RESEARCH PAPER International Journal of Agricultural Sciences, June to December, 2009, Vol. 5 Issue 2 : 590-594

Effect of organic manuring and mineral fertilizer on the growth, yield and economics of soybean [*Glycine max* (L.) Merrill]

G.S. TOMAR* AND S.N. KHAJANJI

Department of Agronomy, College of Agriculture, Indira Gandhi Krishi Vishwa Vidyalaya, RAIPUR (C.G.) INDIA

ABSTRACT

An experiment was conducted at Raipur during 2001-02 and 2002-03 to study the effect of organic and inorganic sources of nutrients on the productivity, quality and economics of soybean [*Glycine max* (L.) Merr.].Treatments consisted of four combinations of organic manuring *viz*. M_0:control, M_1:crop residues-rice straw @ 5 t ha^{-1}, M_2:FYM @ 5 t ha^{-1} and M_3:crop residue + FYM each @ 5 t ha^{-1} + Zinc @ 5 kg ha^{-1}) and three levels of mineral fertilizers *viz*. F_0 :control, F_1: 100 % RDF and F_2:50 % RDF) laid out in split plot design with three replications. Significantly taller plants coupled with more number of branches, nodulation and dry matter accumulation per plant, pods per plant and seeds per pod due to the application of organic manuring and mineral fertilizers resulted higher seed yields during both the years. Organic manuring with crop residue + FYM each @ 5 t ha^{-1} along with 5 kg ha^{-1} of zinc (M_3)registered its superiority with respect to growth and yield contributing parameters and hence seed and stover yields were enhanced significantly over rest of the treatments. Recommended dose of fertilizers(F_1) recorded significantly higher plant height with profuse branching, more number of pods per plant and seeds per pod and finally the seed and stover yields of soybean as compared with control and 50 % RDF.

Key words : Soybean, Organic manuring, Fertilizers, Nutrient content and uptake

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] an important oilseed crop of India. It has the capacity to fix atmospheric nitrogen with the help of rhizobium and improves soil fertility. Soybean is gaining popularity in the new state of Chhattisgarh. However, its average yield is deplorably low in rainfed uplands because of injudicious use of plant nutrients. This calls for balanced use of fertilizers and adoption of appropriate agronomic practices. In view of escalating prices and high demand supply gap of chemical fertilizers, there is strong need to adopt an integrated nutrient supply system by judicious combination of organic manures and mineral fertilizers to improve soil health and soybean productivity. Integrating chemical fertilizers with organic manures has been found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production (Nambiar and Abrol, 1992). The information on the use of organic manuring along with mineral fertilizers is not available especially in the agro-climatic conditions of Chhattisgarh, thus it had become necessary to formulate an experiment to work out the optimum level of nutrient supply system through organic manuring and mineral fertilizers for increasing the yield potential of soybean.

MATERIALS AND METHODS

The present study was conducted at College of Agriculture, IGKV, Raipur during *kharif* seasons of 2001-2002 and 2002-2003. The soils of the experimental site was clayey in texture with pH 7.12, low in available nitrogen (237 kg/ha), medium in available phosphorus (13.75 kg) and high in available potassium (362 kg/ha) The treatments comprised of 4 levels of organic manuring *viz*. M_0:control, M_1:crop residues-rice straw @ 5 t ha^{-1}, M_2:FYM @ 5 t ha^{-1} and M_3:crop residue + FYM each @ 5 t ha^{-1} + zinc @ 5 kg ha^{-1}) allocated to main plot and three levels of mineral fertilizers *viz*. F_0 :control, F_1: 100 % RDF and F_2:50 % RDF) assigned to sub plot laid out in split plot design with three replications. Recommended doses of fertilizers (RDF) *viz*., 20 kg nitrogen through urea, 60 kg phosphorus through single super phosphate and 40 kg potash through muriate of potash were given. Well decomposed farm yard manure (FYM) and crop residue(decomposed rice straw) was incorporated in to the soil a week before sowing, where as full doses of NPK was applied in furrows as basal placement before seed sowing as per the treatments.

Soybean variety JS-335 was sown in third and fourth week of June in 2001 and 2002, respectively using a seed rate of 70 kg per hectare and spaced 30 cm and 5 cm between rows and plants, respectively. Seeds were treated with Carbendazim @ 3 g/kg of seed and latter with *Bradyrhizobium japonicum* culture. A total of 560.11 and 538.4 mm rains were received during crop growth period. To control weeds alachlor was applied @ 2.0 kg/ha as pre-emergence spray. One manual weeding was done 30 days after sowing. The crop was harvested in the second and third week of October during 2001 and 2002, respectively. The observations on growth and yield contributing parameters, seed and straw yields of soybean were recorded and analyzed statistically and harvest index

*** Author for correspondence**

and economics were studied for treatment evaluation. Oil content were determined by Soxhlet appratus oil extraction using petroleum ether and seed protein by using modified Kjeldahl's method. Then oil and protein yield was computed by multiplying the oil and protein content with the seed yield of respective treatments. The economics of different treatments were computed by considering the prevailing market price of inputs and produces of soybean. Since error variances for different growth and yield parameters of soybean in respective treatments during years of experimentation were found homogenous, pooling of data was done.

RESULTS AND DISCUSSION

Results obtained are summarized in Table 1, 2 and 3. Analysis of variance revelaed that different level of organic manuring and miniral fertilizers had significant effect on growth parameters and yield parameters.

Organic manuring:

Growth and yield attributes of soybean like plant height, number of branches, nodules per plant and dry matter accumulation g/plant, number of pods/plant, number of seeds/pod and 100 seed weight were recorded (Table 1 and 2). Combined analysis over the years revealed that growth attributes like plant height, branches per plant and dry matter accumulation increased progressively up to 120 DAS. However, number of root nodules per plant decreased drastically after 60 DAS. It is because of the presence of competition between bacteriods and developing sink for photosynthesis resulting in the adverse effect on nodulation (Finn,1981). Organic manuring in soybean with crop residue + FYM each @ 5 t ha^{-1} + zinc @ 5 kg ha^{-1} (M_3) resulted significantly taller plants coupled with more number of branches/plant, nodules/plant and accumulated maximum amount of dry matter throughout the growth periods of soybean and highest number of pods/plant and seeds/pod which was significantly superior over individual incorporation of either FYM or crop residues. However, 100 seed weight did not differ significantly due to organic manuring. Better growth and development of soybean may be due the availability of different macro and micro nutrients from different organic sources, which helped in acceleration of various metabolic processes (Jain *et al.*,1995).

Looking into the results of mean seed yield, stover yield and harvest index (Table 2) of soybean crop, it was observed that these characters were significantly influenced by incorporation of organic manures. Seed and stover yields of soybean was found to be maximum with the integrated use of crop residue + FYM each @ 5 t ha^{-1} + zinc @ 5 kg ha^{-1} (M_3) which was significantly higher over rest of the organics. The results confirm the findings of Bisht and Chandel (1996).The improvement in soil fertility status facilitated quick and greater availability of plant nutrients, which enhanced the growth and development of the crop. Improvement in growth and yield attributes significantly increased the seed and stover yields of soybean. Amarnath *et al.*(1990) reported positive correlation of seed yield with seeds/pod, branches/plant and 100-seed weight in soybean. The harvest index was also found to be maximum (35.29%) in case of M_3

Table 1 : Effect of organic manuring and mineral fertilizers on the growth attributes of soybean at various growth periods mean of two years)

Treatments	Plant height cm (DAS)			No. of branches/plant^{-1} (DAS)			No. of nodules/plant^{-1} (DAS)			Dry matter accum. g/plant^{-1} (DAS)		
	30	60	120	30	60	120	30	60	120	30	60	120
Organic manuring												
M_0	10.14	30.64	42.68	1.21	3.69	3.87	6.54	35.66	5.44	0.55	4.67	15.05
M_1	11.26	32.09	48.50	1.53	3.60	4.15	7.78	36.91	6.32	0.68	5.19	17.44
M_2	13.62	35.28	51.27	1.80	4.86	5.87	8.65	39.40	7.13	0.81	6.10	18.11
M_3	14.38	38.13	54.77	2.11	5.63	6.10	8.97	42.44	6.80	0.90	6.54	19.68
S.E.±	0.47	0.53	0.71	0.16	0.15	0.17	0.20	0.65	0.24	0.02	0.18	0.24
C.D. (P=0.05)	1.27	1.59	2.08	0.46	0.47	0.50	0.56	1.98	0.63	NS	0.56	0.73
Mineral fertilizer												
F_0	11.25	28.07	41.68	1.35	3.74	8.88	8.60	40.76	7.50	0.62	5.04	15.13
F_1	13.86	43.21	58.41	2.08	5.90	6.47	6.94	38.12	6.31	0.79	6.24	19.44
F_2	12.48	37.77	53.77	1.87	4.88	5.29	6.30	39.30	5.86	0.68	5.51	17.67
S.E.±	0.39	0.57	0.74	0.13	0.12	0.14	0.11	0.54	0.21	0.03	0.11	0.23
C.D. (P=0.05)	1.18	1.65	2.10	0.35	0.33	0.41	0.29	1.64	0.59	NS	0.30	0.72

NS- Non significant

Table 2 : Effect of organic and inorganic fertilizers on yield attributes, seed and stover yields, harvest index ,quality and economics of soybean (Mean of two years)

Treatments	No. of Pods/ plant^{-1}	No. of Seeds/ pod^{-1}	100 seed weight (g)	Seed yield q ha^{-1}	Stover yield q ha^{-1}	Harvest index (%)	Protein in seed (%)	Protein yield q ha^{-1}	Oil in seed (%)	Oil yield q ha^{-1}	Net return Rs.ha^{-1}	Benefit : Cost
Organic manuring												
M_0	20.32	1.95	12.19	9.95	22.85	30.33	37.10	3.69	18.40	1.83	2919.00	0.38
M_1	25.24	2.16	12.28	11.01	23.56	31.85	40.24	4.43	19.44	2.14	1792.00	0.18
M_2	27.33	2.28	12.31	12.09	24.76	32.80	40.51	4.90	19.98	2.41	4187.00	0.48
M_3	28.68	2.95	12.29	13.58	24.90	35.29	41.69	5.66	21.32	2.89	3486.00	0.32
S.E.±	0.91	0.14	0.09	0.47	0.57	0.61	0.64	0.16	0.48	0.12	NA	NA
C.D. (P=0.05)	2.38	0.39	NS	1.21	1.44	1.87	1.89	0.49	1.38	0.32	NA	NA
Mineral fertilizers												
F_0	20.98	1.90	12.32	10.32	21.90	32.02	38.93	4.12	21.37	2.20	2306.00	0.26
F_1	29.22	2.68	12.35	12.88	24.88	34.11	41.97	5.40	19.78	2.54	3508.00	0.35
F_2	25.73	2.25	12.51	11.40	23.46	32.70	40.11	4.57	20.58	2.34	2696.00	0.28
S.E.±	0.75	0.13	0.14	0.41	0.37	0.78	0.55	0.15	0.37	0.14	NA	NA
C.D. (P=0.05)	1.97	0.36	NS	1.14	1.08	1.57	1.57	0.47	1.17	0.43	NA	NA

treatments being significantly superior compared to rest of the organics, which implies greater accumulation of dry matter in seeds. Similar results were also obtained by Bablad (1999).

The seeds were analyzed for protein and oil contents in soybean (Table 2). It was noticed that significantly highest protein (41.69 %) and oil contents (21.32%) in seed was observed with the combined use of crop residue + FYM each @ 5 t ha^{-1} + zinc @ 5 kg ha^{-1} (M_3) compared with no use of organics. Similar results were obtained by Bisht and Chandel (1996). The increase in protein and oil contents may be due to improved nodulation followed by higher nutrient uptake, improved aeration and microclimate of rhizosphere (Yawalkar *et al*.,1996). The protein and oil yield is a function of seed yields, thus M_3 treatments (crop residue + FYM each @ 5 t ha^{-1} + zinc @ 5 kg ha^{-1})appeared to be beneficial, compared to other treatment of organic manuring for enhancing the protein and oil yields of soybean. Significantly maximum net returns of Rs.4187/ ha was recorded which in turn resulted in highest benefit cost ratio (0.48) with the use of organic manuring involving the incorporation of FYM @ 5 t/ha (M2) due to less cost of cultivation. Integrated use of crop residue + FYM each @ 5 t ha^{-1} + Zinc @ 5 kg ha^{-1} (M_3)resulted in less B:C ratio than with FYM alone (M_2)due to higher cost involved in the M_3 treatments.

Mineral fertilizers:

Data presented in Table 1 indicated that plant height, number of branches and plant dry matter were significantly affected due to the application of mineral fertilizers (NPK). The increase in plant height was possibly attributed to internode elongation and F_1 treatments (100 % RDF) gave the maximum plant height at 30,60 DAS and at harvest. The effect of mineral fertilization on number of branches per plant and dry matter accumulation of soybean was found to be significant and both the growth attributes were improved in all the stages of crop growth with the application of 100 % RDF over rest of the treatments. This was possibly because of balance supply of NPK responsible for better vegetative growth of soybean. Reduction in the recommended dose of NPK (50 % RDF) reduced the values of all the growth and yield attributes, however, caused significant positive variations compared with that of control treatment. Unlike the growth parameters application of inorganic fertilizers showed different trend with regard to effect on nodulation of soybean. Higher number of nodules/plant were recorded with control (F_0) which may be because of increasing availability of N decreases the activity of N fixing bacteria. The reproductive phase depends on vegetative growth of plant. More vegetative growth increased the supply of photosynthates for the formation of branches and other yield attributes. Number of pods/ plant and seeds/pod (Table 2) were maximum with the recommended dose of NPK (F_1) which stand significantly superior compared with other fertility levels. However, different fertility treatments did not influence the 100-seed weight significantly. Increase in growth and yield attributes increased the seed and stover yields of soybean. Maximum seed and stover yield was recorded with 100 % RDF (F_1) which was significantly superior to rest of the treatments. The results corroborate the findings of Halvankar *et al*.(1999) The increase in seed yield owing

Table 3 : Interaction effects of organic manuring and mineral nutrition on seed yield of soybean

Organic manuring	Levels of mineral fertilizers (Recommended dose of fertilizers)					
	2001-2002			2002-2003		
	Control (F_0)	100 % RDF(F_1)	50 % RDF(F_2)	Control (F_0)	100 % RDF(F_1)	50 % RDF(F_2)
Control (M_0)	8.68	11.92	9.92	8.29	10.98	9.92
Crop residues @ 5t/ha(M_1)	9.75	12.23	10.85	9.77	12.49	10.99
FYM @ 5 t/ha (M_2)	10.81	12.95	11.32	11.35	13.90	12.22
Crop residue + FYM + Zn @ 5kg/ha(M_3)	11.45	13.75	12.86	12.46	14.85	13.13
$CD_{5\%}$ for 2 SP mean at same MP	1.27				1.19	
$CD_{5\%}$ for 2 MP at same/diff SP	1.64				1.97	

to these treatments may be because fertilizer nutrients influenced the seed yield through source-sink relationship, resulting in higher production of photosynthates and their increased translocation to reproductive parts as these nutrients are essential for growth and development of plant and known to increase the yield of soybean (Saxena *et al*., 2001)

Protein content in seeds increased significantly when soybean was fertilized with the recommended doses of NPK, while the reverse trend was noticed for oil content (Table 2). Application of fertilizers enhanced the protein content in soybean, maximum being recorded under F_1 treatments. However, highest oil content was recorded in no fertilized treatment (F_0) followed by 50 % RDF but difference between these two treatments was non-significant. This might be due to the fact that increasing availability of NPK increased the proportion of proteinaceous substances in the seed. Halvankar *et al*.(1999) found that the oil content in soybean was not altered due to fertility levels. The oil and protein yields were significantly increased with the application of mineral fertilizers, maximum being found under full RDF (F_1). Despite inverse relationship between oil content at increasing levels of fertilizers, increase in oil yield can be explained by proportionately greater increase in seed yield due to application of fertilizers. Increase in protein yield was due to significant increase in protein content in seed and seed yield with balance fertilization. The results are in close agreement with those of Halvankar *et al*.(1999). Application of recommended dose of fertilizers (F_1) resulted higher net returns of Rs. 3508/ha and benefit cost ratio (0.35) due to higher seed and stover yields of soybean. Similar results were also reported by Bablad (1999).

Organic manuring x mineral fertilizers:

The interaction effect of organic manuring and mineral fertilizers on seed yields of soybean was found to be significant during both the years of experimentation (Table 3). Incorporation of crop residues and farm yard manure each at 5 t/ha individually or their conjunctive use (crop residue + FYM each @ 5 t ha^{-1} + zinc @ 5 kg ha^{-1}) increased the seed yields of soybean at the same or different levels of fertility during both the years. Highest seed yield of 13.75 and 14.85 q/ha were obtained in 2001 and 2002, respectively with the integrated use of organic manuring (crop residue + FYM each @ 5 t ha^{-1} + zinc @ 5 kg ha^{-1}) and mineral fertilizers (100 % RDF) following the seed yields from same treatments of organic manuring with 50 % of recommended NPK applied to soybean. As yield is the resultant outcome of the effect of various growth and yield parameters, its expression was observed with their integrated influence. With the increment in supply of essential elements through organic and inorganic sources, their availability, mobilization and influx into the plant tissues increased and thus improved growth and yield components and finally the seed yield of soybean. The results corroborated the findings of Saxena *et al*.(2001).

REFERENCES

Amarnath, K.C.N., Vishuanatha,S.R. and Chennakeshahra, B.C. (1990). Phenotypic and genotypic correlation coefficient of some quantitative characters in soybean. *Mysore J. agric. Sci.,* **24** (4) : 445-449.

Bablad, H.B. (1999). Integrated nutrient management for sustainable production in soybean based cropping system. Ph.D. Thesis, University of Agricultural Sciences, Dharwad, pp. 395-402.

Bisht, J.K. and Chandel, A.S. (1996). Nitrogenese activity and nitrogen fixation in soybean as affected by integrated fertilizer management.*Ann.agric.Res.,* **17** (4) : 429-431.

Finn, G.A. (1981). The role of current photosynthates and carbohydrates reseves in control of nitrogen fixation in soybean. *Dissertation Ab. Int. B.,* **41** (11) : 3971.

Halvankar, G.B., Taware, S.P. and Raut, V.M. (1999). Response of some soybean (*Glycine max*) varieties to different fertility levels. *Indian J. Agron*., **44** (3) : 605-608.

Jain, R.C., Tiwari, R.J. and Singh, K. (1995). Effect of farm yard manure and sugar press mud on productivity and quality of soybean [*Glycine max* (L.)].*Crop Res.*, **9** (2) : 229-232.

Nambiar, K.K.M. and Abrol, I.P. (1992). Long term fertilizer experiments in India-An Overview. *Fertilizer News*, **34** (4):11-26

Saxena, S.C., Manral, H.S. and Chandel, A.S. (2001). Effect of inorganic and organic sources of nutrients on soybean (*Glycine max*). *Indian J. Agron.*, **46** (1) : 135-140.

Yawalkar, K.S., Agrawal, J.P. and Bokade, S. (1996). *Manures and fertilizers*, 8th Ed.Agri.-Horticulture Pub.House, Nagpur.pp.25-26

Received : April, 2009; Accepted : May, 2009