

Effect of nitrogen, its application time and sulphur on yield and quality of soybean (*Glycine max*)

S.P. SINGH, K.N. BANSAL AND V. NEPALIA

Department of Agronomy, Rajasthan College of Agriculture, Rajasthan Agriculture University, Udaipur 313 001

Received : March 1999

ABSTRACT

An experiment with 3 nitrogen levels (30, 60 and 90 kg/ha), 3 times of nitrogen application (full basal, $\frac{1}{2}$ basal + $\frac{1}{2}$ top-dressing and $\frac{1}{2}$ basal + $\frac{1}{4}$ top-dressing + $\frac{1}{4}$ foliar spray) and 3 sulphur levels (0, 30 and 60 kg/ha) was conducted during the rainy season (*kharif*) season of 1995 and 1996. An application of 60 kg N/ha resulted in 22.1 and 21.1% increase in seed yield during the first and second year over 30 kg N/ha. The respective increase in stover and biological yields was 17.8 and 17.1 and 19.1 and 18.2%. The oil and protein content of seed remained at par at all levels of N, while oil and protein yield increased significantly up to 60 kg N/ha. During both the years minimum seed yield (17.37 and 17.64 q/ha) was observed with all basal application. The 2 methods involving splitting of N were at par in this regards and significantly superior to all basal. Similar trend of results was observed for stover and biological yields. Although the oil and protein content of seed remained unaffected by time of N application, full basal resulted in statistically lower oil and protein yields than the remaining 2 methods which were at par with each other. Mean seed yield obtained under 60 kg S/ha was 18.97 q/ha, being significantly higher over the control, and there was no significant variation from 0 to 30 and 30 to 60 kg S/ha. Similar trend was observed for stover, biological, oil and protein yields.

Key words : Soybean, Nitrogen, Sulphur, Yield, Quality

Soybean, being a leguminous crop, is capable to fix atmospheric nitrogen through symbiosis. However, several studies have shown that the symbiotic N-fixation is not able to meet high N-requirement of this crop particularly under the N-deficient conditions. About half of the N in mature soybean seeds is translocated from different parts of the plant and remaining is derived

from the soil and nodules (Hanway and Weber, 1971). The excessive basal N promotes vegetative growth, which can lead to lodging or a reduction in the development of nitrogen fixing nodules. Soybean has a relatively high N requirements, especially at later growth stages (Watanabe *et al.*, 1983). Sulphur is best known for its role in the formation of

sulphur-containing amino acids, synthesis of proteins, vitamins, chlorophyll and oil in oilseeds. Sulphur promotes nodulation in legumes, produces bold seeds in oilseeds consequently sulphur deficiency affects the quality of food for human beings. Hence an experiment was carried out to study response of soybean to N and S.

MATERIALS AND METHODS

The experiment was conducted at Instructional farm, Rajathan College of Agriculture, Udaipur, during the rainy season of 1995 and 1996. The soil of experimental fields was clay loam in texture with bulk density of 1.38 Mg/m³. Soils were alkaline calcareous in reaction with pH 8.2, with normal electrical conductivity of 1.20 and 0.89 dS/m, high in organic carbon, medium in total nitrogen and available phosphorus and well supplied with available potash. The sulphate-sulphur content of soil was 9.4 and 9.7 ppm in respective years. The treatment for the experiment comprised combinations of 3 factors each at 3 levels, N (30, 60 and 90 kg N/ha), time of N application (all basal, ½ basal + ½ top dressing at pre-flowering and ½ basal + ¼ top-dressing at pre-flowering + ¼ foliar spray of 1% N at pod development) and S (0, 30 and 60 kg S/ha). The source of sulphur was gypsum. Total 27 treatment combinations were replicated 3 times in confounded randomized block design. 'PK 472' soybean was sown on 4 and 1 July and harvested on 21 and 20 October during 1995 and 1996 respectively. A spacing of 30 cm × 10 cm was adopted. A uniform dose of 50 kg P₂O₅/ha was drilled through diammonium phosphate.

The experiment was conducted under irrigated conditions.

RESULTS AND DISCUSSION

Nitrogen

The crop gave significantly higher seed and biological yields with 60 kg N/ha, and beyond this level there was a marginal increase in yield; the increase being 21.6 and 18.7% over 30 kg N/ha (Table 1). The stover yield was significantly increased up to 90 kg N/ha. Increasing rate of N application did not show significant effect on oil and protein content of seed, but oil and protein yield improved up to 60 kg N/ha, the increase being 6.84 and 28.53 kg/ha in oil and protein yields over 30 kg N. The observed increase in seed yield is a complex entity, due to progressive increase in N application. This appears to be on account of beneficial effect of N nutrition in exploiting inherent potentials of the crop for vegetative and reproductive growth of the crop. The optimum nutrition especially nitrogen, through greater availability of nutrients and photosynthates results in proper growth and development of both vegetative and reproductive structure of the crop and finally leads to improved productivity (Bhargava *et al.*, 1979). The results are in close agreement with those of Pal and Norman (1987) and Kumawat (1996). Increase in oil and protein yield can be explained by proportionately greater increase in seed yield.

N application time

Significant improvement in seed yield of soybean was noticed owing to split application of N over all basal. Application of N as

Table 1. Effect of nitrogen, its application time and sulphur on yield of soybean

Treatments	Seed yield (q/ha)		Stover yield (q/ha)		Biological yield (q/ha)		Oil (kg/ha)		Protein (kg/ha)	
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
<i>N (kg/ha)</i>										
30	15.83	16.18	35.76	37.46	51.59	53.65	308.42	321.20	578.99	610.45
60	19.33	19.59	42.12	43.85	61.45	63.44	374.95	386.86	723.93	751.90
90	19.91	20.16	43.94	45.74	63.86	65.90	383.60	391.90	752.81	780.09
CD (P = 0.05)	0.89	0.84	1.71	1.81	2.54	2.76	20.01	20.56	40.55	42.10
<i>N (application time)</i>										
AB	17.37	17.64	39.34	41.03	56.71	58.68	335.59	346.14	636.94	664.76
½ B+ ½ T	18.57	18.83	41.01	42.92	59.58	61.76	360.06	368.03	698.41	724.05
½ B+ ¼ T + ¼ F	19.13	19.46	41.48	43.10	60.61	62.56	371.33	385.79	720.37	753.64
CD (P = 0.05)	0.89	0.84	1.71	1.81	2.54	2.76	20.10	20.56	40.55	42.10
<i>S (kg/ha)</i>										
0	17.76	18.05	39.52	41.02	57.29	59.07	341.26	350.33	654.70	683.38
30	18.42	18.82	40.66	42.63	59.08	61.46	357.31	370.84	691.38	722.70
60	18.89	19.06	41.64	43.40	60.54	62.47	368.40	378.80	709.64	736.37
CD (P = 0.05)	0.89	0.84	1.71	1.81	2.54	2.76	20.01	20.56	40.55	42.10

AB, All basal; B, basal; T, tillering; F, flowering

$\frac{1}{2}$ basal + $\frac{1}{2}$ top-dressing resulted in significantly higher seed yield by 6.9 and 6.7% in first and second year respectively over all basal application, but was statistically at par with $\frac{1}{2}$ basal + $\frac{1}{4}$ top-dressing + $\frac{1}{4}$ foliar spray. Stover and biological yields also showed similar trend (Table 1). Oil and protein content of soybean seed remained unaffected due to split N application. However, significant improvement in oil and protein yield was recorded with application of N as $\frac{1}{2}$ basal + $\frac{1}{2}$ top-dressing and $\frac{1}{2}$ basal + $\frac{1}{4}$ top-dressing + $\frac{1}{4}$ foliar spray. The corresponding mean increase in oil and protein yield over basal application was 6.8 and 9.3% and 11.1 and 13.2% respectively. As soybean is a leguminous crop, substantial amount of its N requirement is met out by the process of symbiosis. Since soybean seeds are very rich in protein and oil, the higher carbon and nitrogen requirements for growth of seeds are not met out fully by the plant hence high rate of mobilization from foliage in turn induces leaf senescence and abscission. Thus optimum supply of nitrogen plays a vital role in alleviating nutritional deficiency in plant particularly at reproductive growth stage. Pal and Norman (1987) and Kamel *et al.* (1987) also reported similar results with supplementary N application.

Sulphur

Seed, stover and biological yields increased up to 60 kg S/ha, which was statistically at par with 30 kg S/ha but significantly superior to the control. The crop under the influence of 60 kg S/ha gave the maximum seed, stover and biological yields, being 6.0, 5.6 and 5.7% higher than that of no sulphur respectively. The oil and protein content of soybean seed was not

influenced by the increase in S application. However, the oil and protein yields showed significant improvement up to 30 kg S/ha. The observed results under present investigation are in close conformity with the findings of Bansal (1991) and Singh and Singh (1995).

REFERENCES

- Bansal, K.N. 1991. Effect of levels of sulphur on the yield and composition of soybean (*Glycine max* (L.) Merr.), green gram (*Vigna radiata*), black gram (*Vigna mungo*) and cow pea (*Vigna sinensis*). *Madras Agricultural Journal* **98** (5-8) : 188-190.
- Bhargava, S.C., Tomar, D.P.S. and Sinha, S.K. 1979. Physiological basis of productivity in *Brassica* ecotypes. (In) *Proceedings of Symposium on Research and Development Strategies for Oilseeds Production in India*, held during 2-9 November, held at Indian Agricultural Research Institute, New Delhi. pp. 103-113.
- Hanway, J.J. and Weber, C.R. 1971 Accumulation of N, P and K by soybean [*Glycine max* (L.) Merrill] plants. *Agronomy Journal* **63** : 406-408.
- Kamel, M.S., Metwally, A.A. and Abdalla, S.T. 1987. Effect of soil and foliar fertilization on inoculated and uninoculated soybean. *Journal of Agronomy and Crop Science* **158** (2) : 217-221.
- Kumawat, S.M. 1996. 'Effect of differential nitrogen levels on productivity of soybean [*Glycine max* (L.) Merrill] under varying irrigation regimes.' Ph.D. (Agric.), Thesis, Rajasthan Agriculture University, Udaipur.
- Singh, D. and Singh, V. 1995. Effect of potassium, zinc and sulphur on growth characters, yields attributes and yield of soybean (*Glycine max*). *Indian Journal of Agronomy* **4** (2) : 223-227.
- Watanabe, I., Tabuchi, K. and Nakano, H. 1983. Response of soybean to supplemental nitrogen after flowering. (In) *Proceeding of Symposium on Soybean in Tropical and Subtropical Cropping Systems*, held at Tsukuba, Japan, during 25 September-1 October 1983. pp. 301-308.