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Nutrient Concentration, Dry Matter and Water Productivity of Mustard as Affected by Tillage and Nutrient Management

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ABSTRACT: The experiment was conducted during 2016–17 and 2017-18 at Bihar Agricultural College Farm, Sabour, Bihar, India to find out effect of tillage and nutrient management on nutrient concentration, dry matter and water productivity of mustard. It comprised of three tillage options *i.e.*, conventional, zero tillage and reduced tillage in main plot, three S doses (0, 20 and 40 kg ha^{-1}) in sub-plots and three B doses (0, 1.0 and 2.0 kg ha^{-1}) in sub sub-plots. Results indicated that conventional tillage exhibited significantly maximum water productivity. Significant enhancement was recorded with increase in S doses though variation between 20 and 40 kg S ha^{-1} was non-significant. It was recorded maximum at 1.0 kg B ha^{-1}; being at par with 2.0 kg B ha^{-1}. 40 kg S ha^{-1} registered highest dry matter except 30 DAS; however, it was noted highest with 40 kg S ha^{-1}. 2.0 kg B ha^{-1} recorded maximum dry matter plant^{-1}; being at par with 1.0 kg B ha^{-1}. T_1B_2 and T_1B_3 recorded highest S (1.11 %) in seed; being at par with T_3B_3. S_3B_3 recorded highest S (1.31 %) in seed; being at par with S_2B_3. T_1S_3 recorded highest S (0.31 %) in straw. T_1B_3 recorded highest (0.30 %) in straw; being at par with T_3B_3 and T_3B_2. S_3B_3 recorded significantly highest S (0.37 %) in straw. $T_1S_3B_3$ recorded highest B (18.13 ppm) in seed; being at par with $T_1S_2B_3$. $T_1S_3B_3$ recorded highest B (16.13 ppm) in straw; being at par with $T_1S_2B_3$, $T_1S_1B_3$ and $T_3S_2B_3$.

Keywords: Boron, Mustard, Nutrient concentration, Sulphur, Tillage, Water productivity.

INTRODUCTION

Oilseed crop especially mustard requires higher amount of nutrients including secondary and micronutrients per unit crop production. High input of N fertilizer induces more intensive S shortage. Sulphur had significant variation in growth of mustard. Application of 45 kg S ha^{-1} produced higher dry matter plant^{-1} over control. Maximum dry matter accumulation plant^{-1} was recorded in conventional tillage and was superior over zero tillage but was at par with reduced tillage, due to root proliferation which favored availability of moisture and nutrients resulted in better growth (Sah *et al.*, 2013). Similar findings were reported by Bhattacharyya *et al*. (2013); Dash and Ghosh (2012).

Tillage plays vital role in soil moisture conservation at different depths in rainfed mustard. It improves soil condition by altering mechanical impedance to root penetration, hydraulic conductivity and water holding capacity. Seed yield in reduced tillage was similar to zero tillage, but significantly higher than conventional tillage due to higher dry matter accumulation (Shekhawat *et al.*, 2016). These findings are in agreement with the results of Houx *et al.* (2014); Singh *et al.* (2017). Zero tillage had favorable effect on mustard as it conserved more moisture in soil profile during early growth. Mustard under RDF + crop residues (4 tonnes ha^{-1}) recorded significantly higher water use efficiency (21.63 kg ha^{-1} mm^{-1}), followed by RDF + crop residues (2 tonnes ha^{-1}) + VAM (Jakhar *et al*., 2018). These findings are in agreement with Parihar *et al.* (2017); Saha *et al*. (2015).

S levels significantly influenced the dry matter of mustard. 60 kg S ha^{-1} produced more dry matter at 90 DAS. Maximum S content was recorded significantly with 90 kg S ha^{-1} (Pachauri *et al*., 2012). These findings corroborated with the results of Kurothe *et al.* (2014); Jaiswal *et al.* (2015) ; Kumar *et al.* (2021). 60 kg S ha^{-1} had significant effect on growth of mustard. Dry matter production increased with age of plant and increase was accelerated between 45 and 90 DAS (Ray *et al.*, 2014). These results are in agreement with those of Yadav *et al.* (2016); Kumari *et al.* (2012).

Application of 60 kg S ha^{-1} improved S content in seed and stover. Application of 40 kg S ha^{-1} recorded 13.6 and 38.2% higher S content over 20 kg S ha^{-1} and no S, respectively (Ram *et al.*, 2014). These findings corroborated with the results of Shilpi *et al.* (2022); Chowhan *et al.* (2022). Kumar and Trivedi (2012) reported that S at 20, 40 and 60 kg ha^{-1} led to increase in S content over control, respectively. Similar findings were also reported by Kuotsu *et al.* (2014) ; Singh *et al*. (2017).

Deficiency of B causes restriction of water absorption and carbohydrate metabolism which ultimately affects pod and seed formation and thus reduces yield. Toxicity or deficiency of B affects the viable pollen grain production in flower, ultimately the yield. Choudhary and Bhogal (2013) noticed that dry matter yield of mustard increased significantly with increasing levels of B upto 20 kg borax ha^{-1} over control. Similar findings were reported by Parihar *et al*. (2016); Kour *et al.* (2014).

Information regarding dose of sulphur and boron fertilizer as well as tillage practices for mustard is scanty, therefore, this investigation was carried out to find out the effect of S and B on nutrient concentration, dry matter and water productivity of mustard under different tillage practices.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* (November 2016-March 2017) and (November 2017-March 2018) at research farm of Bihar Agricultural College, Sabour, Bhagalpur at latitude of 25°15' 40" N and longitude 87°2' 42" E with an altitude of 37.46 meters above mean sea level to assess the impact of tillage and nutrient management on nutrient concentration, dry matter and water productivity of mustard. The experiment was sandy loam, low in available N (230.35 kg ha^{-1}) by Subbiah and Asija (1956) and phosphorus (23.9 kg ha^{-1}) by Olsen *et al.* (1954); medium in available potassium (143.4 kg ha^{-1}) by Jackson (1973), S (13.26 ppm) by Chesnin and Yien (1951); low in B (0.44 ppm) by John *et al*. (1975). This consisted of 3 tillage practices *viz.*, conventional tillage, zero tillage and reduced tillage in main plot, 3 doses of S *i.e.* 0, 20, 40 kg ha^{-1} in sub-plots and 3 doses of B *i.e*. 0, 1.0, 2.0 kg ha^{-1} in sub sub-plots laid out in split split plot design replicated thrice.

Conventional tillage was performed by one deep ploughing with cultivator, two harrowing and planking. In reduced and zero tillage, seeds were sown in rows with the help of *Kudal*. 40:20: 20 kg NPK ha^{-1} was uniformly applied as per recommendation. Full dose of N, P and K was applied as basal. Sulphur and boron were applied as per treatment as basal.

Data on growth (dry matter accumulation $plant^{-1}$), nutrient (S&B) content in seed and stover, water productivity in mustard were recorded, statistically analyzed separately to interpret the results. Mean data for each parameter was presented for comparison of 'F' value and for determination of CD at 5 % level of significance. Data of two years 2016-2017 and 2017-2018 were pooled and analyzed.

RESULTS AND DISCUSSION

A. Dry matter accumulation $plant^{-1}$

Dry matter accumulation $plant^{-1}$ increased with advancement in crop age. Tillage practices influenced dry matter accumulation $plant^{-1}$ significantly at 90 DAS. Highest dry matter accumulation was recorded with conventional tillage which was significantly higher than zero tillage. Difference between zero and reduced tillage was found significant (Table 1). Conventional tillage though creating better growth conditions might have enhanced tissue differentiation, expansion and growth that resulted in turn increasing the dry matter accumulation. These results are in conformity with the findings of Saha *et al*. (2015); Das and Ghosh (2012).

Table 1: Effect of tillage, sulphur and boron on dry matter accumulation $plant^{-1}$ (g) of mustard (Pooled mean over two years)

Treatments	Dry matter accumulation $plant^{-1}$ (g)			
	30 DAS	60 DAS	90 DAS	At harvest
Tillage practices				
T_1-Conventional tillage	11.10	29.12	61.14	79.25
T_2- Zero Tillage	11.19	29.49	57.69	76.31
T_3- Reduced Tillage	11.13	29.36	60.73	78.69
SEm±	0.18	0.31	0.51	0.95
CD (p=0.05)	NS	NS	1.66	NS
Sulphur Levels (kg ha^{-1})				
S_1-0	10.94	28.40	54.62	75.30
S_2-20	11.15	29.45	59.95	77.89
S_3-40	11.33	30.12	64.99	81.07
SEm±	0.17	0.37	1.74	1.06
CD (P = 0.05)	NS	1.08	5.09	3.11
Boron Levels (kg ha^{-1})				
B_1-0	10.60	28.85	57.43	76.34
B_2-1.0	11.52	29.94	62.01	78.89
B_3-2.0	11.30	29.19	60.12	79.03
SEm±	0.16	0.23	1.00	0.86
CD (P = 0.05)	0.45	0.65	2.82	2.41
Interaction				
T×S	NS	NS	NS	NS
T×B	NS	NS	NS	NS
S×B	NS	NS	NS	NS
T×S×B	NS	NS	S	S

Application of 40 kg S ha^{-1} yielded significantly highest dry matter accumulation plant^{-1} over control at all the stages except 30 DAS. At harvest, significantly highest dry matter (81.07 g) was recorded with 40 kg S ha^{-1} (Table 1). The results are in conformity to Houx *et al.* (2014); Singh *et al.* (2017); Jakhar *et al.* (2018). Increase in dry matter under higher S level was due to adequate use of S which was directly involved in better absorption of applied nutrients and cell division as well as expansion of deep green colour leaves due to higher chlorophyll synthesis resulted into increase in photosynthetic rate (Kumari *et al*., 2012).

Application of 1.0 kg B ha^{-1} accumulated significantly maximum dry matter accumulation plant^{-1} (11.52 and 29.94 g) at 30 and 60 DAS, respectively over control and was at par with 2.0 kg B ha^{-1} at 30, 90 DAS and harvest (Table 1). Maximum dry matter accumulation plant^{-1} was recorded with 1.0 kg B ha^{-1} followed by 2.0 kg B ha^{-1} and control (Ram *et al.*, 2014). This might be due to increased CO_2 assimilation and stomatal conductance, activities of ribulose-1, 5 bis phosphate carboxylase (Rubisco), NADP- glyceraldehyde-3-phosphate dehydrogenase (NADP-GAPDH) and stomatal fructose -1,6 bis phosphate were lower in B deficient leaves than in control (Kuotsu *et al*., 2014).

Treatment combination of $T_1S_3B_2$ was found the best in terms of highest dry matter accumulation plant^{-1} (72.07 g) at 90 DAS as depicted in Table 2. Treatment combination of $T_1S_3B_2$ was the best in terms of highest dry matter accumulation plant^{-1} (87.66 g) at harvest stage (Table 3).

B. Water productivity

Conventional tillage exhibited maximum water productivity (13.95 kg ha^{-1} mm^{-1}) which was significantly superior over rest of tillage practices (Table 4); it was largely due to higher seed yield due to ameliorative effect of vigorous root proliferation and soil pulverization by conventional tillage, which improved soil aeration that is utilized by crop led to enhanced nutrient uptake and moisture from soil. There was significant enhancement in water productivity due to increasing S dose from 0 to 40 kg ha^{-1} though variation between 20 & 40 kg S ha^{-1} was non-significant.

Application of 40 kg S ha^{-1} exhibited maximum water productivity (13.75 kg ha^{-1} mm^{-1}). This was mainly due to better seed yield of mustard on account of higher S consumption which is responsible for increased leaf area and chlorophyll content causing higher photosynthesis and assimilation, metabolic activities which were responsible for overall improvement in vigour, yield attributes and finally seed yield. Seasonal consumptive water use by mustard and water use efficiency increased progressively up to 40 kg S ha^{-1}.

Water productivity was significantly enhanced up to 1.0 kg B ha^{-1} and recorded 13.57 kg ha^{-1}-mm^{-1}; being at par with 2.0 kg B ha^{-1}. This was mainly attributed due to better seed yield owing to higher B consumption which has vital role in cell differentiation, photosynthates translocation and growth regulators from source to sink and growth of pollen grains, thereby marked increase in seed yield (Jaiswal *et al*., 2015).

Table 2: Interaction effect of tillage, sulphur and boron on dry matter accumulation plant^{-1} (g) at 90 days after sowing of mustard (Pooled mean over two years)

Tillage practices	T_1-CT			T_2-ZT			T_3-RT		
B levels (kg ha^{-1}) \ S levels (kg ha^{-1})	S_1-0	S_2-20	S_3-40	S_1-0	S_2-20	S_3-40	S_1-0	S_2-20	S_3-40
B_1-0	47.60	62.95	69.58	49.95	49.65	65.29	56.28	57.95	57.63
B_2-1.0	57.36	57.74	72.07	59.34	59.72	59.41	58.07	67.01	67.36
B_3-2.0	60.27	60.91	61.80	55.40	58.89	61.57	47.30	64.74	70.22
SEm±	3.00								
CD (P=0.05)	8.46								

Table 3: Effect of tillage, sulphur and boron on dry matter accumulation plant^{-1} (g) at harvest (Pooled mean over two years)

Tillage practices	T_1-CT			T_2-ZT			T_3-RT		
B levels (kg ha^{-1}) \ S levels (kg ha^{-1})	S_1-0	S_2-20	S_3-40	S_1-0	S_2-20	S_3-40	S_1-0	S_2-20	S_3-40
B_1-0	70.04	82.34	83.87	72.33	69.20	82.34	74.87	76.83	75.20
B_2-1.0	76.92	75.38	87.66	76.95	75.90	75.39	78.50	81.60	81.74
B_3-2.0	79.18	78.39	79.51	77.63	78.34	78.72	71.34	82.98	85.18
SEm±	2.57								
CD (P=0.05)	7.24								

Table 4: Effect of tillage, sulphur and boron on water productivity of mustard (Pooled mean over two years)

Treatments	Water productivity (kg ha^{-1} mm^{-1})
Tillage practices	
T_1-Conventional tillage	13.95
T_2- Zero Tillage	11.22
T_3- Reduced Tillage	12.95
SEm±	0.17
CD (P = 0.05)	0.57
Sulphur Levels (kg ha^{-1})	
S_1-0	11.13
S_2-20	13.24
S_3-40	13.75
SEm±	0.48
CD (P = 0.05)	1.41
Boron Levels (kg ha^{-1})	
B_1-0	11.38
B_2-1.0	13.57
B_3-2.0	13.17
SEm±	0.24
CD (P = 0.05)	0.68
Interaction	
T×S	NS
T×B	NS
S×B	NS
T×S×B	NS

Table 5: Effect of tillage, sulphur and boron on S and B content and uptake of mustard (Pooled mean over two years)

Treatments	S (%) in seed	S (%) in stover	S uptake (kg ha^{-1})	B (ppm) in seed	B (ppm) in stover	B uptake (g ha^{-1})
Tillage practices						
T_1-Conventional tillage	1.08	0.26	18.31	16.53	14.53	56.00
T_2- Zero Tillage	0.99	0.19	13.36	15.29	13.25	45.07
T_3- Reduced Tillage	1.00	0.25	16.24	15.63	13.64	50.63
SEm±	0.01	0.01	0.24	0.14	0.13	0.75
CD (P = 0.05)	0.05	0.02	0.77	0.45	0.42	2.46
Sulphur Levels (kg ha^{-1})						
S_1-0	0.80	0.19	10.66	15.32	13.32	41.07
S_2-20	1.05	0.23	16.99	15.98	13.94	54.00
S_3-40	1.21	0.28	20.28	16.15	14.15	56.62
SEm±	0.06	0.01	1.49	0.16	0.16	2.59
CD (P = 0.05)	0.18	0.04	4.35	0.48	0.46	7.55
Boron Levels (kg ha^{-1})						
B_1-0	0.93	0.20	12.54	14.37	12.34	39.24
B_2-1.0	1.05	0.23	17.10	15.87	13.88	54.23
B_3-2.0	1.08	0.27	18.28	17.20	15.21	58.22
SEm±	0.01	0.01	0.29	0.06	0.08	0.70
CD (P = 0.05)	0.03	0.02	0.81	0.18	0.21	1.97
Interaction						
T×S	NS	S	NS	NS	NS	S
T×B	S	S	S	NS	NS	NS
S×B	S	S	S	NS	NS	S
T×S×B	NS	NS	NS	S	S	S

C. S content in seed

Conventional tillage gave significantly higher S content in seed over reduced tillage and zero tillage. However, the difference between reduced tillage and zero tillage was at par (Table 5). Application of 40 kg S ha^{-1} produced significantly highest S content (1.21 %) in seed of mustard over control. Application of 2.0 kg B ha^{-1} produced significantly highest S content (1.08 %) in seed over control and was at par with 1.0 kg B ha^{-1}.

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 more number of branches and dry matter production. This accompanied with better nutrient content with increasing levels of S and B up to 40 kg ha^{-1} and 2.0 kg ha^{-1}, respectively.

D. S content in stover

Conventional tillage gave significantly higher S content in stover over reduced tillage and zero tillage. However, the difference between reduced tillage and conventional tillage was at par (Table 5). Application of 40 kg S ha^{-1} produced significantly highest S content (0.28 %) in stover of mustard over control. Application of 2.0 kg B ha^{-1} produced significantly highest S content (0.27 %) in stover over control.

Sulphur and boron in seed and stover increased with increasing intensity of tillage operations up to conventional tillage. The data revealed that there was marked effect of different tillage practices on S and B content in seed and stover. All the tillage practices differed significantly in nutrient content in seed and stover. This might be attributed to greater availability of nutrients at higher tillage intensity. Pachauri *et al*. (2012) observed higher S content was enhanced with S application.

Higher S and B concentration were recorded in seed than straw suggesting efficient nutrients translocation to the sink *i.e.* seed. Under conventional tillage, there was more healthy plant growth as evident by more number of branches and dry matter production. This accompanied with better nutrient content with increasing tillage intensity up to conventional tillage. These results are in conformity with the findings of Jakhar *et al*. (2018); Chowhan *et al.* (2022).

E. S uptake by mustard

Increasing the intensity of tillage from zero tillage to reduced tillage and conventional tillage correspondingly increased S uptake by mustard (Table 5). This might be attributed due to greater availability of S at higher tillage intensity due to better soil physico-chemical and biological properties. There was more healthy and vigorous plant growth as evident by more branches and dry matter production in conventional tillage. These results are in conformity with the findings of Lavado *et al*. (2001) and Pal and Phogat (2005). S uptake was positively influenced by tillage. Release of nutrients in soil solution depends upon intensity capacity of soil to supply these nutrients. Tillage enhanced supply of S for their effective uptake.

Increase in S level from 0 to 40 kg ha^{-1} registered corresponding increase in S uptake at harvest. Application of 40 kg S ha^{-1} produced significantly highest S uptake (20.28 kg ha^{-1}) over control. Similarly, application of 2.0 kg B ha^{-1} produced significantly highest S uptake (18.28 kg ha^{-1}) over control and 20 kg S ha^{-1}. S uptake increased with increasing levels of S and B. This might be attributed to greater nutrients availability 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 more branches and dry matter production. This accompanied with better nutrient content which resulted into higher nutrient uptake by mustard with increasing S and B level up to 40 kg ha^{-1} and 2.0 kg ha^{-1}, respectively. Raut *et al*. (2000) found that S uptake increased significantly with each successive increase in S level. These results are in conformity with the findings of Kumar and Yadav (2007); Pachauri *et al*. (2012).

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.

F. B content in seed

Conventional tillage gave significantly highest B content in seed over reduced tillage and zero tillage, however, difference between reduced tillage and zero tillage was found at par (Table 5). Application of 40 kg S ha^{-1} produced significantly highest B content in seed (16.15 ppm) over control and was at par with 20 kg S ha^{-1}. Application of 2.0 kg B ha^{-1} produced significantly highest B content in seed (17.20 ppm). Sulphur and boron in seed and stover increased with increasing S and B levels. This might be attributed to greater nutrient availability in soil. Higher concentration of S & B was recorded in seed than straw suggesting efficient translocation of nutrients to the sink *i.e.* seed.

G. B content in stover

Conventional tillage gave significantly highest B content in stover over reduced tillage and zero tillage, however, difference between reduced and zero tillage was at par (Table 5). Application of 40 kg S ha^{-1} produced significantly highest B content (14.15 ppm) in stover over control and was at par with 20 kg S ha^{-1}. Application of 2.0 kg B ha^{-1} produced significantly highest B content (15.21 ppm) in stover. Treatment combination of $T_1S_3B_3$ was found the best in terms of highest B content in straw (16.13 ppm) at harvest stage which was found at par with $T_1S_2B_3$, $T_1S_1B_3$ and $T_3S_2B_3$ (Table 6). Shilpi *et al.* (2012) observed that sulphur content in seed and straw increased significantly with each successive increase in S levels. These results are reported by Choudhary and Bhogal (2013).

Table 6: Effect of tillage, sulphur and boron on boron content (ppm) in straw of mustard (Pooled mean over two years).

Tillage practices	T_1-CT			T_2-ZT			T_3-RT		
S levels (kg ha^{-1}) / B levels (kg ha^{-1})	S_1-0	S_2-20	S_3-40	S_1-0	S_2-20	S_3-40	S_1-0	S_2-20	S_3-40
B_1-0	12.40	12.92	13.71	11.50	11.92	12.17	11.34	12.58	12.47
B_2-1.0	14.52	15.01	14.82	12.54	13.32	13.63	13.06	14.19	13.81
B_3-2.0	15.55	15.70	16.13	14.55	14.34	15.31	14.45	15.51	15.32
SEm±	0.23								
CD (P=0.05)	0.64								

H. B uptake by mustard

Increasing intensity of tillage from zero tillage to reduced tillage and conventional tillage correspondingly enhanced B uptake by mustard (Table 5). Increase in S level from 0 to 40 kg ha^{-1} registered corresponding increase in B uptake at harvest. Application of 40 kg S ha^{-1} produced significantly highest B uptake (56.62 g ha^{-1}) over control and was at par with 20 kg S ha^{-1}. Application of 2.0 kg B ha^{-1} produced significantly highest B uptake (58.22 g ha^{-1}) over control and 1.0 kg B ha^{-1}. This might be attributed to greater nutrient availability and efficient translocation of nutrients to 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 more 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 followed the order as K>N>S>P>B>Zn. Jaiswal *et al*. (2015) reported that B uptake by mustard was increased significantly with increasing B dose and was highest with 2.0 kg B ha^{-1}. Chakraborty and Das (2000) found that increase in B uptake by mustard was noted with combined use of S and B in silty loam soil. Release of nutrients in soil solution depends upon intensity capacity of soil to supply nutrients. S and B levels enhanced nutrients supply and increased B content for effective uptake.

I. Nutrient use efficiency (Agronomic/agro-physiological S/B use efficiency or apparent recovery efficiency of S/B)

Sulphur & boron nutrient use efficiency (agronomic/agro-physiological use efficiency & apparent recovery efficiency) correspondingly decreased with increasing dose of sulphur and boron (Table 7). This might be attributed due to enhanced seed yield with increasing dose of S and B. These results are in conformity with the findings of Kumar and Trivedi (2012); Kour *et al.* (2014); Tedon *et al.* (2014).

Table 7: Effect of tillage, sulphur and boron on nutrient use efficiency, agronomic use efficiency, agro-physiological use efficiency and apparent recovery efficiency of mustard (Pooled mean over two years).

Treatments	Nutrient use efficiency (kg kg^{-1})	Agronomic use efficiency (kg kg^{-1})	Agro-physiological use efficiency (kg kg^{-1})/(kg g^{-1})	Apparent recovery efficiency (%)
Tillage practices				
T_1-Conventional Tillage	-	-	-	-
T_2- Zero Tillage	-	-	-	-
T_3- Reduced Tillage	-	-	-	-
Sulphur Levels (kg ha^{-1})				
S_1-0	-	-	-	-
S_2-20	49.90	8.65	27.38	31.63
S_3-40	25.62	5.0	20.83	24.04
Boron Levels (kg ha^{-1})				
B_1-0	-	-	-	-
B_2-1.0	1017	178	11.88	1.50
B_3-2.0	496	76.5	8.06	0.95

CONCLUSIONS

Thus, it might be concluded that use of 20 kg S ha^{-1} and 1.0 kg B ha^{-1} under conventional tillage resulted into higher water productivity and dry matter accumulation in mustard besides improvement in S and B uptake irrespective of nutrient supplied with tillage practices.

FUTURE SCOPE

Future research options must be focused on response of zero tilled mustard to improved varieties and micronutrient mixture for getting balanced nutrition with yield advantage.

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Conflict of Interests. None.

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