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Shoot Development and Survival of Vegetatively-propagated Cordia africana (Lam.) as Affected by Type of Cutting

Titus Fondo Ambebe[1*], Agbor Emoh Wilsilia Agbor[1], Tanwie Carine Ngwitoh[2]

[1]*Department of Crop Production Technology, College of Technology, The University of Bamenda, Bambili, Cameroon*

[2]*Department of Biological Sciences, Faculty of Science, The University of Bamenda, Bambili, Cameroon*

Corresponding Author:** ***Titus Fondo Ambebe, *Department of Crop Production Technology, College of Technology, The University of Bamenda, Bambili, Cameroon*

Abstract: *To investigate the effect of type of cutting on the growth of vegetatively-propagated Cordia africana (Lam.), cuttings from primary, secondary, and tertiary branches of trees were raised in a non-mist propagator. The cuttings were monitored for shoot development. Measurements of growth were performed three months after the initiation of the experiment. The number of days to shoot development was unaffected by cutting type. Number of shoots, height, stem diameter, stem volume, number of leaves and leaf area of the dominant shoot were significantly lower in soft than either the hard or semi-hardwood cuttings which did not show a significant difference in any trait. A similar but opposite trend of response was observed for mortality. The results suggest that softwood cuttings may not be a suitable propagation material for C. africana (Lam.).*

Keywords: *branch order, Cordia africana (Lam.), growth, montane forest, propagation*

1. INTRODUCTION

A cutting is a part detached from a plant which under favorable conditions can produce a new plant that expresses morphological phenotypes of the donor (Hartmann et al. 2002). They are generally categorized as stem, leaf bud, and root cuttings (Washa 2014). Of the three, stem cutting is the material most commonly used for vegetative propagation of herbaceous and woody plants (Hassanein 2013). Based on maturity, stem cuttings can behardwood, semi-hardwood or softwood (Hartmann et al. 2002) which may correspond to material from primary, secondary or tertiary branches, respectively (Santoso and Parwata 2014). Reasons for the popularity of plant propagation by stem cutting are variable but generally revolve around the low cost (Waziri et al. 2015) associated with and simplicity (Dawa et al. 2017) of the technique. Plant propagation by stem cutting is a practical means for mass production of regeneration stock with desirable traits in a developing country like Cameroon where financial resources and technology are limited.

Success of propagation via stem cutting is influenced by several abiotic and biotic factors (see Ambebe et al. 2018), with type of cutting being an important physiological variable (Leakey et al. 1990). In *Jatropha curcas*, semi-hard and softwood cuttings outperformed hardwood counterparts in height, leaf production, biomass accumulation, and rooting capacity (Santoso and Parwata 2014). Noteworthy, however, is that the differences in root traits between the hard and softwood cuttings of *J. curcas* were not statistically significant. In a related work with *Dalbergia melanoxylon* (Washa 2014), rooting of softwood cuttings was better than that of semi-hardwood and hardwood cuttings where rooting did not occur at all. In contrast, height, diameter, and fresh weight of *Vaccinium floribundum* and *Disterigma alaternoides* were significantly higher in semi-hard than softwood cuttings in a study that involved only the two cutting types (Magnitskiy et al. 2011).The inconsistency in the responses to cutting type described here are, at least in part, due to the fact that the effect of the endogenous and exogenous factors that determine propagation success are species dependent (Hassanein, 2013).

Cordia africana (Lam.) is an early successional afromontane tree. Due to the high quality of its timber and a growing human population, the species is threatened by over-exploitation and habitat fragmentation. This has made an intensification of propagation and conservation of the tree increasingly important in montane sylviculture in the Bamenda Highlands region of Cameroon. Although there is a potential for regeneration of *C. africana* by sexual means, seed viability is highly dependent on environmental conditions with well dried seeds lasting for just six months when stored at 15° C (BGCI 2018) and shorter under ambient room condition. Furthermore, the rather uneven germination of the seeds which are commonly infested by insects (Obeng 2010) starts after 40-60 days (Bekele-Tesema 2017). The slow germination further lengthens the 40-50 years rotation of this timber tree (Obeng 2010). In an attempt to overcome the limitations that are associated with the use of seed, there is a growing interest in propagation by vegetative means. This study was aimed at testing the effect of cutting type on growth and survival of *C. africana* (Lam.).

2. MATERIALS AND METHODS

2.1. Plant Material

Cuttings for the research were obtained from mature *Cordia africana* (Lam.) trees in disturbed forest patches in Kedjom Keku (lat. 6.12° N, long. 10.25° E; alt.1177 m asl) of Mezam Division in the North West Region of Cameroon. Healthy primary, secondary, and tertiary branches located at the lower quadrant of the canopy were selected to be the donors. After collection, the cuttings were immediately sealed in leak-proof polythene bags and transported to the National Forestry Development Agency (ANAFOR) in Bamenda, North West Region, Cameroon where those of similar diameter were resized to a length of 12 cm.

2.2. Experimental Design

The trial was conducted in a non-mist propagator at ANAFOR. It followed a complete randomized design (CRD) with three replications. There were 15 cuttings per cutting type and replication, making a total of 135 cuttings for the experiment. A hole 2 cm deep was created with a wooden dipper in a sand: sawdust (1:1 v/v) mixture in the propagator to prevent the base of the cutting from being damaged during setting. The growth medium was underlain by a water table comprising of successive layers of fine sand, stones, and gravel. The water table was filled to the upper limit of the uppermost (gravel) layer with irrigation water so that the growth medium remained permanently moist. The irrigation was done through a PVC tube built into the propagator that had a marking from which the water level in the propagator could be read. The propagator was enclosed in a wooden frame sealed with a transparent polythene sheet to keep the air around the cuttings humid. Whenever the propagator was opened to inspect the cuttings, check the water status of the growth medium or for some other reason, a mist of water was applied with a spray bottle to maintain the high humidity. The propagator was situated in a shade house roofed with alternating rows of transparent plastic and corrugated iron roofing sheets.

2.3. Data Collection

The number of days to shoot development was recorded. At the end of the experiment, percentage mortality ($\frac{\text{Number of cuttings that died}}{\text{Number of cuttings planted}} \times 100$) was determined. Five cuttings were randomly chosen from each cutting type treatment from which data on number of shoots per cutting, plant height (H), stem diameter (D), stem volume (D^2H, Aphalo and Rikala 2003), and number of leaves of the dominant shoot were collected. In addition, the length (LL) and width (LW) of the most widely expanded leaf of the dominant shoot were measured for determination of leaf area (LL × LW × 0.67, Mosisa and Toru 2016).

2.4. Statistical Analysis

After examining for normality and homogeneity of variance using normal probability plots and histograms, respectively, the untransformed data were subjected to analysis of variance (ANOVA). Whenever the effect of cutting type on any parameter was significant, means were separated with Scheffe's F-test. All the statistical tests were conducted in Data Desk 6.01 (Data Description 1996) at $p < 0.05$.

3. Results and Discussion

Consistent with previous findings on *Psidium guajava* (Rahman et al. 2004), number of days to shoot development did not respond to type of cutting (Table 1). On the other hand, plant height, stem diameter, stem volume, number of leaves, and leaf area were significantly lower in soft than in the hard and semi-hardwood cuttings that showed similar responses of these traits (Table 1). The trends in response have been expressed in other species. For 20 cm long cuttings of *Duranta repens*, for example, number of leaves, sprouts, sprout length, and leaf area were lowest in soft relative to semi-hard and hardwood cuttings (Okunlola 2013). The outcome of an earlier study with *Moringa oleifera* and the three cutting types was that softwood cuttings produced the lowest number of shoots (Antwi-Boasiako and Enninful 2008). Alkurdi et al. (2013) also found semi-hardwood cuttings of *Vitex agnus* to be superior to softwood cuttings in number of branches, leaves, shoot length, and biomass when raised in sand medium. Given that *C. africana* is a hard-to-root species, it was not possible to gather meaningful data on the response of this organ during the 3-month duration of the research. The higher number of shoots and overall growth of the hard and semi-hardwood cuttings of *C. africana* were likely due to the presence of carbohydrate reserves that could be easily mobilized for metabolic processes. However, it was expected that hardwood cuttings would exhibit lower shoot development than the semi-hardwood stock as a result of conversion of a greater portion of the food material for lignification (Santoso and Parwata 2014). It seems that our attempt to homogenize cutting diameter across cutting types compromised the possibility of getting cuttings from relatively older parts of the primary branch that would have undergone such differentiation. The similarity in physiological status of these two cutting types should also explain why mortality did not differ between them (Table 1). The position on the branch is an important determinant of shoot formation, growth and survival of cuttings (Hartmann et al. 2002). This study's finding that values of mortality percentage were highest in softwood cuttings (Table 1) corroborates the work of Sajid et al. (2012) on *Platanus orientalis*. In disagreement with our data, however, softwood cuttings of *P. guajava* displayed higher shoot length, number of leaves, branches, and survival percentage than the other two types of cutting (Rahman et al. 2004). Similarly, hard, semi-hard, and softwood cuttings of *Coffea arabica* failed to exhibit differences in plant height, number of leaves, and biomass accumulation (Rezende et al. 2010). Although the type of cutting can affect shoot formation and survival, the effects vary with substrate, age of the ortet, season of the year, and as mentioned previously, tree species (Girouard 1973), explaining the discrepancies among studies.

4. Conclusion

Unlike softwood, semi-hard and hardwood cuttings showed good responses of growth and survival. It can, therefore, be deduced from this study that the use of softwood cuttings may not be suitable as a method of vegetative propagation of *C. africana* (Lam.).

Table1. *Effect of branch type on morphological traits of cutting-propagated Cordia africana (Lam.). Cuttings taken from primary, secondary, and tertiary branches at the lower quadrant of the canopy of trees were grown in a non-mist propagator for three months.*

Treatment effect	Days to shoot development	Number of shoots	Height (cm)	Stem diameter (mm)	Stem volume (cm^3)	Number of leaves	Leaf area (cm^2)	Mortality (%)
ANOVA								
Bt	0.0638	**0.0477**	**0.0042**	**0.0017**	**0.0071**	**0.0020**	**0.0155**	**≤0.0001**
Repl	0.9087	0.6268	0.6835	0.2527	0.6070	0.9513	0.5371	0.9637
Bt×Repl	0.9950	0.2859	0.2291	0.5203	0.3098	0.7577	0.2185	0.9836
Scheffe's Test								
Primary	9.56 ± 1.63[a]	3.04 ±0.21[a]	8.90 ±0.34[a]	7.60 ±0.27[a]	5.93 ±0.63[a]	8.87 ±0.54[a]	45.03±2.61[a]	5.56 ±2.42[b]
Secondary	11.11 ±1.10[a]	2.69±0.28[ab]	8.56 ±0.39[a]	7.18 ±0.27[a]	5.20 ±0.51[a]	8.07 ±0.46[a]	42.27±2.73[a]	5.56 ±2.94[b]
Tertiary	10.22 ±1.21[a]	1.76 ±0.16[b]	4.92 ±0.30[b]	4.71 ±0.22[b]	1.35 ±0.18[b]	5.04 ±0.28[b]	23.86±2.30[b]	36.67±3.33[a]

Bt = Branch type, Repl = Replication.

Bold face indicates significant effect.

Means (± SE) followed by different alphabets are significantly different from each other.

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REFERENCES

[1] Alkurdi, M., Mustafa, S., Supuka, J. 2013. Influence of different soil substrates, planting times and stem cuttings type on vegetative propagation and growth characteristics of *Vitex agnus*-Castus L. Actahorticulturae et regiotecturae 1:10-13.

[2] Ambebe, T.F., Agbor, E.W.A., Sime Siohdjie, C.H. 2018. Effect of different growth media on sprouting and early growth of cutting-propagated *Cordia africana* (Lam.). International Journal of Forest, Animal and Fisheries Research 2:28-33.

[3] Antwi-Boasiako, C., Enninful, R. 2008. The influence of maturity and length of stem-cutting on the sprouting potential of *Moringa oleifera* Lam. Journal of Science and Technology 28:140-151.

[4] Aphalo, P., Rikala, R. 2003. Field performance of silver-birch planting-stock grown at different spacing and in containers of different volume. New Forests 25:93-108.

[5] Bekele-Tesemma, A. 2017. Useful trees and shrubs for Ethiopa: identification, propagation and management in 17 agroecological zones. Nairobi: RELMA in ICRAF Project, 552 p.

[6] BGCI 2018. *Cordia africana*. https://www.bgci.org. Accessed 15.03.2018.

[7] Data Description. 1996. Data Desk, Version 6.01. Data Description, Ithaca, NY.

[8] Dawa, S., Rather, Z.A., Tundup, P.,Tamchos, T. 2017. Effect of growth regulators and growth media on rooting of semi hardwood cuttings of rose root stocks. International Journal of Current Microbiology and Applied Studies 6:1042-1051.

[9] Girouard, R.M. 1973. Propagation of spruce by stem cuttings. New Zealand Journal of Forest Science 4:140-149.

[10] Hartmann, H.T., Kester, D.E., Davies, F.T., Geneve, R.L. 2002. Plant Propagation, Principles and Practices, 7th Edition, Prentice Hall, Upper Saddle River, New Jersey. 880 pp.

[11] Hassanein, A.M.A. 2013. Factors influencing plant propagation efficiency via stem cuttings. Journal of Horticultural Science and Ornamental Plants 5:171-176.

[12] Leakey, R.R.B., Tchoundjeu, Z., Longman, K.A., Dick, J.McP., Newton, A., Martin, A., Grace, J., Munro, R.C., Mutoka, P.N. 1990. Low-technology techniques for vegetative Propagation of Tropical trees. Common wealth Forest Review. 69:247- 257.

[13] Magnitskiy, S., Ligarreto M.G., Lancheros, H.O. 2011. Rooting of two types of cuttings of fruit crops *Vaccinium floribundum* Kunth and *Disterigma alaternoides* (Kunth) Niedenzu (Ericaceae). Agronomía Colombiana 29:361-371.

[14] Mosissa, F., Toru, T. 2016. Effect of soil composition on seedling growth and quality of *Cordia africana* at Holetta in the Central High Lands of Ethiopia. Journal of Biology, Agriculture and Healthcare 6:34-41.

[15] Obeng, E.A. 2010. *Cordia africana* Lam. [Internet] Record from PROTA4U. Lemmens, R.H.M.J., Louppe, D. and Oteng-Amoako, A.A. (Editors). PROTA (Plant Resources of Topical Africa/ Ressourcesvégétales de l'Afriquetropicale), Wageningen, Netherlands. http://www.prota4u.org/search.asp. Accessed 07.01.2018.

[16] Okunlola, A.I. 2013. The effects of cutting types and length on rooting of *Duranta repens* in the nursery. Global Journal of Human Social Science Volume XIII Issue III Version I.

[17] Rahman, N., Nabi, T.G., Jan, T. 2004. Effect of different growth-regulators and types of cuttings on rooting of guava (*Psidium guajava* L). *Quarterly* SCIENCE VISION 9:1-5.

[18] Rezende, T.T., Baliza, D.P. Oliveira, D.H., Carvalho, S.P., Ávila, F.W., Passos, A.M.A. Guimarães, R.J. 2010. Types of stem cuttings and environments on the growth of coffee stem shoots. ScientiaAgraria, Curitiba, 11:387-391.

[19] Sajid, M., Pervaiz, M., Rab, A., Jan, I., Haq, I., Wahid, F., Shah, S.T., Ali, I. 2012. Response of plane tree (*Platanus orientalis*) to cuttings and planting dates. The Journal of Animal and Plant Sciences 22:420-424.

[20] Santoso, B.B., Parwata, I GM. A. 2014. Seedling growth from stem cutting with different physiological ages of *Jatropha curcas* L. of West Nusa Tenggara Genotypes. International Journal of Applied Science and Technology 4:5-10.

[21] Washa, B.W. 2014. Effective cutting type in the rooting of *Dalbergia melanoxylon* in Tanzania. International Journal of AgriScience 4:256-259.

[22] Waziri, M.S., Kyari, B.A., Ibrahim, M., Apagu, B., Yunana, B., Askira, M.N., Benisheikh, B.A. 2015. Effect of different soil media on the rooting and growth of *Delonix regia* stem cuttings in Maiduguri. International Journal of Innovative Agriculture and Biology Research 3:6-11.

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