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Effect of boron on yield, quality and its uptake in Indian mustard (*Brassica Juncea L*) genotypes

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ABSTRACT

A field experiment was conducted to study the response of mustard cultivars to boron application at Directorate of Rapeseed Mustard Research, Sewar, Bharatpur (Rajasthan). The experiment was laid out in split plot design with three cultivars of mustard (Aravali, Laxmi and Vardan) and five levels of boron (0, 0.5, 1.0, 1.5 and 2.0 kg ha^{-1}) with three replications. The results revealed that the mustard cultivar Laxmi produced higher mean seed yield (16.32q ha^{-1}) followed by Aravali (15.30q ha^{-1}) and Vardan (14.05q ha^{-1}). The seed yield of mustard was significantly influenced with the increase in the levels of B and the highest yield ((17.59q ha^{-1}) was recorded with 2 kg B ha^{-1}, which was significantly at par with 1.5kg B ha^{-1}. The B uptake by mustard seed increased significantly with its application and maximum value (53.6g ha^{-1}) was recorded with 2kg B ha^{-1}. Among the mustard genotypes, Laxmi utilized the maximum amount of B in its seeds followed by vardan and Aravali genotypes. The contents of protein and oil were maximum in seeds of Laxmi cultivars. The yields of protein oil were also highest in Laxmi cultivar. Boron application also significantly improved the contents and yields of protein and oil over control. Fatty acids except those of oleic and linolenic acid were not affected significantly by mustard cultivars. Oleic acid in oil increased and erucic acid decreased with increasing levels of boron. The SFA, linoleic, linolenic acids were not affected significantly by boron application. In general, the amounts of fatty acids were higher in oil of Aravali genotype than those of Laxmi and Vardan genotypes.

Keywords: Boron, oil, protein, fatty acid profile, yield, mustard genotypes

INTRODUCTION

Indian mustard is the predominant crop in Rajasthan where abiotic and biotic stresses are the major factors affecting its production. In the abiolic factors salinity, high temperature and low organic matter in the soil are the major factors for its low productivity. In addition, the major reason of low productivity of the crop is mainly its cultivation on marginal lands. Due to these abiotic stresses number of micronutrients including boron becomes deficient. Boron deficiency, next to zinc and sulphur, has emerged as an important micronutrient problem in Indian soils and crops.Boron is one of the essential micronutrients needed by the plants for their normal growth. It is associated with meristematic activity, auxin, cell wall, and protein and pectin metabolism, maintaining correct water relations within the plant, sugar translocation, fruiting processes etc. Boron is also closely related to the functions that calcium performs in the plant. It has also been suggested that boron is necessary for the lignin polymerization process. Apart from major plant nutrients, boron plays an important role in the production phenology of mustard and this crop responds to applied boron (Yadav *et al.* 2016). Genotypic variations exist in sensitivity to boron deficiency. Differential response of cultivars to nutrients in genetically controlled and is a heritable character. Varietal differences in response and utilization of native as well as applied nutrients have been of great concern for many crops. Since, there are very few studies on the effect of boron on Indian mustard genotypes, so present study has been conducted to study the effect of boron on the yield, quality and its uptake in three cultivars of Indian mustard (*Brassica juncea* L. Czern & Coss.).

MATERIALS AND METHODS

A field experiment was conducted during rabi seasons at research farm of DRMR, Bharatpur (Rajasthan). The soil was sandy loam in texture and slightly alkaline in reaction (pH 7.9), low in organic carbon (3.1g kg^{-1}), available N (171 kg ha^{-1}), available P (9.4 kg ha^{-1}), medium in available K (210 kg ha^{-1}) available S (16kg ha^{-1}), available Zn (0.56mg kg^{-1} and B (0.45mg kg^{-1}). Three cultures of mustard namely

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Aravali, Laxmi and Vardan and five levels of boron (0, 0.5, 1.0, 1.5 and 2.0 kg ha^{-1}) were evaluated in split plot design with three replications. Mustard cultivars were sown in lines 30cm apart using a uniform seed rate of 5 kg ha^{-1} in the first week of October in both the years. Recommended doses of N, P_2O_5 and K_2 @ 80, 40 and 40 kg ha^{-1}were applied through urea, diammonium phosphate and muriate of potash, respectively at the time of sowing. Irrigation was applied 35 days after sowing. The crop was harvesting at physiological maturity and seed yield was recorded. The seed samples were analysed for boron in di acid mixture of HNO_3 and $HClO_4$ by carmine method (Hatcher and Wilcox, 1950). The uptake of boron by mustard seed was computed by multiplying content of boron with the seed yield data. Oil and protein content were estimated using a pre-calibrated NIR Analyser (Dicky John Instalab 600) as described by Kumar *et al.* (2003).

Fatty acid composition was estimated using slightly modified laboratory procedure of AOAC official method. Ten oven dried seeds (45^0C for 6 hours) were crushed in capped test tube in duplicate. 0.5ml of petroleum ether was added, vortexed for 1 minute and left for two hours. Then it was centrifuged at 5000 rpm for 5 minutes to have a clear supernatant. The supernatant was transferred to another capped test tube and 0.5ml sodium methoxide solution (80mg NaOH in 100ml of Methanol) was added to it and vortexed for 30 seconds. After 45 minutes, 0.75ml of 8% NaCl solution was added followed by vortexing, layers were separated. One micro litre of upper layer was injected for fatty acid analysis in a programmed GCMS (Shimadzu 2010ns) with NIST 05 library.The total glucosinolate content was estimated as described by Kumar *et al.* (2004). The seeds to be estimated for total glucosinolate were dried overnight in an oven at 50^0C. The dried seeds (200mg) were crushed with mortar and pestle. Then 300 µl of 80% methanol was added and kept in water bath at 80^0C for 5 min to deactivate myrosinase enzyme. Cool it at room temperature. It is then centrifuged at 5000 rpm for 5 minutes. Five microlitre (5 µl) of upper layer of the supernatant was transferred to ELISA plate and then 300 µl of 0.002M sodium tetrachloropalladate solution was added. The ELISA plate was then placed in the oven at 70^0C for 30 min. The color developed was read at 405nm using micro scan ELISA reader. The concentration of glucosinolate was calculated on the basis of the formula as given below for A405 < 0.8 as: Total glucosinolate concentration (µmoles/g meal) = (A405 - 0.0465) x 82 and for A405 > 0.8 as total glucosinolate concentration (µmoles/g meal) = (A405 - 0.169) x 115.74.The data on various biochemical parameters were analysed statistically.Critical difference (C.D.) was calculated by the method of Panse and Sukhatme, (1961).

RESULTS AND DISCUSSION

Yield

The data (Table 1) showed that the Laxmi cultivar of mustard produced maximum seed yield (16.32 q ha^{-1}) followed by Aravali (15.36 q ha^{-1}) and Vardan (14.05 q ha^{-1}) though the differences in seed yield were non-significant. The seed yield of mustard cultivars increased significantly with boron application over control. The differential responses of various cultivars to added boron have also been reported by Chaudhary and Bhogal (2013) for dry matter yield at flowering stage. On an average, application of 2kg B ha^{-1} significantly increased the seed yield by 41.3 per cent over control. The increase in seed yield may be attributed to promotion of pollen producing capacity of anthers and hence might have produced higher number of seeds per siliqua. The increase in seed yield is largely a function of improvement in the yield attributes. These results are in agreement with those of Mathew and George (2013) and Singh *et al.* (2017). Perusal of data (Table 1) revealed that the average values of oil content in seed of Aravalli, Laxmi and Vardan were 40.57, 40.73 and 40.79 per cent, respectively. The oil content of mustard cultivars increased with increasing levels of B up to 2 kg ha^{-1} over control. Similar observations were reported by Singh *et al.* (2017). The increasing levels of boron from 0 to 2 kg B ha^{-1} significantly increased the oil production in Aravalli, Laxmi and Vardan cultivars. This increase in oil yield may be attributed to greater production of seeds and improvement in oil percentage due to boron addition. The increase in oil yield with boron application has been reported by Singh *et al.* (2017).

Table 1: Effect of boron levels on seed yield and quality parameters of Indian mustard (mean of 2 years)

Treatments	Seed yield (q ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})	Glucosinolate (μ mole/g of deffated mean)	B uptake (g ha^{-1})
Borox (kg ha^{-1})							
0	12.44	40.33	501.7	20.61	257.3	98.86	20.6
0.5	14.17	40.54	574.6	20.88	297.1	94.88	27.5
1.0	15.35	40.71	624.3	21.06	324.6	91.73	35.5
1.5	16.58	40.75	675.2	21.32	355.5	88.88	43.5
2.0	17.59	41.16	724.3	21.43	379.4	86.99	53.6
CD (P=0.05)	1.02	0.44	43..75	0.27	22.67	3.96	2.29
Cultivars							
Aravalli	15.30	40.57	621.7	21.12	326.3	90.90	33.6
Laxmi	16.32	40.73	665.0	21.22	348.3	101.59	39.7
Vardan	14.05	40.79	573.4	20.85	293.8	84.31	35.2
CD (P = 0.05)	0.75	NS	30.72	0.20	16.99	3.18	2.21

The crude protein content in all the cultivars increased significantly with boron application over control. As compared to control, almost all the higher levels of boron were significantly better in respect of protein content in all the three cultivars. The maximum percentage of crude protein was recorded at 2 kg B ha^{-1} dose. Since, boron has vital role in the synthesis of protein in the plants it greatly contributes to the quality of all the crops. The increase in the crude protein content with boron application has been reported in oilseeds by Sinha and Chatterjee (2003). Increasing levels of B from 0 to 2 kg ha^{-1} significantly increased the protein production in each cultivar and maximum protein yields of all the cultivars were recorded under2 kg B ha^{-1}. This increase in protein yield may be attributed to greater production of seed and improvement in protein percentage. The increase in protein yield with boron application has been reported by Singh *et al.* (2017). The glucosinolate content (μmole/g of defatted seed meal) in all the three mustard cultivars differed significantly and was maximum in Laxmi (101.59) followed by Aravalli (90.9) and Vardan (84.31). The boron levels had significant effect on the amount of glucosinolate content over control. The higher levels of boron decreased the glucosinolate as compared to lower levels. Li *et al.* (2006) reported similar results. The per cent decrease in glucosinolate was highest in case of Laxmi (16.07%) followed by Aravalli (10.99 %) and Vardan (7.86 %). Our results are in agreement with the results obtained by Li *et al.* (2005).

The uptake of boron by mustard seeds increased significantly with increasing doses of boron and it was highest with the application of 2kg B ha^{-1}. The increase in boron uptake was in consonance with higher seed yield and increase in B content in seeds with increase in B levels. Similar results were reported by Jaiswal *et al.* (2015) abd Singh *et al.* (2017). Among the genotypes of mustard, Laxmi cultivar utilized the maximum amount of boron in its seeds.

Table 2: Effect of boron levels on fatty acid (%) in seed oil of mustard cultivars (mean of 2 years)

Treatments	SFA	Oleic acid	Linoleic acid	Linolenic acid	Eicosenoic acid	Erucilc acid
Borox (kg ha^{-1})						
0	5.91	12.50	16.97	14.97	7.64	38.23
0.5	5.71	12.95	16.54	14.02	7.76	36.85
1.0	5.74	13.09	15.60	13.57	8.01	34.87
1.5	6.09	13.27	15.76	13.73	7.99	34.52
2.0	6.09	13.27	15.85	13.91	8.10	33.48
CD (P=0.05)	NS	0.56	NS	NS	NS	0.93
Cultivars						
Aravalli	5.98	13.36	16.47	14.34	7.63	35.27
Laxmi	5.95	13.00	15.97	13.44	8.11	30.24
Vardan	5.79	12.74	16.00	14.33	8.15	35.26
CD (P = 0.05)	NS	0.18	NS	0.60	NS	NS

Fatty acid profile

The data (Table 2) showed that the mustard cultivars had more or less similar saturated fatty acid content and B levels did not affect their values. Among the cultivars Aravalli showed the highest amount of oleic acid and lowest in cultivar Vardan. The significant differences in oleic acid content may be attributed to the genetic makeup of the cultivars that control the synthesis of oil. Application of boron to the soil significantly increased oleic acid content of each mustard cultivar. The effect of B on oleic acid content was statistically significant. Li *et al.* (2005) also reported that the boron application increased oleic acid content. The mean linoleic acid content of cultivars Aravalli, Laxmi and Vardan were 16.47, 15.97 and 16.00 %, respectively. It was observed that boron application significantly decreased the linoleic acid content in seed oil of all the cultivars. The linoleic acid content decreased from 16.97 at control to 15.60 % at 1 kg B ha^{-1}. Similar results have also been reported by Li *et al.* (2005). In general, the application of boron did not affect the linolenic acid content. However, the higher levels of boron tended to decrease the linolenic acid content. The oil of Aravalli cultivar had lower amount of 11-eicosenoic acid as compared to oil of other cultivars. The higher values of this acid were recorded in oil of Vardan cultivar. The 11-eicosenoicacid content in oil of cultivars increased with boron application over control and such increases were non-significant. The content increased from 7.64 at control to 8.40 % at 2 kg B ha^{-1}. Erucic acid content was found to be at par in oil of various cultivars of mustard. The boron levels had significant effect on the amount of erucic acid over control. The higher levels of boron decreased the erucic acid content as compared to lower levels. Li *et al.* (2005), reported similar results. It is concluded that B is inevitable element in the peoduction of mustard. This is reflected in terms of significant increase in seed yield, oil content as well as uptake of boron by seed and stover of mustard cultivars. Fatty acid profile was also affected with boron application. Among the cultivars, Laxmi was most promising in respect of yield and quality.

REFERENCES

Chaudhary, S. and Bhogal, N.S. (2013) Response of mustard cultivars to boron application. *Annals of Plant and Soil Research* **15**(2): 131-133

Jaiswal, A.D., Singh, S.K., Singh, Y.K. Singh, S. and Yadav, S.N. (2015) Effect of sulphur and boron on yield and quality of mustard (*Brassica juncea* L.) grown in Vindhyan red soil. *Journal of the Indian Society of Soil Science* **63** (3): 362-364

Kumar, P.R. and Jha, S. K. (2004) WTO and internal factors which impact on the oilseed economy of India. *In* 4th International Crop Science Congress, Australia. pp.1633

Kumar S, Singh A K, Kumar M, Yadav S K, Chauhan J S, Kumar P R (2003) Standardization of near infrared reflectance spectroscopy (NIRS) for determination of seed oil and protein contents in rapeseed-mustard. J Food SciTechnol**40**:306–309.

Kumar S, Yadav S K, Singh A K, Khan N A and Kumar P.R. (2004) .Total glucosinolate estimation by complex formation between glucosinolates and tetrachloropalladate (II) Using ELISA reader. J Food Sci. Technol **41**: 63-65.

Li Zhi-yu, Hu Qiong, Liao Xing, Guo Qing-yuan and Qin Ya-ping (2005) Effects of nitrogen, phosphorus and boron on the yield and quality of high-*eff icient* oilseed rape hybrid Zhongyouza No.8. *Chinese Journal of Oil Crop Science* **27**:59-63

Li Zhi-yu, Liao Xing, TuXue-wen and Guo Qing-yuan, (2003). Effect of N, P, K and B application on yield, quality of rape cultivars. Hubei Agricultural Sciences 2003-06.

Panse V C and Sukhatme P V (1961) Statistical methods for agricultural workers. ICAR publication, New Delhi.

Sinha, P. and Chatterjee, C. (2003) Influence of low boron on yield and seed quality of soybean. *Indian Journal of Agricultural Research* **37**: 193-198.

Singh, R., Kumar, Y. and Singh, S. (2017) Yield quality and nutrient uptake of Indian mustard (*Brassica juncea*) under sulphur and boron nutrition. *Annals of Plant and Soil Research* **19** (2): 227-231

Yadav, S.N., Singh, S.K. and Kumar O.(2016) Effect of boron on yield attributes, seed yield and oil content of mustard (*Brassica juncea* L) on an Inceptisol. *Journal of the Indian Society of Soil Science* **64**(3): 291-296.