# Seed yam tuber production from vine cuttings

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**ABSTRACT**

Seed yam tuber production accounts for 30 per cent to 50 per cent of total cost of production. Efforts to obtain seed yam tubers from vine cuttings are still rudimentary, and research information available is scanty and sparse. Studies to compare the effectiveness of vine cuttings for seed yam tuber production were conducted in 2010 at International Institute of Tropical Agriculture, Ibadan, Nigeria, with a clone of *Dioscorea rotundata* (white yam) TDr 95/18544. Vine cuttings (VCs), with one node, one leaf, and 10 – 15 cm long were cut from the middle portion of the stems of 90-days old mother plants. Healthy VCs were planted singly in a rooting medium, and the rooted VCs were transplanted to the field at 40 days after planting, and harvested 110 days after transplanting when the leaves had senesced. Screenhouse-derived plants (SDP) originated from tissue culture have a higher survival percentage than cuttings from field-derived plants (FDP). Higher shoot formation was also observed in SDP whilst no shoot from FDP. Mean yield of tubercles from SDP was 8.5 times higher ($P = 0.05$) than yield from FDP. The mean percentage change in the yield of tubercles obtained from the cut mother plants and the uncut mother plants was 16 times more in SDP than FDP. Production of healthy seed yam tuber is possible using healthy mother plants for vine cuttings.

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## Introduction

Edible yams are staple food crops for over 100 million people in the humid and subhumid tropics. Global annual production of yam is 30.1 million tonnes. Between 90 per cent and 95 per cent of this amount is produced in West Africa. Nigeria alone accounts for 70 per cent of the world production (FAO, 2009). Food yams are consumed by boiling, frying, and roasting. The boiled yam can be made into pounded yam; the pounded yam is eaten with various sauces. Food yams can be processed into flour, snacks, and flakes. The yam peels are used for livestock feed. Many consumers in Nigeria prefer white yam and believe it is valuable in traditional culture, rituals, religion, and rites (Osunde & Orchevba, 2009).

Seed yam tubers (SYT) are traditionally used as planting material. Seed yams could be small, whole tuber weighing 5 – 100 g regarded as tubercles. A tuber 150 – 250 g is known to be a normal seed yam, and a tuber 500 – 1000 g is a large seed yam (Asumugba *et al*., 2007). The use of any tuber of any size in SYT production schedule is paradoxical in that it takes away edible tubers. The cost of SYT is about two–thirds of the percentage of total cost of production. The three major inputs in yam production in Nigeria are seed yams, labour and staking material. These inputs account for 45, 21 and 16 per cent of yam production cost, respectively. Increased production is believed to be constrained majorly by high cost of SYT. Plant parasitic nematode damage is a major factor in tuber quality reduction and yield loss in the field and in storage (Adegbite & Agbaje, 2007). In yams, underground tubers are seriously affected by pathogen accumulation which reduces the quality of planting material. The sett multiplication ratio for yam is lower (<1:10) when compared to other root and tuber crops such as sweet potato and cassava. Sweet potato and cassava are grown from the stem cuttings which do not use the edible parts as in yams. There is, therefore, the need to improve the propagation method for yams, in order to increase the amount of SYT produced annually without using edible tubers.

Yam vine cuttings (VCs) offer hope for solving the problem of inadequate planting material. Propagation through VCs has been reported to offer higher multiplication rates, and healthy seed tuber. It reduces usage of tubers as planting material for the next cropping season. VCs of *D. rotundata* have produced minitubers within 100 – 120 days after planting (DAP), which could be used for germplasm preservation and seed yam production (Shiwashi, Kikuno & Asiedu, 2005). VCs from aged plants (those plants in the reproductive phase where rapid tuberization and flowering occur; 4 – 5 months old) will produce only roots and tubers, while VCs from non-aged plants (plants in vegetative phase where elongating stems and leaves occur before rapid tuberization and flowering; 2 – 3 months old) under long day-length will produce VCs with roots, shoots, and tubers. Explants sources and age of VCs have effect on the rooting, shooting, and tuber formation (Kikuno *et al*., 2007). Light plays a major role in the morphological development of yams. Depending on the day-length and age of mother plants, the VCs may just form roots and microtubers (Matsumoto *et al*., 2010).

SYT production through VCs rapidly increases multiplication of clones, resulting in seed yams that are free of nematodes and soil borne pathogens. With VC technique more SYT of better quality will be made available for ware yam production in sub-Saharan Africa. Production of SYT using VCs is not yet a commercial practice due to the intensive care required for establishment, however, seed yam production using VCs is possible.

The study, therefore, evaluates the effectiveness of VCs of TDr 95/18544, a high yielding clone of white yam for SYT production.

## Materials and methods

*Experimental location*

The experiment was conducted at the International Institute of Tropical Agriculture (IITA), Ibadan from July to December 2010. IITA is located between 7° 26' N, 3° 54' E in the transition zone between humid and sub-humid tropics. The soil area is derived from basement complex rocks with sandy loam surface texture overlying a layer of angular to sub-angular quartz gravel merging into argillic horizon. The plot was ploughed, disc-harrowed and ridged.

*Experimental design*

The design of the field was randomized

complete block design with four replications. Eight plots were made. Each of the plots was 10 m × 10 m and was separated by 1 m each per plot for demarcation. The ridges were 1 m apart between each row and 25 cm between plants.

*Treatment used*

Mother plants of *Dioscorea rotundata* (white yam) cv. TDr 95/18544 were established in the field with 100 g sett weight (FDP). Mother plants were also established from plants originated from tissue culture and transplanted into pots in the screenhouse (SDP) in March 2010.

*Preparation of rooting medium*

Carbonized rice husks are product of incomplete combustion of organic material. This was prepared by setting fire under half cut drum (400 *l*) containing rice husk for about 1 h. During the burning process, it was stirred intermittently with a stick to achieve uniform carbonization. After burning, the drum was removed from fire, the carbonized rice husk was wet with water to allow it to get cool and prevent total combustion. The topsoil sieved using 20-mm sieve to remove stones and pebbles. The drum containing the top soil was put on the fire for about 1 h. The drum was removed from fire to cool. The carbonized rice husk was mixed with sterilised soil in the ratio 2:1 (by volume). The mixture was distributed in 20 cm × 15 cm black polythene bags.

*Rooting of VCs in the nursery*

Mature lateral branches from 90 day-old plants were excised from the field and the screenhouse in July 2010. A shade was constructed with pole and covered with cheese cloth. Lateral branches having at least six nodes with leaves were excised from plant and kept under the shade for 24 h.

Healthy VCs with one node, one leaf and approximately 10 – 15 cm long were cut from the middle portion of the lateral branches that were kept in a humidity chamber at 28 °C and 76 per cent relative humidity (R.H.). These were planted in the rooting medium singly in slanting position. The VCs planted were kept in the humidity chamber covered with cheese cloth in order to maintain a high R.H. and reduce the intensity of light. Environmental factors such as temperature, R.H. and solar radiation were monitored in the controlled environment daily at 8.30 a.m. and 2.00 p.m., respectively.

*Establishment of plantlets in the field*

At 40 DAP, plantlets with shoot that has 3 – 4 leaves and 15 cm long were selected and transplanted on the ridges in the field at 1m × 0.25 m spacing. Tubercles were formed in the plantlets before transplanting. Trellising of the vines with rope was done 20 days after transplanting (DAT). Tubercles were harvested 110 DAT when the leaves had senesced.

*Variables measured*

Variables such as percentage plant survival, number of tubers per stand, fresh tuber weight, percentage shoot formed, dry weight of tuber, tuber moisture content, and the mean of tuber yield of mother plant from vines cut and the uncut mother plant were recorded. T-test was used to compare means at 5 per cent probability.

## Results

*Survival and shoot formation of VCs in the nursery*

It was observed that most of the vines planted survived. SDP had a higher survival (98%) than survival obtained from FDP at 40 DAP (76%). At 40 DAP, 95 per cent of SDP had shoot with 2 – 4 new leaves but no shoot formed in FDP (Table 1).

*Tubercle formation in vine cuttings*

Tubercles were initiated in SDP (95%) and FDP (68%) at transplanting (40 DAP). At harvesting (150 DAP), 91 per cent of SDP produced tubercles. The mean yield of tubercles produced was 24.6 g with a range of 4.2 – 212 g (Table 2). About 97 per cent of the tubercles obtained from SDP weighed less than 150 g. In FDP, 54 per cent of the plants produced tubercles with a mean yield

TABLE 1

*Percentage Survival, Shoot and Tubercles Initiation of Vine Cuttings, TDr 95/18544 Planted in Rooting Medium.*

| *Derived plants* | *No. of vines established* | *Percentage survived* | *Percentage with shoot* | *Percentage that initiated tubercles* | *Percentage number of tubers harvested* |
|---|---|---|---|---|---|
| Screenhouse | 3,200 | 98 | 95* | 95* | 91* |
| Field | 3,200 | 76 | 0 | 68 | 54 |

* Significant at 5 per cent probability (t-test)

TABLE 2

*Mean Fresh Weight of Tubercles Obtained from Vine Cuttings of TDr 95/18544 at Harvest (150 DAP).*

| *Derived plant* | *Tubercle yield/ plant (g)* | *Maximum weight (g)* | *Minimum weight (g)* | *CV(%)* |
|---|---|---|---|---|
| Screenhouse | 24.6 | 212.4 | 4.2 | 61.3 |
| Field | 2.9 | 8.2 | 0.6 | 46.0 |

TABLE 3

*Mean Separation of Growth Component and Tubercles Yield Obtained from Vine Cuttings of TDr 95/18544.*

| *Derived plant* | *Total no. of shoots* | *No. of stands with multiple tuber* | *Mean yield of tubers per stand* | *Percentage moisture content* |
|---|---|---|---|---|
| Screen house | 96.0* | 1.1 | 24.6* | 75.0 |
| Field | 0.0 | 1.1 | 2.9 | 76.0 |
| | | Ns | | Ns |

* Significant at 5 per cent probability (t-test)

Table 4

*Percentage Distribution of Fresh Tubercles Weight Obtained from Vine Cuttings of TDr 95/18544 at 150 DAP (n=200)*

| *Tubercle weight (g)* | *Screenhouse derived plant (%)* | *Field derived plant (%)* |
|---|---|---|
| 2 – 10 g | 2.5 | 100 |
| 10 – 50 g | 85.0 | 0 |
| 50 – 100 g | 12.0 | 0 |
| 100 – 220 g | 2.5 | 0 |

Table 5

*Mean Yield of Tubercles Obtained from Mother Plant TDr 95/18544 from Which Vines were Cut and the Uncut Mother Plants at 150 DAP*

| *Mother plant* | *Screenhouse mother plant* | *Field mother plant* |
|---|---|---|
| Cut plants | 35.6 | 848.2 |
| Uncut plants | 36.1* | 1016.4* |
| % change | 1.4 | 16.6 |

of 2.9 g (Table 2). All the tubercles obtained from FDP weighed less than 10 g (Table 4). The average number of tubercles produced per VCs in SDP and FDP was 1.1. Moisture content of about 75 per cent was obtained in all the tubercles produced from SDP and FDP (Table 3). There was no significant difference ($P = 0.05$) in the number of tubercles produced per plant in FDP and SDP. However, the mean tubercle yield in SDP was eight times higher than the mean tubercle yield from FDP (Table 5).

*Tubercle production from the mother plants at 150 DAP*

In FDP, the percentage change in mean yield of tubercles obtained from mother plant from which vines were not cut was 16 per cent higher than the cut mother plant. However, there were significant differences in the mean yield of mother plant from which vines were cut and the uncut mother plant in SDP and FDP (Table 5).

## Discussion

The concept of VCs as the initial source for producing seed yam for seed tuber supply is a technology that can replace traditional methods and initiate enterprise for yam production, storage, and marketing across the yam growing areas. VCs can be established very quickly as an effective means of producing disease and nematode free planting material. The use of VCs in producing SYT permits a rapid multiplication within a short duration with limited quantity of planting materials. Carbonized rice husk mixed with soil is a better medium for root initiation in VCs (Shiwashi, Kikuno & Asiedu, 2005), because of better aeration among the roots initiating primary nodal complex on the leafless node.

In the study, good plantlet establishment, high survival percentage (98%) with high shoot formation (96%) observed in SDP was better than those obtained by Ikeorgu *et al*., 2008. This could be due to the use of clean disease free material. The vines from the screenhouse were more succulent and tender, with young leaves which are characteristic of good vine. The used of hormones for better shooting and rooting has been recorded by Acha *et al.* (2004). However, the result obtained in the study shows that SYT production from VCs without using hormone is possible. It can be a profitable way of producing SYT with a reduced cost of cultivation.

The use of three nodes for vine propagation has been reported by Kikuno *et al*. (2007), however, the use of a single node has been found successful in the study for ease of planting as nodal culture reported by Balogun *et al*. (2004). Moreover, the range of 4.6 – 212 g tubercles obtained from SDP in the study is a step further from the result obtained by Shiwashi, Kikuno & Asiedu (2005) with a range of 3 – 20 g. Inability of FDP to form shoot and production of small tubercle may be due to hormonal imbalance, and the physiological activity at the time the mother plant is cut. Change in natural day length may promote tuber development and absence of shoot growth (Asiedu, Cranfurd & Battey, 2006).

High CV (67%) obtained in VCs could be as a result of variation in position of cut from the lateral branches. The moisture content of the tubercles obtained from all the plants was within the range reported for mature seed tubers, indicating the tubercles were matured at harvest despite their small weights. The multiple tubercles obtained in some of the plants shows that multiple tuberisation is a characteristics of the clone. The tubercle yield obtained from mother plant from which vines were cut agreed with that of Diby *et al*. (2009), that minimum defoliation of leaves resulted in formation of new leaves, and does not have a negative effect on yield of *D. rotundata*. Therefore, VC technique can be profitable since both the mother plant and the cut vines can produce tubers.

## Conclusion and recommendations

The study shows that a VC weighing 0.2 – 0.4 g produces tubercles of more than 25 g. The 25 g tubercle obtained from VCs can produce more than 250 g seed yam tuber if it is planted the next season. But with proper timing and good management practices, more than 250 g seed yam tuber can be obtained from VCs in one season. Consequently, healthy seed tuber production is possible if initial VCs used for field planting is obtained from healthy mother plants.

Good management practices for rooting leafy vine cuttings are recommended to obtain good yield. Further research to determine the number of nodes needed for optimum survival and good yield should also be considered.

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