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DOMESTICATION OF *Annona muricata* Lin (SOURSOP) BY MARCOTTING

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ABSTRACT

The study was conducted to determine the effects of rooting substrate, branch positions and branch diameter on the onset of rooting and the growth of root strands. Nine trees of Annona muricata were selected for this study. Four marcots were set on each tree to make a total of thirty-six marcots. On one tree using coconut peat, sawdust and mixture of coconut peat and sawdust as the rooting medium; two branches were selected at the upper position (>1.5m): one of the branches is 1 – 2.3cm and the other is 3 – 4.5cm. Two branches (1 – 2.3cm; 3 – 4.5cm) were also selected at the lower position (<1.5m), this was replicated three times and the same was done for the remaining two rooting substrate (mixture (coconut peat and sawdust 50:50) and sawdust). The result of the study revealed that, coconut peat had the lowest days for time taken to first root growth (63days), compared to sawdust and mixture. The study also established that big diameter branch 3-4.5cm was better than small diameter branch which had mean value of 7.17 for coconut peat, while 4.83 and 4.67 were recorded for sawdust and mixture respectively. Lower branch position tends to produce more root mass in coconut peat medium with mean value of 7.17 while sawdust and the mixture recorded 5.17 mean value respectively. The effect of rooting substrate on the number successful marcots indicated that, coconut peat and the mixture had the highest percentage (100%), while sawdust had the lowest (91.67). Effect of branch position on number of successful marcots also showed that marcots set on lower position had higher percentage (60%). Similarly, marcots set on big sized branch obtained higher percentage (57.14%). It was recommended that, artificial regeneration of Annona muricata should be encouraged and adopted by teaching farmers how to go about the marcotting techniques.

Keywords: Marcotting, Rooting, *Annona muricata*, Fruit trees

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INTRODUCTION

Asexual propagation, also known as regenerative or vegetative propagation describes the regeneration and multiplication of plant kinds from vegetative parts, including buds, leaves, single cells/tissues as well as cuttings of roots and stems Hartmann *et al*. (2007). It offers wide array of applications in Indigenous Fruit Tree (IFT) domestication efforts and general Plant Genetic Resources (PGR) conservation programs in many parts of the world including Nigeria. It is considered the most preferred method for establishing tropical fruit tree orchards and is typically used to multiply selected varieties and cultivars while ensuring that the genetic, physiological characteristics and fruit quality remain the same in the mother and daughter trees (Ken *et al.*, 2017). Vegetative propagation aims at mitigating challenges of poor seed germination and storage behavior, reduce gestation period of fruit bearing species, maintenance of superior genotypes, uniformity of orchards/plantations,

fixing desired attributes of two or more plant genotypes into one plant stand and controlling phases of tree development among others (Stanturf *et al*., 2014).

Marcotting, also known as air layering, is an age long established method of vegetative propagation (asexual propagation) which still finds relevance in present day domestication, PGR conservation and routine plant multiplication efforts (Ogbu, 2019). Unlike in stem cuttings, the induction of adventitious roots on a stem is made possible while the stem remains attached to the parent plant. The successful marcot stem is thereafter cut off to be an independent plant growing from its own roots. The need for a suitable/adaptable rootstock does not arise in marcotting, which gave it an edge over grafting. Since stem cuttings of full-grown tree experience hard to root tendency, marcotting therefore stands out as a preferred option for vegetative propagation plan in domestication of IFT. Moreover, marcots are known to come into fruiting earlier than slower-growing stem cuttings or grafted trees, but possess a shallow root system (Ogbu, 2019).

Despite a considerable increase in global food production over the last few decade, the world's efforts to meet Sustainable Development Goal (SDG) 2: Zero Hunger by 2030 (United Nations. 2015). According to Adeyeye *et al*., (2017), the number of people suffering from chronic hunger has increased from under 800 million in 1996 to over a billion in 2009 with most of the world's hungry people residing in South Asia and Sub-Sahara Africa. These regions have large populations, widespread poverty and extensive areas of low agricultural productivity due to steadily degrading natural resource bases, weak markets and high climatic ricks. Fruit trees are important sources of off-season foods for the vulnerable rural poor populations in the Sub-Sahara Africa. However, due to massive deforestations, these natural endowments are fast disappearing. Therefore, there is urgent need for sustainable conservation and domestication of *Annona muricata* tree species to promote food security.

Annona muricata Linn belongs to the family of Annonaceae. It is an evergreen, terrestrial and erect tree, reaching 5–8m in height and features an open, roundish canopy with large glossy dark green leaves (Patel and Patel, (2016). The fruit of *A. muricata* Linn is of great economic value, cultivated and used widely as edible food (Uchegbu *et al.*, 2017). *Annona muricata* are edible fruit trees that has gained enormous preference for consumption in different regions of Nigeria either as food or medicinal purposes (Brisibe *et al*., 2017). The fruit of *Annona muricata* consists of an edible, white pulp, some fibre, and a core of indigestible black seeds. The pulp is used to make fruit nectar, smoothies, fruit juice drinks, as well as candies, sorbets, and ice cream flavoring (Aswathy, 2016). Due to the fruit's widespread cultivation, its derivative products are consumed in many countries like Mexico, Brazil, Venezuela, Colombia, Nigeria and Fiji. Soursop is also a common ingredient for making fresh fruit juices that are sold by street food vendors (Blancke, (2016).

Although, there have been studies on marcotting techniques particularly on some fruit trees, but most of these studies were based on investigating amenability of a particular fruit trees to Marcotting (Okonkwo *et al*., 2020; Okonkwo *et al*., 2019) . However, the best rooting substrate for marcotting, suitable branch diameter and the best branch position on the tree in which marcots are to be set are limited. It is envisaged that these factors will imperatively affect the marcotting technique. Therefore, the present study focused on investigating the influence of rooting substrate; branch diameter and branch position of tree branches on the rooting initiation, growth of the root strands and the number of successful marcots of the species.

MATERIALS AND METHODS

Tree Selection for Marcotting

The selection of trees of the test specie for marcotting experiment was carried out in Akure and environs where the tree species were available, particularly on farm land. Nine parent trees of *Annona muricata* were selected due the limitation of healthy specie. The three-rooting substrate (coconut peat only, sawdust only, and mixture (i.e. coconut peat + sawdust (50/50%))

were soaked in water separately for water absorption and they were drained such that water could not drip between fingers. Two branches (1 – 2.3cm and 3 – 4.5cm) were selected on the upper position (>1.5m) and two on the lower position (<1.5m) of each parent tree. The selected branches were girdled at a point above the node, the girdled points were debarked while rooting hormone (2000 mg/k indole-3-butyric acid IBA) was robbed around the debarked area. Each of the three-rooting substrate (coconut peat, sawdust, and coconut peat plus sawdust) was also placed around the debarked part of the stem of the trees. These were replicated three times on different parent trees of *Annona muricata.* Four marcots were set on a tree: two at the upper position (>1.5m) and two on the lower position (<1.5m) i.e small and big diameter branches and two at the lower position also using a particular rooting substrate and replicated three times. The method was repeated for the other rooting substrate.

The design of experiment was a 3x2x2 factorial experiment in a randomized completely block design (RCBD) at three replicates per treatment. The treatment includes rooting substrate at three levels; position of marcots set at two levels and tree branch diameter at two levels, all at three replicates per treatment. The layout of the marcotting experiment involve selection of nine (9) trees and setting four (4) marcots per tree, given a total of thirty-six (36) marcots set in all.

Table 1: Layout design

Rooting Substrate	Branch Diameter		Position of Marcots	
Coconut peat	Big	Replicate 1	Upper	Replicate 1
		2		2
		3		3
	Small	Replicate 1	Lower	Replicate 1
		2		2
		3		3
Sawdust	Big	Replicate 1	Upper	Replicate 1
		2		2
		3		3
	Small	Replicate 1	Lower	Replicate 1
		2		2
		3		3
Mixture (Coconut peat + Sawdust)	Big	Replicate 1	Upper	Replicate 1
		2		2
		3		3
	Small	Replicate 1	Lower	Replicate 1
		2		2
		3		3

The set marcots were monitored daily for the onset of rooting, growth of the root strands and the number of successful marcots of *Annona muricata* and data collection (rooting initiation, growth of the root strands and the number of successful marcots of the species) started after the first root strand initiation. The treatment includes tree branch diameter at two levels; position of marcots set at two levels and rooting substrate at three levels, all at three (3) replicates per treatment, using SPSS version 26.0.

RESULTS

Effects of rooting substrate on the onset of rooting, growth of root strands and number of successful marcots

The effects of rooting substrate, morphological positions and branch diameter on the onset of rooting of *Annona muricata* was illustrated in Figure 1. The result indicates that the lowest days taken for first root growth was recorded in coconut peat (63days), this was followed by

mixture (77days) and sawdust recorded the highest number of days taken for the first root growth (91days). Additionally, also it was shown that marcot placed at upper branch (>1.5cm) and lower branch (<1.5) took 65 and 63 days to grow the first root strand respectively while marcot set at branch diameter of .3-4.5cm had the lowest time taken of 63days to grow the first root strand compared to the smallest size of 1-2.3cm which took 69 days to emerge the first root strand.

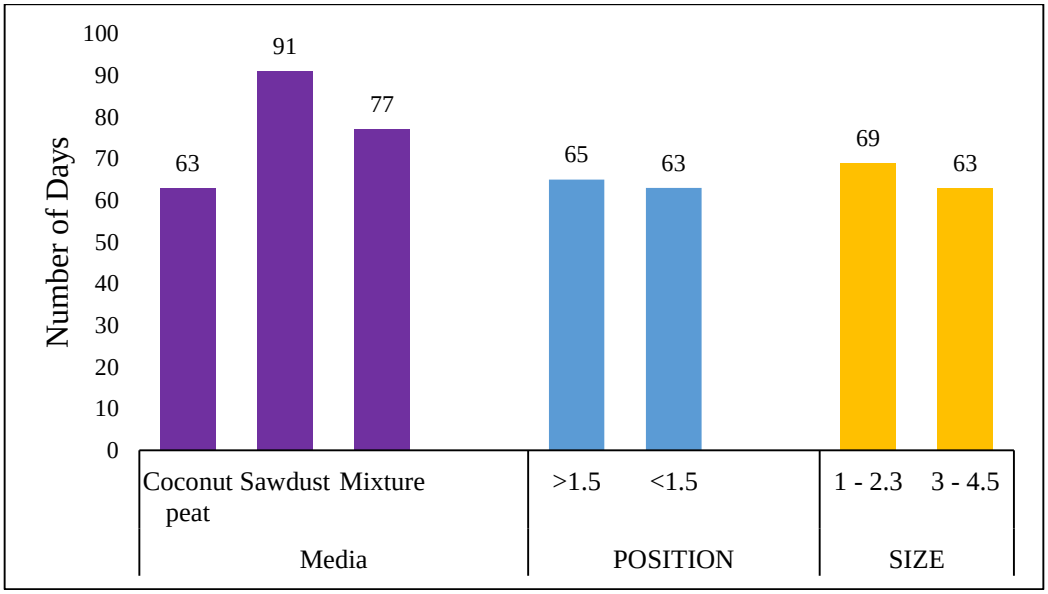

Figure 1. Effects of rooting substrate, branch positions and branch diameter on the onset of rooting of *A. muricata*

Effect of branch diameter and branch position on root mass using different Rooting substrate on *Annona muricata* trees

The effect of branch diameter and branch position on root mass using coconut peat as rooting substrate on *Annona muricata* tree was documented in Table 2. The table revealed that, at upper position, (>1.5) big sized branch had mean value of 6.67±1.15 while at lower position (>1.5), big diameter branch had 7.67±1.15 and at upper position (>1.5), small diameter branch had 5.33±0.57 while at lower position (>1.5), small sized branch had 6.67±0.57. Significant difference exists for different sizes (big and small) under upper and lower position ($p<0.05$) significant level.

The results in Table 3 shows the effect of branch diameter and branch position on root mass using sawdust as rooting substrate on *Annona muricata* tree. The table revealed that, at upper position, (>1.5) big diameter branch had mean value of 3.67±0.57 while at lower position (<1.5), big sized branch had 6.00±1.00 and at upper position (>1.5), small diameter branch had 3.00±1.00 while at lower position (<1.5), small sized branch had 4.33±1.52. Significant difference exists for big and small sizes under upper position at 0.05 significant level. However, no significant difference was found in the big and small size under lower position at 0.05 significant level.

The effect of branch diameter and branch position on root mass using sawdust as rooting substrate on *Annona muricata* tree was presented in Table 4. The table revealed that, at upper position, (>1.5) big sized branch had mean value of 3.67±0.57 while at lower position (<1.5), big sized branch had 3.00±1.00 and at upper position (>1.5), small sized branch had 5.67±0.57 while at lower position (<1.5), small sized branch had 4.67±2.08. Significant difference exists for big and small sizes under upper position at 0.05 significant level. However, no significant difference was found in the big and small size under lower position at 0.05 significant level.

Table 2. Effect of branch diameter and branch position on root mass using coconut peat as rooting substrate on *Annona muricata* tree

Position	Size	Mean	Std. Deviation	N
Upper	Big	6.67[a]	1.155	3
	Small	5.33[b]	.577	3
	Total	6.00	1.095	6
Lower	Big	7.67[a]	1.155	3
	Small	6.67[b]	.577	3
	Total	7.17	.983	6
Total	Big	7.17[a]	1.169	6
	Small	6.00[b]	.894	6
	Total	6.58	1.165	12

Means within the same column and followed by different letter are significantly different (P<0.05).

Table 3. Effect of branch diameter and branch position on root mass growth using sawdust as rooting substrate on *Annona muricata* tree

Position	Size	Mean	Std. Deviation	N
Upper	Big	3.67[a]	.577	3
	Small	3.00a	1.000	3
	Total	3.33	.816	6
Lower	Big	6.00[a]	1.000	3
	Small	4.33[b]	1.528	3
	Total	5.17	1.472	6
Total	Big	4.83[a]	1.472	6
	Small	3.67[b]	1.366	6
	Total	4.25	1.485	12

Means within the same column and followed by different letter are significantly different (P<0.05).

Table 4. Effect of branch diameter and branch position on root mass using mixture as rooting substrate on *Annona muricata* tree

Position	Size	Mean	Std. Deviation	N
Upper	Big	3.67[a]	.577	3
	Small	3.00[a]	1.000	3
	Total	3.33	.816	6
Lower	Big	5.67[a]	.577	3
	Small	4.67[b]	2.082	3
	Total	5.17	1.472	6
Total	Big	4.67[a]	1.211	6
	Small	3.83[a]	1.722	6
	Total	4.25	1.485	12

Means within the same column and followed by different letter are significantly different (P<0.05).

The effect of branch diameter on root mass growth of *A. muricata* using different rooting substrate was presented in Table 5. The table showed that, big branch diameter using coconut peat as rooting substrate had the higher mean value of 7.17 while small branch had 6.00. Big

branch diameter using sawdust as rooting substrate had the higher mean value of 4.83 while small branch had 3.67. Big branch diameter size using mixture as rooting substrate had the higher mean value of 4.67 while small branch had 3.83. Results in Table 6 revealed the effect of position on root mass growth of *A. muricata* using different rooting substrate. The table showed that, marcots set on upper position using coconut peat as rooting substrate had the lower mean value of 6.00 while lower position had higher mean value of 7.17. Marcots set on upper position using sawdust as rooting substrate had the lower mean value of 3.33 while lower position had higher mean value of 5.17. Marcots set on upper position using mixture as rooting substrate had the lower mean value of 3.33 while lower position had higher mean value of 5.17.

Table 5. Effect of branch diameter on root mass growth of *A. muricata* using different rooting substrate

Rooting substrate	Branch diameter	
	Big	**Small**
Coconut peat	7.17	6.00
Sawdust	4.83	3.67
Mixture	4.67	3.83

Table 6. Effect of branch positions on root mass growth of *A. muricata* using different rooting substrate

Rooting substrate	**Position**	
	Upper	**Lower**
Coconut peat	6.00	7.17
Sawdust	3.33	5.17
Mixture	3.33	5.17

The effect of rooting substrate, branch position and branch diameter on number of successful marcots of *A. muricata* was illustrated in Figure 2. Coconut peat and mixture had the highest percentage (100%) of successful marcots while sawdust recorded the lowest percentage of successful marcots (91.67%). The figure also revealed the effect of branch position on the successful marcots, marcots set at upper position had the lower percentage (40%) while the marcots set at the lower position had higher percentage (60%). The percentage of the branch diameter of the successful marcots was also presented on the figure stating that the big sized branch had the higher percentage of 57.14% while the small sized branch had 42.86.

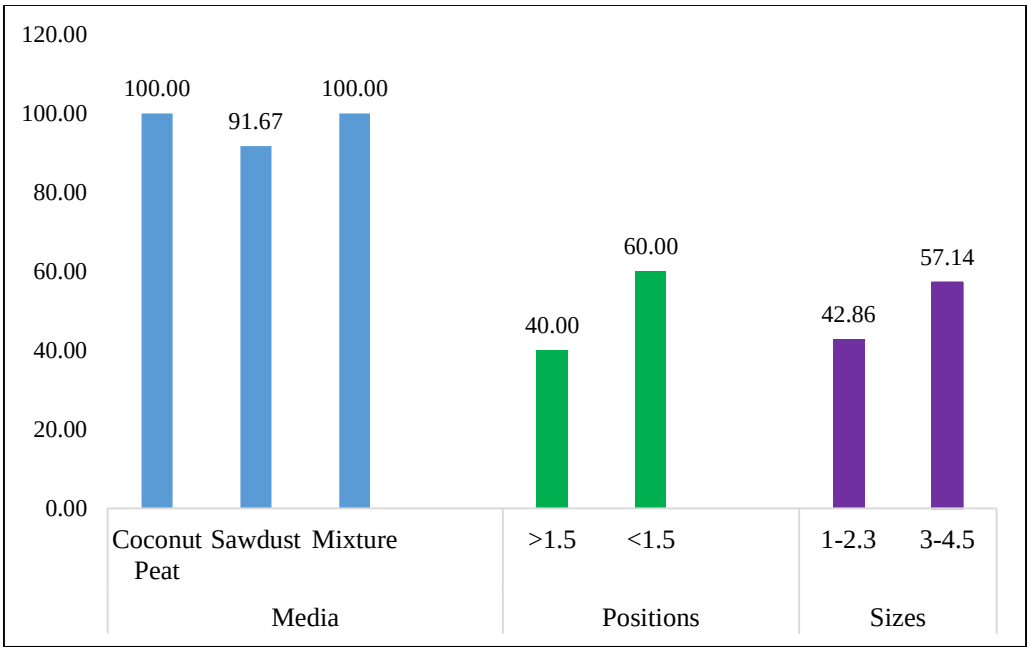

Figure 2. Effect of rooting substrate, branch position and branch diameter on Number of Successful Marcots of *Annona muricata*

DISCUSSION

Effects of rooting substrate on the onset of rooting, growth of root strands and number of successful marcots

According to Caplan *et al*., (2018), the choice of growing medium can influence the rooting of cuttings during vegetative propagation. For example, Bhekithemba and Wahome (2010) showed that, the highest number of roots was recorded when mixture of garden soil, compost and sand at the ratio of 1:1:1 (v/v) was used in the case of *P. hortorum* stem cuttings. While, the use of vermiculite gave the lowest number of roots per cutting Bhekithemba and Wahome (2010). The first root growths among the three treatments in this study was recorded in coconut marcots (Figure 1). This could be due to the good water holding capacity and the proper aeration which helped in better rooting initiation which was more in coconut marcots. Kukal *et al.*, 2012 have reported that coconut peat has a good drainage capacity and porosity. Plant roots need air to respire, hence, good aeration and water holding capacity (WHC) of rooting media is very important. For instance, Soundy and Mpati (2007) conducted research on fever tea and reported the highest root length with stem cuttings grown on pine bark. Similar results also were found when *Warburgia ugandensis* stem cuttings were grown on three different media (milled pine bark, top forest soil and sand). Stem cuttings that were propagated in milled pine bark had the highest number of root sand shoots, shoot length, and root length when compared to cuttings propagated in top soil and sandy soil rooting media (Akwatulira *et al*., 2011). The findings from both experiments were attributed to high aeration and water holding capacity in pine bark. Pine bark is loose in texture as compared to soil and sand hence, it allows good aeration and water flow. Similarly, Yeboah *et al*., (2009) discovered that increased aeration in rooting substratewas responsible for boosting metabolic processes and enhancing root initiation in *Vitellaria paradoxa*. As a result, the type of rooting substrate employed might have a significant impact on the rooting potential of cuttings.

The use of sawdust as a rooting medium took the longest time to emerge first root. This could be attributed to the high concentration form of carbon. Hartman (2017) noted that, pure wood materials like sawdust and wood shavings are very-high in carbon and this carbon will absorb all of the plant-feeding Nitrogen in your soil in the process of decomposing.

Effects of rooting substrate, branch positions and branch diameter on the growth of root strand of *Annona muricata*

Annona muricata with a branch diameter of 3-4.5cm took the shortest time to grow the first root strand compared to *Annona muricata* with a branch diameter of 1-2.3cm. The finding of this study is consistent with FAO (2012), which reports that the most successful marcots were collected from large, sun-lit branches on mature trees, while marcots harvested from thin, shaded branches died or took longer to develop roots. Stewart (2012) found that, marcots performed on large breadfruit branches surpassed marcots conducted on small breadfruit branches. When compared to the small size branch, the early commencement of root strands on the large branch diameter of 3-4.5cm could be related to environmental conditions associated with the large size and their ability to gather nutrient needed for growth and development, the findings of Lange (2016), who studied on fruit plants, support this. He revealed that branch diameter affects the early formation of new roots on marcots, as well as the study of Steward (2012), who discovered that new roots are formed more on bigger branches than on smaller branches, and that environmental circumstances may be responsible for this. This finding is consistent with FAO's (2012) finding that the maximum number of successful marcots were gathered from sun-lit big branches on mature trees. Marcots harvested from thin, shady branches died or took longer to grow roots. Steward (2012) found that marcots conducted on large breadfruit branches performed better than marcots performed on small breadfruit branches. *Annona muricata* marcots developed more root mass on the lower branch (<1.5m) than the top branch (>1.5). This could be attributed to the proximity of the lower branch to the trunk, which also corroborated with the findings of Leweniqila's (2013), who discovered that marcots of breadfruit put on the lower branch produced root balls before those planted on the upper branch. This is also similar with the findings of Saifuddin *et al*., (2013), who observed that basal position cuttings outperformed apical position cuttings in terms of survival, leaf area index (LAI), and root initiation. This could be because the bottom branch is close to the soil, where nutrients and water are swiftly absorbed. *Annona muricata* produced more successful marcots on the lower branch than the higher branch. This could be due to the lower branch's proximity to the roots, where the tree collects water and nutrients, as well as the tree's early rooting (Leweniqila, 2013).

CONCLUSION AND RECOMMENDATION

The study has revealed the effect of marcotting media on the onset of the first root growth; root emergence and on the total number of successful marcots. It was established that Coconut peat was a better media for the onset of rooting, growth of root strands and number of successful marcots. The study demonstrated that the number of root strands were significantly affected by marcotting media. Marcots of *Annona muricata* were significantly influence by growth media ascoconut peat recorded the highest number of root strands. Generally, marcots of the *Annona muricata* fruit tree placed on the big branch diameter (3–4.5cm) produced the highest number of root strands. It is recommended that artificial regeneration of *Annona muricata* should be encouraged by teaching the farmers how to go about the marcotting techniques. The people should also be enlightened on simple silvicultural activities that could be carried out in the management of this fruit tree species. Therefore, establishing a participatory domestication programme for thespecies including some priority indigenous forest fruit trees in the study area, this will go a long way in promoting the benefits of these species which could significantly contribute in the sustenance of livelihood and income generation by small scale farmers especially in the rural areas in Nigeria.

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