

Effect of site-specific nutrient management on growth indices of soybean (*Glycine max* (L.) Merrill) under mid hill conditions of Himachal Pradesh

Navneet Kaur¹, Janardan Singh² and Shilpa³

Department of Agronomy, Forages and Grassland Management
CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur 176062, Himachal Pradesh

*Email: singhjr@rediffmail.com

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) season of 2018 at Palampur, Himachal Pradesh to study the effect of site-specific nutrient management on soybean (*Glycine max* L.). The experiment was laid out in randomized block design comprising of seven treatments [T_1 - $N_{43}P_{43}K_{50}$ (SSNM), T_2 - $N_{43}P_{43}K_0$ (T_1 -K omission), T_3 - $N_{43}P_0K_{50}$ (T_1 -P omission), T_4 - $N_0P_{43}K_{50}$ (T_1 -N omission), T_5 - $N_{20}P_{60}K_{40}$ (RDF), T_6 - FYM@5t/ha (Farmer's Practice alone. It is applied to the field along with RDF, even 5 t FYM supplies only 25 kg N and meagre amount of P, So, this treatment is acceptable and T_7 - $N_0P_0K_0$ (control)]. The soil of experimental site was silty clay loam in texture, acidic in reaction, low in available nitrogen, and medium in available phosphorus and potassium. Site specific nutrient management ($N_{43}P_{43}K_{50}$) resulted in significantly higher values of plant height, dry matter accumulation, absolute growth rate, relative growth rate, crop growth rate, dry matter efficiency and unit area efficiency. Recommended dose of fertilizers ($N_{20}P_{60}K_{40}$) and farmer's practice (FYM@5t/ha) proved to be second and third best treatment, respectively. The omission of nutrients resulted in marked reduction in growth of soybean. The lowest values of growth indices were recorded in absolute control treatment ($N_0P_0K_0$).

Key words: Growth indices, Site-specific nutrient management, Soybean

INTRODUCTION

Soybean (*Glycine max* L.) is an important oilseed crop in Indian sub-continent. It has traditionally been grown on a small scale in Himachal Pradesh, the Kumaon Hills of Uttarakhand, Eastern Bengal, the Khasi Hills, Manipur, the Naga Hills and parts of Central India covering Madhya Pradesh. In India, it is grown on an area of 11.18 million hectares with production and productivity of 13.15 million tonnes and 1235 kilogram per hectares, respectively (Anonymous 2016). Soybean is a potential rainy season crop of mid-hills zone of Himachal Pradesh. It is grown as a sole crop as well as an intercrop with maize. Among the legumes, soybean is valued for its high protein (38-45%) as well as its high oil content (20 %). It supplies approximately 65 per cent world meal and 20 to 24 per cent of the world edible oil. It is soil building crop and requires less water as compared to other crops (Imran et al. 2017). It is also highly adaptable to varying soil and climatic conditions, giving fairly high yields compared to

other pulse crops.

Site specific nutrient management (SSNM) is an important component of precision agriculture. It provides an approach for need based feeding of crops with nutrients while recognizing the inherent spatial variability. The growing concern about impaired soil health, declining productivity growth and decreasing factor productivity or nutrient use efficiency (NUE) are compelling the farmers to use higher level of fertilizers during last two decades. The low NUE and associated environmental pollution and global warming problems have raised serious concerns about the existing nutrient management practices. As such, it is high time to develop site-specific nutrient management(SSNM) technologies which are able to synergic crop-soil nutrient dynamics. Considering the above said facts, the present investigation was undertaken to study the effect of site-specific nutrient management on soybean under mid hill conditions of Himachal Pradesh.

MATERIALS AND METHODS

The field experiment was conducted during rainy (*kharif*) season of 2018 at the Research Farm, Department of Agronomy, Forages and Grassland Management, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The soil of the experimental site was silty clay loam with 5.41 pH, 0.55 % OC, 130.08 kg/ha available nitrogen, 13.08 kg/ha available phosphorus and 256.3 kg/ha available potassium.

The meteorological data during the crop season revealed that the weekly maximum and minimum temperature ranged from 23.57 °C to 32.89 °C and 10.14 °C to 20.64 °C, respectively. The mean relative humidity ranged from 24.07 percent to 94.93 percent and total of 2619.4 mm rainfall was received during the crop season. The experiment was laid out in randomized block design comprising of seven treatments which were replicated thrice. The treatments were T₁-N₄₃ P₄₃ K₅₀ (SSNM), T₂- N₄₃ P₄₃ K₀ (T₁-K omission), T₃- N₄₃ P₀ K₅₀ (T₁-P omission), T₄- N₀ P₄₃ K₅₀ (T₁- N omission), T₅- N₂₀ P₅₀ K₄₀ (RDF), T₆- FYM@ 5t/ha (Farmer's Practice), T₇- N₀ P₀ K₀ (Control). Treated seeds with bavistin were used. Different doses of nitrogen, phosphorus and potassium and farmyard manure were applied as per different treatments, respectively. Pendimethalin (stomp 30 EC) was applied @ 4.5 litre/ha within 48 h of sowing for the control of weeds. Other package of practices recommended for the region was also followed. The periodical plant height and dry matter accumulation were recorded at different growth stages for evaluating different growth indices. The following formulae were used to determine various growth indices:

Absolute growth rate was determined by using the formula given by Radford (1967).

$$\text{AGR(cm/day)} = \frac{h_2 - h_1}{t_2 - t_1}$$

where, h₁ and h₂ are the plant height at t₁ and t₂ times, respectively.

Crop growth rate was determined by using the formula given by Watson (1956):

$$\text{CGR(g/m}^2\text{/day)} = \frac{(w_2 - w_1)}{p (t_2 - t_1)}$$

where w₁ and w₂ are whole plant dry weight at t₁ and t₂ time, respectively and p is the ground area on which w₁ and w₂ are recorded.

Relative growth rate was determined by using the formula given by Fisher (1921):

$$\text{RGR (g/g/day)} = \frac{(\log_e w_2 - \log_e w_1)}{(t_2 - t_1)}$$

where w₁ and w₂ are dry weight of whole plant at times t₁ and t₂, respectively.

Dry matter efficiency is expressed as the percent of dry matter accumulated in the grain from the total dry matter produced over the crop growth period.

$$\text{DME} = \frac{\text{Grain yield (kg/ha)}}{\text{Biological yield (kg/ha)}} \times \frac{100}{\text{Duration of crop (days)}}$$

Unit area efficiency is expressed as the quantum of grain yield produced over a unit land area for a specified crop growth period (kg/ha/day).

$$\text{UAE} = \frac{\text{Grain yield (kg)}}{\text{Land area (ha)}} \times \frac{1}{\text{Duration of crop (days)}}$$

The data obtained were subjected to statistical analysis as per the procedures given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth

Effect of site-specific nutrient management on plant height and dry matter accumulation has been presented in Table 1.

Plant height and dry matter accumulation

These growth parameters were significantly affected by different treatments at different growth stages. Significantly taller plants were recorded in T₁-(N₄₃ P₄₃ K₅₀) which was at par with T₅- N₂₀ P₅₀ K₄₀ (RDF) and T₆- FYM@ 5t/ha (Farmer's Practice) at 30 days after sowing. The shortest plants were observed in T₇- (N₀ P₀ K₀). This might be due to higher availability of nutrients in these treatments as compared to control treatment. Similar results were also reported by Srivastava and Khanna (2003) and Patil et al. (2016) in soybean. Significantly higher dry matter accumulation was recorded in T₁ which was at par with T₅ and T₆ at all the growth stages except 30 days after sowing. The highest dry matter

accumulation (1.4 g/plant) was recorded in T₁. Dry matter increased progressively with advancement in age of the crop. This might be due to more availability of nutrients in site specific nutrient management and recommended dose of fertilizers. The nutrients might have played an important role in enhancing cell division and elongation of leaves resulting in higher biomass. Similar results have been reported by Lone *et al.* (2009) in soybean and Patil *et al.* (2018) in groundnut.

Growth indices

Effect of site-specific nutrient management on absolute growth rate, crop growth rate, net assimilation rate, dry matter and unit area efficiency has been presented in Table 2.

Absolute growth rate

Different treatments significantly influenced absolute growth rate at 30 and 60 days after sowing. Significantly higher value of absolute growth rate was recorded in T₁-(N₄₃ P₄₃ K₅₀) as compared to absolute control. Since absolute growth rate is directly related to plant height so higher plant height in T₁ resulted in higher absolute growth rate (Table 3). The results confirm the findings of Swati and Singh (2018a) in soybean.

Crop growth rate

Significantly higher crop growth rate (0.97 g/m²/day) was noted in T₁-(N₄₃ P₄₃ K₅₀) while it was lower (0.64 g/m²/day) in control at 30 days after sowing. It remained unaffected at other growth stages. Recommended dose of fertilizers and farmer's practice were at par with T₁ (Table 2). The lowest value of crop growth rate was observed in

absolute control. This might be due to the better nutritional environment for plant growth at active vegetative stage as a result in improvement in root and shoot growth which ultimately increased the dry matter resulting in higher value of crop growth rate. Similar results were also observed by Vyas and Kushwah (2015) in soybean.

Relative growth rate

It was significantly affected by different treatments at 30 days after sowing. The highest relative growth rate (0.01 g/g/day) was observed in T₁ while the lowest (0.001 g/g/day) was in T₇. At other stages, relative growth rate was not significantly affected by different and treatments. Recommended dose of fertilizers and farmer's practice were at par with T₁ (Table 2). This might be due to higher dry matter production with better nutrition which resulted in better relative growth rate. Similar results have been reported by Biradar *et al.* (2013) in maize.

Dry matter and unit area efficiency

Significantly higher dry matter efficiency (0.3 %/day) was observed in T₁ and T₅. The lowest dry matter efficiency (0.26 %/day) was observed in absolute control (T₇). Significantly higher unit area efficiency was also observed in T₁ (SSNM). Unit area efficiency noted in T₁ was 15.9 kg/ha/day. The lowest value of unit area efficiency (6.73 kg/ha/day) was recorded in absolute control (T₇) (Table 2). This might be due to reason that balanced application of nutrients resulted in maximum unit area efficiency. Similar results were also reported by Swati and Singh (2018b).

Table 1. Effect of different treatments on plant height and dry matter accumulation

Treatment	Plant height (cm)				Dry matter accumulation (g/plant)			
	30DAS	60DAS	90DAS	Harvest	30DAS	60DAS	90DAS	Harvest
T ₁ - N ₄₃ P ₄₃ K ₅₀ (SSNM)	28.43	63.03	73.13	74.97	1.46	7.43	29.33	32.73
T ₂ - N ₄₃ P ₄₃ K ₀ (T ₁ - K omission)	27.40	57.67	69.53	70.43	1.18	6.37	26.83	30.45
T ₃ - N ₄₃ P ₀ K ₅₀ (T ₁ - P omission)	26.73	57.5	68.57	69.8	1.23	6.53	26.45	30.52
T ₄ - N ₀ P ₄₃ K ₅₀ (T ₁ - N omission)	26.03	54.63	65.80	67.93	1.06	6.12	24.73	28.80
T ₅ - N ₂₀ P ₆₀ K ₄₀ (RDF)	28.43	62.70	72.77	74.52	1.39	7.28	28.16	31.48
T ₆ - FYM@5t/ha (Farmer's Practice)	28.17	60.93	71.40	73.11	1.22	7.27	27.85	31.27
T ₇ - N ₀ P ₀ K ₀ (control)	24.60	52.87	62.27	64.97	1.00	5.93	23.00	25.63
SEm±	0.81	0.71	0.66	2.13	0.02	0.31	0.73	0.46
CD (P = 0.05)	2.49	2.18	2.04	6.57	0.07	0.97	2.25	1.41

SSNM-Site specific nutrient management RDF - Recommended dose of fertilizers

Table 2. Effect of different treatments on growth indices of soybean

Treatment	Absolute growth rate (cm/day) DAS			Crop growth rate(g/m ² /day) DAS			Relative growth rate(g/g/day) DAS			Dry matter efficiency (%/day)	Unit area efficiency (kg/ha/day)
	30	60	90	30	60	90	30	60	90		
T ₁ - N ₄₃ P ₄₃ K ₅₀ (SSNM)	0.95	1.15	0.34	0.97	3.97	14.53	0.01	0.054	0.046	0.30	15.90
T ₂ - N ₄₃ P ₄₃ K ₀ (T ₁ - K omission)	0.91	1.01	0.40	0.79	3.4	13.44	0.006	0.056	0.048	0.28	11.85
T ₃ - N ₄₃ P ₀ K ₅₀ (T ₁ - P omission)	0.89	1.03	0.37	0.80	3.55	13.24	0.01	0.056	0.047	0.28	11.03
T ₄ - N ₀ P ₄₃ K ₅₀ (T ₁ - N omission)	0.87	0.95	0.37	0.68	3.28	12.05	0.002	0.059	0.047	0.29	11.46
T ₅ - N ₂₀ P ₆₀ K ₄₀ (RDF)	0.95	1.14	0.34	0.92	3.88	13.75	0.011	0.055	0.045	0.30	14.25
T ₆ -FYM@5t/ha(Farmer's Practice)	0.94	1.09	0.35	0.79	3.92	13.37	0.01	0.059	0.045	0.29	13.33
T ₇ - N ₀ P ₀ K ₀ (control)	0.82	0.94	0.31	0.64	3.15	10.92	0.001	0.059	0.045	0.26	6.73
SEm±	0.03	0.03	0.03	0.032	0.26	0.69	0.001	0.002	0.001	0.008	0.33
CD (P=0.05)	0.08	0.11	NS	0.1	NS	NS	0.002	NS	NS	0.03	1.03

SSNM-Site specific nutrient management RDF - Recommended dose of fertilizers

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