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Fertility of Soil and NPK Uptake as Affected by Tillage and Nutrient Management in Mustard

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ABSTRACT

A field experiment was conducted in *rabi* season 2016-17 and 2017-18 at research farm of Bihar Agricultural College, Sabour, Bhagalpur to assess the impact of tillage and nutrient management on soil physico-chemical properties and N, P and K uptake by 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 plots was laid out in split plot design with three replications. Results revealed that conventional tillage enhanced N uptake by mustard. 40 kg S ha^{-1} produced highest N uptake over control and was at par with 20 kg S ha^{-1}. 2.0 kg B ha^{-1} produced highest N uptake over control and was at par with 1.0 kg B ha^{-1}. Conventional tillage gave highest P and K uptake over reduced tillage and zero tillage. Difference between conventional and reduced tillage was at par. 40 kg S ha^{-1} produced highest P uptake over control and 20 kg S ha^{-1}. 40 kg S ha^{-1} produced highest K uptake over control. In first year only, 40 kg S ha^{-1} was at par with 20 kg S ha^{-1}. 2.0 kg B ha^{-1} produced highest P uptake over control. In second year, 2.0 kg B ha^{-1} was at par with 1.0 kg B ha^{-1}. 2.0 kg B ha^{-1} produced highest K uptake over control and was at par with 1.0 kg B ha^{-1}. Soil pH, EC and organic carbon did not vary significantly due to tillage, S and B doses. Tillage caused significant improvement in soil available N, P_2O_5 and K_2O indicating higher with zero tillage. Their respective content was found towards increasing trend up to 40 kg S ha^{-1} and 2.0 kg B ha^{-1} and noted remarkable improvement over initial.

Keywords Boron, Mustard, Soil fertility, Sulfur, Tillage.

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INTRODUCTION

Indian mustard is second most important edible oilseed crop after groundnut, accounts for nearly 27 % of total oilseed production of India sharing 27.8 % towards oilseed economy. Rapeseed-mustard oil is considered an important constituent of Indian diet and its oil is used as main cooking medium especially in northern India. Parihar *et al.* (2017) opined that

Table 1. Effect of tillage, sulfur and boron on N, P and K uptake by mustard.

Treatments	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Tillage practices						
T_1- Conventional tillage	51.68	47.27	19.08	18.27	73.90	56.00
T_2- Zero tillage	40.95	36.59	14.84	13.95	61.34	45.36
T_3- Reduced tillage	46.22	42.61	17.37	16.71	67.84	51.64
SEm±	0.63	0.80	0.52	0.58	1.65	1.46
CD (P = 0.05)	2.47	3.13	2.06	2.27	6.49	5.74
Sulfur levels (kg ha^{-1})						
S_1-0	37.79	33.79	13.11	12.30	54.17	39.55
S_2-20	49.20	44.73	18.19	17.43	72.00	54.76
S_3-40	51.84	47.96	20.00	19.20	76.91	58.70
SEm±	1.24	1.27	0.45	0.52	1.62	1.19
CD (P = 0.05)	3.81	3.92	1.40	1.60	4.99	3.65
Boron levels (kg ha^{-1})						
B_1-0	37.49	34.02	12.99	12.46	55.19	41.15
B_2-1.0	49.95	45.62	18.56	17.85	73.16	55.54
B_3-2.0	51.39	46.83	19.75	18.62	74.74	56.32
SEm±	1.09	0.91	0.41	0.36	1.50	1.03
CD (P= 0.05)	3.13	2.60	1.16	1.04	4.30	2.96
Interaction						
T×S	NS	NS	NS	NS	NS	NS
T×B	NS	NS	NS	NS	NS	NS
S×B	NS	NS	NS	NS	NS	NS
T×S×B	NS	NS	NS	NS	NS	NS

zero tillage improved the soil organic carbon. Bhattacharya *et al*. (2010) noted that conservation tillage improved soil organic carbon. Chauhan *et al.* (2012) noticed that organic carbon content was higher near soil surface under zero tillage than conventional tillage. Gangwar *et al.* (2009) and Kushwaha *et al.*

Table 2. Effect of tillage, S and B on soil pH, EC and organic carbon at harvest.

Treatments	pH		EC (dS m^{-1})		Organic carbon (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Tillage practices						
T_1-Conventional tillage	7.79	7.79	0.12	0.13	0.44	0.43
T_2- Zero tillage	7.79	7.78	0.13	0.14	0.43	0.42
T_3- Reduced tillage	7.80	7.79	0.12	0.13	0.43	0.43
SEm±	0.013	0.013	0.002	0.003	0.013	0.012
CD (P = 0.05)	NS	NS	NS	NS	NS	NS
Sulfur Levels (kg ha^{-1})						
S_1-0	7.79	7.79	0.13	0.13	0.42	0.41
S_2-20	7.80	7.80	0.12	0.14	0.44	0.43
S_3-40	7.79	7.77	0.13	0.13	0.45	0.43
SEm±	0.012	0.013	0.003	0.005	0.013	0.013
CD (P= 0.05)	NS	NS	NS	NS	NS	NS
Boron levels (kg ha^{-1})						
B_1-0	7.79	7.79	0.13	0.14	0.43	0.43
B_2-1.0	7.79	7.77	0.12	0.13	0.44	0.44
B_3-2.0	7.80	7.80	0.12	0.14	0.43	0.41
SEm±	0.010	0.010	0.002	0.004	0.010	0.014
CD (P = 0.05)	NS	NS	NS	NS	NS	NS
Initial	7.82	7.83	0.117	0.126	0.47	0.46

Table 2. Continued.

Treatments	pH		EC (dS m^{-1})		Organic carbon (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Interaction						
T×S	NS	NS	NS	NS	NS	NS
T×B	NS	NS	NS	NS	NS	NS
S×B	NS	NS	NS	NS	NS	NS
T×S×B	NS	NS	NS	NS	NS	NS

(2010) noted that soil organic carbon content was higher under zero tillage as compared with conventional tillage.

Nadian *et al.* (2010) opined that addition of S to calcareous soil may result in a decline in soil pH. Yadav *et al.* (2010) reported that the soil samples collected after harvest of mustard showed slight decline in pH and EC and increase in organic carbon, available N, P_2O_5 and K_2O by application of sulfur @ 40 kg ha^{-1}. Ram *et al*. (2014) observed that pH, EC and organic carbon of soil did not vary significantly with application of S and B. Sharma *et al.* (2016) reported that application of B could not significantly influence available N, P and K status of soil at harvest. Hossain *et al.* (2011) noted that grain B concentration increased from 19.96 µg g^{-1} in control to 45.99 and 51.29 µg g^{-1} under 1.0 kg and 2.0 kg B ha^{-1}, respectively. Concerning the effect of B on nutrient uptake, six elements followed the order K> N> S> P> B> Zn. Keeping these issues in view, the present investigation was undertaken to find out the effect of tillage and nutrient management on soil physico-chemical properties and N, P and K uptake by mustard.

Table 3. Effect of tillage, sulfur and boron on available N, P_2O_5 and K_2O in soil at harvest.

Treatments	Available N (kg ha^{-1})		Available P_2O_5 (kg ha^{-1})		Available K_2O (kg ha^{-1})	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Tillage practices						
T_1- Conventional tillage	220.84	223.82	24.51	27.23	159.28	164.02
T_2- Zero tillage	232.46	236.81	25.90	29.07	163.53	167.12
T_3- Reduced tillage	224.59	227.61	24.33	26.76	163.11	166.47
SEm±	1.27	1.92	0.27	0.44	1.66	1.77
CD (P = 0.05)	4.99	7.58	1.07	1.74	6.55	6.95
Sulfur Levels (kg ha^{-1})						
S_1-0	217.88	221.94	21.96	24.57	158.69	162.87
S_2-20	228.35	231.88	25.12	28.63	161.83	165.68
S_3-40	231.66	234.42	27.65	29.86	165.40	169.06
SEm±	2.48	2.22	0.50	0.60	1.33	1.20
CD (P= 0.05)	7.66	6.85	1.56	1.85	4.10	3.70
Boron levels (kg ha^{-1})						
B_1-0	214.06	218.77	19.61	21.49	156.62	160.13
B_2-1.0	227.39	230.24	25.40	28.42	162.41	166.59
B_3-2.0	236.44	239.23	29.72	33.15	166.89	170.89
SEm±	1.98	1.90	0.49	0.74	0.51	0.61
CD (P= 0.05)	5.68	5.47	1.42	2.11	1.47	1.75
Initial	220.35	219.96	23.9	23.8	158.4	161.7
Interaction						
T×S	NS	NS	S	S	NS	NS
T×B	NS	NS	NS	NS	NS	NS
S×B	S	S	NS	NS	NS	NS
T×S×B	NS	NS	NS	NS	NS	NS

Table 4. Interaction effect of S and B on available N (kg ha^{-1}) in soil at harvest (2016-17).

Sulfur levels	Boron levels (kg ha^{-1}) B_1-0	B_2-1.0	B_3-2.0
S_1-0	205.40	212.51	235.73
S_2-20	217.73	226.47	240.84
S_3-40	219.04	243.20	232.73
SEm±		3.42	
CD (P = 0.05)		9.84	

Table 5. Interaction effect of S and B on available N (kg ha^{-1}) in soil at harvest (2017-18).

Sulfur levels	Boron levels (kg ha^{-1}) B_1-0	B_2-1.0	B_3-2.0
S_1-0	212.67	214.47	238.68
S_2-20	220.66	230.09	244.89
S_3-40	222.99	246.15	234.12
SEm±		3.30	
CD (P = 0.05)		9.47	

MATERIALS AND METHODS

A field experiment was conducted during rabi season 2016-17 and 2017-18 to find out the effect of tillage and nutrient management on soil physico-chemical properties and N, P and K 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 sulfur 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 plots laid out in split plot design having three replications. Conventional tillage was done through one ploughing 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. Sulfur and boron were applied at sowing time as per treatment wise schedule.

The data on nutrient uptake (N, P and K) and available nutrients (N, P_2O_5 and K_2O) 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' value and for determination of critical difference at 5% level of significance.

RESULTS AND DISCUSSION

N uptake by mustard

Increasing intensity of tillage from zero tillage to conventional tillage correspondingly enhanced the N uptake by mustard (Table 1). Increase in S levels from 0 to 40 kg ha^{-1} registered corresponding increase in N uptake at harvest stage. Application of 40 kg S ha^{-1} produced significantly highest N uptake (51.84 and 47.96 kg ha^{-1}) over control and was at par with 20 kg S ha^{-1} during 2016-17 and 2017-18, respectively. Application of 2.0 kg B ha^{-1} produced significantly highest N uptake (51.39 and 46.83 kg ha^{-1}) over control and was at par with 1.0 kg B ha^{-1} during 2016-17 and 2017-18, respectively.

P uptake by mustard

Conventional tillage gave significantly highest P uptake by mustard over reduced tillage and zero tillage, however, difference between conventional tillage and reduced tillage was statistically at par (Table 1). Increase in S level from 0 to 40 kg ha^{-1} registered corresponding increase in P uptake at harvest. Application of 40 kg S ha^{-1} produced significantly highest P uptake (20.00 and 19.20 kg ha^{-1}) 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 P uptake (19.75 kg ha^{-1} and 18.62 kg ha^{-1}) over control 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}.

K uptake by mustard

Conventional tillage gave significantly higher K uptake by mustard over reduced tillage and zero tillage, however, difference between conventional tillage and reduced tillage was statistically at par (Table 1). N, P and K uptake increased with increasing intensity of tillage up to conventional tillage. This might be attributed due to greater nutrients availability at higher

Table 6. Interaction effect of tillage and S on soil available P_2O_5 (kg ha^{-1}) at harvest (2016-17).

Tillage practices	Sulfur levels (kg ha^{-1}) S_1-0	S_2-20	S_3-40
T_1-Conventional tillage	22.62	21.47	29.43
T_2- Zero tillage	22.94	29.40	25.36
T_3- Reduced tillage	20.31	24.50	28.17
SEm±		0.87	
CD (P=0.05)		2.71	

Table 7. Interaction effect of tillage and S on soil available P_2O_5 (kg ha^{-1}) at harvest (2017-18).

Tillage practices	Sulfur levels (kg ha^{-1}) S_1-0	S_2-20	S_3-40
T_1-Conventional tillage	25.46	24.42	31.82
T_2- Zero tillage	25.78	33.90	27.53
T_3- Reduced tillage	22.49	27.56	30.24
SEm±		1.04	
CD (P=0.05)		3.20	

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 plant, more number of branches and dry matter. This accompanied with better nutrient content which resulted in significantly higher nutrient uptake by the crop. These results are in conformity with the findings of Pal and Phogat (2009).

Increase in S level from 0 to 40 kg ha^{-1} registered corresponding increase in K uptake at harvest. Application of 40 kg S ha^{-1} produced highest K uptake (76.91 and 58.70 kg ha^{-1}) over control during 2016-17 and 2017-18, respectively. In first year only, 40 kg S ha^{-1} was at par with 20 kg S ha^{-1}. Application of 2.0 kg B ha^{-1} produced significantly highest K uptake (74.74 and 56.32 kg ha^{-1}) over control and was at par with 1.0 kg B ha^{-1} during 2016-17 and 2017-18, respectively.

The data revealed marked effect of S and B doses on N, P and K uptake by crop that might be attributed due to greater nutrient availability due to better soil properties. Hence, under 40 kg S ha^{-1} and 1.0 kg B ha^{-1}, there was more healthy plant growth, more number of branches and dry matter. This accompanied with better nutrient content which resulted in higher nutrient uptake.

Soil pH, EC and organic carbon

Data on soil pH, EC and organic carbon at harvest was not significantly influenced by tillage, S and B doses (Table 2). Conventional tillage exhibited relatively more decrease in soil pH rather than reduced and zero tillage over initial that might be attributed due to increase in intensity of tillage. EC was highest with zero tillage over initial. Decrease in EC might be due to aeration of top soil layers allowed increased leaching to occur in surface soil.

Bhattacharya *et al.* (2010) noticed that conservation tillage improved soil organic carbon. Highest soil pH was recorded with 20 kg S ha^{-1} and 2.0 kg B ha^{-1} but highest soil organic carbon was observed with 40 kg S ha^{-1} and 1.0 kg B ha^{-1} during both the years.

Available N content in soil

Increasing the intensity of tillage from zero tillage to reduced tillage and conventional tillage significantly decreased soil available nitrogen during both the years (Table 3). Application of 40 kg S ha^{-1} produced significantly highest available nitrogen (231.66 and 234.42 kg ha^{-1}) over control and was at par with 20 kg S ha^{-1} during 2016-17 and 2017-18, respectively. Application of 2.0 kg B ha^{-1} produced significantly highest available nitrogen (236.44 and 239.23 kg ha^{-1}) over control and 1.0 kg B ha^{-1} during 2016-17 and 2017-18, respectively. Interaction between sulfur and boron (S×B) was found significant for soil available N (Tables 4, 5). Treatment combination B_2S_3 was the best in soil available N (243.20 and 246.15 kg ha^{-1}) during 2016-17 and 2017-18, respectively.

Available P_2O_5 content in soil

Zero tillage gave significantly highest soil available P_2O_5 over conventional tillage and reduced tillage during both the years (Table 3). Difference between

conventional and reduced tillage was statistically at par. Soil available P_2O_5 enhanced with increasing S dose up to 40 kg ha^{-1}. Application of 40 kg S ha^{-1} produced significantly highest available P_2O_5 (27.65 and 29.86 kg ha^{-1}) over control during 2016-17 and 2017-18, respectively. In second year, 40 kg S ha^{-1} was found at par with 20 kg S ha^{-1}. Application of 2.0 kg B ha^{-1} produced significantly highest available P_2O_5 (29.72 and 33.15 kg ha^{-1}) over control and 1.0 kg B ha^{-1} during 2016-17 and 2017-18, respectively.

Available K_2O content in soil

Increasing the intensity of tillage from zero tillage to reduced tillage and conventional tillage significantly decreased available K_2O in soil during both the years (Table 3). Soil available K_2O increased with increasing S levels up to 40 kg ha^{-1}. Application of 40 kg S ha^{-1} produced significantly highest available K_2O (165.40 and 169.06 kg ha^{-1}) over control during 2016-17 and 2017-18, respectively. 40 kg S ha^{-1} was found at par with 20 kg S ha^{-1} during both the years. Available K_2O in soil increased with increasing B level up to 2.0 kg ha^{-1}. Application of 2.0 kg B ha^{-1} produced significantly highest available K_2O (166.89 and 170.89 kg ha^{-1}) over control and 1.0 kg B ha^{-1} during 2016-17 and 2017-18, respectively.

Interaction between tillage and sulfur (T×S) was found significant for available P_2O_5 in soil (Table 6 and Table 7). Treatment combination T_1S_3 was the best in available P_2O_5 in soil (29.43 kg ha^{-1}) during 2016-17. However, it was noted maximum (33.90 kg ha^{-1}) under T_2S_2 during 2017-18.

Highest available N, P and K in soil were recorded with zero tillage but registered more than initial value during both the years. Increase in intensity of tillage might enhance available N, P and K in soil for their uptake. Available N, P and K in soil increased with increasing levels of S and B up to 40 kg ha^{-1} and 2.0 kg ha^{-1}, respectively that might be due to enhanced nutrients availability in soil. Increase in S and B content assured the availability of these nutrients in adequate amount and remained in soil in substantial quantity after fulfilling the crop requirement (Yadav *et al.* 2010). They also showed slight decrease in pH and EC of soil and increase in organic carbon, available N, P and K in soil by application of 40 kg S ha^{-1} and 2.0 kg B ha^{-1}. Nadian *et al.* (2010) reported that addition of S to calcareous soil might result in decline in soil pH.

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 available nutrients (N, P and K) in soil apart from improvement in nutrients (N, P and K) uptake by the crop.

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REFERENCES

Bhattacharya R, Kundu S, Pandey SC, Singh KP, Gupta HS (2010) Tillage and irrigation effects on crop yields and soil properties under the rice–wheat system in the Indian Himalayas. *Agril Water Manag* 95 (9) : 993—1002.

Chauhan DR, Ram M, Singh I (2012) Response of Indian mustard to irrigation and fertilization with various sources and levels of sulfur. *Ind J Agron* 47 (3) : 422—426.

Gangwar KS, Singh KK, Sharma SK, Tomar OK (2009) Alternative tillage and crop residue management in wheat after rice in sandy loam soil of Indo-Gangetic plains. *Soil Tillage Res* 88 (1) : 242—252.

Hossain MA, Jahiruddin M, Khatun F (2011) Effect of Boron on yield and mineral nutrition of mustard (*Brassica napus*). *Bangladesh J Agril Res* 36 (1) : 63—73.

Kushwaha CP, Tripathi SK, Singh KP (2010) Variation in soil microbial biomass and N availability due to residue and tillage management is a dry land rice agro ecosystem. *Soil Tillage Res* 56 (3) : 153—166.

Nadian H, Najarzadegan R, Saeid KA, Gharineh, MH, Siadat A (2010) Effects of boron and sulfur application on yield and yield components of *Brassica napus* L. in a calcareous soil. *World Appl Sci J* 11 (1) : 89—95.

Pal D, Phogat VK (2009) Effect of sulfur levels on growth, yield

and quality of Indian mustard genotypes and their economics. *J Soils Crops* 22 (2) : 258—263.

Parihar CM, Jat SL, Singh AK, Majumdar K, Jat ML, Saharawat YS, Kuri BR (2017) Bio-energy, water-use efficiency and economics of maize-wheat-mungbean system under precision-conservation agriculture in semiarid agro-ecosystem. *Energy* 119 : 245—256.

Ram B, Singh SK, Latare AM, Kumar O (2014) Effect of sulfur, zinc and boron application on growth and yield of hybrid rice. *J Ind Soc Soil Sci* 62 (2) : 184—188.

Sharma SK, Kapoor S, Rana SS (2016) Effect of the application of nitrogen, zinc and boron on soil properties and available nutrients status after the harvest of wheat. *Ind J Adv Agril Sci Tech* 3 (7) : 12—20.

Yadav HK, Thomas T, Khajuria V (2010) Effect of different levels of sulfur and biofertilizer on the yield of Indian mustard (*Brassica juncea* L.) and soil properties. *J Agril Physics* 10 : 61—65.