EBAUB Journal Volume 1 January 2019

EBAUB Journal

ISSN: 2617 - 8338

An Academic Journal of
EXIM Bank Agricultural University Bangladesh

Effect of Sowing Dates and Harvesting times on Total Soluble Solid, Sucrose Content and Root Yield of Tropical Sugar Beet

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ARTICLE INFO

Received date: Sep. 26, 2018
Accepted date: Dec. 26, 2018

ABSTRACT

A field study was conducted on tropical sugar beet to evaluate the effect of sowing and harvesting time variations on the root yield, total soluble solid (TSS), sucrose content and sucrose yield from November 2011 to May 2012. Three tropical sugar beet genotypes *viz*, Cauvery, Shubhra and EB 0616 were sown on four dates at 1st November, 15th November, 1st December and 15th December following randomized complete block design. Three sugar beet plants were harvested randomly at 120, 135, 150 and 165 days after emergence (DAE) to determine the total soluble solid and sucrose content (Pol %) in root. The highest TSS (19.31) and sucrose content (14.93) were found in the genotype EB 0616 at 1st November. However, there was no significant difference within those sowing time variations but were significantly affected at harvesting time. The highest sucrose yield (14.8 t/ha) and root yield (103.5 t/ha) were found in the genotype EB0616 at 1st November sowing and significantly reduced as the advancement of sowing date. All the genotypes produced higher sucrose yield when harvested at 165 DAE but were statistically similar to the result of 150 DAE. This study recommended that early November sowing date and 150 to 160 DAE harvesting time seems to be high yield of root and sucrose for tropical sugar beet in Bangladesh.

Key words: Harvesting time, Sowing time, Sucrose content, Total soluble solid, Tropical sugar beet, Yield

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1. INTRODUCTION

Sugar beet (*Beta vulgaris* L.) ranks second sugar producing crop in the world (FAO, 2010). Although sugar beet is a temperate crop, some tropical genotypes have been developed by the Syngenta Company which can grow in tropical climatic conditions; hence it has got importance in Bangladesh. This tropical sugar beet is a short duration crop (5-6 months) with high sucrose content (14-20%) compared to sugarcane which is a long duration crop (12-14 months) with low sucrose (10-12%) content. Being a short duration crop compared to sugarcane, sugar beet can be well fitted in the existing cropping pattern of Bangladesh. There is very limited research on tropical sugar beet related to its optimum

To Cite: Ferdous, H.M., Khaliq, Q.A., Karim, M.A. & Rahman, S. (2019). Effect of sowing dates and harvesting times on total soluble solid, sucrose content and root yield of tropical sugar beet. *EBAUB J.*, 1, 104-108.

sowing time and optimum harvesting time for better yield and quality in Bangladesh. It is reported that, sowing date of tropical sugar beet varies with the climate of the region and the genotypes used. Therefore, sowing time is the most crucial factor affecting the yield of this crop to a great extent. In general, if the crop is sown early under favorable climatic and edaphic conditions, it will produce good quality roots (Harwey et al., 1995). Sugar beet sowing time also depends on the cultivation technology chosen (Romaneckas et al., 2003) and is influenced by soil moisture. Substantial yield increase in sugar beet can be achieved by sowing the crop at proper time which may vary from genotypes to genotypes (Abo-Salama & EL-Sayiad, 2000). Earlier studies showed that short vegetation period in the late sowing reduced sugar content and sugar yield (Marlander, 1992). According to Theurer (1979) the earlier the leaf canopy develops, the better the chance for higher sucrose production because the root, rather than the foliage, receives the bulk of the photosynthetic assimilate for a longer period.

Harvesting time is one of the most factors that affects on yield and quality of sugar beet crop. Jaggard& Scott (1999) and Burcky & Winner (1986) suggested that later harvest dates for sugar beet result in greater sugar yield under no rainfall and cold weather. While, Brown (1997) reported that a delay in sugar beet harvest till the end of autumn leads to decrease in sugar beet yield and sucrose percentage and white sugar content. Jozefyova et al. (2004) evaluated the harvest time effect on production of two different sugar beet varieties grown in five variants nitrogen fertilization and reported the postponement of the time of harvest (at 27 days) and increased average root yield by 11.35 t ha^{-1}. Heidari et al. (2008) found that late harvesting (187 days after emergence) resulted in greater yield of root, total and white sugar yield than earlier harvesting.

As a new promising sugar crop in Bangladesh it is necessary to evaluate the optimum sowing time in relation to its root yield and quality parameters. Hence, the study was conducted to find out the optimum sowing time and harvesting time in relation to its root yield, sucrose yield and quality in experimental region of Bangladesh.

2. MATERIALS AND METHODS

The experiment was conducted in the experimental field of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh with Randomized Complete Block Design (RCBD) having two factors with three replications. Seeds of three tropical sugar beet genotypes viz. Shubhra, Cauvery and EB0616 were sown on four different dates at 15 days interval starting from 1st November 2011maintaining 50×20 cm spacing in 3×2 m^2 unit plot.

Dolomite was applied @ 1500kg/ha seven days before sowing to raise the soil pH from 5.7 to 7.2 as sugar beet prefer slightly saline soil (Rahman et al., 2006). During final land preparation cow dung @ 15 t ha^{-1} was incorporated into the soil. A fertilizer dose of 120 kg N, 105 kg P_2O_5, 150 kg K_2O, 18 kg S, 3.5 kg Zn and 1.2 kg B ha^{-1} was applied in the form of urea, TSP, MoP, $ZnSO_4$ and boric acid, respectively. One third of the total urea with all amount of other fertilizers were applied during final land preparation. The remaining amount of urea was applied as top dressing in two equal installments at 60 and 100 days after sowing (DAS). The field was kept weed free by hand weeding at 20, 40 and 60 DAS. Plant was thinned out keeping one plant per hill during the second weeding. Earthting up was done at 60 DAS and 100 DAS after top dressing of nitrogen. Plants were infected by damping off disease at seedling stage, and sclerotium root rot at seedling and later stages of growth. These diseases were controlled by applying Dithane M 45 @ 2.2 kg ha^{-1} at seedling stage, and at later stage by applying Score 250 EC 0.5 ml/L of water.

Out of the 6 m^2 of unit plot 2 m^2 was kept in each plot for final harvest to estimate the root yield and from the remaining 4 m^2 of land three plants were randomly selected from each plot at 120, 135, 150 and 165 days after emergence (DAE) according to sowing dates to determine total soluble solid (TSS) and sucrose content in root.

Total soluble solid in beet juice was determined by using Brix refractometer and sucrose content or pol % was determined by using Automatic Polarimeter (Model: ATAGO AP-300) standardized at 20°C by Horne's dry lead method at the laboratory of Physiology and Sugar Chemistry Division, BSRI, Ishurdi.

Based on sowing dates, plants were harvested at 165 DAE from 2 m^2 of land from each plot and their root yield was calculated to kg m^{-2} and t ha^{-1}. The data were subjected to the combined analysis of variance and LSD test was used for means separation by using the MSTATC statistical software.

3. RESULTS AND DISCUSION

3.1 Total soluble solid (TSS)

Total soluble solid (TSS) in juice of sugar beet root was not significantly affected by sowing dates and the combined effect of sowing dates and harvesting time, but it was significantly affected by harvesting time. Although there is no significant change in the TSS value for different sowing dates, the highest TSS was found in early sown beets while, it reduced with delay in sowing in all the three genotypes (Table 2). The highest TSS (19.31 %) was obtained in the genotype Shubhra when sown on 1st November and the lowest (17.19 %) was found in the genotype Cauvery when sown on 15th December. The reduction in TSS with delay in sowing might be due to prevailing higher temperature during root formation. Reafy (2010) found higher TSS in sugar beet at 15th November sowing date in Saudi Arabia when the mean temperature was lower during the root development stage than that of 15 September and 15 October sowing date. Ohki & Ulrich (1973) also reported that the high temperature reduces the TSS in sugar beet.

Table1. Air temperature, relative humidity and total rainfall at different growth stages of tropical sugar beet during experimental periods.

Sowing dates	Crop growth stage at days after emergence (DAE)	Air temperature (°C)			Relative humidity (%)	Total rainfall (mm)
		Maximum	Minimum	Average		
1st November 2011	Seedling stage up to 60 DAE	25.45	17.61	21.53	88.03	0.00
	Rapid root development stage at 61 to 150 DAE	27.01	15.36	21.22	87.07	4.74
	Late root development stage at 151 to 165 DAE	33.52	21.95	27.73	88.57	97.8
15th November 2011	Seedling stage up to 60 DAE	23.68	14.60	19.14	87.47	0.00
	Rapid root development stage at 61 to 150 DAE	29.30	16.98	23.14	87.36	142.2
	Late root development stage at 151 to 165 DAE	35.20	24.48	29.84	84.85	79.2
1st December 2011	Seedling stage up to 60 DAE	22.64	12.48	17.57	89.24	0.74
	Rapid root development stage at 61 to 150 DAE	31.75	19.96	25.86	86.47	221.21
	Late root development stage at 151 to 165 DAE	34.71	26.53	30.62	85.45	62.8
15th December 2011	Seedling stage up to 60 DAE	22.75	19.90	17.33	86.54	0.74
	Rapid root development stage at 61 to 150 DAE	33.07	22.11	27.59	87.85	284.2
	Late root development stage at 151 to 165 DAE	34.97	27.08	31.02	88.54	65.21

Table.2. Effect of sowing dates on total soluble solid and sucrose content in three tropical sugar beet genotypes (averaged over four harvesting times).

Sowing date	Total soluble solid (%)			Sucrose content (%)		
	Cauvery	Shubhra	EB 0616	Cauvery	Shubhra	EB 0616
1st November 2011	17.59	19.31	17.88	13.98	14.93	13.96
15th November 2011	17.53	19.18	17.66	13.78	14.86	13.83
1st December 2011	17.33	19.04	17.63	13.70	14.55	13.80
15th December 2011	17.19	18.82	17.58	13.50	14.04	13.78
LSD (0.05)	ns	ns	ns	ns	ns	ns
CV%	2.51	2.80	2.59	2.67	2.57	2.90

ns; non-significant

Harvesting time showed significant effect on TSS in tropical sugar beet genotypes (Fig.1). In general, TSS progressively increased with increasing age in all sowing dates and genotypes. Similar trend was also reported by Heidari et al. (2008) and Cakmaki & Oral (2002). They found that the TSS increased with increasing the age of sugar beet plants. Irrespective of sowing dates, the highest TSS was obtained when harvested at 165 DAE in all genotypes. In case of Shubhra, the highest TSS (20.02) was obtained at 165 DAE which was significantly higher than that of earlier three harvesting times viz. 120, 135 and 150 DAE, but in case of the genotype EB0616 the TSS was identical when harvested at 165, 150 and 135 DAE. In case of Cauvery, harvesting at 150 and 165 DAE gave identical TSS.

3.2 Sucrose content

The results revealed that the sucrose content in root was unaffected by sowing dates and interaction effect between sowing dates and harvesting time, but it was significantly affected by harvesting time. Although, the sowing dates did not show significant effect on sucrose content in root, irrespective of genotypes early sown plants contained higher concentration of sucrose and it reduced with delay in sowing (Table 2). This result is in agreement with the findings of

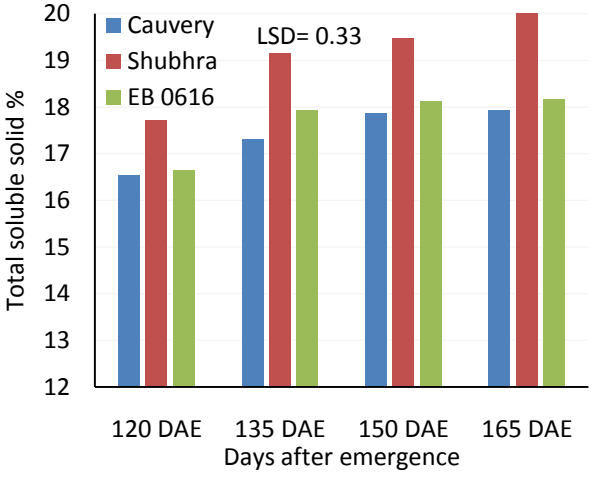

Fig.1. Effect of Harvesting times on TSS in root of three tropical sugar beet genotypes.

Smit (1993). They found that the sucrose content was inversely related with temperature.

As like as TSS, sucrose content also increased with increasing the crop age (Fig.2). Similar trend was also reported by Heidari et al. (2008) and Cakmakci & Oral (2002) in sugar beet. In the genotype Shubhra the highest concentration of sucrose (15.03 %) was recorded at 165 DAE which was identical to that of 150 DAE and significantly higher than that of 120 and 135 DAE.

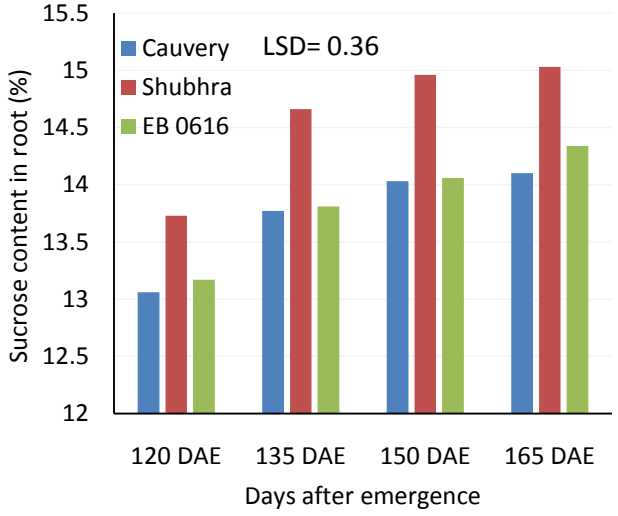

Fig.2. Effect of harvesting times on sucrose content in root of three tropical sugar beet genotypes.

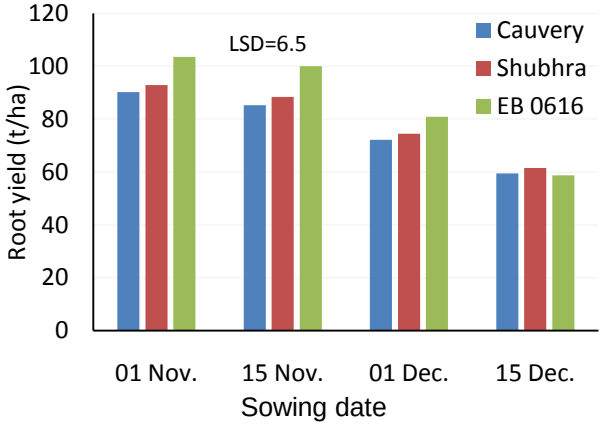

Fig.3. Effect of sowing dates on root yield in three tropical sugar beet genotypes.

Although, the interaction effect of sowing dates and harvesting time was not significant in tropical sugar beet genotypes in terms of sucrose concentration, it increased with delay in harvesting and decreased with delay in sowing. However, the highest sucrose content (15.33 %) was found in the genotype Shubhra when sown on 1st November and harvested at 165 DAE and the lowest was observed in Cauvery on 15th December sowing when harvested at 120 DAE (Table 3).

3.3 Root yield

A significant variation in root yield was observed due to interaction effect of sowing dates and genotypes (Fig.3). The highest root yield was obtained from the genotype EB0616 when sown on1st November (103.5 t ha^{-1}) and on 15thNovember (100 t ha^{-1}). The genotype Cauvery and Shubhra gave identical root yield when sown on 1st November and 15th November and their root yield significantly decreased with delay in sowing. The results revealed that root yield of tropical sugar beet genotypes significantly decreased with delay in sowing. Almost similar result was found by Rahman et al., (2006); BRAC (2010) in Gazipur, Dinajpur, Rajshahi, Thakurgaon, Patuakhali; BSRI (2011) in Pabna, Bangladesh.

Table.3. Interaction effect of sowing dates and harvesting time on sucrose percent in three tropical sugar beet genotypes.

Sowing date	Harvesting time DAE	Sucrose content (%)		
		Cauvery	Shubhra	EB 0616
1st November 2011	120	13.23	14.19	13.30
	135	14.06	14.92	14.04
	150	14.23	15.25	14.16
	165	14.38	15.33	14.34
15th November 2011	120	13.22	14.11	13.26
	135	13.75	14.87	13.83
	150	14.03	15.20	14.00
	165	14.11	15.26	14.24
1st December 2011	120	13.04	13.75	13.25
	135	13.72	14.71	13.76
	150	14.09	14.85	13.95
	165	13.97	14.89	14.25
15th December 2011	120	12.76	12.88	12.86
	135	13.53	14.14	13.60
	150	13.77	14.53	14.13
	165	13.93	14.63	14.52
LSD(0.05)		ns	ns	ns
CV%		2.67	2.57	2.90

3.4 Sucrose yield

The result revealed that the sucrose yield was significantly affected by the sowing date and genotypes. Although the sucrose content did not vary significantly, sucrose yield varied significantly due to significant difference in root yield. In general, sucrose yield significantly decreased in all genotypes due to delay in sowing. This result is in agreement with Al-Gateem (2000) and Amin et al. (1989). The highest sucrose yield (14.83 t/ha) was found in the genotype EB0616 when sown on 1st November which was statistically identical to Shubhra and EB0616 when sown on 1st November and 15th November, respectively (Fig. 4). Seeds sown on 15th December gave the lowest sucrose yield in all genotypes. Among the genotypes, EB0616 and Shubhra gave similar sucrose yield on 1st November, 15th November and 1st

December sowing while on 15th December sowing, all three genotypes gave statistically similar yield.

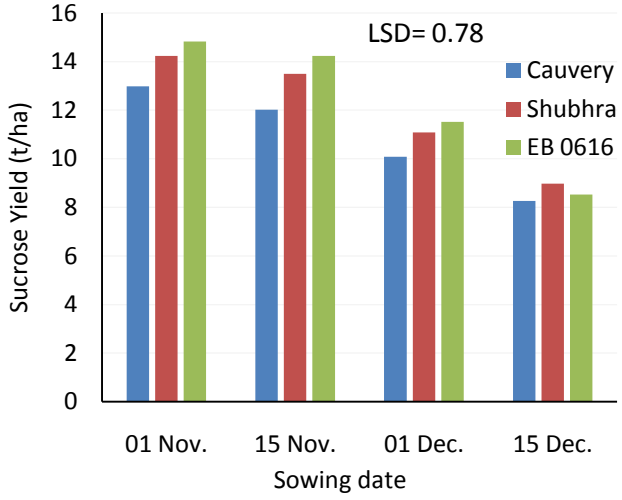

Fig.4. Effect of sowing dates on sucrose yield (t/ha) in three tropical sugar beet genotypes.

3. CONCLUSION

From the study it can be summarized that the tropical sugar beet genotypes viz, Cauvery, shubhra and EB0616 are suitable for cultivation in Bangladesh but the sowing time is very important to get higher root and sucrose yield. Sucrose yield significantly decreased in all the three genotypes with the advancement of sowing dates from 1st November onwards. The TSS and sucrose percent in root also slightly reduces with late sowing in all the three genotypes. The TSS and sucrose content in root remains lower at the early stage of growth and increases with the crop age and root size but at the later stage, those characters remains almost steady. Among the genotypes, shubhra contains more TSS and sucrose while the highest root yield and sucrose yield were achieved from the genotype EB 0616.

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