Indian Journal of Agronomy **64** (2): 275–278 (June 2019)

Research Communication

Effect of nutrient management options on productivity and economics of soybean (*Glycine max*) varieties

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Received : August 2017; Revised accepted : May 2019

ABSTRACT

A field experiment was conducted during the rainy (*kharif*) season of 2015 on a silty clay loam soil at Rahuri, Maharashtra, to study the effect of varying nutrient management on productivity and economics of different varieties of soybean [*Glycine max* (L.) Merr.]. The experiment was laid out in a factorial randomized block design with 15 treatment combinations of 3 varieties 'KDS 344', 'JS 9305' and 'KS 103' and 5 nutrient-management levels, viz. general recommended dose of fertilizer (GRDF)–50, 75, 0-N, P_2O_5, K_2O kg/ha + 5.0 tonnes FYM/ha (N_1); 75% GRDF + 0.5% foliar spray of grade II at 30 and 45 days after sowing (N_2); 100% GRDF + 0.5% foliar spray of grade II at 30 and 45 DAS (N_3); 125% GRDF + 0.5% foliar spray of grade II at 30 and 45 DAS (N_4); and 50, 75, 30 N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha (N_5). The variety 'KDS 344' and application of nutrient dose of 125% GRDF + 0.5% grade II foliar spray at 30 and 45 DAS recorded higher growth and yield attributes, viz. plant height (cm), branches/plant, pods/plant and weight of seeds/plant (g) than 'KS 103' and 'JS 9305'. Similarly, the treatment combination of 'KDS 344' and application of nutrient dose of 125% GRDF + 0.5% grade II foliar spray at 30 and 45 DAS recorded significantly higher grain yield (8.76 and 31.65%) than the variety 'KDS 344' with GRDF and 50, 75, 30 N, P_2O_5, K_2O kg/ha + 5.0 tonnes FYM/ha. The variety 'KDS 344' gave the highest net returns (₹87.3 × 10^3/ha) and benefit: cost ratio (3.17). Similarly, application of nutrient levels 75% GRDF + 0.5% grade II foliar spray at 30 and 45 DAS recorded the highest net returns (₹82.7 × 10^3/ha) and benefit: cost ratio (3.24). Thus, the maximum productivity and profitability of soybean can be achieved from variety 'KDS 344' fertilized with 75% GRDF (37.5, 56.25, 0 N, P_2O_5, K_2O kg/ha + 3.75 tonnes FYM/ha) + 0.5 % Grade II foliar spray of micronutrient at 30 and 45 DAS.

Key words: Economics, Grain yield, Nutrient management, Soybean, Varieties

Soybean is the vital oilseed crop of India and the world that shows a wide range of geographical adaptation and offers many nutritional and health benefits (Dass and Bhattacharyya, 2017). In India, soybean is cultivated on 11.62 million ha that contributes production of 8.64 million tonnes and productivity of 781 kg/ha (SOPA, 2015). Soybean builds up soil fertility by atmospheric nitrogen fixation and it leaves residual nitrogen equivalent to 40 to 60 kg/ha for succeeding crop (Ronaki *et al.,* 2018) Selection of newly released genotype plays a vital role in crop production and helps increase the crop productivity by 20–25%. Balanced and timely nutrient-management practices are equally important to achieve sustainable growth, yield and quality of produce of soybean. Further, integrated nutrient management besides improving crop performance, reduces environmental risks also. Nutrient-management practice that involves the use of appropriate combination of organic (FYM) and inorganic (chemical) fertilizers and foliar spray of grade II micronutrient 30 and 45 days after sowing has been shown to enhance crop productivity and maintain soil health. This is best approach for better utilization of resources and to produce crops with less expenditure in soybean (Shinde *et al.,* 2015). Foliar nutrition is recognized as an important method of fertilization, since foliar nutrients usually penetrate the leaf cuticle or stomata and enter the cells facilitating easy and rapid utilization of nutrients by the crop and also reduction in nutrient losses (Latha and Nadanassababady, 2003). It is an important to identify the appropriate genotype and appropriate combination of nutrient sources like organic, inorganic and foliar spray of micronutrients for increasing

Based on a part of M.Sc. Thesis of the first author, submitted to the Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharahstra during 2016 (unpublished)

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growth, yield and economics of soybean. In the present study, an attempt was made to assess the combined effects of different promising newly released soybean varieties and different nutrient-management levels to increase yield potential and economics of rainy (*kharif*) season soybean.

A field experiment was conducted at Post Graduate Institute, Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, (19°48' N, 74° 32' E, 495 m above mean sea-level), in factorial randomized block design with 3 replications during the rainy (*kharif*) season of 2015. Climatologically, this area falls in the semi-arid tract characterized by scarcity zone and frequently occurring dry spells in *kharif* season. The mean daily minimum and maximum temperature ranged from 14.5 to 23.7°C and 30.1 to 36.0°C, respectively, and the total rainfall of 285.4 mm was received during crop-growth period. Soil of the experimental field was silty clay loam, having *p*H 7.72, medium in organic C (0.47%), low in available N (144.57 kg/ha) and medium in available P (17.24 kg/ha) and available K (388.20 kg/ha). The experiment consisted of 15 treatments with 3 varieties, viz. V_1, 'KDS 344'; V_2, 'JS 9305'; and V_3, 'KS 103' and 5 nutrient-management levels, viz. N_1, general recommended dose of fertilizer (GRDF) – 50, 75, 0 N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha; N_2, 75% GRDF (37.5, 56.25, 0 N, P_2O_5, K_2O kg/ha + 3.75 tonnes FYM/ha) + 0.5% foliar spray of grade II at 30 and 45 DAS; N_3, 100% GRDF (50, 75, 0 N, P_2O_5, K_2O kg/ha+ 5 tonnes FYM/ha) + 0.5% foliar spray of grade II at 30 and 45 DAS; N_4, 125% GRDF (62.5, 93.75, 0 N, P_2O_5, K_2O kg/ha+ 6.25 tonnes FYM/ha) + 0.5% foliar spray of grade II at 30 and 45 DAS and N_5, 50, 75, 30 N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha. The crop soybean was dibbled at 30 cm × 10 cm in I[st] week of July and harvested at I[st] to II[nd] week of October as per treatments. Common treatments of *Rhizobium* and phosphate-solubilizing bacteria (PSB) were given at the time of sowing and 0.5% foliar spray of grade II[nd] micronutrient (Fe, 2.5%, Zn, 3.0%; Mn, 1.0%; Cu, 1.0%; Mo, 0.1%; and Bo, 0.5%) was done at 30 DAS and 45 DAS. The intercultural operations, protective irrigation as per critical growth stages and plant-protection measures were carried out as per the recommendations for soybean crop. The plant stand and crop conditions were good during the experimental period. From each plot, 5 plants were randomly selected in a net plot and observations of growth and yield attributing characters were recorded. Hundred seeds weight was recorded from representative sample taken from net-plot. Soybean grain and stover yields were weighed after threshing and winnowing of net plot.The harvest index was worked out from the grain yield divided by grain + stover yield/ha and multiplying by 100. Net returns were calculated by subtracting cost of production from gross returns. The net retuns per rupees invested (B:C ratio) was calculated by dividing gross returns with cost of cultivation.

'KDS 344' soybean showed significantly higher plant height and number of branches/plant, at harvesting, i.e. an increase of 18.54 and 1.56% than 'JS 9305' and of 7.20 and 8.25% of 'KS 103'. The yield-attributing characters, viz. pods/plant, weight of seeds/plant and 100-grain weight showed an increase of 26.65, 16.52 and 12.24% than va-

Table 1. Effect of different varieties and varying nutrient-management practices on growth, yield attributes, yield and economics of soybean

Treatment	Plant height (cm)	Branches/ plant	Pods/ plant	Weight of seeds/ plant (g)	100-seed weight (g)	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	Cost of cultivation (× 10^3 ₹/ha)	Net returns (× 10^3 ₹/ha)	Benefit : cost ratio
Varieties											
V_1	75.10	4.46	58.88	11.92	12.74	3.66	5.43	40.26	40.6	87.3	3.17
V_2	63.35	4.16	46.49	10.23	11.35	3.20	4.39	42.16	39.3	71.6	2.82
V_3	73.94	4.12	52.85	10.98	12.39	3.41	4.87	41.18	39.9	78.1	2.94
SEm±	0.54	0.07	0.55	0.12	0.10	0.04	0.06	0.26	–	1.7	–
CD (P=0.05)	1.56	0.20	1.59	0.35	0.29	0.14	0.18	0.76	–	5.0	–
Nutrient management											
N_1	70.34	4.3	53.02	10.86	12.22	3.35	4.94	40.41	39.2	77.1	2.96
N_2	71.11	4.08	51.17	10.85	11.87	3.45	5.01	40.78	36.9	82.7	3.24
N_3	70.99	4.15	53.26	11.12	12.02	3.48	5.04	40.84	40.3	80.3	2.98
N_4	72.46	4.74	54.30	11.31	12.35	3.58	5.14	41.05	43.4	80.5	2.85
N_5	69.24	3.94	51.96	11.06	12.34	3.25	4.81	40.32	39.9	74.3	2.86
SEm±	0.65	0.09	0.71	0.04	0.13	0.06	0.07	0.34	–	2.2	–
CD (P=0.05)	1.89	0.26	2.05	0.15	0.37	0.18	0.21	NS	–	NS	–

V_1, 'KDS 344', V_2, 'JS 9305'; V_3, 'KS 103'; N_1, GRDF (50, 75, 0 N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha); N_2, 75% GRDF + 0.5% foliar spray of grade II at 30; 45 DAS; N_3, 100% GRDF + 0.5% foliar spray of grade II at 30 and 45 DAS; N_4, 125% GRDF + 0.5% foliar spray of grade II at 30 and 45 DAS; N_5, 50, 75, 30 N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha

riety 'JS 9305' and 11.41, 7.88 and 2.82% than 'KS 103' (Table 1). The increased parameters might have attributed to higher manufacture of food and its subsequent partitioning towards sink. Data (Table 1) revealed that variety 'KDS 344' gave significantly higher grain and stover yield than 'JS 9305' and 'KS 103'. It has represented an increase of 14.38 and 7.33%, respectively, higher than the variety 'JS 9305' and 'KS 103'. Similarly, the variety 'KDS 344' recorded the lowest harvest index (40.26%) than variety 'JS 9305' (42.16%) and 'KS 103' (41.18%). 'KDS 344' soybean recorded the highest grain yield and ultimately resulted in higher economic indices like net returns (₹87,355), cost of cultivation (₹40,623) and B:C ratio (3.17) than variety 'KS 103' and 'JS 9305'. The variety 'JS 9305' recorded the lowest economic indices like net returns, cost of cultivation and B:C ratio than rest of all varieties. 'KDS 344' soybean has ability to produce higher photosynthates and dry-matter partitioning between roots and shoots. The rate of growth and duration are interrelated into yield, total biomass accumulation and economic returns of crop. These results confirm the findings of Andrade *et al*. (2005) and Lomte *et al*. (2006).

The fertility levels of 125% GRDF + 0.5% Grade II foliar spray at 30 and 45 DAS resulted in significant higher plant height at harvesting, branches/plant, pods/plant and weight of seeds/plant, representing an increase of 4.65, 20.30,4.50 and 2.26%, respectively, over fertilizer levels of 50, 75, 30-N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha. Similarly, these growth and yield attributes were directly reflected on grain yield of soybean. It also recorded significantly 10.15 and 6.86 % higher grain yield and stover yield than 50, 75, 30-N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha; however this treatment was found at par with 75% GRDF and 100% GRDF + 0.5% Grade II foliar spray at 30 and 45 days after sowing (DAS). The application of fertilizer level of 75% GRDF + 0.5% Grade II foliar spray at 30 and 45 DAS exhibited the highest economic indices like net returns (₹82.7×10^3/ha) and B : C ratio (3.24) owing to lower cost of cultivation (₹36.9×10^3/ha) than rest of treatments (Table 1). The results revealed that, foliar application of micronutrient at critical stages of the crop growth also enhances photosynthetic activity in effective leaves and translocated the photosynthates towards developing pods and resulted in increase of soybean productivity. These results are in close conformity with those of Latha and Nadanassababady (2003), Kathmale *et al.,* (2013) and Kambale and Jadhav (2017).

The interactive effect of varieties and fertility levels on grain yield of soybean was found significant (Table 2). Application of fertility levels of 125% GRDF (62.5, 93.75, 0 N, P_2O_5, K_2O kg/ha + 6.25 tonnes FYM/ha) + 0.5% Grade II foliar spray at 30 and 45 DAS with variety 'KDS 344' over rest of treatments. It also represented significant increase of 4.0% and 8.99% grain yield over 50, 75, 30 N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha and GRDF (50, 75, 0 N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha), but at par with 75% GRDF (37.5, 56.25, 0 N, P_2O_5, K_2O kg/ha + 3.75 tonnes FYM/ha) + 0.5 Grade II foliar spray of micronutrient at 30 and 45 DAS with variety 'KDS 344'. It shows that application of 75% GRDF + 0.5 Grade II foliar spray of micronutrient at 30 and 45 DAS was also more beneficial owing to reducing cost of cultivation of farmers and nutrient losses as compred to 125% GRDF + 0.5% Grade II foliar spray at 30 and 45 DAS.

Table 2. Interaction effect of nutrient management and variety on grain yield (t/ha) of soybean

Treatment	Varieties		
Nutrient-management	V_1	V_2	V_3
N_1	3.67	3.14	3.24
N_2	3.85	3.31	3.30
N_3	3.73	3.15	3.57
N_4	4.00	3.19	3.53
N_5	3.20	3.20	3.52
Source	SEm±		CD (P=0.05)
(A × B)	0.11		0.32

V_1, 'KDS 344', V_2, 'JS 9305'; V_3, 'KS 103'; N_1, GRDF (50, 75, 0 N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha); N_2, 75% GRDF + 0.5% foliar spray of grade II at 30; 45 DAS; N_3, 100% GRDF + 0.5% foliar spray of grade II at 30 and 45 DAS; N_4, 125% GRDF + 0.5% foliar spray of grade II at 30 and 45 DAS; N_5, 50, 75, 30 N, P_2O_5, K_2O kg/ha + 5 tonnes FYM/ha

It could be concluded that, maximum productivity and profitability of soybean may be achieved from variety 'KDS 344' fertilized with 75% GRDF (37.5, 56.25, 0 N, P_2O_5, K_2O kg/ha + 3.75 tonnes FYM/ha) + 0.5 % Grade II foliar spray of micronutrient at 30 and 45 DAS.

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