SCREENING OF SWEET POTATO VARIETIES [*Ipomoea batatas*(L.)LAM] FOR THE CHARACTERS OF YIELD AND QUALITY.

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CERTIFICATE

This is to certify that the thesis entitled,“**SCREENING OF SWEET POTATO VARIRTIES [*Ipomoea batatas*(L)LAM] FOR THE CHARACTERS OF YIELD AND QUALITY.**”*submitted to the* ***Department ofAgricultural Botany****Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree ofMaster of Science in Biochemistry, embodies the result of a piece of bonafide research work carried out by* ***EASHETA AKTHER****Registration No.***12-04825***under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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Supervisor

Dated:

SAU,Dhaka

DEDICATED TO

MY BELOVED PARENTS

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SCREENING OF SWEET POTATO VARIETIES [*Ipomoea batatas*(L.)LAM] FOR THE CHARACTERS OF YIELD AND QUALITY.

ABSTRACT

Sweet potato is a tuberous rooted perennial, usually grown as an annual, which is now grown extensively in a wide range of environments. For screening of 13 BARI Sweet Potato varieties, an experiment was carried out in the Agronomic field of Sher-e-Bangla Agricultural University, Dhaka, during November, 2017 to March, 2018. A total number of 13 varieties were planted with 3 replications Randomized Complete Block Design (RCBD).Different varieties have shown different performance for yield and quality characters.The highest and lowest vine length was observed in BARI SP-12 and BARI SP- 4 respectively. The highest and the lowest leaf area index was observed in BARI SP-11 and BARI SP- 2 respectively.The highest and the lowest chlorophyll was observed in BARI SP-9 and BARI SP- 1 respectively. The highest and the lowest number of tuber/plant was observed in BARI SP-10 and BARI SP- 1 respectively. The highest and the lowest weight of tuber/plant was observed in BARI SP-10 and BARI SP- 2 respectively. The highest and the lowest marketable tuber/plant was observed in BARI SP-9 and BARI SP- 2 respectively. The highest and the lowest weight of tuber/plot and yield was observed in BARI SP-6 and BARI SP- 5 respectively. The highest and the lowest dry weight was observed in BARI SP-11 and BARI SP- 9 respectively. The highest and the lowest TSS was observed in BARI SP-1 and BARI SP- 13 respectively.Higher amount of sugar is present in BARI SP-6. BARI SP-1 contains higher amount of starch and BARI SP- 6 contains lower amount of starch. Among 13 varieties BSP-12 has shown highest amount of carotene content. Different sweet potato varieties show different result because of their different genetic makeup.

ACRONYMS

%	:	Percent
^0C	:	Degree Celsius
AEZ	:	Agro Ecological Zone
ANOVA	:	Analysis of Variance
BARI	:	Bangladesh Agricultural Research Institute
BBS	:	Bangladesh Bureau of Statistics
cm	:	centimeter
cm^2	:	Centimeter square
CV	:	Co-efficient of Variation
DAE	:	Department of Agricultural Extension
DW	:	Dry weight
e.g.	:	For example
et al.	:	And others
FAO	:	Food and Agriculture Organization
FAOSTAT	:	Food and Agriculture Organization Statistics
FW	:	Fresh weight
g	:	Gram
G	:	Granule
Kg	:	Kilogram

LSD	:	Least Significant Difference
m	:	Metre
mg	:	Miligram
min	:	Minute
ml	:	Mililitre
mm	:	Milimeter
no.	:	Number
SAU	:	Sher-e-Bangla Agricultural University
SI	:	Serial
SP	:	Sweet potato
t/ha	:	Ton per hectare
TSS	:	Total soluable solid
viz.	:	Namely

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CHAPTER I

INTRODUCTION

Sweet potato [*Ipomoea batatas*(L.) Lam*]* is a perennial herbaceous dicotyledonous species of the morning glory family Convolvulaceae and is a crop grown as an annual. It is a tuberous rooted perennial, usually grown as an annual, which is now grown extensively in a wide range ofenvironments.Sweet potato was brought to Europe by Columbus and subsequently introduced to Africa and Asia by the Portuguese and Spanish traders(Salawu and Mukhtar, 2008).

Sweet potato can grow under many different ecological conditions. It is cultivated throughout the tropics and warm temperate regions of the world for its starchy roots. It is ranked as the world's seventh crop, just after cassava with an annual production of 106 million tons and a cultivated area of 6.6 million ha^2(FAO, 1997).It is one of the world's highest yielding crops with total food production exceeding that of rice.

As a crop, this plant species has a great potential for development because of its relatively short growing season and high nutritional value, compared to other starchy food sources. It contains β-carotene, starch, protein, sugar etc. β-carotene is a main source of Vitamin A which helps to prevent night blindness. It also has a great potential for supporting agriculture on those areas affected by adverse growing conditions such as drought and saline soils. The sweet potato yields reasonably well, even in soils of low fertility. Storage-roots of sweetpotato contain 30% dry matter that70% of it starch, 5%

sugar and 5% protein with vitamin A, Cand B. Especially orange colored sweetpotatoescontainvitaminA (ßeta carotene) and vitamin C (Woolfe, 1992).

Sweet potato ranks ninth in area under cultivation and fourth in production. Sweet potato was introduced into Bangladesh during the second half of the nineteenth century. Four districts in Bangladesh produce 60% of tile national potato crop on 50% of the land planted to potato: Rangpur, Bogra, Dhaka and Comilla. Total sweet potato production in Bangladesh was 262,702 tons in 2017. In this year 63604 acre area were cultivated.It is one of the world's highest yielding crops with total food production exceeding that of rice. As a crop, this plant species has a great potential for development because of its relatively short growing season and high nutritional value, compared to other starchy food sources.

The current world population of 7.3 billion is projected to reach 8.5 billion by 2030 and 9.7 billion in 2050 (Hasanuzzaman*et al*., 2018). Estimated world population by 2050 will be around 9-10 billion which will requiredouble the existing food production in order to feed this vast population(Waraich*et al*.,2011).China is the largest producer of sweet potatoes, accounting for more than 80 per cent of the world supply, of which only 40 per cent of the production is used for humanconsumption and industrial uses, while rest goes as animal feed. Sweetpotato roots with 18-30 per cent (on fresh weight basis) starch are one of themajor sources for the commercial extraction of starch. The roots areextensively used for starch extraction in China, Japan, Korea and Taiwan.Most studied nutraceuticals in sweet potato are carotenoids andanthocyanins. The sweet potato anthocyaninshave multiple physiological functions such as radical scavenging, antimutagenic, hepato protective, antihypertension and hypoglycaemicactivities(Suda*et al*., 2003). Sweet potato starch finds commercial application in theproduction of noodles, sugar syrups, thickener etc.Sweet potato is a natural health food because of its high energy,dietaryfibre, vitamins and mineral content (Padmaja, 2009). Researchers feel that further research is required to standardize technologies to make sweet potato a commercial crop in Bangladesh and to utilize it for feed and for production of starch as is done in China and Japan.

The sweet potato yields reasonably well, even in soils of low fertility (Loebenstein, 2009).The sweet potato grows best in sandy, well drained soils. Planting sweet potato on mounds or ridges helps to improve drainage in low lying areas. The application of fertilizer and supplemental irrigation during the growth stage results in a higher percentage of well shaped, marketable tubers.Documentation is lacking on the performance of this crop species under local growing conditions. In order to assist farmers in improving production practices, agronomic data on the performance of this crop must be generated. The results of this experiment will represent the type of information that is required by farmers who wish to obtain high yielding varieties of sweet potato suitable for planting within their particular land.

Thus the experiment was initiated with the following objectives:

1. To identify high yielding germplasms that is acceptable to the fresh market.
2. To evaluate the quality characters of selected sweet potato germplasms.

CHAPTER II
REVIEW OF LITERATURE

2.1 Sweet potato

Sweet potato is considered as"poors food" in Bangladesh.It is the cheapest source of calories.It produces highest food calories among the tuber and root crops.The sweet potato contains between 16 –40 per cent dry mass, of which 75 – 90 per cent are carbohydrates made up of starch, sugar, cellulose, pectin and hemi-cellulose. Over 95 percent of the global sweet potato is produced in developing countries,where it is the fifth most important food crop in terms of fresh weight.

2.2 Global sweet potato scenario

According to FAO (2017), Sweet potato production from 115 countries was 106,569,572 tons.However supply remains very concentrated, 82.3 per cent of global production being in Asia. China produces 84.4 % of global sweet potato production, Nigeria contributes 3.3%.USA contributes 1% of global sweet potato production but it has vast marketability. USA imports 49% of sweet potato on global market. Though China produces largest amount of sweet potato, it comprises only 13% of global market. In 2017, global sweet potato production was 112.84 million metric tons whereas it was 103.88 million matric tons in 2015. In global distribution of potato imports senario Spain imports highest amount of potato 10.2% whereas 40.1% market is under many other countries (FAOSTAT,2016). So there is a lot ofscope for widening global market of Bangladesh.

2.3Growth of sweet potato

Sweet potato is the top source of calorie in human diet, containing higher calorie content than other root crops. Sweet potato is traditionally a root crop (Ruiz *et al*., 1981); the top however is also valuable forage for ruminants and other livestock species (Backer *et al* 1980; Figueroa and Rodriguez 1994; Gonzalez *et al* 2003; Giang *et al* 2004). Under improved cultivation, sweet potato is capable of very high dry matter yield per unit area of land (Moat and Dryden 1993; Rashid *et al* 2000). Sweet potato vine has a high crude protein content (18-30% in DM), which is comparable to leguminous forages (An *et al* 2003; Mupangwa *et al*1997; Farrell *et al* 2000).

Yield and quality of forage species vary with the age of the plant. Dry matter accumulation usually increases with increasing age while the nutritive value declines (Crowder and Chedda, 1982). Moat and Dryden (1993)reported an increase in dry matter yield of sweet potato, a decrease in protein content, and a fairly constant NDF content in sweet potato forage as the age of the plant increased. Removal of sweet potato vines during growth however reduces the supply of photosynthates during the remainder of the plant's growth with an eventual reduction in root yield (Nwinyi, 1992).

Sweet potato is a natural health food because of its high energy, dietary fiber, vitamins and mineral content (Padmaja, 2009).

Huang *et al*. (2004) reported that the sweet potato leaves containedhigh amounts of total phenolic and flavonoid compounds, which were responsible which were responsible for its DPPH radical scavenging activity. The nutritive value of sweet potato leaves has been attributed to the high content of antioxidants especially phenolic compounds in them (Islam *et al*., 2002). Sweet potato is reported to have anti-diabetic property and the components contributing to this effect have been isolated and studied from white-skinned sweet potatoes (Kusanoand Abe, 2000).The average storage root yield in Bangladesh is very low as compared to those of other tropical and subtropical countries (Verma *et al*., 1994) due to cultivation of local and poor quality indigenous sweet potato varieties.

Acidic soils are one of the most important limitations to agricultural production worldwide (Kochian *et al*., 2004). Acid-soil involves both nutrient deficiencies and toxicities, the tolerance of plants to soil acidity could take the form of efficient uptake and utilization of those nutrients that are deficient under acid soil conditions or outright tolerance to Al and Mn toxicities. Thus, it is important to select acid tolerant sweet potato genotypes with the intention of reducing the dependence of small farmers on lime and fertilizer inputs. Onunka *et al*. (2012) confirmed that yields of sweet potato is presently restricted by many factors among which are low soil fertility, varietal selection, planting date, weather condition, soil type, weed, insect and disease pressure and crop management practices among others. Soils may also become acidified rapidly as a consequence of intensive cultivation of cereals with application of ammonium based N fertilizer (Mahler and Macdole, 1985) and heavy rain in the monsoon. For example, most of the topsoils of the hills, terraces and other flood plains are acidified to variable extends (Sharfuddin and Ahmed, 2005; Sen *et al*., 1988). Foy *et al*. (1992) stated that selection of genotypes with high adaptability to the acid soils is a promising alternative.

2.4 Sweet potato origin and distribution

Sweet potato originated in central or northwest South America(Yen,1982; Huaman,1997; Peet,2000). At present, it is cultivated in tropical, subtropical, and temperate regions in latitudes between 40^0north and 40^0south, and from sea level to elevations of about 2000 m(Huaman, 1997; Peet,2000). There are about 5000 cultivars present in New Guinea, therefore this area is considered as the secondary centre for sweet potato diversity(Yen,1974).

Sweet potato is a member of the Convolvulaceae family and is more commonly grown as an annual than a perennial crop(Onwueme and Charles,1994; Norman *et al*, 1995). It is dicotyledonous, herbaceous plant(Duke,1983; Hahn and Hozyo, 1984; Schultheis and Wilson, 2000) that can be propagated using tuber roots, stem cuttings and seeds;vine cuttings are most commonly used for sweet potato propagation (Onwueme and Charles,1994; Norman *et al*, 1995). The plant habit is vine system, twining and cylindrical stems expand rapidly on the ground and increase under shading. The leaves may be rounded, reniform(kidney shaped), cordate(heart shaped), triangular,hastate and lobed moderately or deeply(Huaman,1992).

Leaves are usually horizontal, prostrate(Brown,1992) and highly variable in their morphology.They are spirally and alternately arranged on the stem. Some cultivars show some variation in leaf shape on the same plant(Huaman,1997). The root system in sweet potato consists of fibrous roots that absorb nutrients and water, and storage roots that hold photosynthetic products,predominately starches and sugars(Huaman,1997). As the plants mature,thick pencil roots with some lignificationand other roots that have no lignificationbecome fleshy and thicken and are called storage roots or tubers (Huaman,1997). Tuber masses vary widely depending on cultivar and environmental conditions(Martin,1988; Goswami *et al*., 1995; Anselmo *etal.* 1998). The development cycle of sweet potato from crop planting to harvesting of storageroots vary depending on the variety, soil type, and moisture and temperature conditions. Bertelson *et al*. (1994) reported the duration ranges from 70 to 150 days, while Ehisiannya*et al*. (2011)reported that sweet potato reaches maturity at three to eight months after planting.

2.5 Ecophysiology

Sweet potato is grown over a broad range of environment and cultural practices and is commonly found in low input agriculture

(Prakash,1994).Genetic and environment factors determine crop growth and yield. Consequently,different crop genotypes may perform differently under diverse environmental conditions. Biophysical factors such as soils,pests and diseases, and other environmental variables, including temperature, light intensity and soil moisture affect physiological responses, growth and yield. Certain ecological ranges are required for sweet potato to produce maximum yield.

Sweet potato requires a moist sandy loam soil with good drainage and pH between 5.6 and 6.6(Martin,1988).Warm days and nights are the optimal conditions for sweet potato growth and development(McCraw,2000). It is a warm weather crop and the best temperatures for growth and yield are above 24^0 C; growth is severely retarded at minimum temperatures below 10^0 C (Onwueme and Charles,1994). Sweet potato grows best under relatively high light intensity, shading therefore should be avoided(Onwueme and Charles,1994).It requires a short day length of 11 hours or less to stimulate tuber formation, while long days tend to favour vine growth at the expense of the root tubers (Onwueme and Charles,1994). Sweet potato is highly sensitive to excessive rainfall and to deficit in soil moisture.The crop requires at least 500 mm of rainfall during growing season with optimum levels at 750-1000 mm (Onwueme and Charles,1994).

Water supply has to be maintained during the first 40 days after planting, and during the tuber formation stage at 7 to 9 weeks after planting(Valenzuela *et al.*, 2000). Maintaining soil moisture above the wilting point during the whole season is essential for the growth and development of storage roots.The yield of storage roots is known to decrease under water deficit stress below 20% of soil water availability (Indira and Kabeerathumma,1988).Due to its intolerance of a limited water supply, the production of sweet potato crops in drought prone semi-arid regions has not been reliable(Yen,1982).

The photosynthetic pathway of sweet potato is similar to that of C_3 plants (Kays,1985).During the early growth period, the net photosynthesis rate(P_N) is highest. It declines at the end of growth periods as the sink attains its maximum size(Bhagsari and Harmon,1982). The rate of photosynthesis in individual leaves of sweet potato is affected by leaf age,and young fully expanded leaves tend to have higher photosynthetic rates.Common leaf chlorophyll concentrations lie between 7.6 and 10.6 mg/g leaf dry mass(Bhagsari and Harmon, 1982).

2.6Morpho–physiology ofsweet potato

Sweet potato seedling showed thee tendency of producing primary branches in the terminal or apical part of the cuttings was more than those of the basal parts and the tip vine produced the maximum branches. Choudhury *et al.* (1986). Shen *et al.* (2015)reported that number of vine plant^{-1} ranges from 10.4–13.3 due to available nutrient present in soil. Delowar and Hakim

(2014) stated that the fresh weight of leaves varied for soil characteristics and minimum growth of the plant occurred perhaps due to a variation in soil acidity. Dayal *et al.* (2006) stated that dry matter content of the sweet potato influenced the growth performance of the plant. Dayal *et al.* (2006) reported that the dry matterof fibrous root was 2.23-0.97%. Dry matter of non storage root was higher in those genotypes whose poor plant growth but higher accumulation rate in non storage roots. Farooque and Husain (1973) also showed that the storage roots number plant^{-1} varied from 4.70-11 and it depends on the genotypes of sweet potato.

Nitrogen (N) is an important factor in determining the yield and nutrient composition of root tubers (Constantin *et al.*, 1984). Among the mineral nutrient elements, N most often limits plant growth and yield (Raymond *et al.*, 1998). It is the most essential mineral nutrient for plant growth and development and its proper management is essential in an intensive agriculture for plant production. Nitrogen application was shown to linearly increase dry matter, carotenoid and protein content of sweet potato (Constantin *et al.*, 1984). Villagarcia found that the response of sweet potato to nitrogen fertilizer application depends highly on genotypic and environmental variations (Villargarcia, 1996).

Rashid *et al*. (2002) and Farooque and Husain (1973)showed that the length of the storage roots differed among the varieties. Rashid *et al*. (2002) and Farooque and Husain (1973) showed that the length of the storage roots differed among the varieties. Siddique *et al*. (1988) stated that the fresh weight of storage roots plant^{-1} varied widely the different genotypes. Delowar and Hakim (2014) reported that dry weight of storage roots depends on the varietal performance to the particular soil. The result showed that some genotypes failed to show the relationship of fresh weight to the dry weight of the storage roots. Naskar and Chowdhury (1994), Siddique *et al*. (1988) and Yooyongwech *et al*. (2014) found that yield potentiality of sweet potato depends on the genetic make-up plant. Sen *et al*. (1988) stated that significant variations among the genotypes were happened may be due to the adoption of proper cultural management techniques.

Tuber yield was determined from the actual area of each plot, which, according to Romani et al. (1993), provides a good estimate of true yield. This is also supported by Neppl et al., (2003) whose study indicated that interactions of centre row with border row were insignificant. Jahan et al. (2009) reported that harvest time had a significant effect on the weight of a tuber, with the maximum weight obtained at 150 days after planting. Monamodi et al. (2003) who reported that the dry weight of sweet potato increases linearly during the crop development stage. Jahan et al. (2009) also came to the conclusion that there is a significant effect of harvest time on the dry matter content of storage-roots.

CHAPTER III
MATERIALS AND METHODS

This chapter contains a precise description on experimental design and layout, time and location of the experiment, climatic condition of experimental site, seed or planting materials, plant growing procedure, nutrient and treatment doses, data collection and statistical analysis of the experiment.

3.1 Experimental location

The experiment was performed in the experimental farm of Sher-e-Bangla Agricultural University(AEZ 28)during the time span of November 2017 to March2018. Complete experiment materials, both technical and biochemical analysis support was facilitated by the Laboratory of Agricultural Botany and Post Harvest Department of BARI.

3.2 Soil and climate

The experimental site is situated in subtropical climate zone, characterized by heavy rainfall during the months from April to September（Kharif season)and scanty rainfall during the rest of the year（Rabi season).The soil of the experimental site was sandy loam.There was no rainfall during the experimental period.Rabi season is characterized by plenty of sunshine.

3.3 Plant materials

Sweet potatovine was used as plant material in conducting the entire experiment. The vine was collected from Tuber Crop Research Centre (TCRC) of Bangladesh Agriculture Research Institute(BARI), Joydebpur, Gazipur, Bangladesh.

Variety:

1.BARI Sweet potato- 1(Tripti)

2.BARI Sweet Potato- 2(Kamlasundori)

3.BARI Sweet Potato- 3

4.BARI Sweet Potato-4

5.BARI Sweet Potato-5

6.BARI Sweet Potato- 6

7.BARI Sweet Potato- 7

8.BARI Sweet Potato- 8

9.BARI Sweet Potato- 9

10.BARI Sweet Potato- 10

11.BARI Sweet Potato- 11

12.BARI Sweet Potato- 12

13.BARI Sweet Potato- 13

These varieties was used as treatment of thesis experiment .

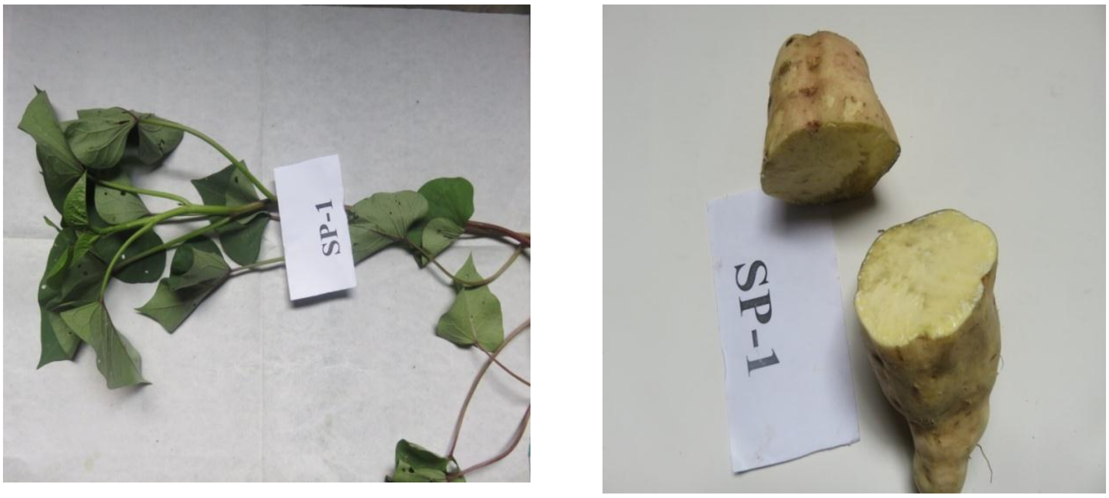

Figure 1. BARI Sweet potato- 1(Tripti)

Figure 2.BARI Sweet potato-2(Kamlasundori)

Figure 3. BARI Sweet potato-3

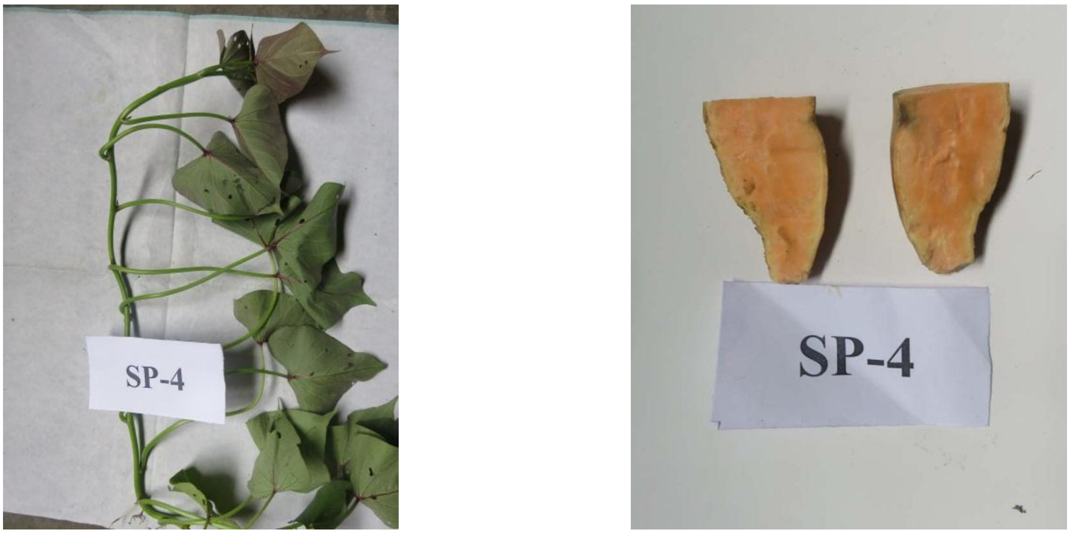

Figure 4. BARI Sweet potato- 4

Figure 5. BARI Sweet potato- 5

Figure 6. BARI Sweet potato- 6

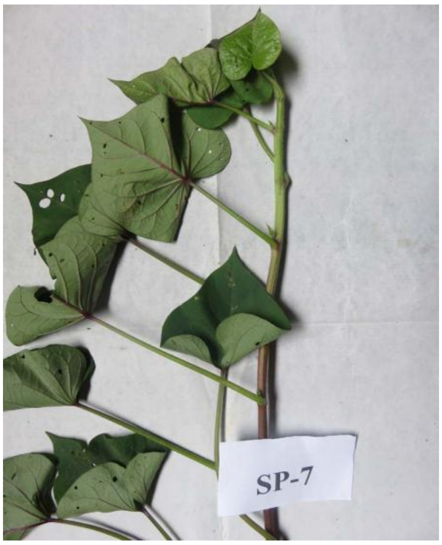

Figure 7. BARI Sweet potato- 7

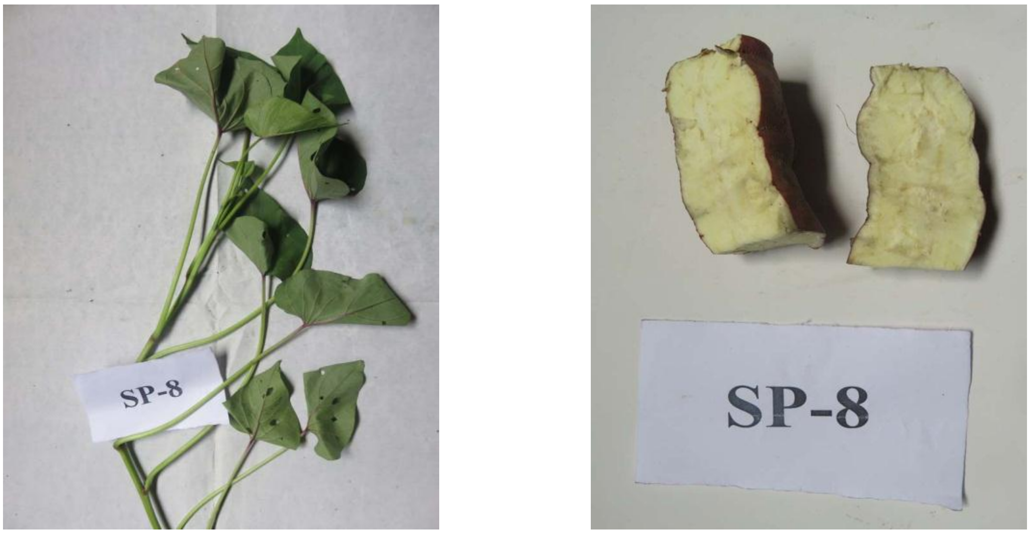

Figure 8. BARI Sweet potato- 8

Figure 9. BARI Sweet potato- 9

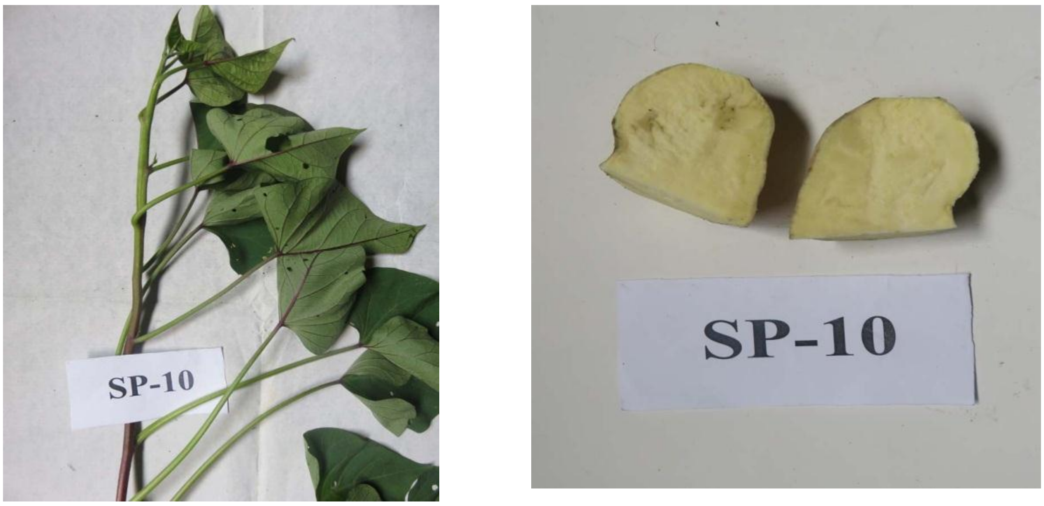

Figure 10. BARI Sweet potato- 10

Figure 11. BARI Sweet potato- 11

Figure 12. BARI Sweet potato- 12

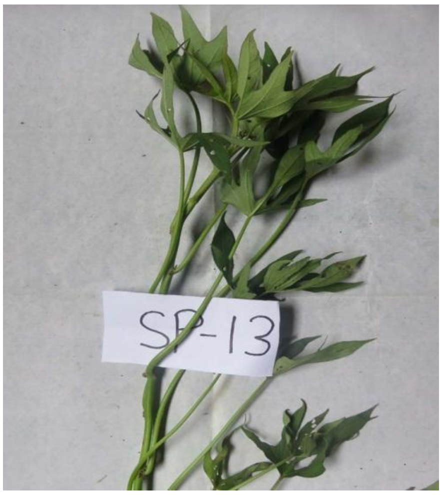

Figure 13. BARI Sweet potato- 13

3.4 Design and layout

The experiment was plotted in a Randomized Complete Block Design (RCBD) with three replications. Thirteen (13) plots for each replication amounting 39 plots in total along with control for each replication was designed to complete the experiment.

3.5 Land preparation

The land was ploughed by a power tiller and was leveled by harrowing and laddering carefully. The weeds and stubble were removed and plots were prepared.

3.6 Fertilizer application

A fertilizer dose of 10 tones cow dung/ha, 200-150-200 kg/ha N, P, K was applied in the form of Urea, Triple Super phosphate (TSP), Murate of potash respectively. After land preparation, full dose of P, K and two third of N were incorporated thoroughly into the soil as basal dose. The remaining amount of N was applied at 25 days interval after seedling emergence

3.7 Vinetransplanting

Vine of 13 sweet potato genotypes were transplanted on 25th November 2017 in rows of 60 cm apart, at the rate of 56 thousand vine/ha.

3.8 Irrigation

Depending on soil water 2-3 irrigation was given. The irrigation was given at 30, 60, 90 days interval.

3.9 Intercultural operation

Lifting up of vine was done after 60 days of transplanting. This operation was done in every month. It prevents rooting from node of vine and increases tuber quality.To prevent weevil attack, Diazinon- 14 G @ 15 kg/ha was applied.

3.10 Data collection

Growth parameters were collected at 60 DAS and at the time of harvesting Data were collected on following sequences:

A. Yield parameter:

1. Length of vine (cm)
2. Number of branch/ plant
3. Chlorophyll content of leaf
4. Leaf area(cm^2)
5. Number of tubers/plant
6. Total weight of tubers/plant (kg)
7. Weight ofMarketable tubers/plant (kg)
8. Yield (t/ha)

B. Quality parameter:

1. Starch content
2. β-carotene content
3. Dry weight

4. Total sugar content
5. TSS

3.11 Sampling Procedure for growth study during the crop growth period

3.11.1 Vine length

Sweet potato vine length was recorded at 60 DAS. Height was measured by scale. Height of 5 plants from each plot was recorded.

3.11.2 No. of branches/plant

Number of branches of 5 randomly selected plants were at 60 days after transplanting. The average number of branches of 5 plants gave number of branch/plant

3.11.3 Chlorophyll content

Chlorophyll content of leaf was measured by cholorphyll content meter (SPAD). Data was recorded from 5 leaves of each sampling plant.

3.11.4 Leaf area measurement

Leaf area was measured by leaf area index meter. Data was recorded from 5 leaves of each sampling plant.

3.11.5 Numberof tuber/plant

Number of tuber per plant was counted from the 5 replications. The average number of tuber/plant gave the numberof tuber per plant.

3.11.6Weight of tuber/plant

All tubersof selected plant were collected.Then these were placed on the digital balance for the calculation of weights.

3.11.7 Weight of marketable tuber/plant

Allmarketable tubers of selected plant were collected.Then these were placed on the digital balance for the calculation of weights.

3.11.8 Yield (t/ha)

All the tubers of field were collected.Then these were placed on the digital balance for the calculation of weights.

3.11.9 Dry matter content

The dry sample content ofsweetpotatoes was determined by drying a representative 100gsweetpotato sample at 80 °C for 72 h in a laboratory drying inoven.The dry matter content (%) was calculated by using theloss weight and the fresh sample weight according to thefollowing formula.

Dry matter (%) = Dry weight of sample /Total weigh of sample x 100

3.11.10 Total Sugar Content

The total sugar content ofsweetpotatoes was determined according to thespectrophotometricAnthrone method modified by Tokusogluet.al., (2003; 2005) using sucrose as standardanhydroglycose for sweetpotato. 50 mg of sample was taken in a test tube, one drop of ethanol was added in the sample. Then 2 ml water was added and vortex for 5 minutes. This mixture was centrifuged for 10 minutes（3500rpm） and clear supernatant was separated. This process is repeated for 3 times. 0.1 ml of sample solution （supernatant）was taken in a test tube and volumed it at 1 litre. 2 ml anthrone reagent was added in the sample, heating for 8 minutes and again cool at 25^0celcius. Standard buffer stocksolutions containing anthrone reagent and samples weremeasured for 630 nm at spectrophotometer.Standardanalytical calibration was found to be R_2= 09942 (Osborne,1986).

3.11.11 Total Starch Content

The total starch content ofsweetpotatoes was determined by using the method ofInternational Starch Institute-Denmark described by Woolfe(1992). The residue left in the test tube in times of sugar estimation was taken in a test tube, dried at 70^0celcius. Water was added in the sample （5 ml）, cooled in ice bath and 6.5 ml perchloric acid was added. Then centrifuged and clear supernatant was separated. This process was repeated for 3 times. 0.1 ml sample solution was taken in a test tube, perchloric acid and anthrone reagent （2ml） was added to the sample and samples weremeasured for 630 nm at spectrophotometer.

3.11.12 Beta-Carotene Content

Beta carotene content was determined by adding acetone, n-Hexane mixture to crushed sweet potato. Acetone and n-Hexane was mixtured in 2:3 ratio. 20 mg of sample (crushed potato) was taken in a test tube, then 10 ml of acetone, n- hexane mixture was added. Vortex the sample for few minutes and centrifuged for 10 minutes. Clear supernatant was separated and then spectrophotometer reading will be taken at four different nanometer length viz. 663 nm, 645nm, 505nm and 453nm (Nagata and Yamashita, 1992). β-Carotene will be calculated by the following formula.

β-Carotene (mg) = 0.216 (Reading of 663nm) + 0.452 (Reading of 453nm) – 1.22 (Reading of 645nm) – 0.304 (Reading of 505nm)

3.12 Statistical Analysis

Data accumulated from different parameters were subjected to analysis of variance (ANOVA) using the software R. Mean separation was done by Fisher's LSD at 5% level of significance

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Growth parameters of sweet potato seedlings

4.1.1 Vine length

Significant increase of vine length was observed in sweet potato seedlings at 60 days after transplanting (Table-1). Thehighest vine length was observed in BARI SP-12(72.45 cm) which was followed byBARI SP-9 (45.34) and BARI SP-10 (43.99), but there was no significant difference between BARI SP-9 and 10 varieties.On the other hand, the lowest vine length was observed in BARI SP- 4 (14.42 cm) which was statistically similar to BARI SP- 1 (15.41 cm) and BARI SP- 8 (15.75 cm).It has been observed that genotypes with long vines also produced a large number of leaves. The variety BARI SP-12, with the longest vines, could therefore, be used as forage for feeding ruminants due totheir richness in protein.Vine length differs due to genetic make up present in the genotype as well as tolerance to the acidic soil. Kareem (2013) reported that mediumsized vine length gave the best yield of sweet potato. Rashid *et al*.(2002), Onuka*et al*. (2012) and yooyongwech*et al.* (2014) stated that vine length is a genetic character and may differ from genotype to genotype under similar soil and environmental conditions.The growth behaviour of sweet potato may vary in particular climate other than it originated.

Table 1. Vine length of 13 sweet potato varieties at 60 days after transplanting

Variety	**Vine length**
BARI SP- 1	15.41 h
BARI SP- 2	29.26 ef
BARI SP- 3	22.81 g
BARI SP- 4	14.42 h
BARI SP- 5	35.77 cd
BARI SP- 6	24.99 fg
BARI SP- 7	38.45 c
BARI SP- 8	15.75 h
BARI SP- 9	45.34 b
BARI SP- 10	43.99 b
BARI SP- 11	24.78 fg
BARI SP- 12	72.45 a
BARI SP- 13	30.78 de
CV（%）	9.91
LSD	5.32

In a column, Mean followed by the same letter (s) did not differ significantly at 5 % level by LSD

4.1.2 Numberof branches/plant

All the branches developed from the main vine were considered the primary branches. The number of vines plant–1 at all growth stages differed significantly due to variety, different vine parts and their interactions. Result revealed that the number of branch per plant has shown satisfactory result(Figure 14). BARI SP-12 has shown highest result attaining 11.3 (a) which was followed by BARI SP-5(8.89) and BARI SP-11 (9.22)but there was no significant difference between BARI SP- 5 and BARI SP- 11. On the other hand, the lowest plant height was observed in BARI SP- 2 (3.19) which was statistically similar to BARI SP- 1 (3.42), BARI SP- 3 (3.78) and BARI SP- 4(3.88) and BARI SP- 8 (4.42).The findings of the present experiment are in agreement with the findings of Choudhury*et al*. (1986). Shen*et al*. (2015) reported that number of vine plant–1 ranges from 10.4-13.3 due to available nutrient present in the soil.

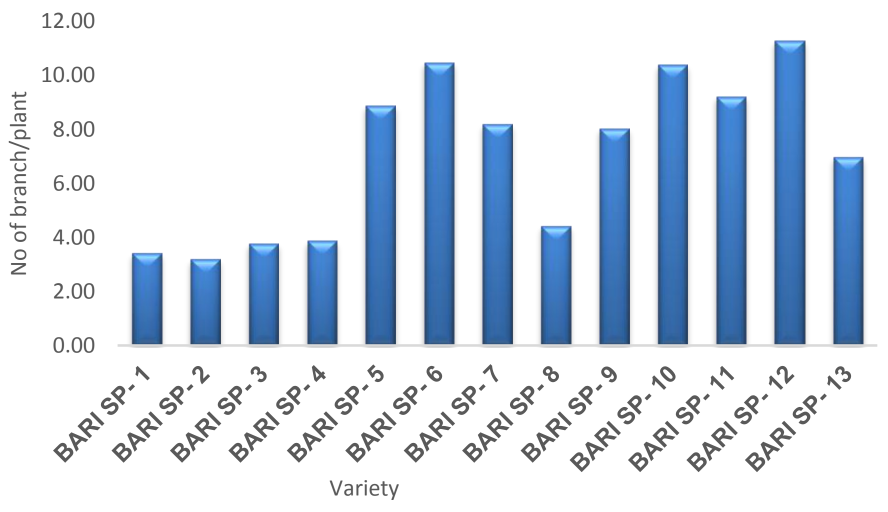

Figure 14. Number of branch per plant of 13 sweet potato varieties

4.1.3 Leaf area index

Significant increase of leaf area index was observed in sweet potato seedlings at 60 days after transplanting (Figure 15). Thehighest leaf area index was observed in BARI SP-11 (32.96 cm^2) which was followed byBARI SP- 5 (28.72 cm^2) and BARI SP-13 (30.37 cm^2) but there was no significant difference between BARI SP-5 and BARI SP- 13 varieties.On the other hand, the lowest plant height was observed in BARI SP- 2 (12.54 cm^2) which was statistically similar to BARI SP- 1 (14.32 cm^2). Leaf area index changes due to genotypic differences and response to photoperiod. Accessions that flowered late took a longer time to transit from the vegetative to reproductive phase and could be classified as late maturing.

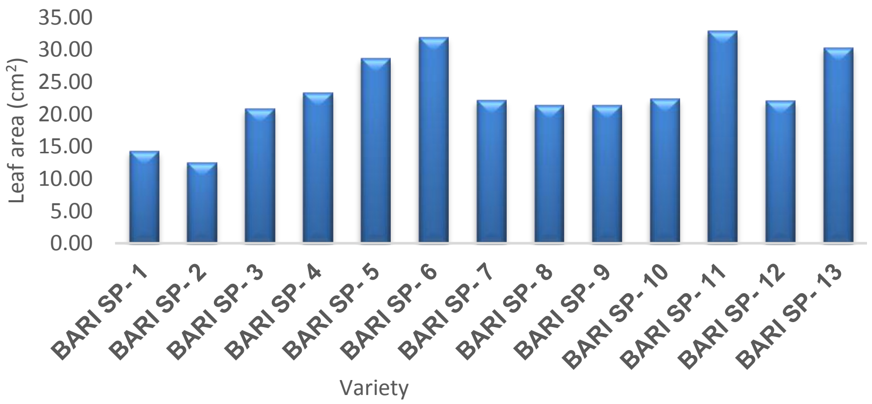

Figure 15. Leaf area of 13 sweet potato varieties

4.1.4Chlorophyll content

Chlorophyll content of sweet potato has shown satisfactory result(Figure 16). Thehighest chlorophyll was observed in BARI SP-1 (41.38 SPAD unit) which was similar toBARI SP- 10 (41.07 SPAD unit) and BARI SP-12 (40.76 SPAD unit).On the other hand, the lowest chlorophyll was observed in BARI SP- 5 (32.51 SPAD unit) which was statistically similar to BARI SP- 1 (32.51 SPAD unit).These results show that leaves of sweet potato plants has been increased in size due mainly of cellular elongation (Fabbri et al., 1986).

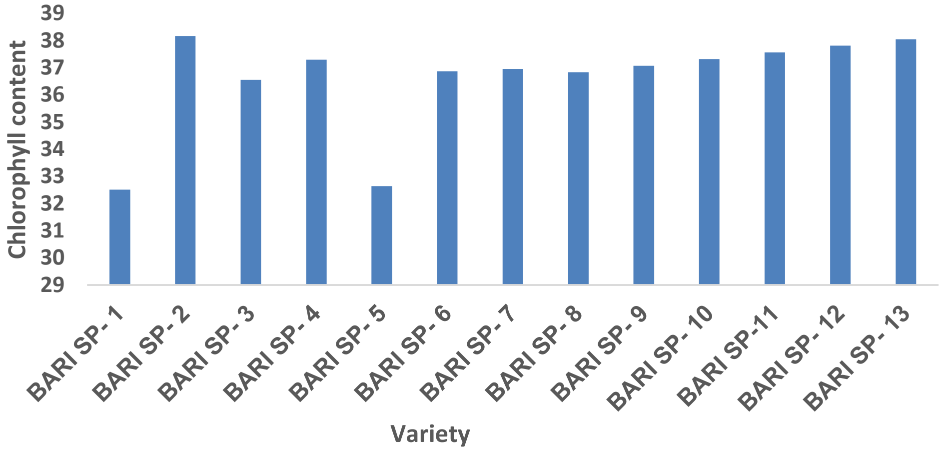

Figure 16. Chlorophyll content of 13 sweet potato varieties

4.2 Yield parameters of sweet potato

4.2.1 Number of tuber/plant

Number of tuber/plant of different sweet potato varieties showed significant differences (Figure 17). Thehighest number of tuber/plant was observed in BARI SP-10 (7.11) which was similar to BARI SP- 7 (6.99) and followed byBARI SP- 5 (6.66). But there was no significant difference between BARI SP-7 and BAPI SP- 5 varieties.On the other hand, the lowest plant height was observed in BARI SP- 1 (2.99) which was statistically similar to BARI SP- 3 (3.99).This might be due to the variation of genetic makeup of the different sweet potato genotypes. The results obtained from the present study are consistent with the results of Rashid *et al.* (2002) and Uwah*et al*. (2013) who stated that the numbers of root plant^{-1} were found considerable variation. Farooque and Husain (1973) also showed that the storage roots number plant^{-1} varied from 4.70-11 and it depends on the genotypes of sweetpotato.

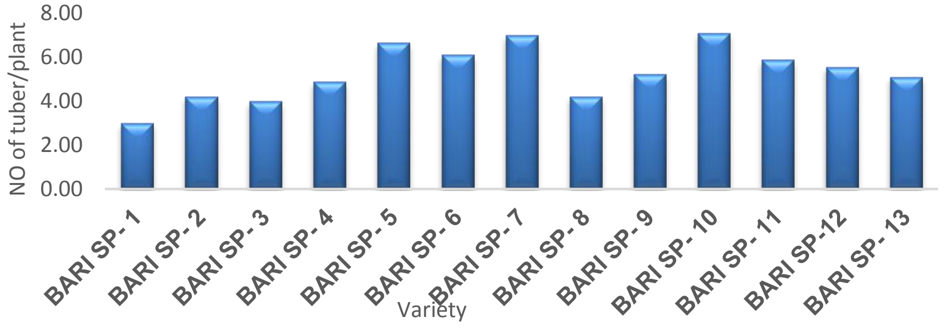

Figure 17. Number of tuber/plant of 13 sweet potato varieties

4.2.2 Weight of tuber/plant

Weight of tuber/plant of different sweet potato varieties showed significant differences (Table 2). Thehighest weight of tuber/plant was observed in BARI SP-10 (2.58 kg) which was followed byBARI SP- 12 (2.44 kg) and BARI SP-13 (2.39 kg)BARI SP- 11 (2.39 kg) and BARI SP- 9 (2.30 kg). But there was no significant difference between BARI SP-12, 13, 11 and 9 varieties.On the other hand, the lowest weight of tuber/plot was observed in BARI SP- 2 (0.98 kg) which was statistically similar to BARI SP- 3 (1.29 kg). Fresh weight of storage roots plant^{-1} differs significantly from genotype to genotype. The present results are in agreement with the findings of Siddique*et al*. (1988) who stated that the fresh weight of roots plant^{-1} varied widely the different genotypes. In the present study, it is clearly indicated that the fresh weight of root increased with the increases of length and diameter of storage roots.

Table 2. Weight of tuber (kg)/plant of different sweet potato varieties

Variety	**Weight of tuber(kg)/plant**
BARI SP- 1	1.40 abc
BARI SP- 2	0.98 c
BARI SP- 3	1.29 bc
BARI SP- 4	1.39 abc
BARI SP- 5	1.79 abc
BARI SP- 6	1.56 abc
BARI SP- 7	2.21 abc
BARI SP- 8	1.50 abc
BARI SP- 9	2.30 ab
BARI SP- 10	2.58 a
BARI SP- 11	2.37 ab
BARI SP- 12	2.44 ab
BARI SP- 13	2.39 ab
CV (%)	39.34
LSD	1.23

In a column, Mean followed by the same letter (s) did not differ significantly at 5 % level by LSD

4.2.3 Marketable tuber/plant

Marketable tuber/plant of different sweet potato varieties showed significant differences (Table 3).Best quality of tuber gives best market value. Thehighest marketable tuber/plant was observed in BARI SP-9 (2.12 kg)which was similar toBARI SP- 10(2.05 kg) and BARI SP-7 (1.95 kg) and followed by BARI SP- 13 (1.83 kg),BARI SP- 11 (1.80 kg),BARI SP- 12 (1.59 kg),BARI SP- 4 (1.50 kg),BARI SP- 6 (1.38 kg),BARI SP- 8 (1.35 kg),BARI SP- 5 (1.27 kg),BARI SP- 1 (1.25 kg),BARI SP- 3 (1.23 kg).But there was no significant difference between BARI SP-10, 7, 13, 11, 12, 4, 6, 8, 5, 1 and 3 varieties.On the other hand, the lowest marketable tuber/plant was observed in BARI SP- 2 (0.82 kg).

Table 3. Marketable tuber (kg)/plant of different sweet potato varieties

Variety	**Marketable tuber(kg)/plant**
BARI SP- 1	1.25 ab
BARI SP- 2	0.83 b
BARI SP- 3	1.24 ab
BARI SP- 4	1.51 ab
BARI SP- 5	1.28 ab
BARI SP- 6	1.38 ab
BARI SP- 7	1.95 a
BARI SP- 8	1.36 ab
BARI SP- 9	2.12 a
BARI SP- 10	2.06 a
BARI SP- 11	1.81 ab
BARI SP- 12	1.59 ab
BARI SP- 13	1.84 ab
CV (%)	42.09
LSD	1.10

In a column, Mean followed by the same letter (s) did not differ significantly at 5 % level by LSD

4.2.4 Weight of tuber/plot

Weight of tuber/plot of different sweet potato varieties showed significant differences (Figure 18). Thehighest weight of tuber/plot was observed in BARI SP-6 (22.97 kg) which was similar to BARI SP- 10 (22.82 kg) and followed byBARI SP- 9 (22.23 kg), BARI SP-7 (22.04 kg) and BARI SP- 8 (21.92 kg). But there was no significant difference between BARI SP-9, 7 and 8 varieties.On the other hand, the lowest weight of tuber/plot was observed in BARI SP- 5 (14.33 kg) which was statistically similar to BARI SP- 4 (15.18 kg).

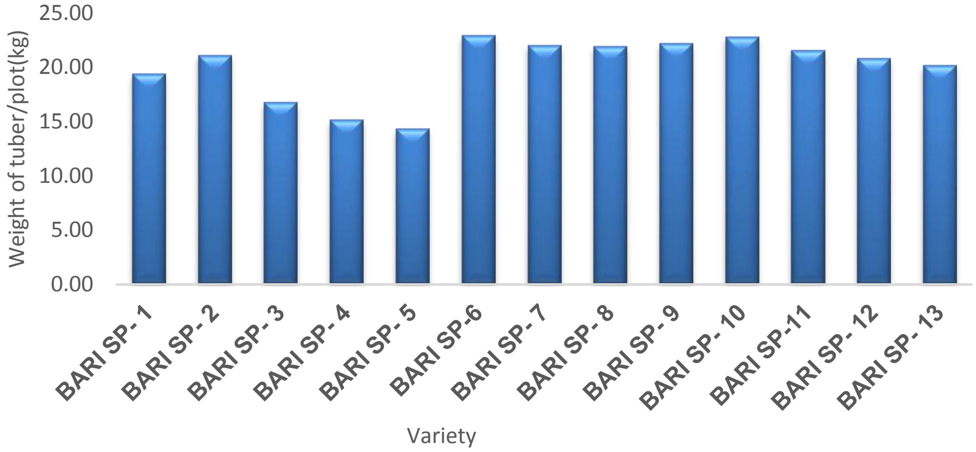

Figure 18. Weight of tuberb/plot of 13 sweet potato varieties

4.2.5 Yield (ton/ha)

Yield (t/ha) of different sweet potato varieties showed significant differences (Table 4). Thehighest yield was observed in BARI SP-6 (25.52 t) which was similar to BARI SP- 10 (25.36 t) and followed byBARI SP-9 (24.69), BARI SP-7 (24.49 t) and BARI SP- 8 (24.36 t). But there was no significant difference between BARI SP-9, 7 and 8 varieties.On the other hand, the lowest yield was observed in BARI SP- 5 (15.93 t) which was statistically similar to BARI SP- 4 (16.87 t).These results are corroborated with the findings of Naskar and Chowdhury (1994), Siddique*et al*. (1988) and Yooyongwech*et al*. (2014) found that yield potentiality of sweet potato depends on the genetic make-up plant. Sen*et al*. (1988)stated that significant variations among the genotypes were happened may be due to the adoption of proper cultural management techniques.

Table 4. Yield (t/ha) of 13 sweet potato varieties

Variety	**Yield(t/ha)**
BARI SP- 1	21.59 c
BARI SP- 2	23.48 abc
BARI SP- 3	18.64 d
BARI SP- 4	16.87 de
BARI SP- 5	15.93 e
BARI SP- 6	25.53 a
BARI SP- 7	24.49 ab
BARI SP- 8	24.36 ab
BARI SP- 9	24.70 ab
BARI SP- 10	25.36 a
BARI SP- 11	23.97 abc
BARI SP- 12	23.17 abc
BARI SP- 13	22.45 bc
CV (%)	6.84
LSD	2.58

In a column, Mean followed by the same letter (s) did not differ significantly at 5 % level by LSD

4.3 Quality parameters of sweet potato

4.3.1 Dry weight

Dry weight of different sweet potato varieties showed significant differences (Figure 19). Thehighest dry weight was observed in BARI SP-11(35.45 g/100 g).On the other hand, the lowest dry weight of tuber was observed in BARI SP- 9 (14.52 g/ 100 g).Delowar and Hakim (2014) reported that dry weight of storage roots depends on the varietal performance to the particular soil. The result showed that some genotypes failed to show the relationship of fresh weight to the dry weight of the roots.

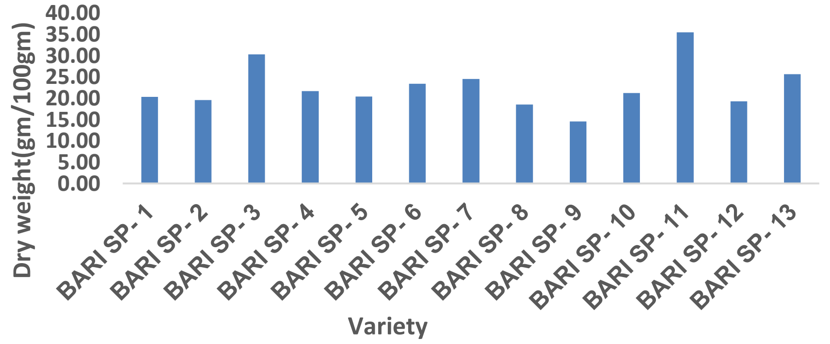

Figure 19. Dry weight of 13 sweet potato varieties

4.3.2 Total soluable solid(TSS)

TSS of different sweet potato varieties showed significant differences (Figure 20). Thehighest TSS was observed in BARI SP-1 (12.29 %) which wasfollowed byBARI SP- 3 (11.56 %).On the other hand, the lowest TSS was observed in BARI SP- 13 (4.03 %).

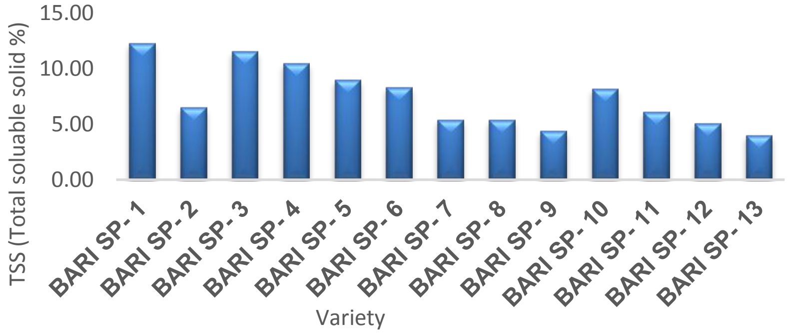

Figure 20. Total soluable solid of 13 sweet potato varieties

4.3.3 Total sugar content

Total sugar of different sweet potato varieties showed significant differences (Figure 21). Thehighest amount of sugar was observed in BARI SP-9 (23.30 %) which was followed byBARI SP- 6 (21.52 %. On the other hand, the lowest amount of sugar was observed in BARI SP- 4 (6.31 %).It has been reported that sucrose is the most abundant sugar in raw sweet potatoes with smaller amount of glucose and fructose (Bouwkamp, 1985).These results correlate with the findings by Chattopadhyay*et al*. (2006).

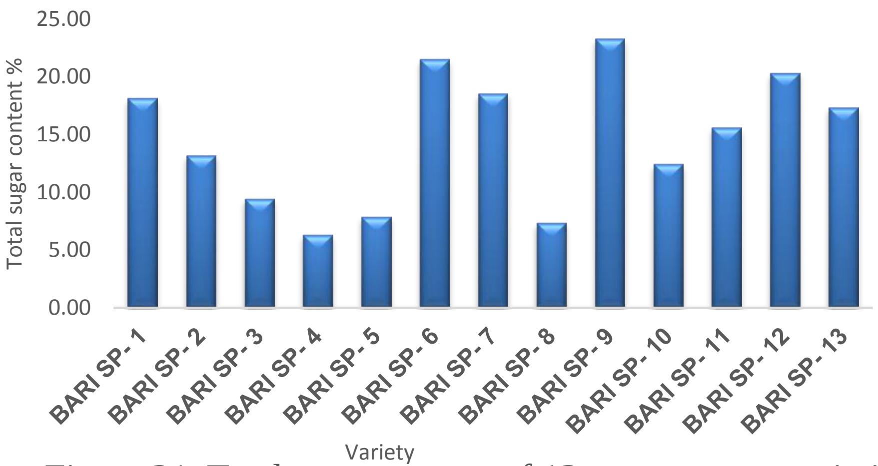

Figure 21. Total sugar content of 13 sweet potato varieties

4.3.4 Starch content

Starch content of different sweet potato varieties showed significant differences (Figure 22). Thehighest amount of starch was observed in BARI SP-1 (75.75 %) which wasfollowed byBARI SP- 2 (72.32 %). On the other hand, the lowest starch content was observed in BARI SP- 6 (23.4 %). Starch content of sweet potato varies due to genetic make up (Chattopadhyay*et al*.,2002).Cultivars containing low starch can be considerable suitable for table purpose (Mitra*etal*.,2010). Sweet potato tuber is highly rich in starch. It is reported that the cultivar with the highest starch content is best for the processing. In food industry, it is applied to enhance functional properties, as in soups, meat sauces, as builders in candies, etc. (Stracke*et al*.,2009).

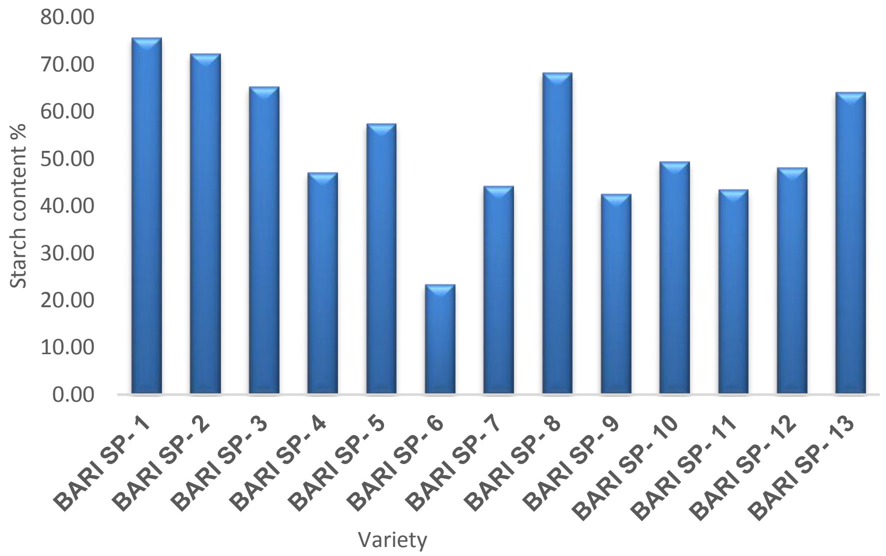

Figure 22. Starch content of 13 sweet potato varieties

4.3.5 Carotene content

Fruits and vegetables contain different types of carotenoids in different amounts (Fesco O.L *et al*.,2002). Carotene content of different sweet potato varieties showed significant differences (Figure 23). Thehighest amount of carotene was observed in BARI SP-12 (1.18 %) which was followed byBARI SP- 8 (1.02 %). On the other hand, the lowest carotene content was observed in BARI SP- 4 (0.04 %). Carotene is an important element in sweet potato. Islam *et al*. (2006) also reported similar results in their study. Sweet potatoes, carrots and leafy vegetables contain high levels of β-carotene, frequently greater than 8000 I.U./100 g, and can, therefore, meet the recommended daily intakes (5000 to 25,000 I.U.) (Fesco O.L *et al*.,2002).

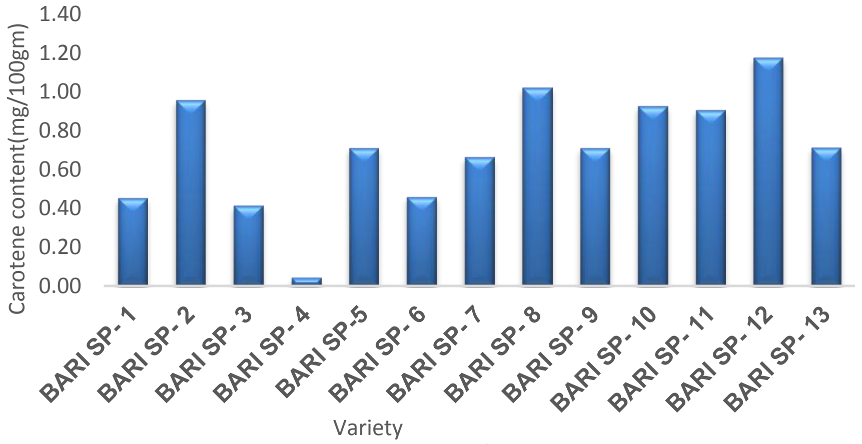

Figure 23. Carotene content of 13 sweet potato varieties

CHAPTER V

SUMMARY AND CONCLUSION

The present study was conducted in the Agronomic field of Sher-e-Bangla Agricultural University, Dhaka, to evaluate sweet potato germplasms for the characters of yield and quality. The experiments were arranged in a Randomized Complete Block Design (RCBD) with three replications. Sweet potato vines were grown in the field and the Data were taken by sampling the vine. Different data of growth, physiology and biochemical parameters were measured. Plant height, fresh weight and dry weight were measured.

Yield parameters includeslength of vine (cm), number branch/ plant, chlorophyll content of leaf, leaf area(cm^2), number of tubers/plant, total weight of tubers/plant, weight of marketable tubers/plant, yield. Quality parameters include starch content, β-carotene content, dry weight, total sugar content and TSS.

In the present study 13 sweet potato varieties from BARI has shown their yield and quality performance. Different varieties have shown different performance in yield and quality analysis. Some varieties have shown better performance in planthight but not good at yield performance.Thehighest and lowest vine length was observed in BARI SP-12 (72.45 cm) and BARI SP- 4 (14.42 cm) respectively. The number of vines plant–1 at all growth stages differed significantly due to variety, different vine parts and their interactions. Thehighest and the lowest leaf area index was observed in BARI SP-11 (32.96 cm^2) and BARI SP- 2 (12.54cm^2) respectively.Leaf area index changes due to genotypic differences and response to photoperiod. Thehighest and the lowest chlorophyll was observed in BARI SP-9 (41.38 SPAD unit) and BARI SP- 1 (32.51 SPAD unit) respectively. Thehighest and the lowest number of tuber/plant was observed in BARI SP-10 (7.11) and BARI SP- 1 (2.99) respectively.This might be due to the variation of genetic makeup of the different sweet potato genotypes.Thehighest and the lowest weight of tuber/plant was observed in BARI SP-10 (2.58 kg) and BARI SP- 2 (0.98 kg) respectively. Fresh weight of storage roots $plant^{-1}$ differs significantly from genotype to genotype.Best quality of tuber gives best market value. Thehighest and the lowest marketable tuber/plant was observed in BARI SP-9 (2.12 kg) and BARI SP- 2 (0.83 kg) respectively. Thehighest and the lowest weight of tuber/plot and yield was observed in BARI SP-6 (22.97 kg, 25.52 t/ha) and BARI SP- 5 (14.33 kg, 15.93 t/ha) respectively.This variety also contains higher amount of chlorophyll in their leaves. Higher amount of chlorophyll in leaves causes higher tuber growth. Thehighest and the lowest dry weight was observed in BARI SP-11 (35.45 %) and BARI SP- 9 (14.52 %) respectively.

Thehighest and the lowest TSS was observed in BARI SP-1 (12.29 %) and BARI SP- 13 (4.03%) respectively.Higher amount of sugar is present in BARI SP-6 (23.30 %). BARI SP-1 (75.75 %) contains higher amount of starch and BARI SP- 6 (42.60 %) contains lower amount of starch. Carotene content is an important parameter of sweet potato which has anti-cancer effect and reduces night blindness. Among 13 varieties BARI SP-12 (1.18%) has shown highest amount of carotene content. The lowest amount of carotene was found in BARI SP- 4 (0.04 %).

Finally, we may conclude with remarks that different sweet potato varieties show different result because of their different genetic makeup. Different varieties have different criteria with different purposes. There are 30 AEZ in our country which show different soil category and environment. Different sweet potato varieties fulfill these purposes.

CHAPTER VI

REFERENCES

An, L. V., Frankow–Lindberg, B. E. and Lindberg. J. E. 2003. Effect of harvesting interval and defoliation on yield and chemical composition of leaves, stems and tubers of sweet potato（*Ipomoea batatas*（L）Lam.） cultivars. Field Crops Research 82(1): 49–58.

Anselmo, B. A., Ganga, Z. N., Badol, E. O., Heimer, Y. M. and Nejidat, A. 1998.Screening sweet potato for drought tolerance in the Philippine highlands and genetic diversity among selected genotypes. Tropical Agriculture, Trinidad. **75**, 189-196.

Backer, J., Ruiz, M. E., Munoz, H. and Pinchinat, A. M. 1980. The use of sweet potato（*Ipomoea batatas*（L） Lam） in animal feeding. II. Beef production. Tropical Animal Production. 5(61).

Bertelson, D., Dismukes, R., Hoff, F. and Lee, H., 1994. Sweet potatoes: An economic assessment of the feasibility of providing multiple-peril crop insurance.

Bhagsari, A. S., and Harmon. 1982.Photosynthesis and photosynthate partitioning in sweet potato genotypes. Journal of American Society Horticulture Science **107**, 506-510.

Brown, R. H. 1992. Photosynthesis and plant productivity in sweet potato.In "Sweet potato technology for the 21st century". Eds. WA Hill, CK Bonsai, PA Loretan. Tuskegee University.Albama.273-281 pp.

Bouwkamp, J. C. 1985. Introduction part 1 Sweet potato products: A Natural Resources for the tropics. In: Bouwkamp, J. C. (Eds), CRP Press, Boca Raton, Florida, USA, pp: 3-7

Chattopadhyay, A., Chakraborty, I. and Sen, H. 2002. Physico-chemical characteristics of sweet potato as a function of cultivars. The Horticultural Journal, 15(2):45-50.

Chattopadhyay, A., Chakraborty, I., Mukhopadhyay, S.K., Kumar, P.R. and Sen, H. 2006. Compositional changes of sweet potatoes. The Horticultural Journal, 18(3):45-50.

Choudhury, S.H., S.U. Ahmed and A.F.M. Sharfuddin, 1986. Effect of number of nodes in different types of vine cuttings on the growth and yield of sweet potato. Bangladesh Hort., 14: 29-33.

Constantin, R. J., Ones, L. G. J., Hammett, H. L., Hernandez, T. P. and Kahlich, C. G. 1984. The response of three sweet potato cultivars to varying levels of Nitrogen. J Am Soc Hort Soc 109: 605-614.

Crowder, L. V. and Chedda, H. R. 1982. Tropical Grassland Husbandry. Longman Inc., New York.

Dayal, T.R., M.D. Upadhya, G.T. Kurup, M.S. Palaniswami and V.P. Pony *et al*., 2006. Possibilities for Improvement of Yield and Dry Matter Content in Sweet Potato (*Ipomoea batatas* L.). In: Tropical Tuber Crops, Problems, Prospects and Future Strategies, Kurup, G.T., M.S. Palaniswami, V.P. Potty, G.Padamaja,S.Kabeerathumma and S.V. Pillai (Eds.). Oxford and IBH Publishing Co., New Dehli, pp: 120-126.

Delowar, H.K.M. and M.A. Hakim, 2014.Effect of salinity levels on the morpho-physiological characteristics and yield attributes of sweetpotato genotypes. Int. J. Sci. Res., 10: 929-934.

Duke, J. A. 1983.*Ipomoea batatas*(L.) Lam. Handbook of Energy Crop (unpublished). Available from: http://www. hort.purdue.edu/ newcrop/duk_ energy/ Ipomoea_batatas.html

Ehisianya, C.N., Lale, N.E.S., Umeozor, O.C., Amadi, C.O. and Zakka, U., 2011. Evaluation of effectiveness of variety, tillage method and time of harvest on sweet potato yield and the population of sweet potato weevils, Cylas punctillis (Bohemann) (Coleoptera: Brentidae). International Journal of Advanced Scientiic and Technical Research (1) 2 165-180.

Fabbri, A., Sutter, E., Dunston, S. K. 1986.Anatomical changes in persistent leaves of tissue cultured strawberry plants after removal from culture. Sci. Hort. 28: 331-374.

FAO (Food and Agriculture Organization of the United Nations).1997.Database at http://apps.fao.org.

FAO (Food and Agriculture Organization of the United Nations).2017.Database at http://apps.fao.org.

FAOStat, 2018. http://www.fao.org/faostat/en/#data/QC Retrieved 18 April 2018.

FAOStat. Food and Agriculture Organization ofthe United Nations.2016. Food and agricultural commodities production.http://faostat3.fao.org.

Farooque, A.M. and A. Husain, 1973.Studies on the comparative morphological characters and the yield of the seven varieties of sweet potato. Bangladesh Hortic., 1: 37-44.

Farrell, D. J., Jibril. H., Perez-Maldonado, R. A., Mannion, P. F. 2000. A note on a comparison of sweet potato vines and Lucerne meal for broiler chickens. Animal Feed Science Technology 85: 145-150.

Fesco, O.L., Boudion O.W. Food and nutrition security for human security; Proceedings of International Conference on Vegetables; Rome, Italy. June 2002; pp. 11–13.

Figueroa, V. and Rodriguez, J. 1994. Un alimento seco para aves basado en mieles de cana de azucar. Livestock Research for Rural Development. 6 (1).

Foy, C.D., J.A. Duke and T.E. Devine, 1992. Tolerance of soybean germplasm to an acid Tatum subsoil. J. Plant Nutr., 15: 527−547.

Giang, H. H., Ly, L. V. and Ogle, B. 2004. Digestibility of dried and ensiled sweet potato roots and vines and their effect on the performance and economic efficiency of F1 cross bred fattening pigs. Livestock Research for Rural Development16（7） 2004.

Gonzalez, C., Diaz, I., Vecchionacce, H., and Ly, J. 2003. Performance traits of pigs fed sweet potato（*Ipomoea batatas* L.） foliage ad libitum and graded levels of protein. Livestock Research for Rural Development（15）9.

Goswami, S. B., Sen, H. and Jana, P. K. 1995.Tuberization and yield potential of sweet potato cultivars as influenced by water management practices. Journal of Root Crops **21**(2), 77-81.

Hahn, S. K. and Hozyo, Y. 1984.Sweet potato.In "The physiology of tropical field crops".Eds PR Goldsworthy, NM Fisher.Johm Wiley &Sons; United Kingdom 551-567 pp.

Hasanuzzaman, M., Bhuyan, M. H. M., Nahar, K., Hossain, M. S., Mahmud, J. A., Hossen, M. S., Masud, A. A. C. and Fujita, M. 2018. Potassium:

A Vital Regulator of Plant Responses and Tolerance to Abiotic Stresses. *Agronomy*.**8**(3): 31.

Huaman, Z. 1992.Descriptor for sweet potato. International Potato Centre, Asian Vegetable Research and Development Centre (AVRDC), International Board for Plant Genetic Resources (IBPGR). Lima, Peru.

Huaman, Z. 1997.Botany, origin, evolution and biodiversity of the sweet potato.In "Sweet potato germplasm management training manual".Ed. Z Huaman. International Potato Centre (CIP); Lima, Peru

Huang, B. and Gao, H. 2000.Root physiological characteristics associateed with drought resistance in tall fescue cultivars. Crop Science **40**, 196-207

Huang, D.J., Lin, C.D., Chen, H.J. and Lin, Y.H. 2004.Antioxidant and antiproliferative activities of sweet potato (*Ipomoea batatas*L. Lam Tainong 57) constituents.*Bot. Bull. Acad. Sin.* 45: 179- 186.

Indira, P. and Kabeerathumma, S. 1988.Physiological response of sweet potato under water stress. 1. Effect of water stress during the different phases of tuberization. Journal of Root Crops **14(**2), 37-40.

Islam, M.S., Yoshimoto, M., Yahara, S. and Yamakawa, O. 2002. Identification and characterization of foliar polyphenolic composition in sweet potato (*Ipomoea batatas*L.) genotypes, *J. Agric. Food Chem.*, 50: 3718- 3722.

Islam, S.N., Nusrat, T., Begum, P. and Ahsan, M. Carotenoids and β-carotene in orange fleshed sweet potato: A possible solution to vitamin A deficiency. Food Chem. 2016;199:628–631. doi: 10.1016/j. foodchem.2015.12.057.

Jahan, M.M.A., Islam, A.K.M. A. and Siddique, M. A. 2009. Studied on growth and yield of sweet potato (Ipomoea batatas poir) as inluenced by variety and time of harvest. http://aminipb. faculty.bsmrau.edu.bd./2009/07.

Kareem, I., 2013. Growth, yield and phosphorus uptake of sweet potato (*Ipomoea batatas*) under the influence phosphorus fertilizers. Res. J. Chem. Environ. Sci., 1: 50-55.

Kays, S. J. 1985.The physiology of yield in sweet potato. In "Sweet potato products: A natural resource for the tropics". ED. JC Bouwkamp. CRC Press; Boca Raton,Florida. 79-132 pp.

Kochian, L.V., O.A. Hoekenga and M.A. Pineros, 2004. How do crop plants tolerate acid soils? mechanisms of aluminum tolerance and phosphorous efficiency. Annu. Rev. Plant Biol., 55: 459-493.

Kusano, S. and Abe, H. 2000. Anti-diabetic activity of white skinned sweet potato (*Ipomoea batatas*L.) in obese zucker fatty rats. *Biol. Pharm. Bull*. 23 (1):23- 26.

Loebenstein, G. 2009.The sweet Potato: Origin distribution and economic importance. In: Loebenstein G &Thottappilly G (Eds.), Springer, p. 9-12.

Mahler, R.L. and R.E. Mcdole, 1985. The influence of lime and phosphorus on crop production in northern Idaho. Commun. Soil Sci. Plant Anal., 16: 485–499.

Martin, F. W. 1988.Sweet potato.http:// echonet.org/ Technotes/ sweetpotato.htm

Martin, F. W. and Rhodes, A. M. 1983. Correlations among characteristics of sweet potato.

McCraw, D. 2000.Sweet potato production.http://agweb. edu/pearl/hort/ vegetables/f6022.htm

Mitra, S., Tarafdar, J. and palaniswami, M.S. 2010.Impacts of different maturity stages and storage on nutritional changes in raw and cooked tubers of orange-fleshed sweet potato (Ipomoea batatas) cultivars. ActaHorticulturae, 858:205-212.

Moat, M. and Dryden, G. M. 1993. Nutritive value of sweet potato forage （*Ipomoea batatas*（L） Lam.） as a ruminant animal feed. Papua-New Guinea Journal of Agriulture Forestry and Fishery. 36（1）: 79-85.

Monamodi, E.L., Bok, I. and Karikari, S. K. 2003. Changes in nutritional composition and yield of two sweet potato（Ipomoea batatasL .） cultivars during their growth in Botswana. UNISWA Journal of Agriculture（11） 5–14.

Mupangwa, J. F., Ngongoni, N. T., Topps, J. H. and Ndlovu, P. 1997. Chemical composition and dry matter degradability profiles of forage legumes *Cassia rotundiflora* cv. Wynn, *Lablab purpureus* cv. Highworth and *Macroptilium atropurpureum* cv. Siratro at 8 weeks of growth（pre-anthesis）. Animal Feed Science Technology 69: 167-178.

Nagata,M.K.D. and I.Yamashita.1992. Simple methods for simultaneous determination of chlorophyll and carotenoids in tomato.J.Japan Soc. Hort. Sci. 61(2): 686-687. potato roots and intraspecific grouping. *Euphytica***32**, 453-463.

Naskar, S.K. and S.R. Chowdhury, 1994.Growth and yield response of eight sweet potato lines. Indian J. Plant Physiol., 37: 200-202.

Neppl, G．P., Wehner, T. C． and Schulthers, J．R．2003．Interaction of border and center rows of multiple row plants in watermelon yield trials．Euphytica 131, N02.

Norman, M. J. T., Pearson, C. J. and Searle, P. G. E. 1995.Sweet potato (*Ipomoea batatas*).In "The ecology of tropical food crops".2nd ed. Cambridge University Press.291-304 pp.

Nwinyi, S. C. O. 1992. Effect of age of shoot removal on tuber and shoot yields at harvest of five sweet potato（*Ipomoea batatas*（L） Lam.） cultivars．Field Crops Research 29（1）：47–54.

Onunka, N.A., L.I. Chukwu, E.O. Mbanasor and C.N. Ebeniro, 2012.Effect of organic and inorganic manures and time of application on soil properties and yield of sweetpotato in a tropical ultisol. J. Agric. Social Res., 12: 183-194.

Onwueme, I. C. 1978.The tropical tuber crops: Yams, cassava, sweet potato and cocoyams. John Wiley &Sons; Chic`hestar, Great Britain.234 pp.

Onwueme, I. C. and Charles, W. B. 1994.Tropical root and tuber crops.Production, perspectives and future prospects.Food and

Agriculture Organization (FAO) of the United Nations. Plant Production and Protection Paper No. 126, Rome. 122 pp.

Osborne, D.R.1986. Analisis de los nutrients de los alimentos.

Padmaja, G. 2009. Uses and nutritional data of sweet potato. In: Loebenstein, G and Thottappilly, G. (eds), *The Sweet potato*. Springer, The Netherlands. pp.189-234.

Peet, M. 2000.Sweet potato. Production practices. http://www.c als.ncsu. edu/sustainable/ peet/profiles/pps_pot.html

Prakash, C. S. 1994.Sweet potato biotechnology: Progress and potential. Biotechnology and development monitor 18, 18-19 http://www. pscw. uva.nl/monitor/1811.htm

Rashid, M. H., Bhuiyan, M. K. R. and Ahmed, M. S. 2000. Sweet potato breeding strategy in Bangladesh. African Potato Association Conference Proceedings Volume 5. Pp59-60.

Rashid, M.M., A.A. Mazumdar and S. Molla, 2002.Performance of exotic germplasm of sweet potato in Bangladesh. Proceedings of the 1st International Conference on Sweetpotato Food and Health, July 26-29, 2001, Lima, Peru, pp: 291-295.

Raymond, W. M. and Gardiner, D. T. 1998. Soils in our environment. Upper Sandy River, New Jersey, USA, pp.736.

Romani, M., Borghi, B., Albercici, R., Delogu, G., Hesselbach, J. and Sclami, F. 1993. Intergenotypic competition and border effect in bread wheat and barley. Euphytica 69, 1-2.

Ruiz, M. E., Lozano, E. and Ruiz, A. 1981. Utilization of sweet potatoes (*Ipomoea batatas* (L) Lam) in animal feeding. III. Addition of various levels of roots and urea to sweet potato forage silage. Tropical Animal Production 6(3): 234-244.

Salawu, I.S. and Mukhtar, A.A. 2008. Reducing the dimension of growth and yield characters of sweet potato (*Ipomoea batatas*L.) varieties as affected by varying rates of organic and inorganic fertilizers.*Asian J. Agric. Res.* 2(2): 41-44.

Schultheis, J.R. and Wilson, L.G. 2000.What is the difference between a sweet potato and a yam http://www.ces.ncsu.edu/depts/hort/hil/hil-23-a.html

Sen, H., N. Roychoudhury and S.K. Mukhopadhyay, 1988.Performance of different sweet potato *Ipomoea batatas* entries in the alluvial soil of West Bengal. Environ. Ecol., 6: 431-436.

Sharfuddin, A.F. and S.U. Ahmed, 2005. Effect of different levels of soil moisture on the growth, photosynthesis and dry matter content of sweet potato. Punjab Veget. Grow., 20: 5-10.

Shen, S., G. Xu, D.R. Clements, G. Jin, A. Chen, F. Zhang and H. Kato-Noguchi, 2015.Suppression of the invasive plant mile-a-minute (*Mikaniamicrantha*) by local crop sweet potato (*Ipomoea batatas*) by means of higher growth rate and competition for soil nutrients. BMC Ecol., Vol. 15. 10.1186/s12898-014-0033-5

Siddique, M.A., A.T.M. Hassanuzzaman and H. Akbar, 1988.Growth and yield of three high-yielding sweet potato genotypes. Bangladesh J. Agric., 13: 139-146.

Stracke, B.A., Rufer, C.E., Weibel, F.P., Bub, A. and Watzl, B. 2009. Three-year comparison of the polyphenol contents and antioxidant capacities in organically and conventionally produced apples (Malusdomesticabork. Cultivar "golden delicious")J. Agric. Food Chem., 57:4598–4605. DOI: 10.1021/jf803961f

Suda, I., Oki, T., Masuda, M., Kobayashi, M., Nishiba, Y. and Furuta, S. 2003.sweet potato as influenced by cultivar, harvest date and cooking. Acta Horticulturae 703:211-218

Tokusoglu, O., Kocak, S., Aycan, S. and Yildirim, Z. 2003.Comparative study for detection of B-group vitamins and folic acid by gas chromatograpy-mass spectrometry (GC-MS) and differential pulse polarography (DPP) in sweet potato (*Ipomeabatatas L.*). In 2003 IFT Annual Meeting Book of Abstracts. p.239. July 12-16 in McCormick Place, South Building, Chicago IL, USA.

Tokusoglu, O., Yildirim, Z. and Durucasu, I. 2005.Nutraceuticalphenolics (total polyphenols, chlorogenic [5-O-Caffeoylquinic] acid) in tubers, leaves, stalks and stems of new developed sweetpotato (*IpomeaBatatas*L.): Alterations in tubers during short-term storage. *Journal of Food Technol*., 3(3): 444-448.

Uwah, D.F., U.L. Undie, N.M. John and G.O. Ukoha, 2013. Growth and yield response of improved sweet potato (*Ipomoea batatas* (L.) Lam) varieties to different rates of potassium fertilizer in Calabar, Nigeria. J. Agric. Sci., 5: 61-69.

Valenzuela, H., Fukuda, S. and Arakaki, A. 2000.Sweet potato production guidelines for Hawaii.http:// www.extento. hawaii. edu/kbase/ reports/ sweetpot_prod.htm

Verma, V.S., K.P. Singh, N.K. Singh, J.R.P. Singh and S.P. Verma *et al*., 1994. Rajendra Shakarkand 35 and Rajendra Shakarkand 43: Two high yielding selections of sweet potato. J. Root Crops, 20: 15-19.

Villargarcia, O. M. R. 1996. Analysis of sweet potato growth underdiffering rates of nitrogen fertilization. North California State

Waraich, E. A., Ahmad, R., Ashraf, M. Y., Saifullah, and Ahmad, M. (2011).Improving agricultural water use efficiency by nutrient management in crop plants.*Acta Agric. Scandinavica*, Section B-Soil Plant Sci. **61**(4): 291-304.

Woolfe, J.A. 1992. Sweet Potato: An untapped food resource. Cambridge University Press, England, pp.643.

Yen, D. E. 1974.The sweet potato in the pacific and Ocania: An essay in ethno botany. Bishop Museum Press; Honolulu.

Yen, D. E. 1982.Sweet potato in historical perspective. In "Sweet potato".Eds. RL Villareal and TD Griggs.Proceedings of the First International Symposium. Asian Vegetable Research and Development Centre (AVRDC), Taiwan. 2-30 pp.

Yooyongwech, S., T. Samphumphuang, C. Theerawitaya, and S. Cha-Um, 2014.Physio-morphological responses of sweet potato [*Ipomoea batatas* (L.) Lam.] genotypes to water-deficit stress. Plant Omics J., 7: 361-368. Zaragoza: Acribia.258 p.

APPENDICES

Appendix I. Mean square values of Plant height, No of branch/plant, Leaf area index, Chlorophyll of 13 BARI Sweet potato varieties.

Mean square of					
Source of variation	df	Plant hight	No of branch/plant	Leaf area index	Chlorophyll
Replicatin	2	10.57	2.11	2.589	5.11
Treatment	12	764.09	26.793	114.841	2.48
Residuals	24	9.98	.962	3.683	1.79

Appendix II. Mean square values of No of tuber/plant, Weight of tuber/plant, Marketable tuber/plant, Weight of tuber/plot, Yield (t/ha) of 13 BARI Sweet potato varieties.

Mean of square						
Source of variation	df	No of tuber/plant	Weight of tuber/plant	Marketable tuber/plant	Weight of tuber/plot	Yield (t/ha)
Replicatin	2	4.372	0.457	1.267	2.368	2.92
Treatment	12	4.65	0.867	0.436	25.02	30.87
Residuals	24	1.016	0.532	0.428	1.894	2.34

Appendix III. Mean square of Dry weight, TSS, Total sugar, Starch , Carotene of 13 BARI Sweet potato varieties

df: degree of freedom

Mean square of						
Source of variation	df	Dry weight	TSS	Total sugar	Starch	Carotene
Replicatin	2	0.105	0.1105	0.042	0.1	.000079
Treatment	12	88.207	22.8128	98.281	657.74	0.281258
Residuals	24	0.032	0.0147	0.017	0.03	.000113

Plate 1. Sweet potato field view

Plate 2. Field visit by honourable teachers