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Effect of boron fertilization on yield and yield attributes of mustard var. BARI Sarisha-14

M. A. Masum, M. N. H. Miah, M. N. Islam, M. S. Hossain, P. Mandal and A. P. Chowdhury

Dept. of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet-3100, Bangladesh.

✉ For any information: ask.author@journalbinet.com
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ABSTRACT

Boron (B) is an essential micronutrient of mustard and play a vital role on its normal growth, and development. A study was conducted at (AEZ-20) Shiberbazar, Sylhet during November 2016-February 2017, to quantify the effect of boron on yield and yield attributes of mustard (BARI Sarisha-14), and different doses and form of B application. Randomized Complete Block Design (RCBD) was followed with three replications to design the study. Five B (boric acid) levels viz. T_1 = basal application of B @ 2kg ha^{-1}; T_2 = foliar spray (FS) of B @ 0.5% at vegetative stage (VS) ; T_3 = FS of B @ 1% at VS; T_4 = FS of B @ 0.5% at VS + pod formation stage (PFS) and T_5 = FS of B @ 1% at VS + PFS and T_6 = control (no boron) were used. Results indicated that yield and yield attributes of mustard were significantly influenced by boron application. The effects of boron were significant on number of siliquae plant^{-1}, number of seeds siliqua^{-1}, seed yield, stover yield, 1000-seed weight, biological yield and harvest index (%). The highest number of siliquae plant^{-1} (35.93), number of seeds siliqua^{-1} (30.03), stover yield (1946.0 kg ha^{-1}) and 1000-seed weight (3.617 g) were obtained from the treatment T_5. The seed yield (801.17 kg ha^{-1}) was found also in the treatment T_5 which was over double than control (T_6). Therefore, two times foliar application of B @1% at VS and PFS is a good option to increase yield and yield contributing characters of BARI Sarisha-14 in AEZ 20.

Key Words: *Mustard, BARI Sarisha-14, Boron, Application method, Application rate, Yield attributes and Yield*

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I. Introduction

Rapeseed-mustard (*Brassica spp*. L.) commonly known as mustard in Bangladesh, is a cool season, thermo sensitive as well as photosensitive crop (Sharif *et al.* 2016). Mustard grows during rabi season (October-February) usually under rainfed and low inputs condition in this country (Ghosh and Chatterjee, 1988). *Brassica* oil crop supplies substantial quality of edible oil in Bangladesh. It accounts for 59.4% of total oil seed production in the country (AIS 2010). In 2013-14, it was cultivated in 724,000 acres, produced 296,000 tons of edible oil seed. In the year 2012-13 and 2014-15 it accounts for 36.61 and 39.84% of total oil seed production in Bangladesh (BBS 2015) but our country is running a short 60-75% of the demand of edible oil (Rahman 2002). At present, the local production of edible oil meets

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only 25% of the country requirement (Chowdhury and Uddin, 1990; Mondal and Wahab, 2001). Among the edible oil cultivation rapeseed and mustard occupies more than 65.91% and sesame occupies 9.23% of the total oilseed area being the largest and the second largest oilseed crop, respectively (Akbar 2011). Mustard plant belongs to the genus *Brassica* under the family cruciferae. The *Brassica* has three species viz. *B. napus, B. campestris and B. junecea,* which are grown in different region in Bangladesh. *Brassica napus,* the mother of this newly developed genotype, often shows sterility in many areas of the country. The average per hectare yield of mustard in this country is critically very poor as compared to advanced countries. The average production of rapeseed-mustard is 739 kg ha^{-1} in the country whereas the world average is 1575 kg ha^{-1} (FAO 2011). BARI developed mustard varieties such as BARI Sarisha-11, BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-16 and BARI Sarisha-17 more productive and improved than others. Therefore, it is necessary to popularize these high yielding varieties of mustard with proper fertilizer management for increasing the oil seed production. Justified fertilizers and resource use is crucial to maintain productivity of crops (Sultana et al. 2015; Hossain and Siddique, 2015). Fertilizers have effect on yield and yield attributes of crops (Sultana et al. 2019; Sultana et al. 2019a). Usually for mustard production farmers apply NPK fertilizers and do not give focus on other micro element as its necessity is unknown to them. *Brassica* sp. is sensitive to low B-supply and severe deficiency may result in floral abortion and significant drop in seed production(Mengel and Kirkby, 1982; Yang *et al.* 1989; Zaman *et al.* 1998). The number of siliquae and seed setting and seed yield of mustard plants is greatly influenced by boron particularly where soil is deficient in boron (Dutta *et al.* 1984; Islam and Sarker, 1993; Lei *et al.* 2009). The uptake and requirement of boron differ in different development stages, soil, plant parts, among cultivars and species (Pommerrenig *et al.* 2018). Sylhet region is belonging to Eastern Surma-Kushiara Floodplain under the Agro Ecological Zone-20 (FAO 1988). Boron deficiency was clearly depicted in the light soil (AEZ- 20) of Sylhet region through a good number of soil analyses reports of OFRD and SRDI. The soil of Sylhet area contains trace amount (0.2-0.3 μg/g soil) of boron (Hussain *et al.* 2008). In addition, it is unknown appropriate boron fertilization mustard crop in AEZ-20. This study was designed to ascertain proper application method and rate to increase grain yield and improving yield contributing characters of high yielding mustard variety BARI Sarisha-14.

II. Materials and Methods

To quantify the proper application methods and rate of boron fertilizer in BARI Sarisha-14 an experiment was conducted under Farmer's field at Sotero Tekerbari, Shiberbazar, Sylhet Sadar, Sylhet under Surma-Kushiyara Floodplain (AEZ-20) during the period of November 2016 to February 2017. The soil was clay loam having a pH value of 4.80, low in fertility status having available phosphorus 0.05 μg g^{-1} soil, exchangeable potassium 0.05 meq 100 g^{-1} soil, low amount of nitrogen and boron but available sulphur was 25 μg g^{-1} soil, organic matter content was 1.82%. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each replication was divided into six plots where different doses of boron were applied according to treatments. The unit plot size was 6 m × 4.15 m (24.9 m^2 ≈ 25 m^2). The experiment was comprised of 6 treatments *viz.* T_1= Basal application of boric acid (BA) @ 2 kg ha^{-1} during final land preparation; T_2= Foliar spraying (FS) of BA @ 0.5% at vegetative stage; T_3= FS of BA @ 1% at vegetative stage; T_4= FS of boric acid @ 0.5% at vegetative stage + pod formation stage; T_5= FS of BA @ 1% at vegetative stage + pod formation stage; T_6= Control (no boron applied). The experimental plots were fertilized at the rate of 150-110-90 and 120 kg ha^{-1} N-P-K and gypsum (BARC 2012). Boric acid (Bingo, 20 % Boron) was used as the source of boron and applied according to experimental treatment set up. Seeds were sown on 24 November, 2017 at the rate of 8.5 kg ha^{-1} and crop was harvested at 76 DAS. Intercultural operations such as weeding, thinning, irrigation, spraying of insecticides and weedicides were done uniformly. Different growth parameters were recorded from different days after sowing of seeds for observing effect on plant growth. At harvesting stage, randomly 10 sample plants were uprooted from each unit plot to collect data on different yield contributing characters and 1 m × 1 m area was selected for yield data. Data were analyzed by statistical analysis program "R". The significance of the mean differences among the treatments was estimated by the Least Significant Deferent Test (LSD) at 5% level of probability (Gomez *et al.* 1984).

III. Results and Discussion

Effect of boron on the yield components: Results indicated that yield and yield contributing characters like number of siliquae $plant^{-1}$, number of seeds $siliqua^{-1}$, 1000-seed weight, seed yield, stover yield, biological yield and harvest index (%) significantly differed among the treatments (Bora and

Hazarika, 1997; Sinha *et al.* 1991 and Hussain *et al.* 2012). However, experimental treatment of boron had no significant effect on plant population m^{-2}, number of branches $plant^{-1}$ and length of siliqua (Yadav *et al.* 2016) (Table 01) and Figure 01, 02 and 03.

Effect of boron on the number of siliquae $plant^{-1}$: The maximum number of siliquae $plant^{-1}$ (35.93) was produced by T_5 (Foliar application of boron @ 1% at vegetative + pod formation) which is statistically similar with T_4 (Foliar application of boron @ 0.5% at vegetative + pod formation stage) and the minimum number of siliquae $plant^{-1}$ (22.07) was produced by T_6 (no boron applied) (Table 01). The number of siliquae $plant^{-1}$ of mustard found higher in presence of available boron in the soil (Chatterjee *et al.* 1985).

Table 01: Effect of different levels of boron on yield attributes of mustard

Treatment	Plant Population m^{-2}	No. of branches $plant^{-1}$	No. of siliqua $plant^{-1}$	Length of siliqua (cm)	No. of seeds $siliqua^{-1}$	1000 Grain wt. (g)	HI (%)
T_1	70.00	2.867	28.20 c	4.790	27.50 ab	2.830 c	30.03 b
T_2	75.33	3.467	31.70 b	4.763	29.43 ab	3.033 bc	31.29 b
T_3	66.00	3.067	32.60 ab	4.713	28.53 ab	3.183 b	35.53 a
T_4	73.33	3.667	35.60 a	4.467	26.87 bc	3.367 ab	32.14 b
T_5	69.33	2.867	35.93 a	4.897	30.03 a	3.617 a	29.21 b
T_6	71.00	2.667	22.07 d	4.890	24.83 c	2.817 c	30.85 b
CV (%)	11.67	15.40	6.09	6.12	5.08	5.99	5.32
F-Value	NS	NS	**	NS	*	**	*

** = Significant at 1% level of probability; * = Significant at 5% level of probability; NS = Non-significant.

Effect of boron on the number of number of seeds $siliqua^{-1}$: The maximum number of seeds $siliqua^{-1}$ (30.03) was recorded in T_5 (Foliar application of boron @ 1% at vegetative + pod formation). But the minimum number of seeds $siliqua^{-1}$ (24.83) was obtained from control treatment (T_6) (Table 01). The results revealed that increased rate of boron application give higher number of seeds $siliqua^{-1}$. Islam and Sarker (1993) also observed that number of seeds $siliqua^{-1}$ increased with the increasing rate of boron application. Yadav *et al.* (2016) reported that the effect of boron on rape seed formation was good and it significantly increased the seeds $siliqua^{-1}$.

Effect of boron on the number of 1000-seed weight: Similarly, highest grain weight (3.617 g) was observed when boric acid applied in the foliage @1% in both vegetative and pod formation stages (T_5) (Table 01). The lowest 1000-grain weight (2.817 g) was recorded in control treatment that is statistically similar with where boron is applied @ 2 kg as a basal dose (T_1). Similar results were found by Subbaiah and Mittra (1996) reported that 1000-seed weight was increased by boron application. Hossain *et al.* (2012) also reported that application of boron gave higher weight of 1000-seed over control.

Seed yield (kg ha^{-1}): Seed yield was significantly affected by different doses of B (Figure 01). The maximum seed yield (801.17 kg ha^{-1}) was recorded in T_5 (Foliar application of B @ 1% at vegetative + pod formation) (Figure 01). But the lowest seed yield (680.17 kg ha^{-1}) was found in T_6 (no boron applied) and that was statistically similar with T_1 and T_2. The second highest seed yield was found in T_4 where B applied in the same stages as T_5 but in different rate (5%). The increasing rate of foliar application of B showed rising tread of seed yield. Some previous result of boron fertilization also showed that increasing rate of boron application produced higher seed yield of mustard (Sinha *et al.* 1991; Islam and Sarker, 1993; Bora and Hazarika, 1997). The number of siliqua $plant^{-1}$, number of seeds per $siliqua^{-1}$ was higher in case of B application in both VS, and PFS (T_5) @1% compare to other treatments and results in higher seed yield with T_5. The performance of yield contributing characters was higher (Table 01) where B applied twice in VS and PFS @1% (T_5) that resulted in higher seed yield.

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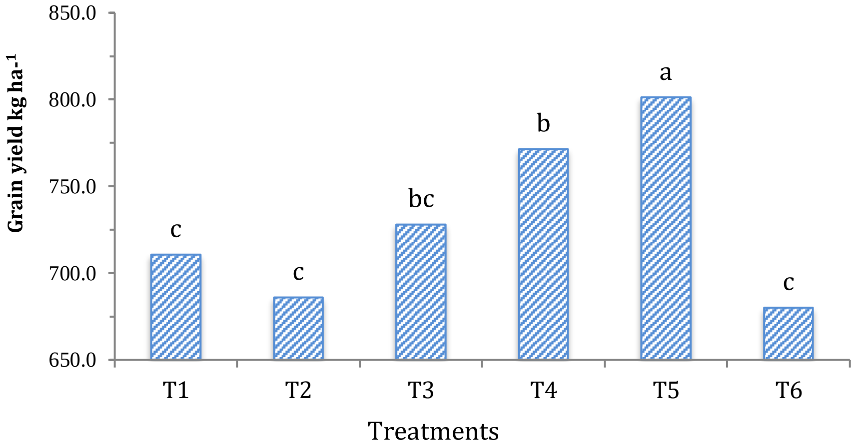

Figure 01. Seed yield of mustard with different doses of boron.

Stover yield: Stover yield of mustard was significantly influenced by different doses of boron (Figure 02). The maximum stover yield (1946.0 kg ha^{-1}) was recorded in T_5 (Foliar application of B @ 1% at vegetative + pod formation). The second highest stover yield (1678.0 kg ha^{-1}) was observed in T_1 (basal application of boron @ 2 kg ha^{-1}). These results are in agreement with research findings of Sinha *et al.* (1991). They reported that the stover yield of mustard increased significantly by boron application. The lowest stover yield (1332.3 kg ha^{-1}) was found in T_3 (Foliar application of B @ 1% at vegetative stage) followed by T_2 (Foliar application of B @ 0.5% at vegetative stage), which revealed that increased application of boron shows higher stover yield of mustard. Maximum plant height and plant population m^{-2} can be a reason for getting higher stover yield. However, we did not find any statistical differences in those parameters. Another possible reason may be higher tissue concentration of the plant of T_5. Our results of stover yield are contradictory of some previous results. Dear and Lipsett (1987) opined that vegetative growth is less sensitive to B deficiency compered to reproductive growth of plant. The yield of mustard stover yield did not influenced by B application in B deficit soil (Saha *et al.* 2003).

Biological yield: Biological yield is the sum of seed yield and stover yield (Bijalwan and Dobriyal, 2014). There was significant difference in biological yield among the treatments (Figure 03). The maximum biological yield (2747.2 kg ha^{-1}) was produced in T_5 (Foliar application of boron @ 1% at vegetative + pod formation) whereas the minimum biological yield was found in T_3 (Foliar application of boron @ 1% at vegetative stage). Results revealed that more boron in split application gave higher biological yield, which may be due to the cumulative of photosynthate and favorable effect of the seed and stover yield of mustard.

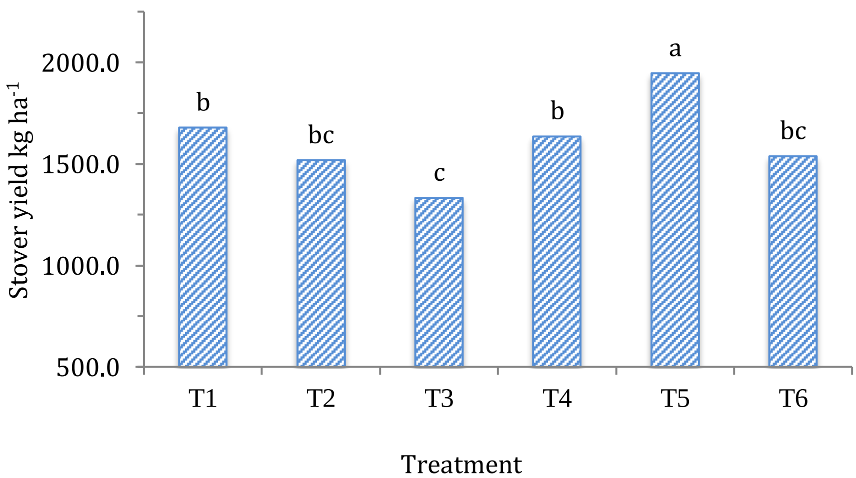

Figure 02. Stover yield of mustard variety BARI Sarisha-14 with different doses of boron.

Harvest index (HI): The highest harvest index (35.33%) was observed in T_3 (Foliar application of boron @ 1% at vegetative stage) (Table 01). The minimum harvest index (29.21%) was found in T_5 (Foliar application of boron @ 1% at vegetative + pod formation). Therefore, the results revealed that the highest and lowest harvest index were due to differences in rate of boron application that was in line with the findings of Hussain *et al.* (2012).

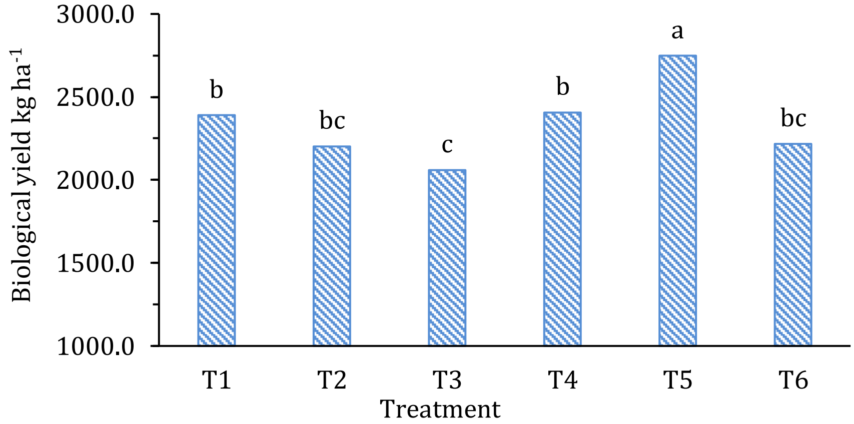

Figure 03. Biological yield of mustard variety BARI Sarisha-14 with different doses of boron.

IV. Conclusion

The yield contributing characters of brassica genotype perform well in two times foliar application of B at vegetative and pod developmental stages, and that finally leaded to higher seed yield. The foliar application of B @1% found as effective application method and rate in this study. However, 1% rate of B for foliar application was maximum dose in this study and showing increasing tread. Therefore, it is very difficult to precisely recommend this rate and method of B application for whole AEZ-20 as the study was conducted in only one location. Multi-location study with same setup with another above 1% two or three doses of B is necessary to finally conclude the proper application rate and method.

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