Air Layering (Marcotting) of Breadfruit *(Artocarpus Altilis*)

Puran Bridgemohan, Musa El S. Mohamed, Arjune Ramoutar, Kimberly Singh, and Ronell Bridgemohan

Biosciences, Agriculture and Food Technology Centre, The University of Trinidad and Tobago

Abstract: **- Marcotting may be employed as a micro-propagation technique to enhance the rapid multiplication of tall, high-yielding breadfruit (*Atrocarpus altilis)* and transform it into short-statured, early maturing breadfruit varieties. In this study, marcotting was performed on two varieties of breadfruit, Dwarf Hawaiian (DH) and Local Yellow (LY) Breadfruit, utilizing two different planting media, Pro-Mix® and sphagnum moss, with and without rooting hormone (active ingredient: Alpha Naphthyl Acetic Acid). Results showed that the Local Yellow Breadfruit variety was more prolific in developing root and calluses and the Dwarf Hawaiian was superior in the survival of rooted cuttings after transplanting. Branches marcotted on the lateral shoots appeared to be more productive than those on shoot tips. It was also observed that utilizing Pro-Mix® proved to be more beneficial when compared to that of using sphagnum moss as the growing media. There were no noticeable differences in the root or callus formation and survival of rooted cuttings post-transplant regarding the hormone application. It is recommended that further research and observations be performed on the established root cuttings to determine age at maturity and height of the trees over time.**

Key words: **breadfruit, atrocarpus altilis, marcotting, lateral shoots, Pro-Mix®, moss, rooting hormone**

I. INTRODUCTION

Breadfruit (*Artocarpus altilis*), is a member of the *Moraceae* (fig) plant family. It is an evergreen tree with an elongated trunk that can attain a height of 10-30m at maturity. It was introduced to the Caribbean in the 18th century as a source of staple food and has high economic value (Soetjipto, 1981). The branches of the tree span diagonally and it possesses large dark-green lobed leaves, a trunk ranging in diameter of 30-90 cm and deep buttress roots. The trees begin bearing fruit in 3 to 5 years and are productive for many decades. It is a high yielding tree which produces on average 175 – 250 fruits annually and also provide construction materials, medicine, fabric, glue, insect repellent and animal feed (Mukesh, 2014). Breadfruit has a wide range of adaptability to ecological conditions.

The crop is grown and utilized throughout various Caribbean nations and has attained national importance in many territories such as Dominica, Trinidad and Tobago, Barbados, Jamaica and St. Lucia. Breadfruit is however, under-utilized and researched (Ragone, 2013). It is mostly grown for domestic consumption but small amounts are in fact exported when prepared. According to a publication by Diane Ragone in 2014 for the Breadfruit Institute of the National Tropical Botanical Garden and Hawai'i Homegrown Food Network, 'breadfruit is high in complex carbohydrates, low in fat, and cholesterol and gluten free. Additionally, the publication states that 100g of breadfruit provides 25% of the recommended daily allowance (RDA) for fiber, and 5-10% of the RDA for protein, magnesium, potassium, phosphorus, thiamine (B_1), and niacin (B_3).'

The tree height of the breadfruit is the main restriction and limitation for harvesting the crop, pruning trees, administering fertilizers and disease and pest control. Fruits are often lost due to this constraint, as fruits are hard to reach, fall and rot or become damaged (Ragone, 2014). There is a high cost associated with maintenance and pruning of these trees and their branches and the harvesting of this crop, is extremely labour intensive (Jones, 2011). One solution is to develop breadfruit varieties with short stature. However, insufficient research on the breadfruit is responsible for information and data on the agronomy, pruning and management of breadfruit being currently limited (Ragone, 2011).

Vegetative propagation, through the air layering or marcotting of branches and shoots, is the preferred form of propagation for the seedless variety of breadfruit. Under good conditions these grafted trees can begin bearing within 2 years (Ragone, 2006). Marcotting is a vegetative method of plant propagation that involves the development of aerial roots while still attached to the parent plant. The formation of roots on the layers, also referred to as marcots, require continuous moisture, adequate aeration and moderate temperatures. Although other methods of propagation exist, marcotting is preferred as it more ensured rooting success, including clones which will not root easily. Additionally, marcotting is simple to perform and it allows for larger plants which are readily mature to be produced in faster time.

The aim of this study is to evaluate marcotting on the lateral shoots and shoot tips of two different varieties of breadfruit, using different planting media and a plant growth regulator, to facilitate rapid multiplication of plant material for short stature and early maturity.

II. MATERIALS AND METHOD

The Dwarf Hawaiian Breadfruit was selected as it has an acceptable yield and fruit quality and is easily adaptable to the local growing conditions. The Local Yellow Breadfruit was

also evaluated as it is popular in large farms and was introduced much earlier than the Dwarf Hawaiian variety.

The trees selected for the study were cultivated at 3 locations. The Dwarf Hawaiian variety was cultivated at the Eastern Caribbean Institute of Agriculture and Forestry (ECIAF) Campus and the Waterloo Research Campus. Alternatively, the Local Yellow variety was located at ECIAF and Warrenville. All the trees were over 7 years old, produce good yields of fruit and are in healthy and disease free conditions.

The marcotting method of propagation was performed on the two varieties of breadfruit trees. A small piece of bark was stripped away from the branch of the breadfruit tree, in order to remove a thin outer layer of the bark so that the inside woody tissue was exposed. The small ring of the stem bark was stripped away without damage to the xylem vessels using a sterilized budding knife (Mohamed *et al* 2014).

This was done on both lateral shoots and shoot tips of the trees (Figure 1). After cutting the bark, either sphagnum moss or Pro-Mix®, with and without rooting hormone (active ingredient Alpha Naphthyl Acetic Acid), was placed on the exposed area and wrapped securely with a piece of black polythene plastic. The plastic was fixed in place with strings to ensure that it would not fall off. Several small perforations were made on the plastic for aeration and water to enter during rainfall. The layering was made just under the main nodes of shoot tips and lateral shoots that varied from 24 to 30 cm in length. Only shoots in fully vegetative stages were selected for treatment. Each treatment was done in duplicate on each tree.

Figure 1: Marcotting on the Shoot Tip and Lateral Shoot of the Breadfruit Tree

This was left in place for 7-8 weeks, after which the branch was cut just under the marcotted area. The plastic and strings were carefully removed and the branch was observed for root and callus formations and left for further growing-out and hardening at a cool place in the greenhouse at the UTT Waterloo Research Campus. These were then planted in bags containing Pro-Mix® and labelled appropriately. The plants were manually watered on a daily basis with a nutrient, their growth observed weekly and all observations recorded.

III. RESULTS AND DISCUSSION

The results assessed two variables; formation of calluses and root development as well as rate of survival of rooted cuttings post-transplant.

Table 1: Successfully Rooted cuttings (%) of two varieties of Breadfruit at 60 days after treatment application

Position on branch	Successfully Rooted Cuttings (%)							
	Var. Local Yellow				Var. Dwarf Hawaiian			
	Rooting Treatment				Rooting Treatment			
	Moss	Pro-Mix®	Moss + RH	Pro-Mix® + RH	Moss	Pro-Mix®	Moss + RH	Pro-Mix® + RH
Shoot Tip	75	100	75	75	0	0	0	25
Lateral Shoot	100	100	100	100	0	25	0	0

RH = Rooting Hormone

It was observed (Table 1) that the Local Yellow Breadfruit variety was more prolific (91%) in producing root calluses as compared to the Dwarf Hawaiian Breadfruit variety, which displayed a lower root callus formation (6%).

It was also observed that marcotted lateral shoots on the Local Yellow Breadfruit variety had 100% success in rooting as compared to the marcotted shoot tips (81%). Marcotting on the Local Yellow Breadfruit which utilized Pro-Mix® proved to promote greater formation of roots and calluses when compared to that of sphagnum moss as the growing medium. Similar results were noted for treatments containing hormone as compared to those without, deeming the application of the rooting hormone insignificant.

The results for the Dwarf Hawaiian Breadfruit showed a 1:1 of successful rooting for both marcotted shoot tips and lateral shoots. It was observed that the Pro-Mix® was a better growing medium in comparison to the sphagnum moss, where no root formations were observed. The application of the rooting hormone on the Dwarf Hawaiian Breadfruit displayed no noticeable differences.

At 60 days after treatment application, all cuttings that resulted in the formation of root calluses (Figure 2) were transplanted into bags containing Pro-Mix®, transferred to the greenhouse at the UTT Waterloo Research Campus and observed on a weekly basis.

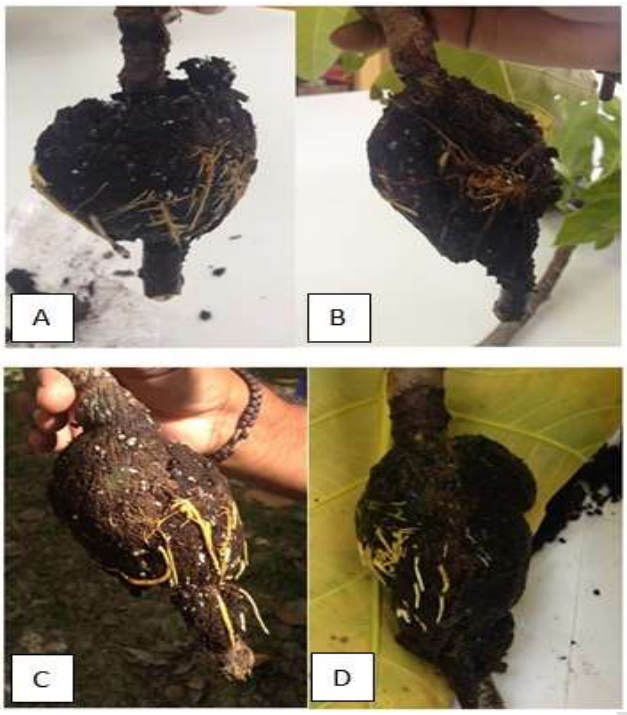

Figure 2: Illustrations of the development of root calluses on cuttings of two breadfruit varieties; A: Yellow (Lateral Shoot - Moss with Rooting Hormone), B: Hawaiian (Lateral shoot - Pro-Mix® without Rooting hormone), C: Yellow (Tip - Pro-Mix® without Rooting Hormone), D: Yellow (Lateral Shoot - Pro-Mix® with Rooting Hormone)

Table 2: Survival Rate (%) of rooted cuttings post-transplant for two varieties of Breadfruit

Position on branch	Survival Rate (%)							
	Var. Local Yellow				Var. Dwarf Hawaiian			
	Rooting Treatment				Rooting Treatment			
	Moss	Pro-Mix®	Moss + RH	Pro-Mix® + RH	Moss	Pro-Mix®	Moss + RH	Pro-Mix® + RH
Shoot Tip	0	50	25	50	0	0	0	25
Lateral Shoot	0	50	25	25	0	25	0	0

RH = Rooting Hormone

Results showed that the Dwarf Hawaiian Breadfruit variety had a higher survival rate of post-transplanted root cuttings compared to the Local Yellow Breadfruit (Table 2). This may be attributable to general greenhouse management. Additionally, for both breadfruit varieties, the Pro-Mix® was the preferred growing medium and there appeared to be no noticeable differences in growth regarding the presence of the rooting hormone.

An inflorescence (male flower) was observed on one of the Dwarf Hawaiian Breadfruit cuttings, as shown in Figure 3.

It is evident that breadfruit farmers or growers desire trees that are of a short stature and produce fruit at an earlier stage in order to achieve an economic advantage and satisfy market needs. The application of marcotting has been a major success in the improvement of trees and shrubs which has multiple desirable traits without genetic segregation (Thirunanvoukkarasu *et al*, 2004). This will allow the plants breeders and agronomists to rapidly multiply plant material to further expand the species and maintain the desired parental genotypes.

Figure 3: Illustration of the development of an inflorescence (male flower) on a marcotted breadfruit cutting

Marcotting can effectively complement the application of other propagation methods to rapidly augment natural populations or can be used to establish a field of parent plants, by easily replicating individual plants with desirable traits (Martins, 2011). Mature trees with desirable traits, including good fruit quality and yield, can be marcotted to produce exact genetic replicas of the parent plant, resulting in faster maturity and earlier fruit development. Coupling this with specific agronomic management activities including the trimming and pruning of branches, we can achieve trees that characteristically shorter in stature than a typical breadfruit tree.

This study indicated that marcotting, as a micro-propagation technique, can enhance the rapid multiplication of tall, high-yielding breadfruit and transform it into short-statured, early maturing breadfruit varieties, even though the yield potential is reduced. This can promote the utilization of the crop into high density planting schemes or even dwarf potted breadfruit for domestic purposes, which can yield a capacity of 7-9 fruits per plant per year.

The study has shown that the Local Yellow Breadfruit was more amiable to rapid micro propagation (91%). Additional work regarding the selection of plant parts and varying levels of rooting hormones can show influences on callus formation

and root development. The Dwarf Hawaiian Breadfruit, on the other hand, was superior when considering survival rate post-transplant. Therefore, the limitation in this study was greenhouse management.

IV. CONCLUSION

In this study, marcotting was performed on the lateral shoots and shoot tips of two different breadfruit varieties, Local Yellow Breadfruit and Dwarf Hawaiian Breadfruit, to facilitate the rapid multiplication of plant material for the purpose of controlling plant stature and to promote early fruit production. Marcotting was performed using either Pro-Mix® or sphagnum moss as the growing medium, with or without rooting hormone.

Results indicated that the Local Yellow Breadfruit was more successful (91%) at developing root calluses via marcotting as compared to the Dwarf Hawaiian variety. The Dwarf Hawaiian, however, was the more robust variety regarding its survival of the rooted cuttings post-transplanting. For both rooting as well as post-transplant survival, it was observed that Pro-Mix® was the preferred growing medium and that the presence of rooting hormone showed no significant differences.

Marcotting, can be employed as a propagation technique of breadfruit, resulting in the production of viable trees that promote shorter stature and early maturation. It is proposed for this study that further research be conducted and additional observations of already established plant material be performed to determine age at maturity and fruiting of rooted breadfruit cuttings.

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