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Effect of weed control, fertilizer application and *Rhizobium* on nutrient uptake under maize + soybean intercropping system

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ABSTRACT

A field experiment was conducted during rainy season (*kharif*) 1993 and 1994 on clay-loam soils of Rajasthan College of Agriculture, Udaipur. Maximum NPK uptake by maize and soybean was recorded under manual weeding twice, followed by application of metolachlor and pendimethalin 1.0 kg/ha. Among weed-control treatments, unweeded check recorded the highest NPK uptake by the weeds. Fertilizer levels and *Rhizobium* inoculation to intercrop had no effect on nutrient uptake of maize, but significantly increased the nutrient uptake of soybean.

Key words : Weed control, Maize-soybean intercropping, *Rhizobium*, Nutrient uptake

The area under soybean as pure as well as intercrop in maize is increasing in the south-east Rajasthan. Soybean intercropping in maize has proved effective in increasing the productivity under rainfed conditions (Gaur *et al.*, 1994; Jat *et al.*, 1998). Weed and fertility management under maize + soybean intercropping is very important. Because of the rainy season, the emergence and growth of weeds is quite vigorous. Further, soybean, despite being a legume crop, requires high amount of nitrogen compared with other rainy season (*kharif*) legumes. An experiment was therefore conducted to study the effect of weeds control, fertilizer application and *Rhizobium* inoculation on yield and nutrient uptake in maize + soybean intercropping system.

MATERIALS AND METHODS

The experiment was conducted during *kharif* 1993 and 1994 at the Agronomy Farm of Rajasthan College of Agriculture, Udaipur. The soil of the experimental field was clay loam with pH 8.3, and had 91, 29.4 and 212.0 kg available nitrogen, phosphorus and potassium respectively. The rainfall was 443.2 mm and 688.6 mm during the crop season of 1993 and 1994.

The experiment was laid out in split-plot design three replications. The experiment comprised three levels of fertilizers (0, 50 and 100% recommended dose) and two levels of *Rhizobium* inoculation (with and without) to the intercrop, allotted in main plots, and six levels of weed control (unweeded check, 2 manual weedings at 25 and 40 days after sowing, fluchloralin 1.0 kg/ha, pendimethalin 1.0 kg/ha, metolachlor 1.0 kg/ha and metribuzin 0.5 kg/ha) in subplots. The recommended dose of nitrogen and phosphorus used for soybean was 60 and 40 kg/ha respectively. The main crop maize was fertilized with 90 kg N and 40 kg P_2O_5/ha. Maize 'Navjot' and soybean 'Gaurav' were sown in alternate rows spaced 30 cm apart.

RESULTS AND DISCUSSION

Effect of weed management

Nitrogen, phosphorus and potassium uptake by maize, soybean and weed was significantly influenced by weed-control treatments during both the years. Highest mean uptake of NPK by maize (173.3, 39.1 and 103.6 kg/ha) and soybean (95.8, 10.8 and 65.2 kg/ha) was recorded under manual weeding, followed by metolachlor and pendimethalin (Table 1). In unweeded check the weeds had a major share of plant nutrients and removed 54.8, 12.1 and 59.4 kg/ha of N, P and K respectively, whereas in manually weeded plots the mean NPK uptake by weeds was only 5.0, 3.0 and 5.5 kg/ha respectively (Table 2).

Greater uptake of nutrients by maize and soybean in weed-managed plots might be the outcome of improved plant growth and higher dry-matter production by the two crops under weed-free environment, along with meagre absorption of plant nutrients by weed. Reduced weed competition in weed-free plots also increased the root development and proliferation, which in turn helped in greater absorption of nutrients from the soil. The results confirm the findings of Thakur *et al.* (1990) in maize and Tuteja *et al.* (1995) in soybean.

Effect of fertilizers

Application of 100% (60 kg N+ 40 kg P_2O_5/ha) and 50% (30 kg N + 20 kg P_2O_5/ha) recommended lose of fertilizers to intercrop resulted in significantly higher uptake of NPK by soybean over no fertilizer application (Table 1). Highest uptake of these nutrients was recorded under application of 100% recommended dose. The increase in nutrient status of plants under fertilization appears to be a cumulative effect of better root development, higher root nodules and greater dry-matter production by crop under an adequate and balanced nutritional environment. Similar were the findings of Pal *et al.* (1988) and Jat *et al.* (1998).

Effect of Rhizobium *inoculation*

Significant increases in nutrient uptake by soybean crop due to *Rhizobium* inoculation was observed during both the years (Table 1). An increase in nutrient uptake by the crop under inoculation might be due to the increased root nodulation and bacterial population, which helped in greater fixation of atmospheric nitrogen and thereby increasing the availability of more nitrogen for soybean plants. Vargas and Ramirez (1989) reported similar findings.

Table 1. Effect of weed management, fertilizer levels and *Rhizobium* inoculation on nutrient uptake by maize and soybean at harvest (kg/ha)

Treatment	Nitrogen						Phosphorus						Potassium					
	Maize			Soybean			Maize			Soybean			Maize			Soybean		
	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean
Fertilizer level																		
F_0	95.5	143.6	119.5	51.7	75.5	63.6	21.7	31.3	26.5	5.8	8.5	7.1	116.6	162.8	139.7	35.3	50.7	43.0
F_1	97.0	147.1	122.0	67.5	92.0	79.8	22.7	32.2	27.4	7.7	10.4	9.0	119.0	166.7	142.8	46.0	62.2	54.1
F_2	98.1	150.8	124.5	82.3	102.1	92.2	22.9	32.9	27.9	9.4	11.6	10.5	121.4	170.5	146.0	57.0	69.4	63.2
CD (P = 0.05)	NS	NS		3.07	4.52		NS	NS		0.33	0.52		NS	NS		2.29	3.21	
Rhizobium inoculation																		
I_0	96.0	146.9	121.4	61.4	80.9	71.2	22.1	31.6	26.8	6.9	9.1	8.0	118.0	164.4	141.2	42.2	54.4	48.3
I_1	97.8	149.1	123.5	73.0	98.8	85.9	22.7	32.6	27.7	8.3	11.2	9.8	120.0	168.9	114.5	50.0	67.2	58.6
CD (P = 0.05)	NS	NS		2.51	3.69		NS	NS		0.27	0.48		NS	NS		1.87	2.62	
Weed management																		
W_0	38.4	70.2	54.3	31.9	50.7	41.3	8.9	15.3	12.1	3.6	6.1	4.9	43.8	75.1	59.4	21.6	34.1	27.9
W_1	138.7	207.9	173.3	84.1	107.4	95.8	32.4	45.9	39.1	9.5	12.1	10.8	169.8	223.4	196.6	57.8	72.6	65.2
W_2	72.4	107.2	89.8	63.4	89.0	76.2	16.1	22.4	19.2	7.2	9.9	8.5	88.6	122.8	105.7	43.2	60.1	51.7
W_3	130.1	194.8	162.4	79.6	101.8	90.7	30.5	43.1	36.8	9.1	11.5	10.3	162.8	227.6	195.2	54.8	69.1	61.9
W_4	132.6	198.6	165.6	81.3	104.7	93.0	31.1	44.0	37.6	9.3	11.8	10.5	164.9	230.6	197.8	56.1	71.1	63.6
W_5	69.0	104.4	86.7	62.9	85.5	74.2	15.5	21.9	18.7	7.1	9.6	8.4	84.3	106.5	95.4	43.0	57.6	50.3
CD (P = 0.05)	5.33	8.36		3.87	5.82		1.26	1.87		0.43	0.67		6.62	9.94		2.75	3.64	

F_0 = No fertilizer; F_1 = 100% recommended dose; F_2 = 50% recommended dose; I_0 = no inoculation; I_1 = *Rhizobium* inoculation; W_0 = unweeded; W_1 = 2 manual weedings; W_2 = fluchloralin 1.0 kg/ha; W_3 = pendimethalin 1.0 kg/ha; W_4 = metolachlor 1.0 kg/ha; W_5 = metribuzin 0.5 kg/ha

Table 2. Effect of weed management, fertilizer levels and rhizobium inoculation on nutrient uptake by weeds at harvest and seed yield of maize and soybean

Treatment	Nutrient uptake (kg/ha)									Seed yield (q/ha)					
	Nitrogen			Phosphorus			Potassium			Maize			Soybean		
	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean
Fertilizer level															
F_0	9.4	12.8	11.1	5.6	7.6	6.6	10.3	14.3	12.3	30.5	44.7	37.6	6.1	8.6	7.3
F_1	9.8	13.4	11.6	5.8	8.0	6.9	10.7	14.7	12.7	31.4	45.7	38.5	7.4	10.3	8.8
F_2	10.1	13.9	12.1	6.1	8.4	7.2	11.2	15.2	13.2	32.1	46.7	39.4	8.6	11.7	10.1
CD (P = 0.05)	0.39	0.58		0.27	0.36		0.46	0.54		NS	NS		0.33	0.50	
Rhizobium *inoculation*															
I_0	9.7	13.2	11.5	5.8	7.9	6.8	10.6	14.6	12.6	31.2	45.4	38.3	7.0	9.4	8.2
I_1	9.8	13.5	11.7	5.9	8.1	7.0	10.8	14.8	12.8	31.5	45.9	38.7	7.7	11.1	9.4
CD (P 0.05)	NS	NS		NS	NS		NS	NS		NS	NS		0.27	0.38	
Weed management															
W_0	24.0	32.8	28.4	14.3	19.7	17.0	26.3	36.1	31.2	14.6	26.2	20.4	3.8	6.7	5.2
W_1	4.2	5.8	5.0	2.5	3.5	3.0	4.7	6.4	5.5	43.0	61.5	52.2	8.7	11.6	10.1
W_2	9.3	12.7	11.0	5.5	7.6	6.6	10.2	14.0	12.1	24.1	34.5	29.3	7.3	10.6	8.9
W_3	6.7	9.2	8.0	4.0	5.5	4.8	7.4	10.1	8.8	41.5	59.3	50.4	8.5	11.3	9.9
W_4	6.5	8.9	7.7	3.9	5.3	4.6	7.1	9.8	8.5	41.9	59.9	50.9	8.6	11.5	10.0
W_5	7.8	10.8	9.3	4.7	6.4	5.5	8.6	11.8	10.2	22.9	32.7	27.8	7.1	9.9	8.5
CD (P = 0.05)	0.50	0.74		0.34	0.44		0.59	0.75		1.75	2.92		0.41	0.65	

F_0 = No fertilizer; F_1 = 100% recommended dose; F_2 = 50% recommended dose; I_0 = no inoculation; I_1 = *Rhizobium* inoculation; W_0 = unweeded; W_1 = 2 manual weedings, W_2 = fluchloralin 1.0 kg/ha; W_3 = pendimethalin 1.0 kg/ha; W_4 = metolachlor 1.0 kg/ha; W_5 metribuzin 0.5 kg/ha

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