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Economic optima of phosphorus in yellow and black soybean (*Glycine max*)

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ABSTRACT

An experiment was conducted during the rainy seasons of 1986 and 1987 to assess the relationship between phosphorus level of yellow ('JS 72-44') and black ('JS 76-188') soybean [*Glycine max* (L.) Merr.]. Soybean responded well to P application and the optimum level was 88.09 and 94.47 kg/ha, yielding 1,760.33 and 1,870.79 kg/ha in yellow and black soybean respectively. However, the yield maximization of yellow and black soybean required 94.93 and 104.82 kg P_2O_5/ha, giving yield 1,764.03 and 1,877.46 kg/ha respectively. The net profit obtained was Rs 17.76 and 15.40/Re invested on optimum P_2O_5 level of fertilization. The economic optima at various price ratios showed a decrease in optimum level with the increase in ratio.

Adoption improved varieties coupled with suitable crop management practices results in further hike in production of soybean [*Glycine max* (L.) Merr.] achieved by Agronomic trials with soybean have shown that phosphorus is the most important nutrient element for soybean production (Nimje and Seth, 1987). Among all the inputs, fertilizer is the costly one. Therefore, economic optimal use of phosphorus in soybean is essential for getting maximum economic returns. Hence the present investigation was undertaken to study the response of yellow and black soybean to phosphorus application.

MATERIALS AND METHODS

The field experiment was conducted at Sehore during the rainy seasons (*kharif*) of 1986 and 1987. The soil of experimental field was clay loam having available N, P and K @ 336,13 and 575 gk/ha respectively, with pH 7.6. The experiment was laid out in randomized block design with 4 replications. The treatments consisted of combinations of 2 soybean varieties, viz. 'JS 72-44' (yellow) and 'JS 76-188' (black), and 7 levels of phosphorus (0, 20, 40, 60, 80, 100 and 120 kg/ha). A uniform dose of 20 kg/ha of each nitrogen and potassium was applied in all plots. Only pooled data were taken into consideration to compute quadratic equation for each variety. Yield maximization and optimum levels of P was estimated as proposed by Heady and Dhillon (1981). The economic dose of P at various input : output prices ratio was also computed.

RESULTS AND DISCUSSION

Effect of phosphorus

Soybean responded positively to the application of P in both the years as well as

Table 1. Observed yield of soybean and maginal analysis as influenced by P level

P_2O_5 (kg/ha)	Yield (kg/ha)		Marginal response (kg/ha)	Marginal value (Rs/ha)	Cost of P_2O_5 (Rs/ha)	Net profit (Rs/ha)	Benefit : cost
	Observed	Estimated					
0	1,042 (1,200)	1,052 (1,196					
20	1,280 (1,439)	1,320 (1,431)	268 (235)	2,147 (1,646)	180 (180)	1,967 (1,466)	11.92 (9.14)
40	1,575 (1,590)	1,525 (1,617)	205 (186)	1,642 (1,299)	180 (180)	1,462 (1,119)	9.12 (7.21)
60	1,666 (1,814)	1,668 (1,753)	142 (136)	994 (952)	180 (180)	814 (772)	5.52 (5.28)
80	1,701 (1,834)	1,746 (1,839)	79 (86)	630 (605)	180 (180)	450 (425)	3.50 (3.36)
100	1,729 (1,869)	1,762 (1,876)	16 (37)	125 (258)	180 (180)	—55 (78)	0.69 (1.43)
120	1,744 (1,874)	1,714 (1,863)	—47 (—13)	—381 (—90)	180 (180)	—561 (—270)	—2.11 (—0.50)

Data are inside parentheses outside and for yellow ('J 72-44) and black soybean ('JS 76-188')

in pooled analysis (Table 1). In general the yield of black soybean was higher at each level of P applied than that of yellow soyban. A linear increase in soybean yield was recorded as the levels of P increased, indicating that highest yield was obtained with 120 kg P_2O_5/ha. These findings are in conformity with the results of Mishra *et al.* (1990).

The response to each additional was linearly decreased in both the varieties and it was negative at 120 kg P_2O_5/ha. When comparing with control, yield increased only up to 100 kg/ha. The yellow soybean responded better up to 60 kg/ha than black soybean. However, the just reverse trend was noticed beyond 60 kg P_2O_5/ha.

Economic optima and maxima

The relationship between P and seed yield was best described by quadratic equation in yellow and black soybean:

Yellow soybean

$$Y = 1{,}052.00 + 15.0\ P - 0.079\ P^2$$
$$(R^2 = 98.36\%)$$

Black soybean

$$Y = 1{,}196.00 + 13.0\ P - 0.062\ P^2$$
$$(R^2 = 97.56\%)$$

From the equation the maximum estimated yields of 'JS 72-44' and 'JS 76-188' were found to be 1,764.03 and 1,877.46 kg/ha respectively. The economic optimum level of P for both the varieties were 88.09 and 94.47 kg/ha, giving soybean yield 1,760.33 and 1,870.79 kg/ha respectively.

Similarly, Pal *et al.* (1989) and Chiezey *et al.* (1991) opined that the 26 kg P_2O_5/ha was found to be optimum for soybean in sandy-loam acidic soils.

Economic returns and optimum levels of P at various input : output

The estimated additional response with net profit due to increment in P level

Table 2. Economic dose of phosphorus at various input : output prices for the varieties of soybean

Cost of P (Rs/kg)	Price of soybean (Rs/kg)	Price ratio	Optimum level of P (kg/ha)	Added yield (kg/ha)	Added value (Rs/ha)	Cost of P (Rs/ha)	Net profit (Rs/ha)	Benefit : cost ratio
				'JS 72-44' (yellow)				
6	4.00	1.50	85	705	2,820	513	2,307	5.50
	4.50	1.33	86	706	3,179	519	2,660	6.12
	5.00	1.20	87	707	3,537	524	3,013	6.75
	5.50	1.09	88	708	3,895	528	3,367	7.37
7	4.00	1.75	84	702	2,809	587	2,222	4.78
	4.50	1.55	85	704	3,170	596	2,574	5.32
	5.00	1.40	86	706	3,529	602	2,927	5.86
	5.50	1.27	87	707	3,888	608	3,280	6.39
				'JS 76-188' (black)				
6	3.50	1.71	91	670	2,344	546	1,797	4.29
	4.00	1.50	93	672	2,689	556	2,133	4.83
	4.50	1.33	94	674	3,034	564	2,470	5.37
	5.00	1.20	95	676	3,378	571	2,807	5.92
7	3.50	2.00	89	665	2,329	621	1,708	3.75
	4.00	1.75	91	669	2,676	635	2,041	4.21
	4.50	1.55	92	672	3,023	646	2,377	4.68
	5.00	1.40	94	674	3,368	655	2,713	5.14

(Table 1) indicated that the economic optimum level of P at prevailing prices was 80 kg P_2O_5/ha for both the varieties of soybean, which yielded marginal profit of Rs 450 and 425 for 'JS 72-44' and 'JS 76-188' with the investment of Rs 180 on fertilizer. The estimated rate of return of response over 0 level of P was maximum at 20 kg/ha and subsequently it decreased. In general, the rate of return was higher in yellow than in black soybean.

The maximum profitable level of P/ha computed for various input : output prices revealed that as the prices of output increased keeping the prices of P constant, the optimum level of P increased for obtain higher yield. These results are in agreement with the findings of Lomte and Khuspe (1990) in summer groundnut.

It was concluded that P_2O_5 @ 88.09 and 94.47 kg/ha would be necessary to harvest optimum production of yellow ('JS 72-44') and black ('JS 76-188') soybean.

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