Ann. Agric. Res. New Series Vol. 35 (4) : 406-410 (2014)

Integrated nutrient management options for soybean (*Glycine max* L., Merrill) varieties for higher productivity, quality and profitability under west-central plains of India

Rakesh Singh[1], H.B. Sharma[2], Parveen Kumar[1], Dinesh Kumar Paliwal[3]

Raja Balwant Singh College, Bichpuri Agra-282007
E-mail: pkumarcssri@gmail.com

Received : June 2014 ; Revised accepted : October 2014

Abstract

Integrated nutrient management has become very important due to deteriorating soil health specially decline in organic carbon content in the west-central plains of India. A field experiment was conducted during 2009 and 2010 on sandy-loam soil. Three cultivars of soybean (JS-93-05; PK-472; NRC-37) were sown with six nutrient management options. The results indicated that maximum value of seed yield (2.90 t/ha) and protein yield (1134.6 kg/ha) were recorded with treatment 15-30-20 kg/ha N:P_2O_5:K_2O + poultry manure @ 5 t/ha. Though, maximum yield of oil (552.1 kg/ha) was recorded in treatment 60-60-40 kg/ha N:P_2O_5:K_2O where 200% N was applied along with recommended dose of P and K, but it was very close and statistically at par with treatment 15-30-20 kg/ha N:P_2O_5:K_2O + poultry manure @ 5 t/ha (551.7 kg/ha). Maximum net returns (Rs.35,761) and benefit cost ratio (2.56) were also recorded in treatment 60-60-40 kg/ha N:P_2O_5:K_2O, which was statistically similar with treatment 15-30-20 kg/ha N:P_2O_5:K_2O + poultry manure @ 5 t/ha (Rs. 34,810 and 2.43, respectively). Across the nutrients management options maximum, seed yield (2.72 t/ha), oil yield (523.8 kg/ha) protein yield (1065.1 kg/ha), net returns (Rs.33,387) and benefit cost ratio (2.47) were recorded in cultivar JS 93-05 while, lowest values for above stated variables were observed in cultivar PK 472.

Key words : Soybean, integrated nutrient management, seed yield, quality, economics.

Soybean crop have shown response to fertilizer nutrients. Increase in yield due to application of one or more nutrients in different agro-climatic regions has been well documented (Gangasaran and Rana, 1994). It is known that in several parts of India, there are nutrient deficiencies of N, P, K, S, and the micronutrients like Zn, Mn, Fe and B in one or the other oilseed crops. Therefore, to sustain or increase the productivity of oilseed crops management of nutritional disorders is of paramount importance. The situation is further aggravated with chances of horizontal expansion being very limited; increase in oilseed production has to come primarily from land saving technologies such as use of high yielding input responsive varieties, better nutrient management preferably through integrated nutrient management (INM), use of modern methods of irrigation etc. Now-a-days the role of organic manures in oilseed production is being increasingly recognized. Besides, FYM and compost there are several other organic sources with good nutrient supplying potential. Use of poultry manure increased the pod yields of groundnut more than FYM and pig manure (Das *et al*., 1992). There is a need to integrate with different organic manures available in different regions with chemical fertilizers for cropping

[1]*Central soil salinity Research Institute, Karnal-132 001,*
[2]*Hamelmalo, College of Agriculture, Eritrea*
[3]*Krishi Vigyan Kendra, Kasturbagram, Indore, M.P.*

systems involving oilseeds. However, information is scanty on their integration with inorganic fertilizers in oilseed crops in general and soybean in particular. In this backdrop the present study was conducted to evaluate the different nutrient management options on productivity, quality and profitability of soybean (*Glycine max* (L.) Merrill) varieties under semi-arid condition of south-west Uttar Pradesh.

Materials and Methods

The field experiment was conducted at Raja Balwant Singh College, Agricultural Research Farm, Bichpuri, Agra (UP) during the year 2009 and 2010. The Research Farm is situated on Agra-Bharatpur road, about 11 km in south-west of Agra city. The soil samples were taken from experimental field before sowing of the crop from 0-30 cm soil depth from 20 random spots during both the years of study. The soil samples were thoroughly mixed and a composite soil sample was prepared and analyzed for physical and chemical properties in triplicate.

The experimental soil was well drained and sandy loam in texture. The top soil (0-30 cm) of the experimental field was slightly alkaline in reaction, low in organic carbon and available nitrogen, high in available phosphorus and potassium during both the years of investigation (Table 1). Organic carbon was determined by rapid titration method (Walkley and Black, 1934). Available nitrogen, phosphorus and potassium were determined by the methods described by Subbiah and Asija (1956), Olsen *et al.* (1954) and Merwin and Peech (1950), respectively. The experiment was laid out in 'Factorial Randomized Block Design' with 18 treatment combinations (6 nutrient management treatments: Control; 15-30-20 N:P_2O_5:K_2O kg/ha; 30-60-40 N:P_2O_5:K_2O kg/ha; 60-60-40 N:P_2O_5:K_2O kg/ha; 15-30-20 N:P_2O_5:K_2O kg/ha + 2.5 t/ha poultry manure (PM); 15-30-20 N:P_2O_5:K_2O kg/ha +5 t/ha PM and 3 soybean cultivars: JS-93-05; PK-472; NRC-37) replicated four times. The plot size used in the investigation was 4×3 m. Pre-sowing irrigation was applied to ensure the uniform germination and plant stand. The sowing was done in third week of June during both the years of study. Full dose of nitrogen, phosphorus and potassium were applied as per treatments at the time of sowing. One post-sowing irrigation was applied in 2009 only because during 2010 crop season there was no need of post-sowing irrigation due to good rainfall. The maximum temperature during crop season ranged between 32.6 °C - 43.8 °C during 2009 and 28.1 °C - 35.0 °C during 2010. The corresponding minimum temperatures were between 17.2 °C - 29.4 °C during 2009 and 20.0 °C - 29.7 °C during 2010, respectively. The total rainfall received from sowing to harvest was 532.0 and 656.4 mm during 2009 and 2010, respectively. The oil content (%) was estimated with the help of Soxhelet's extraction method. The protein content was calculated by multiplying nitrogen content of soybean seed estimated through Kjeldahl method (Prasad, 1998) by 6.25. The data was subjected and analyzed using Analysis of Variance (ANOVA) by using Statistical Analysis System (SAS Institute, 2001).

Economics of various treatments was worked out in the present experimentation on the basis of input-output relationship with respect to net return (Rs/ha) and income per rupee spent (benefit:cost ratio), as these two economic parameters are the final criteria for the adoption

Table 1. Mechanical and chemical analysis of experimental soil.

Components	Values		Component	Values	
	2009	2010		2009	2010
Sand (%)	57.7	58.7	pH	8.20	8.10
			EC (dS/m)	1.81	1.75
Silt (%)	23.3	22.2	Organic C (%)	0.44	0.41
Clay (%)	19.0	19.1	Available N (kg/ha)	183.4	182.6
Texture Class	Sandy loam	Sandy loam	Available P (kg/ha)	27.8	27.8
			Available K (kg/ha)	315.5	315.4

of any crop production recommendations by the farmers. The market rates prevailing during the study were taken into account for calculating cost of cultivation and gross returns.

Results and Discussion

Seed yield and yield attributes

Shelling percentage in soybean was significantly affected by different nutrient management options and varieties during both the years (Table 2). Across soybean varieties maximum shelling percentage was recorded in control treatment while, lowest shelling percentage (41.29) was recorded in treatment 15-30-20 N:P_2O_5:K_2O kg/ha +5 t/ha PM. However, this treatment remained at par with treatments 15-30-20 N:P_2O_5:K_2O kg/ha + 2.5 t/ha; 60-60-40 N:P_2O_5:K_2O kg/ha and 30-60-40 N:P_2O_5:K_2O kg/ha on pooled basis. Across the nutrient management options soybean varieties JS 93-05 (44.43%) and NRC-37 (44.85%) had significantly higher shelling percentage than PK-472 (40.90%). Fertility treatments and variety showed non-significant effect on 100-seed weight of soybean (Table 2). Nutrient management and cultivars influenced the seed yield in soybean during both the years of investigation. In general, the seed yield was realized higher during 2010 than 2009. Maximum seed yield (2.90 t/ha) was recorded in treatment 15-30-20 N:P_2O_5:K_2O kg/ha + PM @ 5 t/ha, which was 29% higher over control (no fertilizer) on pooled basis and statistically at par with treatment 60-60-40 N:P_2O_5:K_2O kg/ha. This might be due to more photosynthetic rate and N absorption by plants. It is a known fact that N being structural constituent of protein is essential for cell division and cell expansion. These two components are of prime importance for plant growth and development, hence, N application increased the plant growth, yield and yield attributes under balanced nutrient application. Phosphorus is the second important nutrient, next to nitrogen for all crops, in general, and for legumes in particular. The role of potassium in crop production is quite obvious and may not be ruled out; as it induces plumpness in grain and provide strength and shining in grains and essential for photosynthetic activities of plants. The beneficial effect of these nutrients has also been advocated by other several workers (Giri *et al*., 2006; Jaat *et al*., 2011).

Across nutrient management treatment

Table 2. Effect of nutrient management and cultivars on yield attributes and yield of soybean.

Treatment	Shelling (%)			100-seed weight (g)			Seed yield (t/ha)		
	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
Nutrient management (N-P_2O_5-K_2O kg/ha)									
Control	47.89	47.73	47.81	9.63	9.89	9.76	1.99	2.14	2.06
15-30-20 (50% RDFa)	46.57	44.13	45.35	9.89	10.1	9.99	2.20	2.32	2.26
30-60-40 (RDF)	44.38	39.65	42.01	10.0	10.2	10.1	2.38	2.49	2.44
60-60-40	43.50	40.20	41.85	9.71	10.1	9.89	2.84	2.91	2.87
15-30-20+2.5 t/ha PMb	44.08	40.03	42.05	9.86	10.1	9.95	2.55	2.63	2.59
15-30-20+5 t/ha PM	41.19	41.39	41.29	9.97	9.91	9.94	2.85	2.94	2.90
SEm+	1.06	1.32	0.42	0.19	0.20	0.15	0.01	0.01	0.01
CD (P=0.05)	3.01	3.75	1.19	NS	NS	NS	0.03	0.04	0.02
Varieties									
JS 93-05	45.93	42.94	44.43	9.87	9.95	9.91	2.67	2.77	2.72
PK- 472	42.27	39.52	40.90	9.76	10.2	9.99	2.24	2.39	2.32
NRC- 37	45.60	44.10	44.85	9.89	9.98	9.94	2.50	2.55	2.52
SEm+	0.75	0.93	0.59	0.13	0.14	0.11	0.01	0.01	0.01
CD (P=0.05)	2.13	2.65	1.69	NS	NS	NS	0.02	0.03	0.02

[a]RDF= Recommended dose of fertilizers; [b]PM= poultry manure

soybean variety JS 93-05 had maximum seed yield during both the years of study followed by NRC-37 and lowest in PK-472. On pooled basis JS-93-05 (2.72 t/ha) had 14.71% higher yield than PK 472 (2.32 t/ha). The differences in seed yield among varieties may be ascribed to promising yield contributing characters, such as number of pods and seed/plant, pod weight/plant, pod length, number of grain/pod, seed weight/plant and 100- seed weight. A varietal difference for seed yield in soybean has earlier been reported by Majumdar *et al.* (2006).

Quality

The data given in the Table 3 indicated that oil as well as protein content in soybean varieties did not differ due to varied nutrient management options in the present investigation. However, oil yield differed a lot due to nutrient management treatments. Treatment 60-60-40 N:P_2O_5:K_2O kg/ha (552 kg/ha) was significantly superior over all other treatments, except treatment 15-30-20 N:P_2O_5:K_2O kg/ha +5 t/ha PM (552 kg/ha) for oil yield. As expected, the minimum oil yield was realized in control treatment (398 kg/ha). Protein yield was significantly influenced by different nutrient management treatments. Nutrient management treatment 15-30-20 N:P_2O_5:K_2O kg/ha +5 t/ha PM (1135 kg/ha) was significantly superior over remaining treatments in a descending order, 60-60-40 N:P_2O_5:K_2O kg/ha (1125 kg/ha), 15-30-20 N:P_2O_5:K_2O kg/ha + 2.5 t/ha PM (1062 kg/ha), 30-60-40 N:P_2O_5:K_2O kg/ha (953 kg/ha), 15-30-20 N:P_2O_5:K_2O kg/ha (883 kg/ha) and control (810 kg/ha), however, treatments 60-60-40 N:P_2O_5:K_2O kg/ha and 15-30-20 N:P_2O_5:K_2O kg/ha +5 t/ha PM were at par for protein yield. The higher protein and oil yield in the fertilized plots (inorganic/organic) can be attributed to higher seed yield as oil and protein content remained similar under different nutrient management options. Similar results were also reported by Saxena *et al.* (2010) under Tarai conditions of Uttarakhand.

Across nutrient management treatments, oil and protein yields were the highest with variety JS 93-05, which were found to be significantly higher over NRC-37 and PK-472. The higher oil and protein yield in JS 93-05 may be ascribed to its higher seed yield as compared to other varieties tested in the study.

Table 3. Effect of nutrient management and cultivars quality parameters and economics of soybean (2 years pooled data).

Treatment	Oil content (%)	Oil yield (kg/ha)	Protein content (%)	Protein yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
Nutrient management (N-P_2O_5-K_2O kg/ha)								
Control	19.3	398.0	39.3	810.2	19,938	42,657	22,719	2.14
15-30-20 (50% RDF[a])	18.7	421.0	39.2	883.3	21,245	45,154	25,219	2.19
30-60-40 (RDF)	18.6	452.7	39.1	953.4	22,503	50,031	27,504	2.22
60-60-40	19.2	552.1	39.1	1124.6	22,898	58,659	35,761	2.56
15-30-20+2.5 t/ha PM[b]	19.3	500.0	39.2	1061.9	22,800	53,118	30,317	2.33
15-30-20+5 t/ha PM	19.0	551.7	39.2	1134.6	24,350	59,161	34,810	2.43
SEm±	0.23	5.93	0.07	3.54	462	1286	777	0.05
CD (P=0.05)	NS	16.9	NS	10.1	1062	2958	1788	0.12
Varieties								
JS 93-05	19.3	523.8	39.2	1065.1	22,571	55,958	33,386	2.47
PK- 472	19.9	438.9	39.2	907.5	22,242	47,456	25,213	2.13
NRC- 37	18.8	474.9	39.2	988.8	22,066	51,631	29,566	2.34
SEm±	0.16	4.19	0.05	2.50	506	1166	534	0.05
CD (P=0.05)	NS	11.9	NS	7.1	1129	2798	1261	0.12

[a]RDF= Recommended dose of fertilizers; [b]PM= poultry manure

Economics

The net returns and benefit:cost ratio were affected by various treatments (Table 3). Over soybean varieties, highest net return (Rs. 35,761/ ha) and B:C ratio (2.56) was realized with treatment 60-60-40 N:P_2O_5:K_2O kg/ha, where only inorganic nutrition was given, however net returns was statistically similar to treatment 15-30-20 N:P_2O_5:K_2O kg/ha +5 t/ha PM, where integrated use of organic and inorganic fertilizer was done. The lowest net returns and B:C ration was observed in control treatment. Among soybean varieties, JS 93-05 had highest net returns and B:C ratio followed by NRC-37 and lowest in PK-472. The higher monetary advantage in JS 93-05 can be attributed to its higher seed yield than other varieties tested in the study.

Keeping the soil health and sustainability issues in mind, it can be inferred from the present study that use of ½ recommended dose of fertilizer along with integrated use of poultry manure @ 5 t/ha in soybean variety 'JS 93-05' is advisable for realizing higher productivity, quality and net returns in west-central Plains of India.

References

Das, M., Singh, B.P., Ram, M. and Prasad, R.N. 1992. Mineral nutrition of maize and groundnut as influenced by P enriched manures on acid Alfisol. *J. Ind. Soc. Soil Sci.* **40**: 580-583.

Gangasaran and Rana, D.S. 1994. Integrated nutrient management in oilseed production. In proc. of symposium on "Integrated input management for efficient crop production", TNAU, Coimbatore, 124-141.

Giri, A.N., Deshmukh, M.N. and Gore, S.B. 2006. Nutrient management in cotton (*Gossypium hirsutum*)-based cropping systems. *Ind. J. Agron*. **51**: 116-118.

Jaat, R.S., Dayal, D., Meena, H.N., Singh, V. and Gediya, M.V. 2011. Long term effect of nutrient management and rainfall on pod yield of groundnut (*Arachis hypogaea*) in groundnut-based cropping systems. *Ind. J. Agron*. **56**: 145-149.

Majumdar, A., Nath, R., Kundu, G.K. Chakraborthy, S., Islam, J.J. and Bandopadhyay, R. 2006. Sustainability performance of soybean (*Glycine max*. (L.) Merrill) varieties under rainfed early Stemin red and laterite zone of west Bengal. *Environ. and Eco*. **242**: 440-442.

Merwin, H.D. and Peech, M. 1950. Exchangeability of soil potassium in the sand, silt and clay fractions as influenced by the nature of complimentary exchangeable cations. *Soil Sci. Soc. Am. Proc*. **15**: 125-128.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus by extraction with sodium bicarbonate. United States Department Agricultural Circular **939**: 19.

Prasad R. 1998. A practical Manual for Soil Fertility. Division of Agronomy, IARI, New Delhi-12.

Saxena, S.C., Singh, R. and Singh, K. 2010. Effect of nutrient management on yield attributes yield, harvest index, quality and economics of soybean (*Glycine max*. (L.) Merrill) under *Tarai* conditions of Uttaranchal. *Pantnagar J. Res*.**8** : 8-10.

SAS Institute. 2001. SAS/STAT user's guide. Version 8-1. SAS Institute, Cary, NC.

Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for estimation of available nitrogen in soils. *Curr. Sci*. **25**: 259-260.

Walkley, A. and Black, C.A. 1934. An examination of the Digtjareff method for determination of soil organic matter and a proposed modification of chromic acid titration method. *Soil Sci*. **37**: 29-39.