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Soil Fertility status and S and B uptake as Influenced by Tillage and Nutrient Management in Mustard

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ABSTRACT: Productivity of rainfed mustard is too low, largely due to lack of inadequate nutrient management and deficit moisture conservation in soil profile. Keeping issues in view, a field experiment was conducted in rabi season 2016-17 and 2017-18 at research farm of Bihar Agricultural College, Sabour, Bhagalpur to determine the impact of tillage and nutrient management on soil fertility and nutrient uptake of S and B in mustard. It comprised of main plot having three tillage strategies *viz*., conventional, zero and reduced tillage, three doses of S (0, 20 and 40 kg ha^{-1}) in sub plots and three doses of B (0, 1.0 and 2.0 kg ha^{-1}) in sub sub plots was laid out in split split plot design with three replications. Results revealed that increasing the intensity of tillage from zero tillage to reduced tillage and conventional tillage correspondingly increased S and B uptake by mustard during both the years. Increase in S level from 0 to 40 kg ha^{-1} registered corresponding increase in S and B uptake at harvest during both the years. Application of 40 kg S ha^{-1} produced significantly highest S uptake over control plot and 20 kg S ha^{-1} during both the years. Similarly, application of 2.0 kg B ha^{-1} produced significantly highest S uptake over control plot during both the years. In second year only, 2.0 kg B ha^{-1} was found at par with 1.0 kg B ha^{-1} for S uptake, however, application of 40 kg S ha^{-1} produced significantly highest B uptake over control and was at par with 20 kg S ha^{-1} during both the years. Application of 2.0 kg B ha^{-1} produced significantly highest B uptake over control and 1.0 kg B ha^{-1} during both the years. Available S and B in soil was significantly affected by tillage practices resulted maximum available S and B content in soil with zero tillage, 40 kg S ha^{-1} and 2.0 kg B ha^{-1} treated plots over the initial value.

Keywords: Boron, Mustard, Nutrient uptake, Soil fertility, Sulphur and Tillage.

INTRODUCTION

In 'Rapeseed and Mustard' group of oil seeds, Indian mustard (*Brassica juncea* L.) occupies the prime position in India. Rapeseed-mustard oil is considered to be an important constituent of Indian diet and its oil is used as main cooking medium especially in northern India. Both the seed and oil are used as condiment in the preparation of pickles and flavoring curries and vegetables. Indian mustard occupies more than 70 % of the area under rapeseed and mustard. It is preferred by the farmers of rainfed areas because of its capability to yield satisfactorily under sub optimal resources. Inherited yield potential can be realized by providing nutrients in balanced proportion with suitable agronomic package of practices. Aggressive seed bed preparation under conventional tillage leads to declining soil carbon pools (Gathala *et al*., 2011 and Bhattacharyya *et al*., 2013), while reduced tillage and zero tillage with crop residues increases carbon sequestration in soil by improving soil aggregate stability (Bhattacharyya *et al*., 2012).

Rana and Rana (2003) reported that application of S is also important in increasing the efficacy of other nutrients. A high input of nitrogen fertilizers induces more intensive appearance of sulphur shortage (Raut *et al*., 2000). Continuous removal of S from soils through plant uptake has led to widespread S deficiency and affected soil S budget (Aulakh, 2003). Boron is one of the important micronutrients required in lesser quantities by most of the field crops, but it affects the crop yield to the greater extent (Brown *et al*., 2002 and O'Neill *et al*., 2004).

The impact of conservation tillage on soil physical environment is not always positive and varies from one soil to the other soil. These techniques offer numerous benefits, including farm productivity and profitability enhancement, moisture conservation, weed control and improvement in soil health (Govaerts *et al*., 2007 and Limon-Ortega *et al*., 2002). Keeping these points in view, the present experimentation was conducted to assess the impact of tillage and nutrients (S & B) management on soil fertility status and S and B uptake by mustard.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season 2016-17 and 2017-18 at research farm of Bihar Agricultural College, Sabour, Bhagalpur to find out the

effect of tillage and nutrient management on soil fertility status and S and B uptake by mustard. The experimental comprised of three tillage practices *viz.*, conventional tillage, zero tillage and reduced tillage in main plot, and three doses of sulphur i.e., 0, 20 and 40 kg ha^{-1} in sub plots and three doses of boron i.e., 0, 1.0 and 2.0 kg ha^{-1} in sub sub plots laid out in split split plot design having three replications.

Conventional tillage was done through one ploughing by nine-tyne cultivator followed by harrowing twice and leveling with planker. In reduced and zero tillage, tillage operations are minimized only restricted to seed bed preparation. Fertilizer dose (40:20: 20 kg NPK ha^{-1}) was applied as per critical stages of the crop. Full N dose and full P and K dose were applied at sowing. Sulphur and boron were applied at sowing time as per treatment wise schedule.

The data on nutrient uptake (sulphur and boron**)** and available nutrients (sulphur and boron) in soil at harvest stage of mustard crop were recorded. Data were statistically analyzed separately to interpret the results. The mean data for each parameter has been presented. For comparison of 'F' values and for determination of critical difference at 5 % level of significance, Fisher (1970) was consulted.

RESULTS AND DISCUSSION

A. Effect of tillage on S uptake by mustard

Increasing the intensity of tillage from zero tillage to reduced tillage and conventional tillage correspondingly increased S uptake by mustard during both the years (Table 1).

This might be attributed due to greater availability of sulphur at higher tillage intensity due to better soil physico-chemical and biological properties. Hence, under conventional tillage, there was more healthy and vigorous plant growth as evident by taller plants, more number of branches and dry matter production.

These results are in close conformity with the findings of Lavado *et al*. (2001) and Pal and Phogat (2005). S uptake was positively influenced by tillage. The release of nutrients in soil solution depends upon intensity capacity of soil to supply these nutrients. Tillage enhanced supply of S content for their effective uptake.

Increase in S level from 0 to 40 kg ha^{-1} registered corresponding increase in S uptake at harvest during both the years. Application of 40 kg S ha^{-1} produced significantly highest S uptake (21.23 and 19.32 kg ha^{-1}) over control plot and 20 kg S ha^{-1} during 2016-17 and 2017-18, respectively. Similarly, application of 2.0 kg B ha^{-1} produced significantly highest S uptake (19.29 and 17.26 kg ha^{-1}) over control plot during 2016-17 and 2017-18, respectively. In second year only, 2.0 kg B ha^{-1} was at par with 1.0 kg B ha^{-1}.

B. Effect of S and B doses on S uptake by mustard

Sulphur uptake increased with increasing levels of S and B. A close examination of the data revealed marked effect of different doses of S and B on S uptake by mustard (Table 1). This might be attributed to greater availability of nutrients and efficient translocation of nutrients to the sink i.e., seed due to better soil properties. Hence, under 40 kg S ha^{-1} and 1.0 kg B ha^{-1}, there was more healthy and vigorous plant growth as evident by taller plants, more number of branches and dry matter production.

Table 1: Effect of tillage, doses of S and B on S and B uptake, available S and B of soil at harvest.

Treatments	S uptake (kg ha^{-1})		B uptake (g ha^{-1})		Available S (ppm)		Available B (ppm)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Tillage practices								
T_1- Conventional tillage	19.17	17.46	57.56	54.44	9.78	9.83	0.44	0.49
T_2- Zero Tillage	14.23	12.49	46.76	43.37	11.93	11.95	0.48	0.53
T_3- Reduced Tillage	17.04	15.44	51.91	49.34	11.17	11.20	0.46	0.50
SEm±	0.25	0.39	1.29	0.77	0.130	0.153	0.013	0.005
CD (P = 0.05)	0.97	1.57	5.09	3.02	0.51	0.60	NS	0.02
Sulphur Levels (kg ha^{-1})								
S_1-0	11.30	10.02	42.56	39.58	10.35	10.41	0.43	0.48
S_2-20	17.91	16.06	55.47	52.52	10.92	10.94	0.44	0.48
S_3-40	21.23	19.32	58.20	55.05	11.61	11.63	0.51	0.55
SEm±	0.75	0.58	1.47	1.23	0.174	0.194	0.021	0.014
CD (P = 0.05)	2.31	1.78	4.54	3.80	0.54	0.60	0.06	0.04
Boron Levels (kg ha^{-1})								
B_1-0	13.25	11.84	40.31	38.17	10.16	10.22	0.38	0.42
B_2-1.0	17.90	16.30	55.70	52.76	10.98	11.00	0.48	0.52
B_3-2.0	19.29	17.26	60.21	56.23	11.74	11.76	0.53	0.57
SEm±	0.41	0.39	0.95	1.02	0.144	0.166	0.011	0.011
CD (P = 0.05)	1.19	1.14	2.74	2.92	0.41	0.48	0.03	0.03
Initial	-	-	-	-	10.26	10.30	0.44	0.46
Interaction								
T×S	NS	NS	NS	NS	NS	NS	NS	NS
T×B	NS	NS	NS	NS	NS	NS	NS	NS
S×B	S	S	NS	NS	NS	NS	S	S
T×S×B	NS	NS	NS	NS	NS	NS	NS	NS

This accompanied with better nutrient content which resulted in significantly higher nutrient uptake by mustard with increasing levels of S and B up to 40 kg ha^{-1} and 2.0 kg ha^{-1}, respectively. Raut *et al*. (2000) observed that sulphur uptake increased significantly with each successive increase in levels of sulphur. These results are in close conformity with the findings of Kumar and Yadav (2007). Pachauri *et al*. (2012) also reported that S uptake by mustard was enhanced with S application.

Chakraborty and Das (2000) found that increase in S uptake by mustard was noted with combined application of S and B in silty loam soil. The release of nutrients in soil solution depends upon intensity capacity of soil to supply these nutrients. Levels of S and B enhanced supply of nutrients and increased S content for their effective uptake.

C. Effect of tillage on B uptake by mustard

Increasing intensity of tillage from zero tillage to reduced tillage and conventional tillage correspondingly enhanced B uptake by mustard during both the years (Table 1). Increase in sulphur level from 0 to 40 kg ha^{-1} registered corresponding increase in B uptake at harvest stage during both the years. Application of 40 kg S ha^{-1} produced significantly highest B uptake (58.20 and 55.05 g ha^{-1}) over control plot and was at par with 20 kg S ha^{-1} during 2016-17 and 2017-18, respectively. Similarly, application of 2.0 kg B ha^{-1} produced significantly highest B uptake (60.21 and 56.23 g ha^{-1}) over control plot and 1.0 kg B ha^{-1} during 2016-17 and 2017-18, respectively.

D. Effect of S and B doses on B uptake by mustard

Boron uptake increased with increasing levels of S and B. A close examination of the data revealed marked effect of different doses of S and B on B uptake by mustard (Table 1). This might be attributed to greater availability of nutrients and efficient translocation of nutrients to the sink i.e., seed due to better soil properties.

Hence, under 40 kg S ha^{-1} and 1.0 kg B ha^{-1}, there was more healthy and vigorous plant growth as evident by taller plants, more number of branches and dry matter production. This accompanied with better nutrient content which resulted in significantly higher nutrient uptake by mustard with increasing levels of S and B up to 40 kg ha^{-1} and 2.0 kg ha^{-1}, respectively. Hossain *et al*. (2011) reported that nutrient uptake by six elements followed the order as K>N>S>P>B>Zn.

Jaiswal *et al*. (2015) reported that uptake of boron by mustard was increased significantly with increasing doses of boron and it was highest with application of 2.0 kg B ha^{-1}. Chakraborty and Das (2000) found that increase in B uptake by mustard was noted with combined application of S and B in silty loam soil. The release of nutrients in soil solution depends upon intensity capacity of soil to supply these nutrients. Levels of S and B enhanced supply of nutrients and increased B content for their effective uptake.

E. Effect of tillage, doses of S and B on available sulphur content in soil

Increasing intensity of tillage from zero tillage to conventional tillage significantly decreased the sulphur content in soil at harvest during both the years (Table 1). Available sulphur increased significantly with increasing S and B levels up to 40 and 2.0 kg ha^{-1}, respectively. Application of 40 kg S ha^{-1} produced significantly highest available S in soil (11.61 and 11.63 ppm) over control and 20 kg S ha^{-1} during 2016-17 and 2017-18, respectively. Similarly, application of 2.0 kg B ha^{-1} produced significantly highest available S content in soil (11.74 and 11.76 ppm) over control and 1.0 kg B ha^{-1} during 2016-17 and 2017-18, respectively. Different tillage practices exhibited significant improvement in available sulphur of soil. Highest available S content in soil were recorded with zero tillage but registered relatively more than initial value during both the years. Increase in intensity of tillage might enhance supply of nutrients and increased available S for their effective uptake. Available S in soil increased with increasing levels of sulphur and boron that might be due to enhanced nutrients availability in soil owing to increasing S levels. Increase in sulphur content assured the availability of these nutrients in adequate amount and remained in soil in substantial quantity after fulfilling the crop requirement that ultimately improved the soil fertility status (Yadav *et al*., 2010). The successive S fertilization might have improved the S content in soil over its original level. These results are in line with the findings of Singh *et al*. (2002). Yadav *et al*. (2010) reported that soil samples collected after harvest of mustard showed slight increase in available sulphur in soil by application of 40 kg S ha^{-1}.

F. Effect of tillage, doses of S and B on available boron content in soil

Zero tillage gave highest available B content in soil over reduced tillage and conventional tillage during 2016-17, however, difference in soil available B content owing to tillage practices was not significant (Table 1). Different tillage practices exhibited significant improvement in available boron of soil. Highest available B content in soil was recorded with zero tillage but registered relatively more than initial value during both the years. Increase in intensity of tillage might enhance supply of nutrients and increased available B for their effective uptake. Available boron in soil increased gradually with increasing S and B levels up to 40 and 2.0 kg ha^{-1}, respectively. Application of 40 kg S ha^{-1} produced significantly highest available B in soil (0.51 ppm and 0.55 ppm) over control and 20 kg S ha^{-1} during 2016-17 and 2017-18, respectively. Application of 2.0 kg B ha^{-1} produced significantly highest available B content in soil (0.53 and 0.57 ppm) over control and 1.0 kg B ha^{-1} during 2016-17 and 2017-18, respectively. Available B in soil increased with increasing levels of S and B up to 40 kg S ha^{-1} and 2.0 kg B ha^{-1} that might be due to enhanced nutrient availability in soil.

Increase in sulphur content assured the nutrient availability in adequate amount and remained in soil in substantial quantity that ultimately improved soil fertility (Yadav *et al.,* 2010). Goldberg *et al.* (2000) reported that availability of B to plant is affected by variety of soil factors *i.e.,* soil solution, pH, texture, moisture, temperature, oxide content, carbonate content and organic matter.

G. Interaction effect of S and B doses on S uptake by mustard

Only interaction between sulphur and boron (S×B) was significant for S uptake during both the years (Table 2 and Table 3). Treatment combination of S_3B_3 was found the best in terms of highest S uptake (25.41 and 22.91 kg ha^{-1}) during 2016-17 and 2017-18, respectively.

H. Interaction effect of S and B doses on available boron in soil

Interaction effect between sulphur and boron levels (S×B) was found significant for available boron during both the years (Table 4 and Table 5). Treatment combination of S_3B_3 was outstanding in recording highest available boron (0.591 and 0.632 ppm) during 2016-17 and 2017-18, respectively.

Table 2: Interaction effect of sulphur and boron on S uptake (kg ha^{-1}) by mustard (2016-17).

Boron Levels (kg ha^{-1}) / Sulphur Levels (kg ha^{-1})	B_1-0	B_2-1.0	B_3-2.0
S_1-0	8.13	12.72	13.04
S_2-20	15.40	18.93	19.41
S_3-40	16.21	22.06	25.41
SEm±	0.72		
CD (P=0.05)	2.05		

Table 3: Interaction effect of sulphur and boron on S uptake (kg ha^{-1}) by mustard (2017-18).

Boron Levels (kg ha^{-1}) / Sulphur Levels (kg ha^{-1})	B_1-0	B_2-1.0	B_3-2.0
S_1-0	6.99	11.50	11.56
S_2-20	13.74	17.11	17.32
S_3-40	14.79	20.28	22.91
SEm±	0.69		
CD (P=0.05)	1.97		

Table 4: Interaction effect of S and B on available B (ppm) of soil in mustard (2016-17).

Boron Levels (kg ha^{-1}) / Sulphur Levels (kg ha^{-1})	B_1-0	B_2-1.0	B_3-2.0
S_1-0	0.299	0.449	0.471
S_2-20	0.402	0.469	0.523
S_3-40	0.436	0.512	0.591
SEm±	0.015		
CD (P=0.05)	0.044		

Table 5: Interaction effect of S and B on available B (ppm) of soil in mustard (2017-18).

Boron Levels (kg ha^{-1}) / Sulphur Levels (kg ha^{-1})	B_1-0	B_2-1.0	B_3-2.0
S_1-0	0.354	0.489	0.511
S_2-20	0.442	0.511	0.567
S_3-40	0.476	0.552	0.632
SEm±	0.018		
CD (P=0.05)	0.050		

CONCLUSION

Thus, it might be concluded that application of 40 kg S ha^{-1}, 2.0 kg B ha^{-1} and conventional tillage in mustard recorded highest nutrients (S & B) uptake besides improvement in available nutrients (S & B) in soil under zero tillage at same nutrient levels prevalent into nutrient enrichment with tillage practices.

FUTURE SCOPE

Future research may be tested on S & B source, dose & time of application either soil or foliar form on yield of mustard varieties to get prominent results.

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Conflict of interest. None

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