Macro-propagation of Two Nigerian Varieties of Sweet Potato (Ipomoea batatas [L.] Lam) Using three Growth Media

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Abstract: **This study was conducted to investigate the sprouting potential of two varieties ((purple-skin with white-flesh - PSWF and cream-skin with yellow-flesh - CSYF)) of sweet potatoes (*Ipomoea batatas* [L.] Lam) commonly grown and consumed in Nigeria. The tubers of the two varieties were cultivated in three substrates (hydroponics, sawdust and topsoil) to generate vines with assigned treatment groups – control (whole tuber), T1 (whole tuber with scarified buds), T2 (whole tuber split into two), T3 (whole tuber split into four) in a humidity chamber. Each treatment was replicated three times. The vines were grown for a study period of five weeks and the number and length of vines were recorded. It was observed that the different treatment levels showed variability for the cream and purple skinned, mean length of vines in topsoil (control 0,110; T1 0,105; T2 5.5,0; T3 0,18.3), in sawdust (control 0,0; T1 0,0; T2 0,0; T3 0,3), and in hydroponics (control 10.2,0; T1 17.7, 10.5; T2 3.6, 6; T3 0,0) respectively and number of vines in topsoil (control 0,4; T1 0,4; T2 1,0; T3 0,3), in sawdust (control 0,0; T1 0,0; T2 0,0; T3 0,3) and in hydroponics (control 5,0; T1 13,3; T2 8,8; T3 0,0) respectively. The result revealed that splitting of tubers and planting in topsoil and sawdust is not viable for the generation of vines for the two varieties as it gave little or no sprouts. The use of whole tubers or whole tubers with scarified buds planted in water is recommended since it produced the highest number of vines.**

Keywords**: bud scarification, cream and purple skin, sweet potatoes, tuber, hydroponics, sawdust, topsoil**

I. INTRODUCTION

The recognition of the great potential of sweet potato crop as a nutritious food for humans and animals has resulted in intensified research efforts to enhance production and consumption in recent decades (Ahmed *et al*., 2012)

Sweet potato (*Ipomoea batatas* [L.] Lam) is a major staple food in Africa, Asia, the Caribbean, and South America (da Conceicao Nhanala, 2021), where they are important sources of carbohydrates, vitamin A and C, fiber, iron, potassium, and protein (Mbusa *et al*., 2018), used as animal feed and grown over a broad range of environments and cultural practices (Stahr & Quesada-Ocampo, 2020) and is commonly grown in low-input agriculture systems (Conz *et al.*, 2022).

Sweet potato (*Ipomoea batatas*) originated from Central America where it was found growing in the wild spreading across the Pacific from Central America and transported to warmer regions of Asia and Africa by Spanish and Portuguese traders. Sweet potato is grown in more than 100 countries in tropical, subtropical and temperate climates (Mvula, 2019). Sweet potato thrives well in sandy-loam and clay loam soils (Szarvas *et al.*, 2018), which must be well drained because of the plant sensitivity to long lasting excessive moisture in the soil (Chaudhary *et al* 2014). It is very sensitive to alkaline and saline conditions which influence growth (Yang *et al.*, 2020). Soil pH between 5.6 and 6.6 is very good for production (Anda *et al.*, 2018).

In developing countries, sweet potato is an highly adaptable crop that generates large amounts of food per unit area and unit time during relatively short rainy periods, giving it an advantage over major staples (Motsa *et al.*, 2015). It also has flexible planting and harvesting times (Heider *et al.*, 2021), tolerates high temperatures and low fertility soils (Mbusa *et al*., 2018). It is drought tolerant and easy to propagate (Low *et al.*, 2017). Furthermore, compared to other crops, sweet potato requires fewer inputs and labour making it particularly suitable for households threatened by migration or diseases such as HIV/AIDS (Kabirizi *et al.*, 2017).

The genus Ipomoea consist of 600-700 species (Park *et al.*, 2018). Sweet potato belongs to the family called Convolvulaceae and is a creeping plant that consists of perennial vines and adventitious roots (Makanjuola & Alokun, 2017). It is usually propagated vegetatively by using both roots and stem cuttings and grown primarily for the edible root which takes about 5-6 months to mature (Rouse, 2019).

The largest producer of sweet potato is China, with 80% of annual world supply (El Sheikha & Ray, 2017). It is the third most important root and tuber crop in Sub-Saharan Africa Africa produces 11.6 million tons annually with Nigeria being the largest producer followed by Uganda and Tanzania (Neela & Fanta, 2019).

The nutritional value of sweet potato includes the following; Vitamins A, B and C as well as minerals like phosphorous, iron and calcium (Alam *et al.*, 2020). The roots can also be boiled, baked or fried (Adepoju & Adejumo, 2015).

The aim of this study is to know the best method for growing sweet potatoes through macro propagation.

II. MATERIALS AND METHODS

Experimental Site

The study was conducted at the Ecology center of the Department of Plant Science and Biotechnology, University of Port Harcourt. It is located on latitude 4º 53' 14'' N through 4º 54' 42'' N and longitude 6º 54' 00''E through 6º 55' 50'' E.

Plant Materials

Fresh tubers of sweet potatoes of two varieties, purple skinned and cream skinned were obtained from a local market in Choba and transported to the experimental area for preparation and planting.

Tuber Preparation and Planting

A total of 34 tubers with a uniform weight 400g, 17 each for each variety of different weights were used for the experiment. All the tubers were subjected to four treatments;

Control: Whole tuber intact.

Treatment 1 (T1): Whole tuber with scarified buds.

Treatment 2 (T2): Tuber split into two.

Treatment 3 (T3): Tuber split into four.

6 tubers were used for the control and treatment 1, 3 tubers were used for treatment 2 and 2 were used for treatment 3 and it was replicated twice in each variety for three media. This was established in a randomized complete block design with the replications spaced at 20 x 20 cm. The tubers were planted on the 10th of July, 2019.

Planting of Tubers

The selected tubers were potted in polybags with topsoil and sawdust respectively, plastic was filled with water and tubers were put in for hydroponics. The polybags and plastics containing the tubers were incubated inside a macro propagation humidity chamber for growth..

Materials And Method

Experimental Site

The study was conducted using at the Field facility at the Ecology Center, University of Port Harcourt located on latitude 4º 53' 14'' N through 4º 54' 42'' N and longitude 6º 54' 00''E through 6º 55' 50'' E.

Plant Materials

Fresh tubers of two sweet potatoes varieties, purple-skinned with white-flesh (PSWF) and cream-skinned with yellow flesh CSYF) were obtained from a market in Choba and transported to the experimental area for preparation and planting.

Tuber Preparation and Planting

A total of 34 tubers, 17 each for each variety of different weights were used for the experiment. All the tubers were exposed to the four treatments;

1) Control: Whole tuber intact.
2) Treatment 1 (T1): Whole tuber with scarified buds.
3) Treatment 2 (T2): Whole tuber split into two.
4) Treatment 3 (T3): Whole tuber split into four.

Planting of Tubers

The selected tubers were potted in polybags with topsoil and sawdust respectively, plastic were filled with water and tubers were put in for hydroponics. The polybags and plastics containing the tubers were incubated inside a macro propagation humidity chamber for growth.

Plate 1: Macro Propagation Humidity Chamber

Data Collection and Analysis

Data was taken based on the weight of each tuber prior to splitting and planting, number of days to first sprout, vine length and number of nodes per vine. The data was subjected to analysis of variance (ANOVA) to test for the significance of effects of treatments on the parameters measured.

III. RESULT

The studies on *Ipomoea batatas* in different medium of different treatments were carried out for five weeks. The results are presented below in sections. The vine length (performance) of *Ipomoea batatas* in the three substrates are shown in Plate 1, 2 and 3

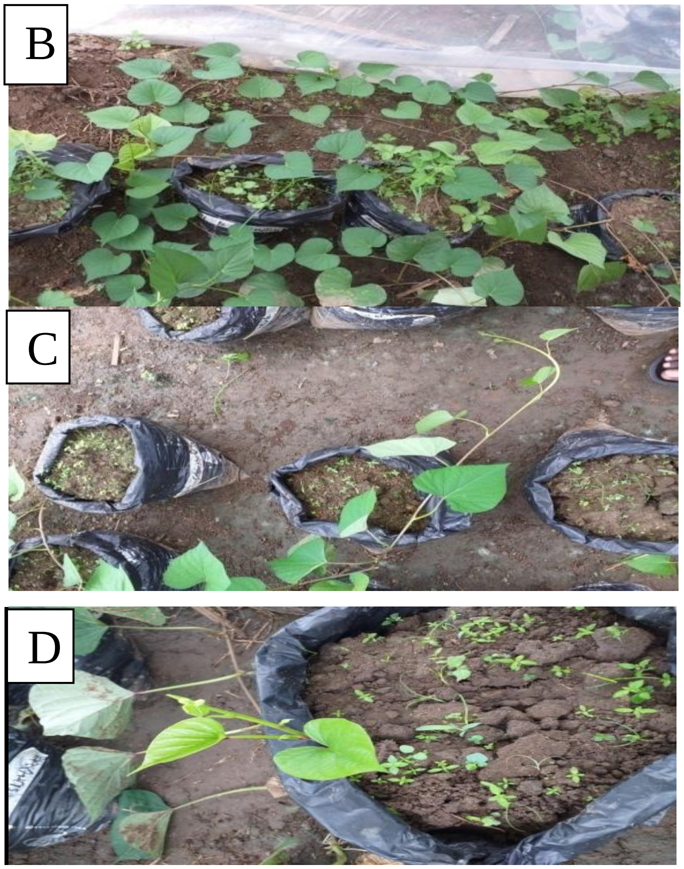


Plate 2: (A-D): Ipomoea batatas in Topsoil; (A) Control (B) Treatment 1 (C) Treatment 2 (D) Treatment

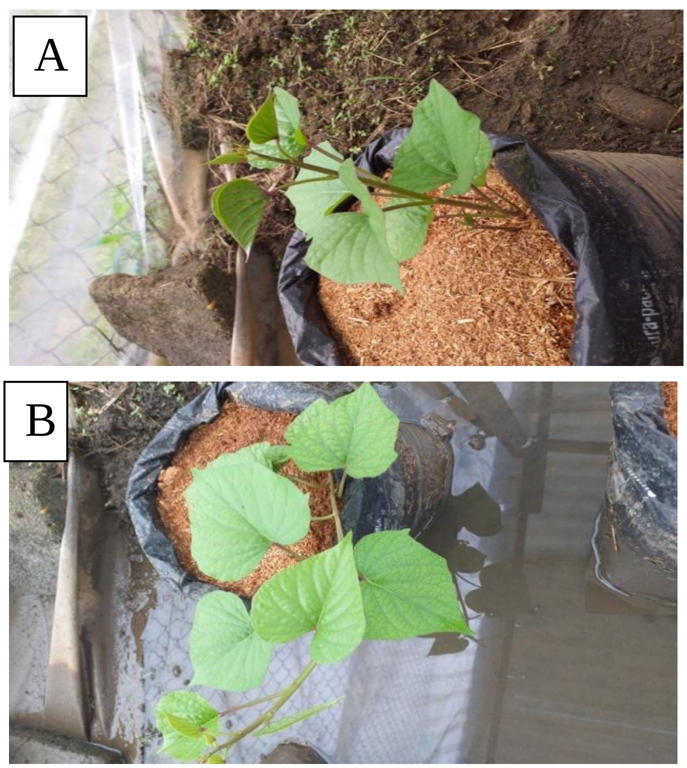
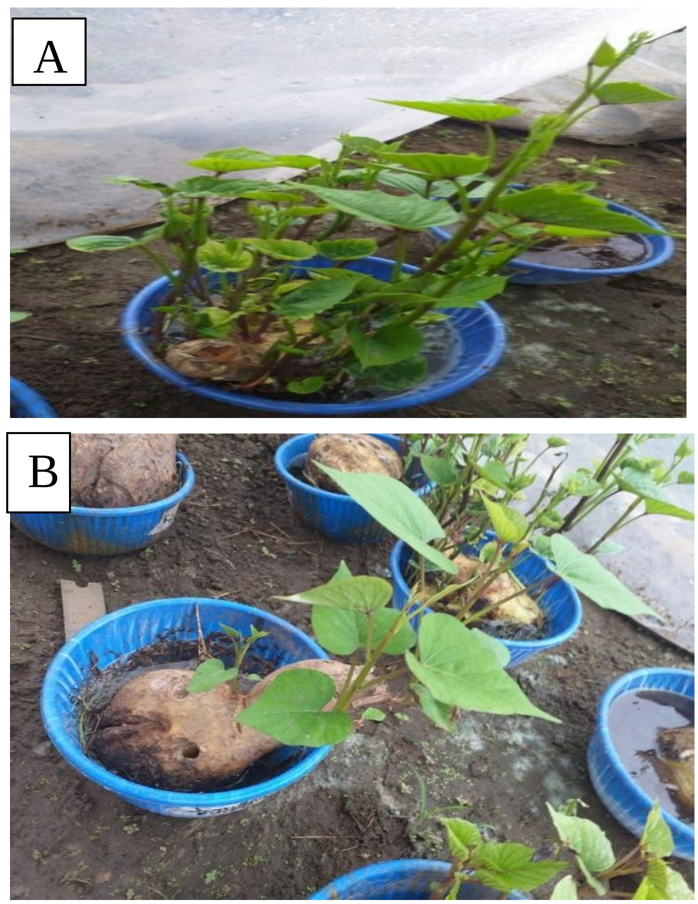


Plate 3 (A-D): Ipomoea batatas of Purple Skinned in Sawdust; (A) Control (B) Treatment 1 (C) Treatment 2 (D) Treatment 3



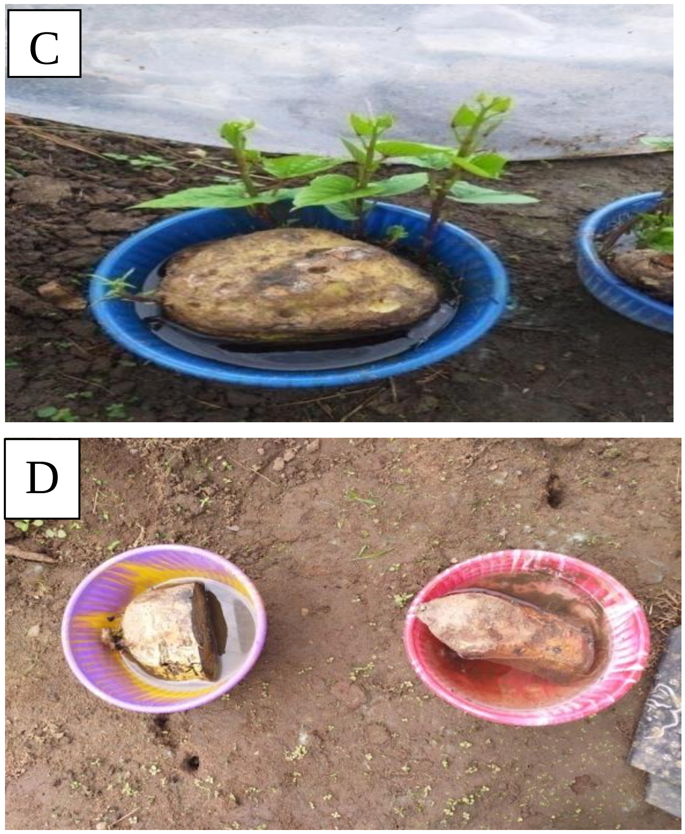


Plate 4 (A-D): Ipomoea batatas in Hydroponic; (A) Control (B) Treatment 1 (C) Treatment 2 (D) Treatment 3

Number of Vines

The numbers of vines of two varieties of *Ipomoea batatas* with different treatments grown in varying substrates are shown in Figure 1, Fig 2 and Fig 3. Fig 1 is water medium and shows that T1 of the cream-skinned sweet potato had the highest number of vines, T3 of the cream and purple skinned had no growth. The result also shows that cream-skinned control=5, T1=13, T2=8, T3=0 while for the purple skinned control=0, T1=3, T2=8, T3=0.

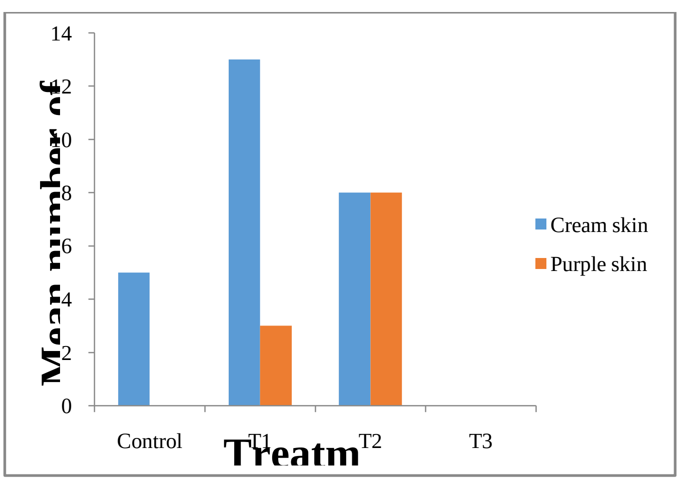


Figure 1: Mean number of vines of the two varieties of *Ipomoea batatas* in water

growth medium.

The figure below is sawdust and shows purple skinned had the highest number of vines and there was no growth in T1 and T2. There was no growth in all treatments for the cream skinned. The graph shows that for purple skinned control=24, T1=0, T2=0, T3=3 while for the cream skinned control=0, T1=0, T2=0, T3=0, T4=0.

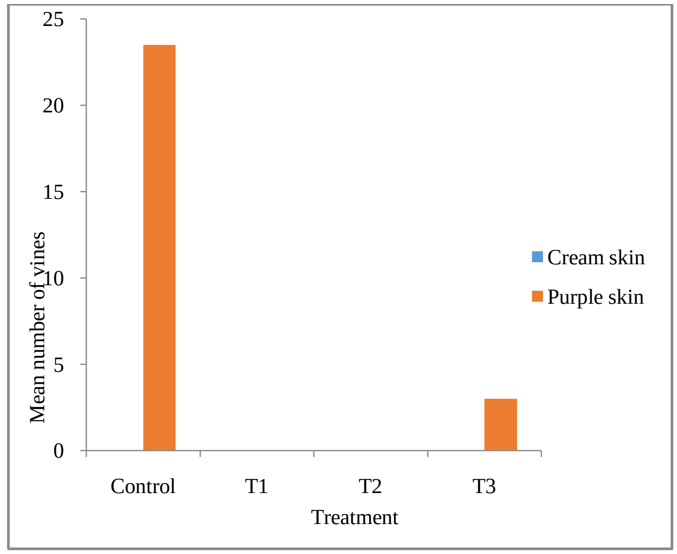


Figure 2: Mean number of vines of the two varieties of *Ipomoea batatas* in sawdust medium.

The figure below is topsoil and shows that in the purple skinned control and T1 had the highest growths which were equal and there was no growth in T2. The cream skinned grew only in T2. The graph shows that for purple skinned control=4, T1=4, T2=0, T3=3 while for cream skinned control=0, T1=0, T2=1, T3=0

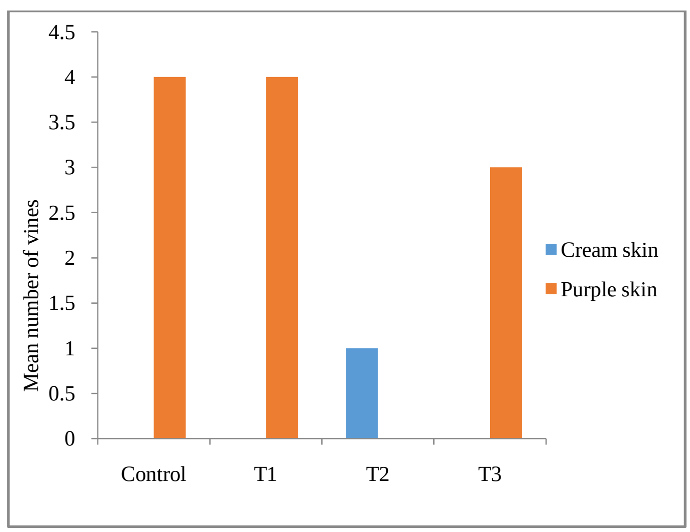


Figure 3: Mean number of vines of the two varieties of *Ipomoea batatas* in top soil medium.

Vine Length

There was increase in vine length. Fig 3.4 shows that in hydroponics medium for the cream skinned T 1 has the highest vine length and there was no growth in T3. Mean vine length control=10,

T1=18, T2=4, T3=0 while for the purple skinned T2 had the highest growth, control=0, T1=10, T2=6, T3=0

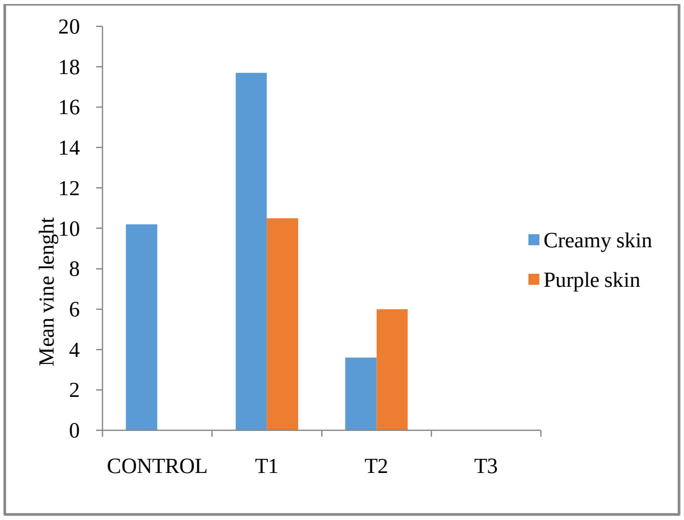


Figure 4: Mean vine length (cm) of the two varieties of *Ipomoea batatas* in hydroponic medium.

The below figure shows the sawdust substrate in which the control of the purple skinned had the highest vine length and there was no growth in T1 and T2, the graph shows that control=24, T1=0, T2=0, T3=3 while for the cream skinned there was no growth in all treatments.

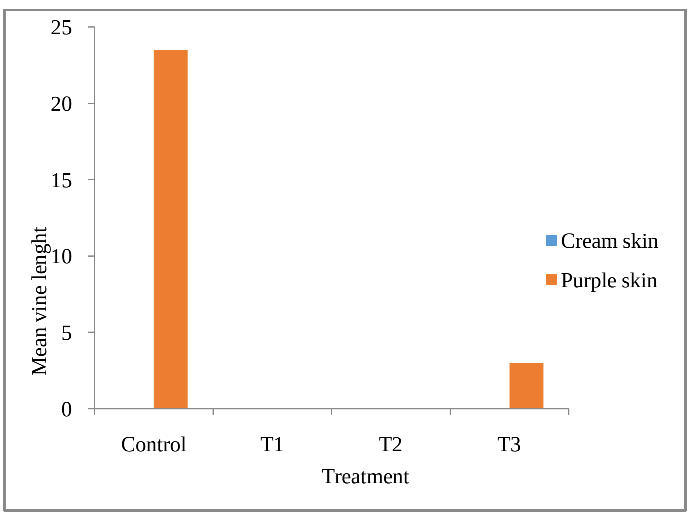


Figure 5: Mean vine length (cm) of the two varieties of *Ipomoea batatas* in sawdust

Fig 6 shows that in topsoil, for the purple skinned control had the highest vine length and there was no growth in T2, the graph shows that control=110, T2=105, T3=0, T4=20 while for the cream skinned there was no growth in all treatment but T2, the graph shows that control=0, T1=0, T2=5, T3=0.

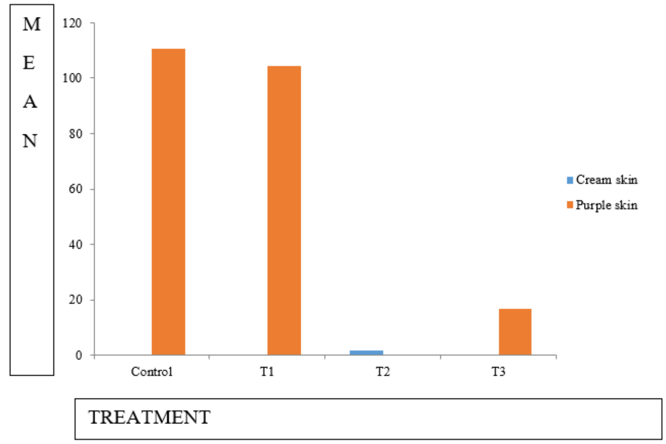


Figure 6: Mean vine length (cm) of the two varieties of *Ipomoea batatas* in topsoil

Tuber Weight

Table 1: Tuber weight of sweet potatoes used for the different treatments.

	Purple	Cream	Purple	Cream
Control	0.4kg	0.4kg	0.4kg	0.4kg
Treatment 1	0.4kg	0.4kg	0.4kg	0.4kg
Treatment 2	0.2kg	0.2kg	0.2kg	0.2kg
Treatment 3	0.1kg	0.1kg	0.1kg	0.1kg

IV. DISCUSSION

This study shows that sweet potato vines can be grown using all substrate. The best for fast generation of plant slips was the hydroponic media; this media can help potential farmers generate plant slips in large proportion prior to field establishment (Sakamoto & Suzuki, 2020). The top soil serves as a media for rapid growth of the vines and of the plant generally (Riaz *et al.*, 2015). Sawdust produced least sprouts and this is an indication that it may not be a good substrate for vine regeneration (Ambebe *et al*., 2018).

In this study the use of medium in Macro propagation has proven to be a cheap and effective method of propagation (Panda *et al.*, 2019). Macro propagation is viewed as better than micro propagation (tissue culture) (Ntamwira *et al.*, 2017), considering it is unlikely that farmers will develop the capacity to do in vitro which is more expensive and requires specialized facilities that are not readily available in Nigeria. It was also observed that micro propagation assures more rapid production of plant materials but also requires more sophisticated techniques, skills and care to handle the material (Cardoso *et al.*, 2018)

Similarly in this study to compare between hydroponic and soil based system it shows that hydroponics has a better effect as it makes the plant grow faster (Baiyin *et al.*, 2021).

Sawdust can be used as an alternative medium in planting although growth parameters were delayed which may be due to the unavailability of soil microorganisms that can make medium nutrient rich through decomposition process as compared to soil medium (Agboola *et al.*, 2018)

In this study the production of vines by two varieties of sweet potato showed a variation. A large number of low or no slips can be seen in the cream skinned sweet potato which can be attributed to numerous internal and external factors (Kannahi & Buvaneswari, 2019). Also purple skinned sweet potato produced more slips which is an indication that it may be a good variety for the production of slips.

The performance of sweet potato was best using the whole tuber (control) and the whole tuber with scarified buds (T1). This study shows the essence of scarification of seeds. Scarification of buds encourages sprout multiplication in vegetative propagated crops (Tumuhimbise & Talengera, 2018).

Split sweet potatoes produced least sprouts, which could be as a result of environmental conditions.

V. CONCLUSION

The use of hydroponics as a growth medium improved the multiplication of vines (plant slips) of *Ipomoea batatas*. It was also observed that the use of soil as a medium also facilitates rapid growth of vines and the plant as a whole. The use of sawdust as a medium for planting sweet potatoes is not advisable as it induces poor growth and tuber rotting. Therefore, for faster multiplication, the use of whole potato tuber with scarified buds and hydroponics as a medium is recommended.

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