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Yield and economics of soybean as influenced by various levels of nitrogen and phosphorus

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Abstract

A field experiment was conducted at Main Agricultural Research Station, Dharwad on medium black soil during *Kharif*-2015. There were twelve treatment combinations consisted of three levels of nitrogen (20, 40 and 60 kg N ha^{-1}) and four levels of phosphorus (40, 60, 80 and 100 kg P_2O_5 ha^{-1}). Significantly higher soybean seed yield (25.77 q ha^{-1}), haulm yield (31.32 q ha^{-1}), net returns (72438 Rs. ha^{-1}) and B:C ratio (3.38) recorded with combined application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 80 kg ha^{-1}compared to other treatments and it was on par with application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 100 kg ha^{-1}. Application of nitrogen @ 60 kg, phosphorus @ 80 kg and potash @ 25 kg per hectare found optimum to obtain substantial soybean seed yield.

Keywords: Soybean, nitrogen, phosphorus, yield and economics.

Introduction

Soybean (*Glycine max* L. Merrill), is an introduced and commercially exploited crop in India. The crop is also called as “Golden Bean” or “Miracle crop” of the 21st century on account of its multiple uses. It has highest protein 40 %, oil 20 %, rich in lysine and vitamins A, B and D and also rich in mineral salts. Among the nutrients; nitrogen is a major essential plant nutrient element. Soybean being a legume crop is capable of fixing atmospheric nitrogen through symbiosis but the symbiotic N-fixation alone is not enough to meet high N-requirement of this crop (Ashour and Thalooth, 1983) [2]. Application of small amount of fertilizer N at sowing time as a starter dose for the crop improves the biological nitrogen fixation (BNF). Nitrogen tends primarily to encourage above ground vegetative growth and to impart deep green colour to the leaves. Plants receiving insufficient nitrogen are stunted in growth with restricted root systems. The leaves turn yellow or yellowish green and tend to drop off. Phosphorus stimulates rhizobial activity, nodule formation and thus helps in N_2-fixation. It increases the water use efficiency, improves storage quality and hardiness of the bean seed coat. As phosphorus plays a role in photosynthesis, respiration, energy storage and transfer, cell division and enlargement, it has been shown to be important for growth, development and yield of soybean (Kakar *et al*., 2002) [7]. It helps in uptake of more nutrients and balances the nitrogen deficiency in soil and assists in seed maturation. Thus, it is needed to find out proper amount of nitrogen and phosphorus required for achieving better yield of soybean. Hence, in order to verify and workout the optimum nitrogen and phosphorus dose the present investigation was undertaken.

Material and Methods

The field experiment was carried out at Main Agricultural Research Station, Dharwad, during *kharif*-2015 to study the "yield and economics of soybean as influenced by various levels of nitrogen and phosphorus"

The experiment was replicated thrice in Randomized Complete Block Design in factorial concept. There were twelve treatment combinations consisted of three nitrogen levels (20, 40 and 60 kg N ha^{-1}) and four phosphorus levels (40, 60, 80 and 100 kg P_2O_5 ha^{-1}). One of the treatment combinations comprised the recommended dose of 40 kg N, 80 kg P_2O_5 and 25 kg K_2O per hectare. The soil was medium deep black with pH 7.10. The available N, P_2O_5 and K_2O contents were 252, 32.5 and 292.8 kg ha^{-1}, respectively. FYM @ 5 t ha^{-1} was applied 15 days before sowing of the crop. The gross plot size was 5.0 m × 3.6 m and net plot size was 4.8 m × 3.0 m.

Seeds were treated using *Rhizobium* and Phosphorus solubilizing bacteria @ 1250 g per hectare. Two seeds per hill were dibbled 5 cm deep in furrows at a spacing of 30 cm x 10 cm. Recommended dose of K_2O @ 25 kg ha^{-1} was applied at the time of sowing. N and P_2O_5 were applied as basal as per the treatments. The crop was harvested at its physiological maturity.

The data was statistically analysed as per the procedure given by Gomez and Gomez (1984) [6].

Results and Discussion

Seed yield and haulm yield

Application of nitrogen @ 60 kg ha^{-1} recorded significantly higher seed yield (24.44 q ha^{-1}) and haulm yield (29.75 q ha^{-1}) compared to 20 (17.45 and 21.40 q ha^{-1}, respectively) and 40 (22.42 and 27.35 q ha^{-1}, respectively) kg N ha^{-1}. Among the phosphorus levels, application of phosphorus @ 80 kg ha^{-1} recorded significantly higher seed yield (22.57 q ha^{-1}) and haulm yield (27.52 q ha^{-1}) compared to 60 (20.73 and 25.32 q ha^{-1}, respectively) and 40 (19.47 and 23.81 q ha^{-1}, respectively) kg P_2O_5 ha^{-1} however, it was on par with 100 (22.97 and 28.00 q ha^{-1}, respectively) kg P_2O_5 ha^{-1}. In combined application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 80 kg ha^{-1} recorded significantly higher seed yield (25.77 q ha^{-1}) and haulm yield (31.32 q ha^{-1}) compared to other treatment combinations however, it was on par with application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 100 (26.07 and 31.67 q ha^{-1}) kg ha^{-1} (Table-1). With respect to harvest index Non-significant difference among treatment combinations noticed. It is mainly attributed to application of nitrogen and phosphorus accelerated the photosynthetic rate leading to more production of carbohydrates, it involved in nodulation and being the constituent of ATP which regulate vital metabolic processes in the plant, helping in root formation and nitrogen fixation results in positive effect on photosynthesis which in turn favors better growth and yield of the crop. These results are in line with the findings of Yadav and Chandel (2010) [11], Sohrabi *et al.* (2012) [10], Bhattacharjee *et al.* (2013) [3] and Dhage *et al.*(2014) [4]

Economics

Application of nitrogen @ 60 kg ha^{-1} recorded significantly higher gross returns, net returns and B:C ratio (97535 ₹ ha^{-1}, 67672 ₹ ha^{-1} and 3.26, respectively) compared to 20 (69647, 40287 and 2.37, respectively) and 40 (89470, 59858 and 3.02, respectively) kg N ha^{-1}. Among the phosphorus levels, application of phosphorus @ 80 kg ha^{-1} recorded significantly higher gross returns, net returns and B:C ratio (90070 ₹ ha^{-1}, 59921 ₹ ha^{-1} and 2.98, respectively) compared to 60 (82730 ₹ ha^{-1}, 53656 ₹ ha^{-1} and 2.84, respectively) and 40 (77706 ₹ ha^{-1}, 49707 ₹ ha^{-1} and 2.77, respectively) kg P_2O_5 ha^{-1} however, it was on par with 100 (91697 ₹ ha^{-1} and 60473 ₹ ha^{-1} and 2.93, respectively) kg P_2O_5 ha^{-1}. In combined application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 80 kg ha^{-1} recorded significantly higher gross returns, net returns and B:C ratio (102839 ₹ ha^{-1}, 72438 ₹ ha^{-1} and 3.38, respectively) compared to other treatment combinations however, it was on par with application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 100 (72559 ₹ ha^{-1}, 102035 ₹ ha^{-1} and 3.31, respectively) kg ha^{-1} (Table-2). These results are in conformity with the findings of Saini and Chogtham (2010) [8], Geeta and Radder (2015) [5], Anon (2011) [1] and Singh *et al.* (2013) [1].

Table 1: Seed yield and haulm yield of soybean as influenced by different levels of nitrogen and phosphorus

Phosphorus (kg ha^{-1})	Seed yield (q ha^{-1})				Haulm yield (q ha^{-1})				Harvest index (%)			
	Nitrogen (kg ha^{-1})											
	20	40	60	Mean	20	40	60	Mean	20	40	60	Mean
40	16.55	19.59	22.26	19.47	20.33	23.95	27.15	23.81	44.88	44.99	45.05	44.97
60	17.32	21.20	23.66	20.73	21.25	25.87	28.85	25.32	44.91	45.04	45.06	45.00
80	17.70	24.23	25.77	22.57	21.69	29.57	31.32	27.52	44.94	45.04	45.14	45.05
100	18.22	24.63	26.07	22.97	22.31	30.02	31.67	28.00	44.95	45.07	45.15	45.07
Mean	17.45	22.42	24.44		21.40	27.35	29.75		44.91	45.05	45.10	
	S.Em±		CD at 5 %		S.Em±		CD at 5 %		S.Em±		CD at 5 %	
Nitrogen	0.15		0.45		0.16		0.48		0.11		NS	
Phosphorus	0.18		0.51		0.19		0.55		0.12		NS	
Interaction	0.30		0.89		0.33		0.96		0.21		NS	

Table 2: Economics of soybean as influenced by different levels of nitrogen and phosphorus

Phosphorus (kg ha^{-1})	Gross returns (₹ ha^{-1})				Net returns (₹ ha^{-1})				B:C ratio			
	Nitrogen (kg ha^{-1})											
	20	40	60	Mean	20	40	60	Mean	20	40	60	Mean
40	66072	78211	88834	77706	38325	50212	60583	49707	2.38	2.79	3.14	2.77
60	69137	84620	94433	82730	40315	55546	65107	53656	2.40	2.91	3.22	2.84
80	70644	96728	102839	90070	40747	66579	72438	59921	2.36	3.21	3.38	2.98
100	72735	98322	104035	91697	41763	67098	72559	60473	2.35	3.15	3.31	2.93
Mean	69647	89470	97535		40287	59858	67672		2.37	3.02	3.26	
	S.Em±		CD at 5 %		S.Em±		CD at 5 %		S.Em±		CD at 5 %	
Nitrogen	603		1767		603		1767		0.02		0.06	
Phosphorus	696		2041		696		2041		0.02		0.07	
Interaction	1205		3535		1205		3535		0.04		0.12	

Conclusion

The investigation revealed that application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 80 kg ha^{-1} and potassium @ 25 kg ha^{-1} found to optimum to achieve higher soybean seed yield and net returns.

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