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Effect of Graded Doses of Sulfur and Boron on Growth and Yield Attributes, Yield and Nutrient Content in Chickpea under Central Plains of Uttar Pradesh

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Abstract A factorial experiment in randomized complete block design involving three sulfur levels i.e. 0, 20 and 40 kg S ha^{-1} and levels of boron viz., 0, 0.5 and 1 kg B ha^{-1} with nine treatment combinations with four replications was carried out during *rabi* season, 2012-13 to evaluate the effect of graded doses of sulfur and boron on growth and yield attributes, yield and nutrient content in chickpea crop. Results revealed that increasing S levels up to 40 kg ha^{-1} significantly increased growth and yield attributes, and yield attributes and yield of chickpea except no. of branches per plant . Similar trend was observed for N, P, K, S and B content in grain and stover. Application of B up to 0.5 kg ha^{-1} significantly increased the growth and yield attributes and yield except no. of seeds per pod and grain yield which increased significantly up to 1.0 kg B ha^{-1}. Maximum N, P, K, S and B content in grain and stover was observed with application of 1.0 kg B ha^{-1} which was at par with its lower dose (0.50 kg B ha^{-1}) but significantly higher than control except boron content in grain where the nutrient contents increased significantly with each increase in boron levels.

Keywords S levels, B levels, Growth, Yield, Chickpea.

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Introduction

In India, 25.23 million hectares of agricultural land is under the cultivation of pulses with the production of about 19.27 million tonnes with an average productivity of about 0.76 tonnes ha^{-1} [1] which is much lower than that of the other pulse producing countries of the world. India imports about 2 mil-

lion tonnes of pulses per year to meet its domestic requirement. Chickpea is the most important pulse crop of India contributing 48% of total production. Optimization of macro-and nicro-nutrient application will enhance the productivity of chickpea. Sulfur and boron fertilization is critical for achieving higher growth and yield in legumes. Sulfur requirement of plant makes it to be recognised as the fourth major nutrient in addition to N, P and K. As a nutrient it is a basic requirement for protein synthesis, especially S-containing amino acid i.e. methionine, cystine and cysteine. It is constituent of vitamins (thiamine and biotin) and other biologically active compounds like lipoic acid, acetyl coenzyme-A, ferredoxin and glutathione. Sulfur deficiency adversely affects the chlorophyll synthesis. Beneficial effect of sulfur attributed to increase to increase the number of nodules/ plant resulting from improved root growth [2]. the widespread role of boron (B) within the plant includes cell-wall synthesis , sugar transport, cell division, differentiation, membrane functioning, root elongation, regulation of plant hormone level and generative growth of plants. So, S and B deficiency can hamper the performance of chickpea. Taking this in view, the present investigation was undertaken to examine the appropriate doses of application for sulfur and boron in chickpea crop central plains of Uttar Pradesh, India.

Materials and Methods

Experimental site and soil

A fieldexperiment was conducted during *rabi* season of 2012-13 at pot house of the Department of Soil Science and Agricultural Chemistry, C. S. Azad University of Agriculture and Technology, Kanpur with the coordinates 26.46° North and 80.35°East at the elevation of 125.9 meters above the mean sea level with mean annual rainfall is about 816.0 mm. In order to determine the initial physio-chemical characteristics and fertility status of experimental field, the soil samples were collected randomly from the each micro plot to the depth of 0-15 cm with the help of soil auger prior to crop cultivation. The treatment wise soil samples were collected for mechanical and chemical analysis. In which pH (1 : 2.5) was found to be vary from 8.10 to 8.25, EC-0.26 to 0.30 dSm^{-1}, organic carbon 0.36 to 0.38%, available nitrogen (kg ha^{-1}) 178 to 180, available phosphorus (kg ha^{-1}) -10.32 to 10.90, available potassium (kg ha^{-1})160 to 165, available sulfur (mg kg^{-1}) 6.50 to 6.70 and available boron (mg kg^{-1}) -0.450 to 480 with the loam texture.

Experimental details

Three levels of sulfur (0, 20 and 40 kg S ha^{-1}) and three levels of boron (0,0.5 and 1 kg B ha^{-1}) with a total of nine treatment combinations viz. T_1 - (S_0B_0) 0 kg S ha^{-1} + 0 kg B ha^{-1}, T_2 - (S_1B_0) 20 kg S ha^{-1} + 0 kg B ha^{-1}, T_3 - (S_2B_0) 40 kg S ha^{-1} + 0 kg B ha^{-1}, T_4 - (S_0B_1) 0 kg S ha^{-1} + 0.5 kg B ha^{-1} , T_5 - (S_1B_1) 20 kg S ha^{-1}+ 0.5 kg B ha^{-1}, T_6 - (S_2B_1) 40 kg S ha^{-1} + 0.5 kg B ha^{-1} , T_7- (S_0B_2) 0 kg S ha^{-1} + 1.0 kg B ha^{-1}, T_8 -(S_1B_2) 20 kg S ha^{-1} + 1.0 kg B ha^{-1} and T_9 - (S_2B_2) 40 kg S ha^{1} + 1.0 kg B ha^{-1} were laid out in factorial experiment in randomized complete block design with four replications . The size of each micro plots were 0.374 m^2, in the glasshouse. The variety of crop chickpea under investigation was Udai (K-75).

Application of fertilizer

Nitrogen, phosphorus and potash were applied as basal dressing in all plots @ 20, 50 and 20 kg ha^{-1}, respectively. The sources of fertilizers were diammonium phosfate for nitrogen and phosphorus and muriate of potash for potassium, which were applied as basal. Besides these application of sulfur and boron was also done basally as per the treatment through elemental sulfur and borax, respectivly.

Analytical methods

Nitrogen content in plant sample was determined by Kjeldahl's method as described by Piper [3], phosphorus content was determined colorimetrically as described by Piper [3], potassium content was determined by flame photometer method described by Jackson [4]. Sulfur content in plant sample was determined by turbidimetric method as described by Chesnin and Yien [5] and boron content in plant sample was determined by taking one gram of the plant material in 100 ml flask, 15 ml mixture of di-acid (10 : 4 of AR grade HNO_3 : $HClO_4$) was added

Table 1. Effect of graded doses of sulfur and boron on growth and yield attributes and yield of chickpea.

Treatments	No. of branches per plant at 70 DAS	Plant height (cm) at harvest	No.of pods per plant	No.of seeds per pod	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
S levels (kg/ha)							
0	9.127	51.600	57.267	1.370	1403.00	1486.66	48.557
20	11.273	57.317	65.950	1.550	1571.33	1704.00	47.993
40	11.730	63.750	73.000	1.717	1760.00	1883.33	48.040
SEd	0.331	0.869	1.060	0.025	36.355	46.087	0.220
CD (p=0.05)	0.683	1.793	2.188	0.052	75.054	95.144	0.454
B levels (kg/ha)							
0	9.913	55.650	62.717	1.470	1490.66	1596.66	48.317
0.5	10.957	57.750	65.817	1.557	1583.33	1695.00	48.307
1.0	11.260	59.267	67.683	1.610	1660.33	1782.33	47.967
SEd	0.331	0.869	1.060	0.025	36.355	46.087	0.220
CD (p=0.05)	0.683	1.793	2.188	0.052	75.054	95.144	NS
Interaction	S	NS	NS	NS	NS	NS	NS

to each flask and whole mass was digested on a hot plate to get white solution . The digestate was collected in the 50 ml. volumetric flask and volume was made up to the mark with distilled water [4]. The data collected were analyzed as per Gomez [6].

Results and Discussion

Growth and yield attributes and yield

The data given in Table 1 revealed that graded doses of sulfur and boron caused significant variation in no. of branches per plant, plant height, no. of pods per plant, no. of seeds per pod, grain yield and stover yield significantly except the stover yield where B levels was non-significant and the interaction effect was found to be non significant except no. of branches per plant.

Increasing sulfur level up to 40 kg ha^{-1} significantly increased all the growth and yield attributes and yield of chickpea expect no. of branches per plant for which it was at par with 20 kg ha^{-1} . Increase in grain and stover yield of chickpea obtained due to application of highest dose of sulfur i.e. (40 kg S ha^{-1}) over control were 25.45% and 26.68%, respectively. Maximum value for harvest index was recorded with control treatment where as application of 20 kg S ha^{-1} recorded lowest value. Similar results about sulfur were also reported earlier [7—12].

As regard to boron levels, increasing the boron application up to 0.5 kg ha^{-1} significantly increased no. of branches per plant, plant height, no. of pods per plant, thereafter increasing B levels though increased the growth and yield attributes but could not increase their values up to the level of significance. Straw yield followed the same trend but highest no. of seeds per pod and grain yield was recorded with application of 1.0 kg B ha^{-1} which was significantly higher than its lower levels. The magnitude of grain yield increment over control was 11.38% . Beneficial effect of boron on germination, nodulation and chlorophyll content is reported by Guhey et al. [13]. Application of boron at the rate of 1.5 kg ha gave best nodule parameters [14]. Beneficial effects of B on grain yield [13, 15] and yield losses under boron deficiency in chickpea has also been reported Ceyhan et al. [16].

The interaction between S and B levels were found significant for no. of branches per plant (Table

Table 2. Interaction of sulfur and boron levels on no.of branches per plant of chickpea.

S levels (kg ha^{-1})	B levels (kg ha^{-1}) 0	0.5	1.0	Mean
0	7.250	9.770	10.360	9.127
20	10.890	11.360	11.570	11.273
40	11.600	11.740	11.850	11.730
Mean	9.913	10.957	11.260	
SEd	0.573			
CD (p=0.05)	1.183			

2). Maximum no. of branches per plant was observed with application of S_2B_2 (40 kg S ha^{-1} and 1.0 kg B ha^{-1}) which was at par with S_2B_1, S_2B_0, S_1B_2, S_1B_1 and S_2B.

N, P, K, S and B content
in grain and stover

N, P, K, S and B content in grain and stover of chickpea is presented in Table 3 shows that the graded doses of sulfur and boron caused significant variation in grain and stover N, P, K, S and B content. Highest N, P, K, S and B content in grain and stover was recorded with application of highest dose of sulfur i.e. (40 kg S ha^{-1}) which was significantly higher than its lower doses. The lowest N, P, K, S and B content in grain and stover was observed with control treatment. Increment in sulfur content in grain and stover of chickpea with the application of sulfur has been reported earlier [8, 17]. Application of sulfur results in increased N fixation [2, 7, 18] which might have promoted production of higher amounts of above ground dry matter that could have led to higher acquisition of nutrients ultimately resulted in higher nutrient content in grain and stover.

For B levels, highest grain and stover N, P, K, S and B content was found with application 1.0 kg B ha^{-1} which was at par with its lower dose (0.50 kg B ha^{-1}) but significantly higher than control except boron content in grain which increased significantly with each increase in boron levels. The lowest P, K, S and B content in grain and stover was registered with control treatment. Positive effect of boron on chlorophyll content that may be responsible for production of higher quantities of photosynthates thereby could have supplied more energy root development and absroption of nutrients leading to increased nutrient content [13].

From the above experiment it may be concluded that S and B fertilization have a pivotal role in enhancing performance of chickpea. Application of 40 kg ha^{-1} of S and 0.5 kg B ha^{-1} proved to increase the growth and yield attributes and yield as well as nutrient contents of chickpea under central Plains of Uttar Pradesh, India.

Table 3. Effect of graded doses of sulfur and boron and their interaction on N, P, K, S and B content in grain and stover of chickpea.

Treatments	N content (%)		P content (%)		K content (%)		S content (%)		B content (ppm)	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
S levels (kg/ha)										
0	3.150	2.110	1.243	0.463	0.523	1.730	0.691	0.220	51.617	40.817
20	3.190	2.267	1.370	0.537	0.620	1.850	0.720	0.250	55.550	42.982
40	3.220	2.503	1.497	0.570	0.720	1.900	0.750	0.281	57.733	46.067
SEd	0.007	0.053	0.036	0.011	0.019	0.022	0.0018	0.006	0.736	0.742
CD (p=0.05)	0.015	0.109	0.075	0.023	0.040	0.046	0.0038	0.013	1.520	1.533
B levels (kg/ha)										
0	3.173	2.217	1.320	0.507	0.583	1.790	0.711	0.240	53.783	42.050
0.5	3.187	2.293	1.373	0.523	0.623	1.823	0.720	0.251	55.133	43.417
1.0	3.200	2.370	1.417	0.540	0.657	1.867	0.730	0.260	55.983	44.400
SEd	0.007	0.053	0.036	0.011	0.019	0.022	0.0018	0.006	0.736	0.742
CD (p=0.05)	0.015	0.109	0.075	0.023	0.040	0.046	0.0038	0.013	1.520	1.533
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

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