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Vine cuttings technology in food yam (*Discorea Rotundata*) production

[1]Muamba J. Kabeya[*], [2]Uzoma C. Kabeya, [3]Berhanu D. Bekele and [2]H. Kikuno

[1]Department of Crop Physiology, University of Agricultural Sciences-GKVK, Bangalore, India
[2]International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria
[3]Department of Biotechnology, University of Gondar, Ethiopia

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ABSTRACT

This study was designed to evaluate the rooting and tuberization (mini tubers) potentials of vine cuttings of six genotypes (TDr 131, TDr 335, TDr 97/00925, TDr 98/01230, TDr 98/ 00718 and TDr 97/00940) of white yam (D. rotundata) using plant hormone. Vine cuttings from 120 days old plants were collected from the six genotypes for root formation. Three to four nodes leafy vine cuttings were prepared and the lower portion of these nodes were wounded with a clean razor blade and then dusted with 1.0% Indole-3 butyric acid (IBA) powder in order to promote rooting. The vine cuttings were sampled for mini tuber formation three months after transplanting. There were no significant differences ($P \leq 0.05$) among the genotypes for both mean root per vine and the mean root length of the cuttings. There was a significant difference ($P \leq 0.05$) in the total mini tubers number and the weight of mini tubers which ranged from 8.3 to 82.95 and 1.9 g to 6.9 g respectively.

Key words: Genotypes, IBA, mini-tuber, root formation, vine cuttings.

INTRODUCTION

Limited availability and cost of planting material is a major constraint for yam production in Africa. Planting materials account for about 50% of the cost of the production. Large amounts of material (about 10,000 seed yams) are needed to plant 1 hectare. If farmers do not buy new seed yams, they must set aside 30% of their harvest for the next year planting. In addition, seed yams are bulky and perish quickly.

Food yams are predominantly cultivated in the humid forest, forest/savanna transition and the southern guinea savanna (SGS) zones of West Africa. Large percentages of current production are in the SGS [1]. The contribution of yams to the dietary needs of man and economic gains accrue from its cultivation cannot be over emphasized [2]. Yams are usually made into various food items, recipes and confectionary according to individuals' preference or needs [3]. It is an ancient crop in central West Africa [4,5] and provides a promising avenue for alleviating the current food crises.

Nigeria produces most of the world's annual output of over 27 million tones of yams. Despite this great potential, limited research has been carried out on agronomic techniques in the recent past to improve yam cultivation in sub-Saharan Africa [6, 7, 8, 9]. The edible part of yam is the underground starchy stem called 'tuber' which also serves as the conventional propagules of the crop.

In most tropical countries, food yams are propagated vegetatively by planting small whole tubers or pieces cut from large tubers. This means that some marketable tubers must be reserved for planting. This method competes with yam

availability for human consumption and at the same time makes the cultivation expensive for large scale production. The cost of planting material is over 33% of the total outlay for yam production, so there is a need to improve the rate of yam multiplication [10]. Because of difficulties in propagation, the yam is under threat in many traditional areas of production [11].

Nevertheless, the propagation of yam through vine cuttings and aerial tubers (bulbils) could offer an even high multiplication rate than the mini-sett technique [12]. This technique was first reported in non-food yams [13] and in recent times, it has been extensively reported in food yams [14]. Successful root development by vine cuttings has been reported but growth was limited and tuber production has been challenging [12].

Cutting of several yam species have been rooted in sand media without hormones [15], however, hormone treatment may accelerate root, shoot and tuber formation [16]. Akoroda and Okanmah [17] obtained that small tubercles, whose size and quantity were not specified from rooted vine cuttings of yam.

Kabeya [18] studied the effect of auxin on root development in *D. rotundata* vines and observed the formation of mini tubers. Vine cuttings of *D. rotundata* can be used to produce mini tubers within 100-120 days that could be used in germplasm exchange and for production of seed yams. The objective of this study was to evaluate the potential of mini tuber production using vine cuttings of *D. rotundata* and possible contribution to yam production, a feasible and an adoptable measure by yam farmers.

MATERIALS AND METHODS

The experiment was conducted at the International Institute of Tropical Agriculture (IITA), Ibadan (7°26'N, 3°54'E), a rainforest - savanna transition zone. The soil in this area is also classified as Oxic paleustalf soil series (Greenland 1981). A total of six yam genotypes, *Dioscorea rotundata* Poir ((TDr 131, TDr 335, TDr 97/00925, TDr 98/01230, TDr 98/ 00718 and TDr 97/00940), obtained from the Germplasm Collection Unit of IITA were used to evaluate the tuberization potentials from vine cuttings of some yam clones. This study was carried out with vine cutting materials collected from the field condition.

Seed setts (150 – 200 g) of six genotypes of *Discorea rotundata* (TDr 131, TDr 335, TDr 97/00925, TDr 98/01230, TDr 98/ 00718, and TDr 97/00940) were planted on the field. Twelve plants of each genotype were randomly selected at 120 Days after planting (DAP) and healthy vine cuttings were collected around 9 am. In order to maintain moisture, vines of each genotype were placed in a moist transparent polyethylene bag immediately after collection and then taken to the green house for further processing. From the middle portion of each vine 25 cm long, cuttings with three nodes each were prepared. Before planting, the leaves of the two lower nodes of the cuttings were removed by detaching their petioles from the vine with a clean scissor and the end portion of the vine were slantly cut in order to increase the absorption surface area. To promote root initiation, the cut surfaces of the two lower nodes of the cuttings were then dusted with 1.0 % Indole butyric acid (IBA, Okishiberon, Sionogi, Co, Japan) powder. The treated cuttings were then planted in slanting position in plastic baskets filled with 1 kg carbonised rice husk [19] allowing the lower sides of the nodes dusted with IBA come in contact with the soil. The nodes were then covered with the soil and leaves were left upright to trap sunlight in order to produce more assimilates that will be translocated to the rooting zone. The cuttings were watered sparingly and the baskets were arranged in a complete randomized design with four replications in the glasshouse. A transparent polythene sheet was then used to construct humidity chamber over the baskets in order to maintain a higher relative humidity with the chamber while cheesecloth was used to construct a shade above this chamber in order to reduce the incidence of the sunlight. Thirty days after treatment (DAT), the chamber was left opened and the cuttings were exposed to the ambient temperature. Three weeks after, rooted cuttings were transplanted on well mulched and watered nursery beds (28 m x 5 m) at the distance of 50 cm x 30 cm. Cheesecloth was then constructed above the beds in order to reduce the sun intensity and the impact of rainfall. The vine cuttings were sampled for rooting percentage, number of roots, root length and mini tuber initiation 21 days after transplanting, and for number and weight (g) of mini tubers three months after transplanting respectively.

Fungicide (Benlate) was applied 15 DAP at concentration of 2.5g l^{-1}. All affected leaves were removed to avoid contamination of the healthy ones. The application of Benlate fungicide continued once a week until a week to harvest. Data collection of mini tubers was taken three month after transplanting.

Statistical Analysis: The data were analyzed using analysis of variance (ANOVA) for individual experiments using the windows version of Statistical Analysis System (SAS). The means were separated with t-test for significant variables.

RESULTS

It was observed that not all the setts (150 – 200 g) sprouted among the six genotypes planted on the field (Table 1). There were a significant different among genotypes with the sprouting percentages between 56.9% for TDr 335 which was the lowest and 96.3 % for TDr 97/00925 with the highest. The average percentage of the six genotypes was 72.4% with an error of 5.84. The sprouting percentage of TDr 131 was similar to that of TDr 335. Also the sprouting for TDr 97/00940 was at par with TDr 98/01230.

Table 1. The sprouting percentages of yam setts of the six genotypes tested.

Genotypes	Number of planted Setts	Number of Harvested Setts	Sprouting (%)
TDr 131	58	34a	58.6d
TDr 335	72	41c	56.9d
TDr 97/00925	80	77a	96.3a
TDr 97/00940	80	60b	75.0b
TDr 98/01230	77	58b	75.3b
TDr 98/00718	80	58b	72.5bc
Mean ± SD	74.5 ± 3.6		

The mean followed by the same letter in a column are not statistically different at P = 0.05

The planted setts were observed for the vegetative growth. All the genotypes under study produced shoots with appreciable number of branches (Table 2). The number of primary branches varied from 9.8, which was the lowest, to 18.2 being the highest for TDr 131 and TDr 98/00718 respectively, and with a mean of 13.2 and error of 1.36 (Table 2). For the secondary branches, it varied from 7.6 for TDr 98/00718 to 21.4 for TDr 97/00940 with the mean of 14.5 and error of 1.92. The highest branches were recorded.

Table 2: Average number of branches per plant of the six yam genotypes

Genotypes	1^0 Branches	2^0 Branches
TDr 131	14.5ab	12.2c
TDr 335	9.8c	13.0c
TDr 97/00925	10.6c	18.0ab
TDr 97/00940	9.0c	21.4a
TDr 98/01230	17.2a	17.2ab
TDr 98/00718	18.2a	7.6d

The means followed by the same letters in a column are not statistically different at P = 0.05

The planted seed setts (100-150 g) of all six genotypes were harvested and weighed individually 8 months after planting. There were significant differences in weights among the six genotypes. The individual weight ranged from 29.43 kg for TDr 98/00718 to 140.25 kg for TDr 97/00940 (Table 3). The tubers moisture content ranged from 56.3 % for TDr 97/00940 to 69.7% for TDr 335 (Table 3).

Root formation was observed on some cuttings of all 6 genotypes used in this study. The percentage root formation ranged from 10% to 55% for TDr 97/00940 and TDr 98/01230 (Table 4). There were no significant differences ($P \leq 0.05$) among the genotypes for both mean root per vine and the mean root length of the cuttings. However, the highest response of mean root was 5.92 for TDr 98/01230 and the least response of 1.94 for TDr 98/00940 (Table 4). Mini tubers were evidently produced from the cuttings of some tested clones of *D. rotundata* (Table 4). There was a significant difference in the total mini tubers number which ranged from 8.3 to 82.95 for TDr *97/0*0925 and TDr 335 respectively. The results show that each genotype produced at least one mini tube per vine. TDr 131 produced the least average number (1.19) of mini tubers per vine followed by TDr 97/00925 with an average of 1.33 per vine. TDr 97/00940 and TDr 335 produced the highest number of mini tubers per vine with an average of 3.25 per vine.

Table 3: The tubers yields (kg) obtained from the six genotypes

Genotypes	Tuber weight (kg)	Moisture content (%)
TDr 131	113.95b	63.6c
TDr 335	102.95c	69.7a
TDr 97/00925	72.75d	67.3ab
TDr 97/00940	140.25a	63.0c
TDr 98/01230	31.70e	63.0c
TDr 98/00718	29.43e	56.3d

The means followed by the same letters in a column are not statistically different at P = 0.05

The weight of mini tubers for each genotype ranged from 1.9 g to 6.9 g for TDr 131 and TDr 335 respectively (Table 4). These results show that there were differences among the genotypes and the weight varied from one genotype to another. The data show that the 6 genotypes of *D. rotundata* differ in their ability to root when propagated from vine cuttings. The moisture content ranged from 68.1% for TDr 98/01230 to 77.1% TDr 98/00718 (Table 4).

Table 4: Results of mini tubers production and weights (g) per plant of tested genotypes of *D. rotundata*

Genotypes	Number Rooted (n=20) (%)	Mean number of roots/vines	Root length/vine (Mean±SE)	Total Number of Tubers	Number of tubers/vine (Mean±SE)	Weight/ tuber (g)	Moisture content (%) (Mean±SE)
TDr 97/00925	50	5.91a	6.2 ± 1.2	8.36e	1.33 ± 0.16	2.5c	76.4 ± 0.9
TDr 131	40	4.73a	3.2 ± 0.6	23.77c	1.19±0.78	1.9c	76.2±1.1
TDr 98/00718	30	3.59a	4.9 ± 0.6	39.45b	2.45±1.52	5.6ab	77.1±1.1
TDr 97/00940	10	1.94a	3.4 ± 0.7	17.89d	3.25±1.35	5.4b	69.9±1.9
TDr 335	40	4.73a	5.8 ± 0.7	82.95a	3.25 ±1.6	6.9a	68.2±1.6
TDr 98/01230	55	5.92a	4.7 ± 0.6	27.37bc	2.08 ±1.71	4.5b	68.1±1.8

The means followed by the same letters in a column are not statistically different at P = 0.05

DISCUSSION

Vine cuttings technology is a rapid emerging technique used in the yam production and it has recently received great attention for its importance in yam breeding. The technique can be established very quickly and an effective means of not only rapid multiplication of limited quantity of planting materials but also producing disease and nematode free planting materials. Also the propagation of food yams using stem cuttings represents a departure from the conventional method of propagation using tuber pieces.

It was observed in this study that setts of 6 genotypes of *D. rotundata* weighing 100-150g gave the sprouting percentage ranged from 56.9% to 96.3%. Healthy vine cuttings of intermediate age prepared from branches of two-three months old plants of 7 clones of *D. rotundata* rooted 50% to 77.1% under intermittent mist in a rooting medium of equal quantities of carbonised rice husk [18 20]. In this study, 10% to 55% rooting was observed on the 6 clones of *D. rotundata* evaluated. This low performance was due to the old age of the vine cuttings. This is also attributed to reduction in the activity of the meristem due to age of cuttings. As old aged plant already changed growth phase from vegetative phase to reproductive phase, the growth of new shoots and leaves are hampered while the growth of tuber enlargement and flowering is accelerated. This could be the reason why rooted cuttings became senescence early.

The cultivars with higher vegetative growth (TDr 98/00718 and TDr 98/01230) produced the least tuber weights while those with low vegetative growth (TDr 131, TDr 335 and TDr 97/00940) produced the highest tuber weights. This corroborates to the findings of our previous study [19]. This suggests that those with low tuber weights converted most of their photo-assimilates for vegetative growth, while those with low vegetative growth diverted more photo-assimilates to the storage tissue (i.e. tubers). These attributes help cultivars with high vegetative growth rates to possess higher survival rates than those with low vegetative growth rates as indicated in our results.

Shiwachi [12] observed the formation of mini tubers when studying the effect of auxins on root development in *D. rotundata* vine, but whose size and quantity were not specified. Kabeya [18] also reported in the previous study the production of mini tubers, which ranged from 1.2 g to 4.2 g in weights and which was similar to the report in 2007

by [19]. In this study, the average mini tubers production was between 1.9 g to 6.9 g in weight. The mini tubers production in this study gave a better yield than the previous studies probably due to highly modified techniques. For the best results, cuttings must be taken early and the source of cuttings must be considered

The small tuber sett weights produced from this technology can provide suitable materials for research in physiology, botany or entomology where the emphasis is not on commercial tuber yield evaluations per se. The small size (compact shape), wholeness and reduced weight of tubercles make them easier to pack and transport, being less prone to injury than tubers, and are therefore suitable specimens for easy transfer of genetic material in tuber form.

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