Indian Journal of Agronomy **44** (2) : 232–236 (June 1999)

Productivity potential of rice-sunflower-greengram cropping system as influenced by rational use of phosphorus

S. C. MASTHAN, S. N. REDDY, T. M. M. REDDY AND SHAIK MOHAMMAD

Department of Agronomy, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad 500 030

Received: September 1997

ABSTRACT

A field experiment was conducted during 1991-93 at Hyderabad to study the effect of P in rice-sunflower-greengram cropping system in sandy loam soil with moderate available P. The number of tillers and panicles/m^2, filled grains/panicle and test weight of rice significantly increased up to 60 kg P_2O_5/ha. The mean rice grain yield increased by 1,082 kg/ha over control (without P). The yield of sunflower in succeeding *rabi* significantly improved by residual P applied at 60 kg P_2O_5/ha to preceding rice and the direct effect of 60 kg P_2O_5/ha to sunflower. The mean seed yield of sunflower increased from 1,156 kg/ha in control to 1,611 kg/ha with direct application of 60 kg P_2O_5/ha. The mean sunflower yield increased significantly due to the cumulative effect of 60-60 kg P_2O_5/ha to rice in *kharif* and sunflower in *rabi*. The cumulative effect of P through 60-60 kg P_2O_5/ha to rice-sunflower also increased the mean grain yield of greengram to 912 kg/ha in the following summer season compared to 692 kg/ha through residual effect of 60 kg P_2O_5/ha only to rice and 707 kg/ha through residual effect of 60 kg P_2O_5/ha only to sunflower. However, the rice grain equaivalent yield of 11,546 kg/ha/year was obtained with application of 60 kg P_2O_5/ha both to rice and sunflower, being on par with 60 kg P_2O_5/ha to rice in *kharif* and 30 kg P_2O_5/ha to sunflower in *rabi*. Thus there was a saving of 30 kg P_2O_5/ha/year.

Key words: Rice, Sunflower, Greengram, Cropping system, Phosphorus

Intensive cropping is one of the most important and widely recognised agronomic considerations for sustaining and increasing the level of food grain production. It is also not unlikely that the soaring prices of fertilizers hinder the farmers to apply optimum dose. Phosphorus is the costliest major nutrient. Yet its application is inevitable to recap its heavy removal from different layers of the soil by the crops grown in succession. Most of the Indian soils have a poor to medium reserve of available P. Inclusion of a legume component in a cropping system would considerably save the fertilizer requirement due to the residual effect of its application to the preceding crop, varying mobilisation power of the component crops and mineralisation of residues left behind by the preceding crops (Vyas *et al.*, 1992). For optimum production of food grains, rational applica-

tion of P is immensely useful. Hence, this study was taken up on the rational use of P in rice-sunflower-greengram cropping system.

MATERIALS AND METHODS

A fields experiment was conducted at Hyderabad during 1991-93. The soil was sandy loam, low in available N (253 kg/ha), but medium in succeeding *rabi* and greengram 'LGG 127' in available P (18.2 kg/ha) and K (308.4 kg/ha). The rice cv. 'Tella Hamsa' was sown in *kharif*, sunflower hybrid 'APSH-11' in succeding *rabi* and greengram 'LGG 127' in summer. One month old rice seedlings were transplanted in third week of June and harvested in October. Sunflower was sown in the first week of November and harvested in February. Greengram was sown in third week of April and harvested in third week of June in the two years.

The experiment was laid out in randomised block design with three replications. There were nine treatments with 3^2 factorial combination of phosphorus applied at 0.30 and 60 kg P_2O_5/ha each to rice and sunflower. Greengram was grown without P. Rice and sunflower were fertilized with a basal dose of 40 kg N and 40 kg K_2O/ha at planting. Later, additional dose @ 40 kg N/ha was top dressed during tillering and panicle initiation in rice, and one month after sowing in sunflower.

RESULTS AND DISCUSSION

The direct, residual and cumulative influence of phosphorus applied at different doses had a significant role on the crop growth and yield of the three crop components viz., rice, sunflower and greengram.

Rice

The application of 30 kg P_2O_5/ha to rice significantly increased total number of tillers and panicles/m^2, filled grains/panicle, test weight, and seed and straw yields (Table 1). The crop produced additional mean yield of

Table 1. Influence of posphorus on yield components and yield of rice in rice-sunflower-greengram cropping system (Mean of 2 seasons)

Phosphorus (P_2O_5 kg/ha)	Total tillers/m^2	Panicles/ m^2	Panicle length (cm)	Filled grains/ panicle	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
Direct (kharif)							
0	318.5	294.5	17.2	62.6	19.26	4,301	4,769
30	383.8	363.4	18.9	68.3	20.47	4,921	5,253
60	400.4	441.8	21.0	77.3	22.22	5,383	5,521
CD (P = 0.05)	56.6	62.0	NS	4.9	1.04	443	266
Residual (rabi)							
0	364.4	352.1	18.4	68.1	20.21	4,807	5,150
30	381.6	362.4	18.8	69.1	20.50	4,880	5,176
60	396.4	381.7	19.5	70.6	20.90	4,962	5,270
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS

620 kg/ha over mean yield of 4301 kg/ha in control. Panda *et al.* (1995) also observed better performance of rice with 30 kg P_2O_5/ha. Increasing the dose of P to 60 kg P_2O_5/ha in rice produced an additional mean yield of 1,082 kg/ha over control. These results are in accordance with the findings of Panda *et al.* (1995).

The residual effect of P applied to rice or sunflower in first year had no effect on seed and straw yields or yield components of rice in second year. This lack of response could be attributed to the fact that preceding greengram grown during summer utilized the residual P for its growth and development. Hence, it is essential to apply 60 kg P_2O_5/ha direct to rice even in the second year sequence.

Sunflower

The application of 60 kg P_2O_5/ha significantly increased yield attributes (capitulum diameter, filled seeds/capitulum, test weight), oil content and seed yield (Table 2), probably due to effective translocation of photosynthates. The oil content also increased from 38.68% in control to 41.27%. This improvment in oil content might be due to the key role of P in inter-conversion of carbohydrates and other related compounds, amino acid metabolism, fat metabolism, and sulphur metabolism. The mean seed yield increased from 1,155 kg/ha in control to 1,610 kg/ha with 60 kg P_2O_5/ha. Thus, an additional yield of 455 kg/ha was produced. The mean stalk yield also increased from 2,767 kg/ha in control to 3,088 kg/ha with 60 kg P_2O_5/ha. Sharma (1994) reported that 45 kg P_2O_5/ha was optimum for better crop growth, yield attributes and yield of sunflower. However, Chaniara *et al.* (1989) emphasised the need to apply 80 kg P_2O_5/ha to realise high yield of sunflower. Inconsistencies in the dose of P needed by sunflower have been reported for the same variety at different locations and different varieties at the same location due to varying soil physical and environment factors, the root cation exchange capacity and the available P in the labile pool (Nambiar and Gosh, 1984)

Table 2. Influence of phosphorus on average yield components, oil content and yield of sunflower in rice-sunflower-greengram crop sequence (Mean of 2 seasons)

Phosphorus (P_2O_5 kg/ha)	Capitulum diameter (cm)	Filled seeds/ capitulum	Test weight (g)	Oil content (%)	Seed yield (kg/ha)	Stalk yield (kg/ha)
Direct (rabi)						
0	11.58	283.78	41.00	38.68	1,155	2,767
30	12.92	340.50	44.09	40.56	1,472	2,976
60	15.09	391.02	46.80	41.27	1,610	3,088
CD (P = 0.05)	1.45	35.5	2.55	1.03	58	180
Residual (kharif)						
0	11.83	301.34	40.36	39.64	1,296	2,846
30	13.38	339.49	44.15	40.30	1,436	2,959
60	14.37	374.47	47.28	40.58	1,503	3,026
CD (P = 0.05)	1.45	35.5	2.55	NS	58	NS

Sunflower was benefited by the residual effect of P applied to rice in preceding season. The capitulum diameter, filled seeds/capitulum, test weight and seed yield were significantly influenced with the application of 60 kg P_2O_5/ha. The additional seed yield was 195 kg and 219 kg/ha over control.

The cumulative effect of 60 kg P_2O_5/ha applied each to rice and sunflower significantly increased the seed yield of sunflower (Table 4). The mean yield was 1,731 kg/ha compared with 1,212 kg and 1,448 kg/ha obtained through the residual effect of 60 kg P_2O_5 to rice and direct effect of 60 kg P_2O_5/

Table 3. Influence of phosphorus applied to rice and sunflower on the performance of greengram (Mean of 2 seasons)

Phosphorus (P_2O_5 kg/ha)	No. of pods/plant	No. of seeds/pod	Test weight (g)	Seed yield (kg/ha)	Haulm yield (kg/ha)
Residual (kharif)					
0	12.06	7.04	36.10	648	1,846
30	12.71	7.44	38.48	744	1,891
60	13.29	8.18	40.13	804	2,078
CD (P = 0.05)	NS	NS	3.50	64	166
Residual (rabi)					
0	11.54	6.67	35.41	645	1,840
30	12.72	7.50	38.50	737	1,958
60	13.79	8.39	40.76	813	2,018
CD (P = 0.05)	1.74	1.35	3.50	64	160

Table 4. Influence of phosphorus on seed yield of sunflower, greengram and rice equivalent yield in rice-sunflower-greengram cropping system (Mean of 2 seasons)

Phosphorus (P_2O_5 kg/ha)		Seed yield of sunflower (kg/ha)	Seed yield of greengram (kg/ha)	Rice grain equivalent yield (kg/ha/year)
Kharif	*Rabi*			
0	0	1,086	568	8,082
0	30	1,356	668	8,979
0	60	1,447	707	9,359
30	0	1,166	677	9,110
30	30	1,491	735	10,089
30	60	1,653	821	10,705
60	0	1,212	692	9,721
60	30	1,568	808	10,884
60	60	1,731	911	11,546
CD (P = 0.05)		98	110	968

ha to sunflower in the preceding *kharif* and *rabi* seasons, respectively.

Greengram

The performance of greengram was significantly influenced by the residual effect of P applied in *kharif* and *rabi* as well as due to cumulative effect. The test weight, seed and haulm yields were significantly more due to residual effect of 60 kg P_2O_5/ha applied to rice in *kharif* (Table 3). An additional seed yield of 156 kg/ha was realised over control. The residual effect of P through sunflower was more pronounced. The yield attributes and seed and haulm yields were significantly improved with 60 kg P_2O_5/ha. The increase in yield of greengram owing to residual effect of P applied to preceding crops was also reported by Varma and Sharma (1994). The crop produced significantly more seed yield (902 and 921 kg/ha) due to cumulative effect of 60 kg P_2O_5/ha applied to each rice and sunflower than due to the residual effect of P through one of these crops (Table 4). The mean yield was 911 kg/ha due to cumulative effect compared with 692 and 707 kg/ha through the residual effect of 60 kg P_2O_5/ha to rice and sunflower in the preceding *kharif* and *rabi* seasons.

The rice equivalent yield of the cropping system (Table 4) increased significantly by application of 60 kg P_2O_5/ha both to rice and sunflower but was on par with 60 kg P_2O_5/ha to rice and 30 kg P_2O_5/ha to sunflower. Thus there was a saving of 30 kg P_2O_5/ha in *rabi* season.

It is concluded from the study that the application of 60 kg P_2O_5/ha to rice in *kharif* and 30 kg P_2O_5/ha to sunflower in *rabi* enhanced the total production in terms of rice equivalent yield in rice-sunflower-greengram cropping systems.

REFERENCES

Chaniara, N. J., Patel, J. C., Malavia, D. D. and Baidha, N. M. 1989. Effect of irrigation. N and P on the productivity of sunflower. *Indian Journal of Agronomy* **34** (4) : 399-401.

Nambiar, K. K. M and Ghosh, A. B. 1984. Highlights of research on long term fertilizer experiments in India (1971-82). *LTFA Project*. pp. 100.

Panda, S. C., Panda, P. C. and Nanda, S. S. 1995. Effect of levels of nitrogen and phosphorus on yield and nutrient uptake of rice. *Oryza* **32** : 18-20.

Sharma, 1994. Influence of irrigation schedule and fertility levels on yield of sunflower. *Indian Journal of Agronomy* **39** (3) : 496-497.

Verma, L.P. and Sharma, N.L. 1994. Residual effect of phosphatic fertilizers applied to wheat on succeeding crop of greengram. *Indian Journal of Agronomy* **39** : 237-240.

Vyas, A.K., Rai, R.K. and Sinha, M.N. 1992. Effect of planting patterns and phosphorus on availability of nutrients in sandy loam soil. *Annals of Agricultural Research* **13** : 262-266.