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VINE CUTTING PROPAGATION IN FOUR VARIETIES OF YAM (DIOSCOREA SPECIES) USING DIFFERENT PLANTING MEDIA

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ABSTRACT

This study was conducted over a two-year period (two seasons) to assess the potentials of mini tuber production, through vine cutting propagation on four local varieties of yam (Agbagba, Danisa, Shangari and *Alata*). Three propagation media used were sandy loamy soil, sandy loamy soil with carbonized rice husk (1:7) and sandy loamy soil with carbonized sawdust (1:7). The set up was a 4 by 3 factorial experiment laid out in a Completely Randomized Design (CRD) with three replicates consisting of 288 excised vines with 24 vines per variety per treatment per replicate. The data obtained (percentage survival of vines, number of rooted vines, vines with shoots, numbers of roots/vine, vines with tubers, and number of tubers/vine and fresh weight of tuber/vine) were subjected to statistical analysis and their means compared. Analysis of variance (ANOVA) revealed high significant differences ($P \leqslant 0.01$) in percentage survival, number of rooted vines, number of roots/vine, vines with shoots, vines with tubers, number of tubers and fresh weight of tubers among treatments, varieties, and treatment by varieties in the two seasons of the study. Percentage survival of vines and number of vines with tubers/pot were generally higher in all *Dioscorea rotundata* (agbagba, danisa and shangari) than in *Dioscorea alata* in both seasons while rooting of vines and fresh weight of tubers/vine were better in *Dioscorea alata*. Also, sandy loamy soil proved to be the best medium of propagation followed by sandy loamy soil with carbonized rice husk while sandy loamy soil with carbonized saw dust was the least.

Keywords: Yams, Vine cuttings, Media, Rooting, Tubers

INTRODUCTION

Yams (*Dioscorea* spp), are one of the most important staple crops in West Africa (Onwueme, 2005). They belong to the family *Dioscoreaceae*, which produce economically important tubers and bulbils (Degras, 1993). They are vegetatively propagated by small whole tubers or pieces (>200 g) of tubers (Okoli and Akoroda, 1995). Yam (*Dioscorea* spp.) originated from Africa and Asia and later spread to other parts of the world (Hahn *et al*., 1987). There are many cultivars of yam, though only six are important as staple foods in the tropics, the economically important species grown are *Dioscorea rotundata* (white yam), *Dioscorea alata* (water yam), *Dioscorea bulbifera* (aerial yam), *Dioscorea esculenta* (Chinese yam) and *Dioscorea dumetorum* (trifoliate yam) (FAO, 2010). Yam is very important in West Africa where approximately 60 million people individually obtain huge calories of energy of about 800 KJ per day (Nweke *et al*., 1991); and especially in Nigeria where it is massively grown and serves as an indigenous source of food among the people (Orkwor and Ekanayake, 1998). Most of the world's annual production of the crop, running into over 27 million tons comes from Nigeria (FAO, 2005); hence, sustainable production and utilization of the crop are important steps in enhancing food security and alleviating poverty particularly in West Africa (Nweke *et al.,* 1991; FAO, 2003).

The tuber (edible part of yam) serves as the conventional propagules of the crop (Kabeya, 2006). Thus, about 30% of the previous harvest is normally utilized to raise a new crop during a new planting season. In this regard, some marketable tubers must be reserved for planting making the cost of planting material to be more than 33% of the total outlay for yam production, hence, the need to improve the rate of yam multiplication (Okoli and Akoroda, 1995). Yam propagation also face difficulties that arise from poor sprouting and sensitivity to moisture stress in the soil despite the advancements in the yam mini sett technology, a condition that has placed the crop under threat in many traditional areas of production (Dumont and Tokpa, 1990; IITA, 1994).

For the distribution of high quality and improved varieties of yam, techniques of rapid multiplication and devoid of contaminants are desirable. Propagation using vine cuttings is one of such techniques with the following proven merits. First, it excludes transfer of nematodes to seed tubers. Second, it reduces usage of tubers for seed production and third, it produces whole mini tubers which promise high sprouting rate and uniformity compared with mini-setts. Media like carbonized rice husk have produced mini tubers of *Dioscorea alata* of up to 3 g in weight by vine cuttings with about 63% of mini tubers sprouting after 77 to 105 days of storage (Shiwachi *et al*., 2005) and Kikuno *et al.* (2006) have achieved greater success in seed tuber production through vine cuttings.

Root development by vine cuttings of yam has been successful but growth and tuber production were limited (Akoroda and Okonmah, 1982). Stimulation of development of small tubers and significant enhancements of number of roots has been achieved via the treatment of vines of *Dioscorea rotundata* in indole butyric acid (IBA) (Acha *et al*., 2004). This approach is very expensive due to the high cost and scarcity of hormones to farmers. Hence, methods for successful rooting of yam vines without the use of synthesized auxins are required to enhance adoption of vine cutting techniques by farmers in the developing countries. Matsunmoto *et al*. (2013) reported that in vine cuttings of *Dioscorea alata*, rooting rate decreased by the increase in age of mother plant. Up to 3 months old plants showed more than approximately 80% of rooting rate of vine cuttings while 4 and 5 months aged plants showed less than 80% of rooting rate. There is possibility of vine cutting techniques in yam using natural materials which can be adopted by farmers (Kikuno *et al.* 2006b, 2007). About 5% of rice straw ash enhanced rooting rate, number of roots and tuber formation from vine cuttings of yam (Kikuno *et al*., 2006).

The objective of this research was to evaluate the potential of mini tuber production, through vine cutting propagation techniques on three local varieties of white yam (*Dioscorea rotundata* Poir.) and one variety of water yam in various propagation media.

MATERIALS AND METHODS

Tuber Collection

The research was conducted at the Experimental field of the Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria between February and November, 2015 (season 1) and 2016 (season 2). Four local varieties of yam (agbagba, shangari, danisa and alata) were received from local farmers at Akungba-Akoko, Ondo State. A total of ninety six (96) mini setts were prepared; with 24 setts from each variety. Setts were air dried for 24 hrs before being transferred to the field for planting.

Planting of Setts

The mini setts were planted in the field using a spacing of 100 cm within row and 100 cm between rows per variety per replication in three replicates. Each variety consisted of 8 setts per replicate and 24 for the three replicates in a Randomized Complete Block Design (RCBD). A month after planting the yam setts, each plant was staked.

Vine propagation

At four months after planting (MAP), single nodal vines with two leaves each were excised from the mother plants and planted in media [sandy loamy soil, mixture of sandy loamy soil with carbonized rice husk (1:7) and mixture of sandy loamy soil with carbonized saw dust (1:7)], serving as different treatments (T_1, T_2 and T_3) respectively. A total of 288 vines were excised; with 24 vines per variety per treatment per replicate and propagated in a Completely Randomized Design (CRD), replicated three times. The vines were excised early in the morning between 6am and 9am using a new scissors. The cuttings were planted by burying the vines in the media with the leaves of the cuttings exposed above the media. The surface of each leaf was wiped clean to prevent decaying of the leaf.

Data Collection on Vines

Data were collected on percentage survival of vines at 4 and 18 weeks after propagation, number of rooted vines, numbers of roots per vine, vines with tubers, and number of tubers per vine and fresh weight of tubers per vine.

Statistical Analysis

The data obtained were subjected to Analysis of Variance (ANOVA) and Least Significant Difference (LSD), $P \leq 0.01$ level of significance was used to compare the differences in means between the treatments and varieties.

RESULTS

In seasons 1 and 2, results obtained from analysis of variance revealed high significant differences ($P \leq 0.01$) among treatments for all traits studied. Effect of variety was highly significant ($P \leq 0.01$) for all traits of the vine cuttings, while treatment by variety effect was also highly significant for all traits (Table 1a and b).

Table 1a: Mean Square Values of All Parameters of Vine Cuttings during the Season 1 of Propagation

Source of Variation	NRV (4WAP)	NR (4WAP)	PS (18WAP)	VWS	VWT	NT	FWT
TRT	3.03**	3.62**	156.25**	0.00ns	0.69**	0.59**	7.71**
VRT	3.07**	19.92**	1613.14**	2.25**	8.99**	2.03**	23.19**
TRT x VRT	2.00**	3.10**	185.19**	0.00ns	0.66**	1.14**	6.77**
ERROR	0.42	1.04	9.03	3.62	0.25	0.19	0.28

** Significant at $P \leq 0.01$; ns: Not significant. NRV: Number of rooted vines; NR: Number of roots per vine; PS: Percentage survival of vines; VWS: Vines with shoots; VWT: Vines with tubers; NT: Number of tubers per vine; FWT: Fresh weight of tubers; WAP: Weeks after planting.

Table 1b: Mean Square Values of All Parameters of Vine Cuttings during the Season 2 of Propagation

Source of Variation	NRV (4WAP)	NR (4WAP)	PS (18WAP)	VWS	VWT	NT	FWT
TRT	1.08**	36.00**	421.00**	0.36**	1.36**	4.00**	32.22**
VRT	1.51**	38.00**	286.35**	0.78**	1.21**	1.66**	71.73**
TRT x VRT	0.79**	13.78**	33.28**	0.25**	0.21ns	1.07**	29.84**
ERROR	0.22	1.06	8.17	0.25	0.39	0.39	0.83

**Significant at $P \leq 0.01$; ns: Not significant. NRV: Number of rooted vines; NR: Number of roots per vine; PS: Percentage survival of vines; VWS: Vines with shoots; VWT: Vines with tubers; NT: Number of tubers per vine; FWT: Fresh weight of tubers; WAP: Weeks after planting.

In season 1, number of rooted vine at 4 weeks after vine propagation was highest (4.33) in T_2 (sandy loamy soil with carbonized rice husk) for V_1 (*alata*), highest (2.33) in T_2 (sandy loamy soil with carbonized rice husk) and T_3 (sandy loamy soil with carbonized saw dust) for V_2 (shangari), highest (2.67) in T_1 (sandy loamy soil) for V_3 (danisa) and highest (2.67) in T_2 (sandy loamy soil with carbonized rice husk) for V_4 (agbagba); while the lowest values were found in T_3 (sandy loamy soil with carbonized saw dust) for V_1 (alata) and V_3 (danisa) (1.67 and 1.00), in T_1 (sandy loamy soil) for V_2 (shangari) and V_4 (agbagba) (2.00 and 1.33) (Table 2a). In season 2, vines behave almost exactly as season 1 with exception in V_4 (agbagba) which had the highest number of rooted vines in T_1 (sandy loamy soil). The highest values in season 2 were 2.33 in T_2 for alata, 2.67 in T_2 for shangari and 1.33 in T_1 for danisa; while the lowest values (1.00, 1.33, 1.00 and 1.33 respectively) were obtained in T_1 (sandy loamy soil) for V_1 (alata), T_3 (sandy loamy soil with carbonized saw dust) for V_2 (shangari), T_2 (sandy loamy soil with carbonized rice husk) and T_3 (sandy loamy soil with carbonized saw dust) for V_3 (danisa) and V_4 (agbagba) in season 2.

Table 2a: Number of Rooted Vines at 4 Weeks after Propagation in Season 1 (Means ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	3.33 ± 0.17^b	2.00 ± 0.29^a	2.67 ± 0.17^c	1.33 ± 0.17^a
T_2	4.33 ± 0.17^c	2.33 ± 0.17^a	1.67 ± 0.17^b	2.67 ± 0.17^c
T_3	1.67 ± 0.17^a	2.33 ± 0.17^a	1.00 ± 0.00^a	2.00 ± 0.29^b
LSD	0.52	0.52	0.52	0.52

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

Table 2b: Number of Rooted Vines at 4 Weeks after Propagation in Season 2 (Means ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	1.00 ± 0.00^a	2.33 ± 0.16^b	1.33 ± 0.16^a	2.00 ± 0.00^b
T_2	2.33 ± 0.16^b	2.67 ± 0.16^b	1.00 ± 0.00^a	1.33 ± 0.16^a
T_3	1.33 ± 0.16^a	1.33 ± 0.16^a	1.00 ± 0.00^a	1.33 ± 0.16^a
LSD	0.53	0.53	0.53	0.53

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

In season 1, T_2 (sandy loamy soil with carbonized rice husk) produced the highest number of roots (3.88 and 2.77) per vine at 4 weeks after propagation in shangari and danisa, T_1 (sandy loamy soil) had the highest number of roots (6.50) in alata while the highest in agbagba (3.33) was recorded in T_3 (sandy loamy soil with carbonized saw dust). The lowest number of roots (4.17, 1.42 and 1.00 respectively) was recorded in T_3 for alata, shangari and danisa, while T_1 (sandy loamy soil) had the lowest number of roots (1.82) in agbagba. Overall, T_3 produced the lowest number of roots in most of the varieties (Table 3a) in season 1. In season 2, the highest number of roots (10.67, 6.33, 2.33 and 6.00 respectively) was obtained in T_2 for alata, and in T_1 for shangari, danisa and agbagba. The least number of roots (3.33, 1.33 and 2.33, 1.00 respectively) was obtained in T_3 for alata, shangari and agbagba, in T_2 and T_3 for danisa in season 2 (Table 3b).

Table 3a: Number of Roots per Vine at 4 Weeks after Propagation in Season 1 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	6.50 ± 0.50^b	2.33 ± 0.08^b	1.78 ± 0.21^a	1.82 ± 0.25^a
T_2	5.01 ± 0.43^{ab}	3.88 ± 0.21^c	2.77 ± 0.31^b	2.63 ± 0.19^{ab}
T_3	4.17 ± 0.30^a	1.42 ± 0.15^a	1.00 ± 0.00^a	3.33 ± 0.44^b
LSD	0.85	0.85	0.85	0.85

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

Table 3b: Number of Roots per Vine 4 Weeks after Propagation in Season 2 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	5.33±0.16^b	6.33±0.60^b	2.33±0.16^b	6.00±0.50^b
T_2	10.67±0.34^c	5.33±0.34^b	1.00±0.00^a	3.00±0.29^a
T_3	3.33±0.16^a	1.33±0.16^a	1.00±0.00^a	2.33±0.16^a
LSD	1.17	1.17	1.17	1.17

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

In season 1, by 18th week of vine propagation, survival of vines was highest (16.67%, 29.17% and 50.00% respectively) in T_1 for alata, danisa and agbagba, in T_3 (29.17%) for shangari. T_1 (sandy loamy soil) had the highest percentage survival of vines for most of the varieties propagated at 18 weeks of vine propagation. T_2 had the lowest percentage survival (4.17%, 20.83% and 33.33% respectively for alata, danisa and agbagba while the lowest for shangari (8.53%) was obtained in T_1 (Table 4a). In season 2, survival percentage of vines was highest (16.67%, 25.00% and 29.17% respectively) in T_1 (sandy loamy soil) for alata, shangari and agbagba, and in T_3 for danisa (25.00%). The lowest survival percentage (4.17%, 12.50%, 8.33% and 20.83% respectively) was obtained in T_2 (sandy loamy soil with carbonized rice husk) for alata, shangari, danisa and agbagba (Table 4b). Overall, in both seasons, T_1 had the highest survival percentage while T_2 had the lowest survival percentage (Table 4a and b).

Table 4a: Percentage Survival of Vines at 18 Weeks after Propagation in Season 1 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	16.67±0.58^c	8.33±0.08^a	29.17±1.50^c	50.00±0.25^c
T_2	4.17±0.08^a	20.83±0.42^b	20.83±1.16^a	33.33±1.10^a
T_3	8.33±0.44^b	29.17±0.36^c	25.00±0.72^b	41.67±1.67^b
LSD	2.43	2.43	2.43	2.43

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

Table 4b: Percentage Survival of Vines at 18 Weeks after Propagation in Season 2 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	16.67±1.05^c	25.00±0.72^c	20.83±0.42^b	29.17±0.55^c
T_2	4.17±0.30^a	12.50±0.72^a	8.33±0.44^a	20.83±1.50^a
T_3	12.50±0.80^b	16.67±0.83^b	25.00±0.72^c	25.00±0.00^b
LSD	3.26	3.26	3.26	3.26

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

In season 1, highest number of vines with tubers (1.33 and 4.00) was obtained in T_1 for alata and agbagba; in T_2 (1.67) for shangari and in T_3 (2.00) for danisa. The lowest values were found in T_1 for shangari (1.00), in T_2 and T_3 for alata (1.00), in T_2 for danisa (1.00) and agbagba (2.67) (Table 5a). In season 2, number of vines with tuber was highest (1.33, 2.00 and 2.33 respectively) in T_1 (sandy loamy soil) for alata, shangari and agbagba, and in T_3 (sandy loamy soil with carbonized saw dust) for danisa (2.00). The lowest values (1.00, 1.00, 1.00 and 1.67 respectively) were obtained in T_2 (soil with carbonized rice husk) for all varieties and in T_3 (sandy loamy soil with carbonized saw dust) for alata (Table 5b). Overall, the highest values for number of vines with tubers were obtained in sandy loamy soil, while the lowest values for most varieties were obtained in sandy loamy soil with carbonized rice husk.

Table 5a: Number of Vines with Tubers per Pot in Season 1 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	1.33 ± 0.17^a	1.00 ± 0.00^a	1.67 ± 0.17^b	4.00 ± 0.28^c
T_2	1.00 ± 0.00^a	1.67 ± 0.17^b	1.00 ± 0.00^a	2.67 ± 0.17^a
T_3	1.00 ± 0.00^a	1.67 ± 0.17^b	2.00 ± 0.00^b	3.33 ± 0.17^b
LSD	0.40	0.40	0.40	0.40

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

Table 5b: Number of Vine with Tubers per Pot in Season 2 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	1.33 ± 0.17^a	2.00 ± 0.29^b	1.67 ± 0.17^{ab}	2.33 ± 0.17^a
T_2	1.00 ± 0.00^a	1.00 ± 0.00^a	1.00 ± 0.00^a	1.67 ± 0.17^a
T_3	1.00 ± 0.00^a	1.33 ± 0.17^{ab}	2.00 ± 0.29^b	2.00 ± 0.29^a
LSD	0.71	0.71	0.71	0.71

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy oil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

Number of tubers per vine in season 1 was highest (1.33) in T_1 (sandy loamy soil) for alata and shangari, in T_3 (sandy loamy soil with carbonized saw dust) for danisa (1.67) and in T_2 (sandy loamy soil with carbonized rice husk) for agbagba (3.33). The lowest values (1.00) for number of tubers were recorded in T_2 and T_3 for alata and shangari, in T_1 for danisa (1.00) and in T_1 for agbagba (1.67) (Table 6a). In season 2, number of tubers was highest (1.33, 3.33 and 2.67 respectively) in T_3 for alata, shangari and danisa, while the lowest values (1.00) were obtained in T_1 for alata and danisa, in T_2 for shangari. There were no differences among the treatments for agbagba (Table 6b).

The lowest fresh weight (1.80 g) of tuber in season 1 was observed in T_3 for alata, in T_2 for shangari (0.47 g) and danisa (0.73 g), in T_1 for danisa (0.73 g) and agbagba (0.77 g), while the highest tuber weight was recorded in T_1 for alata (7.50 g) and shangari (1.93 g), in T_2 for agbagba (1.17 g) and in T_3 for danisa (0.90 g) (Table 7a). In season 2, the lowest values for fresh weight of tubers (2.60 g) was also observed in T_3 for alata, in T_2 for shangari and agbagba (1.70 g and 0.63 g respectfully) and in T_1 for danisa (1.10 g). The highest values for fresh weight of tubers (14.37 g and 3.00 g) were obtained in T_1 for alata and shangari; and in T_3 for danisa and agbagba (Table 7b).

Table 6a: Number of Tubers per Vine in Season1 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	1.33 ± 0.17^a	1.33 ± 0.17^a	1.00 ± 0.00^a	1.67 ± 0.17^a
T_2	1.00 ± 0.00^a	1.00 ± 0.00^a	1.33 ± 0.17^a	3.33 ± 0.17^b
T_3	1.00 ± 0.00^a	1.00 ± 0.00^a	1.67 ± 0.17^b	1.33 ± 0.17^a
LSD	0.36	0.36	0.36	0.36

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

Table 6b: Number of Tubers per Vine in Season 2 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	1.00 ± 0.00^a	1.33 ± 0.17^a	1.00 ± 0.00^a	1.00 ± 0.00^a
T_2	1.00 ± 0.00^a	1.00 ± 0.00^a	1.33 ± 0.17^a	1.00 ± 0.00^a
T_3	1.33 ± 0.17^a	3.33 ± 0.33^b	2.67 ± 0.44^b	1.00 ± 0.00^a
LSD	0.71	0.71	0.71	0.71

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

Table 7a: Fresh Weight (g) of Tubers in Season 1 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	7.50 ± 0.12^c	1.93 ± 0.14^c	0.73 ± 0.07^a	0.77 ± 0.06^a
T_2	3.30 ± 0.10^b	0.47 ± 0.04^a	0.73 ± 0.09^a	1.17 ± 0.08^a
T_3	1.80 ± 0.40^a	1.43 ± 0.14^b	0.90 ± 0.05^a	1.00 ± 0.14^a
LSD	0.42	0.42	0.42	0.42

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

Table 7b: Fresh Weight (g) per Tuber per Vine in Season 2 (Mean ± Standard Error)

TRT	V_1	V_2	V_3	V_4
T_1	14.37 ± 0.67^c	3.00 ± 0.23^b	1.10 ± 0.05^a	1.27 ± 0.09^a
T_2	4.53 ± 0.18^b	1.70 ± 0.28^a	1.37 ± 0.18^a	0.63 ± 0.14^a
T_3	2.60 ± 0.15^a	2.97 ± 0.22^{ab}	1.60 ± 0.28^a	1.37 ± 0.14^a
LSD	1.04	1.04	1.04	1.04

Mean values followed by same letters within a column are not significantly different from one another at $P \leqslant 0.01$ level of significance. LSD = Least significant difference. T_1: Sandy loamy soil; T_2: Sandy loamy soil with carbonized rice husk; T_3: Sandy loamy soil with carbonized saw dust; V_1: Alata; V_2: Shangari; V_3: Danisa; V_4: Agbagba.

DISCUSSION

There is need for commercial planting of vines to generate quick mini setts that are both nematode and disease free as observed by Behera *et al.* (2009). In this study, different methods were employed to ascertain the best media that can root vines and generate tubers that can be used for propagation by farmers without additional rooting hormones. These methods included propagating local varieties in sandy loamy soil, sandy loamy soil with carbonized rice husk (1:7) and sandy loamy soil with carbonized sawdust (1:7) with the hope of identifying the best media for propagation and also the best variety that responds to propagation.

From the analysis of variance in both seasons, it can be explained that there was the existence of sufficient genetic variability among the local varieties of all yams tested for all characters, and also that the response to different treatments among these varieties were totally different, even for the interactions between treatments and varieties.

After one month of propagation, between 20 to 41.67 percent of *D. alata*, 41.67 to 100 percent of *D. rotundata* (shangari, danisa and agbagba) survived (season 1) and about 29.16 to 33.33 percent of *D. alata*, 33.33 to 83.33 percent of *D. rotundata* (shangari, danisa and agbagba) survived (season 2); also, at 5 months of propagation, between 4.17 to 16.67 percent of *D. alata* and 8.33 to 50 percent of *D. rotundata* (season 1), between 4.17 to 16.67 percent of *D. alata* and 8.33 to 29.17 of *D. rotundata* (season 2) survived across the media of propagation. This is similar to the findings of Igwilo (2003) on *D. alata* and *D. rotundata* and Behera *et al.* (2009) on *Dioscorea alata*, and also the findings of Dibi *et al.* (2014) on *Dioscorea rotundata* utilizing the effect of different modes of planting on vine propagation in yam. Even though the survival rate of vines in the present study was far beyond the number of days recorded by the previous researchers, the results are still comparable. Based on survival of vines, it can be concluded that the *Dioscorea rotundata* can respond better than *Dioscorea alata* to vine cutting propagation as all *rotundata* involved had higher survival rates than *alata* even up to 18 weeks of propagation. This is in contradiction to the findings of Dibi *et al*. (2014) who maintained that *Dioscorea alata* responded better to vine propagation than *rotundata*. Sandy loamy soil proved to be the best for *Dioscorea alata* and *Dioscorea rotundata* (danisa and agbagba) followed by sandy loamy soil with carbonized saw dust for all varieties based on survival rate at 18 weeks of vine propagation.

Number of rooted vines per pot and number of roots per vine were highest in *Dioscorea alata* compared to what was obtainable in the other three varieties of *Dioscorea rotundata* in season 1, similar trend was also observed in season 2. For *D. alata*, soil, and mixture of sandy loamy soil with carbonized rice husk produced the highest number of rooted vines per pot and the highest number of roots per vine at 4 weeks of vine propagation (seasons 1 and 2). Sandy loamy soil with carbonized rice husk also produced the highest number of roots per vine in all the *D. rotundata* vines propagated in both seasons. Carbonized rice husk has been reported to be an effective medium of rooting vines for propagation (Agele *et al*., 2010; Dibi *et al*., 2014; Aighewi *et al*., 2015). Agele *et al*. (2010) observed that vines treated with root promoting substances did not produce significantly different amount of roots than the control planted on carbonized rice husk.

Sandy loamy soil produced the highest number of tubers per vine and the highest tuber fresh weight per vine in *Dioscorea alata* and shangari (*D. rotundata*) in season 1. But in season 2, sandy loamy soil with carbonized saw dust produced the highest number of tubers in *D. alata*, shangari and danisa (*D. rotundata*). Sandy loamy soil also produced the highest tuber weight in *D alata* and agbagba (*D. rotundata*). Sandy loamy soil with carbonized rice husk produced the best tuber weight per vine in agbagba (*D. rotundata*) while sandy loamy soil with carbonized saw dust produced the best tuber weight in danisa (*D. rotundata*) in season 1. Overall, sandy loamy soil happened to be the best media of propagation based on the values of tuber weight produced. Similar range of number of tubers per vine and tuber weight have been reported by many researchers working on vine cuttings in different yam species employing different methods of generating tubers from vines (Shiwachi *et al*., 2005; Kikuno, 2006; Behera *et al*., 2009; Ayankanmi and Agele 2010; Kabeya *et al*., 2013 and Dibi *et al*., 2014).

From this work, even though survival of vines was generally higher in all *Dioscorea rotundata* than in *Dioscorea alata* in both seasons, rooting of vines and fresh weight of tubers per vine were better in *Dioscorea alata* than all *Dioscorea rotundata*. Also sandy loamy soil proved to be the best media of propagation followed by sandy loamy soil with carbonized rice husk. Sandy loamy soil with carbonized saw dust and sandy loamy soil with carbonized rice husk also produced good results among *Dioscorea rotundata*.

In conclusion, natural products like carbonized rice husk and carbonized saw dust can be used in addition to soil to enhance rooting especially in *Dioscorea rotundata* rather than depending on expensive hormones for vine cutting propagation. These methods for successful rooting of yam vines without the use of synthesized hormones can be adopted by farmers in the developing countries for sustainable yam production.

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