

EFFECT OF SULPHUR AND BORON ON GROWTH, YIELD AND ECONOMICS OF SOYBEAN

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ABSTRACT

An experiment was conducted at College of Agriculture, Nagpur to study the effect of different levels of sulphur and boron on growth and yield of soybean during *kharif* season of 2015-16 in factorial randomized block design with four different levels of sulphur viz., S_0 - 0 kg S ha⁻¹, S_1 - 20 kg S ha⁻¹, S_2 - 30 kg S ha⁻¹ and S_3 - 40 kg S ha⁻¹ and four different levels of boron viz., B_0 - 0 kg B ha⁻¹, B_1 - 0.5 kg B ha⁻¹, B_2 - 1.0 kg B ha⁻¹ and B_3 - 1.5 kg B ha⁻¹ replicated thrice. The soil was clayey, low in nitrogen, medium in phosphorus and high in potassium with pH 7.7. Growth and yield attributing characters viz., Plant height, number of branches plant⁻¹, dry matter accumulation, leaf area plant⁻¹, number of pods plant⁻¹, 100 seed weight, seed yield plant⁻¹, seed and straw yield ha⁻¹, GMR (49435 Rs. ha⁻¹), NMR (28013 Rs. ha⁻¹) and B:C ratio (2.31) were significantly more with the application of 40 kg S ha⁻¹. In case of boron application, the growth and yield contributing characters, yield and monetary returns were significantly increased due to application of boron @ 1.5 kg ha⁻¹ which was at par with boron @ 1.0 kg ha⁻¹.

Based on present investigation it can be inferred that application of 40 kg sulphur ha⁻¹ and 1.5 kg boron ha⁻¹ yielded maximum grain and dry matter, growth contributing and economics of soybean also improved.

(Key words: Sulphur, boron, growth, yield, economics)

INTRODUCTION

Soybean [*Glycine max* (L.)] belongs to family Leguminosae. It is basically a pulse crop containing 40% quality protein and gained the importance as an oilseed crop, as it contains 20 % cholesterol free oil. Being a high protein and energy crop it requires high nutrients and its productivity is often limited by the low availability of essential nutrients or imbalanced nutrition forming one of the important constraints to soybean productivity in India.

Sulphur is important nutrient for optimum production of high yielding soybean. It is component of several amino acids, the building block of proteins, very important with respect to quality. It is also essential for formation of nodules on the root of legumes. Boron is also necessary for the germination of pollen, formation of flowers and fruits and for the absorption of cations.

There is a paucity of response of soybean to application of sulphur and boron in the typical black cotton soils of the region and hence, an attempt was made to study the effect of different levels of sulphur and different levels of boron on growth and yield of soybean.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy farm, College of Agriculture, Nagpur during *kharif* season

of 2015-16. The experiment was laid out in factorial randomized block design with one factor using four different levels of sulphur viz., 0, 20, 30 and 40 kg S ha⁻¹ and four different levels of boron viz., 0, 0.5, 1.0 and 1.5 kg B ha⁻¹ as another factor forming sixteen treatment combinations replicated thrice. The soil of experimental plot was clayey in texture, low in available nitrogen (205.16 kg ha⁻¹), medium in phosphorus (19.21 kg ha⁻¹) and organic carbon (0.55 %) and very high in available potash (340.0 kg ha⁻¹) and slightly alkaline in reaction (pH 7.7).

The crop variety NRC-37 was used with gross plot size of 4.5 m × 3.6 m and net plot size was 4.3 m × 2.7 m. Full dose of phosphorus and half dose of nitrogen were applied at sowing and remaining half dose of N was applied at 30 DAS. In order to represent the plot, five plants of soybean from each net plot were selected randomly, labeled properly. The growth attributing characters viz., plant height, number of branches plant⁻¹, dry matter accumulation and leaf area plant⁻¹ were recorded at harvest and yield attributing characters and yield viz., number of pods plant⁻¹, 100 seed weight, seed yield plant⁻¹, seed and straw yield (kg ha⁻¹) were also recorded at harvest. The gross monetary and net monetary returns along with B:C ratio were calculated.

RESULTS AND DISCUSSION

Effect on growth attributes

The data pertaining to various growth attributes

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studied viz., plant height, number of branches plant⁻¹, dry matter accumulation and leaf area plant⁻¹ as influenced by various treatments are presented in table 1.

Sulphur levels

Data in table 1 revealed that plant height, number of branches plant⁻¹, dry matter accumulation (g) and leaf area plant⁻¹(dm²) in soybean were significantly affected due to different levels of sulphur and was significantly more with the application of 40 kg S ha⁻¹ and comparable to 30 kg S ha⁻¹. Prakasha *et al.* (2010) reported that application of sulphur @ 40 kg ha⁻¹ recorded highest plant height, leaf area and leaf area index of soybean. Significant increase in plant height might be due to vigorous root growth and formation of chlorophyll resulting in higher photosynthesis which led to higher plant height. Banger *et al.* (2015) stated that application of sulphur @ 40 kg ha⁻¹ produced the highest number of branches, plant⁻¹, stem dry weight and leaf area in soybean. The significant increase in number of branches plant⁻¹ with the application of sulphur may be because of increment in height as well as due to biosynthesis of proteins and amino acids that leads to cell division and increment in height of plant that induces greater branches. Gupta and Abraham (2003) reported that increase in the dry matter accumulation in soybean might be due to stimulated photosynthetic activity and synthesis of chloroplast and protein with the application of sulphur which might have resulted in higher dry matter production in soybean.

Boron levels

Data revealed that plant height, number of branches plant⁻¹, leaf area plant⁻¹ and dry matter accumulation plant⁻¹ of soybean were significantly affected due to application of boron and were significantly maximum with the application of boron @ 1.5 kg ha⁻¹ but remained at par with the application of 1.0 kg B ha⁻¹. Rahman *et al.* (1999) reported that the increase in plant height and dry matter accumulation and number of leaves of soybean due to application of boron might be due to role of boron in cell division and cell differentiation and calcium utilization by the plant. Adkine *et al.* (2011) reported that application of boron increased the number of branches plant⁻¹ due to increase in height of plant that increased nodes which induced more branches and leaves on the main shoot of plant. Abidi *et al.* (2013) reported that leaf area plant⁻¹ of soybean was significantly influenced due to application of boron @ 1.5 kg ha⁻¹.

Effect on yield attributes

Data pertaining to various yield attributes studied as influenced by various treatments are presented in table 1.

Sulphur levels

Different levels of sulphur significantly influenced yield attributes of soybean. Highest number of pods plant⁻¹ and seed yield plant⁻¹ were recorded with the application of 40 kg sulphur ha⁻¹ but it was at par with 30 kg S ha⁻¹ and significantly superior over 0 and 20 kg S ha⁻¹.

Nandeeni *et al.* (2000) reported that sulphur levels showed significant influence on number of pods plant⁻¹ in soybean. It might be due to involvement of sulphur in the synthesis of fatty acids and also increased protein content through the synthesis of different amino acids that had induced more pods on the plant. Kandpal and Chandel (1993) found that seed yield plant⁻¹ of soybean was significantly influenced by different sulphur levels. Significant increase in seed yield plant⁻¹ of soybean might be due to improved nitrogenase activity and nitrogen fixation which increased dry matter production that is translocated to seed production with the application of sulphur to deficient soil. Application of sulphur to soybean did not show any significant influence on the 100 seed weight of soybean. However, application of sulphur 40 kg ha⁻¹ showed higher 100 seed weight amongst all the treatments. Seed yield ha⁻¹ of soybean was significantly higher with the application of 40 kg S ha⁻¹ and was at par with the application of 30 kg S ha⁻¹. Higher seed yield might be due to the cumulative favourable effect of the higher number of effective pods plant⁻¹ and seed yield plant⁻¹ occurred due to better plant metabolism which in turn produced higher seed yield. Vaiyapuri *et al.* (2010) stated that the seed yield (kg ha⁻¹) of soybean was significantly influenced due to sulphur application treatments. The straw yield (kg ha⁻¹) of soybean was significantly influenced due to sulphur application and was significantly higher with the application of 40 kg sulphur ha⁻¹ and was at par with 30 kg S ha⁻¹. The highest straw yield might be due to the fact that sulphur encourages above ground vegetative growth due to increased synthesis of amino acids and fatty acids and meristematic activity.

Boron levels

Various boron levels significantly influenced yield attributes of soybean. Highest number of pods plant⁻¹ and seed yield plant⁻¹ in soybean were obtained with the application of boron @ 1.5 kg ha⁻¹, which was at par with boron @ 1.0 kg ha⁻¹ and significantly more over 0.5 kg B ha⁻¹ and 0 kg B ha⁻¹. Gowthami and Rama Rao (2014) found that the significant increase in number of pods plant⁻¹ due to application of boron might be because of involvement of boron in various processes such as cell division, flowering and fruiting, water relations that increased the growth attributes which ultimately increased the yield attributes and also the increase in seed yield plant⁻¹ might be due to increased growth attributes that may in turn increased translocation of photosynthates to seed production. Schon and Blevins (1987) observed that the boron application significantly influenced the seed yield plant⁻¹ of soybean with the application of boron @ 1.5 kg ha⁻¹. Application of boron to soybean did not show any significant influence on the 100 seed weight. However, highest 100 seed weight of soybean was found with the application of 1.5 kg boron ha⁻¹. The seed yield ha⁻¹ of soybean was significantly influenced due to boron application and was significantly higher with the application of boron @ 1.5 kg ha⁻¹ as compared to all other treatments and was at par with 1.0 kg B ha⁻¹. Higher grain yield might be due to the cumulative

Table 1. Growth and yield attributes, yield and economics of *kharif* soybean as influenced by different levels of sulphur and boron

Treatments	Growth attributes				Yield attributes		Yield			Economics		
	Plant height (cm)	No. of branches plant ⁻¹	Leaf area plant ⁻¹ (dm ²)	Dry matter accumulation plant ⁻¹ (g)	No. of pods plant ⁻¹	Seed yield plant ⁻¹ (g)	100 seed weight (g)	Seed yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Gross Monetary return (Rs. ha ⁻¹)	Net Monetary return (Rs. ha ⁻¹)	B:C Ratio
Sulphur (S)												
S ₀ - 0 kg S ha ⁻¹	51.22	6.36	11.03	18.88	23.55	4.98	8.12	1031	1671	40441	19806	1.97
S ₁ - 20 kg S ha ⁻¹	54.68	6.83	14.10	20.55	24.94	5.03	8.31	1184	1880	46400	25065	2.14
S ₂ - 30 kg S ha ⁻¹	56.51	8.16	14.98	22.31	28.25	5.50	10.01	1388	2037	54030	32345	2.46
S ₃ - 40 kg S ha ⁻¹	58.72	8.75	16.05	22.97	29.87	5.56	10.38	1464	2090	56869	34835	2.55
SE (m) ±	1.10	0.21	0.53	0.81	0.60	0.11	0.79	26	33	954	954	-
CD at 5%	3.10	0.62	1.54	2.33	1.75	0.30	—	77	95	2862	2862	-
Boron levels (B)												
B ₀ - 0 kg B ha ⁻¹	51.70	6.96	12.66	18.99	25.23	4.99	8.19	1160	1795	45339	24029	2.20
B ₁ - 0.5 kg B ha ⁻¹	54.44	7.36	13.56	20.84	26.10	5.11	8.24	1218	1885	47633	26248	2.27
B ₂ - 1.0 kg B ha ⁻¹	56.76	7.73	14.73	21.50	26.95	5.47	9.97	1307	1997	51029	29569	2.42
B ₃ - 1.5 kg B ha ⁻¹	58.16	8.04	15.20	23.37	28.33	5.51	10.42	1382	2000	53739	32204	2.54
SE (m) ±	1.10	0.21	0.53	0.81	0.60	0.11	0.79	26	33	954	954	-
CD at 5%	3.10	0.62	1.54	2.33	1.75	0.30	—	77	95	2862	2862	-
Interaction (SX B)												
SE (m) ±	2.20	0.42	1.06	1.62	1.21	0.21	1.02	52	66	1909	1909	-
CD at 5%	-	-	-	-	-	-	-	-	-	-	-	-

favourable effect of the higher number of effective pods plant⁻¹ and seed yield plant⁻¹ due to better plant metabolism which in turn produced higher grain yield. Adkine *et al.* (2011) concluded that the application of boron recorded significantly higher seed yield (kg ha⁻¹) as compared to all other treatments. Application of boron @ 1.5 kg ha⁻¹ (B₃) treatment recorded significantly higher straw yield ha⁻¹ as compared to all other treatments. But was found at par with the application of boron @ 1.0 kg ha⁻¹ (B₂). Singh *et al.* (2012) recorded that the straw yield (kg ha⁻¹) of soybean was significantly influenced due to boron application treatments.

Economic studies

Data on gross monetary returns, net monetary returns and B:C ratio as affected by various treatments are presented in table 1.

Sulphur levels

Gross monetary returns (Rs 56869 ha⁻¹) and net monetary returns (Rs 33515 ha⁻¹) were highest with the application of 40 kg S ha⁻¹ which was significantly superior over 0 and 20 kg S ha⁻¹ but remained at par with 30 kg S ha⁻¹. Highest B:C ratio was obtained with the application of sulphur @ 40 kg ha⁻¹ (2.55) and followed by the application of 30 kg S ha⁻¹ (2.46). Uparkar *et al.* (2016) reported that the application of 30 kg S ha⁻¹ recorded significantly highest B:C ratio.

Boron levels

The gross monetary returns and net monetary returns were significantly influenced due to various levels of boron. Application of boron @ 1.5 kg ha⁻¹ recorded significantly higher gross and net monetary returns over application of boron 0.5 kg ha⁻¹ and 0 kg ha⁻¹ but was at par with the application of 1.0 kg boron ha⁻¹. The B:C ratio was maximum with the application of boron @ 1.5 kg ha⁻¹ (2.54) followed by boron @ 1.0 kg ha⁻¹ (2.42). Adkine *et al.* (2010) reported that the highest GMR and NMR were found with the application of boron @ 1.5 kg ha⁻¹.

Interaction effect

Interaction effect between sulphur and boron levels were found non-significant in case of growth and yield attributes, yield and monetary returns of soybean.

Based on present investigation it can be inferred that application of 40 kg sulphur ha⁻¹ and 1.5 kg boron ha⁻¹ yielded maximum grain and dry matter, growth contributing characters and economics of soybean also improved.

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