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Effect of nitrogen on growth, nodulation and seed protein content in soybean

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Replicated field experiment in F.R.B.D. was conducted during kharif 2002 to study the effect of soil and foliar application of nitrogen (N) at flowering in addition to basal N dose on nodulation, growth & seed protein content in soyabean. Plant height was significantly increased due to N application. While nodulation was significantly decreased with increased doseof N. Maximum seed protein content (%) was recorded by application of 45 kg. + 30 kg. N ha^{-1} at 40 D.A.S. Significantly increased and highest dry weight along with maximum Relative Growth Rate (RGR) was observed by 45 kg. N ha^{-1} (basal dose). Where as, significant varietal differenceswere also noted in respect of Leaf Area Index (LAI), Leaf Area Ratio (LAR) and Net Assimilation Rate (NAR).

Key words : Soybean, Nitrogen nutrition, Growth, Nodulation and Seed protein.

INTRODUCTION

SOYBEAN (*Glycine max* L. Merill) a well known oil seed, pulse crop and cheapest source of quality proteins requires large amount of nitrogen for optimum production due to high protein content. A good crop of soybean utilizes upto 240-250 kg. N ha-1 out of which approximately 100-110 Kg. N ha^{-1} is fixed symbiotically (Chandell & Saxena, 1988). Instead of giving nutrients at the time of sowing, as followed in present recommendations, spilt application may be advantageous for pod development. Successive increase in N lead to progressive and significant increase in grain yield (Nandurkar, *et al.* 2000). Nitrogen at 30 and 60 kg. ha^{-1}, exhibited significant influence on growth and yield of soybean (Krishna, *et al.* 1995). Protein content range from 35-40 per cent in soybean. Soybean with high protein content is preferred in international market. Seed protein content could be increased with increased level of N (Bishnoi and Dutt, 1980). The unique feature of soybean is that, most of the N fixation occurs after flowering. Increase in the supply of mineral nitrogen during post flowering stage proportionately retards symbiotic N fixation. Thus while planning a favorable regime for this nutrient, care should be taken that the added nitrogen should be completely assimilated by the plant up to mid flowering stage. Inoculation with *Rhizobium* strain and application of nitrogen have been reported to affect nodulation, oil and protein content in soybean (Verma & Tiwari, 1976).

Considering the effect of N on growth, nodulation and protein content, the present investigation, therefore, was under taken to assess the potentiality of soybean under variable N doses.

MATERIALS AND METHODS

The present research work captioned 'Effect of Nitrogen on Growth, Nodulation and Seed Protein Content in Soybean', was carried out during kharif 2002 at Department of Botany, Dr. PDKV, Akola. Seeds of soybean varieties TAMS-38 & MACS – 450 obtained from Regional Research Center, Amravati were inoculated with *rhizobium* culture @ 5 g kg^{-1} and sown with 45 x 5 cm. Of spacing in each plot of size 1.35 x 1.45 m, fitted in Factorial Randomized Block Design with three replications and treatments as follows :

A) First factor treatment

i) V_1 – TAMS-38

ii) V_2 – MACS-450

B) Second factor treatment

N_0 – Control (N_0 nitrogen)
N_1 – 30 kg. N ha^{-1} (basal dose)
N_2 – 30 kg. + 15 kg. N ha^{-1} at 40 DAS
N_3 – 30 kg. + 30 kg. N ha^{-1} at 40 DAS
N_4 – 45 kg. N ha^{-1} (basal)
N_5 – 45 kg. + 15 kg. N ha^{-1} at 40 DAS
N_6 – 45 kg. + 30 kg. N ha^{-1} at 40 DAS
N_7 – 30 kg. + 2% urea spray at 40 DAS
N_8 – 45 kg. + 2% urea spray at 40 DAS

Observation were recorded on different characters viz. plant height (cm), number of root nodules plant^{-1}, crude protein (%) of seed, total dry weight plant^{-1} (g), Leaf Area Index (LAI), Leaf Area Ratio (LAR), Net Assimilation Rate (NAR) and Relative Growth Rate (RGR) to assess the growth and yield potential of soybean under variable doses of nitrogen. The data on various characters were subjected to statistical analysis by employing standard statistical methods for F.R.B.D.

RESULTS AND DISCUSSION

Data collected on plant height (cm), number of root nodules plant^{-1} and seed crude protein (%) of soybean are presented in Table 1.

Plant height (cm)

Plant height was significantly increased due to N application. Treatments N_2, N_3, N_4, N_5, N_6, N_7 and N_8 showed significantly higher height than control (47.48) with maximum plant height recorded in N_5 (52.16). Varietal and interaction effects were non-significant. Above findings are in confirmation with the results reported by Singh *et al.* (1971) & Mandal *et al.* (1997).

Number of root nodules plant^{-1}

Maximum and significantly greater number of root nodules plant^{-1} was recorded in the control. Number of root nodules plant^{-1} were significantly decrease with increased dose N fertilization (N_2, N_3, N_4, N_5 & N_6). Interaction effects were nonsignificant. Similar results were reported by Thakur & Hasan (1972) and Shrinivasulu (2000).

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Table 1 : Effect of nitrogen on mean plant height (cm), mean number of root nodules plant^{-1} and crude protein content (%) in seed.

V	Mean plant height (cm) 75 DAS			Mean number of root nodules plant^{-1} 75DAS			Crude protein content (%) in seed		
N	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
N_0	47.40	47.48	47.44	28.16	25.06	26.61	34.87	35.24	35.06
N_1	48.52	48.65	48.58	25.19	24.09	24.64	39.24	38.93	39.09
N_2	48.75	49.05	48.90	22.83	19.73	21.28	39.62	40.06	39.84
N_3	51.44	51.72	51.58	21.03	17.93	19.48	41.12	41.49	41.30
N_4	52.01	51.80	51.90	21.86	18.76	20.31	41.37	41.97	41.67
N_5	51.98	52.35	52.16	20.35	17.25	18.80	42.49	41.62	42.06
N_6	51.40	51.58	51.49	16.55	13.55	15.10	42.74	43.24	42.99
N_7	48.72	49.00	48.86	24.28	21.18	22.73	41.37	41.12	41.24
N_8	48.81	49.13	48.97	24.22	21.12	22.67	41.87	41.37	41.62
Mean	49.89	50.08	-	22.73	19.85	-	40.52	40.56	
	V	N	V X N	V	N	V X N	V	N	V X N
SE±	0.202	0.428	0.606	0.18	0.382	0.54	0.137	0.291	0.411
CD at 5%	-	1.23	-	0.51	1.09	-	-	0.83	-

Table 2 : Effect of nitrogen on mean total dry matter (g/plant) of soybean.

V	15 DAS			30 DAS			45 DAS			60 DAS			75 DAS		
N	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
N_0	2.47	1.86	2.16	4.15	3.61	3.8	5.92	5.21	5.56	15.15	14.45	14.8	17.85	17.06	17.45
N_1	2.98	2.37	2.67	4.38	3.82	4.1	6.88	5.97	6.42	15.57	14.87	15.22	20.28	19.49	19.88
N_2	3.42	2.81	3.11	5.03	4.47	4.75	10.0	9.37	9.68	15.98	15.28	15.63	21.58	20.79	21.18
N_3	4.14	3.53	3.83	5.43	4.88	5.15	11.21	10.57	10.89	16.26	15.56	15.91	22.47	21.34	21.90
N_4	3.64	3.03	3.33	5.54	4.99	5.26	8.35	7.71	8.03	16.41	15.71	16.06	22.76	21.97	22.36
N_5	3.80	3.19	3.49	5.73	5.19	5.46	7.74	7.10	7.42	16.54	15.94	16.24	22.67	21.85	22.26
N_6	3.46	2.85	3.15	5.34	4.78	5.06	8.01	7.34	.67	16.86	16.16	16.51	22.27	21.69	21.98
N_7	2.58	2.09	2.33	4.57	4.02	4.29	8.72	8.04	8.38	15.48	14.78	15.13	20.57	19.82	20.19
N_8	2.62	2.08	2.35	4.6	4.07	4.33	8.78	7.96	8.37	15.50	14.81	15.15	20.64	19.86	20.25
Mean	3.23	2.64		4.97	4.42		8.4	7.69		15.97	15.28	15.62	21.33	20.43	
	V	N	VXN	V	N	VXN	V	N	VXN	V	N	VXN	V	N	VXN
SE±	0.023	0.049	0.069	0.04	0.089	0.13	0.042	0.09	0.126	0.06	0.128	0.181	0.056	0.13	0.169
CD at 5%	0.06	0.14	-	0.12	0.25	-	0.12	0.26	-	0.17	0.36	-	0.16	0.34	

Table 3 : Effect of Nitrogen on LAI (75 DAS), LAR (75 DAS), NAR (40-600DAS) and RGR (60-75 DAS).

V	LAI (75 DAS)			LAR (75 DAS)			NAR (40-60 DAS)			RGR (60-75 DAS)		
N	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
N_0	4.34	4.33	4.34	0.547	0.572	0.560	0.0638	0.0640	0.0639	0.0106	0.0106	0.0106
N_1	5.19	5.18	5.19	0.576	0.600	0.588	0.0547	0.0565	0.0556	0.0173	0.0176	0.0175
N_2	5.56	5.34	5.45	0.580	0.578	0.579	0.0492	0.0348	0.0420	0.0196	0.0200	0.0198
N_3	6.20	6.17	6.18	0.621	0.650	0.635	0.0266	0.0263	0.0264	0.0210	0.0206	0.0208
N_4	6.30	6.41	6.36	0.623	0.656	0.640	0.0428	0.0420	0.0424	0.0216	0.0216	0.0216
N_5	6.79	6.76	6.78	0.674	0.698	0.686	0.0478	0.0453	0.0465	0.0206	0.0206	0.0206
N_6	6.88	6.87	6.87	0.696	0.711	0.703	0.0450	0.0465	0.0458	0.0180	0.0193	0.0186
N_7	5.81	5.08	5.45	0.564	0.577	0.571	0.0407	0.0408	0.0408	0.0183	0.0190	0.0186
N_8	5.20	5.11	5.16	0.568	0.519	0.574	0.0402	0.0455	0.0428	0.0186	0.0193	0.0190
Mean	5.81	5.69	--	0.605	0.625	--	0.0456	0.0446	--	0.0184	0.0187	--
	V	N	VXN	V	N	VXN	V	N	VXN	V	N	VXN
SE±	0.118	0.25	0.354	0.011	0.023	0.033	0.0016	0.0034	0.0048	0.00028	0.00061	0.0008
CD at 5%	--	0.71	--	--	0.067	--	--	0.0090	--	--	0.0017	--

Crude protein (%) of seed

Protein content in seed was significantly higher in treatments receiving higher amounts of N fertilization than control. Treatment N6 (42.99) recorded maximum seed crude protein content over control (35.06). Treatment N_3, N_4, N_5 and N_7 recorded higher protein content and were at par. Bishnoi Ram Dutt (1980) and Pawar *et al.* (1982) also reported that increase in rate of N application increased protein content of seed.

Total dry weight plant^{-1}(g)

Data on mean total dry weight plant^{-1} (g) are presented in Table 2. At 75 DAS, all N-treatments recorded significantly higher total dry weight than control (17.45). Treatments N_4(22.36) and N_5 (22.26) recorded maximum total dry weight. Treatments N_1, N_3, N_6, N_7 and N_8 were also at par. Cultivar TAMS-38 recorded significantly higher total dry matter than MACS-450. International effects were non significant. Above finding are in confirmation with Joshi *et al.* (1989) and Madal *et al.* (1997).

Leaf Area Index (LAI)

LAI gradually increased up to 60 DAS followed by sharp decline at 75 DAS. All N-treatments recorded significantly higher LAI than control at 75 DAS. Treatment N_6 (0.703) recorded maximum LAI (Table 3). Cultivar and interaction effects were non-significant at all stages of growth. Data indicated maintain ace of higher LAI during pod development stage and grain growth stage under higher levels of nitrogen fertilization (N_2, N_3, N_4, N_5 and N_6). Similar results were reported by Jadhav *et al.* (1994).

Leaf Area Ratio (LAR)

At 75 DAS, maximum LAR was recorded in N_6 (0.703) and minimum in N_0(0.560) (Table 3). Data indicated maintenance of higher LAR during grain development phase in N_2, N_3, N_4, N_5 and N_6 as compared to control. C Paul *et al.* (1984) reported similar result.

Net Assimilation Rate (NAR)

During 45-60 DAS, all treatments recorded lower NAR than N_0(0.0639). Treatments N_2, N_4, N_5, N_6, N_7 and N_8 were at par (table 3). Cultivar and interaction effects were non-significant.

Relative Growth Rate (RGR)

Maximum RGR values were noted during 45-60 DAS. Whereas, RGR was found to be decreased at 60-75 DAS. Treatment N_4 recorded maximum RGR. Cultivar and interaction effects were non-significant (table3.)

Therefore, considering the effect of N-fertilization on growth, nodulation and seed protein content it is concluded that biologically fixed nitrogen is insufficient to explore the genetic potential of cultivars in respect of grain yield. The biologically fixed N is also insufficient to maintain the seed protein content required for international market. The data thus, suggested that soybean should be fertilized with nitrogen as a basal dose. The productivity can be improved by 45 kg. N ha^{-1} as basal application. The higher dose of N however, inhibits nodulation and thereby biological N fixation in soybean.

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