10.7	13.7	58.0	40.9	44.1	47.7
T_8	23.1	19.0	20.9	21.0	20.0	8.9	9.4	12.8	59.1	35.0	37.8	44.0
CD ($P = 0.05$)	3.62	7.16	7.87	5.68	2.60	4.35	4.56	3.12	8.30	14.99	16.08	11.30

T_1, 80 kg N + 40 kg P_2O_5 + 20 kg K_2O/ha + lime (1.25 tonnes/ha); T_2, 60 kg N + 30 kg P_2O_5 + 20 kg K_2O/ha + lime (1.25 tonnes/ha) + FYM (4 tonnes/ha); T_3, 80 kg N + 40 kg P_2O_5 + 20 kg K_2O/ha + lime (1.25 tonnes/ha) + B(10 kg/ha); T_4, 60 kg N + 30 kg P_2O_5 + 20 kg K_2O/ha + lime (1.25 tonnes/ha) + FYM (4 tonnes/ha) + B (10 kg/ha); T_5, 80 kg N + 60 kg P_2O_5 (30 kg as SSP and 30 kg as MRP) + 20 kg K_2O/ha; T_6, 80 kg N + 60 kg P_2O_5 (as MRP) + 20 kg K_2O/ha; T_7, 80 kg N + 40 kg P_2O_5 as DAP + 20 kg K_2O/ha; T_8, 80 kg N + 40 kg P_2O_5 + 20 kg K_2O/ha (recommended dose for wheat)

N + 40 kg P_2O_5 + 20 kg K_2O/ha + lime (1.25 tonnes/ha); T_2, 60 kg N + 30 kg P_2O_5 + 20 kg K_2O/ha + lime (1.25 tonnes/ha) + FYM (4 tonnes/ha); T_3, 80 kg N + 40 kg P_2O_5 + 20 kg K_2O/ha + lime (1.25 tonnes/ha) + B (10 kg/ha); T_4, 60 kg N + 30 kg P_2O_5 + 20 kg K_2O/ha + lime (1.25 tonnes/ha) + FYM (4 tonnes/ha) + B (10 kg/ha); T_5, 80 kg N + 60 kg P_2O_5 (30 kg as SSP + 30 kg as MRP) + 20 kg K_2O/ha; T_6, 80 kg N + 60 kg P_2O_5 (full as MRP) + 20 kg K_2O/ha; T_7, 80 kg N + 40 kg P_2O_5 as DAP + 20 kg K_2O/ha; and T_8, 80 kg N + 40 kg P_2O_5 + 20 kg K_2O/ha (recommended dose for wheat). The N was applied in form of urea, K_2O in form of muriate of potash and P_2O_5 in form of SSP or MRP as per treatments. The carry-over effects on 'Gaurav' soybean were studied with a common dose of 30 kg N + 60 kg P_2O_5 + 30 kg K_2O/ha, except that of T_5 and T_6 where P_2O_5 was not added. Lime and FYM were mixed with soil 15 days before sowing of wheat. The test crop wheat was established by sowing in 20 cm row spacing in the second fortnight of October and the crop was grown under irrigated condition. After wheat, individual plots without changing the layout were prepared for soybean and sown in 40 cm rows in second fortnight of June as a rainfed crop. Grain and straw samples of both the crops were collected at harvest and analysed for total N (modified micro-kjeldahl's method), P (vanado-molybdo phosphoric acid yellow colour method by spectrophotometer) and K (flame photometer).

RESULTS AND DISCUSSION

The grain yield of wheat and its components, viz. plant height, ear length, seeds/ear, ears/m length and 1,000-grain weight, were significantly higher either in lime alone or in lime + FYM or lime + boron or lime + FYM + boron or even in 50% P_2O_5 as SSP + 50% P_2O_5 as MRP-treated plots along with inorganic nutrients compared with the recom-

Table 2. Effect of different treatments on yield attributes and straw or stalk yield of wheat and soybean (pooled data of 3 years)

Treatment	Wheat						Soybean			
	Plant height (cm)	Ear length (cm)	Grains/ ear	Ears/m length	1,000-grain weight	Straw yield (q/ha)	Plant height (cm)	Pods/ plant	Seed/ plant	Stalk yield (q/ha)
T_1	76.6	9.08	28.1	54.8	42.5	44.5	41.6	36.4	2.66	38.7
T_2	77.0	9.22	28.2	55.2	42.5	44.3	42.4	37.3	2.72	39.6
T_3	77.2	9.23	28.2	55.0	42.5	47.1	43.5	38.2	2.82	41.5
T_4	78.6	9.41	28.6	56.8	42.6	50.1	45.3	40.2	2.90	41.8
T_5	76.0	9.19	28.0	54.7	42.4	43.3	39.1	36.0	2.62	34.3
T_6	72.2	8.82	27.4	53.9	42.3	38.6	38.0	36.9	2.70	31.9
T_7	72.1	8.81	27.3	53.8	42.3	38.2	36.9	31.8	2.28	26.9
T_8	70.2	8.76	27.1	52.4	42.1	35.1	35.8	30.7	2.18	24.4
CD (P = 0.05)	2.6	0.42	1.2	2.8	NS	8.9	6.42	6.81	0.64	8.6

Details of treatments are given under Materials and Methods

Table 3. Effect of different treatments on nutrient uptake (kg/ha) by wheat–soybean cropping system (pooled data of 3 years)

Treatment	Uptake by wheat (kg/ha)			Uptake by soybean (kg/ha)			Total uptake in system(kg/ha)		
	N	P	K	N	P	K	N	P	K
T_1	86.2	7.8	52.6	122.8	15.9	40.8	209.0	23.7	93.4
T_2	96.4	8.1	54.0	129.0	16.8	42.6	225.4	24.9	96.6
T_3	102.0	8.6	58.0	138.2	17.6	43.8	240.2	26.2	101.8
T_4	105.8	9.0	63.0	149.6	18.2	46.0	255.4	27.2	109.0
T_5	82.8	7.7	51.8	117.6	14.7	38.6	200.4	22.4	90.4
T_6	66.4	7.0	48.0	115.6	13.6	37.5	182.0	20.6	85.5
T_7	65.1	6.6	44.6	112.0	13.0	34.2	177.1	19.6	78.8
T_8	58.9	6.2	42.0	105.0	12.0	33.6	163.9	18.2	75.6
CD (P = 0.05)	21.24	1.62	8.84	16.32	2.84	7.56			

Details of treatments are given under Materials and Methods

mended dose of fertilizer for wheat (Tables1, 2). However, application of 60 kg N + 30 kg P_2O_5 + 20 kg K_2O/ha + lime (1.25 tonnes/ha) + B (10 kg/ha) + FYM (4 tonnes/ha) resulted in the highest average grain yield of wheat. The effect may be attributed to supply of nutrients particularly of NPK which can be explained by increase in plant uptake of 24–47 kg N/ha, 1.5–3.0 kg P/ha and 10–21 kg K/ha in treated plots over that of recommended dose (Table 3). The increase in N uptake due to liming could be attributed to possibility of increase in mineralization and nitrification rate in the soil (Datta and Gupta, 1983). The highest P uptake could be due to increased mineralization of organic P and breaking of Fe and Al phosphate complexes and ultimately increased available P content in the soil. The increased K- supplying capacity of acid soils could be due to lime application. Similar results were also reported by Prasad and Singh (1987). The plant uptake of N, P and K followed the pattern of wheat-grain yield. The higher nutrients could enable the wheat plant to produce longer ear length, more seeds/ear, ears/m length and 1,000-grain weight which were positively correlated with the yield.

The residual effect of lime or lime+ FYM or lime + boron or lime + FYM + boron resulted in significantly higher seed or grain yield, yield attributes and nutrient uptake of soybean. But the carry-over effect of 50% P_2O_5 as SSP + 50% P_2O_5 as MRP was not found significant in increasing yield of soybean over that of recommended dose of fertilizer for wheat. The improvement in soybean could be attributed to increased rhizobial population in the rhizosphere. The similar results of increase in yield and nutrient uptake due to lime in wheat–soybean cropping system was also reported by Dixit *et al.* (1993).

Pooled data indicate that application of 60 kg N + 30 kg P_2O_5 + 20 kg K_2O + lime (1.25 tonnes/ha) + FYM (4 tonnes/ha) + B (10 kg/ha) proved beneficial to wheat crop and also to soybean crop grown with 30 kg N + 60 kg P_2O_5 + 30 kg K_2O/ha to a great extent. It indicates that the crops should also receive fertilizer directly to achieve higher productivity of wheat–soybean cropping system.

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