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Effect and boron and zinc level on growth, yield and yield parameters of Mustard (*Brassica campestris* L.)

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Abstract
A field experiment was carried out during the winter season of 2020-21 at the Crop Research Farm, Department of Agronomy, Allahabad School of Agriculture, SHIATS Allahabad (U.P.) titled "Effect of boron and zinc levels on growth and yield of yellow mustard (*Brassica campestris* L.)." The experiment was laid out in Randomized Block Design with nine treatments and replicated thrice. The plot consisted of two levels of boron (1 and 2 kg/ha) and zinc (5 and 10 kg/ha) along with RDF as NPKS each at 80:40:40:40 kg/ha respectively. The results revealed that the maximum no. of siliqua plant-1 (86.07), no. of seeds siliqua-1 (40.27), test weight (3.85 g), seed yield (1.95 t ha-1), stover yield (2.96), harvest index (39.70%) and benefit cost ratio (2.6) was obtained in the treatment (T2) RDF + 1 kg B/ha.

Keywords: Boron and zinc levels, sulphur, yellow mustard

Introduction
India is the 4th largest oil seed producing economy in the world after USA, China and Brazil, which contributes about 10% of the world oilseeds production, 6-7% of the global production of vegetable oil, and nearly 7% of protein meal. Although India has 20.8% of the world's area under oilseed crops, it accounts for about 10% of global production. This is because of low productivity of oilseed crops and year to year fluctuations in production in India. Currently, India accounts for about 13% of world's oilseeds area, 7% of world's oilseeds output and 10% of world's edible oil consumption. Among the seven edible oilseeds cultivated in India, rapeseed-mustard contributes 28.6% in the total oilseeds production and rank second after groundnut sharing 27.8% in the India's oilseed economy. In India, area, production and yield of rapeseed-mustard was 5.8 million hectare (Mha), 6.3 million tonnes (Mt) and 10.9 q/ha, respectively (Anonymous, 2016) [3]. In Uttar Pradesh, rapeseed and mustard is grown on 6.58 lakh ha area with production of 0.76 mt and productivity of 1155 kg/ha (Anonymous, 2007) [2].
Mustard is an energy rich crop which requires the major, secondary and micronutrients in adequate quantity for higher production. Mustard is quite responsive to micronutrients zinc (Zn) and boron (B), which plays important role in growth and development of this crop.
Availability of boron to plant is affected by variety of soil factor including soil pH, texture, moisture, temperature, oxide content, carbonate content, organic matter content and clay mineralogy (Goldberg *et al.*, 2000) [6]. Its deficiency has been realized as the second most important micronutrient constraint in crops after that of zinc on global scale (Ahmed *et al.*, 2012) [1]. Boron plays an important role in the development and differentiation of sugar in plant. It helps in the normal growth of plant and in adsorption of nitrogen (N) in soil and also makes up the calcium (Ca) deficiency to some extent. Boron also helps in root development, flowers and pollen grain formation. Boron application produced the best quality of seeds in respect of protein content of mustard (Sharma *et al.*, 1990) [15]. Boron. deficiency in mustard may cause sterility i.e., less pods and less seeds per pod, attributing low seed yield (Islam and Anwar 1994) [8].
Zinc is an important constituent of several enzymes which regulates various metabolic processes in the plants and also influences the formation of several growth hormones like IAA in plants. Zinc stimulates the pod setting, seed formation and oil synthesis in the seeds of mustard and it increases the biological seed and stover yield of mustard (Sinha *et al.*, 2000) [16]. Zinc has vital role in carbohydrate and protein metabolism as well as it controls the plant growth hormone indole acetic acid (IAA). it is an essential component of dehydrogenase, proteinase and promotes starch formation, seed maturation and production (Mandal *et al.*, 2002) [12].

Although zinc can be applied as foliar application in emergency measure, greatest yields are obtained when it is applied to the soil. Soil application of zinc is normally made at the seeding of crop. Sometimes, Zn deficiency appears due to the low amount of Zn as recommended and low temperature as required during the crop growth. Deficiency of zinc can also appear after seeding of the crop in soils with high phosphorus contents. Zinc sulphate improves phosphorus utilization and regulates plant growth and increase leaf size, promotes silking, hastens maturity and increase to test weight.

Materials and Methods

The experiment was conducted during the *Rabi* season 2020, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25o39‟42” N latitude,81o67‟56” E longitude and 98m altitude above the mean sea level (MSL). This area is situated on the right side of the Yamuna River by the side of Prayagraj - Rewa road about 12 km from the city.

The soil was sandy loam, pH of soil was 7.4 with 0.39% organic C, having available N, P, K (185.5, 36 and 98 kg ha-1 respectively). The experiment was laid out in randomized block design (factorial) with three replications, having two factors are boron (1 and 2 kg/ha) and zinc levels (5 and 10 kg/ha). Half dose of nitrogen (40 kg/ha) and full dose of phosphorus potash and sulphur each 40 kg/ha was applied basal and remaining half dose of nitrogen (40 kg ha-1) was applied after the first irrigation. There was total 9 treatment combinations in all. The net size was 3 m x 3m. All other agronomic practices i.e., thinning, hoeing, eradication of weeds and irrigation was done timely. Yellow mustard variety 'NRCYS-05-02' was sown. The line sowing was done at a spacing of 30 × 10 cm.

Results and Discussion

Growth characters: Growth parameters of yellow mustard, *viz*. plant height, and dry matter accumulation (DMA), crop growth rate (CGR) and relative growth rate (RGR) were influenced by boron and zinc levels. Application of 1 kg boron ha-1 recorded significant increase in the plant height (119.63 cm) which was significantly superior to all other treatments. At 100 DAS, the maximum dry weight plant-1 was recorded significantly higher in the treatment T2 - 1 kg boron ha-1 (15.32g) as compared to all other treatments. Days to 50% flowering was found non-significant among the treatments.

Yield and Yield attributes

Number of siliqua plant-1, number of seeds siliqua-1, test weight and harvest index of yellow mustard increased non-significantly due to boron and levels. However, seed yield and stover yield was significantly increased due to boron and levels. The maximum number of siliqua plant-1 (86.07) and number of seeds siliqua-1 (40.27) was recorded maximum in the treatment T2 (RDF + 1 kg B/ha). However, it was non-significant. Significantly higher stover yield (2.96 t ha-1) was recorded in the treatment T^2 (RDF + 1 kg B/ha). However, T3 (RDF + 2 kg B/ha), T^5 (RDF + 10 kg Zn/ha), T8 (RDF + 2 kg B/ha + 5 kg Zn/ha) and T^9 (RDF + 2 kg B/ha + 10 kg Zn/ha) are statistically par with T^2 (RDF + 1 kg B/ha). Results revealed that the maximum test weight (3.85g) was recorded in the treatment T2 (RDF + 1 kg B/ha) followed by all other treatments. The maximum seed yield (1.95 t ha-1) was found significantly higher in the treatment T2 (RDF + 1 kg B/ha). However, T3 (RDF + 2 kg B/ha), T_5 (RDF + 10 kg Zn/ha), T_8 (RDF + 2 kg B/ha + 5 kg Zn/ha) and T_9 (RDF + 2 kg B/ha + 10 kg Zn/ha) are statistically par with T2 (RDF + 1 kg B/ha). While, minimum seed yield (1.28 t ha-1) was found in the treatment T1 (RDF). The harvest index of (39.70) was recorded higher in T2 (RDF + 1 kg B/ha). however, it was found non-significant. Among treatment combinations of yellow mustard under different levels of boron and zinc, the highest B:C ratio (2.6) was obtained in treatments T2 (RDF + 1 kg B/ha), while lowest B:C ratio (1.41) was obtained in treatment T1 (RDF).

Table 1: Interaction effect and different levels of Boron and Zinc on growth and yield of yellow mustard (*Brassica campestris* L.)

Treatments	Plant height (cm)	Plant dry weight (g)	Siliqua Per plant (no.)	Seeds per Siliqua (no.)	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	B:c ratio
T_1: RDF	110.33	9.24	68.60	35.53	3.61	1.28	2.73	1.41
T_2: RDF + 1 kg B/ha	119.63	15.32	86.07	40.27	3.85	1.95	2.96	2.6
T_3: RDF + 2 kg B/ha	113.80	11.55	71.27	39.07	3.70	1.74	2.91	2.2
T_4: RDF + 5 kg Zn/ha	112.50	11.24	72.07	35.40	3.74	1.38	2.74	1.53
T_5: RDF + 10 kg Zn/ha	115.27	12.28	63.60	36.33	3.71	1.60	2.83	1.87
T_6: RDF + 1 kg B/ha + 5 kg Zn/ha	114.40	11.83	76.93	32.53	3.75	1.46	2.77	1.66
T_7: RDF + 1 kg B/ha + 10 kg Zn/ha	114.17	11.56	80.27	35.73	3.70	1.44	2.76	1.58
T_8: RDF + 2 kg B/ha + 5 kg Zn/ha	118.07	14.26	74.87	35.87	3.82	1.84	2.93	2.32
T_9: RDF + 2 kg B/ha + 10 kg Zn/ha	117.10	13.06	65.53	36.20	3.76	1.75	2.92	2.11
F test	S	S	NS	NS	NS	S	S	-
S.Em±	1.24	0.94	8.93	1.71	0.05	0.13	0.06	-
CD (P = 0.05)	3.71	2.83	-	-	-	0.40	0.17	-

NS - Non-significant

Discussion

Number of siliqua plant-1 is a key factor for determining the yield performance in yellow mustard. The productive capacity of yellow mustard is ultimately considered by the number of siliqua plant-1. Number of seeds siliqua-1 is considered an important factor that directly imparts in exploiting potential yield recovery in oilseed crops. 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. (Hussain *et al*., 2008) [7] reported that to produce higher seed yield, 1-1.5 kg B ha-1 should be applied along with recommended dose of fertilizers. The highest plant height, number of branches plant-1 number of siliqua and number of seed siliqua-1 was obtained from 1kg B ha-1, which was significantly different from all other treatments. Similar results were reported by (Verma *et al*., 2012) [7] that the application of 1.0 kg B ha-1 significantly increased seed yield, economic, oil yield, protein yield and nutrient uptake (kg ha-1) of mustard over control and other treatments. (Rashid *et al*., 2012) [14] reported that yield and yield contributing characters increased significantly with the increased rate of boron application up to 1.5 kg B ha-1. (Lal and Singh, 2012) [9] reported that application of sulphur and boron levels enhanced significantly all the growth parameters at higher dose i.e., 50 kg S ha-1 and 1.5 kg B ha- 1, respectively although. Application of various nutrients increased the dry matter accumulation of the crop plant and hence, other growth indices like CGR (Crop growth rate), RGR (Relative growth rate) and NAR (Net Assimilation Rate) values were recorded highest at the initial growth stages and declined thereafter. Seed yield of a variety (NRCYS-05-02) is the result of interplay of its genetic makeup and environmental factors in which plant grow. These results are in line with the findings of (Malewar *et al*., 2001) [11] also reported that Stover and seed yield increased significantly with each increment of either zinc or boron. There was additive effect of zinc and boron on both the yield parameters indicating possible interaction between zinc and boron in mustard. (Dabhi *et al*., 2010) [4] also showed that the maximum growth, yield attributes and uptake of S under, 40 kg S ha-1 ultimately result in the highest seed yield of mustard. (Manoj *et al*., 2018) [13] revealed that higher levels of B and Zn along with RDF recorded higher growth and yield attributes at harvest, *viz*. plant height, branches/plant, siliquae/plant, seeds/siliqua and test weight of mustard crop than recommended dose of fertilizers and other treatments. (Verma *et al*., 2012) [7] observed the effect of S (0, 20, 40 and 60 kg S ha-1), Zinc (0, 5 and 10 kg Zn ha-1) and B (0, 0.5 and 1.0 kg B ha-1) levels on quality, economics and uptake of nutrients in mustard. Result revealed that application of 60 kg S ha-1 and 1.0 kg B ha-1 significantly increased seed yield, economics and oil yield over the control. (Malewar *et al*., 2001) [11] from Maharashtra reported that with increase in zinc levels from 0, 10, 20 and 30 Kg/ha the seed and stower yields increased significantly with increasing zinc levels. (Dubey *et al*. 2013) [5] also reported that the application of 60 kg S ha−1 and 10 kg Zn ha−1, produced significantly higher plant, primary and secondary branches plant−1, number of leaves plant−1, days taken to flowering, days taken to maturity, number of siliqua plant−1, length of siliqua, and number of seeds siliqua−1, harvest index and oil content. Similarly, (Mahabeer Meena *et al*., 2018) [10] on a study with various levels of NPK and ZnSO4 found that (NPK 100% and ZnSo4 100% best for increasing yield attributes in Mustard.

Conclusion

It is concluded that application of RDF (NPKS) 80:40:40:40 and Boron at 1 kg ha-1 recorded highest yield and yield attributes. Since the data is based on the study conducted in one season, the experiment may be repeated to confirm the findings.

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