Original Research Article

Leaf Chlorophylls and Carotenoids Status and their correlation with storage root weight of Some Local and Exotic Sweetpotato Genotypes

.

ABSTRACT

The investigation was carried out to characterize of chlorophyll components and carotenoids of leaves of some local and exotic genotypes of sweet~~-~~potato namely Local-1, Local-2, Local-5, Local-8, Exotic-1, Exotic-2, Exotic-4 and BARI SP-4 and their effect on production of total dry matter and dry weight of storage roots during November 2015 to April 2016. The experiment was laid out in Randomized Complete Block Design with three replications~~applications~~. Fresh leaves of 5-6th position from the top of vine were collected from the research field into polybag with proper tagging and brought to the laboratory in the~~at~~ morning of~~at~~ 30, 60, 90 and 120 days after planting. Collected leaves were washed, wiped out of excess water, cut into small pieces leaving away mid ribs, mixed thoroughly, and 250 mg of leaf materials were taken in a mortar. Leaf materials were grinded finely by a pestle with 25 ml of cold 80% acetone for two minutes. Sample tubes were centrifuged for 10 minutes. The homogenate was filtered and made up to 25 ml with cold 80% acetone. The centrifuged samples were incubated in dark for half an hour. The optical density (OD) for each solution was measured at 663, 645 and 440.5 nm against 80% acetone as blank in one cm cell of spectrophotometer. Triplicate estimation was done for each character. Chemical analyses were performed at Regional Laboratory of Soil Resource Development Institute, Sylhet-3100, Bangladesh. Statistical analyses was done using MSTATC software following analysis of variance technique and Duncan's Multiple Range Test. Results show that chlorophyll-a gradually increased up to 60 DAP in all genotypes, thereafter it continued only in Exotic-4, Exotic-3 and Local-1 up to 90 DAP. The highest amount of chlorophyll-a (10.27±0.45 mg 100 gfw^{-1}) was in Local-1 at 90 DAP. The highest amount of chlorophyll-b (mg 100 gfw-1) was in Exotic-3 (19.13±0.53) followed by Local-1 (16.85±0.50) at 30 DAP. Carotenoids content of all genotypes increased gradually up to 90 DAP and thereafter decreased except Exotic-4. The highest carotenoids was in Exotic-3 (10.78 mg 100 gfw^{-1}) followed by Local-1 (10.13 mg 100 gfw^{-1}) at 90 DAP. At 120 DAP, the highest storage roots weight was in Local-8 (232.40±5.97), followed by Local-1 (187.50±5.23). Chlorophylls and carotenoids had no significant effect on total dry matter and storage roots dry weights at 30 DAP. All chlorophyll components and carotenoids had positive correlation with TDM and storage roots dry weights at 120 DAP. In conclusion, chlorophyll-a had positive effect on storage roots dry weight after 90 DAP while chlorophyll-b came to positive effect on storage roots dry weights after 60 DAP. At final harvest, the higher chlorophyll, carotenoids and dry matter synthesizing genotypes were Local-1 and Local-8.

***Keywords**: Chlorophyll, carotenoids, exotic genotype, local genotype, yield, correlation*

1. INTRODUCTION

Sweet potato (*Ipomoea batatas* L. Lam.) is a dicotyledonous plant of the family Convolvulaceae. It is perennial in nature but it is grown in an annual crop. The plants bear

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adventitious roots which enlarge near the stem and form edible storage roots. In Bangladesh it is produced about 0.761 million ton on about 0.045 million ha of land with an average yield of 16.91 t ha^{-1} [1]. It is characterized by low production, yield and storage root quality compared to Japan, Senegal and Israel [2]. However, it is easy to grow and capable of growing under adverse weather and soil conditions. It requires low input and less management practices [3]. It is a very efficient food crop and produces more dry matter, protein and minerals per unit area in comparison to cereals [4]. Storage roots are rich source of energy, several minerals and micronutrients [5] and leaves are rich in vitamin B, beta-carotene, iron, calcium, zinc and protein [6].

The yield of sweet potato depends on the production of assimilates (source) and its accumulations (sink). Storage roots (number and weight) are predominant sink whereas leaves and tender vines are the source. The photosynthetic rate and the leaf area are regarded as the source potential. Leaves take part in the production of assimilates. The leaves of plant contain chlorophylls (Chlorophyll-a, Chlorophyll-b) and carotenoids. Chlorophyll-a possesses a green-blue color while chlorophyll-b possesses green-yellow color [7]. Chlorophyll with the pigments has a central role in light harvesting, photosystem protection, and other growth functions [8, 9]. Carotenoids participate in harvesting light energy for photosynthesis [10]. They are also involved in the defense mechanism against oxidative stress [11], and play an essential role in the dissipation of excess light energy and provide protection to reaction centers [12, 13].

Recent studies show that chlorophyll and carotenoids have positive effect on human health. Chlorophyll is often referred to as the green blood of plants due to the identical molecular structure with hemoglobin with only difference in center atom (iron or magnesium). This similarity makes chlorophyll so important to our health, it improve digestive, immune and detoxification systems of human body [14]. Leaves contain phenols, flavonoids, β-carotene, anthocyanin, and caffeoylquinic acid derivatives [15]. Carotenoids extract from leaves functions as a cheap natural yellow dye. It can be beneficial to human health compare to the artificial colouring dye [16].

There are many local sweet potato genotypes are available in Sylhet region and many of them are growing at the farmer's level sporadically. Rajput *et al*. [17] reported that the functional leaves may directly reflect to yield. Besides, for adaptive trial of improved sweet potato cultivars developed by different countries and organization, it is necessary to determine chlorophyll and carotenoids. Moreover, it is necessary to determine how these genotypes/cultivars can be made available to the farmers of Bangladesh. Therefore, an experiment was undertaken to characterize different types of chlorophyll features of leaves of local and exotic genotypes of sweet potato.

2. METHODOLOGY

The experiment was carried out at Sylhet Agricultural University Farm, Tilagarh, Sylhet during November 2015 to March 2016. It lies between 24°54′33.5″ to 24°54′34.7″ N latitude and 91°54′ 04.6″ to 91°54′05.6″ E longitude. Texture of top soils was Loam (sand 50%, silt 37%, clay 13%). Well drained soil. Top soil (0-15 cm) is deep brown in color. The soil is characterized as Ramgarh soil series of Northern an Eastern Piedmont Plains (AEZ 22) in Bangladesh [18].

2.1 Planting Materials

Nine sweeetpotato genotypes/cultivars namely Local-1, Local-2, Local-5, Local-8, Exotic-1, Exotic-2, Exotic-4 and BARI SP-4 were used as planting materials while BARI SP-4 was check variety.

2.2 Experimental Procedure and Design

The experiment was set in a Randomized Complete Block Design (RCBD) with three replications. The experimental field was fertilized with manures and fertilizers as per soil test value: Cow dung =5000 kg, Urea =212 kg, TSP =186 kg, MoP =187 kg, Gypsum =63 kg, Zinc sulfate (Hepta) =9 kg, Solubor =3 kg, Magnesium sulfate =84 kg and dolomite = 988 kg. Before final land preparation, half of urea and MoP, full of other fertilizers and cow dung were applied. Rest of Urea and MoP were applied as side dressing after 35 days of planting at earthen~~earthing~~ up operation. Soil reaction (pH) was corrected by dolomite application prior to 15 days of planting followed by bed preparation. Raised beds were prepared and cuttings of sweet potato vines were planted in lines maintaining row to row 60 cm and plant to plant 30 cm. The unit plot size was of 4.8 m × 4.2 m with a block to block distance 1.0 m and plot to plot distance 0.6 m. Weeding was done as and when necessary. Irrigation was done at 30 and 60 days after planting (DAP).

2.3 Data Collection

Leaves were collected at 30, 60, 90 and 120 DAP and chlorophyll a, chlorophyll b, chlorophyll a/b ratio, total chlorophyll and carotenoids contents were estimated.

2.4 Sample Preparation and Chemical Analysis

Collected fresh leaves were cut into small pieces leaving away mid ribs, mixed thoroughly and 250 mg of leaf materials were taken in a mortar and small amount of sodium carbonate (Na_2CO_4) was added into it to check the degradation of pigments. Leaf materials were grinded finely by a pestle with 25 ml of cold 80% acetone for two minutes. Sample tubes were centrifuged for 10 minutes (Model- SORVALL Legend Micro 21R Centrifuge, Thermo Fisher Scientific, Germany). The homogenate was filtered through Whatman number 1 filter paper and made up to 25 ml with cold 80% acetone. The centrifuged samples were incubated in dark for half an hour. The optical density (OD) for each solution was measured at 663, 645 and 440.5 nm (Model T80+, UV/VIS Spectrometer, PG Instruments Ltd., UK) against 80% acetone as blank in one cm cell. The amount of chlorophyll-a and chlorophyll-b were determined by using specific absorption coefficient of McKinney [19] and the formula of Maclachalan and Zalik [20], Duxbury and Yentsch [21]. The amount of carotenoids was determined by the equation of Holm [22].

i) $C_a = \frac{(12.3 \times D663 - 0.86 \times D645)V}{\text{d} \times 1000 \times W}$ mg/g fresh leaf [20]

ii) $C_b = \frac{(19.3 \times D645 - 3.6 \times D663)V}{\text{d} \times 1000 \times W}$ mg/g fresh leaf [21]

iii) $C_c = 4.695 \times D440.5 - 0.268\ C\ (a+b)$ [22]

iv) Total chlorophyll (mg g fresh leaf^{-1}) = Chlorophyll a + Chlorophyll b

v) Chlorophyll-a and Chlorophyll-b ratio = $\frac{\text{Chlorophyll a}}{\text{Chlorophyll b}}$

Where,
Ca = Chlorophyll a (mg g fresh leaf^{-1})
Cb = Chlorophyll b (mg g fresh leaf^{-1})
D = Optical density (O.D.) at wave length indicated
V = Final volume (ml)
W = Fresh weight of leaf materials used (g)
d = Length of light path (cm)
Cc = Concentration of carotenoids in μg ml^{-1}, which was then converted into mg

g^{-1} fresh leaf

2.5 Statistical Analysis of Data

The data were analyzed using Analysis of Variance (ANOVA) technique through MSTATC package. Comparative analysis of the results was done using Duncan's Multiple Range Test (DMRT) at 1% level of significance. A p-value $p \leq 0.01$) was considered statistically significant.

3. RESULTS AND DISCUSSION

3.1 Chlorophyll Content in Leaves

Chlorophyll-a content (mg 100 gfw^{-1}) in leaves of all genotypes show that it gradually increased up to 60 DAP, after that it increased sharply in Exotic-4, Exotic-3 and Local-1, and decreased in Local-2, Local-5 and Exotic-1 up to 90 DAP (Fig. 1). After 90 days of planting, chlorophyll-a content decreased sharply up to 120 DAP. Local-1 produced the highest amount of chlorophyll-a (5.63±0.08) at 30 DAP, increased to 8.80±0.58 at 60 DAP, 10.27±0.45 at 90 DAP and finally reduced to 3.45±0.09 at 120 DAP.

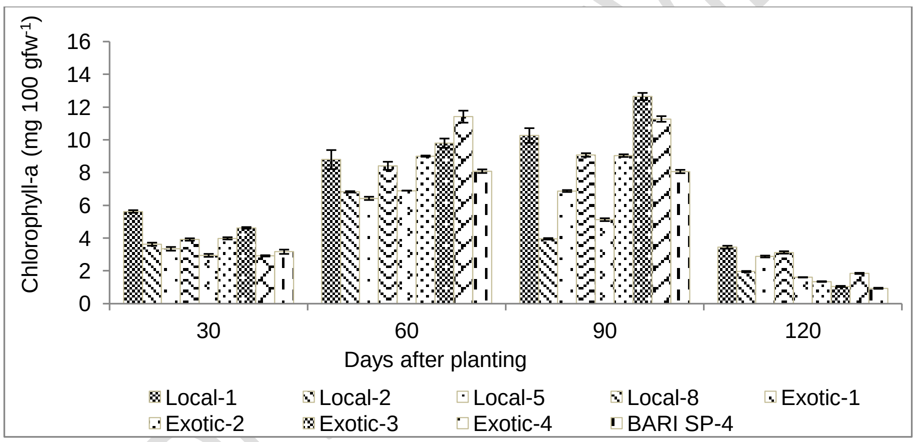

Fig. 1. Effect of genotype on the chlorophyll-a content in leaves of sweetpotato at different days after planting (DAP)
*** $P \leq 0.01$, Mean ± S.E.M = Mean values ± Standard error of means, n=3.*

Chlorophyll-b content in leaves (in mg 100 gfw^{-1}) had significant variations (Fig. 2). At initial stage, the amount of chlorophyll-b was higher in all of the genotypes and thereafter decreased dramatically. At 30 DAP, the highest amount of chlorophyll-b (mg 100 gfw^{-1}) was found in Exotic-3 (19.13±0.53) followed by Local-1 (16.85±0.50). At 60 DAP, the highest amount of chlorophyll-b was in Local-1 (5.57±0.07) followed by Local-2 (5.37±0.22) and Local-8 (4.76±0.30) and the lowest was in Exotic-1 (1.94±0.04). At 90 DAP, the highest amount was in Local-1 (5.60±0.01) followed by Exotic-3 (4.54±0.17) and the lowest was in Exotic-1 (1.62±0.03). At 120 DAP, the highest amount was in Local-8 (4.55±0.06) followed by Local-1 (4.26±0.15) and the lowest was in Exotic-3 (1.41±0.10). The ratio of chlorophyll-a to chlorophyll-b in higher plants is approximately 3:1 [7].

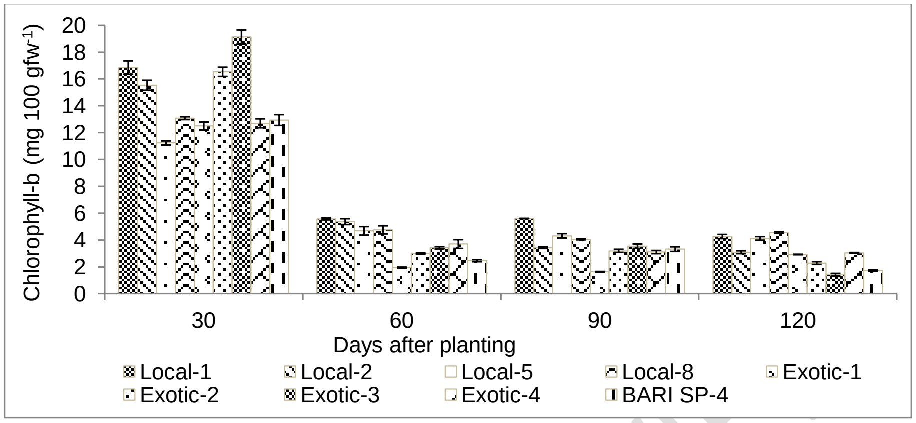

Fig. 2. Effect of genotype on the chlorophyll-b content in leaves of sweetpotato at different DAP

*** $P \leq 0.01$, Mean ± S.E.M = Mean values ± Standard error of means, n=3.*

As like as chlorophyll-a and chlorophyll-b, the ratio of them was also very low at initial stage and as days passes the ratio was increased up to 60 DAP (Fig. 3). From 60-90 DAP, ratio of Local-1, Local-5, Local-8 and Exotic-4 increased whereas ratio of Local-2, Exotic-1, Exotic-2, Exotic-3 and BARI SP-4 decreased gradually. After 90 days of planting, ratio decreased harshly. The highest ratio (3.65±0.17) was in Exotic-4 and the lowest was in Local-2 (1.15±0.03) at 90 DAP. The chlorophyll a/b ratio of Local-1 was seen 0.34±0.01 at 30 DAP, 1.58±0.11 at 60 DAP, 1.81±0.08 at 90 DAP and 0.81±0.04 at 120 DAP.

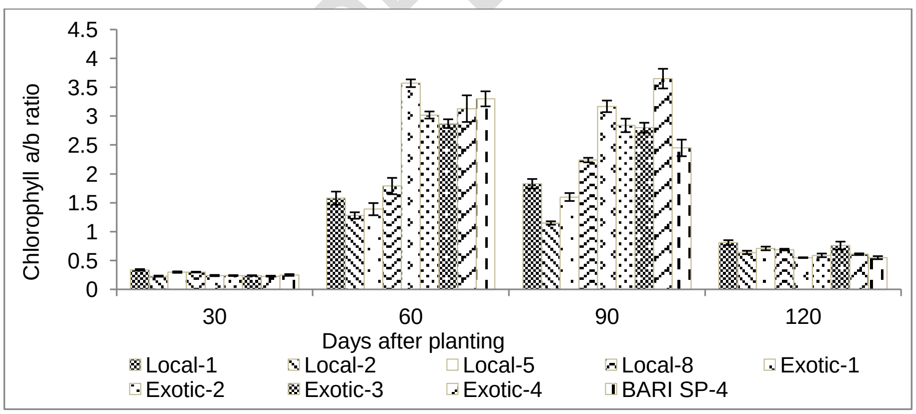

Fig. 3. Effect of genotype on the chlorophyll a/b ratio in leaves of sweetpotato at different DAP

*** $P \leq 0.01$, Mean ± S.E.M = Mean values ± Standard error of means, n=3.*

Total chlorophyll consists of chlorophyll-a and chlorophyll-b varied significantly (Table 1). Initially although the total chlorophyll content (mg 100 gfw^{-1}) was high but it reduced with plant ages in all of the genotypes. After 30 days of planting, the highest total chlorophyll content was in Exotic-3 (23.76±0.56) followed by Local-1 (22.48±0.46) and the lowest in

Local-5 (14.58±0.32). After 60 days of planting, the highest total chlorophyll content was in Exotic-4 (15.12±0.60) followed by Local-1 then Exotic-3 and Local-8. The lowest was in Exotic-1 (8.84±0.04). After 90 days of planting, the highest total chlorophyll content was in Exotic-3 (17.18±0.34) followed by Local-1 (15.87±0.44) and the lowest were in Exotic-1 (6.75±0.08). At final harvest, Local-1 (7.71±0.13) and Local-8 (7.68 mg) were showed similar content of total chlorophyll.

Table 1. Total chlorophyll content in leaves of sweet_potato genotypes at different DAP

Genotypes	Total chlorophyll content in leaves at different DAP (mg 100 gfw^{-1})			
	30	60	90	120
Local-1	22.48±0.46 b	14.37±0.55 ab	15.87±0.44 b	7.71±0.13 a
Local-2	19.16±0.33 d	12.20±0.20 cd	7.38±0.06 g	5.04±0.09 c
Local-5	14.58±0.14 g	11.11±0.28 de	11.19±0.15 f	7.00±0.12 b
Local-8	16.99±0.09 e	13.18±0.28 bc	13.13±0.10 d	7.68±0.12 a
Exotic-1	15.45±0.27 f	8.84±0.04 f	6.75±0.08 g	4.53±0.02 d
Exotic-2	20.52±0.32 c	12.00±0.05 cd	12.22±0.10 e	3.63±0.09 e
Exotic-3	23.76±0.56 a	13.22±0.3 bc	17.18±0.34 a	2.46±0.09 f
Exotic-4	15.62±0.32 f	15.12±0.60 a	14.38±0.15 c	4.89±0.03 c
BARI SP-4	16.10±0.36 f	10.54±0.10 e	11.39±0.15 ef	2.67±0.03 f
CV (%)	1.51	4.23	3.10	2.45
$LSD_{.01}$	0.657	1.239	0.902	0.292

Figures (Mean ± S.E.M) in a column having same letters do not differs significantly at 0.01 level of significance by DMRT

The variations in chlorophyll-a, chlorophyll-b, chlorophyll and their corresponding a/b ratio and total chlorophyll are probably due to genotypic, fertilization as well as growth stages. The results corroborate with findings of Katayama and Shida [23] and Yooyongwech *et al.* [24]. Katayama and Shida [23] reported chl a, chl b and ratio of a/b were 69.1 mg 100 gfw^{-1}, 23.5 mg 100 gfw^{-1} and 2.949, respectively in the leaves of 6th position in the swee_tpotato vine. They reported that the contents of chlorophyll a and b will change in their absolute amount and also in their ratio a/b according to the kind of materials or to the different developmental stages as well as fertilizers, chemicals, moisture and other environments. They added that the change of chlorophyll contents was observed corresponding to the developmental stages of leaves in swee_tpotato. Rashid [25] established that the content of chlorophyll-a, chlorophyll-b, and their ratio were influenced by the cultivar.

On the other hand, Yooyongwech *et al.* [24] reported the chlorophyll a, chlorophyll b, total chlorophyll contents and ratio of Chl a : Chl b in three genotypes of sweet_potato grown under well watering in the pot culture were ranged 24.07-33.46 mg 100 gfw^{-1}, 11.75-14.43 mg 100 gfw^{-1}, 36.95-47.89 mg 100 gfw^{-1} and 1.71-2.32 mg 100 gfw^{-1}. They reported that the variation of the chlorophyll contents of the present result was perhaps due to genetic makeup.

3.2 Carotenoids Content in Leaves

Carotenoids content (mg 100 gfw^{-1}) of all genotypes increased gradually up to 90 DAP and thereafter decreased except Exotic-4 (Fig. 4). At 90 DAP, the highest carotenoids was in Exotic-3 (10.78 mg) followed by Local-1 (10.13 mg) and the lowest was in Exotic-1 (7.93 mg). Overall, all of the genotypes were found better over the check variety BARI SP-4 in carotenoids production except Exotic-1.

The variations in carotenoids among the genotypes may be genotypic and/or environmental conditions. The results are in line of the works of the following researchers. Woolfe [4] reported carotenoids in sweetpotato leaves ranged from 0.38-7.24 mg 100 gfw^{-1}. Motsa *et al.* [26] reported that total carotenoids and total chlorophyll content of edible leaves were ranged from 90 to 390 mg 100 gdw^{-1} and 1.54 to 4.47 mg 100 gdw^{-1}, respectively. They added that total carotenoids and chlorophyll content in leaves were significantly affected by environmental conditions.

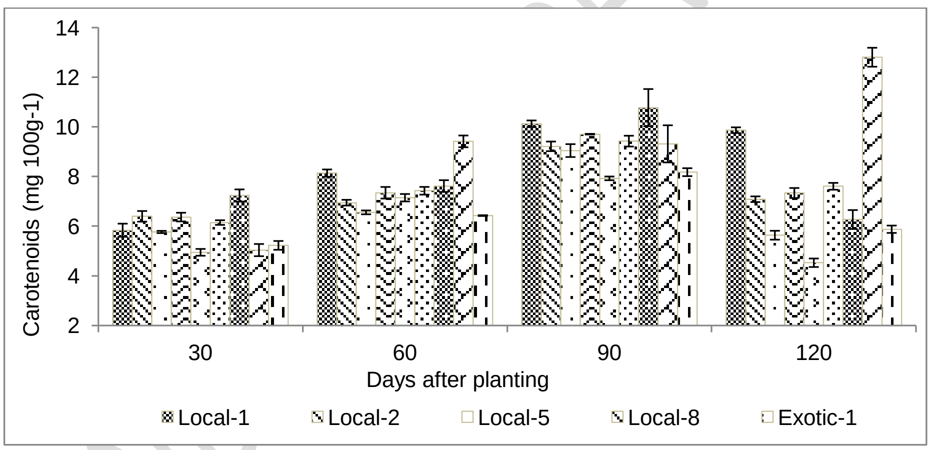

Fig. 4. Effect of genotype on the carotenoids content in leaves of sweet_potato at different DAP

*** $P \leq 0.01$, Mean ± S.E.M = Mean values ± Standard error of means, n=3.*

3.3 Total Dry Matter (g $plant^{-1}$)

Total dry matter (TDM) increased gradually up to 60 DAP and thereafter increased very rapidly up to 120 DAP in all genotypes (Table 2). At 120 DAP, the highest TDM was in Local-8 (327.10±5.52) followed by Local-1 (292.30±5.65), and the lowest was in Exotic-3 (116.90±1.36).

Hossain and Islam [27] reported that total dry weights of 10 sweet_potato genotypes increased up to 165 DAP. Nandi and Sen [28] reported that the total biomass yield increased linearly up to 120 DAP except two genotypes. Nair and Nair [29] reported a linear increase in

TDM. Mannan *et al.* [30] established that storage root DM increased rapidly from 90 to 150 DAP. Haque [31] reported that TDM had a linear growth phase that continued until about 120 DAP. Watson [32] stated that total dry matter production of a crop is dependent on the source and its activities as well as the length of its growth period, during which photosynthesis continues. The above results agree with the present result.

Table 2. Effect of genotypes on the total dry matter of sweet potato at different DAP

Genotypes	Total dry matter (g plant^{-1})			
	30	60	90	120
Local-1	23.03±1.22 a	34.87±1.16 a	100.30±1.22 b	292.30±5.65 b
Local-2	17.97±0.50 b	32.38±0.43 b	93.82±0.96 c	232.90±2.39 c
Local-5	12.08±0.46 c	23.42±0.52 d	74.07±1.64 e	170.90±2.87 e
Local-8	15.32±0.28 b	32.06±0.31 b	118.70±2.97 a	327.10±5.52 a
Exotic-1	15.28±0.49 b	22.72±0.43 d	56.85±0.71 fg	134.20±1.57 g
Exotic-2	16.27±0.87 b	28.19±0.70 c	77.56±1.83 e	157.10±0.56 f
Exotic-3	9.11±0.22 d	16.98±0.50 e	51.68±1.66 g	116.90±1.36 h
Exotic-4	16.53±0.52 b	24.66±0.22 d	62.76±1.15 f	175.80±1.50 e
BARI SP-4	11.80±0.09 c	23.99±0.33 d	85.46±1.31 d	209.10±3.13 d
CV%	7.20	3.89	3.32	2.69
Lsd .01	2.622	2.468	6.350	12.970

Figures (Mean ± SEM) in a column having similar letters do not differ significantly at 1% level of significance by DMRT

3.4 Storage Root Dry Weight (g plant^{-1})

Storage roots dry weight increased gradually up to 90 DAP and then increased sharply up to 120 DAP (Table 3). After 30 days of planting, storage roots appeared only in Local-8 (0.65±0.09) and check variety BARI SP-4 (1.88±0.08). After 60 days of planting, all of the genotypes initiated storage roots in except Exotic-1 and Exotic-4. After 90 days of planting, all of the genotypes initiated storage roots. After 120 days of planting, the highest weight was in Local-8 (232.40±5.97), followed by Local-1 (187.50±5.23) and the lowest weight was in Exotic-1 (54.05±1.11).

The above results corroborate with the findings of Oswald *et al*. [33] where the storage root dry matter of sweet potato increment followed a sigmoid pattern, and Nair and Nair [29] while they reported a linear increase in storage root dry matter and the increase in storage root dry matter was the maximum during 48 to 161 days of planting.

Table 3. Effect of genotypes on the storage roots dry weight of sweet potato at different DAP

Genotypes	Storage root dry weight (g plant^{-1})			
	30	60	90	120
Local-1	0.00±0.00 c	2.73±0.04 de	31.13±0.46 c	187.50±5.23 b
Local-2	0.00±0.00 c	4.30±0.14 c	29.88±0.80 cd	152.90±1.61 c
Local-5	0.00±0.00 c	2.90±0.05 d	25.08±1.36 de	98.28±1.53 d
Local-8	0.65±0.09 b	7.97±0.02 b	60.09±2.47 a	232.40±5.97 a
Exotic-1	0.00±0.00 c	0.00±0.00 g	13.07±0.91 f	54.05±1.11 f
Exotic-2	0.00±0.00 c	2.57±0.09 e	29.18±0.91 cd	86.42±1.31 d
Exotic-3	0.00±0.00 c	1.66±0.06 f	22.80±1.62 e	68.98±0.32 e
Exotic-4	0.00±0.00 c	0.00±0.00 g	8.720±0.15 f	93.39±1.55 d
BARI SP-4	1.88±0.08 a	8.27±0.08 a	53.24±0.22 b	144.20±3.14 c
CV%	17.48	3.48	7.37	4.12
Lsd .01	0.1067	0.2822	5.337	12.22

Figures (Mean ± SEM) in a column having similar letters do not differ significantly at 1% level of significance by DMRT

3.5 Correlation of Chlorophyll and Carotenoids with Yield of Sweetpotato

At 30 DAP chlorophylls and carotenoids had no significant effect on total dry matter and storage roots dry weight (Table 4). However, Chlorophyll-a was highly correlated with chlorophyll-b, total chlorophyll, chlorophyll a /b ratio and carotenoids whereas chlorophyll-b with total chlorophyll and carotenoids.

After 60 days of planting chlorophyll-b had positive significant correlation with TDM while chlorophyll a/b ratio correlated negatively (Table 5). Carotenoids had negative correlation with storage roots dry weight and had positive correlation with chlorophyll-a and total chlorophylls. Same correlation was observed at 90 DAP except carotenoids with storage root dry weight (Table 6).

After 120 days of planting it is seen that all chlorophyll components and carotenoids had positive correlation with TDM and storage roots dry weight (Table 7) while chlorophyll-a, chlorophyll-b and total chlorophylls had significant correlation with them. It is also indicates that Chorophyll-a had no effect on storage roots dry weight up to 90 DAP while chlorophyll-b and total chlorophyll up to 60 DAP. Chlorophyll-b had positive correlation with TDM from the beginning while chlorophyll-a, total chlorophyll and chlorophyll a/b ratio was negative or insignificant up to 120 DAP.

Table 4. Correlation of chlorophyll and carotenoids with total dry matter and storage root dry weight (g plant^{-1}) at 30 DAP

	TDM	SDW	Chl-a	Chl-b	Total chl	Chl a/b ratio
SDW	-0.307					
Chl-a	0.375	-0.250				
Chl-b	0.099	-0.282	0.722**			
Total chl	0.178	-0.290	0.836**	0.983**		
Chl a/b ratio	0.333	-0.049	0.612**	-0.096	0.086	
Carotenoids	-0.187	-0.218	0.514**	0.731**	0.715**	-0.011

TD = Total dry matter (g plant^{-1}), SDW = Storage root dry weight (g plant^{-1}), Chl-a = Chlorophyll-a, Chl-b = Chlorophyll-b, Chl a/b ratio = Ratio chlorophyll-a and chlorophyll-b

Table 5. Correlation of chlorophyll and carotenoids with total dry matter and storage root weight (g plant^{-1}) at 60 DAP

	TDM	SDW	Chl-a	Chl-b	Total chl	Chl a/b ratio
SDW	0.349					
Chl-a	-0.152	-0.260				
Chl-b	0.645**	0.179	-0.093			
Total chl	0.301	-0.094	0.754**	0.583**		
Chl a/b ratio	-0.587**	-0.275	0.396*	-0.936**	-0.295	
Carotenoids	0.089	-0.522**	0.775**	0.138	0.723**	0.165

TD = Total dry matter (g plant^{-1}), SDW = Storage root dry weight (g plant^{-1}), Chl-a = Chlorophyll-a, Chl-b = Chlorophyll-b, Chl a/b ratio = Ratio chlorophyll-a and chlorophyll-b

Table 6. Correlation of chlorophyll and carotenoids with total dry matter and storage root weight (g plant^{-1}) at 90 DAP

	TDM	SDW	Chl-a	Chl-b	Total chl	Chl a/b ratio
SDW	0.783**					
Chl-a	-0.171	-0.037				
Chl-b	0.397*	0.282	0.487**			
Total chl	-0.010	0.061	0.960**	0.712**		
Chl a/b ratio	-0.571**	-0.391*	0.478*	-0.510**	0.221	
Carotenoids	0.088	0.004	0.610**	0.713**	0.719**	-0.165

TD = Total dry matter (g plant^{-1}), SDW = Storage root dry weight (g plant^{-1}), Chl-a = Chlorophyll-a, Chl-b = Chlorophyll-b, Chl a/b ratio = Ratio chlorophyll-a and chlorophyll-b

Table 7. Correlation of chlorophyll and carotenoids with total dry matter and storage root weight (g plant^{-1}) at 120 DAP

	TDM	SDW	Chl-a	Chl-b	Total chl	Chl a/b ratio
SDW	0.984**					
Chl-a	0.715**	0.634**				
Chl-b	0.686**	0.591**	0.950**			
Total chl	0.708**	0.618**	0.985**	0.990**		
Chl a/b ratio	0.303	0.306	0.563**	0.301	0.425*	
Carotenoids	0.268	0.202	0.252	0.230	0.243	0.148

TD = Total dry matter (g plant^{-1}), SDW = Storage root dry weight (g plant^{-1}), Chl-a = Chlorophyll-a, Chl-b = Chlorophyll-b, Chl a/b ratio = Ratio chlorophyll-a and chlorophyll-b

3.4 Contribution to the Existing Knowledge/Implication of the Study

Piedmont soil is acidic in nature. Sweet potato is capable of rapid coverage, so research on acid reclamation and reducing soil erosion through cultivation of Local-1, Local-5, Local-8 and Exotic-1 need to be initiated. These genotypes may be incorporated in Jum cultivation in hilly areas.

4. CONCLUSION

Chlorophyll-a content decreased after 60 days of planting while chlorophyll-b decreased from 30 DAP and carotenoids decreased from 90 DAP. At 120 DAP, the higher chlorophyll and carotenoids synthesizing genotypes were Local-1, Local-8, Exotic-3 and Exotic-4, and storage roots dry weight obtaining genotypes were Local-8 and Local-1. Chlorophyll-b had positive correlation with TDM from the beginning while chlorophyll-a, total chlorophyll and chlorophyll a/b ratio had negative or insignificant effect on TDM up to 120 DAP. Chlorophyll-a had positive effect on storage roots dry weight after 90 DAP while chlorophyll-b and total chlorophyll came to positive effect on storage roots dry weights after 60 DAP.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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