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SEED YIELD, NUTRIENT UPTAKE AND QUALITY OF MUSTARD (*BRASSICA JUNCEA* L.) UNDER DIFFERENT SULPHUR AND BORON LEVELS IN ESTERN UTTAR PRADESH CONDITION

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ABSTRACT

A field experiment was conducted to study the response of mustard (Brassica juncea L.) to different levels of sulphur and boron on yield and quality at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumargunj, Faizabad (U.P.) during rabi season of 2012-13 and 2013-14,. The experiment, comprising of sixteen treatment combinations, four levels of sulphur (0, 20, 40 and 60 kg ha^{-1}) and four levels of boron (0, 0.5, 1.0 and 1.5 kg ha^{-1}) was laid out in RBD with three replication. Results revealed that the application of sulphur and boron significantly increased the yield attributes, yield and quality of mustard. The maximum number of siliquae plant^{-1} (304.31), number of seeds siliqua^{-1} (14.17), test weight (4.82 g), seed yield (18.25 q ha^{-1}) and stover yield (51.65 q ha^{-1}) were recorded with 60 kg S ha^{-1} which was at par with 40 kg S ha^{-1}. The highest level of boron (1.5 kg boron ha^{-1}) also recorded maximum number of siliquae plant^{-1} (293.11), test weight (4.57 g), seed yield (18.34 q ha^{-1}) and stover yield (49.97 qha^{-1}) which was at par 1.0 kg boron ha^{-1}. The mustard variety NDR–8501 was taken as test crop.

INTRODUCTION

India is supporting 17% of the human and about 11% of livestock's population on just 2.4% land and 4.2% water resources of the world. Country needs to produce about 5-6 million tonnes additional food grains every year along with proportional increase in oilseeds, fibres, sugar, vegetables, fruits and livestock's products to meet the requirement of the burgeoning population. Oilseeds occupy a prestigious place in Indian agriculture due to their vital role in the sustainable economy of the country. Among the seven edible oilseeds viz groundnut, rapeseed and mustard, soybean, safflower, niger, sesamum and sunflower cultivated in India, rapeseed-mustard (*Brassica spp.*) contributes 28.6% in the total production of oilseeds. It is the second most important edible oilseed and sharing 27.8% in the India's oilseed economy. The share of oilseeds is 14.1% out of the total cropped area in the country, rapeseed-mustard accounts for 3% of it (Shekhawat *et.al.*, 2012). The seed yield and oil quality of mustard can be improved by proper application of essential nutrients like sulphur and boron. Sulphur is a master nutrient of oilseeds, it is considered as fourth major nutrient of plant (Nyborg and Bently, 1977; Brogan and Murphy, 1980). Sulphur involved in various metabolic processes of the plants. It is a constituent of the amino acids like - cysteine, cystine and methonine (Marschner, 1995). Deficiencies of amino acids cause serious malnutrition. It improves the quantity and quality of oilseeds. Similarly Boron also plays an important role in growth and development of mustard. Its deficiency or access affects the growth and yield of the crop. It plays an important role in cell differentiation and development, translocation of photosynthates and growth regulators from source to sink and growth of pollen grains thereby marked increase in seed yield of crops (Sakal et al., 1991). The quality of seeds is deteriorated with low B as it is reflected by increase in, starch, protein and oil content of mustard. However, studies investigating the impact of sulphur and boron fertilization on seed yield and quality of mustard remain scarce. Keeping in view of that facts present investigation was planned to study the effect of sulphur and boron on productivity and quality of mustard.

MATERIALS AND METHODS

The experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumargunj, Faizabad, U.P. (26.47^{0} N latitude, 82.12^{0} E longitude and altitude 113 m), India, during Rabi season of 2012–13 and 2013–14.

The soil of the experimental field was slightly alkaline reaction and silt loam, which was low in organic C (0.33%) and medium in available phosphorus (12.43 kg ha^{-1}) and potassium (221.15 kg ha^{-1}), but deficient for sulphur (2.02 kg ha^{-1}) and boron (0.30 ppm). The experiment was conducted in factorial randomized block design with three replications. The treatments consisted of 4 levels of sulphur (0, 20, 40 and 60 kg ha^{-1}) and 4 levels of boron (0, 0.5, 1.0 and 1.5 kg ha^{-1}). The crop was fertilized with recommended dose of NPK @ 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}. As per treatment full doses of sulphur and boron, half dose of nitrogen along with full doses of phosphorus and potassium were applied as basal. Remaining half dose of nitrogen was applied through top dressing after 27 days after sowing. The source of sulphur was elemental sulphur (85% S) and for boron it was borax (20% B). The average minimum temperature range was 2.9^{0}C - 21.8^{0}C and 5.9^{0}C -23.5^{0}C during 2012-13 and 2013-14, respectively. Similarly, the maximum temperature range was 14.8^{0}C to 33^{0}C and 15.5^{0}C to 31.8^{0}C during 2012-13 and 2013-14, respectively. The crop was received 85.80 and 111.8 mm rainfall during the cropping season of 2012-13 and 2013-14. Mustard variety NDR-8501 was sown in rows 45 cm apart on 01 and 03 November and harvested 16 and 20 March during 2012-13 and 2013-14 respectively. Pendimethalin (Stomp 30 EC) herbicide @ 3.3 litre ha^{-1} was applied using 500 liters water on the same day of sowing, followed by one manual weeding was done to control weeds. The thinning was carried out at 20 days after sowing to have optimum plant stand. The total siliquae separated from five randomly selected plants and averaged was reported as number of siliquae plant^{-1}. Five siliqua were selected for count number of seeds siliqua^{-1} and threshed it than healthy seeds were counted to represent as number of seeds siliqua^{-1}. Data on seed yield, stover yield and biological were collected at the time of harvest. The following formula was used to calculate yield response:

Yield response (%) = [(Treatment yield – Control yield)/Control yield] × 100

Sulphur was determined by Turbidimetric method as described by Chesnine and Yien (1951) and Boron by Azomethine–H method (Hot $CaCl_2$-extractable) as described by Shanina *et al*. (1967). Oil content in seed was estimated by Oxford analytical method new part 4000 NMR and protein content was obtained by multiplying N content with a constant factor of 6.25 (Jackson, 1973). The uptake of nutrients was determined by standard methods. The data were analysed by using standard procedures of ANOVA at 5% level of significance.

RESULTS AND DISCUSSION

Yield and yield attributes

Yield and yield contributing characters viz number of siliquae plant^{-1}, length of siliqua, number of seeds siliqua^{-1}, 1000 seed weight, seed yield, stover yield, and biological yield were significantly affected due to different levels of sulphur and boron. On the basis of 2 years mean, higher number of siliquae plant^{-1}, length of siliqua (cm), number of seeds siliqua^{-1}, 1000 seed weight, seed yield, stover yield, biological yield, were recorded under 60 kg sulphur and 1.5 kg boron ha^{-1} which was statistically at par with 40 kg sulphur and 1.0 kg boron ha^{-}

Table 1: Effect of sulphur and boron nutrition on growth, yield attributes, yield and harvest index of mustard (mean data of two years research)

Treatments	No. of siliquae plant^{-1}	Length of siliqua (cm)	No. of seeds siliqua^{-1}	1000 seed weight (g)	Seed yield (qha^{-1})	Stover yield(qha^{-1})	Biological yield (qha^{-1})	Harvest Index(%)
A.	Levels of sulphur							
S_0	222.25	5.85	11.78	3.89	13.82	37.28	51.10	27.05
S_{20}	265.59	6.43	12.95	4.39	16.33	45.08	61.41	26.59
S_{40}	291.44	6.87	13.67	4.60	18.19	49.57	67.75	26.85
S_{60}	304.31	6.93	14.17	4.82	18.25	51.65	69.90	26.11
CD at 5%	16.95	0.48	0.66	0.21	0.98	2.85	3.55	-
B.	Levels of boron							
B_0	239.35	6.16	12.42	4.20	13.52	40.37	53.88	25.10
$B_{0.5}$	264.18	6.50	13.10	4.39	16.87	44.32	61.18	27.57
$B_{1.0}$	286.94	6.68	13.46	4.55	17.86	48.93	66.79	26.73
$B_{1.5}$	293.11	6.75	13.61	4.57	18.34	49.97	68.30	26.85
CD at 5%	16.95	NS	NS	0.21	0.98	2.85	3.55	-

Table 2: Effect of sulphur and boron nutrition on S & B uptake, quality of mustard (mean data of two years research)

Treatments	Yield response (%)	Total S uptake(kg ha^{-1})	Total B uptake(g ha^{-1})	Oil content (%)	Protein content (%)
A.	Levels of sulphur				
S_0	-	21.72	10.53	38.89	19.81
S_{20}	18.16	31.85	12.69	41.74	20.78
S_{40}	31.62	37.32	14.32	41.90	21.42
S_{60}	37.01	39.26	14.98	42.41	21.80
CD at 5%	-	1.28	0.78	0.85	1.06
B.	Levels of boron				
B_0	-	25.84	8.66	39.56	19.66
$B_{0.5}$	24.78	31.98	12.75	41.02	21.10
$B_{1.0}$	32.10	35.55	14.71	41.94	21.44
$B_{1.5}$	35.65	36.78	16.40	42.41	21.62
CD at 5%	-	1.28	0.78	0.85	1.06
	-				

[1] and significantly higher than rest of the levels of sulphur and boron (Table 1). The higher value of yields and yield attributes might be due to favourable effects of growth under highest level of nutrients. Ferdousi *et al.* (2012) and Verma *et al.* (2012) also recorded similar types of results. Shekhawat *et al.* (2012) reported, that the seed yield of mustard increased significantly (16–47%) with the application of boron. Hussain *et al.* (2008) reported that the yield contributing characters of mustard increased significantly due to boron application. Hossain *et al.* (2011) reported that the B had positive role in protein synthesis. Rashid *et al.* (2012) reported that yield and yield contributing characters increased significantly with the increased rate of boron. Oil content (%) was significantly increased due to increment of boron levels upto 1.5 kg boron ha^{-1}.

Uptake of nutrients

The highest uptake was recorded under higher levels of sulphur and boron which was significantly higher than all other treatments (Table 2). This may be ascribed to better fertilization, resulting in better growth and higher grain and stover yields under these treatments greater absorption of nutrients from soil and resulted in higher S uptake. The minimum S uptake was recorded under control. Moreover, adequate availability of nutrients in these treatments helped in enhanced nutrient uptake. Verma *et al.* (2012) also reported highest S uptake with 60 kg S ha^{-1} in mustard.

The highest uptake of B might be due to vigorous root growth and increase in rate of water absorption. Devi, *et al.* (2012) and Choudhary and Bhogal (2013) reported similar results.

Quality

The quality of mustard (protein and oil content) was significantly influenced by sulphur and boron treatments (Table 2). The protein and oil content were higher under 60 kg sulphur ha^{-1} treatments than control. The highest protein and oil content recorded under 60 kg sulphur ha^{-1} but significantly higher than control and 20 kg sulphur ha^{-1} and statistically at par with 40 kg sulphur ha^{-1}. This was probably due to the fact that sulphur is a essential constituent of amino acids like–cysteine, cystine and methonine and essential for synthesis of lipids, which helps in conversion of these amino acids into protein. The increase in protein content in seed of mustard with sulphur application was also reported by Malviya *et al.* (2007) and Verma *et al.* (2012).

The highest protein and oil content was recorded under 1.5 kg boron ha^{-1}, protein content was significantly higher than control treatment and statistically at par with rest of the treatments. However, oil content was significantly higher over control and 0.5 kg boron ha^{-1} and at par with 1.0 kg boron ha^{-1} treatment. This was probably due to the fact that boron plays important role in fat metabolism (Tucker, M. Ray, 1999), synthesis of uracil, which is an essential component of RNA. In the absence of uracil the RNA containing assemblies such as ribosomes cannot be formed. In the absence of ribosomes the protein synthesis can not be take place.

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