Leaf Characteristics and Chlorophyll Concentration of Different Sugarbeet Genotypes at Different Harvesting Stages

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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 leaf characteristics and chlorophyll concentration of different genotypes of 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). Leaf fresh and dry weight were found higher at earlier harvesting stage (120 DAS), Leaf Area Index (LAI) was found better at early to mid-harvesting level (120-160 DAS) and drastically reduced to late harvesting level (180 DAS), Chlorophyll concentration was found higher at early harvesting stage (120 DAS) for maximum genotypes of beet. Among the genotypes Cauvery, Shubrha, HI 0044, HI 0473 and SV 893 were identified as early maturing and rest of the genotypes as mid maturing varieties for their variation of leaf physiological traits (Leaf fresh weight, Leaf dry weight, LAI, Chlorophyll) related them with sucrose content (pol% beet).

Key words: Leaf characteristics, chlorophyll, sugarbeet, maturity stages

INTRODUCTION

Sugarbeet (*Beta vulgaris* L.) belongs to the family *Chenopodiacea* is one of the important commercial crops that supplies approximately 35% of the worlds sugar (Wu *et al.*, 2016).Leaves characteristics plays an important role on sugarbeet production and quality. Leaves are the interface between a crop and its atmospheric environment. They largely determine the amount of radiation intercepted and transpiration and thus water requirements and crop productivity. For healthy and unstressed crops of sugarbeet, the total amount of dry matter is proportional to the amount of radiation intercepted by the canopy during the growth (Jaggard and Qi, 2006).

The number of leaves is also play an important role in selecting crop variety. The rapid formation of LAI is necessary for maximizing (> 85%) solar radiation interception (Jaggard and Qi, 2006; Tsialtas and Maslaris, 2008), which along with the maintenance of an an adequate LAI for as long as possible during the growing season contribute to crop productivity (Liu *et al.*, 2005; Cerkal*et al.*,2007).

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Ober *et al.* (2005) found that greenness index, a measure of green color intensity of the leaves, can be used as a selection criterion for drought tolerant genotypes. Actually, these researchers made an assessment of the chlorophyll content at canopy level. Photosynthesis is classified as a fundamental biological process. Photons are absorbed by chlorophyll molecules and then the excitation energy is transferred to reaction center of the photosystems. The energy is primary used in photochemical reactions and then initiating energy conversion in photochemical and biological pathways (Govindjee, 1995).

The relationship between physiological traits and yield could be beneficial for sugarbeet improvement since physiological traits could be used as indirect criteria for increased selection accuracy (Edmeades*et al.*, 2004;Ober *et al.*, 2005).

Concluding, physiological traits could explain genotypic response to different environments and could be useful tools for selecting the most productive genotypes in each specific environment. However, field works studying the variation of leaf physiological traits of sugarbeet genotypes and relating them to yield and quality are limited. Thus, the aim of this work was to study the variation of leaf physiological traits in 17 (seventeen) sugarbeet genotypes grown in Bangladesh and to relate them with sucrose content.

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: 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 5 m × 4 m. The seeds of sugarbeet were sown on 15 December, 2015 maintaining line to line distance 50 cm and plant to plant distance 20 cm. 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 was applied in the line before ridge preparation. Rest amount of Urea and MoP was 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*. The rate of germination was found more than 95%. Data collection was started from 120 DAS and continued upto 180 DAS at 20 days interval. Data were collected on the following parameters viz., leaf fresh weight, leaf dry weight, LAI, chlorophyll (spad unit) and sucrose content.

Leaf fresh weight

Five sugarbeet plants were selected randomly and leaves were harvested and immediately weighted from one unit plot at 120, 140, 160 and 180 DAS.

Leaf dry weight

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

Leaf area Index (LAI)

LAI was defined as the one-sided green leaf area per unit ground surface area (LAI = leaf area/ground area, m^2/m^2). LAI was determined from fresh leaves of five randomly selected plants with leaf area meter (Model:CI-202, USA)

Chlorophyll (Spad unit)

Twenty young fully expanded leaves per unit plot were selected in each dates during crop growth cycle. Chlorophyll content was measured *in vivo* in each leaf with the SPAD meter (SPAD-502 plus,Minolta, Japan).

Sucrose content (Pol% beet)

Five beets per unit plot were randomly collected and prepared cossettes in each data collecting 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).

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) 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

Variations were observed in the genotypes of sugarbeet in respect of age of plant/days after sowing (DAS) for different physiological parameters like leaf fresh weight, leaf dry weight, LAI, chlorophyll content (SPAD value) in leaf, brix and pol% etc. (Table 1-3).

Leaf weight at different harvesting times

From the Table 1 it was observed that the higher leaf fresh weight was found from the variety V_{11} (850 g) at 120 DAS which was statistically similar to the variety V_7(750 g)and V_{17}(740 g) of same aged plant. The lowest leaf fresh weight was found from the varieties V_5(59.9 g)and V_4(62.2 g) at 180 DAS.The highest leaf dry weight was found from the variety V_{17}(71.8 g) at 120 DAS which was statistically similar to the variety V_1(64.7 g) of same aged plan. The lowest dry weight of leaf was found from the variety V_5(5.9 g) at 180 DAS, although there were no significant differences among the varieties in 180 DAS. It was also observed that leaf weight varied due to varieties. Similar results were also found by Rahman *et al.*(2013) stated that, genotypeCauvery produced more leaves than Shubhra.

Table 1. **Leaf weight (Fresh and Dry) at different harvesting times**

Genotypes	Leaf Fresh Weight (g)				Leaf Dry Weight (g)			
	120 DAS	140 DAS	160 DAS	180 DAS	120 DAS	140 DAS	160 DAS	180 DAS
V_1	725	525.1	235.5	71.1	58.8	43.3	23.4	7.03
V_2	525	417.7	262.2	77.8	42.0	35.7	26.9	7.7
V_3	535	428.8	295.5	71.1	41.1	38.3	28.2	7.03
V_4	515	313.3	191.1	62.2	37.9	30.7	18.2	6.1
V_5	691.6	417.8	244.4	59.9	35.9	29	23.1	5.9
V_6	625	406.6	267.7	84.4	38.8	30.6	24.0	8.3
V_7	750	715.5	353.3	88.8	58.8	50.5	31.7	8.5
V_8	555	471.1	267.7	73.3	38.1	41.3	26.1	8.3
V_9	450	308.8	217.7	83.3	29.4	25.1	21.4	8.2
V_{10}	695	553.3	300.0	106.6	42.8	44.8	27.6	10.5
V_{11}	850	595.5	366.6	133.3	64.7	41.1	38.7	13.2
V_{12}	665	680.0	335.5	92.8	48.0	46.1	35.6	10.8
V_{13}	555	502.2	328.9	106.6	36.9	32.6	29.2	10.7
V_{14}	625	555.5	288.9	119.9	46.2	44.0	31.6	11.8
V_{15}	695	537.7	257.8	88.9	53.1	40.4	27.6	8.8
V_{16}	615	357.7	264.4	95.5	48.9	30.8	27.8	9.4
V_{17}	740	462.2	314.4	86.6	71.8	37.4	34.5	8.5
LSD $_{(0.05)}$	124.04				9.95			
CV (%)	20.61				20.31			

Leaf area index at different harvesting times

From the Table 2, it was observed that the highest LAI was found from the variety V_{10} (3.05) in 160 DAS while the lowest was found from the genotype V_4 (0.41) in 180 DAS. In general, increasing LAI was found from early harvesting stage (120 DAS) and it continued up to 160 DAS, thereafter it was drastically reduced to minimum level. The result was supported by Gonzalez *et al.* (2010) stated that, an increase in leaf area can be due to the production of an enlarged primordium during the initiation at the meristem and/or to a progressive increase in size resulting from a faster and/or a prolonged growth period.

Chlorophyll content (SPAD value) at different harvesting times

From Table 2, it was observed that, the highest chlorophyll content (SPAD value) was found from the variety V_{11} (55.23) in 120 DAS which was statistically similar to the varieties V_3 (53.46), V_7 (51.10) and V_9 (49.10). The lowest value of chlorophyll was found from the variety V_{13} (34.00) although there was no significant difference was found among the varieties in 180 DAS. In general, the chlorophyll content was found better at early harvesting stage (120 DAS) and it tends to decrease at later maturing stage of sugarbeet. In sugarbeet, the economic product (sucrose) was a vegetative component of the growth phases. The supply of photosynthate to the root is linearly related to sucrose yield. In theory, the longer the green leaves remained photosynthetically active the more photosynthate was supplied to the root, which should then relate to higher sucrose yields (Doney,1990). In current experiment, sugarbeet genotypes also exhibited significant effect on chlorophyll content. In general, chlorophyll content was found higher at early harvesting stage (120 DAS) and it tends to decrease at later maturing stage of sugarbeet, this might be due to a greater number of leaves become senescence at later harvesting stage.

Table 2. Leaf area index and chlorophyll concentration at different harvesting times

Genotypes	Leaf Area Index				Chlorophyll (SPAD value)			
	120 DAS	140 DAS	160 DAS	180 DAS	120 DAS	140 DAS	160 DAS	180 DAS
V_1	1.59	1.30	1.50	0.47	46.7	41.10	39.90	38.50
V_2	1.25	0.87	2.09	0.51	47.06	37.98	40.13	35.66
V_3	0.99	0.77	1.72	0.47	53.46	40.75	41.46	37.83
V_4	1.32	0.86	1.36	0.41	52.66	42.26	40.56	35.16
V_5	1.07	1.01	0.84	0.44	44.06	38.51	42.83	36.20
V_6	0.86	1.01	1.04	0.61	39.36	36.23	38.13	34.83
V_7	1.10	1.04	1.36	0.59	51.10	46.63	42.36	40.43
V_8	0.99	1.03	1.58	0.49	46.53	37.33	44.33	34.30
V_9	1.20	0.85	1.17	0.55	49.10	42.25	42.86	35.96
V_{10}	1.37	1.23	3.05	0.71	46.63	42.68	44.53	36.96
V_{11}	1.15	1.22	2.37	0.89	55.23	45.28	44.16	37.73
V_{12}	1.48	1.11	1.69	0.73	47.73	42.53	42.60	34.43
V_{13}	1.09	1.20	1.95	0.61	40.13	38.21	44.23	34.00
V_{14}	1.32	1.23	1.74	0.80	44.30	40.27	43.26	36.00
V_{15}	1.03	1.20	2.08	0.59	43.56	38.05	43.60	39.86
V_{16}	1.05	1.18	1.96	0.64	46.56	42.68	44.73	38.96
V_{17}	1.13	1.36	2.11	0.58	40.66	39.36	43.73	37.13
$LSD_{(0.05)}$	0.66				6.53			
CV (%)	35.58				9.71			

Brix and pol% at different harvesting times

From Table 3, it was observed that, the highest brix per cent of sugarbeet was found from the variety V_{16}(23.03%) in 160 DAS which was statistically similar to the varieties V_{12}(22.16%), V_{11}(22.03%), V_{17}(21.80%) and V_{10}(21.70%) at 5% level of significance. On the other hand, the lowest brix% was found from the variety V_{13}(11.10%) in 120 DAS, but there was no significant difference was found among the varieties in 120 DAS.

The highest pol% was found from the variety V_3 (15.86%) in 160 DAS which was statistically similar to the genotypes V_{12} (14.21%), V_1 (13.97%) and V_{11} (13.91%) in 160 DAS. On the other hand, lower pol% was found from the varieties V_{13} (8.60%) and V_7 (8.86%) in 120 DAS, although there was no significance difference was found among the varieties except V_3 in 120 DAP.Comparatively the varieties V_1 (Cauvery), V_2 (Shubrha), V_3 (HI 0044), V_4 (HI0473) and V_{11} (SV893) contained higher brix and pol% at earlier maturity stage (120 DAS) and rest of the varieties contained higher brix and pol% at mid maturity stage (140 and more DAS). The brix and pol% of beet were significantly varied in different DAS even within the varieties of sugarbeet. Similar results were also reported by Rahman *et al.* (2013), Abd EL-Gawad *et al.* (2000) and Kandil *et al.* (2002).

Table 3. **Brix and pol% at different age of plant**

Genotypes	Brix				Pol%			
	120 DAS	140 DAS	160 DAS	180 DAS	120 DAS	140 DAS	160 DAS	180 DAS
V_1	12.23	16.83	19.86	18.83	10.21	13.02	13.97	12.56
V_2	12.30	16.16	19.10	16.86	10.07	13.20	12.44	12.75
V_3	12.50	17.20	20.46	19.33	10.93	13.03	15.86	13.78
V_4	11.60	15.06	19.26	16.06	10.33	12.20	12.73	13.52
V_5	11.66	14.96	17.73	16.20	9.33	11.92	13.71	13.50
V_6	11.60	16.86	20.73	17.93	9.28	13.05	14.40	13.48
V_7	11.20	14.86	18.66	16.66	8.86	12.23	13.65	13.63
V_8	12.30	15.93	18.86	16.40	9.60	11.83	13.76	12.26
V_9	12.26	16.36	20.00	18.13	9.68	13.62	13.41	14.43
V_{10}	11.13	16.03	21.70	17.00	9.08	13.39	12.90	11.32
V_{11}	12.60	16.60	22.03	19.23	10.40	13.46	13.91	13.25
V_{12}	11.56	15.40	22.16	18.86	9.13	12.59	14.21	12.85
V_{13}	11.10	15.23	19.56	15.33	8.60	12.28	12.89	11.74
V_{14}	12.10	14.76	20.26	16.33	9.46	12.01	12.09	11.98
V_{15}	12.23	15.67	20.73	16.33	9.58	13.30	12.16	12.00
V_{16}	12.26	15.00	23.03	17.26	9.66	12.42	12.36	11.72
V_{17}	12.30	14.16	21.80	17.33	9.78	12.34	13.52	12.20
$LSD_{(0.05)}$	2.18				1.98			
CV (%)	8.27				10.11			

In general, Leaf fresh and dry weight were found higher in earlier mature stage (120 DAS), LAI was found better at early to mid-maturity level (120-160 DAS) and drastically reduced to late maturity level (180 DAS), Chlorophyll concentration was found higher in early maturity stage (120 DAS) for maximum cultivars of beet. Comparatively V_1 (Cauvery), V_2(Shubrha), V_3(HI 0044),V_4 (HI 0473) and V_{11}(SV 893) were identified as early harvesting and rest of the varieties as mid harvestinggenotypes for their variation of leaf physiological traits (Leaf fresh weight, Leaf dry weight, LAI, chlorophyll) related with sucrose content.

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