



## Comparative studies on the use of five different root inducing substrates in vegetative propagation of *Irvingia gabonensis*

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### Abstract

**Background:** Over the years a lot of difficulties are usually encountered in the mass propagation of most woody tree species, and *irvingia* is not excluded. This study was design to compare the performances of five different root inducing substrates in vegetative propagation (marcotting) of *irvingia gabonensis*.

**Materials and Methods:** Five different root inducing substrates (River sand, Top soil, Poultry droppings, Cow dungs and *Chromolena odorata* grinded leaves) were used to induce roots in *I. gabonensis* marcotted branches. After two weeks of marcotting, selected branches were checked weekly for root emergence and leaves performance. Data collected on root emergence and leaves performance were subjected to a two ways analysis of variance in order to determine the significant difference between means.

**Results:** The results revealed that 50% of branches that were marcotted with root inducing substrate of *C. odorata* grinded leaves lost their leaves. After two weeks of marcotting, there was root emergence of an average root length of 1.5cm on the branches that were marcotted with *C. odorata* grinded leaves (Sample E). Branches marcotted with other root inducing substrates produced callus only. It was observed that 55% of branches that were marcotted with *C. odorata* died after eight weeks of marcotting.

**Conclusion:** Early emergence of roots was achieved when *C. odorata* grinded leaves was used as root inducing substrate in the vegetative propagation of *I. gabonensis*. *C. odorata* grinded leaf can be used as root inducing substrate when carrying out vegetative propagation of *I. gabonensis* through marcotting.

**Keywords:** Marcotting, *chromolena odorata*, *irvingia*, rooting substrates and vegetative propagation

### Introduction

*Irvingia gabonensis*, sometimes known by the common names wild mango, African mango, bush mango, dika or ogbono, bear edible mango-like fruits, and are especially valued for their fat- and protein-rich nuts. *Irvingia gabonensis* is a large evergreen tree, distributed throughout West and Central Africa. The fruit pulp of *I. gabonensis* is widely eaten, and the kernels are used both as a source of oil for making soap and for medicinal purposes (Abbiw, 1990) <sup>[1]</sup>. *Irvingia spp* is pollinated by Coleoptera, Diptera, Hymenoptera and Lepidoptera (Orwa., *et al* 2009) <sup>[2]</sup>. It flowers from March to June and has two fruiting seasons: from April to July and from September to October (*National Academies Press.*, 2006) <sup>[3]</sup>. The numbers of those animals pollinating it has been reduced by human activities, the spread and regeneration of dika decreases and it becomes dependent on human planting (Tchoundjeu and Atangana 2007) <sup>[4]</sup>. Seeds are dispersed by specialized vertebrates as squirrel, elephants, monkeys and gorillas. By reducing the number of those animals, the spread and regeneration of dika decreases and it becomes dependent on human planting (Tchoundjeu and Atangana 2007) <sup>[4]</sup>. *Irvingia gabonensis* and *Irvingia wombolu* are two of these non-timber forest resources which in recent times have become very important products.

The kernels of *I. gabonensis* and *I. wombolu* are classed as

oilseeds. *Irvingia* kernels form an important part of the West and Central African diet, providing carbohydrate and protein (Onyeike., 1995) <sup>[5]</sup>. The kernels are highly valued for the slimy consistency they produce. They are ground with a pestle and mortar or on a stone into a paste or cake called 'dika bread', which is used as a soup, stew or sauce additive, for flavouring and thickening. Both *Irvingia spp.* are used in soup making, but *Irvingia gabonensis* kernels can only be used when fresh since they become too slimy over time (Okafor, 1975) <sup>[6]</sup>. Fat extracted from the kernels can be used for food applications, such as in margarine or cooking oil, and is also suitable for soap, cosmetics and pharmaceuticals (Ejiofor, 1987) <sup>[7]</sup>.

*Irvingia spp* is mostly propagated by seed, but methods of vegetative propagation have been developed. Because the seed loses its viability within one month, thus the seed has to be planted soon after collection. Vegetative propagation of plants is essentially the reproduction of plant material from vegetative organs so that the offspring will contain the exact characteristics of the parent plant with regards to genotypes and health status (Macdonald, 1996) <sup>[8]</sup>. This is possible because plants unlike animals have meristematic, undifferentiated cells that can differentiate to the various organs necessary to form a whole new plant. Thus a piece of plant shoot, root, or leaf can grow to form a new plant that

contains the exact genetic information of its source plant.

Air layering (marcotting) technique is similar to cuttings with the advantage that the propagule is detached from the parent plant only after development of roots. Its multiplication rate is lower than that of cuttings though the plants are larger (Kengue, 2001) [9]. Methods of layering are the oldest used for vegetative propagation. The technique is characterized by the initiation of adventitious roots on one part of the tree branch in-situ. After root initiation, the rooted part (marcott) is weaned from the tree and transplanted in a substrate where it grows independently of the mother tree. Like other vegetative propagation techniques, the main advantages of marcotting are cloning selected trees with desirable traits and shortening the period for fruit production (Kengue, 2001; Hartmann., *et al* 1997) [9, 10].

Three 'classes' of layering methods, depending on the soil and stem relationship can be distinguished: mound layering or trench layering (soil is mounded to the stem), simple layering or tip layering (stems are lowered into the soil) and air layering (stems are not covered by soil). Air-layering is the technique that has been widely used in the domestication of indigenous fruit trees in West and Central Africa in capturing the attributes of elite trees within genetically diverse wild populations, so avoiding the long, slow process of tree breeding. In all vegetative reproduction techniques (marcotting, grafting, cutting, etc), the physiological state of the mother tree is a key factor of rooting ability. Trees at the physiological stage of ascending sap are in all cases most suitable to rooting, or grafting success. The existence of genetic differences among trees within the same population is largely recognized, and this could affect the physiology of each tree, and consequently the rooting ability of marcotts (Tchoundjeu 1989; Kengue, *et al* 1998; and Mpeck. *et al* 2004) [11, 9, 13].

This research work was designed to carry out a comparative study on the use of different rooting substrates in *Irvingia* vegetative propagation.

### Materials and Method

A comparative study on the use of five different roots inducing substrates in *Irvingia gabonensis* propagation was carried out in the National Centre for Genetic Resources and Biotechnology (NACGRAB) conservation field at Iyanomo, Edo state, Nigeria. The field of study is located between latitude 6°00' and 7°00' North and longitude 5°00' and 6°00' East of the Equator. A total of fifty (50) *Irvingia gabonensis* matured trees were used for the experiment. Five different roots inducing substrates were used in aiding root development in the research experiment. River sand, Top soil, *Chromolana odorata* grinded leaves, Poultry droppings and Cow dungs were used to aid root development.

### Rooting Substrates used for Marcots

Sample A = River sand

Sample B = Top soil

Sample C = Poultry droppings

Sample D = Cow dungs

Sample E = *Chromolana odorata* grinded leaves

River sand was collected from Ogbekpen River in Edo state.

*Chromolana odorata* grinded leaves was collected within the NACGRAB conservation field and it was air dried and blended to fine particles and stored in a polythene bag from where samples were drawn for use. Poultry droppings and cow dungs were collected from Okha community in Edo state. All root inducing substrates that were used to aid root formation were mixed with adequate quantity of water before use.

Girdling and scrapping of stems was carried out in August 2018, with the aid of a sharp knife. Two cuts of about 2cm to 10cm in length were made to remove the bark of the stem shoot; phloem and cambium were also removed from stem shoot to prevent the wound from healing thereby inhibiting the reconnection of the upper and lower barks of the stem. After moistening the different roots inducing substrates with water, the moistened substrates were placed around the debarked stems and wrapped with a piece of transparent polythene sheet, with each tree carrying five different treatments. The lower end of the polythene was gathered and tied before the roots inducing substrates was gradually inserted through the opened upper end. After filling the polythene sheet with the root inducing substrate, the upper end of the polythene sheet was gathered and tied.

After two weeks, data were collected in order to determine leaves performance and root formation. Subsequently, data were collected weekly for a period of six weeks. Data collected from all the treatments were subjected to analysis of variance in order to determine the significant difference between means. A scale of five (5) was used for evaluation of leaves performance and root formation on the *Irvingia gabonensis* marcotted branches, with 5 representing very good, 4 represents good, 3 represents undecided, 2 represents bad and 1 represents very bad.

### Results

Table 1 showed the mean value of data collected on the leaves performance of marcotted *Irvingia gabonensis* branches. The results showed that there was significant difference in the leaves performance of the five different media that was used in vegetative propagation of *Irvingia gabonensis* through marcotting.

**Table 1:** Leaves performance on marcotted *Irvingia gabonensis* branches

	Leaves Performance				
	A	B	C	D	E
Wk 2	4.8 <sup>a</sup>	4.5 <sup>a</sup>	4.4 <sup>a</sup>	4.4 <sup>a</sup>	3.4 <sup>a</sup>
Wk 3	4.6 <sup>a</sup>	4.5 <sup>a</sup>	4.3 <sup>a</sup>	4.2 <sup>a</sup>	3.4 <sup>a</sup>
Wk 4	4.4 <sup>a</sup>	4.3 <sup>a</sup>	4.2 <sup>a</sup>	4.1 <sup>a</sup>	3.2 <sup>b</sup>
Wk 5	4.4 <sup>a</sup>	4.0 <sup>a</sup>	4.2 <sup>a</sup>	4.0 <sup>a</sup>	3.2 <sup>b</sup>
Wk 6	4.3 <sup>a</sup>	4.1 <sup>a</sup>	3.8 <sup>b</sup>	4.0 <sup>a</sup>	3.0 <sup>c</sup>
Wk 7	4.3 <sup>a</sup>	3.0 <sup>b</sup>	3.7 <sup>b</sup>	3.7 <sup>b</sup>	2.5 <sup>c</sup>
Wk 8	3.9 <sup>a</sup>	3.0 <sup>b</sup>	3.5 <sup>ab</sup>	3.7 <sup>a</sup>	2.3 <sup>c</sup>

Mean values bearing the same superscripts on the same row are not significantly different as ( $p \geq 0.05$ )

A = River sand (control)

B = Top soil

C = Poultry droppings

D = Cow dungs

E = *Chromolana odorata* grinded leaves

The results of data collected on root formation of marcotted *Irvingia gabonensis* branches are depicted in Table 2. The results showed that there was significant difference in roots formation of branches marcotted with *Chromolena odorata* grinded leave and the branches marcotted with River sand, Top soil, Poultry dropping and Cow dungs roots inducing substrates. The results showed that there was early emergence of roots in *Irvingia gabonensis* branches that were marcotted with *Chromolena odorata* root inducing substrates.

**Table 2:** Roots performance on marcotted *Irvingia gabonensis* branches

	Roots Emergence				
	A	B	C	D	E
Wk 2	4.7 <sup>a</sup>	4.8 <sup>a</sup>	4.3 <sup>a</sup>	4.2 <sup>a</sup>	3.6 <sup>b</sup>
Wk 3	4.6 <sup>a</sup>	4.5 <sup>a</sup>	4.1 <sup>ab</sup>	4.0 <sup>ab</sup>	3.2 <sup>b</sup>
Wk 4	4.4 <sup>a</sup>	4.3 <sup>a</sup>	4.0 <sup>a</sup>	4.0 <sup>a</sup>	3.0 <sup>b</sup>
Wk 5	4.1 <sup>a</sup>	4.0 <sup>a</sup>	3.8 <sup>ab</sup>	3.8 <sup>ab</sup>	3.0 <sup>b</sup>
Wk 6	3.5 <sup>b</sup>	3.9 <sup>a</sup>	3.3 <sup>b</sup>	3.7 <sup>a</sup>	2.8 <sup>c</sup>
Wk 7	3.4 <sup>b</sup>	3.5 <sup>a</sup>	3.0 <sup>a</sup>	3.5 <sup>a</sup>	2.5 <sup>b</sup>
Wk 8	3.3 <sup>a</sup>	3.4 <sup>a</sup>	3.0 <sup>a</sup>	3.2 <sup>a</sup>	2.4 <sup>b</sup>

Mean values bearing the same superscripts on the same row are not significantly different as ( $p \geq 0.05$ )

A = River sand (control)

B = Top soil

C = Poultry droppings

D = Cow dungs

E = *Chromolena odorata* grinded leaves.

**Table 3** showed the percentage of *Irvingia gabonensis* branches that survived after marcotting, the result showed that 90% of branches that were marcotted with *Chromolena odorata* died after eight weeks of marcotting.

**Table 3:** The percentage of branches that survived after marcotting

Treatments	Survived Marcotted Branches (%)							
	wk1	wk2	wk3	wk4	wk5	wk6	wk7	wk8
A	100	100	95	87	80	80	80	70
B	100	100	90	85	80	75	75	50
C	100	100	100	100	85	70	60	60
D	100	100	100	100	95	95	80	80
E	100	100	90	75	50	50	45	45

A = River sand (control)

B = Top soil

C = Poultry droppings

D = Cow dungs

E = *Chromolena odorata* grinded leaves

## Discussion

After three weeks of marcotting, the leave performance of *Irvingia gabonensis* on different substrates (soil medium) showed that there was no significant difference in the leaves performance on branches of the five different soil substrates (media) that were used in vegetative propagation of *Irvingia gabonensis*. It was observed that after four weeks of marcotting, the leaves of branches that were marcotted with *Chromolena odorata* grinded leave (sample E), top soil (sample B), and poultry droppings (sample C) started losing their green pigments. It was also observed that the leaves of branches marcotted with *Chromolena odorata* has more severity in loss of green pigmentation; while the leaves of branches marcotted with river sand and cow dungs retained their green pigments all through the experiment. These findings suggested that, using river sand and

cow dung media in marcotting will support leaves of marcotted branches in retaining their colour pigments. The presence of green pigment in leaves is important to the health of a plant as they control photosynthesis, growth and development of the plant (The Gale Encyclopedia of Science. 2018). It was further observed that 50% of the branches that were marcotted with *Chromolena odorata* grinded leave (sample E) loss all their leaves at week 8 of the experiment. This result supported the previous research findings which stated that high mortality is associated with vegetative propagation of *Irvingia gabonensis* (Anegbeh *et al* 2005)<sup>[15]</sup>.

After two weeks of marcotting, five branches per treatment were checked at random for root emergence; it was observed that the 60% of branches that were marcotted with *Chromolena odorata* grinded leave has visible roots of an average length of 1.5cm. This finding suggested that *Chromolena odorata* grinded leave support quick emergence of root in marcotting. However, a great deal of work is required to fully develop the propagation potential of the species (Tchoundjeu, *et al* 2010)<sup>[16]</sup>. One key area is to understand the factors which affect rooting and sprouting of *I. gabonensis* marcotts (Tchoundjeu, *et al* 2010)<sup>[16]</sup>. It was further observed that branches marcotted with rooting substrate of river sand, top soil, poultry droppings, and cow dungs has no visible roots (0%), except some callus like features. Delay in root emergence of marcot of *Irvingia gabonensis* has been reported by researchers (Tchoundjeu, *et al* 2010)<sup>[16]</sup>; this may be attributed to the difficulties associated with vegetative propagation of woody tree species. Various factors (genetic, environmental and physiological) may influence the rooting and shooting abilities of marcots (Tchoundjeu, *et al* 2010)<sup>[16]</sup>. Studies had shown that rooting ability of marcots may vary with branch diameter, bark thickness, roots inducing substrate, type of hormone, hormone concentration and length of marcots (Hartmann, *et al* 1997; Kengue and Tchio 1994; and Mialoundama *et al* 2002)<sup>[10, 12, 18]</sup>. It has also been demonstrated that rooting and sprouting requirements are highly variable within and among species. Therefore, assessing factors that affect rooting and sprouting abilities of marcots in each species is an important prerequisite for its successful propagation through marcotting. After week five (5), it was observed that 50% of the roots that emerged from the branches that were marcotted with *Chromolena odorata* rooting substrate died. By the end of the experiment (week 8), it was observed that 55% of the roots that emerged had died. At the end of the experiment (week 8), it was also observed that marcots with rooting substrate of river sand, top soil, poultry dropping and cow dung did not develop visible roots. The non-emergence of roots may be as a result of the short duration of time that the experiment was allowed to run; as the branches were still carrying green leaves, which is an indication that the branches are still very healthy. In all vegetative reproduction techniques (marcotting, grafting, cutting, etc), the physiological state of the mother tree is a key factor of rooting ability. Trees at the physiological stage of ascending sap are in all cases most suitable to rooting, or grafting success. The existence of genetic differences among trees within the same population is largely recognized, and this could affect the physiology of each tree, and consequently the rooting ability of marcots (Mpeck, *et al* 2004)<sup>[13]</sup>.

## Conclusion

This study revealed that early emergence of roots can be achieved when *Chromolena odorata* grinded leaves are use as root inducing substrate in the vegetative propagation of *Irvingia gabonensis*. This study will help researchers to uncover the critical area of using grinded weeds in inducing roots in the vegetative propagation of woody tree species. Thus, a new substrate that can be used to induce roots in the vegetative propagation of *Irvingia gabonensis* has discovered.

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