J. Soils and Crops 27 (1) 158-161, June 2017 ISSN 0971-2836

EFFECT OF SULPHUR AND BORON ON QUALITY, NUTRIENT CONTENT AND UPTAKE AND RESIDUAL SOIL FERTILITY IN 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 quality, nutrient content and uptake and residual soil fertility 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. Quality characters and nutrient content and uptake viz., oil content and oil yield kg ha^{-1}, sulphur content in grain and straw and its uptake, boron content in grain and straw and its uptake, available sulphur and boron in soil were significantly more with the application of 40 kg S ha^{-1}. In case of boron application, the quality characters and nutrient content and uptake by seed and straw 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} improved the quality characteristics and the uptake of nutrients (viz., S and B) by soybean.

(Key words: Sulphur, boron, nutrient content, nutrient uptake, quality, soybean)

INTRODUCTION

Soybean (*Glycine max* (L.) belongs to family Leguminoceae. It is basically a pulse crop containing 40% quality protein and 20% cholesterol free oil and gained the importance as an oilseed crop. It is also involved in the formation of oil. Apart from its effect on yield, sulphur plays an important role in improving the quality of the produce. Sulphur can improve crop quality by increasing oil content, Sulphur represents the ninth and least abundant essential macronutrient in plants, preceded by C, H, O, N, K, Ca, Mg and P. Sulphur plays various critical roles in catalytic or electrochemical function of biomolecules in the cells. Legumes specially pulses are particularly responsive to sulphur containing fertilizers.

The use of micronutrients boron in soybean is one of the way to boost up the productivity and to improve the seed quality parameters. Boron is essential for all plant growth, it aids in the increase in pollination and seed development. Soybean requires an adequate supply of available boron, especially during flowering and seed development. It helps in carbohydrate transport. Boron is also necessary for the germination of pollen, formation of flowers and fruits and for the absorption of cations. Soybean response to applied boron is generally greatest when there is adequate supply of the other plant nutrients. With these facts the present study was conducted to study the effect of different levels of sulphur and boron on quality, nutrient content and its uptake and residual soil fertility in 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 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. The quality characters *viz..*, oil content and oil yield (kg ha^{-1}) was estimated with Nuclear Magnetic Resonance (NMR) Sepctrometer (Reaney, *et al.,*1999) and sulphur and boron were estimated with Turbidimetric method (Chesnin and Yein, 1951) and Hot water extraction method (Tandon, 1995) after harvest of the crop. The available sulphur and boron in soil before and after harvest were also estimated. Respectively uptake of sulphur and boron were calculated by given formulas

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$$\text{Uptake of sulphur by seed (kg ha}^{-1}) = \frac{\text{Seed yield (kg ha}^{-1}) \times \text{Sulphur content in seed (\%)}}{100}$$

Total uptake of Sulphur = S uptake by seed + S uptake by straw

$$\text{Uptake of boron by seed (kg ha}^{-1}) = \frac{\text{Seed yield (kg ha}^{-1}) \times \text{boron content in seed}}{100}$$

Total uptake of boron = B uptake by seed + B uptake by straw

RESULTS AND DISCUSSION

Effect on quality parameters

The data pertaining to various quality parameters studied viz., oil content (%) and oil yield (kg ha^{-1}) as influenced by various treatments are presented in table 1.

Sulphur levels

Data in table 1 revealed that oil content (%) and oil yield (kg ha^{-1}) in soybean were affected due to different levels of sulphur and oil yield (kg ha^{-1}) was significantly more with the application of 40 kg S ha^{-1} which was at par with the application of 30 kg S ha^{-1} and significantly superior over 0 and 20 kg S ha^{-1}.

Singh *et al*. (2006) reported that oil and protein content in soybean seed was increased with successive increase of sulphur levels. Oil content increased from 15.57% to 19.47% at 60 kg S ha^{-1}.The increase in oil content on addition of sulphur might be associated with increase in acetyl- COA carbohydrate activity through the enhancement of acetyle COA concentration. Ganeshamurthy (1996) reported that application of 40 kg S ha^{-1} significantly increased oil content of grain and oil yield of soybean.The increase in oil yield of soybean was due to the increase in oil content and grain yield due to application of higher levels of sulphur to soybean.

Boron levels

Data revealed that the oil content (%) and oil yield (kg ha^{-1}) of soybean were affected due to application of boron and significantly maximum oil yield was obtained with the application of boron @ 1.5 kg ha^{-1} but remained at par with the application of 1.0 kg B ha^{-1}. Oil content of soybean was highest with the application of boron @ 1.5 kg ha^{-1} amongst all other treatments. Ismile *et al*. (2013) reported that the highest oil content (18.90 and 19.38%) and oil yield (354 and 453 kg ha^{-1}) were observed with the application of 20 kg borax ha^{-1}.This might be due to cumulative effect of increase in oil content and seed yield of soybean crop due to boron application.

Effect on nutrient content and uptake

Data pertaining to nutrient content and uptake in grain and straw yield in soybean as influenced by various treatments are presented in table 1.

Sulphur levels

Different levels of sulphur significantly influenced nutrient content (sulphur and boron) and its uptake by soybean. Highest nutrient content (sulphur and boron (%) and nutrient uptake (kg ha^{-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} to soybean. Sonune, (2001) observed the effect of application of sulphur as gypsum on soybean and reported that significantly highest sulphur content of soybean grain (0.482 %) and straw (0.279 %) were noticed with 40 kg S ha^{-1}.This might be due to increase in availability of sulphur with increasing level of sulphur application. Gokhale *et al*. (2005) reported that increased level of sulphur @ 40 kg ha^{-1} significantly increased the sulphur uptake by soybean. This might be due to more availability of sulphur in soil solution at higher levels of sulphur resulting into more uptake of sulphur. Nandeeni *et al*. (2000) recorded that highest boron content in grain and straw was recorded with the application of sulphur @ 40 kg ha^{-1}. This might be due to increase in availability of boron with the increasing level of sulphur application. Singh *et al*, (2006) reported that application of sulphur in deficient soil increased concentration of both sulphur and boron in soil solution. The total sulphur and boron uptake by crop was also increased significantly with increased levels of sulphur.

Boron levels

Different levels of boron significantly influenced the nutrient content (sulphur and boron) and their uptake by soybean. Highest nutrient in grain and straw and their uptake was observed with the application of boron @ 1.5 kg ha^{-1} and was at par with 1.0 kg B ha^{-1}

Nandeeni *et al*. (2000) observed that highest sulphur content in seed and straw was registered with the application of boron @ 1.5 kg ha^{-1}. This might be due to synergistic effect of boron on sulphur availability with increasing levels of application. Ismile *et al.* (2013) showed that total sulphur uptake of soybean was significantly influenced by different levels of boron application. Highest total sulphur uptake was recorded with the application of boron @ 1.5 kg ha^{-1}. This might be due to the increased levels of sulphur application which provided more availability of nutrients resulting into higher growth attributes and higher uptake by plants. Shekhawat and Shivay (2008) reported that application of boron @ 0.75 kg and 1.5 kg ha^{-1} increased the total nutrient concentration and uptake of S and B by sunflower. Different levels of B improved the uptake of N and B significantly in the seed, stover and as well as total uptake by the crop. Kushwaha *et al*. (2009) recorded that the total boron uptake by crop

Table 1.Quality parameters and nutrient content and uptake, residual fertility status in soil of *kharif* soybean as influenced by different levels of sulphur and boron

	Quality parameters		S content and uptake				B content and uptake				Available nutrient status	
	Oil content (%)	Oil yield (kg ha^{-1})	S content in grain (%)	S content in straw (%)	S uptake grain (kg ha^{-1})	S uptake straw (kg ha^{-1})	B content grain (mg kg^{-1})	B content Straw (mg kg^{1})	B uptake grain (g ha^{-1})	B uptake straw (g ha^{-1})	Available S in soil (mg kg^{1})	Available B in soil (mg kg^{-1})
Sulphur levels (S)												
S_0 - 0 kg S ha^{-1}	19.34	199.20	0.48	0.11	4.94	1.83	0.89	3.93	9.17	65.68	14.82	0.34
S_1- 20 kg S ha^{-1}	19.99	236.68	0.52	0.12	6.15	2.25	0.92	3.99	10.89	75.02	18.69	0.36
S_2 - 30 kg S ha^{-1}	20.57	285.51	0.54	0.15	7.49	3.05	0.95	4.33	13.18	88.19	20.75	0.45
S_3 - 40 kg S ha^{-1}	21.75	318.42	0.57	0.16	8.34	3.34	0.96	4.37	14.05	91.33	23.18	0.46
SE (m) ±	-	11.45	-	-	0.34	0.22	-	-	0.31	2.93	0.99	0.02
CD at 5%	-	33.07	-	-	0.98	0.65	-	-	0.89	8.48	2.85	0.07
Boron levels (B)												
B_0 - 0 kg B ha-^{1}	19.57	227.01	0.48	0.10	5.56	1.79	0.89	3.93	10.32	70.55	16.72	0.35
B_1- 0.5 kg B ha-^{1}	19.69	239.82	0.51	0.12	6.21	2.26	0.92	4.00	11.20	75.39	18.72	0.38
B_2 - 1.0 kg B ha-^{1}	20.97	274.07	0.55	0.14	7.18	2.79	0.96	4.34	12.54	86.68	20.10	0.43
B_3 - 1.5 kg B ha-^{1}	21.42	296.02	0.56	0.17	7.70	3.40	0.97	4.38	13.34	87.64	21.90	0.46
SE (m) ±	-	11.45	-	-	0.34	0.22	-	-	0.31	2.93	0.99	0.02
CD at 5%	-	33.07	-	-	0.98	0.65	-	-	0.89	8.48	2.85	0.07
Interaction (S XB)												
SE (m) ±	-	22.90	1.06	-	0.68	0.45	-	-	0.62	5.87	1.98	0.05
CD at 5%	-	-	-	-	-	-	-	-	-	-	-	-

increased significantly with increased in the levels of boron up to 4.0 kg ha^{-1}. This might be due to more availability of boron resulting into more uptake of boron and also the yield was more that had increased the uptake.

Effect on residual soil fertility status in soil

Data pertaining to available nutrient (sulphur and boron %) in soil as influenced by various treatments are presented in table 1.

Sulphur levels

Different levels of sulphur significantly influenced available sulphur in soil. The highest available sulphur content in soil (23.18 mg kg^{-1}) was recorded with the application of sulphur @ 40 kg ha^{-1}(S_3) and significantly superior over lower levels but found to be at par with the sulphur @ 30 kg ha^{-1}(S_2). Dhage *et al*. (2014) reported that the residual available sulphur content in soil was increased with each increasing levels of sulphur. The highest available boron content in soil was also recorded with the application of sulphur @ 40 kg ha^{-1}.These findings are similar to Jadhao *et al*. (2014) who observed that the nutrient status of soil after harvest of soybean was significantly influenced with increasing levels of sulphur in soybean.

Boron levels

Residual available sulphur content in soil was increased with each increasing levels of boron. The highest available sulphur content in soil was recorded with the application of boron @ 1.5 kg ha^{-1}. Residual available boron content in soil was increased with each increasing levels of boron. The highest available boron content in soil was recorded with the application of boron @ 1.5 kg ha^{-1}(B_3) significantly superior over lower levels but found to be at par with 1.0 kg boron ha^{-1}(B_2). Mondal and Poi (2005) reported highest available boron in soil 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 quality parameters and nutrient content and uptake 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} improved the quality characteristics (oil content and oil yield) and the uptake of nutrients (viz., S and B) by soybean.

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Rec. on 05.07.2016 & Acc. on 25.07.2016