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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

OPEN ACCESS Pakistan Journal of Biological Sciences

ISSN 1028-8880
DOI: 10.3923/pjbs.2016.36.42

Research Article
Propagation by Cutting of *Grewia coriacea* Mast. (Malvaceae)

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Abstract

Congolese forests contain important spontaneous food plants. Among these plants, there is the *Grewia coriacea* Mast., called in the national language «Tsui-téké», which is a tree of 4-25 m high and of 12-40 cm in diameter. Its fruits are used in several drinks making (juice, sparkling wine, syrup) and lollipops. Grewia's barks are used in pharmacopoeia to cure of stomach aches, syphilis. However, the fruits harvesting method based on branches or trees cutting as well as swidden agriculture by local people dangerously threatens the Grewia in the natural ecosystems of Congo. To insure the longevity of this species, we undertook trials of vegetative reproduction of the plant by means of propagation by cuttings for its domestication. Less woody leafless cuttings of 30 cm in length provided best results with a resumption rate of 63.3%, a good rooting production and an average duration of the apparent plastochrone of three days from the second to the fifth leaf. The study shows that domestication of the *Grewia coriacea* Mast. is possible today by cuttings. Its culture might allow the diversification of species which can be used in orchards.

Key words: *Grewia coriacea* Mast., propagation by cuttings, woody cuttings, leafy cuttings

Received: April 03, 2015 **Accepted:** September 14, 2015 **Published:** December 15, 2015

Citation: Bita Alain Mercier, Attibayéba, Kampé Jean Pierre, Ngantsoué Léon and Mialoundama Fidèle, 2016. Propagation by Cutting of *Grewia coriacea* Mast. (Malvaceae). Pak. J. Biol. Sci., 19: 36-42.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The genus *Grewia* belongs to the Malvaceae family which comprises 48 genera and more than 600 species worldwide but in the Republic of Congo, there are 10 genera and 29 species (Makita-Madzou, 1985). Among those species, there is *Grewia coriacea* Mast. which has being described as a plant of the spontaneous Guineo-Congolese flora region which produces edible fruits (INEAC., 1963). The plant is a tree or a shrub of 4-25 m high and 12-40 cm in diameter which can also develop buttresses (Makita-Madzou, 1985). Its wood is used in making plates, spoons, forks and as firewood. The darkish, glabrous and fibrous bark is used in pharmacopoeia to cure of stomach aches and syphilis and in craftsman's trade to make strap and ropes. Leaves are big in size, smooth, symmetric and used as a cover for cassava (Ngantsoue *et al*., 2005). Fruits of *Grewia coriacea* are grouped into clusters. They are ovoid drupe of 2.5-4 cm long and 1.8-4 cm width, green when unripe and become red-dark shiny or purple when ripe. The fruit is made up of a relatively thick epicarp; a fleshy, thick and spongious mesocarp containing fibres saturated with a red juice; an endocarp composed of a hard husk in which there is an almond (INEAC., 1963). Grewia's fruits are very much consumed in Congo and represent an importance source of ascorbic acid and sugar (Attibayeba *et al*., 2007). Transformation tests of the fruit in the informal sector into juice and liqueur are nowadays undertaken by Nuns of the Divine Providence de Ribeauville in Congo.

In the wild, *Grewia coriacea* reproduces by sowing; seeds are dispersed by barochory. On the opposite side, the presence of seedlings in the understory is very rare. Given that the tree can reach 25 m of height, harvesting its fruits is not easy. Consequently, people harvest them by cutting branches or even the whole tree. As result, individuals of Grewia are becoming rarer. This phenomenon is aggravated by the swidden agricultural practice. The species is therefore threatened to disappear in the Lefini valley.

Extinction of *Grewia coriacea* Mast. as for many other wild fruiting trees can only be avoided if there is an optimal approach of conservation of the resource. In order to answer to this concern, germination tests have been carried out. Seeds stay for about for a month in hibernation before the root piercing of the teguments (Engangoye and Kaboulou, 2002). Aerial marcottage works have shown that *Grewia coriacea* Mast. is perfectely adapted with this practice (Attibayeba *et al*., 2006). This study aims to optimise the propagation by cuttings of *Grewia* in order to insert it into the existing agricultural system.

MATERIALS AND METHODS

Plant materials: Cuttings come from the Lefini basin approximately 135 km away in the North of Brazzaville. They were collected by means of a horticultural saw from the twigs of branches which have already fruit at least once. All the cuttings collected were transported in a bucket containing a humid lump in which was buried a basal part of the cuttings. Apical parts were covered by candle's wax pour limit cuttings' evapotranspiration.

Methods

Influence of lignification level on cuttings: After their collection, cuttings were grouped into 4 piles to identify optimal qualities of plant material required for propagation by cuttings:

- Pile 1: 30 non-woody cuttings or leafy herbs
- Pile 2: 30 non-woody leafless cuttings
- Pile 3: 30 Less woody or less woody leafy cuttings
- Pile 4: 30 Less woody and leafless cuttings

All these cuttings are 20 cm long and have a diameter ranging from 1.5-2 cm. The foliar area of leafy cuttings is reduced to 3/4 to mitigate wither of the material by evapotranspiration.

From this experience we searched for the influence of the length of less woody leafless cuttings on the propagation by cuttings.

Influence of less woody leafless cuttings' size on propagation by cuttings: To measure the effect of cuttings' size on the success of propagation by cuttings, interest was exclusively placed on less woody leafless cuttings, based on results of a test on influence of woodiness degree of the collected twig. These less woody leafless cutting are divided into 3 piles:

- Pile 1: 30 cuttings of 10 cm having 6 nodes
- Pile 2: 30 cuttings of 20 cm having 10 nodes
- Pile 3: 30 cuttings of 30 cm having 14 nodes

These cuttings also have a diameter comprised between 1.5 and 2 cm.

All these cuttings are planted into phytocells filled up at 3/4 of 2 kg of dark humid soil taken from the understory of the former ORSTOM centre.

Maintenance of the cuttings: Watering was done each three days and no inputs were added at the beginning (starter) or during the hoeing. To fight against insects, plants were treated with the insecticide: the Thiodan 50 EC.

Analysis of the means characteristics of the cuttings: To obtain average variables characterising different populations of cuttings from Grewia, the Excel software was used. A collected specimen at each test needed 10 viable cuttings of each pile. Among the retained variables, there are: the resumption rate of the cuttings, apparent plastrochrone, the number and length of appeared leaves, the number and length of the produced roots. The Fischer Student t-test was used to calculate means between them.

The resumption rate is calculated as follow:

$$Tr = \frac{nb}{NB} \times 100$$

where, nb is effective cuttings bearing viable buds; NB is total number of planted cuttings.

The apparent plastochrone, lapse of time between the emission of two successive leaves out of the terminal bud for a given pant (Champagnat *et al*., 1986), is determined by the fourth and fifth leaf (the first leaves not being representatives: Heller *et al*., 2000) during three months of development. In this study, a leaf was only considered when its apex was visible (Millet, 1970). At the age of 3 month, ten individuals per treatment were collected to evaluate the number and the length of the formed roots.

To appreciate whether the treatment had or didn't have an effect on the studied variable, the Fischer Student t test was used by comparing respective means (Dagnelie, 1975).

When the calculated t is greater than the theoretical t read in the distribution table, difference between the modalities of factors is significant at the considered threshold (1 or 5%).

RESULTS

Behavior of the less woody and non woody cuttings: The first budding appeared on less woody cuttings height days after the propagation by cuttings with a resumption rate of 6.66% for the leafy cuttings, 19.9% for leafless cuttings as shown in Table 1. However, the budding on non woody cuttings was only observed from the 15th day. Most non woody cuttings (green) or leafy less woody cuttings turn black and dry after three weeks; hence their weak resumption percentage 30 days after planting.

From 30 days of monitoring, the highest resumption rate was observed on less woody leafless cuttings (63.33%) while that of the non woody leafless cuttings was 36.6%.

Influence of the length of less woody leafless cuttings on the propagation by cuttings: Figure 1 shows that the resumption rate of cuttings varies according to their length. After three months of development, resumption rate of 13.3, 43 and 53.3% for cuttings of 10, 20 and 30 cm, respectively.

Evolution of the number of buds produced by less woody leafless cuttings: Figure 2 indicates that production of buds and their growth started at the eighth day after the planting of cuttings. The aborted buds were developed into twigs.

The budding of the cuttings varied in relation to their size. The number of produced buds by the plants developed from the cuttings of 30 cm long increases between the eighth and the 30th day before reaching a plateau from the 45th day. The curve relative to the number of buds of the cuttings of 20 cm long shows the same general tendency that that of the cuttings of 30 cm between the eighth and the 15th day before stabilizing at 12 buds from the 60th day. The number of buds observed on the cuttings of 10 cm long decreases considerably from the 30th day until the 75th day.

For the two other types of the cuttings (10 and 20 cm), the produced buds perish in huge quantity after the 15th day. It is within those cuttings that we observe a weak survival rate three months later as indicates the Fig. 1.

Number and length of the formed twigs: On a sample of 10 cuttings per treatment, we counted the number of shoots and measured their length. Table 2 gives the number and length of twigs produced by the cuttings of 10, 20 and 30 cm after three months of development. The number of twigs don't vary from one cutting to another while the length varies. The examination of the significance test 't' of Student Fischer is realized as, Table 3 indicates to see if these variations are due

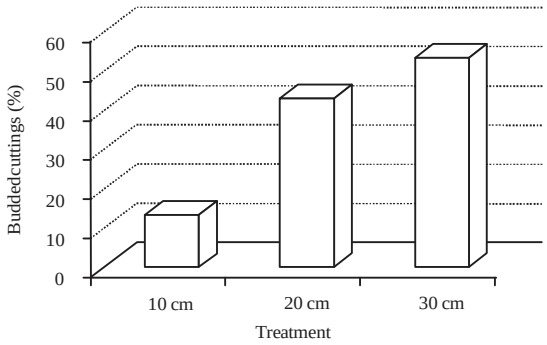

Fig. 1: Resumption and survival rate of less woody leafless cuttings of 10, 20 and 30 cm after three months of development

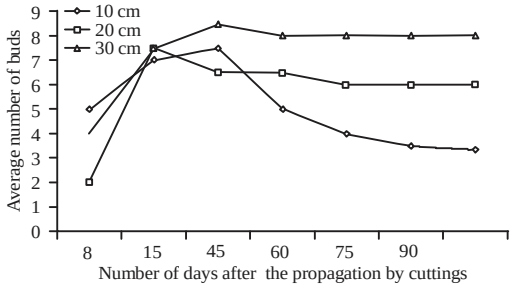

Fig. 2: Evolution of the buds' number on less woody leafless cuttings of 10, 20 and 30 cm after three months of development in relation to the time

Table 1: Behaviour of the less woody and non woody cutting

Resumption rate (%)	Non woody cuttings		Less woody cuttings	
Period	Leafy cuttings	Leafless cuttings	Leafy cuttings	Leafless cuttings
8 JAB	0	0	6.66	19.9
15 JAB	6.66	26.6	6.66	53.33
30JAB	13.33	36.6	19.80	63.33

Table 2: Number and length of twigs and leaves of the less woody leafless cuttings of 10, 20 and 30 cm after three months of development

Parameters	No. of twigs	Length of twigs (cm)	No. of leaves	Length of leaves (cm)
Cuttings of 10 cm	6.0±2.0	13.2±2.2	45±15.0	11.8±1.9
Cuttings of 20 cm	6.0±2.0	16.1±4.2	62±8.0	11.3±2.7
Cuttings of 30 cm	6.0±2.0	26.3±3.3	62±9.0	15.5±9.2

Table 3: Comparison of twigs elongation two by two of different cuttings

Parameters	Length of twigs of 10/20 cm	Length of twigs of 10/30 cm	Length of twigs of 20/30 cm
$D = X_1-X_2$	6.55	13.49	6.89
d.f.	18.00	18.00	18.00
t_{cal}	4.14	11.52	3.98
t_{th} at treshold of 5%	2.10	2.10	2.10
Remark	$t_{cal}>t_{th}$	$t_{cal}>t_{th}$	$t_{cal}>t_{th}$
Conclusion	***	***	***

*** Highly significant difference

to a treatment effect. Length differences of the twigs are highly significant. There is by consequence 95% of chance that these observed differences being true and being due to the size effect.

Number and length of the produced leaves: On a sample of 10 cuttings per treatment, we counted the number of leaves and measured the length of the fourth and fifth leaf of the twigs (the first leaves not being

Table 4: Two by two comparison of the number of leaves produced by different cuttings

Parameters	Leaves of the cuttings of 10/20 cm	Leaves of the cuttings of 10/30 cm	Leaves of the cuttings of 20/ 30 cm
$D = X_1-X_2$	16.6	16.4	0.2
d.f.	18.0	18.0	18.0
t_{cal}	3.18	3.11	0.05
t_{th} at threshold of 5%	2.10	2.10	2.10
Remark	$t_{cal}>t_{th}$	$t_{cal}>t_{th}$	$t_{cal}<t_{th}$
Conclusion	***	***	-

***Highly significant difference, - Non significant difference

Table 5: Two by two comparison of the length of leaves produced by different cuttings

Parameters	Length of cuttings of 10/20 cm	Length of cuttings of 10/30 cm	Length of cuttings of 20/30 cm
$D = X_1-X_2$	11.84	11.29	15.59
d.f.	18.00	18.00	18.00
t_{cal}	11.16	5.35	7.08
t_{th} at threshold of 5%	2.10	2.10	2.10
Remark	$t_{cal}>t_{th}$	$t_{cal}>t_{th}$	$t_{cal}>t_{th}$
Conclusion	***	***	***

*** Highly significant difference

Table 6: Average number and roots after 90 days

Parameters	Cuttings of 10 cm	Cuttings of 20 cm	Cutting of 30 cm
Average number	36.5±8.61	38.40±9.79	29.20±7.70
Average length	10.5±1.86	13.72±3.90	18.51±6.09

representative, Attibayeba *et al*., 2006) after three months of development.

Table 2 shows that the cuttings of 10 cm have 45 observed leaves against 62 leaves for the cuttings of 20 and 30 cm. The foliar elongation is observed since the third week. When showing up, the leaves have a length comprised between 0.5 and 1 cm. They reach 11.8, 11.3 and 15.5 cm on cuttings of 10, 20 and 30 cm, respectively after three months of development.

For the cuttings of 10 cm, the average length of the leaves is 11.84 cm. This average is of 11.29 cm for cuttings of 20 cm and of 15.59 cm for those of 30 cm.

The Table 4 addressing the significance test of the number of leaves appeared on cuttings of 10, 20 and 30 cm shows that that variable is function of the size of the cutting. A highly significant difference exists between the number of leaves formed by the cuttings of 10 and 20 cm then between those of 10 and 30 cm. However, there is no significant difference between the number of leaves of cuttings of 20 and 30 cm. The criterion «size of cuttings» must therefore be taken into account for the propagation by cuttings of *Grewia coriacea* Mast.

The comparison test of the length of leaves of cuttings of 10, 20 and 30 cm (Table 5) shows that a highly significant difference exists between the length of leaves of 30 cm and that of leaves of 10 and 20 cm. These observed differences are not due to a hazard fact.

Roots' production: The roots production at the less woody leafless cuttings starts 20 days after the propagation by cuttings while that relative to non woody leafy cuttings only starts 25-30 days after planting.

Overall, the cuttings surviving bear some tracing roots at their basal part. The budded cuttings but which perishing some days later do not bear roots.

Influence of the cuttings size on rooting: In general, the length of roots is more important for cuttings of 30 cm than those of 10 and 20 cm.

The number of roots is inversely proportional to the length of the roots as shown on Table 6. The average number of roots of the cuttings of 10 cm is 36.5 for an average length of 10.5 while for the cuttings of 30 cm, this number is 29 whereas, the length reaches 18.51 cm.

The comparison test of the number and length of the roots produced by the cuttings of 10, 20 and 30 cm show that the number and length of roots is function to the size of the cutting is presented in Table 7 and 8. The difference is much more significant between the number and the length of roots produced by the cuttings of 10 and 20 cm than between those of 10 and 30 cm. However, there is no significant difference between the number and the length of roots of the cuttings of 20 and 30 cm. The criterion «size of cuttings» must be taken into account for propagation by cuttings if we want to have a good anchorage of the cuttings of *Grewia coriacea* Mast.

Table 7: Two by two comparison of the number of roots of different cuttings

Parameters	Number of roots of cuttings of 10/20 cm	Number of roots of cuttings of 10/30 cm	Number of roots of cuttings of 20/30 cm
$D=X_1-X_2$	1.9	7.3	9.2
d.f.	18.0	18.0	18.0
t_{cal}	0.47	1.99	2.33
t_{th} at threshold of 5%	2.10	2.10	2.10
Remark	$t_{cal}<t_{th}$	$t_{cal}<t_{th}$	$t_{cal}>t_{th}$
Conclusion	-	-	***

*** Highly significant difference, - No significant difference

Table 8: Two by two comparison of the length of the roots of different cuttings

Parameters	Length of the roots of cuttings of 10/20 cm	Length of the roots of cuttings of 10/30 cm	Length of the roots of cuttings of 20/30 cm
$d=X_1-X_2$	3.2	7.96	4.79
d.f.	18.00	18.00	18.00
t_{cal}	2.32	3.95	2.09
t_{th} at threshold of 5%	2.10	2.10	2.10
Remark	$t_{cal}>t_{th}$	$t_{cal}>t_{th}$	$t_{cal}<t_{th}$
Conclusion	***	***	-

*** Highly significant difference, - Non significant difference

Table 9: Duration of the apparent plastochron of less woody leafless cuttings of 10, 20 and 30 cm

	Duration of the apparent plastochron		
Types of cuttings	From the 2nd to the 3rd leaf	From the 3rd to the 4th leaf	From the 4th to the 5th leaf
10 cm	5 days	5 days	4 days
20 cm	4 days	4 days	3days
30 cm	4 days	3 days	3 days

Duration of the apparent plastochrone: The Table 9 shows that the time interval separating the appearance of two successive leaves (in days here) of cuttings is of 5, 4 and 3 days on average for cuttings of 10, 20 and 30 cm, respectively. Leaves of cuttings of 30 cm have an appearance rythm greater than that of the other cuttings.

DISCUSSION

The less woody leafless cuttings give better resumption rates (63.33%) in comparison to herbaceous cuttings (36.6%). These observations were also done by How land reported by Martin and Quillet (1974) during the propagation by cuttings of «Okoumé» and Eucalyptus. He notes that woody leafy cuttings resume less well because they rapidly lost their stocks by evapotranspiration and that fewer herbaceous leafy or leafless cuttings resume.

Causes for these divergences are multiple: The light, the substrate which might not have been uniform, the choice of the plant material, the suitable period for the propagation by cuttings and the age of the twigs to propagate by cuttings. These causes are among the elements which can intervene in the variability of the results obtained by different researchers.

Our results fit those of Koyo (1994) who reveals on *Terminalia superba* (Combretaceae) that the propagation by cuttings is favourable on the woody twigs which produce high success rates.

In terms of the size of the cuttings, Kengue and Tchio (1994) obtained the best resumption rates with the cuttings of 30 cm with *Dacryodes edulis*. Similarly, working on woody cuttings of *Eucalyptus grandis* and *urophylla*. Babakouka (2001) reveals that a good resumption is observed when the cuttings exceed 25 cm of length. The withering and drying up noticed in most cuttings having a length less than 25 cm show that their growth is done to the detriment of the stocks contained in the cutting at the beginning. This behaviour is the consequence of the running out of stocks before the root system installs and that the leaves take over. Leakey and Newton (1994) and Koyo (1994) noticed also during the propagation by cuttings that if the cuttings are collected from twigs of the same individuals, the rooting rate will be strongly influenced by the number of cuttings collected per the mother-individual and the height of the insertion of the twig on the principal stem of the tree. Our results are in contrast to those obtained by Martin and Quillet (1974) on *Eucalyptus* sp. and those of Oukama (2004) on «Troène blanc» who showed that the herbaceous cuttings are those which produce the best results. Martin and Quillet (1974), working on

Eucalyptus sp, find that the herbaceous cuttings are very good for propagation by cuttings. In general, woody cuttings first start by producing leaves on their stocks, the roots formation takes place at the second time when the photosynthesis is sufficient. That is why there is a latency period between the placement of the cuttings and the growth of the sapling. That is what we observed on less-woody cuttings of *Grewia coriacea* Mast. during this study. For the herbaceous cutting, there is an opposite phenomenon which occurs as it was observed at «Troène blanc» (Oukama, 2004).Contrarily to some species of which the propagation by cuttings is sold by failures (Philippe, 1957; Mialoundama *et al*., 2001) on *Dacryodes edulis* tree, Elgoual'ch (1985) on the green Oak, *Grewia coriacea* is behaving well for the propagation by cuttings and supports the trauma created during the making of the cuttings. The resumption rated exceeds 50% for cuttings of 30 cm, with a good foliar production.The plastochrone is of regular type; it is of about three days and at each group there is a single leaf which is produced as in *Musanga cecropoïdes* (Kesler, 1950).

CONCLUSION

Our results show that *Grewia coriacea* Mast. can be domesticated today by means of propagation by cuttings with a high success rate using the less-woody cuttings of 30 cm long. Its cultivation might be perfectly fitted in the diversification of the cultivated species in orchard or in agroforestery. Its domestication would allow fighting against its current scarcity in wild ecosystems of Congo.

ACKNOWLEDGMENTS

The authors thank Marcel Andzouana, member of the laboratory of Organic Chemistry Faculty of Sciences and Technics, Marien NGOUABI University Republic of Congo for assistance to submit this paper.

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