

Effect of inorganic and organic sources of nutrients on soybean (*Glycine max*)

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ABSTRACT

An experiment was conducted on soybean [*Glycine max* (L.) Merr.] during rainy season (*kharif*) of 1996 and 1997 to study the response of crop to inorganic and organic sources of nutrients. The plant height, number of trifoliates/plant, plant dry matter, leaf-area index, physiological and other growth parameters and seed yield increased significantly by the use of 50 kg N + 1 tonne neem-cake/ha. Maximum seed yield was obtained with 25 kg N + 5 tonnes FYM/ha which was on par with 25 kg N + 1 tonne neem-cake.

Key words : Soybean, Inorganic, Organic nutrients, LAI, Growth and physiological parameters, Yield

Symbiotically soybean fixes 125–150 kg N/ha (Chandel *et al.*, 1989) and leaves about 30–40 kg N/ha for succeeding crop (Sexena and Chandel, 1992). With the increasing degradation, cost of chemical fertilizers, there is need to integrate them with organic sources which are good for the soil health besides supplying nutrients for longer period of time. Therefore present study was planned to find out the response of soybean to varying levels of inorganic and organic sources of nutrients, alone and their combinations, in respect of physiological parameters, growth, seed yield and its quality.

MATERIALS AND METHODS

An experiment was conducted at Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar Udham Singh Nagar, during rainy season (*kharif*) 1996 and 1997 to study the effect of organic and inorganic sources of nutrients on soybean ('PK 262'). The soil of experimental site was clay loam, well-drained (pH 7.4), high in available phosphorus (61.6 kg/ha), available potassium (268.8 kg/ha) and medium in organic carbon (0.66%). The experiment was laid out in randomized block design with 3 replications. The crop was sown in

rows 60 cm apart. Seed was inoculated by *Bradyrhizobium japonicum* @ 500 g/75 kg seed. Except control, all treatments (Table 1) were given as basal. To control weeds Alachlor was applied @ 2.0 kg ai/ha as pre-emergence spray. One manual weeding was done 30 days after sowing (DAS). Oil content and crude protein (%) were determined by ether extract using Soxhlet extraction apparatus and seed protein by using modified Kjeldahl's method.

RESULT AND DISCUSSION

Plant height, number of trifoliates, plant dry matter and leaf-area index (LAI) were significantly affected due to application of inorganic nitrogen combined with organic sources of nutrients. The increase in plant height was possibly attributed to internode elongation and 50 kg N + 1 tonne neem-

cake/ha gave the maximum plant height due to the presence of nitrogen with other nutrients received by the plants from organic sources. Number of trifoliates/plant with 50 kg N + 1 tonne neem-cake/ha was at par with 25 kg N + 1 tonne neem-cake/ha, 25 kg N + 5 tonnes/ha FYM/ha and 50 kg N + 5 tonnes/ha FYM and significantly greater than rest of the treatments at 45 days after sowing. This increase in number of trifoliates/plant was attributed in later stages, nitrogen being an essential component for vegetative growth produced significant effect on number of trifoliates of soybean combined with neem-cake. The effect of different inorganic and organic sources of nutrient on dry-matter accumulation of soybean (Table 1) was found significant and increased the plant dry matter at 45 days after sowing and at

Table 1. Effect of inorganic and organic sources of nutrients on growth parameters of soybean at 45 days after sowing and at harvest (pooled data of 2 years)

Treatment	At 45 days*		Trifoliates/ plant	Plant dry matter (g)	
	Plant height (cm)	Leaf area index		45 days*	At harvest
Control (inoculated)	45.4	4.12	10.1	10.7	21.1
25 kg N/ha	49.1	4.55	10.7	12.2	30.1
50 kg N/ha	61.0	4.77	13.4	17.4	34.6
5 tonnes FYM/ha	51.3	4.41	12.6	16.1	33.9
1 tonne neem-cake/ha	59.0	4.39	12.8	16.5	36.2
25 kg N + 1 tonne neem-cake/ha	59.4	4.69	16.3	19.2	38.3
50 kg N + 1 tonne neem-cake/ha	64.1	4.90	17.0	24.8	46.9
25 kg N + 5 tonnes FYM/ha	59.2	4.52	15.9	18.8	37.3
50 kg N + 5 tonnes FYM/ha	61.5	4.93	16.3	22.4	41.9
Recommended N : P : K (20 : 60 : 40)	57.5	4.54	12.3	14.3	31.8
CD (P = 0.05)	6.33	0.36	2.70	2.41	6.44

*Days, Days after sowing

harvest. This was possibly because of supply of N with other nutrients, and particularly neem-cake was responsible for better vegetative growth. Besides the manurial properties of neem, it also acts as insect-controlling source and therefore, where neem-cake was used as manure the attack of insects on the crop was also less in comparison to the other treatments, which also resulted in increased dry matter of plant (Table 1). Application of nitrogen helped in increasing the vegetative growth of plants and also plant dry matter. Nimji and Seth (1988) also indicated that application of increasing rates of P_2O_5 (0, 40 or 80 kg/ha) and FYM (0 and 15 tonnes/ha) resulted in increased dry-matter production in soybean.

The effect of various treatments on leaf-area index was significant at 45 days after sowing. Leaf-area index/plant increased owing to more activities of meristematic tissues of the plant producing more number of trifoliates, which ultimately increased total photosynthetic surface area and leaf-area index of the plant. This contributed towards higher production of branches and increase in dry matter at different growth stages. Application of fertilizers, singly or integrated with FYM increased the LAI and photosynthetic efficiency of soybean (Table 1). The results confirm the findings of Bisht and Chandel (1991).

Physiological parameters

Application of different inorganic and organic nutrients had significant effect on physiological parameters like crop-growth rate (CGR) relative growth rate (RGR) and net assimilation rate (NAR) of soybean at

stage I (30–45 DAS), whereas leaf-area ratio (LAR) was significantly affected at both the stages (30–45 and 45–60 DAS). Maximum CGR, RGR and NAR were with 50 kg N + 1 tonne neem-cake/ha during stage I, while there was no significant effect of this treatment at stage II (Table 2). This was possibly due to accelerated photosynthetic activity which also contributed towards stronger reproductive phase resulting more dry-matter production. Kumar and Gangwar (1985) reported that an increase in CGR, RGR, NAR and LAR in oilseeds at higher nitrogen rates. Increased NAR and dry matter in above-ground parts were observed during vegetative phase of the plant. Non-significant effect at stage II was found because of diversion of photosynthates towards reproductive phase for formation of pods and seeds etc. (Table 2). But the trend in LAR was not same as of other physiological parameters.

Yield attributes and yield

The reproductive phase depends on vegetative growth of plant. More vegetative growth increased LAI and supply of photosynthates for the formation of branches and other yield attributes. Branches/plant and pods/plant were maximum with recommended doses of NPK. Increase in N and P rates increased the pods/plant, seeds/pod, 100-seed weight and protein content. The different nutritional treatments with and without organic manures (neem-cake/FYM) did not influence the seeds/pod of the soybean significantly during 1996 and 1997. Increase in yield attributes significantly

Table 2. Effect of inorganic and organic sources of nutrient on physiological parameters of soybean (pooled data of 2 years)

Treatment	Crop-growth rate (g/day)		Relative growth rate (g/g/day)		Net assimilation rate (g/cm ² /day)		Leaf-area ratio (cm ² /g)	
	Stage I	Stage II	Stage I	Stage II	Stage I	Stage II	Stage I	Stage II
Control (inoculated)	0.527	0.133	0.0886	0.0114	568×10^{-6}	96×10^{-6}	157.66	118.87
25 kg N/ha	0.616	0.087	0.0948	0.0062	609×10^{-9}	58×10^{-6}	156.55	118.31
50 kg N/ha	0.922	0.053	0.1058	0.0028	829×10^{-6}	34×10^{-6}	127.68	89.09
5 tonnes FYM/ha	0.874	0.087	0.1119	0.0049	878×10^{-6}	58×10^{-6}	127.60	87.17
1 tonne neem-cake/ha	0.898	0.146	0.1136	0.0084	930×10^{-6}	102×10^{-6}	122.21	82.15
25 kg N + 1 tonne neem-cake/ha	1.053	0.140	0.1148	0.0069	972×10^{-6}	51×10^{-6}	118.66	76.20
50 kg N + 1 tonne neem-cake/ha	1.389	0.044	0.1216	0.0019	$1,192 \times 10^{-5}$	26×10^{-6}	102.38	64.91
25 kg N + 5 tonnes FYM/ha	1.005	0.071	0.1074	0.0041	945×10^{-6}	49×10^{-6}	114.61	78.21
50 kg N + 5 tonnes FYM/ha	1.236	0.049	0.1166	0.0020	$1,067 \times 10^{-6}$	29×10^{-6}	109.55	71.17
Recommended N : P : K (20 : 60 : 40)	0.763	0.056	0.1068	0.0035	744×10^{-6}	34×10^{-6}	143.94	102.15
CD (P = 0.05)	0.154	NS	0.0125	NS	14×10^{-5}	NS	17.57	11.47

Table 3. Effect of inorganic and organic sources of nutrients on seed quality, yield attributes and yield of soybean (pooled data of 2 years)

Treatment	Seed quality		Branches/ plant	Pods/ plant	Seeds/ pod	1,000- seed weight (g)	Seed yield (q/ha)
	Crude protein (%)	Oil content (%)					
Control (inoculated)	34.42	19.03	6.0	58.4	2.1	127.8	6.89
25 kg N/ha	37.92	16.00	6.8	64.7	2.1	121.2	9.25
50 kg N/ha	37.04	18.72	7.2	83.1	2.0	199.8	8.94
5 tonnes FYM/ha	35.73	19.23	6.0	63.5	2.0	120.6	8.00
1 tonne neem-cake/ha	35.44	17.93	6.6	60.6	1.9	127.5	10.72
25 kg N + 1 tonne neem-cake/ha	37.92	18.85	6.8	81.1	1.9	118.3	15.17
50 kg N + 1 tonne neem-cake/ha	37.04	19.65	7.9	90.9	2.1	126.6	12.33
25 kg N + 5 tonnes FYM/ha	38.06	16.83	6.8	81.9	2.0	114.0	15.67
50 kg N + 5 tonnes FYM/ha	37.63	18.17	8.0	112.9	1.9	123.0	12.03
Recommended N : P : K (20 : 60 : 40)	38.94	18.92	8.3	124.4	2.1	100.0	13.25
CD (P = 0.05)	NS	1.776	1.29	12.55	NS	7.97	2.72

increased the seed yield of soybean. Amarnath *et al.* (1990) reported positive correlation of seed yield with seeds/pod, branches/plant and 100-seed weight in soybean. Thus, more branching increased the number of pods, more seeds/pod showed their additive effect in influencing the seed yield with balanced fertilization. Seed yield increased significantly with the application of nitrogen combined with organic sources (neem-cake/FYM). Maximum seed yield/ha was found with 25 kg N + 5 tonnes FYM/ha which was at par with 25 kg N + 1 tonne neem-cake/ha, recommended N : P : K (20 : 60 : 40) and significantly superior to rest of the treatments. The increase in seed yield owing to these treatments may be because

of the fact that nitrogen played an important role in the synthesis of chlorophyll and amino acids, and neem-cake besides supplying N, P and K also had insecticidal property. Nitrogen influenced the seed yield through source-sink relationship, resulting in higher production of photosynthates and their increased translocation to reproductive parts as nitrogen being the most important essential plant nutrient needed for growth and development of plant and known to increase the yield of soybean (Table 3).

Therefore the productivity of soybean can be increased with the use of any of the organic sources of nutrients used along with nitrogen or by following recommended fertilization. Besides increase in yield,

neem-cake also helped in reducing insect population.

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