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Yield and Quality Attributes of Tropical Sugarbeet Genotypes

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ABSTRACT

An experiment was conducted at BSRI farm, Ishurdi, pabna during the period from December, 2014 to June, 2015 to evaluate the yield and quality attributes of seventeen genotypes of tropical sugarbeet.The experiment was laid out following two factorial RCB design with three replications. Factor 1 was 17 sugarbeet genotypes and factor 2 was different harvesting times viz. 120, 140, 160 and 180 days after sowing (DAS).Higher beet length was recorded 21.89 cm from the genotype V_{12}(SV 894) at 140 DAS.Higher average beet diameter was found 8.50 cm from the genotype V_{14}(Aranka) at 160 DAS. Higher beet fresh and dry weight were observed 1277 g and 143.33 g from the genotypes V_{17}(1277g) and V_6 (143.33 g),respectively at 160 DAS.Higher pol% beet (15.86%) and yield (127.77 tha^{-1}) was recorded from the genotypes V_3 (HI 0044) and V_{17} (Belleza), respectively at 160 DAS. On the basis of beet growth, beet yield and pol% beet analysis,the genotypes V_2 (Shubrha), V_{10} (SV 892) and V_{15} (Serenada) can be harvested at 140 DAS whereas the genotypes V_1 (Cauvery), V_3 (HI 0044), V_5 (SZ 35), V_6 (PAC 60008), V_7 (SV 887), V_8 (SV 889), V_{11} (SV 893), V_{12} (SV 894), V_{13} (Danicia), V_{14} (Aranka), V_{16} (Natura) and V_{17} (Belleza) can be harvested at 160 days after sowing. On the other hand, the genotypes V_4 (HI 0473) and V_9 (SV 891) can be harvested at 180 DAS for obtaining higher yield.

Key words: Yield, quality attributes, harvesting times, tropical sugarbeet

INTRODUCTION

Sugarbeet (*Beta vulgaris* L.) is 5-6 months crop with an average yield of 85-125 t $ha^{-1}$and sugar content of 14-20%. It is one of the important commercial crops that supplies approximately 35% of the worlds sugar (Wu *et al.*, 2016). It is a hardly biennial plant whose root contains a high concentration of sucrose. During its first growing season, it produces a large (1-2 kg) storage root whose dry mass is 15-20% sucrose by weight.

Sugarbeet is a biennial plant completing its life cycle in two years. In its first year of growth, it develops a rosette of leaves and alarge fleshy root, which stores the food reserve in the form of sugar. The yield components in sugarbeet consist of biomass, root, and sugar-yield of which the white sugar yield is concerned as the most important component (Mohammadi and Assad, 1997). Therefore, understanding the sugar yield

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interrelationships with other agronomic traits may lead in determination of selection indices for higher white sugar yield.

Sugar content, and both chemical and physical states of beet roots, known as beet quality, greatly affect sugar and its by-product yield. In Bangladesh only sugarcane is being used to produce sugar and goor but the areas and production of which is decreasing day by day. So, the deficit of sugar can be minimized through cultivation of another short duration sugar crop like sugar beet. With the help of Syngenta Bangladesh Ltd., Sesvanderhave (Belgium) and KWS (Germany), Bangladesh Sugarcrop Research Institute (BSRI) has been trying to establish seventeen tropical sugarbeet genotypes in Bangladesh. As these sugarbeet genotypes are new in Bangladesh, intensive research on yield and quality traits is deemed necessary. Therefore, the present experiment was undertaken to evaluate the yield and quality of the seventeen tropical sugarbeet genotypes on the basis of physio-chemical analysis.

MATERIALS AND METHODS

The experiment was conducted at Bangladesh Sugarcrop Research Institute (BSRI) farm, Ishurdi, pabna during the period from December 2014 to June 2015. The experiment was laid out following two factorial randomized complete block design with three replications. The treatments of this experiment were as follows:

Factor 1: Tropical sugarbeet genotypes

V_1 (Cauvery), V_2 (Shubrha), V_3 (HI 0044), V_4 (HI 0473), V_5 (SZ 35), V_6 (PAC 60008), V_7 (SV 887), V_8 (SV 889), V_9 (SV 891), V_{10} (SV 892), V_{11} (SV 893), V_{12} (SV 894), V_{13} (Danicia), V_{14} (Aranka), V_{15} (Serenada), V_{16} (Natura) and V_{17} (Belleza).

Factor 2: Harvesting times

H_1 : 120 Days after sowing (DAS)
H_2 : 140 DAS
H_3 : 160 DAS
H_4 : 180 DAS

The unit plot size was 5m×4m. The seeds of sugarbeet were sown on 15 December, 2015 maintaining line to line distance 50cm and plant to plant distance 20cm. All recommended agronomic and cultural operations including weeding, fertilization, irrigation and plant protection measures were followed during the entire course of study on a standardized uniform pattern for all the plots. After seed bed preparation Urea, TSP, MoP, Gypsum, Zinc sulphate and Boric acid were applied at the rate of 260 Kg, 120 Kg, 225 Kg, 100 Kg, 10 Kg and 20 Kg per hectare, respectively (Anonymous, 2005). Total TSP, Gypsum, Zinc sulphate, Boric acid, 1/3 Urea and MoP were applied in the line before ridge preparation. Rest amount of Urea and MoP were applied in two installments at 30 and 60 days after sowing. Management practices, like thinning for once at 4-5 leaf stage, harrowing, weeding (3 times at 25, 50 and 75 DAS), irrigation (5 times at 1, 15, 30, 60 and 90 DAS) and other intercultural operations were done regularly. To control *Spodoptera litura* (a Lepidopterous insect), an integrated approach was rendered. Nitro 505 EC (Chlorpyriphos + Cypermethrin) @ 0.1% was sprayed at 7 days interval. Sex pheromone trap (*Spodoptera* pheromone) was also placed @ 45 traps per hectare in the field to trap male insect. Predator insect (*Bracon hebetor*) was also released in the field to

control *Spodoptera litura*. Data on beet length (cm), beet diameter (cm), beet fresh weight (g), beet dry weight (g) yield (t ha^{-1}), brix% and sugar content (pol% beet) were collected in different harvesting times (Started from 120 DAS and continued upto 180 DAS at 20 days interval).

Beet length (cm)

Five sugarbeet plants were selected randomly and uprooted. The leaves were detached from the beet then beet length was measured by scale.

Beet diameter (cm)

Beet diameter was measured by slide calipers. Five sugarbeet plants were selected randomly and uprooted. Diameter of the sampled beet was recorded from top, middle and lower portion of the beet.

Beet fresh weight (g)

Five sugarbeet plants were selected randomly and uprooted from each unit plot. The leaves were detached from the beet then the sampled beet was weighted by digital balance at 120, 140, 160 and 180 DAS.

Beet dry weight (g)

The sampled beets were properly dried in open sunlight for 3 days then again dried in oven at 70^0C temperature for 72 hours to remove the moisture for having constant weight.

Sucrose content (pol% beet)

Five beets per unit plot were randomly collected and prepared cossettes in each harvesting dates.Twenty six (26) gram of cossettes blended with 100 ml of water and then 1 g of dry Lead Acetate was added with blended mixture and allowed a reaction for 10 minutes. The mixture was filtered properly and polarity was measured in 200 mm tube by automatic polarimeter (AP-300, Atago, Japan).

Yield (tha^{-1})

Sugarbeets from 10 m^2 area of each unit plot was harvested at 120, 140, 160 and 180 DAS. Beet yield of the sampled area was recorded and then converted to tha^{-1}.

The collected data were compiled and analyzed statistically using the analysis of variance technique with the help of a computer package program Statistix 10 and the mean differences were compared by least significance difference test at 5% level of probability.

RESULTS AND DISCUSSION

Significant differences were observed in different genotypes in respect of age of plant/days after sowing (DAS) for different physiological parameters like beet length, beet diameter,beet fresh weight, beet dry weight, pol% beet and yield.

Beet length at different harvesting times

From Table 1 it was observed that beet length was significantly varied at different age of plant and within different genotypes. Initially beet length was comparatively lower at 120 DAS and increasing up to 180 DAS for all the genotypes, except V_1 which found almost similar at different harvesting times. Abou El -Maged *et al.* (2003) in Egypt also found that root length was positively increased by delaying harvest dates from 170, 190

to 210 days from sowing.From the present experiment, highest beet length was found from the genotype V_{12} (21.89cm) in 140 DAS which was statistically similar to V_5 (21.23cm) in 180 DAS and V_{11} (21.11cm) in 140 DAS. The lowest beet length was found from V_{16} in 120 DAS, although no significant difference were found from the genotypes V_{13}(13.33cm), V_{15}(12.00cm) and V_{17} (13.33cm) in 120 DAS. Rahman *et al.* (2013) did not find any significant difference for beet length sown in the same time (for the genotypes Shubrha and Cauvery).

Beet diameter at different harvesting times

Beet diameter was significantly varied at different age of plant and within different genotypes (Table 1).The diameter of beet was found increasing up to last harvesting time (180 DAS) for the genotypes V_1, V_2, V_3, V_4, V_5, V_6, V_7, V_8 and V_9 and for rest of the genotypes although it was increasing from 120 DAS to 160 DAS but turned to decrease at later maturity stage (180 DAS). On the other hand, Al-Sayed *et al.* (2012) found that delaying harvest date up to 210 days from sowing gave the highest root dimension (length and diameter), root yield compared with harvesting at 180 days from sowing.This variation may be due to differences in the genetic make up among sugarbeet genotypes and their response to the environmental condition. However, the highest average beet diameter was found from the genotype V_{14}(8.50 cm) in 160 DAS which was statistically similar to the genotypes V_{17}, V_{16}, V_{15}, V_{11} V_{13}, V_{12} and V_{10} at 160 DAS. The lowest beet diameter was found from the genotype V_2 (5.37 cm) in 120 DAS which was statistically similar to the genotype V_{17} (5.96 cm) in 120 DAS.

Table 1. Beet length and diameter of sugarbeet genotypes at different harvesting times

Genotypes	Beet length (cm)				Beet diameter (cm)			
	120 DAS	140 DAS	160 DAS	180 DAS	120 DAS	140 DAS	160 DAS	180 DAS
V_1	20.00	16.44	18.33	18.1	6.37	7.79	6.96	8.00
V_2	16.00	19.00	18.23	20.56	5.37	7.58	6.86	7.10
V_3	17.00	17.89	17.33	18.46	6.64	6.14	6.5	6.36
V_4	16.66	17.44	18.43	19.23	6.54	7.18	7.5	7.53
V_5	17.33	20.55	18.23	21.23	6.98	6.98	7.36	8.36
V_6	17.00	18.66	20.00	19.8	6.88	7.07	7.06	7.06
V_7	18.33	16.11	18.56	20.2	6.63	7.23	7.36	7.16
V_8	16.00	18.33	17.23	19.76	6.16	7.31	7.23	7.71
V_9	17.33	18.55	16.70	20.00	6.15	6.60	6.36	7.26
V_{10}	15.00	19.00	17.80	21.20	6.98	6.84	8.06	7.16
V_{11}	13.00	21.11	16.66	19.10	6.21	7.89	8.36	7.76
V_{12}	16.66	21.89	16.90	19.76	6.57	7.41	8.16	7.63
V_{13}	13.33	19.33	18.76	20.10	6.14	7.24	8.2	7.53
V_{14}	15.66	20.66	19.33	19.63	7.07	7.63	8.5	7.96
V_{15}	12.00	20.22	19.30	19.23	7.21	7.46	8.26	7.50
V_{16}	11.33	18.00	17.90	19.90	6.34	7.75	7.93	7.10
V_{17}	13.33	20.11	19.90	19.56	5.96	7.25	8.43	7.06
$LSD_{(0.05)}$	3.51				1.00			
CV (%)	12.00				8.62			

Beet weight (fresh and dry) of sugarbeet genotypes at different harvesting times

Significantly higher fresh and dry weight of beets was recorded for all genotypes except V_{17}, when increasing harvesting dates from 120 up to 180 days from sowing. From Table 2, it was observed that, the highest beet fresh weight was found from the genotype V_{17} (1277 g) in 160 DAS which was statistically similar to the genotype V_{14}(1240 g) in 160 DAS. The lowest beet fresh weight was found from the genotype V_3 (453.3 g) in 120 DAS which was statistically similar to the genotypes V_{13} (480 g) and V_{15} (486.7 g) both in 120 DAS.

The highest beet dry weight was obtained from the genotype V_6(143.33 g) in 160 DAS which was statistically similar to the genotype V_{17} (141.97 g) in 160 DAS. The lowest beet dry weight was attained from the genotype V_{13} (47.70 g) in 120 DAS which was statistically similar to the genotype V_3 (52.20 g) in 120 DAS. Azzazy *et al.* (2007) and El-Sheikh *et al.* (2009) found higher beet weight at 210 DAS than the other two harvest dates 180 and 195 DAS. This contradiction may be due to genotypic and environmental differences.

Table 2. **Beet weight (fresh and dry) of sugarbeet genotypes at different harvesting times**

Genotypes	Beet fresh weight (g)				Beet dry weight (g)			
	120 DAS	140 DAS	160 DAS	180 DAS	120 DAS	140 DAS	160 DAS	180 DAS
V_1	813.3	913.3	761.9	1157.8	75.17	110.32	110.33	114.93
V_2	553.3	822.2	858.9	1020.0	62.50	106.92	127.07	112.10
V_3	453.3	662.2	753.4	880.0	52.20	96.84	97.87	101.40
V_4	620.0	742.2	866.7	897.8	59.30	98.00	97.43	82.53
V_5	646.7	933.3	957.8	1138.9	67.80	116.33	109.80	107.43
V_6	486.7	817.8	955.6	1057.8	57.07	116.27	143.33	116.50
V_7	540.0	800.0	1033.3	1195.6	59.13	102.93	133.10	110.53
V_8	560.0	762.2	821.1	1037.8	55.07	120.20	103.67	99.17
V_9	520.0	711.1	703.4	1044.5	54.50	104.57	99.57	108.07
V_{10}	780.0	988.9	1075.6	1054.5	65.03	128.30	113.90	107.77
V_{11}	626.7	1013.3	1080	1089.1	69.47	97.23	132.70	97.37
V_{12}	830.0	1064.4	1108.9	1066.7	92.60	108.07	115.83	97.27
V_{13}	480.0	866.7	1095.6	1033.3	47.70	81.90	122.13	113 .00
V_{14}	513.3	933.3	1240	1088.9	53.33	88.30	120.33	125.13
V_{15}	486.7	871.1	1160	1077.8	58.83	88.01	94.73	99.03
V_{16}	546.7	880.0	1013.3	1055.5	56.47	84.90	117.93	101.57
V_{17}	553.3	842.2	1277.8	955.3	61.13	86.67	141.97	94.37
$LSD_{(0.05)}$	253.48				29.81			
CV (%)	17.95				19.18			

Pol% beet at different harvesting times

The results showed in Figure 1 revealed that the pol% of the tropical sugarbeet genotypes varied significantly at different harvesting times. Initially beet pol% was lower at 120 DAS for all genotypes. Pol% beet was increasing consistently after 140 to 160 DAS. The highest pol% beet (15.86%) was observed in V_3 (HI 0044) at 160 DAS and the lowest (8.60%) was recorded in V_{13} (Danicia) at 120 DAS. For maximum genotypes pol%

beet were found higher at 160 DAS except V_2 (Shubrha), V_4 (HI 0473), V_9 (SV 891) V_{10} (SV 892) and V_{15} (Serenada). At 180 DAS, pol% beet was decreased in all the genotypes except V_4(HI 0473) and V_9 (SV 891) comparing to 160 DAS.

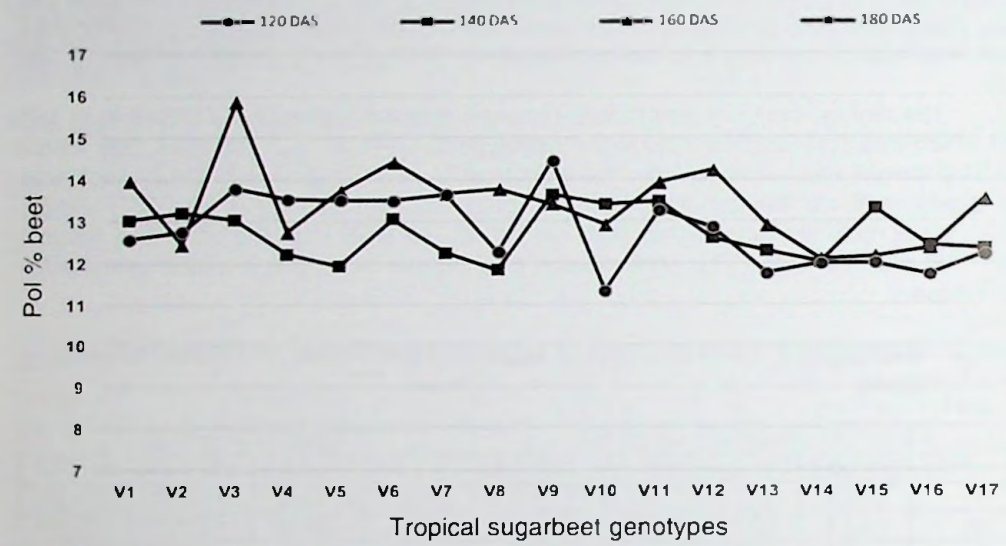

Figure 1. Pol% beet of seventeen sugarbeet genotypes at different harvesting times

Yield of sugarbeet at different harvesting times

From the Table 3 it was observed that, beet yield was increasing up to last harvesting time (180 DAS) for the genotypes V_1, V_2, V_3, V_4, V_5, V_6, V_7, V_8, V_9, V_{10}, V_{16} and rest of the genotypes showed inverse results.Aly (2006) reported that the maximum beet yield was obtained from 180 upto 210 DAS. It was also observed that, the highest yield was recorded from the genotype V_{17} (127.77 t ha^{-1}) at 160 DAS which was statistically similar to the genotype V_{13} (122.90 tha^{-1}) at the same crop age. On the other hand, the lowest yield was found from the genotype V_3 (45.33 t ha^{-1}) at 120 DAS.

Table 3. Yield performance of sugarbeet genotypes at different harvesting times

Genotypes	Yield (tha^{-1})			
	120 DAS	140 DAS	160 DAS	180 DAS
V_1	81.33	91.33	76.23	115.77
V_2	57	82.20	85.90	102.00
V_3	45.33	76.20	75.37	86.00
V_4	62.00	74.86	86.67	89.77
V_5	63.33	93.33	95.80	113.90
V_6	46.00	81.77	95.57	105.80
V_7	54.00	82.00	103.33	119.33
V_8	56.00	80.00	75.43	104.43
V_9	52.00	71.10	70.37	104.47
V_{10}	78.00	98.90	100.9	115.47
V_{11}	62.67	101.33	107.97	108.87
V_{12}	83.00	106.43	110.87	106.67
V_{13}	48.00	88.67	122.9	103.33
V_{14}	51.33	93.33	121.33	108.87
V_{15}	48.67	87.10	115.97	107.80
V_{16}	54.67	88.00	101.33	105.53
V_{17}	55.33	84.23	127.77	95.53
$LSD_{(0.05)}$	25.79			
CV (%)	18.27			

From the above discussion it can be concluded that on the basis of beet growth, beet yield and pol% beet analysis the genotypes V_2(Shubrha), V_{10} (SV 892) and V_{15} (Serenada) may be suggested for harvesting at 140 days after sowing whereas the genotypes V_1 (Cauvery), V_3 (HI 0044), V_5 (SZ 35), V_6 (PAC 60008), V_7 (SV 887), V_8 (SV 889), V_{11} (SV 893), V_{12} (SV 894), V_{13} (Danicia), V_{14} (Aranka), V_{16} (Natura) and V_{17} (Belleza) can be harvested at 160 days after sowing. On the other hand, the genotypes V_4(HI 0473) and V_9 (SV 891) can be harvested at 180 days after sowing for obtaining higher yield.

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