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Review

Effect of seed rate, row spacing and fertility levels on relative economics of soybean (*Glycine max*. L.) under temperate conditions

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A field experiment was conducted at Shalimar campus during *kharif* seasons in 2004 and 2005 on a silt clay loam soil, with average available N and K, and low P. The experiment was done to study the production performance of soybean as influenced by seed rate, row spacing and fertility levels under temperate conditions. The experiment, comprising 27 treatment combinations viz., 3 levels each of seed rate (40, 60 and 80 kg ha^{-1}), row spacing (30, 45 and 60 cm) and fertility (40:60:40, 60:90:60 and 80:120:80 of N:P_2O_5:K_2O kg ha^{-1}), was laid out in split plot design, and replicated thrice. The highest B:C ratio of 3:20 and maximum net returns of Rs. 37351 were recorded with treatment combination of 60 kg seed rate ha^{-1} at 45 cm row to row spacing and with the application N:P_2O_5:K_2O in the ratio of 60:90:60 kg ha^{-1}.

Key words: Fertility, seed rate, soybean, spacing, relative economics, temperate.

INTRODUCTION

Soybean designated as 'miracle bean' has established its potential as an industrially vital and viable oilseed crop in many areas of India. Soybean has now been established as one of the most important oilseed crops in the world, accounting for more than 50% of oilseeds production and 30% of the total supply of all vegetable oils. It is a unique two-in-one crop, having both high quality protein (43) and oil (20%) content. The protein form of soybean is equivalent in quality to that of meat, milk products and eggs. Soybean (including its products), mainly on account of its dietetic, industrial, agricultural and medicinal importance, has various uses. The soya meal is an important human food and soya flour is essential in various preparations viz, bread, cakes, muffins, biscuits and pastry. Being medicinal, soybean is of great importance in diabetic dietary.

Soybean plays a vital role in agricultural economy of India. The low productivity of the crop is due to several constraints, one among them is unbalanced nutrition (Sharma et al., 1996). For its optimum yield realization, it is necessary to optimize the nutrient inputs. Fertilizer application is a very important practice, and at present the most baffling. Studies carried out indicate that soybean shows inconsistent response to application of nitrogen, phosphorus and potassium.

Plant population is another important factor for higher yield realization through light penetration in crop canopy. If plant density is above the optimum, the plant growth may be poor due to competition for nutrients, light and space. On the other hand, if it is below optimum then the nutrients, space and light will not be utilized to their fullest, thus resulting in poor yield. For exploiting the potential of high yield varieties, the optimum plant stand is a very important non-monetary input. Solar energy being unlimited, inexhaustible and non-pollutant, its efficient utilization for crop production could be major consideration especially for a row crop like soybean. Also for higher crop productivity, total leaf area per unit land area and light penetration to lower layers of the canopy assume importance. Increasing or reducing the leaf area index from the optimum reduces the crop growth rate due to lesser energy capture or shading of lower canopy layers. Therefore, it is imperative to find out the optimum planting density to obtain optimum leaf area index and to maintain it for longer period to improve yield potential of

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Abbreviations: N, Nitrogen; **P,** phosphorus; **K,** potassium; **Rs,** Indian currency (Rupee).

Table 1. Relative economics of soybean pooled data (2004 and 2005) as affected by treatment combinations, seed rate, spacing and fertility levels under temperate conditions.

Treatment	Gross returns (Rs ha^{-1})		Total (Rs ha^{-1})	Total cost of cultivation	Net returns (Rs ha^{-1})	B:C ratio
	Grain	Straw				
R_1 S_1 F_1	32598	2045	34643	11928	22715	1.98
R_1 S_1 F_2	32958	2086	35044	12491	22603	1.80
R_1 S_1 F_3	33220	2101	35329	12882	22972	1.78
R_1 S_2 F_1	34362	2131	36493	11623	24870	2.13
R_1 S_2 F_2	34992	2170	37162	12043	25119	2.08
R_1 S_2 F_3	35478	2206	37684	12562	25122	1.99
R_1 S_3 F_1	36342	2238	38580	11292	27288	2.41
R_1 S_3 F_2	37008	2248	39256	11488	27468	2.39
R_1 S_3 F_3	37854	2283	40137	12895	26242	2.03
R_2 S_1 F_1	34884	2251	37135	11997	25138	2.09
R_2 S_1 F_2	37314	2254	39568	13592	25976	2.91
R_1 S_1 F_3	38142	2250	40392	14370	26022	2.81
R_2 S_2 F_1	40572	2372	42944	11122	31822	2.86
R_2 S_2 F_2	46566	2431	48997	12646	37351	3.20
R_2 S_2 F_3	47124	2516	49640	12648	36992	2.92
R_2 S_3 F_1	44676	2483	47159	11318	35841	3.16
R_2 S_3 F_2	45108	2506	47614	11726	35888	3.06
R_2 S_3 F_3	44676	2562	47238	12489	34749	2.78
R_3 S_1 F_1	41292	2518	43810	11665	32154	2.75
R_3 S_1 F_2	41724	2505	44229	12123	32106	2.64
R_3 S_1 F_3	42264	2496	44760	13688	31072	2.27
R_3 S_2 F_1	41076	2509	43585	11242	32343	2.87
R_3 S_2 F_2	41580	2520	44100	12038	32062	2.70
R_3 S_2 F_3	43812	2539	46351	13073	33278	2.54
R_3 S_3 F_1	43560	2593	46153	11910	34243	2.87
R_3 S_3 F_2	44532	2646	47178	12600	34578	2.74
R_3 S_3 F_3	43524	2712	46236	13238	32998	2.49

Cost of seed (PS-1092) = Rs 45/kg; Sale price = Rs.18/kg; S.S.P = Rs.683/q; Phorate = 68/kg; Sale price of straw = Rs.60/q; M.O.P. = Rs.455/q; Urea = Rs.490/q; Labour = Rs.70/day.

soybean. The optimum plant density with proper geometry of planting is dependent on variety, its growth habit and agro-climatic conditions. The row-to-row spacing with plant population should be maintained for getting better results from this crop.

RESULTS AND DISCUSION

Relative economics with respect to grain and straw yield of soybean was worked out for all treatment combinations of seed rate, spacing and fertility levels in pooled data of two years viz., 2004 and 2005 (Table 1). Gross returns, net returns and benefit cost ratios were calculated on the basis of cost of cultivation viz., fertilizers, seed, labour, tractorization and other miscellaneous costs. Kacha et al. (1990) reported that 30 cm row spacing gave the maximum net returns of Rs 4849 ha^{-1}. The net returns (Rs 5082 ha^{-1}) were also highest with fertility level of 30 kg N + 60 kg P_2O_5. Population of 0.6 million plants ha^{-1} gave the highest net returns compared with other population levels (0.2, 0.4 and 0.8 million plants ha^{-1}) (Sharma and Sharma, 1993). Singh et al. (1994) reported that the highest net returns were obtained with combination of 40 kg N and 80 kg P_2O_5 ha^{-1}. However, the benefit cost ratio was maximum at lower fertilizer rate (10 kg N + 20 kg P_2O_5 ha^{-1}) and it decreased at higher fertilizer rates. Goswami et al. (1999) reported that application of P_2O_5 at 60 kg ha^{-1} resulted in highest net returns. Nimje et al. (2003) while making economic evaluation of the planting densities revealed that the lowest density of 444,000 ha^{-1} was found most remunerative with regard to time and seed requirement. Besides, it increased net returns by Rs 6,669 ha^{-1} with B:C ratio 4.31 compared to control (1.00). Also at 666,000 and 533,000 plants ha^{-1}, B:C ratio was 1.95 and 3.03, respectively.

Pooled data of 2004 and 2005 revealed highest gross

returns of Rs.49, 640 ha^{-1} realized from treatment combination of seed rate at 60 kg ha^{-1}, with spacing 45 cm and highest fertilizer dose with B:C ratio of 2.92. However, B:C ratio of 3.2 was highest in treatment combination of seed rate at 60 kg ha^{-1} sown at spacing of 45 cm with medium fertility level of N_{60}, P_{90} and K_{60}. This was due to higher input cost of fertilizer in case of $R_2S_2F_3$ and lower input fertilizer cost in $R_2S_2F_2$. Singh et al. (1994) also reported that highest net returns were obtained with combination of 40 kg N and 80 kg P_2O_5 ha^{-1}.

Conclusion

The results of the study for the consecutive two years showed that among different levels of seed rate, row to row spacing and fertility levels, 80 kg ha^{-1}, 60 cm and N_{80}:P_{120}:K_{80} kg ha^{-1}, respectively realized significantly higher grain yield of soybean. But the benefit cost ratio of Rs.3.20 and net returns of Rs.37,351 were observed due to the treatment combination of seed rate of 60 kg ha^{-1} × row to row spacing of 45 cm and N : P_2O_5 and K_2O at N_{60} : P_{90} and K_{60} kg ha^{-1}. In view of this, it is recommended to sow the soybean with given combination of seed rate, spacing and fertility levels.

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