EFFECTS OF NUMBER OF NODES AND CUTTING POSITION ON MORPHO-PHYSIOLOGICAL ATTRIBUTES AND YIELD OF SWEET POTATO

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CERTIFICATE

*This is to certify that the thesis entitled "**EFFECTS OF NUMBER OF NODES AND CUTTING POSITION ON MORPHO-PHYSIOLOGICAL ATTRIBUTES AND YIELD OF SWEET POTATO**" submitted to the Department of Agricultural Botany, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE (M.S.)** in Agricultural Botany, embodies the result of a piece of bonafide research work carried out by **Md. Towkir Ahmmed** Registration No.* ***14-06166*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged

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DEDICATED TO

MY

BELOVED PARENTS

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ABSTRACT

The sweet potato is an alternative energy source but its sustainability depends on higher yield. A field experiment was conducted at Sher-e-Bangla Agricultural University farm, Dhaka during the period from October 2019 to April 2020, to investigate the effects of number of nodes and cutting position on morpho-physiological attributes and yield of sweet potato. The experiment was consisted of nine treatments, and followed Randomized complete block design (RCBD) with three replications. Treatments (9) *viz,* T_0= 3 nodes from top cut, T_1= 3 nodes from middle cut, T_2= 3 nodes from basal cut, T_3= 5 nodes from top cut, T_4= 5 nodes from middle cut, T_5= 5 nodes from basal cut, T_6= 7 nodes from top cut, T_7= 7 nodes from middle cut and T_8= 7 nodes from basal cut. Data on different parameters were collected for assessing results for this experiment and showed significant variation in respect of node number and cutting position of vine of sweet potato. Among different treatments T_3 (5 nodes from top cut) out performed from all the other treatments and recorded maximum number of tubers plant^{-1} (5.15), total weight of tuber plant^{-1} (867.00 g), weight of marketable tuber plant^{-1} (802.00 g), total weight of tuber plot^{-1} (10 kg), tubers yield (27.56 t ha^{-1}) and dry matter (30.85 %) of tuberous root of sweet potato comparable to other treatments. The performance of T_0 (3 nodes from top) and T_6 (7 nodes from top) were also significantly better. Thus for propagating of sweet potato through vine, 5 node from top cut is suitable for achieving higher yield.

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ABBREVIATIONS

Full word	Abbreviations	Full word	Abbreviations
Agriculture	Agric.	Milliliter	mL
Agro-Ecological Zone	AEZ	Milliequivalents	Meqs
And others	et al.	Triple super phosphate	TSP
Applied	App.	Milligram(s)	mg
Asian Journal of Biotechnology and Genetic Engineering	AJBGE	Millimeter	mm
Bangladesh Agricultural Research Institute	BARI	Mean sea level	MSL
Bangladesh Bureau of Statistics	BBS	Metric ton	MT
Biology	Biol.	North	N
Biotechnology	Biotechnol.	Nutrition	Nutr.
Botany	Bot.	Pakistan	Pak.
Centimeter	Cm	Negative logarithm of hydrogen ion concentration (-log[H+])	pH
Completely randomized design	CRD	Plant Genetic Resource Centre	PGRC
Cultivar	Cv.	Regulation	Regul.
Degree Celsius	°C	Research and Resource	Res.
Department	Dept.	Review	Rev.
Development	Dev.	Science	Sci.
Dry Flowables	DF	Society	Soc.
East	E	Soil plant analysis development	SPAD
Editors	Eds.	Soil Resource Development Institute	SRDI
Emulsifiable concentrate	EC	Technology	Technol.
Entomology	Entomol.	Tropical	Trop.
Environmment	Environ.	Thailand	Thai.
Food and Agriculture Organization	FAO	United Kingdom	U.K.
Gram	g	University	Univ.
Horticulture	Hort.	United States of America	USA
International	Intl.	Wettable powder	WP
Journal	J.	Serial	Sl.
Kilogram	Kg	Percentage	%
Least Significant Difference	LSD	Number	No.
Liter	L	Microgram	µ

CHAPTER-1

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L). Lam), is a member of the morning glory family, Convolvulaceae, and the only member of the genus *Ipomoea* whose roots are edible. It is native of South America but presently grown throughout the tropical and subtropical regions of the world. Sweet potato is the sixth most important food crop of the world after rice, wheat, potato, maize and cassava (FAOSTAT, 2020).

Sweet potato is a dicotyledonous, herbaceous plant with creeping perennial vines and adventitious roots. It is grown as a starchy food crop throughout the tropical, subtropical and frost free temperate climate zones in the world (ICAR, 2007). It is among the world's most important versatile and underutilized food crop grown for its storage roots (Tortoe, 2010). It is a short duration crop usually matures in three to four months and can be grown two or three times in a year (Anyaegbunam *et al*., 2008). Sweet potato is rich in many vitamins, minerals, and beneficial fibers (Bovell-Benjamin, 2007). The unpretentious sweet potato's antioxidant, vitamin, and mineral values make it a "superfood". Calorie-wise, sweet potato is an ideal food (Rumbaoa *et al*., 2009). Naturally sweet, one medium potato has only 105 calories with four grams of fiber and, unless it is served with butter, zero fat ((Yoshimoto *et al*., 1999 and Islam, 2006). It also supplies 438% of the daily value of vitamin A and 37% of the daily value of vitamin C, as well as being a good source of important B vitamins, manganese, copper, and iron (Szalay, 2017). There is also good evidence from medical studies that antioxidants in sweet potatoes may be beneficial in preventing several chronic and deadly diseases, including diabetes and cancer (Rumbaoa *et al*., 2009 and Islam *et al*., 2002)

Sweet potato is widely grown between latitude 40° N to 40° S and altitude as high as 2500 m at the equator (Hahn and Hozyo, 1984). The crop generally requires a growth season of four to five months with optimum temperatures of 20°C - 25°C. It can be, grown at a wide range of temperatures between 15°C and 35°C. The highest root yields are obtained during day temperatures of 25 to 30°C and night temperatures of 15 to 20 °C. Sweet potato is grown in more than 100 countries. About 90 per cent of the sweet potatoes grown in the world are produced in Asia, five per cent are in Africa and the rest are on other continents (Horton *et al.,* 1989). China accounts for highest sweet potato production in the world followed by Uganda and Nigeria (FAO, 2004). The total production of sweet potato in Bangladesh increased 3.16% (from 235881 to 245719.20 metric tons (MT) in 2019 to 2020), and area increased by 1.94% (from 56869 to 60647.38 acre in 2019 to 2020. (BBS, 2021). This is due to the introduction and adoption of Bangladesh Agricultural Research Institute (BARI, 2019) releasing modern varieties, improved cultivation techniques, and awareness building by sweet potato growers. This crop also contributes greatly to farmers' income in Bangladesh (BARI, 2019). The typical yield of sweet potato in Bangladesh is only 10.20 ha^{-1} (FAOSTAT, 2017). while the probable or achievable yield has been stated to be as much as 40 t ha^{-1}. There are considerable opportunities for increasing the yield of sweet potato by limiting the yield gap (BARI, 2019). Yields of sweet potato could be improved by the use of good planting materials in terms of number of nodes and part of vine used.

Sweet potato is commercially propagated by vine cuttings. Vegetative method of propagation in sweet potato offers an advantage to the farmers to use all storage roots for consumption or for sale. Plants derived from vine cuttings are free from soil borne disease (Phills and Hill, 1984) and also vine cuttings produce roots of uniform size and shape. Yield of sweet potato could be improved by the use of good planting materials. Cuttings from the apical portion of the shoot are regarded as a better planting material than middle or basal vine cuttings ((Eronica *et al.*, 1981 and Schuthesis *et al.*, 1994). Apical cuttings may ensure better rooting and establishment and faster shoot growth and therefore early closure for weed suppression (Eronica *et al.*, 1981 and Hall, 1987). The apical and middle portion vine cuttings are also regarded to be the best planting materials for getting higher root yield ((Mukhopathyay, 1990). Basal vine cuttings are usually thick and woody, sometimes fail to establish and there is a greater chance of weevil incidence due to proximity with the crown portion where sweet potato weevil multiplies (Nair, 2006). Cuttings from apical shoot grow more vigorously and produce large storage roots compared with cuttings from middle and basal portions. Tewe *et al.* (2003) reported that apical cuttings of sweet potato had significantly higher marketable and total tuber yield than the middle followed by the basal cuttings. Cuttings from the shoot apex give more branches due to the fact that they establish quickly in the soil by initiating more roots and thereby encourage subsequent production of branches and greater number of root tubers than semi hardwood and hardwood cuttings (Choudhury *et al*., 1986)

The number of nodes on cuttings used as planting material may be an important aspect of yield variability. Increase in node number might result in more nodes buried and more roots initiated from the nodes for early establishment. In higher node number cuttings, early rapid growth, tuber initiation and bulking began earlier than in lower node number cuttings. This translates into higher tuber yield in the higher node number cuttings. Onwueme and Sinha (1991) indicated that tuber yield tends to increase with increase in the length of the vine cutting used and a length of about 30 cm is recommended. Cuttings of greater length than this tend to be wasteful of planting material, while shorter cuttings establish more slowly, and give poor yields. Depending on the availability and convenience in handling farmers generally use long lengths of vine as planting material obtained from established sweetpotato field. This method uses quite a lot of plant material that if taken from older portions of the vine may be a potential source of insect pests and diseases (Ray *et al*., 2001). The length of vine and the part used may affect the growth and yield of sweet potato favourably or unfavourably. Most farmers plant the crop using the vine cuttings irrespective of the number of nodes and part of vine cutting. The agronomy of sweet potato is well documented. Nevertheless, understanding the effect of number of nodes and part of vine cutting on growth and development is important for improving the yield and quality of sweet potato.

Keeping this in view, the present research was undertaken to investigate the effects of number of nodes and cutting position on morpho-physiological attribute and yield of sweet potato with the following objectives:

Objectives:

i. To study the effect of number of nodes on growth and tuber yield of sweet potato Cv. BARI Misti Alu-12
ii. To study the influence of portion of vine cutting on growth and tuber yield of sweet potato.
iii. To find out suitable vine position for the commercial cultivation of sweet potato.

CHAPTER-2

REVIEW OF LITERATURE

An attempt was made in this section to collect and study relevant information available regarding to the effects of number of nodes and cutting position on morpho-physiological attribute and yield of sweet potato to gather knowledge helpful in conducting the present piece of work.

2.1. Origin and distribution

The Sweet potato - *Ipomoea batatas (L)* Lam of the family Convolvulaceae is native to Central America (Hahn, 1977; Ambe, 1997), although it has been cultivated throughout the warm islands o f the Pacific Ocean for an equally long time (Sowley, 1999). It ranks seventh in total production among the world's food crops (Opena *et al.,* 1989), and is grown in areas reaching 40°N and 40°S latitudes and as high as 2000 m above sea level (Hahn, 1977) in more than 100 countries. Among the world's root crops, it is second only to white potato *(Solarium tuberosum)* in importance (Horton, 1989).

World production in 2001 was 135,918,673 metric tons of which 10,203,169 metric tons was produced in Africa and 90,000 metric tons produced in Ghana (FAO, 2001). Roughly 80% of the world's production is grown in Asia and just under 15% in Africa with only about 5% grown in the rest of the world. Developing countries grow nearly all the world's sweet potatoes. China alone accounts for about 80% and also has much higher yields and production per head (Horton, 1989). The largest producing countries in Africa are Rwanda and Uganda. In West Africa, it is important in Liberia and Sierra Leone (Otoo *et al.,* 1998) Its introduction to Ghana (Gold Coast) is believed to have been in the second half of the 17th century (M.O.A., 1988).

2.2 Botany of sweet potato

Setijati *et al.,* (1981); Cobley and Steele, (1983); and Purseglove (1987) describe the sweet potato as a self incompatible, short day, dicotyledonous perennial herb cultivated as an annual with trailing or twining stems 1 -5 m in length with latex in all its parts. The stems are mainly prostrate, sometimes twining and light green to purple. The leaves are spirally arranged and either simple or deeply lobed. They are up to 15 cm long with pointed tips and may be green to purple. The root system is extensive and roots grow from the stem nodes where stems contact the soil. Tuber structure is mainly globular and smooth or ridged. The tuber surface may be white, yellow, orange, purple or brown and the flesh is white, yellow, orange, red or purple. The flowers may be single or in clusters (cymes); the calyx is five lobed, the corolla is funnel shaped or tubular and the petals are purple with pale margins.

2.3 Importance of sweet potato

Sweet potato (*Ipomoea batatas* (L.) Lam.) which belongs to the family Convolvulaceae is a herbaceous, dicotyledonous plant (2n=90) native to Central America (Byju and George, 2005) and is widely grown throughout the tropics and subtropics. It is the seventh most important crop in the world in terms of production (FAOSTAT, 2017) although the bulk of the production is in China (Low *et al*., 2017). It is a staple food for smallholder farmers in much of Sub-Saharan Africa (SSA).

The crop is regarded as the most important root crop of the tropics because of its flexibility in a number of production aspects including short cropping season, use of non-edible parts as planting material, non-trellising growth habit as well as low requirement for soil nutrients (Motsa *et al*., 2015).

Sweet potato is a food security crop (Ebregt *et al*., 2007; Lebot, 2008; Low *et al*., 2017; Motsa *et al*., 2015) as it survives where staple crops totally fail. It therefore contributes to food availability by providing high output per unit of land. In the densely populated semi-arid plains of eastern Africa, sweet potato is often referred to as *cilera abana,* "protector of the child" (Byju and George, 2005) which alludes to the vital role it fulfils in thousands of villages where people depend on the crop to combat hunger.

According to Lebot (2008), sweet potato has often been a lifesaver, for example it saved the Japanese nation when the typhoons destroyed all their rice fields just before world war I. During the early 1960s, China was plagued by famine and the availability of sweet potato saved millions of the population from starvation. The Orange Fleshed Sweet potato (OFSP) varieties played a major role in addressing hunger and drought mitigation after biotic stresses in different parts of the world, including after the floods in Mozambique in 2000. Its use as a lifesaver is evidence that sweet potato is indeed a food security crop (Amajor *et al*., 2014; Bovell-Benjamin, 2007; Ebregt *et al*., 2007).

The crop is one of the most affordable and nutrient rich food crops in Sub-Saharan Africa which possess carbohydrates, vitamin A, vitamin C, fibre, iron, potassium and protein (Motsa *et al*., 2015; Woolfe, 1992). Bovell-Benjamin (2007) reported that sweetpotato produces more edible energy than any other major food crop.

Research findings have also shown that OFSP play an important role in combating vitamin A deficiencies in SSA particularly the OFSP varieties which contain high amounts of β-carotene, a precursor for vitamin A (Low *et al*., 2017; Motsa *et al*., 2015).

Research has also demonstrated that sweetpotato vines and non-commercial roots are important animal feed. The vines are reported to contain high protein content (16% crude protein) making them an ideal dairy and pig feed (Kabirizi *et al*., 2017; Low *et al*., 2017; Peters, 2008).

2.4 Sweet potato production constraints

Although sweet potato crop is vegetatively propagated, certain particularities related to seed production are somewhat different than with the potato crop. In most developing countries Kenya being no exception, there is no formal seed system. The crop in most parts of the world is propagated by stem cuttings. These cuttings are usually obtained from mature plants for the following season. In some parts of Sub-Saharan Africa where unimodal patterns of rainfall exist, seed availability is a serious constraint (Gibson *et al*., 2009). Foliar cuttings can only be available for a short period of time and will be useless for a following dry season in which there is no cropping.

Sweet potato has had low productivity in Kenya because of susceptibility of local varieties to sweet potato viral disease (SPVD) and weevils (Kivuva *et al*., 2014). Lack of clean vines is also one of the major yield limiting factors in sweet potato production. FAOSTAT (2017) shows sweet potato hectarage in Kenya to have remained and constantly oscillated from 58509 ha in 2013 to 61067 ha in 2014, 72162 ha in 2015 and 47,184 ha in 2016 and 70821 in 2017.

Research has demonstrated that lack of sustainable seed systems is one of the major constraints to improving sweet potato productivity in SSA. A CIP survey of National Agricultural Research Systems (NARS) priority (Gibson *et al*., 2011; Fuglie, 2007) reported that "virus management, seed quality and supply systems," was ranked as the highest priority for future research and development. CIP pro-poor research targeting further indicates that research on virus control in sweet potato through provision of clean planting material alone could yield rates of return of between 56 – 84 % depending on rate of adoption and adoption ceiling.

2.5 Propagation of sweet potato

Sweet potato is a perennial plant, but it is normally grown as an annual crop. It is traditionally propagated by vegetative method. Various planting materials are used to propagate sweet potato, like slip cuttings, cut tubers and vine cuttings.

The sprouts or slips produced from storage roots prove excellent planting material for commercial farmers worldwide (Khan *et al*., 2008). Three types of transplants: sprouts, cut sprouts and vine cuttings are normally used in the sub-tropical and warm temperate areas (Edmond, 1971a; Daisy, 1998).

Sprouts: these are entire plants, which arise and are pulled from the bedded roots. At the time they are ready for pulling, the above ground portion of the stems is 15-20cm, has 4-6 physiologically active leaves, and an underground portion with a developed extensive root system. Although they require somewhat shorter time for their development than do cut-sprouts and vine cuttings, their main disadvantage is that sprouts spread Fusarium wilt, black rot and soil rot or scurf from infected soils to the field.

Cut sprouts are essentially the above ground portions of sprouts. The stems of individual plants are cut usually at or just below the level of the bedding media when the aboveground portion is about 18-25cm long.

Vine cuttings are the terminal portions of plants growing in the plant bed or in the field. Usually, the stems are cut at the fifth or sixth node back from the terminal. In general, vine cuttings are used for the establishment of new plantings in tropical and subtropical regions, and in warm temperate regions adjacent to subtropical regions (Edmond, 1971).

Nair *et al.,* (1989) reported that in Asia, sweet potato is propagated through vine cuttings obtained from either freshly harvested plants or a nursery. In Indonesia, farmers meet their planting material needs by taking apical vines from a previous crop or from stored roots (Jusuf *et al.,* 1998).

2.6 Importance of vine cutting

Vine cuttings are better planting material in tropical regions than sprouts from tubers for several reasons. Firstly, plants derived from vine cuttings are free from soil-born diseases (Onwueme, 1978; Phills and Hill, 1984). Secondly, by propagating with vine cuttings the entire tuber harvest can be saved for consumption or marketing instead of reserving some of it for planting purposes. Thirdly, vine cuttings yield better than sprouts, and produce roots of more uniform size and shape. Cuttings from the shoot apex are considered better planting material than basal and middle vine cuttings (Shanmugavelu *et al*., 1972; Godfrey-Sam-Aggrey, 1974; Eronico *et al*., 1981; Villanueva, Jr., 1985; Choudhury *et al*., 1986; Villamayor, Jr and Perez, 1988; Balasurya, 1991; Schultheis and Cantliffe, 1994).

Vine cuttings are commonly used to propagate sweet potato. Use of Vine cuttings for sweet potato propagation have numerous reasons including, free from soilborne diseases, better yield, more uniform size and shape. Accordingly apical cuttings were considered and appropriated than cutting of vines from the middle and basal portion of the stem (Shanmugavelu *et al.,* 1972). In cutting of the vines, a length of 30cm is recommended since length of the vine cuttings affect root yield. It was established increase in length of vines tends to increase yield of sweet potato (Onwueme, 1978).

Sprouts from roots are also used as means of propagation but they are not recommended because, poor yields are produced as compared to vine cuttings (Ikemoto, 1971). Productions of slips from the tuber before planting and successive cuttings of slips are recommended in some temperate countries where winter is not suitable for keeping vines growing for sweet potato cultivation.

In tropics, where sweet potato continues luxurious vine growth in off season i.e., in summer, the use of vine cutting is commonly recommended as commercial method of propagation (Onwueme, 1978). Generally the farmers use different portion of vine cuttings as planting material. The portion and length of cutting may also have effects on growth and yield of sweet potato.

2.7 Nutritional requirements for sweet potato vine growth

Generally, biomass in sweet potato is partitioned as storage roots (66%), foliage (32%) or fibrous roots (2%), (Hozyo *et al*., 1971; Somasundaram and Mithra, 2008). However, this biomass accumulation is divided into three phases, namely i) the initial phase of extensive growth of fibrous roots with limited vine growth ii) the middle phase where vines grow extensively and fast. Storage roots are initiated and there is a tremendous increase in green leaf area and iii) the final phase where bulking of storage roots occurs with very little growth of vines and fibrous roots. In this phase, initially the green leaf area stays constant and then decreases.

Nutrients play a major role in the growth and development of higher plants. Sixteen elements are essential in plants and can be divided into two groups: the macronutrients (those required in relatively large quantities) including carbon, hydrogen, oxygen, Nitrogen, Phosphorus, potassium, Calcium, magnesium and Sulfur and the micronutrients (those required in small quantities) including iron, chlorine, manganese, Boron, zinc, copper and molybdenum. Usually only a small proportion of the total nutrient is available for uptake by the plant. Availability of many essential nutrients is affected by the pH. For instance, at high pH (alkaline nutrient solution), the solubility of P and many micronutrients (e.g. Fe, Mn, Zn and Cu) is greatly reduced, and the crop may experience deficiencies of these nutrients. At low pH (acid nutrient solution), the solubility of some elements, particularly P and Mo, is reduced, while that of Al and Mn may be increased to toxic levels. The plant's requirement of essential nutrients will increase as the plant accumulate more biomass. Nutrient omission pot experiments have revealed that sweetpotato vine yields were only limited to Nitrogen, Phosphorus, Sulfur, Calcium, Boron and Molybdenum (Taraken *et al*., 2010).

2.8 Effect of number of nodes and cutting position of vine of sweet potato

Ncube *et al.* (2019) worked on the effect of cutting position and vine pruning level on yield of sweet potato (*Ipomoea batatas* L.) and revealed that, both apical and middle cuttings give high yield in terms of storage roots and vines.

Idoko *et al.* (2017) studied the effect of intra row spacing and portion of planting material on the growth and yield of sweet potato in Makurdi, Southern Guinea Savannah Agro-Ecological zone of Nigeria and showed that the apical portion of the planted vine produced highest vine length, number of leaves, number of branches, fresh and dry fodder weight per hectare, root girth, root length, number of salable roots per plant and net yield.

Dumbuya *et al.* (2017) conducted an experiment to study the effect of vine cutting length and potassium fertilizer rates on sweet potato growth and yield components and revealed that vine with the length of 30cm have more nodes (5,7) recorded 100% crop establishment and early rapid growth which translated into higher roots yield and greater marketable yields.

Musyimi and Dau (2016) studied the effect of variety and size of stem cutting on flesh root yield and yield components of sweet potato. In four varieties K135, Bungoma, SPK004 and Mtwapa and four stem cutting sizes of 4, 6, 8 and 10 nodes studied and reported that cutting size of 6 nodes gave the same yield as the recommended size of eight nodes, and if adopted, farmers will be able to reduce the cost of planting materials. Finally, concluded that variety K135 can be promoted for adoption by farmers alongside with stem cutting size of six nodes.

Munetsi (2015) worked on the effect of cutting position and vine pruning level on growth and yield of sweet potato (*Ipomoes batatas* L.) and reported that apical and middle cuttings can be used during the shortage of planting material and stated that apical cuttings recorded higher yield that middle vine cuttings.

Kibrom *et al.* (2015) conducted an experiment to study the effect of number of nodes and storage duration of vine cuttings on growth, yield and yield components of sweet potato (*Ipomoea batatas* L.) at Jimma, Southwest Ethiopia and reported that vine with 9 nodes gave significantly higher total tuber yield than nodes 5 and 7.

Essilfie *et al.* (2015) conducted an experiment on number of nodes and part of vine cutting effect on the growth and yield of sweet potato (*Ipomoes batatas* L. Lam) in Transitional Zone of Ghana and revealed that among cuttings taken from the apical part with 4, 5, and 6 nodes, cuttings with 5 nodes apical portion gave high vegetative growth while cuttings with 6 nodes apical portion gave high yield and marketable tubers.

Puran and Ronell (2014) studied the effects of initial stem nodal cutting strength on dry matter production and accumulation in cassava and reported that the normal farmer practice is to use cuttings between 15-40cm from old plant with a minimum of

3 to 5 nodes in order to achieve better germination and survival. The assumption is that a larger cutting has a higher opportunity for sprouting and developing due to the presence of more nodes and higher carbohydrate reserve.

Nedunchezhiyan *et al.* (2012) reported that studies in Bangladesh showed that increasing the number of nodes per vine increased the number of vines per plant, the vine length and the root yield.

Echoi (2011) was conducted a research work titled Yield effects of *cassava (Manihot esculenta,* L. *Crantz)* as affected by different stem cutting lengths in Makurdi, Nigeria and reported that shorter cutting length have fewer number of nodes and could be more susceptible to rapid dehydration as a result of the low level of carbohydrate reserve, thus prolonging days to establishment as well as growth and quality yield.

Kenneth Richardson (2010) worked on evaluation of two different types of planting material for sweet potato production with two varieties 'Antigua' and 'Six Weeks' by comparing two-week-old rooted two-node cuttings and plants obtained from freshly cut 60 cm vine lengths and revealed that plants established in the field using rooted plantlets resulted in a higher number of marketable tubers and higher marketable tuber weights than plants generated from fresh unrooted vine cuttings**.**

Nazim uddin (2006) investigated on effect of different parts of vine on the growth and yield of sweet potato with four sweet potato varieties viz. Kamala sundari, barisp-5,barisp-6 and barisp-6 in combination with four types of vine and revealed that the different varieties, types of vines and their interaction showed significant influence on the survivability of the planted vines, length of the longest vines, fresh weight of vines, number of branches per plant, and weight of tuberous roots per plant and the yield of sweet potato. Further, Kamala sundari produced the highest yield (40.41 t/'ha) among the four varieties. Tip vine cuttings produced the maximum (41.13t/ha) yield followed by the middle vine (33.38 t/ha) and the basal vine produced the lowest yield (22.44 t/ha). From this he suggested terminal cuttings followed by middle cuttings are suitable for sweet potato production for getting higher production.

Belehu *et al.* (2004) examined the origin and structure of adventitious roots in sweet potato (*Ipomoea batatas*) and revealed that the use of apical vine cuttings will contribute to improved crop establishment and increased yield.

Nair (2000) in manual of non wood forest produce plants of Kerala stated that bottom portion of vine which is used as planting material is usually thick and woody sometimes fails to establish and there is a greater chance of weevil incidence due to proximity with the crown portion where sweet potato weevil multiplies.

Amoah (1997) examined the number of nodes per cutting and potassium fertilizer on the growth, yield and yield components of sweet potatoes (*Ipomoea batatas* Poir) and revealed that the vine cuttings should have at least five nodes for getting better yield.

Alcoyl *et al.* (1993) worked on influence of planting material and time of harvest on plant to plant yield variability of sweet potato and indicated that apical cuttings showed superior performance over basal cuttings in terms of per cent Survival, early canopy development and onset of tuberous root initiation. Basal cuttings regardless of the variety resulted in greater number of non-marketable roots and also the variation on number of storage roots between plants was significantly reduced when bushy type (VSP 1) was used compared to the creeping type (VSP 5). Similary, harvesting at 105 or 120 DAP resulted in marked reduction in plant to plant variability on number of storage roots, number of marketable roots and number of lateral branches. Further more, mean weight per storage root and weight of marketable roots were found to have significant positive correlation with root yield**.**

A series of experiments were conducted in the Philippines to find out the effect of vine position (apical, middle and basal) and source of planting material (rejuvenated and recurrent) on growth and dry matter partitioning in sweet potato by De-silva and Premathilake (1992). The results indicated that the growth and yield parameters were higher with apical cuttings and rejuvenated vines as they had high physiological vigour.

Mukhopathyay *et al.* (1990) examined the effect of planting materials on growth and yield of sweet potato and reported that apical vine portion is the best planting material because it produces more branches which resulted in production of higher root yield.

Hendroatmodio (1990) worked on dry matter distribution and tuber yield of three sweet potato cultivars grown from apical and sub apical cuttings and observed that apical cutting increased early tuber growth.

Ghosh *et al.* (1988) suggested that cuttings obtained from apical and middle portion of vines are preferred for planting. Crop establishment was poor in basal cuttings while apical cuttings recorded better establishment. They also reported that sprouting was poor when basal cuttings are used as planting material.

Choudhury *et al.* (1986) worked on the effect of number of nodes in different types of vine cutting on the growth and yield of sweet potato and suggested that apical cutting showed better performance and gave higher yield than middle portion of the stem cutting.

Hossain *et al.* (1984) studied the effect of production method and planting materials on growth and yield of sweet potato and reported that type of planting materials have profound effect on the production of sweet potato. Higher growth and yield were recorded from apical cutting than middle cutting.

Chiappe *et al.* (1984) conducted an experiment to study the effects of depth of planting on the development and yield of sweet potato using different types of cuttings and reported that apical cuttings gave better crop establishment, vigorous growth and yield than middle portion vine cuttings.

Bhuyan and Chowdhury (1984) studied the effects of three methods of planting and three types of cuttings on sweet potato growth and yield in sandy loam soil and reported apical cuttings produced higher yield than mid vine cuttings with 3 or 5 nodes.

CHAPTER-3

MATERIALS AND METHODS

The experiment was conducted at the research farm of Sher-e-Bangla Agricultural University, Dhaka to study the effects of number of nodes and cutting position on morpho-physiological attribute and yield of sweet potato. Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1 Experimental period

The experiment was conducted during the period from October 2019 to April 2020.

3.2 Description of the experimental site

3.2.1 Geographical location

The experiment was conducted both in the Central Laboratory and Agronomy field of Sher-e-Bangla Agricultural University (SAU). The experimental site is geographically situated at 23°77′ N latitude and 90°33′ E longitude at an altitude of 8.6 meter above sea level (Anon., 2004).

3.2.2 Agro-Ecological Zone

The experimental field belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28 (Anon., 1988 a). This was a region of complex relief and soils developed over the Modhupur clay, where floodplain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as 'islands' surrounded by floodplain (Anon., 1988 b). For better understanding about the experimental site has been shown in the Map of AEZ of Bangladesh in Appendix-I.

3.2.3 Soil

The soil texture was silty clay with pH 6.1. The morphological, physical and chemical characteristics of the experimental soil have been presented in Appendix- II.

3.2.4 Climate and weather

The climate of the experimental site was subtropical, characterized by the winter season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al.*, 1979). Meteorological data related to the temperature, relative humidity and rainfall during the experiment period of was collected from Bangladesh Meteorological Department (Climate division), Sher-e-Bangla Nagar, Dhaka and has been presented in Appendix-III.

3.3 Test crop

Sweet potato variety namely BARI Misti Alu-12 was used as test crop for this experiment. The important characteristics of this variety is mentioned below:

BARI Misti Alu-12

BARI Misti Alu-12 was developed by Bangladesh Agriculture Research Institute (BARI), Gazipur, Bangladesh. It was developed by using several lines that were collected from International Potato Research Center in 2006 and evaluated in different regions of Bangladesh. The CIP 440001 line performed better and this line released as BARI Misti Alu-12. It was released in the year of 2013. The main characterise of the variety *viz*., Vine and leaf color green, skin of tuber yellow, flesh orange, average weight of tuber 160-180g. This variety is cultivated all regions of Bangladesh. It gives yield 35-40 t/ha. It's quite resistance weevil attract. It contains Vitamin A 5800 IU/100 g flesh and dry matter 29.46%.

3.4 Tuber seed collection

The tuber seed of BARI Misti Alu-12 was collected from tuber crops research center (TCRC) of bangladesh agricultural research institute (BARI), Joydeppure, Gazipur.

3.5 Planting materials

The experiment was carried out with the freshly detached vine cuttings of different length was used as planting material and were collected from the seed multiplication bed of the Sher-e-Bangla Agricultural University farm, Dhaka.

3.6 Experimental treatments

The experiment was consisted of 9 treatments *viz*;

T_0= 3 nodes from top cut,

T_1= 3 nodes from middle cut,

T_2= 3 nodes from basal cut,

T_3= 5 nodes from top cut,

T_4= 5 nodes from middle cut,

T_5= 5 nodes from basal cut,

T_6= 7 nodes from top cut,

T_7= 7 nodes from middle cut and

T_8= 7 nodes from basal cut.

3.7 Detail of experimental preparation

3.7.1 Preparation of the experimental field

The land was thoroughly ploughed to a depth of 15-20 cm and brought in to a fine tilth. Well decomposed FYM @ 10 t ha^{-1} was incorporated into the soil uniformly during the final ploughing as a basal application. The experimental area was divided in to plots of 2 × 1.8 m size. Irrigation channels of 0.5 m size were prepared between two plots. Cuttings were planted in the plots at a spacing of 60×30 cm and 5-7 cm depth. Standard recommended cultural practices were followed during the entire crop period.

3.7.2 Experimental design

The experiment was laid out in Randomized complete block design (RCBD) with three replications. There are 9 treatments and 27 unit plots. The unit plot size was 3.6 m^2 (2.0 m × 1.8 m). The blocks and unit plots were separated by 1.0 m and 0.50 m spacing, respectively. The layout of the experimental field was shown in Appendix-IV.

3.7.3 Planting in the experimental field

The cuttings procured for planting were prepared at 14th November 2019, as per the treatments and planted. Care is taken while preparing the cuttings as they should meet the requirements of the treatments. The cuttings which are prepared are planted on the base of the ridges in the plot.

3.7.4 Fertilizer application

The recommended dosage of N, P and K @ 60:25:50 kg ha^{-1} was applied in the form of Urea, Single Super Phosphate and Muriate of Potash respectively. The entire dose of Phosphorus, half dose of Potash and Nitrogen were applied as a basal dose. The remaining half dose of Nitrogen and Potash were applied at 25 days after planting of cuttings.

3.8 Intercultural operations

i. Weeding and earthing up

The experimental site was kept free from weeds by periodical hand weeding and these were taken up at 30 and 60 days after planting of cuttings. Light earthing up was given at the time of each weeding operation to keep the soil in a porous condition.

ii. Diseases and pest control

The crop was almost free from diseases and insect pests. A few weeks after planting the crop was slightly infested by caterpillar, which were controlled with the application of Ripcords 10 EC at a concentration of 1ml $liter^{-1}$ and apply 3 times in total with 7 days intervals

iii. Irrigation

Regular irrigations were given at initial stage of the crop growth, further irrigations were provided at an interval of 7-10 days depending on the soil moisture condition.

3.9 General observations of the experimental field

Regular observations were made to see the growth stages of the crop. In general, the field looked nice with normal green plants, which were vigorous and luxuriant.

3.10 Harvesting

The crop was harvested at 25th March 2020. Light irrigation was given one day prior to harvesting for easy lifting of tubers. Harvesting was done manually by digging followed by uprooting the invaded vine along with tubers.

3.11 Data collection

The data were recorded on the following parameters

a. Morpho-physiological attribute

i. Vine length (cm)
ii. Number of branches plant^{-1}
iii. Number of leaf plant^{-1}
iv. Chlorophyll content of leaf

b. Yield attributes

v. Number of tubers plant^{-1}
vi. Total weight of tuber plant^{-1} (g)
vii. Weight of marketable tuber plant^{-1} (g)
viii. Total weight of tuber plot^{-1} (kg)
ix. Yield (t ha^{-1})
x. Dry matter percentage of tuber root (%)

3.12 Procedure of recording data

i. Vine length (cm)

Length of the vine was measured from cotyledonary node to the tip of the vine with the help of a scale and expressed in centimetres. It was measured at 50, 70 and 100 DAP respectively.

ii. Number of branches plant^{-1}

The numbers of branches on the randomly selected plant were counted and the averages were worked out to record the number of branches per plant. It was measured at 50, 70 and 100 DAP respectively.

iii. Number of leaf plant^{-1}

The numbers of leaves on the randomly selected plant were counted and the averages were worked out to record the number of leaves per plant.

iv. Chlorophyll content of leaf

Chlorophyll content of leaf was measured by using SPAD meters. It was measured at 50, 70 and 100 DAP respectively.

v. Number of tubers plant^{-1}

Number of roots plant^{-1} was counted and the mean value was expressed in number.

vi. Total weight of tuber plant^{-1} (g)

Total weight of tuber roots per plant was calculated and the average was expressed in g

vii. Weight of marketable tuber plant^{-1} (g)

Total weight of marketable tuber plant^{-1} was calculated and the average was expressed in g.

viii. Total weight of tuber plot^{-1} (kg)

Total weight of tuber plot^{-1} was calculated and the average was expressed in kg.

ix. Yield (t ha^{-1})

The tuber yield per plot was initially computed by electronic balance and averages were estimated per hectare and expressed in tonnes.

x. Dry matter percentage of tuber root (%)

For dry matter measurement, about 100 g of sweet potato was collected for each variety and was oven-dried for about 24 h at 80 °C. Finally, the amount of root dry matter (%) was determined using the following equation:

Dry matter (%) = Sample dry weight/Total sample weight × 100

3.13 Data analysis technique

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program named Statistix 10 Data analysis software and the mean differences were adjusted by Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER-4

RESULTS AND DISCUSSION

Results obtained from the present study have been presented and discussed in this chapter with a view to investigate the effects of number of nodes and cutting position on morpho-physiological attribute and yield of sweet potato. The data are given in different tables and figures. The results have been discussed, and possible interpretations are given under the following headings.

4.1 Morpho-physiological attribute

4.1.1 Vine length

Different number of node and cutting position significantly effect on vine length of sweet potato at different days after planting (Table 1). Experimental result revealed that the maximum vine length (75.64, 103.93 and 143.91 cm) at 50, 70 and 100 DAP, respectively were recorded in T_3 (5 nodes from top cut) treatment which was statistically similar with T_6 (7 nodes from top cut) treatment recorded vine length (74.22 and 141.61 cm) at 50 DAP and 100 DAP, respectively. Whereas the minimum vine length (48.41, 57.64 and 74.57 cm) at 50, 70 and 100 DAP, respectively were recorded in T_8 (7 nodes from basal cut) treatment. The difference of vine length among treatments were due to reason that unlike basal cuttings, apical cuttings have new and active cells which support the development of lateral roots through the supply of auxin from growing apical point. Apical cuttings supply the establishing roots with starch stored in the stem cells since they have higher starch level than lignin. The growing tip of the apical cutting also grow nippily and support growth of new shoots that in turn photosynthesize to supply roots with photosynthates. Also young nodes near the vine apex result in fast growing lateral roots that bulk to form storage roots. Thus apical cutting gives vigour growth and the ability to root faster. These results are in conformity with the findings of Idoko *et al.* (2017) who reported that cuttings from terminal portion of the vine produced highest vine length.

Table 1. Effect of number of nodes and cutting position on vine length of sweet potato

Treatments	Vine length of sweet potato		
	50 DAP	70 DAP	100 DAP
T_0	70.82 b	93.46 c	132.31 b
T_1	64.59 c	82.96 d	113.60 c
T_2	64.47 c	78.75 e	102.79 d
T_3	75.64 a	103.93 a	143.91 a
T_4	62.37 c	78.45 e	107.39 d
T_5	55.16 e	71.25 f	93.49 e
T_6	74.22 a	98.76 b	141.61 a
T_7	59.84 d	76.85 e	90.38 e
T_8	48.41 f	57.64 g	74.57 f
$LSD_{(00.05)}$	2.32	2.21	5.77
CV (%)	2.10	1.55	3.00

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_0= 3 nodes from top cut, T_1= 3 nodes from middle cut, T_2= 3 nodes from basal cut, T_3= 5 nodes from top cut, T_4= 5 nodes from middle cut, T_5= 3 nodes from basal cut, T_6= 7 nodes from top cut, T_7= 7 nodes from middle cut and T_8= 7 nodes from basal cut.

4.1.2 Number of branches plant^{-1}

Number of branches plant^{-1} was significantly affected by the number of nodes and position of vine cuttings at 50, 70 and 100 days after planting (Table 2). Experimental result revealed that the maximum number of branches plant^{-1} (10.33, 13.72 and 17.36) were recorded in T_3 (5 nodes from top cut) treatment which was statistically similar with T_6 (7 nodes from top cut) treatment recorded number of branches plant^{-1} (10.33) and with T_0 (3 nodes from top cut) treatment recorded number of branches plant^{-1} (9.93) at 50 DAP; with T_6 (7 nodes from top cut) treatment recorded number of branches plant^{-1} (13.51) at 70 DAP; and with T_6 (7 nodes from top cut) treatment recorded number of branches plant^{-1} (17.19) and T_0 (3 nodes from top cut) treatment recorded number of branches plant^{-1} (16.67). Whereas the minimum number branches plant^{-1} (5.80, 7.68 and 9.18) was recorded in T_8 (7 nodes from basal cut.) treatment. The differences of number branches plant^{-1} might be due to differences in node number and vine part used as planting material. Similar results were reported by Mukhopathyay *et al.* (1990) stating that terminal cuttings along with cuttings from middle portion of the vine are found to be the best planting materials for getting higher root yield which is as a result of production of higher number of vine branches.

Table 2. Effect of number of nodes and cutting position on number of branches plant^{-1} of sweet potato

Treatments	Number of branches plant^{-1} of sweet potato		
	50 DAP	70 DAP	100 DAP
T_0	9.93 a	13.31 b	16.67 a
T_1	7.70 b	11.13 c	14.80 b
T_2	7.53 bc	10.89 c	13.99 c
T_3	10.33 a	13.72 a	17.36 a
T_4	7.37 bc	10.50 d	13.55 cd
T_5	6.93 c	10.48 d	13.06 d
T_6	10.33 a	13.51 ab	17.19 a
T_7	7.13 bc	10.29 d	11.33 e
T_8	5.80 d	7.68 e	9.18 f
$LSD_{(00.05)}$	0.71	0.32	0.78
CV (%)	5.04	1.61	3.02

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_0= 3 nodes from top cut, T_1= 3 nodes from middle cut, T_2= 3 nodes from basal cut, T_3= 5 nodes from top cut, T_4= 5 nodes from middle cut, T_5= 3 nodes from basal cut, T_6= 7 nodes from top cut, T_7= 7 nodes from middle cut and T_8= 7 nodes from basal cut.

4.1.3 Number of leaves plant^{-1}

Number of leaves plant^{-1} of sweet potato was significantly influenced by the number of nodes and position of vine cuttings at 50, 70 and 100 days after planting (Table 3). Experimental result showed that the maximum number of leaves plant^{-1} (83.24, 131.24 and 157.15) at 50, 70 and 100 DAP were recorded in T_3 (5 nodes from top cut) treatment which was statistically similar with T_6 (7 nodes from top cut) treatment and T_0 (3 nodes from top cut) treatment recorded number of leaves plant^{-1} (82.99 and 81.59) at 50 DAP and with T_0 (3 nodes from top cut) treatment recorded number of leaves plant^{-1} (129.53 and156.52) at 70 and 100 DAP. Whereas the minimum number of leaves plant^{-1} of sweet potato (41.86, 54.40 and 73.58) at 50, 70 and 100 DAP were recorded in T_8 (7 nodes from basal cut) treatment. Top cuttings influences the number of leaves plant^{-1} of sweet potato could be due to the presences of optimum number of nodes which might have enhanced the development of more roots, better and early establishment of cuttings, rapid vine development, more branches and more leaf production.

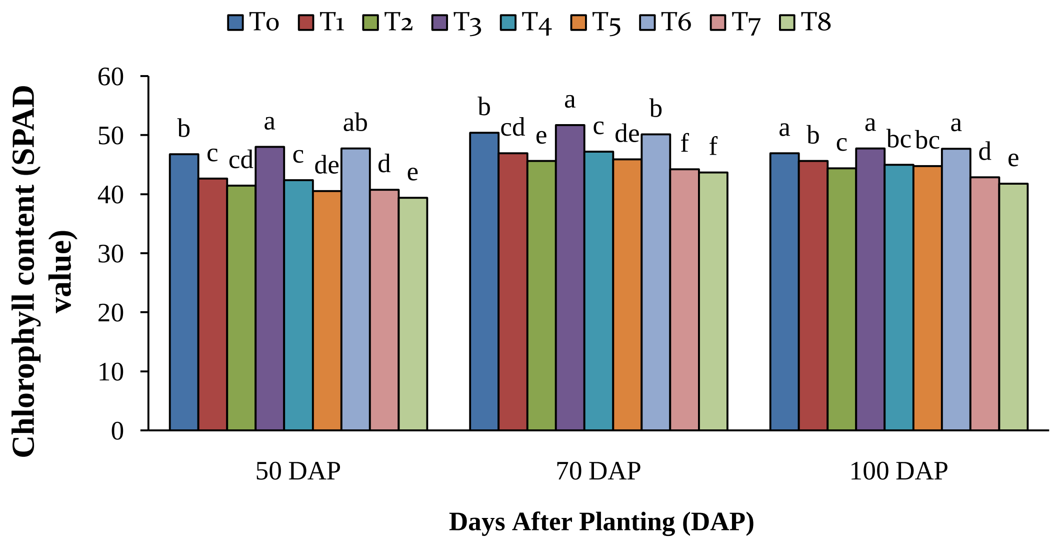
Table 3. Effect of number of nodes and cutting position on number of leaves plant^{-1} of sweet potato

Treatments	Number of leaves plant^{-1} of sweet potato		
	50 DAP	**70 DAP**	**100 DAP**
T_0	81.59 a	129.53 ab	156.52 a
T_1	73.07 b	112.56 c	134.82 c
T_2	60.39 d	84.92 e	112.63 e
T_3	83.24 a	131.24 a	157.15 a
T_4	69.03 c	103.13 d	129.37 d
T_5	57.17 e	79.89 f	101.98 f
T_6	82.99 a	128.94 b	150.87 b
T_7	53.65 f	68.34 g	88.56 g
T_8	41.86 g	54.40 h	73.58 h
LSD $_{(00.05)}$	2.80	1.89	2.65
CV (%)	2.42	1.10	1.24

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_0= 3 nodes from top cut, T_1= 3 nodes from middle cut, T_2= 3 nodes from basal cut, T_3= 5 nodes from top cut, T_4= 5 nodes from middle cut, T_5= 3 nodes from basal cut, T_6= 7 nodes from top cut, T_7= 7 nodes from middle cut and T_8= 7 nodes from basal cut.

4.1.4 Chlorophyll content (SPAD value)

Chlorophyll content (SPAD value) of sweet potato leaf was significantly differ due to the effect of nodes number and cutting position of vine (Figure 1). Experimental result showed that the maximum Chlorophyll content of sweet potato leaf (47.99, 51.70 and 47.76) at 50, 70 and 100 DAP were recorded in T_3 (5 nodes from top cut) treatment which was statistically similar with T_6 (7 nodes from top cut) treatment recorded chlorophyll content of sweet potato leaf (47.75) at 50 DAP and with T_6 (7 nodes from top cut) and T_0 (3 nodes from top cut) treatment recorded chlorophyll content of sweet potato leaf (47.71 and 46.91) 100 DAP. Whereas the minimum chlorophyll content of sweet potato leaf (39.38, 43.68 and 41.77) at 50, 70 and 100 DAP were recorded in T_8 (7 nodes from basal cut) treatment.



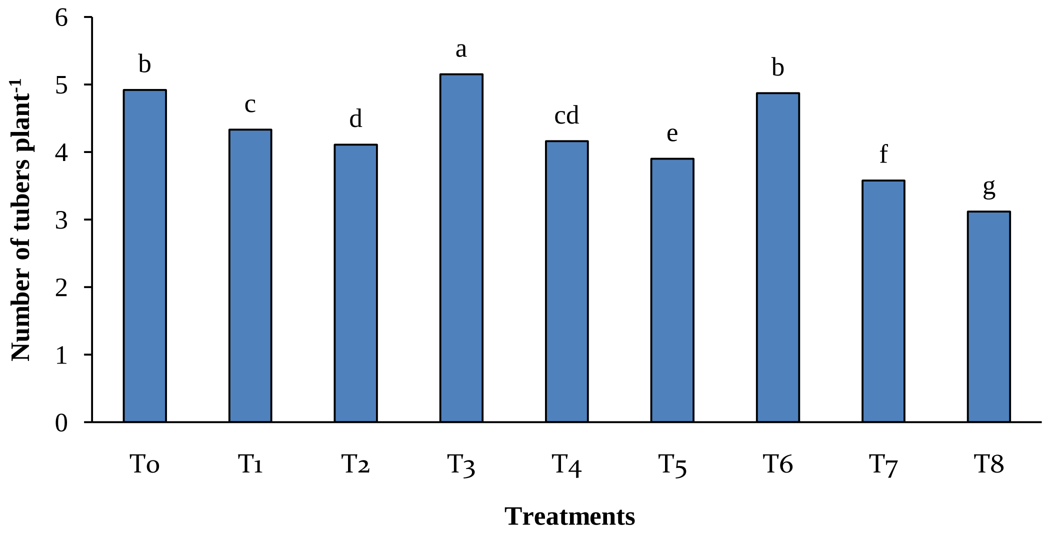
In a graph means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Figure 1. Effect of number of nodes and cutting position on chlorophyll content of leaf of sweet potato.

4.2 Yield attribute

4.2.1 Number of tubers plant^{-1}

Different number of node and cutting position of vine significantly effect on number of tubers plant^{-1} at harvest (Figure 2). Experimental result showed that the maximum number of tubers plant^{-1} (5.15) was recorded in T_3 (5 nodes from top cut) treatment whereas the minimum number of tubers plant^{-1} (3.12) was recorded in T_8 (7 nodes from basal cut) treatment. Young nodes near the vine apex develop healthy performing root primordia and this might be the reason for terminal cuttings more productive as compared to middle and basal cuttings. The result obtained from the present study was similar with the findings of Belehu *et al.* (2004) and reported that the use of apical vine cuttings will contribute to improved crop establishment and increased yield.

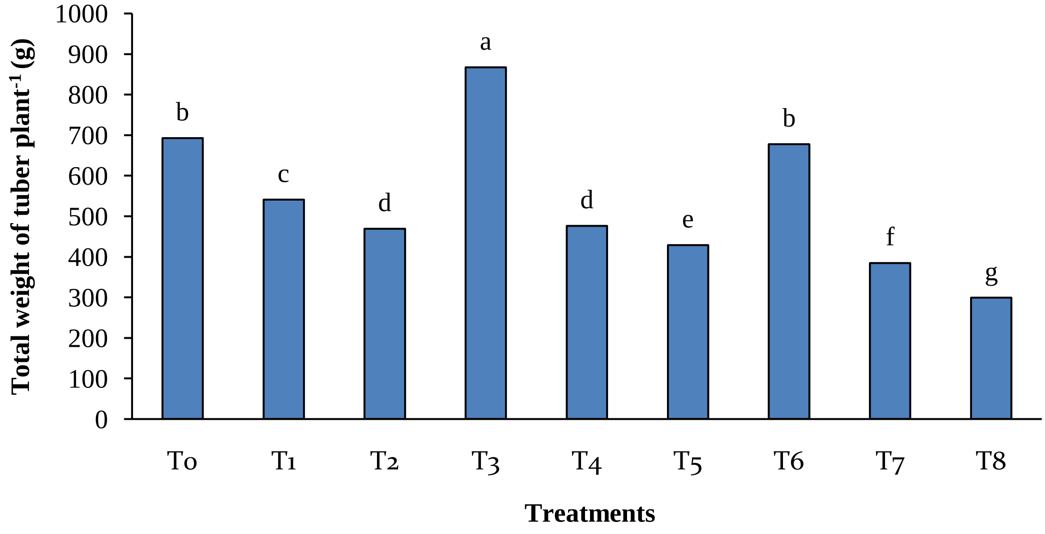


In a graph means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Figure 2. Effect of number of nodes and cutting position on number of tubers plant^{-1} of sweet potato.

4.2.2 Total weight of tuber plant^{-1} (g)

Total weight of tuber plant^{-1} of sweet potato was significantly influenced due to the effect of nodes number and cutting position of vine (Figure 3). Experimental result showed that the maximum total weight of tuber plant^{-1} of sweet potato (867.00 g) was recorded in T_3 (5 nodes from top cut) treatment whereas the minimum total weight of tuber plant^{-1} of sweet potato (299.00 g) was recorded in T_8 (7 nodes from basal cut) treatment. Basal cuttings had the lowest total weight of tuber plant^{-1} due to highly lignified cells of the cutting that probably resulted in poor root system for water and nutrient uptake to support vine growth. Whereas top cut with optimum number of nodes recorded higher tuber yield per plant might be due to maximum diameter and more number of tubers per plant as compared to rest of the treatments.

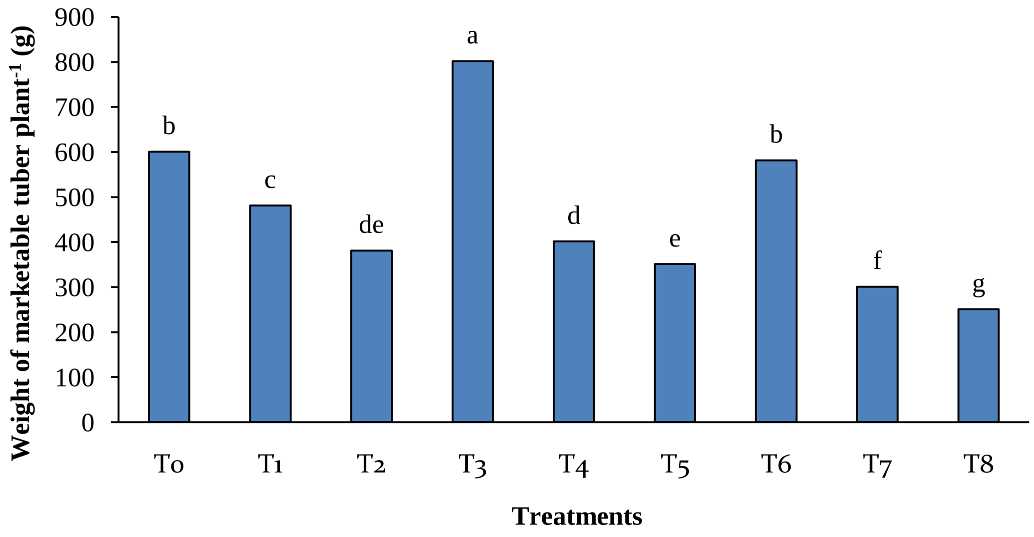


In a graph means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Figure 3. Effect of number of nodes and cutting position on total weight of tuber plant^{-1} of sweet potato.

4.2.3 Weight of marketable tuber plant^{-1} (g)

Different number of node and cutting position significantly effect on weight of marketable tuber plant^{-1} (g) of sweet potato at harvest (Figure 4). Experimental result revealed that the maximum weight of marketable tuber plant^{-1} of sweet potato (802.00 g) was recorded in T_3 (5 nodes from top cut) treatment which might be due to more vigorous growth and actively growing part of the vine. Whereas the minimum weight of marketable tuber plant^{-1} of sweet potato (251.00 g) was recorded in T_8 (7 nodes from basal cut) treatment. The present investigation was similar with the reports of Mukhopathyay *et al*. (1990) and indicated that terminal cutting ensure better rooting, establishment and faster shoot growth and also higher marketable tuber roots.

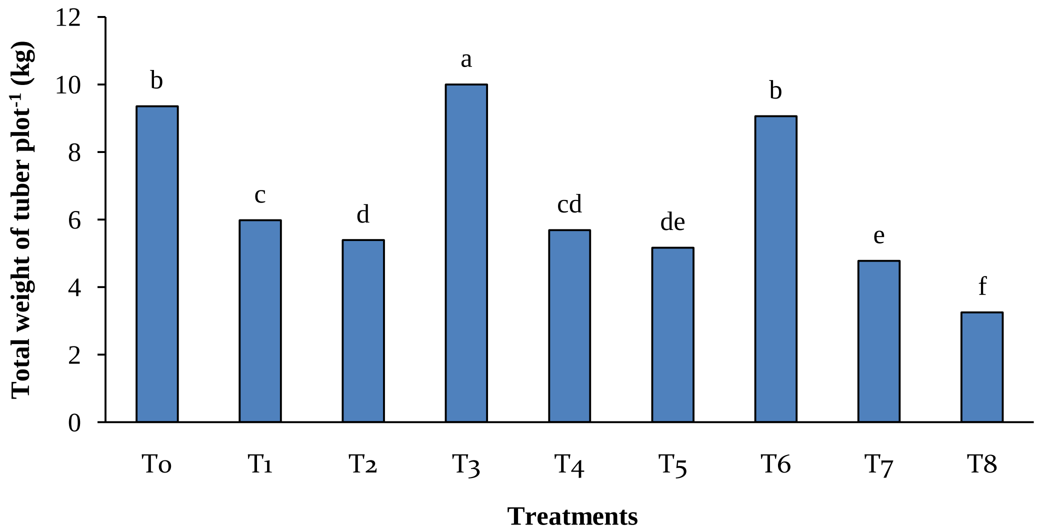


In a graph means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Figure 4. Effect of number of nodes and cutting position on weight of marketable tuber plant^{-1} (g) of sweet potato.

4.2.4 Total weight of tuber plot^{-1} (kg)

Total weight of tuber plot^{-1} (kg) of sweet potato was significantly differ due to the effect of nodes number and cutting position of vine (Figure 5). Experimental result revealed that the maximum total weight of tuber plot^{-1}of sweet potato (10 kg) was recorded in T_3 (5 nodes from top cut) treatment which was due to maximum tuber diameter, higher tuber yield per vine as compare to rest of the treatments. Whereas the minimum total weight of tuber plot^{-1}of sweet potato (3.25 kg) was recorded in T_8 (7 nodes from basal cut) treatment. The result obtained from the present study was similar with the findings of Essilfie *et al.* (2015) and revealed that among cuttings taken from the apical part with 4, 5, and 6 nodes, cuttings with 5 nodes apical portion gave high vegetative growth while cuttings with 6 nodes apical portion gave high yield and marketable tubers. Nedunchezhiyan *et al.* (2012) reported that that increasing the number of nodes per vine increased the number of vines per plant, the vine length and the root yield.

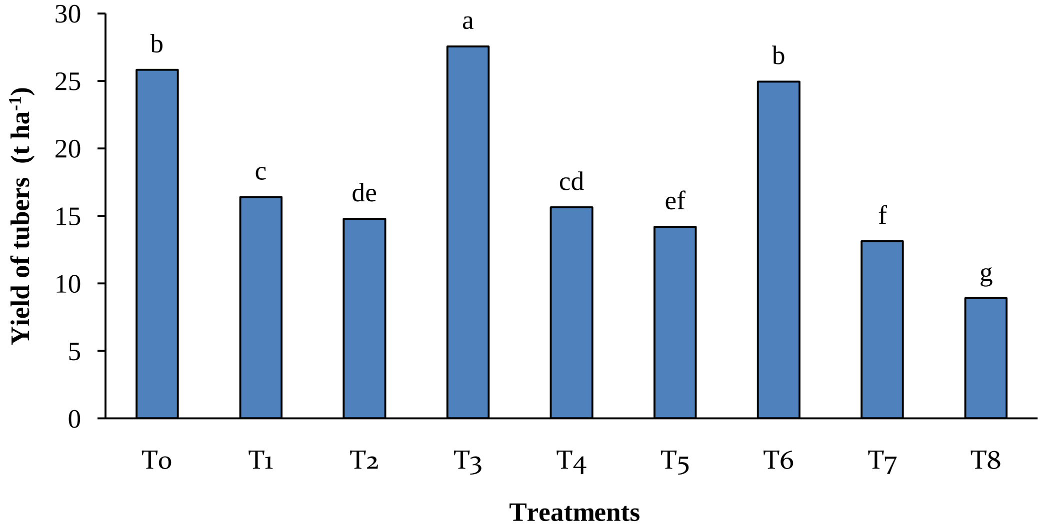


In a graph means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Figure 5. Effect of number of nodes and cutting position on total weight of tuber plot^{-1} (kg) of sweet potato.

4.2.5 Yield of tubers (t ha^{-1})

Different number of node and cutting position significantly effect on yield of tubers (t ha^{-1}) of sweet potato at harvest (Figure 6). Experimental result showed that the maximum yield of tubers of sweet potato (27.56 t ha^{-1}) was recorded in T_3 (5 nodes from top cut) treatment which was due to maximum tuber yield per plot as compared to rest of the treatments. Whereas the minimum yield of tubers of sweet potato (8.90 t ha^{-1}) was recorded in T_8 (7 nodes from basal cut) treatment. The result obtained from the present study was similar with the findings of Ncube *et al.* (2019) worked on the effect of cutting position and vine pruning level on yield of sweet potato (*Ipomoea batatas* L.) and revealed that, both apical and middle cuttings give high yield in terms of storage roots and vines. Munetsi (2015) also reported that apical and middle cuttings can be used during the shortage of planting material and stated that apical cuttings recorded higher yield that middle vine cuttings.

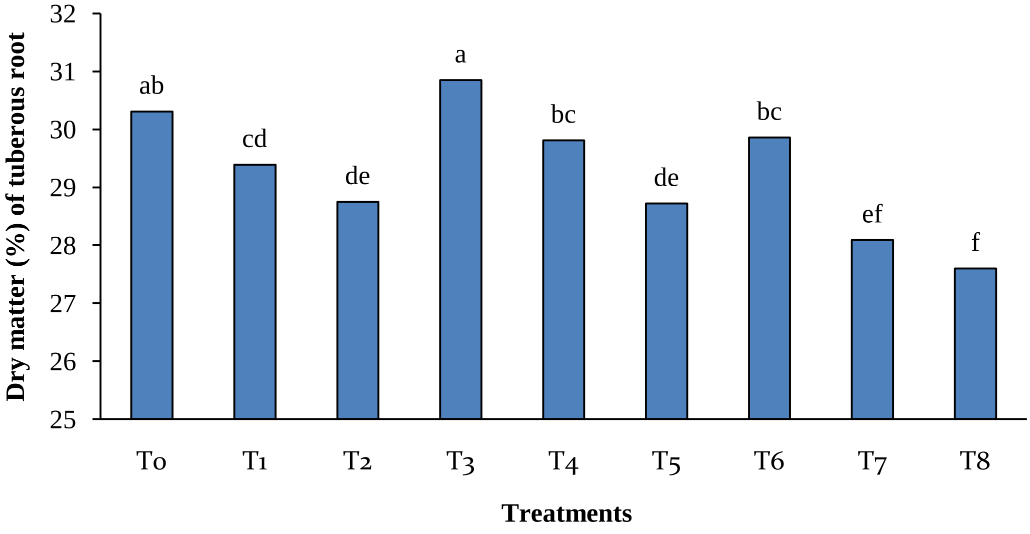


In a graph means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Figure 6. Effect of number of nodes and cutting position on tuber yield of (t ha^{-1}) of sweet potato.

4.2.6 Dry matter (%) of tuberous root

Dry matter (%) of tuberous root of sweet potato was significantly differ due to the effect of nodes number and cutting position of vine (Figure 7). Experimental result revealed that due to different treatment the dry matter (%) of tuberous root of sweet potato ranges between (27-31 %). Among different treatment the maximum dry matter (30.85 %) of tuberous root of sweet potato was recorded in T_3 (5 nodes from top cut) treatment whereas the minimum dry matter (27.60 %) of tuberous root of sweet potato was recorded in T_8 (7 nodes from basal cut) treatment. The portion of vine cuttings from the shoot has influence in induction of rooting, establishment, faster shoot growth, thereby early smoother of crop to suppress weed growth and increasing yield which influences dry matter percentage of tuberous root of sweet potato.



In a graph means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Figure 7. Effect of number of nodes and cutting position on dry matter (%) of tuberous root of sweet potato

CHAPTER-5

SUMMARY AND CONCLUSION

A field experiment was conducted at Sher-e-Bangla Agricultural University farm, Dhaka during the period from October 2019 to April 2020, to investigate the effects of number of nodes and cutting position on morpho-physiological attribute and yield of sweet potato. The experiment consisted nine treatments, and followed Randomized complete block design (RCBD) with three replications. Treatments (9) *viz,* T_0= 3 nodes from top cut, T_1= 3 nodes from middle cut, T_2= 3 nodes from basal cut, T_3= 5 nodes from top cut, T_4= 5 nodes from middle cut, T_5= 3 nodes from basal cut, T_6= 7 nodes from top cut, T_7= 7 nodes from middle cut and T_8= 7 nodes from basal cut. Data on different parameters were collected for assessing results for this experiment and showed significant variation in respect of node number and cutting position of vine of sweet potato.

In case of morpho-physiological attributes experimental result revealed that, the maximum vine length (75.64, 103.93 and 143.91 cm), number of branches plant^{-1} (10.33, 13.72 and 17.36), number of leaves plant^{-1} (83.24, 131.24 and 157.15) and Chlorophyll content of sweet potato leaf (47.99, 51.70 and 47.76) at 50, 70 and 100 DAP were recorded in T_3 (5 nodes from top cut) treatment. Whereas the minimum vine length (48.41, 57.64 and 74.57 cm), minimum number branches plant^{-1} (5.80, 7.68 and 9.18), number of leaves plant^{-1} of sweet potato (41.86, 54.40 and 73.58) and chlorophyll content of sweet potato leaf (39.38, 43.68 and 41.77) at 50, 70 and 100 DAP were recorded in T_8 (7 nodes from basal cut) treatment.

In case of yield attributes, the maximum number of tubers plant^{-1} (5.15), total weight of tuber plant^{-1} of sweet potato (867.00 g), weight of marketable tuber plant^{-1} of sweet potato (802.00 g), total weight of tuber plot^{-1}of sweet potato (10 kg), yield of tubers of sweet potato (27.56 t ha^{-1}) and dry matter (30.85 %) of tuberous root of sweet potato were recorded in T_3 (5 nodes from top cut) treatment. Whereas the minimum number of tubers plant^{-1} (3.12), total weight of tuber plant^{-1} of sweet potato (299.00 g), weight of marketable tuber plant^{-1} of sweet potato (251.00 g), total weight of tuber plot^{-1}of sweet potato (3.25 kg), yield of tubers of sweet potato (8.90 t ha^{-1}) and dry matter

(27.60 %) of tuberous root of sweet potato were recorded in T_8 (7 nodes from basal cut) treatment.

Conclusion

It could be concluded from the present investigation that, number of nodes and cutting position significantly influences the growth and yield of sweet potato cv. BARI Sweet potato-12. Among different treatment T_3 (5 nodes from top cut) treatment perform well and recorded the maximum number of tubers plant^{-1} (5.15), total weight of tuber plant^{-1} (867.00 g), weight of marketable tuber plant^{-1} (802.00 g), total weight of tuber plot^{-1} (10 kg), yield of tubers (27.56 t ha^{-1}) and dry matter (30.85 %) of tuberous root of sweet potato comparable to other treatments. Thus for propagating of sweet potato through vine, 5 node from top cut is suitable for achieving higher yield.

Recommendations

The following recommendations are proposed here under:

- ❖ Before making final conclusion, further trials with the same treatment combinations with different varieties on different locations of Bangladesh would be useful.

Direction for future research work

- ❖ The best treatments of present experiment can be used with different organic and Inorganic feritlizers for standardizing nutrient management.
- ❖ The best treatments of present investigation can be treated with different plant growth regulators and bio-stimulants to study their influence on growth and tuber yield.

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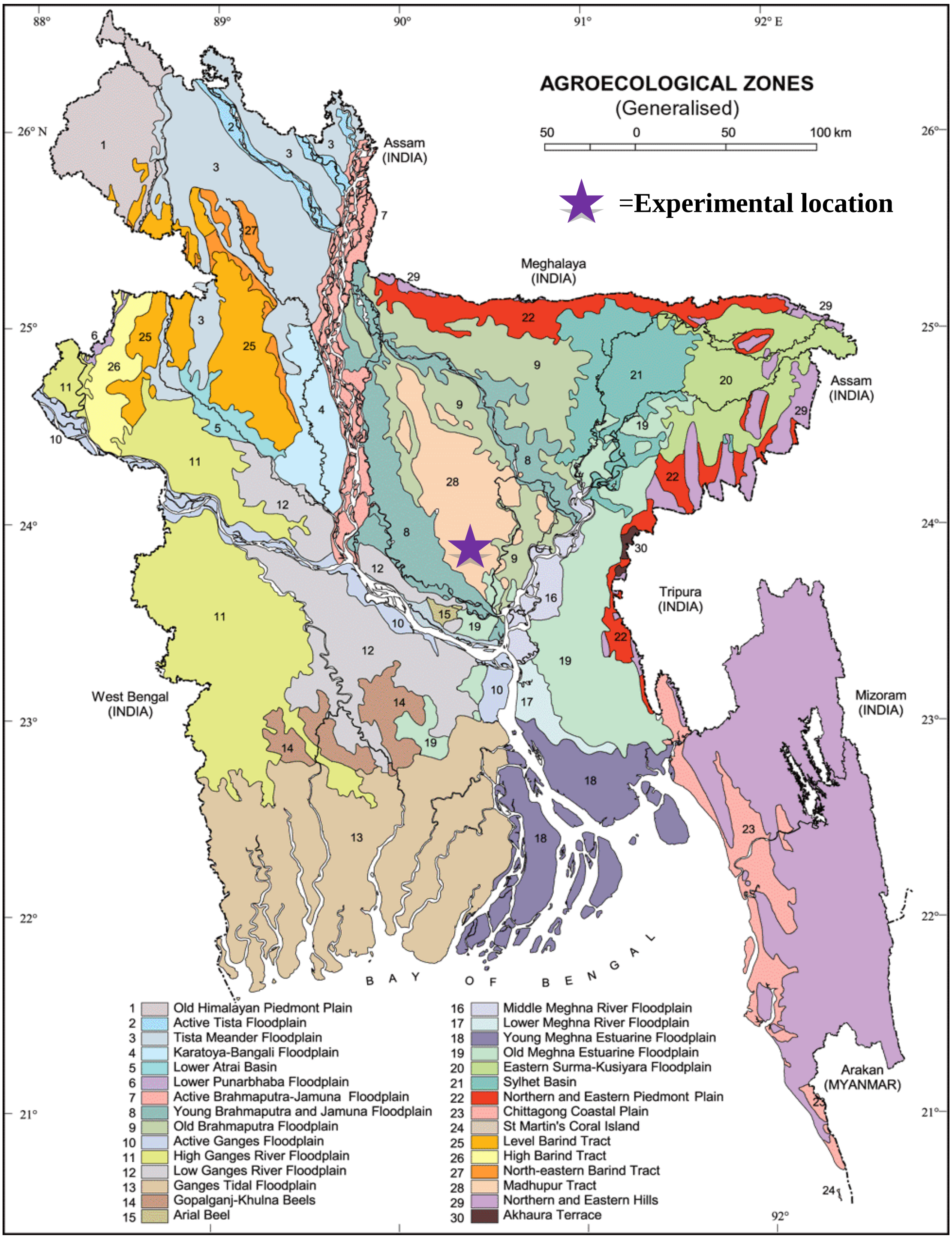
APPENDICES

Appendix I. Map showing the experimental location under study



Appendix II. Soil characteristics of the experimental field

A. Morphological features of the experimental field

Morphological features	Characteristics
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Shallow Red Brown Terrace Soil
Land type	High land
Location	Sher-e-Bangla Agricultural University Agronomy research field, Dhaka
Soil series	Tejgaon
Topography	Fairly leveled

B. The initial physical and chemical characteristics of soil of the experimental site (0 - 15 cm depth)

Physical characteristics

Constituents	Percent
Clay	29 %
Sand	26 %
Silt	45 %
Textural class	Silty clay

Chemical characteristics

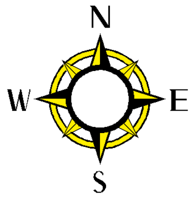
Soil characteristics	Value
Available P (ppm)	20.54
Exchangeable K (mg/100 g soil)	0.10
Organic carbon (%)	0.45
Organic matter (%)	0.78
pH	5.6
Total nitrogen (%)	0.03

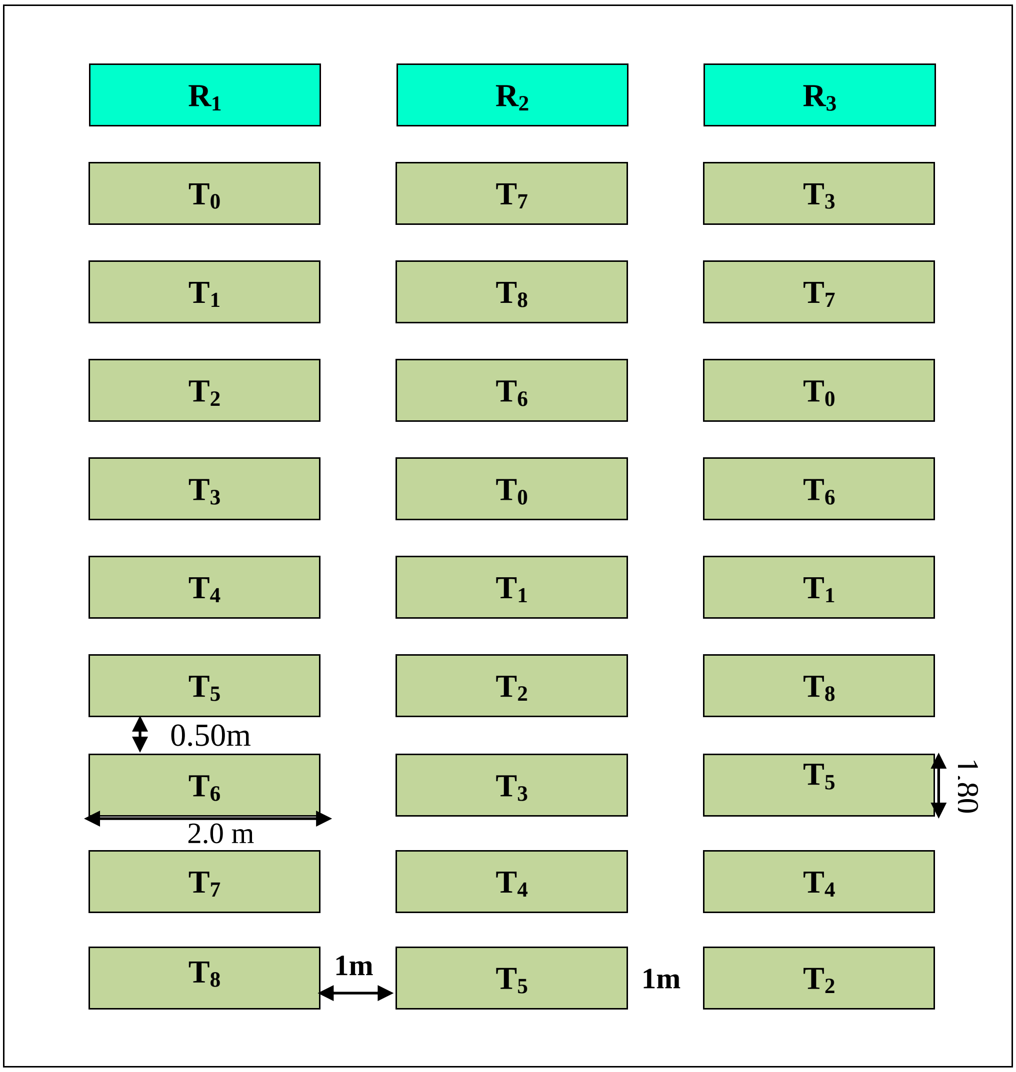
Appendix III. Monthly meteorological information during the period from October, 2019 to April 2020.

Year	Month	Air temperature (^{0}C)		Relative humidity (%)	Total rainfall (mm)
		Maximum	Minimum		
2019	October	31.2	23.9	76	52
	November	29.6	19.8	53	00
	December	28.8	19.1	47	00
2020	January	25.5	13.1	41	00
	February	25.9	14	34	7.7
	March	31.9	20.1	38	71
	April	32.7	23.8	74	168

(Source: Metrological Centre, Agargaon, Dhaka (Climate Division)

Appendix IV. Layout of the experimental field





LEGENDS
T_0= 3 nodes from top cut, T_1= 3 nodes from middle cut, T_2= 3 nodes from basal cut, T_3= 5 nodes from top cut, T_4= 5 nodes from middle cut, T_5= 3 nodes from basal cut, T_6= 7 nodes from top cut, T_7= 7 nodes from middle cut and T_8= 7 nodes from basal cut

Appendix V. Analysis of variance of the data of vine length of sweet potato at different days after planting

Mean square of vine length at				
Source	Df	50 DAP	70 DAT	1000 DAP
Replication (R)	2	4.695	6.849	10.63
Treatment	8	235.641**	619.208**	1732.55**
Error	16	1.799	1.637	11.12
Total	26			

**: Significant at 0.01 level of probability

Appendix VI. Analysis of variance of the data of branches plant^{-1} of sweet potato at different days after planting

Mean square of branches plant^{-1} at				
Source	Df	50 DAP	70 DAT	1000 DAP
Replication (R)	2	4.93481	0.3060	0.5741
Treatment	8	8.22676**	11.4207**	22.6941**
Error	16	0.16731	0.0332	0.1816
Total	26			

**: Significant at 0.01 level of probability

Appendix VII. Analysis of variance of the data of number of leaves plant^{-1} of sweet potato at different days after planting

Mean square of number of leaves plant^{-1} at				
Source	Df	50 DAP	70 DAT	1000 DAP
Replication (R)	2	2.318	0.12	1.09
Treatment	8	646.541**	2460.49**	2784.09**
Error	16	2.621	1.19	2.34
Total	26			

**: Significant at 0.01 level of probability

Appendix VIII. Analysis of variance of the data of leaves chlorophyll content plant^{-1} of sweet potato at different days after planting

Mean square of number of leaves plant^{-1} at				
Source	Df	50 DAP	70 DAT	1000 DAP
Replication (R)	2	6.1442	1.7185	0.2905
Treatment	8	32.9371**	24.2941**	12.8182**
Error	16	0.5120	0.4620	0.2712
Total	26			

**: Significant at 0.01 level of probability

Appendix IX. Analysis of variance of the data of number of tubers plant^{-1}, total weight of tuber plant^{-1} and weight of marketable tuber plant^{-1} of sweet potato

Mean square of number of leaves plant^{-1} at				
Source	Df	Number of tubers plant^{-1}	Total weight of tuber plant^{-1}	Weight of marketable tuber plant^{-1}
Replication (R)	2	0.53404	397.4	703.0
Treatment	8	1.32410**	94726.8**	90920.5**
Error	16	0.01031	536.9	817.4
Total	26			

**: Significant at 0.01 level of probability

Appendix X. Analysis of variance of the data of total weight of tuber plot^{-1}, yield of tubers and dry matter (%) of tuberous root of sweet potato

Mean square of number of leaves plant^{-1} at				
Source	Df	Total weight of tuber plot^{-1}	Yield of tubers	Dry matter (%) of tuberous root
Replication (R)	2	0.3220	0.844	0.14658
Treatment	8	16.6472**	127.594**	3.37651**
Error	16	0.1113	0.446	0.21064
Total	26			

**: Significant at 0.01 level of probability

PLATES

Plate 1: Photograph showing data collection

Plate 2: Photograph showing harvesting of sweet potato tuber plot^{-1}

Plate 3: Photograph showing weighting of sweet potato tuber plant^{-1}

Plate 4: Photograph showing weighting of sweet potato tuber plot^{-1}