Effect of Sulfur and Boron on Nutrients in Mungbean (*Vigana radiata* L.) and Soil Health

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Abstract

A field experiment was conducted at the research farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from February to May 2008 to study the effects of sulfur and boron on nutrients of mungbean and the soil health. The variety BARI mung-6 was used as the test crop. In most of the cases of sulfur and boron application, the individual treatments 8 kg S and 2 kg B ha^{-1} showed the highest nutrient concentration and maximum uptake of N, P, K, S and B by the seed and the stover of mungbean. Side by side sulfur and boron with the 8 kg S plus 2 kg B ha^{-1} treatment combination revealed the highest nutrient concentration and maximum uptake of N, P, K, S and B by the seed and the stover of mungbean. In case of S treatments the highest pH, organic matter, total N, available P, exchangeable K, available S and available B was recorded from S_8 (8 kg S ha^{-1}) and the lowest pH, organic matter, total N, available P, exchangeable K, available S and available B was observed from S_0 (no sulfur) treatment. In case of B application the highest pH, organic matter, total N, available P, exchangeable K, available S and available B was recorded from B_2 (2 kg B ha^{-1}) and the lowest pH, organic matter, total N, available P, exchangeable K, available S and available B was found from B_0 (no boron) treatment. For combined application of S and B the highest pH, organic matter, total N, available P, exchangeable K, available S and available B was recorded from S_8B_2 (8 kg S ha^{-1} and 2 kg B ha^{-1}) treatment combination causing better soil health and the lowest pH, organic matter, total N, available P, exchangeable K, available S and available B was observed from S_0B_0 (no sulfur and boron). Individually 8 kg S and 2 kg B ha^{-1}, but as combined 8 kg S plus 2 kg B ha^{-1} treatments revealed the highest nutrient concentration and maximum uptake of N, P, K, S and B by the seed and the stover of mungbean and also showed the improvement in the nutrient status of post harvest soil.

1. Introduction

Bangladesh grows various types of pulse crops. Among them grasspea, lentil, mungbean, blackgram, chickpea, field pea and cowpea are important. Pulse crop is an important food crop because it provides a cheap source of easily digestible dietary protein which complements the stable rice diet in the country. According to FAO (1999) a minimum intake of pulse by a human should be 80 g per head per day, whereas it is only 14.19 g in Bangladesh (BBS, 2007). This is because of the fact that national production of the pulses is not adequate to meet the national demand. Mungbean can also fix atmospheric nitrogen through the symbiotic relationship between the host mungbean roots and soil bacteria and thus improves soil fertility.

Mungbean plays an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh, but the acreage and production of mungbean is steadily declining (BBS, 2007). However, it is one of the least cared crops. Mungbean is cultivated with minimum land preparation and without fertilizer application and with no or minimum insect, diseases or weed control measures. All these factors are responsible for low yield of mungbean. Cultivation of high yielding varieties of wheat and winter rice has occupied considerable land suitable for mungbean cultivation. Beside these, low yield potentiality of this crop is responsible for declining area and production. At present, the area under pulse crops is 0.406 million hectares with a production of 0.322 million tonnes where mungbean is cultivated in the area of 0.108 million hectares (BBS, 2007). The average yield of mungbean is 0.69 t ha^{-1} which is considerably poor in comparison to mungbean growing countries in the world.

There are many reasons of low yield of mungbean. The management of fertilizer is one important factor that greatly affects the growth, development, nutrient concentration, nutrient uptake, yield of the crop and also the post-harvest soil nutrient status causing a reasonable change in soil health. There are 18 essential nutrient elements that can effect the growth and yield of mungbean. Among them a very few works has been done on sulfur and boron on the yield of mungbean. Sulfur plays a remarkable role in protein metabolism. It is required for the synthesis of proteins, vitamins and chlorophyll and also S containing amino acid such as cystine, cysteine and methionine which are essential components of proteins (Tisdale et al., 1999). On the other hand, boron is an essential mineral element for all vascular plants like mungbean. Some functions of B are interrelated with those of N, P, K and Ca in plants. S and B are essential nutrients, so, they should have some appreciable effect on soil health. In this context, there is some scope of evaluating soil health after application of S and B as fertilizers in soil.

2. Materials and Methods

The experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from February to May 2008 to study the effect of sulfur and boron on concentration and uptake of nutrients by mungbean and the improvement of soil health of the research area. The experiment was consisted of two factors: Factor A: Sulfur (4 levels); S_0: 0 kg (Control), S_4: 4 kg, S_8: 8 kg and S_{12}: 12 kg S ha^{-1}; Factor B: Boron (3 levels): B_0: No boron (Control), B_1: 1 kg and B_2: 2 kg B ha^{-1}. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The significance of the difference among the treatment means was estimated by the least significant difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984). The nutrient status of initial soil prior to fertilization is presented in table 1.

Table 1: Analytical data of the experimental soils (pre-sowing)

Location	Textural class	pH	Organic matter	Total N (%)	Available P (ppm)	Available K (meq%)	Available S (ppm)	Available B (ppm)
SAU Farm, Dhaka	Silty clay loam	4.6	0.840	.067	18	0.13	0.21	0.085

3. Results and Discussion

3.1. N, P, K, S, B concentration in seed

Statistically significant variation was recorded for N, P, K, S and B concentration in seed due to fertilization of soil with different levels of sulfur, boron and their combined applications. In case of sulfur fertilizer application, the maximum concentration in seed for N (3.39%), P (1.012%), K (1.005%), S (1.014%) and B (0.086%) was recorded from S_8 and the minimum concentration in seed for N (2.57%), P (0.476%), K (0.382%) and S (0.377%) was observed from S_0 (No sulfur) treatment, but for B it was found minimum (0.061%) from S_{12} (12 kg S ha^{-1}) treatment (table 2).

For the application of boron the maximum concentration in seed for N (3.40%), P (1.045%), K (0.896%), S (0.922%) and B (0.078%) was recorded from B_2 and the minimum concentration in seed for N (2.64%), P (0.541%), K (0.603%), S (0.537%) and B (0.052%) was found from B_0 treatment with no B application (table 2). Due to the interaction effect of sulfur and boron, the maximum concentration in seed for N (3.85%), P (1.509%),

Table 2: Effect of sulfur and boron on the concentration of N, P, K, S and B in seed and stover of mungbean

Treatment	Concentration (%) in grain					Concentration (%) in stover				
	N	P	K	S	B	N	P	K	S	B
S_0	2.57^c	0.476^c	0.382^c	0.377^c	0.066^b	4.46^{bc}	0.421^b	0.444^b	0.311^c	0.010^b
S_4	3.29^a	1.009^a	0.962^a	0.984^a	0.066^b	4.67^{ab}	0.428^b	0.450^{ab}	0.347^{ab}	0.011^b
S_8	3.39^a	1.012^a	1.005^a	1.014^a	0.086^a	4.89^a	0.430^b	0.457^a	0.355^a	0.013^a
S_{12}	3.07^b	0.674^b	0.594^b	0.658^b	0.061^b	4.31^c	0.471^a	0.460^a	0.339^b	0.013^a
LSD (p=0.05)	0.157	0.083	0.063	0.077	0.065	0.284	0.031	0.010	0.010	0.01
B_0	2.64^c	0.541^c	0.603^c	0.537^c	0.052^c	4.23^c	0.414^b	0.427^c	0.317^b	0.010^b
B_1	3.19^b	0.793^b	0.708^b	0.816^b	0.066^b	4.59^b	0.438^{ab}	0.458^b	0.344^a	0.012^a
B_2	3.40^a	1.045^a	0.896^a	0.922^a	0.078^a	4.93^a	0.460^a	0.474^a	0.352^a	0.012^a
LSD (p=0.05)	0.136	0.072	0.054	0.066	0.053	0.246	0.027	0.009	0.009	0.09

K (1.357%), S (1.246%) and B (0.140%) was recorded from S_8B_2 treatment combination and the minimum concentration in seed for N (2.21%), P (0.360%), K (0.345%), S (0.327%) and B (0.037%) was observed from no S plus no boron (S_0B_0) treatment (table 3).

3.2. N, P, K, S, B concentration in stover

A statistically significant variation was recorded for N, P, K, S, B concentration in stover due to the application of different levels of sulfur, boron and their interaction. For the application of sulfur the maximum concentration in stover for N (4.89%) from 8 kg S ha^{-1}, P (0.471%) from 12 kg S ha^{-1}, K (0.460%) from 12 kg S ha^{-1}, S (0.355%) from 8 kg S ha^{-1} and B (0.013%) from each of 12 and 8 kg S ha^{-1} was recorded. The minimum concentration in stover for N (4.31%) was observed in S_{12} treatment, while for P (0.421%), K (0.444%), S (0.311%) and B (0.010%) it was observed from S_0 treatment. In case of boron the maximum concentration in stover for N (4.93%), P (0.460%), K (0.474%), S (0.352%) and B (0.012%) was recorded from B_2 and the minimum concentration in stover for N (4.23%), P (0.414%), K (0.427%), S (0.317%) and B (0.010%) was observed from B_0 treatment (table 2). In case of interaction effect of sulfur and boron the maximum concentration in stover for N (5.58%), P (0.535%), K (0.482%), S (0.370%) and B (0.015%) was recorded from S_8B_2 and the minimum concentration in stover for N (4.12%), P (0.405%), K (0.403%), S (0.276%) and B (0.008%) was observed from S_0B_0 (table 3).

3.3. N, P, K, S, B uptake by seed

A statistically significant variation was recorded for N, P, K, S, B uptake by seed due to different level of sulfur, boron and their interaction. Due to the application of sulfur the maximum uptake by seed for N (36.52 kg ha^{-1}), P (5.58 kg ha^{-1}), K (12.55 kg ha^{-1}), S (7.50 kg ha^{-1}) and B (0.106 kg ha^{-1}) was recorded from S_8 and the minimum uptake by seed for N (24.61 kg ha^{-1}),

Table 3: Interaction effect of sulfur and boron on the concentration of N, P, K, S and B in seed and stover of mungbean

Treatment	Concentration (%) in grain					Concentration (%) in stover				
	N	P	K	S	B	N	P	K	S	B
S_0B_0	2.21^{g}	0.360^{e}	0.345^{g}	0.327^{e}	0.037^{e}	4.12^{e}	0.405^{b}	0.403^{e}	0.276^{e}	0.008
S_0B_1	2.65^{f}	0.464^{b}	0.372^{fg}	0.429^{e}	0.107^{b}	4.59^{bcde}	0.434^{b}	0.467^{abc}	0.328^{d}	0.014
S_0B_2	2.84^{def}	0.605^{fgh}	0.430^{fg}	0.374^{e}	0.053^{d}	4.67^{bcde}	0.446^{b}	0.463^{abc}	0.329^{d}	0.011
S_4B_0	2.64^{f}	0.718^{ef}	0.885^{c}	0.658^{d}	0.054^{d}	4.27^{cde}	0.416^{b}	0.421^{d}	0.332^{cd}	0.012
S_4B_1	3.52^{b}	1.078^{c}	0.934^{c}	1.074^{b}	0.042^{e}	4.74^{bcd}	0.425^{b}	0.450^{c}	0.349^{bc}	0.014
S_4B_2	3.71^{ab}	1.231^{b}	1.067^{b}	1.220^{a}	0.053^{d}	5.00^{b}	0.421^{b}	0.481^{a}	0.360^{ab}	0.013
S_8B_0	2.69^{ef}	0.560^{gh}	0.716^{d}	0.716^{d}	0.058^{d}	4.34^{cde}	0.422^{b}	0.430^{d}	0.335^{cd}	0.010
S_8B_1	3.64^{ab}	0.968^{cd}	0.941^{c}	1.081^{b}	0.057^{d}	4.76^{bc}	0.456^{b}	0.458^{bc}	0.359^{ab}	0.012
S_8B_2	3.85^{a}	1.509^{a}	1.357^{a}	1.246^{a}	0.140^{a}	5.58^{a}	0.535^{a}	0.482^{a}	0.370^{a}	0.015
$S_{12}B_0$	3.01^{cd}	0.525^{gh}	0.467^{f}	0.446^{e}	0.059^{d}	4.19^{de}	0.413^{b}	0.455^{bc}	0.326^{d}	0.008
$S_{12}B_1$	2.97^{cde}	0.662^{fg}	0.583^{e}	0.681^{d}	0.058^{d}	4.26^{cde}	0.438^{b}	0.456^{bc}	0.341^{bcd}	0.010
$S_{12}B_2$	3.21^{c}	0.836^{de}	0.730^{d}	0.849^{c}	0.068^{d}	4.48^{bcde}	0.438^{b}	0.470^{ab}	0.350^{bc}	0.011
LSD (p=0.05)	0.271	0.144	0.109	0.133	0.087	0.491	0.054	0.017	0.017	0.017

P (3.69 kg ha^{-1}), K (8.65 kg ha^{-1}), S (4.86 kg ha^{-1}) and B (0.089 kg ha^{-1}) was observed from S_0. Singh et al. (1997) reported that sulfur significantly improved nitrogen & sulfur uptake and the optimum application rate being 30 kg ha^{-1}. In case of boron the maximum uptake by seed for N (35.69 kg ha^{-1}), P (5.45 kg ha^{-1}), K (12.13 kg ha^{-1}), S (7.01 kg ha^{-1}) and B (0.104 kg ha^{-1}) was recorded from B_2 and the minimum N (25.74 kg ha^{-1}), P (3.88 kg ha^{-1}), K (9.30 kg ha^{-1}), S (5.07 kg ha^{-1}) and B (0.094 kg ha^{-1}) was observed from B_0 (table 4). For the interaction effect of sulfur and boron the maximum uptake by seed for N (41.52 kg ha^{-1}), P (6.34 kg ha^{-1}), K (14.15 kg ha^{-1}), S (8.89 kg ha^{-1}) and B (0.113 kg ha^{-1}) was recorded from S_8B_2 treatment combination and the minimum uptake by seed for N (21.04 kg ha^{-1}), P (3.00 kg ha^{-1}), K (7.44 kg ha^{-1}), S (4.33 kg ha^{-1}) and B (0.079 kg ha^{-1}) was observed from no sulfur plus no boron (S_0B_0) treated plots (table 5).

3.4. N, P, K, S, B uptake by stover

A statistically significant variation was recorded for N, P, K, S, B uptake by stover due to the application of different levels of sulfur, boron and their interaction effect. In case of sulfur the maximum uptake by stover for N (70.69 kg ha^{-1}), P (16.54 kg ha^{-1}), K (37.34 kg ha^{-1}), S (3.07 kg ha^{-1}) and B (0.119 kg ha^{-1}) was recorded from S_8 and the minimum uptake by stover for

Table 4: Effect of sulfur and boron on the uptake of N, P, K, S and B in seed and stover of mungbean

Treatment	Uptake by grain (kg ha^{-1})					Uptake by stover (kg ha^{-1})				
	N	P	K	S	B	N	P	K	S	B
S_0	24.61^{d}	3.69^{d}	8.65^{d}	4.86^{d}	0.089^{b}	41.68^{d}	10.66^{d}	23.66^{d}	2.37^{c}	0.109^{c}
S_4	32.78^{b}	5.01^{b}	11.28^{b}	6.71^{b}	0.102^{a}	63.75^{b}	14.17^{b}	32.00^{b}	2.98^{ab}	0.115^{b}
S_8	36.52^{a}	5.58^{a}	12.55^{a}	7.50^{a}	0.106^{a}	70.69^{a}	16.54^{a}	37.34^{a}	3.07^{a}	0.119^{a}
S_{12}	29.49^{c}	4.50^{c}	10.50^{c}	5.59^{c}	0.095^{a}	56.91^{c}	12.72^{c}	28.72^{c}	2.82^{b}	0.115^{b}
LSD (p=0.05)	1.873	0.284	0.603	0.578	0.034	2.968	0.751	1.597	0.215	0.021
B_0	25.74^{c}	3.88^{c}	9.30^{c}	5.07^{c}	0.094^{b}	45.28^{c}	12.93^{b}	28.88^{b}	2.65^{b}	0.113^{b}
B_1	31.12^{b}	4.75^{b}	10.81^{b}	6.42^{b}	0.096^{b}	62.49^{b}	13.61^{a}	30.74^{a}	2.85^{a}	0.113^{b}
B_2	35.69^{a}	5.45^{a}	12.13^{a}	7.01^{a}	0.104^{a}	67.01^{a}	14.03^{a}	31.67^{a}	2.94^{a}	0.118^{a}
LSD (p=0.05)	1.622	0.246	0.522	0.501	0.023	2.570	0.650	1.383	0.186	0.013

Table 5: Interaction effect of sulfur and boron on the uptake of N, P, K, S and B in seed and stover of mungbean

Treatment	Uptake by grain (kg ha^{-1})					Uptake by stover (kg ha^{-1})				
	N	P	K	S	B	N	P	K	S	B
S_0B_0	21.04^{h}	3.00^{h}	7.44^{h}	4.33^{e}	0.079	36.21^{f}	10.16^{f}	21.69^{g}	2.26^{e}	0.097
S_0B_1	24.28^{g}	3.71^{g}	8.87^{g}	5.04^{cde}	0.101	44.81^{e}	10.61^{ef}	23.97^{fg}	2.41^{de}	0.115
S_0B_2	28.52^{ef}	4.36^{ef}	9.66^{fg}	5.22^{cde}	0.076	44.02^{e}	11.21^{ef}	25.32e^{f}	2.44^{de}	0.116
S_4B_0	24.89^{g}	3.80^{g}	9.83^{fg}	5.64^{bcd}	0.104	45.35^{e}	13.59^{bc}	30.68^{bc}	2.76^{bcd}	0.113
S_4B_1	34.39^{cd}	5.25^{cd}	11.03^{de}	6.63^{b}	0.102	72.31^{b}	14.28^{bc}	32.24^{bc}	3.04^{abc}	0.115
S_4B_2	39.08^{ab}	5.97^{ab}	12.98^{b}	7.86^{a}	0.099	73.60^{b}	14.64^{b}	33.07^{b}	3.16^{ab}	0.117
S_8B_0	31.10^{de}	4.75^{de}	10.74^{def}	5.40^{cde}	0.097	53.35^{d}	16.06^{a}	36.26^{a}	2.90^{abc}	0.119
S_8B_1	36.94^{bc}	5.64^{bc}	12.76^{bc}	8.23^{a}	0.096	73.09^{b}	16.52^{a}	37.30^{a}	3.14^{ab}	0.119
S_8B_2	41.52^{a}	6.34^{a}	14.15^{a}	8.89^{a}	0.113	85.63^{a}	17.03^{a}	38.45^{a}	3.18^{a}	0.123
$S_{12}B_0$	25.94^{fg}	3.96^{fg}	9.19^{g}	4.93^{de}	0.106	46.21^{e}	11.90^{de}	26.88^{de}	2.69^{cd}	0.122
$S_{12}B_1$	28.87^{ef}	4.41^{ef}	10.57^{ef}	5.77^{bcd}	0.104	59.76^{c}	13.04^{cd}	29.44^{cd}	2.81^{abcd}	0.122
$S_{12}B_2$	33.66^{cd}	5.14^{cd}	11.73^{cd}	6.08^{bc}	0.108	64.78^{c}	13.22^{cd}	29.85^{c}	2.96^{abc}	0.101
LSD (p=0.05)	3.245	0.491	1.045	1.002	-	5.141	1.301	2.765	0.372	-

N (41.68 kg ha^{-1}), P (10.66 kg ha^{-1}), K (23.66 kg ha^{-1}), S (2.37 kg ha^{-1}) and B (0.109 kg ha^{-1}) was observed from no sulfur application (S_0) treatment. For boron the maximum uptake by stover for N (67.01 kg ha^{-1}), P (14.03 kg ha^{-1}), K (31.67 kg ha^{-1}), S (2.94 kg ha^{-1}) and B (0.118 kg ha^{-1}) was recorded from B_2 and the minimum uptake by stover for N (45.28 kg ha^{-1}), P (12.93 kg ha^{-1}), K (28.88 kg ha^{-1}), S (2.65 kg ha^{-1}) and B (0.113 kg ha^{-1}) was observed from B_0 (no boron) treatment (table 4). Due to the interaction effect of sulfur and boron the maximum uptake by stover for N (85.63 kg ha^{-1}), P (17.03 kg ha^{-1}), K (38.45 kg ha^{-1}), S (3.18 kg ha^{-1}) and B (0.123 kg ha^{-1}) was recorded from S_8B_2 and the minimum uptake by stover for N (36.21 kg ha^{-1}), P (10.16 kg ha^{-1}), K (21.69 kg ha^{-1}), S (2.26 kg ha^{-1}) and B (0.097 kg ha^{-1}) was observed from no sulfur plus no boron (S_0B_0) treatment (table 5).

3.5. Post-harvest soil

Significant differences was recorded for pH, organic matter, total N, available P, exchangeable K, available S and available B in post-harvest soil for application of different levels of sulfur, boron and their interaction. Sheikh et al., 2009 found that when mungbean was cultivated in a Transplant Aman-Mustard-Mungbean cropping pattern soil pH, organic matter, total N, P, S, Zn and B content was increased. In case of sulfur the highest pH (5.43), organic matter (1.37%), total N (0.39%), available P (20.39 ppm), exchangeable K (0.16 me%), available S (0.27 ppm) and available B (0.145 ppm) was recorded from 8 kg S ha^{-1} (S_8) treatment and the lowest pH (4.37), organic matter (1.06%), total N (0.23%), available P (15.51 ppm), exchangeable K (0.12 me%), available S (0.20 ppm) and available B (0.123 ppm) was observed from no sulfur application (S_0) treatment (table 6). According to Saha et al., 2003 the nutrients added to the soil in the form of fertilizers are not being removed or utilized fully by the crops in one season. So, proper fertilizer management is very important considering the residual effect of the nutrients. So, organic matter, total N, available P, exchangeable K, available S and available B in post-harvest soil might be increased in mungbean cultivation with S and B fertilization in the present study. For boron the highest pH (5.05), organic matter (1.25%), total N (0.35%), available P (19.02 ppm), exchangeable K (0.15 me%), available S (0.27 ppm) and available B (0.148 ppm) was recorded from B_2 and the lowest pH (4.61), organic matter (1.12%), total N (0.22%), available P (15.72 ppm), exchangeable K (0.12 me%), available S (0.22 ppm) and available B (0.111 ppm) was observed from no boron (B_0) (table 6). Due to the interaction effect of sulfur and boron the highest pH (5.57), organic matter (1.45%), total N (0.45%), available P (22.78 ppm), exchangeable K (0.18 me%), available S (0.30 ppm) and available B (0.162 ppm) was recorded from 8 kg S ha^{-1} plus 2 kg B ha^{-1} (S_8B_2) treatment combination and the lowest pH (3.96), organic matter (1.02%), total N (0.16%), available P (13.75 ppm), exchangeable K (0.11 me%), available S (0.17 ppm) and available B (0.086 ppm) was observed from treatment combination with no sulfur plus no boron (S_0B_0) (table 7).

Table 6: Effect of sulfur and boron on the pH, organic matter, available phosphorus, exchangeable K, available S and B on post-harvest soil

Treatment	pH	Organic matter (%)	Total N (%)	Available P (ppm)	Exchan. K (me%)	Available S (ppm)	Available B (ppm)
S_0	4.37^{b}	1.06^{c}	0.23^{c}	15.51^{c}	0.12^{c}	0.20^{d}	0.123^{c}
S_4	4.62^{b}	1.16^{b}	0.28^{b}	17.39^{b}	0.14^{b}	0.26^{b}	0.133^{b}
S_8	5.43^{a}	1.37^{a}	0.39^{a}	20.39^{a}	0.16^{a}	0.27^{a}	0.145^{a}
S_{12}	4.62^{b}	1.16^{b}	0.26^{bc}	16.91^{b}	0.13^{c}	0.25^{c}	0.132^{b}
LSD (p=0.05)	0.442	0.083	0.031	0.872	0.010	0.010	0.013
B_0	4.61^{b}	1.12^{b}	0.22^{c}	15.72^{c}	0.12^{c}	0.22^{c}	0.111^{c}
B_1	4.62^{b}	1.18^{ab}	0.30^{b}	17.91^{b}	0.14^{b}	0.24^{b}	0.140^{b}
B_2	5.05^{a}	1.25^{a}	0.35^{a}	19.02^{a}	0.15^{a}	0.27^{a}	0.148^{a}
LSD (p=0.05)	0.383	0.072	0.027	0.755	0.009	0.009	0.007

Table 7: Interaction effect of sulfur and boron on pH, organic matter, available phosphorus, exchangeable K, available S and B on post-harvest soil

Treatment	pH	Organic matter (%)	Total N (%)	Available P (ppm)	Exchan. K (me%)	Available S (ppm)	Available B (ppm)
S_0B_0	3.96^{d}	1.02^{e}	0.16^{g}	13.75^{f}	0.11^{e}	0.17^{g}	0.086
S_0B_1	4.17^{cd}	1.05^{de}	0.22^{ef}	16.13^{e}	0.13^{de}	0.20^{f}	0.149
S_0B_2	4.96^{abc}	1.10^{cde}	0.29^{cd}	16.66^{de}	0.13^{d}	0.23^{e}	0.161
S_4B_0	4.35^{cd}	1.05^{de}	0.17^{fg}	15.83^{e}	0.13^{cd}	0.23^{e}	0.135
S_4B_1	4.78^{abcd}	1.21^{bcd}	0.34^{bc}	17.88^{cd}	0.14^{cd}	0.27^{b}	0.153
S_4B_2	4.74^{abcd}	1.20^{bcd}	0.33^{bc}	18.47^{c}	0.15^{bc}	0.27^{bc}	0.147
S_8B_0	5.38^{ab}	1.33^{ab}	0.34^{bc}	17.84^{cd}	0.13^{d}	0.24^{de}	0.121
S_8B_1	5.34^{ab}	1.32^{ab}	0.37^{b}	20.54^{b}	0.16^{b}	0.28^{b}	0.140
S_8B_2	5.57^{a}	1.45^{a}	0.45^{a}	22.78^{a}	0.18^{a}	0.30^{a}	0.162
$S_{12}B_0$	4.55^{bcd}	1.09^{cde}	0.19^{fg}	15.47^{e}	0.12^{de}	0.25^{cd}	0.101
$S_{12}B_1$	4.40^{cd}	1.14^{cde}	0.27^{de}	17.08^{cde}	0.13^{d}	0.22^{e}	0.117
$S_{12}B_2$	4.91^{abc}	1.24^{bc}	0.31^{cd}	18.17^{cd}	0.13^{de}	0.26^{bc}	0.150
LSD (p=0.05)	0.765	0.144	0.054	1.510	0.017	0.017	-

Now, as discussion, we can say that S and B treatments both individually and combinedly increased the nutrient concentration and uptake in most of the cases significantly over control. 8 kg S and 2 kg B ha^{-1} were the best individual treatments in case of S and B application. In case of combined application of S and B 8 kg S plus 2 kg B ha^{-1} treatment combination showed the best results in case of nutrient concentration and nutrient uptake. For soil health it was observed that individual S treatment with 8 kg S ha^{-1} increased soil organic matter content of the experimental area upto certain limit, whereas B treatment increased organic matter content upto its highest dose level with 2 kg B ha^{-1}. It is evidenced by many of the researchers that inclusion of a pulse crop in the cropping pattern would reduce the requirement of chemical fertilizer in the next crop maintaining a good health of soils through biological nitrogen fixing and addition of organic matter to soil. Balasubramanian and Sekayanae, 1991 and Bheemalah et al., 1992 reported that biomass of legumes and arable crops improved soil health with little or no reduction in crop yields. So, from the above results it has been revealed that combined application of 8 kg S with 2 kg B ha^{-1} in most of the cases caused maximum nutrient uptake by mungbean crop and also increased the post-harvest nutrient status of soil.

4. Conclusion

So, from the above results it has been revealed that combined application of 8 kg S with 2 kg B ha^{-1} in most of the cases caused maximum nutrient uptake by mungbean crop and also increased the post-harvest nutrient status of the soil.

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