Bangladesh J. Sugarcane, 36 : 1-8 *June, 2015*

Influence of Boron on Yield, Juice Quality and Crown Rot Incidence of Tropical Sugarbeet Cultivar 'Shubrha' Grown at Two AEZs of Bangladesh

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ABSTRACT

The experiment was conducted at Bangladesh Sugarcrop Research Institute farm, Ishurdi (AEZ 11) and Regional Sugarcrop Research Station farm, Thakurgaon (AEZ 1) during 2014-2015 with a view to find out the influence of boron application on yield, juice quality and crown rot incidence of tropical sugarbeet cultivar 'Shubrha'. The experiment was laid out in a Randomized Complete Block Design with three replications and comprised of six treatments viz,. T_1 – Boron control, T_2 – Boron basal application @ 1.2 kg ha^{-1}, T_3 – Boron basal application @ 1.5 kg ha^{-1} , T_4 – 50 ppm boron, T_5 – 75 ppm boron, T_6 – 100 ppm boron. All the growth parameters and yield of sugarbeet responded significantly due to boron application. At Ishurdi site, the highest percent brix and pol of sugarbeet, lowest incidence of crown rot, highest number of millable beet, maximum yield of beet and MBCR were obtained in treatment T_3 where boron was applied in soil @ 1.5 kg ha^{-1} as basal. At Thakurgoan site, similar trend was observed by the treatment T_3 regarding yield and quality in sugarbeet. It was also found that soil application of boron performed better regarding yield, juice quality, and suppression of crown rot disease incidence in sugarbeet at both the locations under study.

Key words: Boron, yield, juice quality, crown rot, sugarbeet

INTRODUCTION

Sugarbeet (*Beta vulgaris* L.) is a biennial sugar producing tuber crop, grown in temperate countries. Now tropical sugarbeet varieties are gaining momentum in tropical and sub tropical countries including Bangladesh as a promising alternative sugar crop for the production of white sugar. The bi-products of sugarbeet *viz.,* beet top can be used as green fodder, while beet pulp and filter cake from industry can be used as cattle feed. Sugarbeet has now emerged as a new sugar crop of Bangladesh because of the favourable characters like (i) tropical sugarbeet varieties suitable for the climate of Bangladesh (ii) shorter duration of 5 to 6 months (iii) moderate water requirement of 80–100 cm. (iv) higher sugar content of 12 to15% (v) improvement of soil conditions because of tuber crop and (vi) suitability for saline and alkali soil. Further, as the harvesting period of sugarbeet coincides with the period from March to June, the human resource of sugar factory in the off season could be efficiently utilized in processing of sugarbeet in the

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sugar mills, that will facilitate continuous functioning of the sugar mills. Boron is required for all its plant growth. Adequate B nutrition is critical for high yields and quality of the crops. Boron increases the rate of transport of sugars (which are produced by photosynthesis in mature plant leaves) towards actively growing regions and in developing fruits. Allen and Pilbeam (2007) stated that sugar beet crop has high requirements for boron (B). Boron was found as the most important trace element needed in sugar beet because, without an adequate supply, the yield and quality of roots was very depressed (Cooke and Scott, 1993). A severe lack of boron causes complex symptoms in sugarbeet known as heart and crown rot and its principal effects are well known. Both soil application and foliar spray of boron demonstrated equally effective, hence the fresh root weight, sucrose %, root and top yields significantly increased by increasing boron levels (Jaszczolt, 1998). Hence, an attempt has been under taken to find out the effect of boron application on the growth, yield and quality of sugarbeet at Thakurgoan and Ishurdi sites under AEZ 1 and AEZ 11 of Bangladesh.

MATERIALS AND METHODS

The experiment was conducted at BSRI farm, Ishurdi (AEZ 11) and RSRS farm, Thakurgaon (AEZ 1) during 2014-2015 cropping season and was laid out in a RCBD with three replications. The experiment was comprised of six treatments viz., T_1 – Boron control, T_2 – Boron basal application @ 1.2 kg ha^{-1}, T_3 – Boron basal application @ 1.5 kg ha^{-1} , T_4 – 50 ppm boron, T_5– 75 ppm boron, T_6– 100 ppm boron. Boron solution was sprayed in two times during the growing season i.e. at 50 and 80 days after sowing. In each plot all other recommended manure and fertilizers were applied @ Mustard oil cake- 450 kg ha^{-1}, N- 120 kg ha^{-1}, P- 20 kg ha^{-1}, K- 112.5 kg ha^{-1}, S- 18 kg ha^{-1}, Zn- 3.5 kg ha^{-1}. The experimental plot size was 4 m x 5 m where line to line and plant to plant spacing were 60cm and 20 cm, respectively. The sugarbeet variety Shubrha was used as test crop. Necessary intercultural operations were done throughout the cropping season for proper growth and development of the crop. Collected data were compiled and tabulated in proper form and were subjected to statistical analysis by using the computer package Statistix 10 program for Windows Version. Computation was done by the use of Microsoft Excel 2003 program.

RESULTS AND DISCUSSION

Ishurdi site (AEZ 11)

Results presented in Table 1, showed that all the growth, yield and quality parameters of sugarbeet responded significantly due to boron application at Ishurdi site (AEZ 11). The highest percent brix (20.25%) of sugarbeet was found in treatment T_3 (20.25 %) where boron was applied @ 1.5 kg ha^{-1} as basal, and the lowest (19.20 %) was found in control (no boron). The highest pol (%) beet was also obtained in treatment T_3 (13.70%) which was statistically identical with T_2 (13.40 %) and T_5 (13.27%). The lowest Pol (%) beet was obtained in control (11.14%). This result corroborates with that of El-Hawary (1994) and Bondok (1996) stated that sugar yield was increased due to boron application. Armin *et al.* (2012) also reported higher sucrose concentration in sugarbeet with boron application. The highest millable sugarbeet was obtained in treatment T_3

(87.00 x 10^3 ha^{-1}) which was followed by T_2 (85.17 x 10^3 ha^{-1}) and T_5 (80.50 x 10^3 ha^{-1}). The lowest millable sugarbeet was found in control (65.50 x 10^3 ha^{-1}). The highest yield of sugar beet was found in treatment T_3 (84.00 tha^{-1}), which was followed by T_2 (82.33 t ha^{-1}) and the lowest was found in control (72.00 tha^{-1}). This findings was at par with that of Mirvat *et al.* (2005) who reported higher beet root yield was produced with high level of boron (2.0 Kg/acre) applied in soil.

Table 1. Effect of boron application on yield and quality of sugarbeet at Ishurdi site

Treatment	Brix (%)	Pol (%) Beet	Millable Sugarbeet (x 10^3 ha^{-1})	Yield of Sugarbeet (tha^{-1})
T_1	19.20 c	11.14 c	65.50 d	72.00 e
T_2	19.42 bc	13.40 a	85.17 ab	82.33 ab
T_3	20.25 a	13.70 a	87.00 a	84.00 a
T_4	19.70 b	12.20 b	76.67 c	76.00 d
T_5	19.66 b	13.27 a	80.50 abc	80.00 bc
T_6	19.67 b	12.70 b	77.67 bc	79.00 c
LSD (0.05)	0.19	0.25	3.46	1.31
CV (%)	1.17	2.45	5.38	2.04

Means followed by uncommon letters are statistically different from each other at 5% level of probability as per DMRT

Figure 1 revealed that the highest crown rot incidence was found in control (18.13 %) and the lowest incidence was found in treatment T_3 (2.13%) where boron was applied in soil @ 1.5 kg ha^{-1} as basal at Ishurdi site (AEZ 11). This might be due to higher boron application in treatment T_3 which may led lower incidence of crown rot of sugarbeet at Ishurdi site. This results corroborates with that of Hughes *et al.* (1935) who reported boron deficiency caused crown rot in sugarbeet.

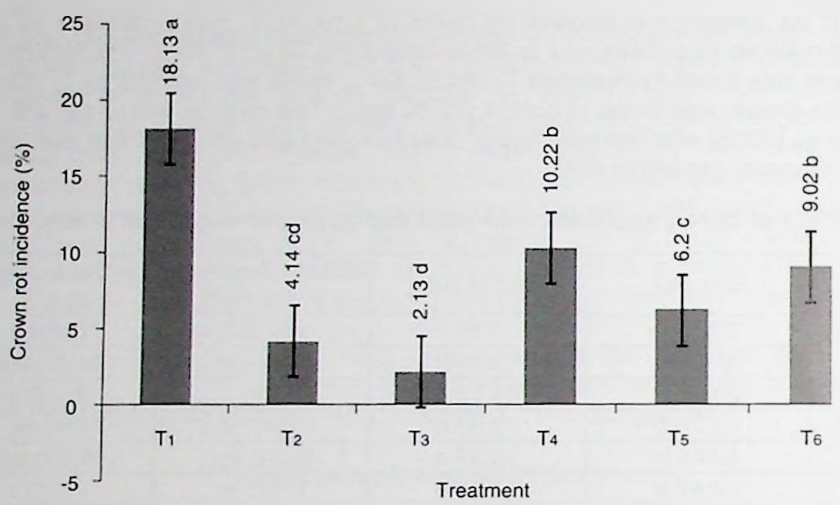

Figure 1. Influence of different boron rate on crown rot incidence of sugarbeet at Ishurdi site (AEZ 11)

Vertical bars represent standard error of treatment means. Means followed by uncommon letters are statistically different from each other at 5% level of probability as per DMRT

Initial and post harvest nutrient status of soil of the experimental plot were presented in Table 2. It revealed that organic carbon percent, pH, nitrogen, phosphorus, potassium and sulpher contents in soil slightly changed due to the use of different boron treatments in sugarbeet plots under study.

Table 2. Initial and post harvest nutrient status at Ishurdi site

Treatment	OC (%)	pH	N (%)	P (ppm)	K(meq%)	S (ppm)
Initial Soil	0.62	7.58	0.06	9.0	0.12	28.0
Post Harvest Soil						
T_1	0.60	7.60	0.055	8.5	0.12	25.0
T_2	0.62	7.55	0.058	8.5	0.13	26.0
T_3	0.61	7.58	0.065	9.0	0.13	26.0
T_4	0.60	7.55	0.055	9.5	0.12	27.0
T_5	0.60	7.55	0.050	9.5	0.13	25.0
T_6	0.60	7.58	0.060	9.0	0.12	26.0

Economic performance

The economic performance of different levels of boron on sugarbeet at Ishurdi site (AEZ 11) was presented in Table 3. The highest gross return was obtained from 1.5 kg B ha^{-1} (T_3) but its variable cost was also highest. The highest Marginal Benefit Cost Ratio

(MBCR) was also obtained in treatment T_3 where 1.5 kg B ha^{-1} was used along with the blanket dose of MOC_{450}, N_{120}, P_{20}, $K_{112.5}$, S_{18}, and $Zn_{3.5}$. Hence, application of 1.50 kg B ha^{-1} in sugarbeet at Ishurdi (AEZ 11) was found to be the most profitable economically.

Table 3. Economic performance of different level of boron (B) on sugarbeet production (Ishurdi site)

Treatment	Applied Boron	Yield (Kg ha^{-1})	Gross return	Variable cost	MBCR [1]
			----------Tk.ha^{-1}----------		
T_1	0	72000	360000	30629	-
T_2	1.2 Kg ha^{-1}	82330	411650	32549	1.59
T_3	1.5 Kg ha^{-1}	84000	420000	32789	1.82
T_4	50 ppm	76000	380000	30701	0.65
T_5	75 ppm	80000	400000	30737	1.30
T_6	100 ppm	79000	395000	30773	1.14

Input Price: Urea = Tk. 16.00 kg^{-1} . TSP = Tk. 22.00 kg^{-1}, MOP = Tk. 15.00 kg^{-1}, Gypsum = Tk. 15.00 kg^{-1}, Zinc Sulphate Mono: Tk. 120 kg^{-1}, Boric Acid = 240 kg^{-1} , Mustard Oil Cake: Tk. 40 kg^{-1}. Variable cost includes fertilizer cost only. Output Price: Sugarbeet: Tk. 5.00 kg^{-1}

Thakurgaon site (AEZ 1)

Results presented in Table 4 showed that growth parameters and yield of sugarbeet responded significantly due to boron application at Thakurgoan site. The highest brix percent of sugarbeet was found in treatment T_2 (19.17%) where boron was applied @ 1.2 kg ha^{-1} as basal which was statistically similar with T_4 (18.78 %), T_6 (18.67 %) and T_3 (18.61%). This result also partially corroborates with that of El- Hawary (1994) and Bondok (1996) stated that sugar yield was increased due to boron application. Armin *et al.* (2012) also reported higher sucrose concentration in sugarbeet with boron application. The highest millable sugarbeet was obtained in treatment T_3 (90.00×10^3 ha^{-1}), which was followed by T_2 (88.50×10^3 ha^{-1}), T_5 (86.33×10^3 ha^{-1}) and T_6 (85.67 x 10 ha^{-1}). The lowest millable sugar beet was found in control (57.30×10^3 ha^{-1}). The highest yield of sugarbeet was found in treatment T_3 (85.17 tha^{-1}) which was followed by T_2 (82.83 t ha^{-1}) and the lowest was found in control (70.67 t ha^{-1}). This finding was also at par with that of Mirvat *et al.* (2005) who reported higher beet root yield was obtained with high level of boron (2.0 Kg/acre) application in soil. It revealed from Figure 2 that the highest crown rot disease incidence was also found in control (17.21 %) and the lowest incidence was found in treatment T_3 (1.48 %) at Thakurgoan site (AEZ 1).

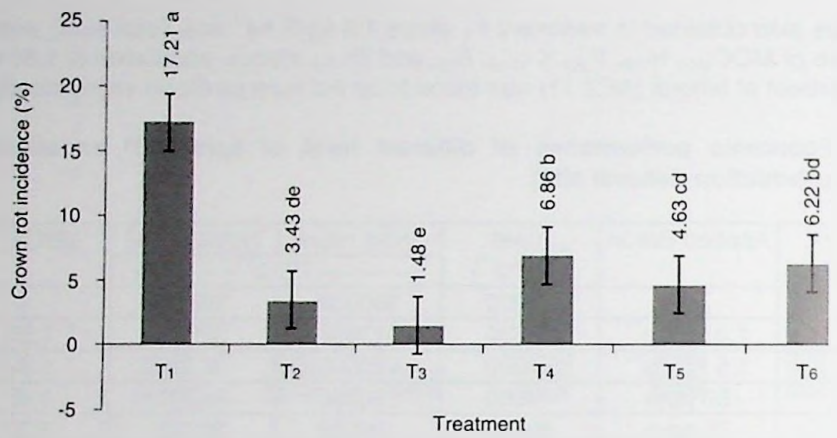

Figure 2. Influence of different boron rate on crown rot incidence of sugarbeet at Thakurgoan site (AEZ 1)

Vertical bars represent standard error of treatment means. Means followed by uncommon letters are statistically different from each other at 5% level of probability as per DMRT

Table 4. Effect of boron application on yield and quality of sugarbeet at Thakurgaon site

Treatment	Brix (%)	Millable Sugarbeet (x 10^3 ha^{-1})	Yield of Sugarbeet (tha^{-1})
T_1	18.45 b	57.30 c	70.67 d
T_2	19.17 a	88.50 a	82.83 ab
T_3	18.61 ab	90.00 a	85.17 a
T_4	18.78 ab	83.00 b	76.67 c
T_5	18.33 b	86.33 ab	79.33 bc
T_6	18.67 ab	85.67 ab	78.50 c
LSD (0.05)	0.28	3.61	1.63
CV (%)	1.81	2.41	2.54

Means followed by different letters are statistically different from each other at 5% level of probability as per DMRT

Initial and post harvest nutrient status of soil of the experimental plot were presented in Table 5. It revealed that organic carbon percent, pH, nitrogen, phosphorus, potassium and sulpher contents in soil slightly changed due to different boron treatments used in sugarbeet production.

Table 5. Initial and post harvest nutrient status at Thakurgoan site

Initial Soil						
Treatment	OC (%)	pH	N (%)	P (ppm)	K(meq%)	S (ppm)
	1.28	5.05	0.12	29.0	0.14	58.0
Post Harvest Soil						
T_1	1.22	5.05	0.10	24.o	0.11	48.0
T_2	1.24	5.10	0.12	26.0	0.13	55.0
T_3	1.25	5.10	0.12	25.0	0.14	54.0
T_4	1.23	5.08	0.11	24.0	0.12	50.0
T_5	1.25	5.10	0.12	26.0	0.13	55.00
T_6	1.26	5.08	0.13	28.0	0.14	57.00

Economic performance

The economic performance of different levels of boron on sugarbeet at Thakurgoan (AEZ 1) is presented in Table 6. The highest gross return (Tk. 425850) and MBCR (2.21) was also obtained in treatment T_3 as in Ishurdi site. Hence, application of 1.50 kg B ha^{-1} in sugarbeet at Thakurgoan (AEZ 1) was also found to be the most profitable economically.

Table 6. Economic performance of different level of boron (B) on sugarbeet production (Ishurdi site)

Treatment	Applied Boron	Yield (Kg ha^{-1})	Gross return	Variable cost	MBCR [1]
			----------Tk.ha^{-1}----------		
T_1	0	70670	353350	30629	-
T_2	1.2 Kg ha^{-1}	82830	414150	32549	1.87
T_3	1.5 Kg ha^{-1}	85170	425850	32789	2.21
T_4	50 ppm	76670	383350	30701	0.98
T_5	75 ppm	79330	396650	30737	1.41
T_6	100 ppm	78500	392500	30773	1.27

Input Price: Urea= Tk. 16.00 kg^{-1}. TSP= Tk. 22.00 kg^{-1}, MOP= Tk. 15.00 kg^{-1}, Gypsum= Tk. 15.00 kg^{-1}, Zinc Sulphate Mono: Tk. 120 kg^{-1}, Boric Acid= 240 kg^{-1}, Mustard Oil Cake: Tk. 40 kg^{-1}. Variable cost includes fertilizer cost only
Output Price: Sugarbeet: Tk. 5.00 kg^{-1}

Results revealed that in both the locations, the highest pol (%), millable sugarbeet, yield of beet, MBCR and the lowest crown rot was obtained in treatment T_3, where boron was applied in soil @ 1.5 kg ha^{-1}. This might be due to efficient and higher uptake of boron by sugarbeet crop which may led higher sugar accumulation and maximum yield of beet root. It was also observed from the results that soil application of boron responded better than that of foliar application regarding yield and quality parameters of sugarbeet. This result was in agreement with that of Gezgin *et al.* (2001) who reported highest yield and the better quality of sugarbeet was found with the soil application method of boron at the level of 0.3 kg/da as borax material.

From the above discussions, it may be concluded that at Ishurdi site (AEZ 11), the highest brix and pol percent of sugarbeet, lowest incidence of crown rot, highest millable beet, yield of beet and MBCR were obtained in treatment T_3 where boron was applied in soil @ 1.5 kg ha^{-1} as basal. At Thakurgoan site (AEZ 1) similar trend was observed in growth parameters, yield and economic performance due to boron application in sugarbeet. It was also found that soil application of boron performed better regarding yield, quality and suppression of crown rot disease incidence in sugarbeet at both the location.

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