

Response of Soybean Varieties to Various Rates of Nutrients along with Bio-Organic Spray on growth and Yield

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Abstract

The present investigations were undertaken to study the effect of nutrients on growth and yield of soybean during *kharif* of 2006. There was significant variation between soybean varieties PK 416 and JS 335 for different growth parameters like plant height, number of trifoliates per plant, dry matter accumulation, tap root length and yield. PK416 showed superiority over JS 335 for almost all the characters. The growth parameters viz., plant height, number of trifoliates per plant, tap root length and dry matter significantly increased with the basal application of nitrogen and phosphorous and foliar application of Humaur at 1 ml/liter at 30, 45 and 60 days after sowing (DAS). At 30 DAS basal application of 25 kg ZnSO₄/ha produced more number of nodules and dry weight of nodules per plant. At 45 and 60 DAS recommended dose of nitrogen and phosphorus (25 : 50 kg per hectare) along with spray of Humaur at 1 ml/liter at 30, 45 and 60 DAS produced significantly more number and dry weight of nodules per plant than rest of the treatments. The highest value of LAI was recorded for the treatment nitrogen and phosphorus with foliar spray of Humaur at 1 ml/liter at 30, 45 and 60 DAS and significantly greater than rest of the treatments. The application of nitrogen, phosphorus with spray of Humaur at 1 ml/liter at 30, 45 and 60 DAS gave maximum yield (28.05 q/ha) compared to other treatments.

Key words : Soybean varieties, Nutrients, Bio-organic spray, Growth, Yield.

Soybean is an important pulse crop of India and occupies an important position next to groundnut and rapeseed-mustard, in respect of area as well as production. Besides having highly yield potential it is also inherited with high nutritional value. Soybean is known as natural fertilizer factory as it enriches the soil through symbiosis and adds about 30—40 kg N/ha for succeeding crop (1). It is reported as one of the richest repositories of good quality seed protein (40—42%) and oil (20—21%). Management of soybean is an interlocking system of many aspects viz., sowing date, seed rate, fertilizer rate change in one aspects will likely require a corresponding adjustment in other aspects to keep the system operating at maximum yield level. Soybean in India is mostly grown as a rainfed crop during *kharif* season. Lack of optimum plant population owing to poor germinability under adverse soil and weather conditions leads to lower yields. For maximum productivity and quality of crop, the essential plant nutrients must be applied in balance form. Full benefit of nitrogen, phosphorus and potassium

can be realised only when limitation of other nutrients is also met. With this in view development efforts are being made to elucidate the link between micro nutrient content of soil, micro nutrient uptake and utilization by plants and the effects of micro nutrients on yield and crop quality. Thus, it is rather essential to see the effect of different nutrients alone and in combination with organic substances on various growth parameters and seed yield of soybean. Keeping these points in view the response of soybean varieties to varying rates of inorganic and organic nutrients along with bio-organic spray on growth and yield has been under taken.

Methods

The experimental trials were conducted at the Agricultural Research Farm of Amar Singh (P.G.) College, Lakhaoti, Bulandshahr (UP). The soil of the experimental site was low in organic carbon (0.49), available nitrogen (162.0 kg/ha), available phosphorus (10.0

Table 1. Effect of varieties and different treatments on the plant height, number of trifoliolate/plant, fresh weight of nodules and dry weight of nodules of soybean at various stages of crop growth. DAS : Days after sowing.

Treatments	Plant height (cm)			Number of trifoliolate/plant		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
Varieties						
JS 335 (V ₁)	28.01	50.52	62.34	8.75	12.01	20.34
PK 416 (V ₂)	31.79	59.59	72.98	10.01	15.42	28.97
SE ±	0.33	0.45	0.49	0.05	0.21	0.27
CD at 5%	1.01	1.32	1.53	0.15	0.64	0.79
Fertility Levels						
NP (25 : 50) kg/ha (T ₁)	29.21	54.02	64.98	8.92	11.87	21.02
NP + FYM 10 t/ha (T ₂)	31.24	56.32	66.35	9.19	12.76	23.87
NP + 25 kg ZnSO ₄ /ha (T ₃)	30.90	57.94	67.23	9.01	13.98	21.89
NP + spray of Humaur 1 ml/liter at 45 and 60 DAS (T ₄)	28.65	57.83	67.43	8.75	15.01	27.21
NP + spray of Humaur 1 ml/liter at 30, 45 and 60 DAS (T ₅)	28.70	58.23	68.12	8.84	15.46	27.45
SE ±	0.78	0.53	0.89	0.12	0.40	0.39
CD at 5%	NS	1.65	NS	NS	1.21	1.35

Table 1. Continued.

Treatments	Fresh weight of nodules (g)			Dry weight of nodules (g)		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
Varieties						
JS 335 (V ₁)	0.042	0.164	0.484	0.011	0.121	0.378
PK 416 (V ₂)	0.076	0.249	0.776	0.020	0.189	0.709
SE ±	0.001	0.004	0.016	0.0006	0.0031	0.0091
CD at 5%	0.003	0.009	0.042	0.0011	0.0101	0.0291
Fertility Levels						
NP (25:50) kg/ha (T ₁)	0.053	0.169	0.452	0.016	0.130	0.387
NP + FYM 10t/ha (T ₂)	0.063	0.183	0.594	0.018	0.126	0.493
NP + 25 kg ZnSO ₄ /ha (T ₃)	0.066	0.213	0.671	0.018	0.155	0.576
NP + spray of Humaur 1 ml/liter at 45 and 60 DAS (T ₄)	0.055	0.230	0.679	0.014	0.167	0.596
NP + spray of Humaur 1 ml/liter at 30, 45 and 60 DAS (T ₅)	0.054	0.242	0.754	0.017	0.181	0.672
SE ±	0.003	0.005	0.025	0.0008	0.0058	0.0151
CD at 5%	0.005	0.013	0.096	0.0021	0.0171	0.0461

kg/ha) and potassium (208.0 kg/ha) and sandy loam in texture having pH 7.5. The water table during the crop season was at 3.5 m depth. Soybean variety JS-335 and PK-416 was inoculated by *Bradyrhizobium japonicum* and sown in the experimental field. Experiment was conducted in factorial randomized block design with two varieties and five fertility levels in three replications. The five fertility levels were - 25 kg N + 50 kg P per ha, 25 kg N + 50 kg P + FYM at 10 t/ha, 25 kg N + 50 kg P + 25 kg ZnSO₄ per ha, 25 kg N + 50 kg

P + spray of Humaur at 1 ml at 45 days and 60 days after sowing and 25 kg N + 50 kg P + spray of Humaur at 1 ml at 30, 45 and 60 days after sowing. Basal application of fertilizers and manure's and aerial spray of bio organic spray (Humaur) as per the treatments was done. The source for nitrogen was Urea, for phosphorus S. S.P, for Zn application ZnSO₄ and for other micronutrients, Humaur as bio-organic spray was used. The net plot size was 4.0 × 1.8 meter square. The plant height (cm), number of leaves or trifoliolate

Table 2. Interaction between varieties and fertility treatments for fresh and dry weight of nodules (g) per plant at various stages of crop growth. DAS : Days after sowing.

Treatments	Fresh weight of nodules (g)				Dry weight of nodules (g)	
	30 DAS		45 DAS		JS 335	PK 416
	JS 335	PK 416	JS 335	PK 416		
NP (25 : 50) kg/ha (T ₁)	0.027	0.072	0.138	0.139	0.281	0.481
NP + FYM@ 10 t/ha (T ₂)	0.048	0.077	0.148	0.217	0.311	0.661
NP + 25 kg ZnSO ₄ /ha (T ₃)	0.051	0.079	0.172	0.252	0.411	0.731
NP + spray of Humaur 1 ml/liter at 45 and 60 DAS (T ₄)	0.035	0.074	0.176	0.271	0.391	0.791
NP + spray of Humaur 1 ml/liter at 30, 45 and 60 DAS (T ₅)	0.031	0.073	0.181	0.301	0.481	0.851
SE ±	0.0012		0.0041		0.018	
CD at 5%	0.0034		0.0134		0.056	

per plant, dry matter accumulation in different plant parts and tap root length (cm) have been observed 30, 45 and 60 days after sowing (DAS) from the five randomly selected plants in each plot and averaged. Dry matter accumulation per plant was recorded at harvesting stage also. The leaf area was calculated by measuring the leaf length (L) from base to tip and its maximum breadth (B) and then length and breadth were multiplied with correction factor. Later the leaf area was calculated as :

$$\text{Leaf area} = L \times B \times \text{Correction factor}$$

Then leaf area index was calculated by following formula :

$$\text{Leaf area index} = \frac{\text{Leaf area}}{\text{Land area}}$$

The nodulation studies were made at 60 days after sowing on the plants harvested for dry matter studies. Roots of the sample plants used for recording pre-harvest observations were digged along with soil mass of surrounding area and washed carefully in running tap water to remove soil particles adhered to it. Nodules were separated from the roots and then blot dried with the help of filter paper. After counting the number of nodules of each plot, these were weighed and kept for drying in forced air oven at 70 ± 1°C for 48 hours. Then dry weight was recorded.

Results and Discussion

Data pertaining to the plant height, number of trifoliolate per plant, fresh weight of nodules per plant and dry weight of nodules per plant as affected by

varieties and different treatments at different stages of crop growth are presented in Table 1. Soybean cv PK-416 gave significantly higher plant height (31.79 cm, 59.59 cm and 72.98 cm, respectively), number of trifoliolate per plant (10.01, 15.42 and 28.97, respectively), fresh weight of nodules per plant (0.076g, 0.249g and 0.776g, respectively) and dry weight of nodules per plant (0.020g, 0.189g and 0.709g, respectively) at all stages of growth (30, 45 and 60 days after sowing) than JS-335. After 30 days of sowing, maximum plant height (31.24 cm) and number of trifoliolate per plant (9.19) was recorded with the treatment T₂ having nitrogen at 25 kg, phosphorus at 50kg and FYM at 10t per hectare followed by treatment T₃ while, maximum fresh weight of nodules per plant (0.066g) and dry weight of nodules per plant (0.018) was recorded with the treatment T₃ having nitrogen at 25 kg, phosphorus at 50 kg and ZnSO₄ per hectare followed by treatment T₂. At 45 and 60 days of sowing, maximum plant height (58.23 and 68.12 cm), number of trifoliolate per plant (15.46 and 27.45), fresh weight of nodules per plant (0.242 and 0.754g) and dry weight of nodules per plant (0.181 and 0.672g) was recorded with the treatment T₅ having nitrogen at 25 kg, phosphorus 50 kg and foliar application of Humaur at 1 ml/liter at 30, 45 and 60 days after sowing per hectare followed by treatment T₄. The results were certainly in conformity with the findings of Singh et al. (2). This was possibly due to the fact that regular supply of the micro-nutrients was very much necessary for effective growth and development but at earlier stage plant did not respond well due to under development process. Salem (3) reported that foliar application of GA₃, IAA and BA (benzladenine) alone or in combination with

Table 3. Effect of varieties and different treatments on dry matter accumulation, number of nodules, tap root length, leaf area index and yield of soybean. DAS : Days after sowing.

Treatments	Dry matter accumulation (g)			At harvest	Number of nodules/plant
	30 DAS	45 DAS	60 DAS		
Varieties					
JS 335 (V ₁)	3.19	14.78	16.41	33.53	84.31
PK 416 (V ₂)	3.75	21.90	23.19	42.18	80.31
SE ±	0.06	0.48	0.43	0.77	0.52
CD at 5%	0.18	1.18	1.00	2.06	1.29
Fertility levels					
NP (25 : 50) kg/ha (T ₁)	3.43	15.12	17.06	34.27	80.62
NP + FYM 10 t/ha (T ₂)	3.64	18.30	20.05	38.08	80.85
NP + 25 kg ZnSO ₄ /ha (T ₃)	3.61	18.89	20.17	37.94	82.75
NP + spray of Humaur 1 ml/litre at 45 and 60 DAS (T ₄)	3.54	18.34	20.37	37.96	83.18
NP + spray of Humaur 1 ml/liter at 30, 45 and 60 DAS (T ₅)	3.48	20.06	21.36	41.04	84.15
SE ±	0.05	0.68	0.59	1.15	0.75
CD at 5%	0.16	1.79	1.50	3.18	1.97

Table 3. Continued.

Treatments	Tap root length (cm)			Leaf area index			Yield (q/ha)
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	
Varieties							
JS 335 (V ₁)	10.221	11.151	11.701	2.44	4.45	5.40	23.73
PK 416 (V ₂)	10.331	11.411	11.711	2.83	4.81	5.76	30.31
SE ±	0.061	0.13	0.11	0.009	0.006	0.011	0.78
CD at 5%	NS	NS	NS	0.028	0.019	0.031	2.24
Fertility levels							
NP (25 : 50) kg/ha (T ₁)	9.701	10.441	11.381	2.66	4.43	5.41	25.95
NP + FYM 10 t/ha (T ₂)	10.861	11.321	11.811	2.87	4.64	5.57	27.57
NP + 25 kg ZnSO ₄ /ha (T ₃)	10.431	11.391	11.831	2.75	4.68	5.64	26.15
NP + spray of Humaur 1 ml/liter at 45 and 60 DAS (T ₄)	10.311	11.521	11.831	2.48	4.81	5.76	27.39
NP + spray of Humaur 1ml/liter at 30, 45 and 60 DAS (T ₅)	10.101	11.731	11.971	2.61	4.82	5.80	28.05
SE ±	0.91	0.15	0.16	0.019	0.009	0.009	1.72
CD at 5%	0.27	0.48	NS	0.062	0.029	0.039	NS

librel BMX (micronutrient fertilizer) gave greater plant height, number of leaves and branches in soybean. Kulkarni et al. (4) reported that nodulation was increased with soil application of B, Mn and Zn and foliar application of Fe and Mn.

Both the varieties showed significant increase in fresh weight and dry weight of nodules per plant due to different treatment but soybean cv PK-416 gave

significantly higher fresh (0.079g) and dry weight of nodules (0.301g), than JS-335 (Table 2). At 30 days after sowing, basal application of 25 kg ZnSO₄ with nitrogen at 25 kg and phosphorus at 50kg per hectare gave significantly higher fresh weight of nodules than other treatments and were at par with basal application of FYM at 10 t per hectare while, after 45 days after sowing treatment T₅ gave maximum fresh weight

of nodules per plant. The interaction effect between varieties and fertility treatments for dry weight of nodules (g) per plant was significant at 60 days after sowing. Both varieties showed increase in dry weight of nodules with treatment T₅ having nitrogen at 25 kg, phosphorus at 50kg and foliar application of Humaur at 1 ml/liter at 30, 45 and 60 days after sowing per hectare. However, nodule dry weight was 77% higher for PK-416 than JS-335 with treatment T₅.

Data pertaining to the dry matter accumulation per plant, number of nodules per plant, tap root length, leaf area index and yield as affected by varieties and different treatments has been presented in Table 3. PK-416 gave significantly higher dry matter accumulation per plant (3.75g, 21.90g, 23.19g and 42.18g), tap root length (10.331 cm, 11.411 cm and 11.711 cm), leaf area index (2.83, 4.81 and 5.76) and yield (30.31 q/ha) than JS-335. At 30 days after sowing, maximum dry matter accumulation per plant (3.64g), tap root length (10.861 cm) and leaf area index (2.87) was recorded with the treatment T₂ having nitrogen at 25 kg, phosphorus at 50 kg and FYM at 10t per hectare followed by treatment T₃ while, at 45 and 60 days after sowing, maximum dry matter accumulation per plant (20.06g and 21.36g), tap root length (11.731 cm and 11.971 cm) and leaf area index (4.82 and 5.80) was recorded with the treatment T₅ having nitrogen at 25 kg, phosphorus at 50 kg and foliar application of Humaur at 1 ml/liter at 30, 45 and 60 days after sowing per hectare followed by treatment T₄. Maximum number of nodules per plant (84.15) was recorded in treatment T₅ followed by treatment T₅ followed by treatment T₄. Bharati et al. (5) reported that soybean with increasing rates of P₂O₅ and FYM (0 and 15 t/ha) resulted in increased dry matter production in soybean. Abdel et al. (6) observed that GA₃ with or without 2g librel BMX/liter, 50 ppm BA alone or with librol BMX significantly increased dry matter accumulation. Kulkarni et al. (4) reported that nodulation was increased with soil application of B, Mn and Zn and foliar application of Fe and Mn. The leaf area index per plant increased probably due to more activities of meristematic tissues of the plant producing more number of trifoliates, correlated with increase in total photosynthetic surface and increased leaf area index of the plant during the vegetative phase. Thus it contrib-

uted towards the higher production of branches and also increased the dry matter accumulation at different growth stages. Bisht and Chandel (7) reported that application of the fertilizers, singly or in combination increased LAI and photosynthetic efficiency of soybean. Variety PK-416 gave 30 per cent higher yield than JS-335. Different fertility levels did not affect the grain yield significantly though the maximum yield (28.05 q/ha) was obtained with treatment T₅ having nitrogen at 25 kg, phosphorus at 50 kg and foliar application of Humaur at 1 ml/liter at 30, 45 and 60 days after sowing per hectare. Same result was also reported by Sarma and Ravinder (8) in India who found that soybean seed yield was increased with the application of micronutrient as foliar and seed treatment. Seed yield was not increased due to different treatments may be because of inherent soil properties or due to good soil health.

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