

EFFECT OF SOWING DATE AND VARIETY ON THE YIELD OF TROPICAL SUGAR BEET (*Beta vulgaris*)

M. M. Hossain, M.A. Kader and M.A. Kashem¹

Department of Agronomy, Bangladesh Agricultural University, Mymensingh

¹ Director, PIU-BARC NATP Phase 1, BARC, Dhaka

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Abstract

A field experiment was conducted at the Agronomy Field, Bangladesh Agricultural University, Mymensingh from November 2010 to April 2011. The experiment comprised four sowing dates viz., 10 November, 20 November, 30 November and 10 December and five varieties viz., Shubhra, Cauvery, EB- 0616, EB-0626 and EB-0809. The experiment was laid out in a split plot design (SPD) with three replications. The results revealed that both the variety and sowing date exerted significant influence on the yield of beet. The highest beet yield (89.74 t ha⁻¹) was obtained from the variety EB-0809 while EB-0626 gave the lowest beet yield (58.91 t ha⁻¹). The highest beet yield (106.8 t ha⁻¹) was obtained from 10 November sowing and the beet yield declined gradually with sowing afterwards. The interaction of sowing date and variety showed significant effect on beet yield. The variety EB-0809 produced the highest yield at 10 November sowing which was significantly superior to that any other variety in combination with the sowing dates.

Introduction

Sugar beet (*Beta vulgaris* L.) ranks second next to sugarcane in terms of world's sugar production. Sugar beet is a temperate crop, generally grown in Europe, North America and temperate zones of Asia. According to FAO, France, Germany, Russia, USA and Ukraine are most sugar beet producing country of the world. Sugar beet is known as one of the salinity tolerant crop species. Although it is a temperate crop, recently several varieties have been developed which can successfully be grown in tropical regions. Tropical sugar beet brings significant agronomic, environmental and out advantages to many tropical countries such as India, Pakistan, Sudan etc. Compared to sugarcane, this tropical sugar beet can be grown in relatively dry areas with substantially less water. It is faster growing and can be harvested after five months allowing farmers to grow a second crop on the same land. Most importantly, sugar beet is the most salt tolerant terrestrial crop species. Therefore, cultivation of tropical sugar beet might be a very good alternative crop for drought prone Barind areas and salinity prone coastal areas of Bangladesh.

The suitable time for sowing of tropical sugar beet in Bangladesh is *Rabi* season (October - November) (Anonymous, 2005). Generally the time of sowing of tropical sugar beet varies with the climate of the region and the variety used. The duration of growing period of the crop is narrow. Therefore, planting time is the most crucial factor affecting the yield of this crop to a great extent. Substantial yield increase of sugar beet can be achieved by planting the crop at proper time which may vary from variety to variety (Abo-Salama and EL-Sayiad (2000). The sowing time of sugar beet at any location is decided by the prevailing temperature and the optimum temperature limit ranges between 15-25°C for germination, 21-35°C for growth and development and 15-18°C for maturation (Ustimenko-Barumovsky, 1983). So it is crucial to find out an optimum planting date with a view to obtain maximum beet yield from tropical sugarbeet in Bangladesh.

Sowing time has a profound bearing on the yielding ability of tropical sugarbeet. Many investigators have studied the effect of planting dates on yield and quality of sugarbeet. Badawi (1985) and Hanna (1988) recorded that planting sugarbeet on 10th October produced the highest TSS %, sucrose % and root, top as well as sugar yields fad^{-1} . Badawi (1989) found that early planting *i.e.* 1st September associated with higher TSS %, sucrose %, purity %, root, top and sugar yields fad^{-1} . He also recorded that planting on 1st September or 1st October has not significant differences in all studied characteristics. EL-Kassaby and Leilah (1992) detected that sowing dates had significant effects on root and sugar yields fad^{-1} . Sowing sugar beet during October recorded the higher root, top and sugar yields fad^{-1} than sowing during November. Leilah and Nasr (1992) stated that sowing dates markedly affected sucrose and juice purity percentages as well as root and sugar yields fad^{-1} . They also confirmed that early sowing on 15th September recorded the highest root yields fad^{-1} . On the other hand, the highest mean of sugar yield was obtained from sowing sugar beet on 15th October. Badawi *et al.* (1995) and Ghonema (1998) reported that planting dates had obvious effect on sucrose and purity percentages as well as root and sugar yields fad^{-1} . They concluded that planting sugar beet during October produced the maximum sucrose %, purity %, root and sugar yields fad^{-1} as compared with planting during September or November. Ramadan and Hassanin (1999) revealed that sown sugar beet on 10th September produced greater root and recoverable sugar yields fad^{-1} . They also recorded that delaying sowing date to 10th November intensified reducing in sucrose, purity and recoverable sugar percentages. Abdou (2000) and Abo-Salama and EL-Sayiad (2000) found that planting tropical sugar beet on 1st October gave obvious increment in root, top and sugar yields fad^{-1} . On the other hand, the greatest values of TSS, sucrose and purity percentages were resulted from planting sugarbeet on 1st September. Refay (2010) concluded from the experiment which was conducted with three sugarbeet varieties (Universe, Samo-1 and Samo-2) in relation to three planting dates (15th of September, October and November). This study appeared that delays in sowing mid September to mid November the proper varieties of sugarbeet gave higher root yield and sugar yield with good quality. Beet yield was greater for Samo-2 as compared, to those other two Univers and Samo-1. These results are in agreement with the finding of Joseph (1997) and Smit (1993). Kandil *et al.* (2002) reported that planting dates showed favorite effect on quality parameters (TSS, sucrose and juice purity percentages) and root, top as well as sugar yields fad^{-1} . Finally, planting on 15th October gave the highest means of the most yield and quality characters.

Rahman *et al.* (2006) reported from the experiment conducted in BSRI farm, Ishurdi and RARS, Thakurgaon with five sugar beet varieties viz., Shubhra, Cauvery, EB-0618, EB-0626 and EB-0809 having two sowing dates viz., 8 November 2010 and 8 December 2010. There was significant reduction in the yield when the crop was sown on 8 December 2010. Sowing on 8 November 2010 provided the most favorable conditions for the growth of the sugar beet. On both sowing dates Shubhra gave the highest yield (133 t ha^{-1}) followed by Cauvery (126.6 t ha^{-1}), EB-0618 (110 t ha^{-1}), EB-0809 (98.33 t ha^{-1}) and EB-0626 (71.67 t ha^{-1}). Rahman (2011) concluded from several experiments conducted at BSRI farm and their RARS farm during the period from 2006 to 2011. In all cases early sowing date produces the highest yield. Thus he concluded that sugarbeet can successfully be cultivated in Bangladesh twice in a year viz., November to April and December to May. But November to April season is best for producing maximum yield.

BARI (2010) conducted trials with 14 varieties planted during November, 2009 and February, 2010. Second planted plots were destroyed due to heavy rain. Among the varieties planted on November, 2009, the white rooted varieties gave the higher yield ($46\text{-}85 \text{ t ha}^{-1}$) compared to the reddish brown rooted varieties ($38.2\text{-}70.6 \text{ t ha}^{-1}$).

BRAC (2010) conducted field experiment with 9 varieties (viz., Shubhra, Cauvery, C-Green, EB-0513, EB-0616, EB-0617, EB-0621, EB-0625 and EB-0626) planted in November, 2009 and January, 2010 in different regions namely, Gazipur, Dinajpur, Rajshahi, Thakurgaon, Patuakhali

and Noakhali. In all the regions November, 2009 planting gave the higher yield compared to January 2010. Among the 9 varieties Cauvery gave the highest yield (120 t ha^{-1}).

Planting time is a non monetary input but play a significant role in increasing the yield of tropical sugarbeet. Therefore, identification of variety specific sowing date is essential for economic yield of the crop. Considering the above facts, the present research work was conducted to find out appropriate sowing time of different varieties.

Materials and Methods

The field trial was conducted at the Agronomy Field, Bangladesh Agricultural University, Mymensingh from November 2010 to April 2011 using five varieties viz., Shubhra, Cauvery, EB-0616, EB-0626 and EB-0809 sown at different dates viz., 10 November, 20 November, 30 November and 10 December. The experimental design was SPD with three replications. The experimental field belongs to non-calcareous dark gray flood plain soil. The field was medium high land of silty loam in texture with moderately acidic in nature having pH around 6.8. The experimental field was well prepared by ploughing and cross ploughing four times followed by laddering. All weeds, stubbles and crop residues were removed and then divided into the experimental units. The land was uniformly fertilized with 260 kg Urea, 100 kg triple super phosphate (TSP), 225 kg muriate of potash (MOP) and 100 kg gypsum ha^{-1} respectively. Seeds were sown followed by line sowing method at the rate of 1 seed hill^{-1} at 2 cm depth. A distance of 50 cm \times 20 cm was maintained. Necessary thinning and gap filling was done at the age of 35 days from planting to obtain one plant hill^{-1} . Plants were kept free from weeds, which were manually controlled by hand hoeing. The common agricultural practices for growing sugar beet according to the recommendations of Bangladesh Sugarcane Research Institute (BSRI) were followed. The results were statistically analyzed according to Gomez and Gomez (1984). Least significant difference (LSD) method was used for mean comparisons.

Results and Discussion

The results revealed that both the variety and sowing date along with their interaction exerted significant influence on the yield of beet and different plant characters. Results obtained from the study discussed under the following headings as bellows:

Effect of variety

The result showed that beet yield (t ha^{-1}) and other plant characters viz., plant weight (t ha^{-1}), plant height (cm), beet length (cm), beet girth (cm), leaf weight (t ha^{-1}) and leaf length (cm) showed a significant response to varieties (Table 1). The highest beet yield (89.74 t ha^{-1}) was obtained from the variety EB-0809 while EB-0626 gave the lowest beet yield (58.91 t ha^{-1}). The variety EB-0809 produced the highest plant weight (134.2 t ha^{-1}) and the lowest plant weight was obtained from the variety EB-0626. The highest plant height (70.79 cm) and the lowest plant height (56.96 cm) were obtained from the variety EB-0809 and EB-0626 respectively. In case of beet length, beet girth and leaf weight the highest value 26.29 cm, 28.24 cm and 45.21 t ha^{-1} respectively obtained from the variety EB-0809 followed by Shubhra, Cauvery, EB-0616 and EB-0626. The longest leaf (50.60 cm) was obtained from the variety EB-0809 followed by Shubhra, EB-0616, Cauvery and EB-0626.

Effect of variety on the beet yield and other plant parameters in our study revealed that among the five varieties used, variety EB-0809 yielded the highest values for beet yield including all the plant characters. This happened might be due to the genetical variation for yield potentials among the varieties/lines. This statement supports the previous results of Rahman (2011) and Abo-Salama and EL-Sayiad (2000).

Table 1. Effect of variety on different plant characters of sugarbeet

Variety	Plant weight (t ha ⁻¹)	Plant height (cm)	Root yield (t ha ⁻¹)	Root length (cm)	Root girth (cm)	Leaf weight (t ha ⁻¹)	Leaf length (cm)
Shubhra	114.2	62.21	75.93	25.28	29.97	39.29	43.00
Cauvery	106.8	59.58	66.78	24.56	27.94	41.57	39.34
EB-0616	108.9	59.63	72.99	20.24	27.74	37.56	39.76
EB-0626	97.96	56.96	58.91	19.01	25.77	38.45	38.55
EB-0809	134.2	70.79	89.74	26.29	28.24	45.21	50.60
LSD (0.05)	9.13	2.50	7.84	2.41	2.26	6.952	1.82
CV (%)	7.17	3.57	9.49	9.15	7.17	15.18	3.81

Effect of sowing date

Sowing date exerted significant influence on beet yield, plant weight (t ha⁻¹), plant height (cm), beet length (cm), beet girth (cm), leaf weight (t ha⁻¹) and leaf length (cm) (Table 2). The highest beet yield (106.8 t ha⁻¹) was obtained from 10 November sowing and the beet yield declined gradually with sowing afterwards. 10 November sowing gave the highest plant weight (160.5 t ha⁻¹) while 10 December sowing gave the lowest (67.70 t ha⁻¹). The highest plant height (76.67 cm) was obtained from 10 November sowing and the one was obtained from 10 December sowing. The highest beet length (25.84 cm) was obtained from 10 November sowing while the lowest (21.42 cm) from the 10 December sowing. The highest (34.02 cm) and the lowest (23.36 cm) beet girth were obtained from 10 November and 10 December sowing respectively. The highest leaf weight (55.08 t ha⁻¹) was obtained from 10 November sowing while the lowest (21.36 t ha⁻¹) from the 10 December sowing. 10 November sowing date also gave the highest leaf length (51.50 cm) and 10 December sowing gave the lowest one (36.30 cm).

The above stated results revealed that beet yield including all other plant characters studied gave the highest value on 10 November sowing and the values for all the parameters decreased gradually with sowing after 10 November. This happened might be due to the deviation of temperature range from the optimum required to obtained highest values that prevails on 10 November sowing date. Sowing on 10 November might influence plant establishment by giving better establishment than the later ones. Better plant establishment obtained from 10 November might be due to providing better opportunity for increased leaf area index and consequently the amount of solar radiation interception. Early crop establishment might provide better chance to exploit good weather conditions that leads higher beet yield during 10 November sowing compared to sowing on other dates. This result supports the previous results of Rahman (2011), Refay (2010) and Fortune *et al.* (1999).

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Table 2. Effect of sowing date on different plant characters of sugarbeet

Sowing date	Plant weight (t ha ⁻¹)	Plant height (cm)	Root yield (t ha ⁻¹)	Root length (cm)	Root girth (cm)	Leaf weight (t ha ⁻¹)	Leaf length (cm)
10 November	160.5	76.67	106.8	25.84	34.02	55.08	51.50
20 November	118	63.09	74.88	23.79	27.85	42.46	42.39
30 November	103	56.98	61.13	22.22	26.50	42.76	38.80
10 December	67.7	50.63	48.35	21.42	23.36	21.36	36.30
LSD (0.05)	9.36	2.56	8.04	2.48	2.32	7.12	1.87
CV (%)	7.17	3.57	9.51	9.15	7.17	15.18	3.81

Interaction effect of sowing date and variety

Interaction effect of variety and sowing date on beet yield and different plant characters was significant (Table 3). The highest beet yield (157.0 t ha⁻¹) was observed in variety EB-0809 with 10 November sowing interaction and the lowest beet yield (44.01 t ha⁻¹) was observed in EB 0626 with 10 December sowing interaction. The highest plant weight (222.0 t ha⁻¹), plant height (89.57 cm), beet length (28 cm), beet girth (38.01 cm), leaf weight (63.87 t ha⁻¹) and leaf length (64.47 cm) was observed in variety EB-0809 with 10 November sowing interaction. The lowest plant weight (63.78 t ha⁻¹), plant height (47.52 cm), beet length (15.89 cm), beet girth (23.01 cm), leaf weight (15.74 t ha⁻¹) and leaf length (33.83 cm) was observed in variety EB-0626 with 10 December sowing interaction.

Table 3. Interaction effect of planting date and variety on plant characters and yield of tropical sugarbeet

Interaction (D V)	Plant weight (t ha ⁻¹)	Plant height (cm)	Root yield (t ha ⁻¹)	Root length (cm)	Root girth (cm)	Leaf weight (t ha ⁻¹)	Leaf length (cm)
D ₁ V ₁	164.1	82.03	110.5	26.27	37.00	53.88	57.52
D ₁ V ₂	142.8	73.13	94.38	25.53	32.79	50.87	45.08
D ₁ V ₃	155.0	70.43	100.1	27.39	33.00	58.88	43.60
D ₁ V ₄	118.3	68.17	71.89	22.00	29.32	47.92	46.83
D ₁ V ₅	222.0	89.57	157.0	28.00	38.01	63.87	64.47
D ₂ V ₁	125.2	63.20	89.40	25.71	29.38	34.52	40.15
D ₂ V ₂	112.1	52.00	60.25	24.55	29.33	51.06	35.10
D ₂ V ₃	113.3	66.99	75.61	21.43	27.45	36.68	45.20
D ₂ V ₄	112.2	59.63	59.17	20.43	26.61	50.84	38.62
D ₂ V ₅	127.5	73.63	89.97	26.83	26.48	39.21	52.90
D ₃ V ₁	98.88	53.52	55.25	25.23	30.64	44.30	37.90
D ₃ V ₂	106.9	64.77	68.46	24.13	27.20	37.47	41.85
D ₃ V ₃	99.76	50.97	64.55	17.87	26.10	35.21	34.12
D ₃ V ₄	97.51	52.53	58.67	17.65	24.13	39.29	34.90
D ₃ V ₅	113.8	63.10	58.69	26.23	24.43	57.51	45.23
D ₄ V ₁	68.55	50.10	48.61	23.90	22.88	24.45	36.44
D ₄ V ₂	65.23	48.43	44.01	24.00	22.46	26.89	35.32
D ₄ V ₃	67.72	50.11	51.74	16.67	24.43	19.46	36.10
D ₄ V ₄	63.78	47.52	44.01	15.89	23.01	15.74	33.83
D ₄ V ₅	73.67	56.97	53.40	26.67	24.04	20.24	39.79
LSD (0.05)	14.34	3.93	12.31	3.79	3.56	10.91	2.86
CV (%)	7.17	3.57	9.51	9.15	7.17	15.18	3.81

D₁= 10 November, D₂= 20 November, D₃ = 30 November, D₄= 10 December, V₁= Shubhra, V₂=Cauvery, V₃ =EB-0616, V₄=EB-0626, V₅ = EB-0809

From the present study it was evident that the highest beet yield was produced by the variety EB-0809 when seeds were sown on 10 November might be due to better exploitation of environmental factors that facilitates the higher production and translocation of photosynthates from the source (leaf) to sink (beet).

Conclusions

The present study revealed that both the sowing date and variety exerted significant effect on yield and plant characters of tropical sugarbeet. The beet yield decreased gradually with sowing after 10 November. The results indicated that all the varieties gave higher yield with 10 November sowing compared to the sowing on other dates used in the study and overall the variety EB-0809 yielded the highest beet (89.74 t ha^{-1}) among five varieties. The interaction effect of variety and sowing date showed significant effect on most of the plant characters. Finally, it may be concluded that the highest yield in tropical sugarbeet could be obtained if variety EB-0809 is sown on 10 November under Agro-ecological condition of Old Brahmaputra Floodplain.

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