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(RESEARCH ARTICLE)

Interactive effects of branch type and growth medium on early growth and survival of cutting-propagated *Cordia africana* (Lam.)

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Abstract

Cordia africana Lam is an economically and ecologically valuable tree of the Western Highlands forest of Cameroon that is under pressure of over-exploitation and habitat fragmentation. There is a need for fast and easy means of mass production of quality planting stock for upregulation of the population of the species. An experiment was carried out to investigate the combined effects of branch type and growth medium on early growth and survival of *C. africana* cuttings. Treatments were comprised of three branch types (primary, secondary, tertiary) of cuttings origin and three growth media (sand, sawdust, 1:1 sand: sawdust) laid out in a split-plot design in a non-mist propagator. Data were collected three months after the initiation of treatments. Sawdust significantly reduced shoot height, stem diameter, stem volume, number of leaves, and leaf area while it increased mortality. There was no significant difference between sand and sand: sawdust for any of the parameters. The five growth parameters were significantly lower in cuttings from tertiary branches than those obtained from primary and secondary branches. In contrast, mortality of cuttings declined from the tertiary to primary and secondary branch types that displayed statistically similar values of the trait. There was no significant interactive effect of treatments on any of the attributes examined in this study. The findings indicate that a tertiary branch and sawdust may not be a suitable source and growth medium, respectively for vegetative propagation of *C. africana*.

Keywords: *Cordia africana* (Lam.); Growth; Morphology; Mortality; Non-mist propagator

1. Introduction

Cordia africana Lam. (common name large-leaved cordia) is a multipurpose tree that attains a height of 30 m and diameter of 90 cm. It occurs in open forest, riverine forest, edges and clearings in montane forest, and wooded grassland at elevations of 500 - 2700 m. The mean annual rainfall and temperature in its area of distribution is 900 - 2000 mm and 16 - 22°C, respectively (Obeng, 2010). The tree is valued for its moderately hard and durable wood which makes it ideal for construction and production of high quality furniture and household materials (Alemayehu et al., 2016). It is the preferred material for artisanal woodwork, an important income generating activity for indigenous peoples of the western high plateau of Cameroon. In addition, *C. africana* is a good source of medicine, food, fodder, fuelwood, bee forage but also an agent of soil fertility improvement and water conservation (Teklay, 2013; Alemayehu et al., 2016; Raga and Denu 2017). The species is an important component of the Western Highlands forest of Cameroon where its populations and habitats are threatened by unsustainable human behaviour. Most of the forest that once blanketed the landscape has been lost to farming, logging, bushfires and other human driven occurrences. There is a need to protect the remainder of *C. africana* trees and to increase its population in the biome.

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Propagation of *C. africana* can be achieved both sexually and asexually. However, germination of the seeds is slow and uneven (Maundu et al., 2005), making vegetative propagation a useful alternative for its regeneration. The technique is promising for a mass and speedy production of forest planting stock. Moreover, vegetative propagation offers a means to maintain desirable traits of the species which may otherwise get lost or diluted during sexual propagation (Santoso and Parwata 2014).

Stem cutting is the most common of vegetative propagation methods. Its popularity may be explained by low cost and the ease with which it is performed (Alikhani et al., 2011; Waziri et al., 2015; Dawa et al., 2017). The outcome of cutting propagation is determined by many factors including age of donor (Ambebe et al., 2017), growth medium (Ashiono et al., 2017), cutting/branch type (Washa, 2014), plant hormones (Bhardwaj et al., 2017), plant species (Hassanein, 2013), health of donor plant, size of cutting, and environmental conditions (Kramer and Kozlowski 2014). Furthermore, these factors may interact with each other in affecting plants in ways that are not necessarily additive. The purpose of this study was to investigate the interactive effects of branch type and growth medium on early growth and mortality of *C. africana*.

2. Material and methods

2.1. Site of cuttings collection

The cuttings were collected from Big Babanki (latitude 6.12° N, longitude 10.25° E; altitude: 1177 m above sea level), a village located north of Bamenda (latitude 5.95° N, longitude 10.14° E; altitude: 1258 m above sea level) in northwestern Cameroon. The area is characterized by a tropical monsoon climate (mindat.org). The wet season runs from March to November while the dry season extends from November to March. The wettest month is September while the driest is January. The wet season is humid and overcast, the dry season is partly cloudy and warm. During the course of the year, the temperature typically varies from 14.4 °C to 27.8 °C (weatherspark.com).

2.2. Experimental design

The experiment followed a split-plot design with growth medium as the main plot and branch type as the sub-plot. There were three growth media (river sand, sawdust, 1:1 sand:sawdust) and three branch types (primary, secondary, tertiary) from which cuttings were obtained. Each treatment was replicated thrice. The cuttings were obtained from lower branches of healthy trees. Cuttings from all the trees were bulked per branch type, sealed in an air-tight polythene bag and transported to ANAFOR Bamenda where they were resized to a length of 12 cm and set to a depth of 2 cm in three non-mist propagators, each constituting a replication. Each propagator was made up of three chambers containing the three growth media. Each of the chambers was subdivided into three subunits in which cuttings of the three branch types were randomly assigned. There were fifteen cuttings in each treatment combination and replication. Irrigation was done by providing water through PVC tubes that were installed through the layer of growth medium into an underlying water table made up of successive layers of fine sand, stone, and gravel. Each of the tubes had a marking which was used to gauge the water status of the propagator for irrigation. The propagators were situated in a shade house roofed with alternating rows of transparent plastic and metal sheets.

2.3. Data collection

Three months after the start of the experiment, five cuttings were randomly chosen from each chamber and growth medium for data collection. Height (H) and stem diameter (D) of the dominant shoot were measured with a ruler and caliper, respectively. Stem volume (SV) was calculated according to equation 1 (Aphalo and Rikala, 2003):

$$SV = D^2H \quad (1)$$

The number of leaves, and the length and width of the most widely expanded leaf per cutting were determined. In the measurement of leaf dimensions, leaf length (LL) was considered to be the axis from the upper edge of the leaf to the lowest point while leaf width (LW) was taken as the widest region across the lamina perpendicular to the length. Leaf area (LA) was calculated using equation 2 (Mosissa and Toru, 2016):

$$LA = LL \times LW \times LACF \quad (2)$$

Where LACF is the Leaf Area Correction Factor with the value 0.67.

2.4. Statistical analysis

The data were examined for normality and homoscedasticity before being subjected to split-plot ANOVA untransformed. Separation of means for significant effects of treatments was conducted with Scheffe's F-test. All the analyses were carried out in Data Desk 6.01 at 5% level of significance

3. Results and discussion

3.1. Effect of growth medium

There was a significant effect of growth medium on shoot height, stem diameter, stem volume, number of leaves, leaf area, and survival (Table 1). Values of all the six parameters were significantly lower in sawdust than either sand or the combination treatment which did not differ for any of the attributes (Figures 1 and 2). The differences in response can be explained by differences in the physical properties of the growth media (Khayyat et al., 2007). Although sawdust has a lower bulk density and a lower labour requirement, there is an underlying limitation on yield potential because of low air-filled porosity (Baiyeri, 2005). Its high water holding capacity relative to the other growth media can present a major barrier to the diffusion of oxygen with the outcome that a cutting therein experiences anoxia at its base (Loach, 1986). In the course of the experiment, sawdust exhibited a lower need for irrigation than the two other growth media, lending credence to the theory of high water retention.

Table 1 ANOVA p-values for the effects of growth medium (Gm), branch type (Bt) and their interaction on growth and mortality

Response	**Treatment effects**		
	Gm	**Bt**	**Gm × Bt**
Height	0.0020	0.0042	0.5131
Diameter	0.0099	0.0017	0.4987
Stem volume	0.0154	0.0071	0.2713
Number of leaves	0.0006	0.0020	0.2384
Leaf area	0.0035	0.0155	0.1297
Mortality	0.0052	≤0.0001	0.5454

On the other hand, the rapid growth in the other two media portrays sand as an appropriate growth medium with a possession of an optimal volume of gas-filled pore space and an oxygen diffusion rate that allows proper respiration to maintain root uptake of water and nutrients (Fonteno and Nelson, 1990). Moreover, sand warms up more rapidly than sawdust leading to increased root growth and function (Brady and Weil, 1999).

3.2. Effect of branch type

All the six traits investigated here responded to branch type (Table 1). Shoot height, stem diameter, stem volume, number of leaves, and leaf area were significantly lower in cuttings from tertiary than in counterparts from primary and secondary branches. Differences between cuttings from the two higher order branch types were not statistically significant (Figures 1 and 2). Mortality showed a trend in response similar but opposite to that of the other five traits (Figure 2).

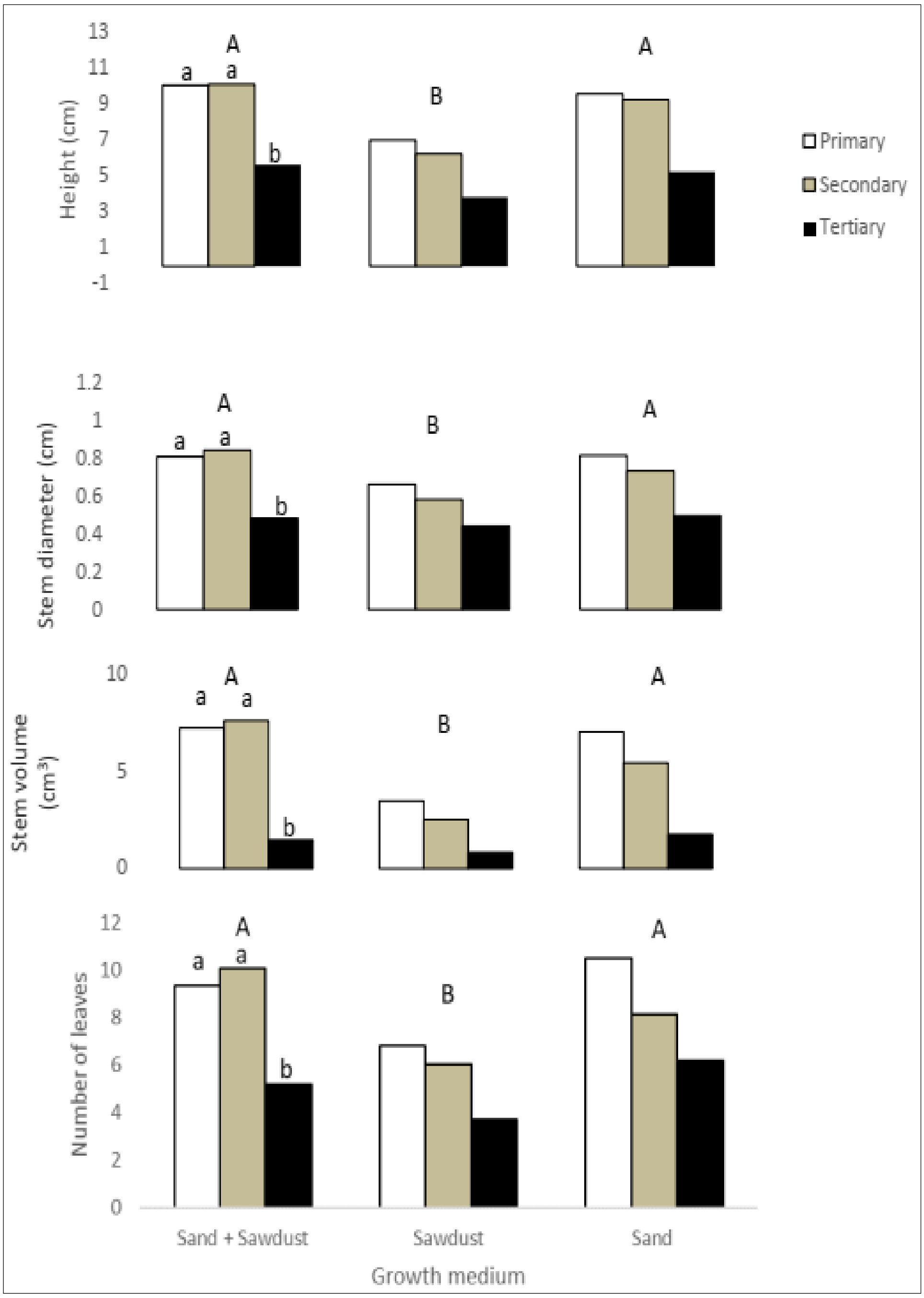

Figure 1 Effects of growth medium, branch type, and their interaction on morphology. The upper and lowercase letters represent the effects of growth medium and branch type, respectively

The overall better performance of the primary and secondary branch derived cuttings was likely due to the presence of carbohydrate reserves that could be easily mobilized for metabolic processes. We, however, expected the secondary type to have an edge over the primary branch in cutting performance because 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 branch 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. The point of origin on the mother plant is an important determinant of shoot formation, growth and survival of cuttings (Hartmann et al., 2002).

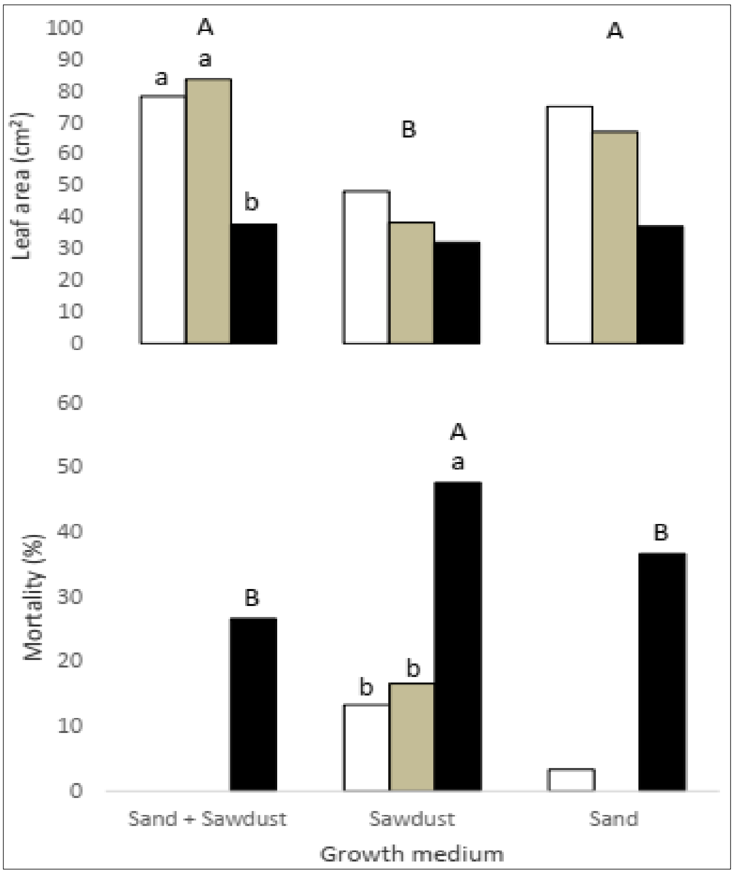

Figure 2 Effects of growth medium, branch type, and their interaction on leaf area and mortality. The upper and lowercase letters represent the effects of growth medium and branch type, respectively

3.3. Combined effects of growth medium and branch type

There were no significant interactions between growth medium and branch type on any parameter, suggesting that the responses of early growth and survival to branch type were not dependent on growth medium.

4. Conclusion

In this study, growth and survival of cutting-propagated *C. africana* declined under the tertiary branch type and sawdust treatments. Thus, the use of this growth medium and cuttings from this branch order may not be suitable for cutting propagation of species. In contrast, good results may be expected with a sand-based medium and cuttings from higher order branches.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

References

[1] Alemayehu, G., Asfaw, Z. and Kelbessa, E. (2016). *Cordia africana* (Boraginaceae) in Ethiopia: A review of its taxonomy, distribution, ethnobotany and conservation status. International Journal of Botany Studies 1: 38-46.

[2] Alikhani, L., Ansari, K., Jamnezhad, M. and Tabatabaie, Z. (2011). The effect of different mediums and cuttings on growth and rooting of pomegranate cuttings. Iranian Journal of Plant Physiology 1: 199-203.

[3] Ambebe, T.F., Akenji, M.J. and Njoya, M.T.M. (2017). Growth responses of branch cuttings of *Cordia africana* to physiological age. Journal of Horticulture and Forestry 9: 91-97.

[4] Aphalo, P. and 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] Ashiono, F.A. Wangechi, H.K. and Kinyanjui, M.J. (2017). Effects of sawdust, forest soil and cow dung mixtures on growth characteristics of blue gum (*Eucalyptus saligna*) seedlings in South Kinangop Forest, Nyandarua, Kenya. Open Journal of Forestry 7: 373-387.

[6] Baiyeri, K.P. (2005). Response of Musa species to macro-propagation: II: The effects of genotype, initiation and weaning media on sucker growth and quality in the nursery. African Journal of Biotechnology 4: 229-234.

[7] Bhardwaj, D.R., Singh, R., Lal, H., Nath, V. and Singh A.K. (2017). Effect of node number and auxin concentration on propagation of ivy gourd (*Coccinia cordifolia* Cogn) through stem cuttings. Vegetos 30:1.

[8] Brady, N.C. and Weil, R.R. (1999). The Nature and Properties of Soils. 12th Edition, Prentice Hall Publishers, London.

[9] Dawa, S., Rather, Z.A., Tundup, P. and 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.

[10] Fonteno, W.C. and Nelson, P.V. (1990). Physical properties of plant responses to rockwool amended media. Journal of the American Society for Horticultural Science 115: 375-381.

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

[12] Hassanein, A.M.A. (2013). Factors influencing plant propagation efficiency via stem cuttings. Journal of Horticultural Science and Ornamental Plants 5(3): 171-176.

[13] Khayyat, M., Nazari, F. and Salehi, H. (2007). Effect of different pot mixtures on pothos (*Epipremnum Aureum* L. And Andre 'Golden Pothos') growth and development. American-Eurasian Journal of Agricultural and Environmental Sciences 2: 341-348.

[14] Kramer, P.J. and Kozlowski, T.T. (2014). Physiology of woody plants. Academic Press, San Diego, California.

[15] Loach, K. (1986). Rooting of cuttings in relation to propagation medium. Proceedings of the International Plant Propagators' Society 35: 472-485.

[16] Maundu, P.M., Tengnäs, B. and Birnie, A. (2005). Useful trees and shrubs for Kenya. Technical Handbook No. 35. World Agroforestry Centre, Nairobi.

[17] mindat.org. Babanki, North West Region, Cameroon. https://www.mindat.org/feature-2235293.html. Accessed 24.12.2022.

[18] Mosissa, F. and 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.

[19] 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/Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands.

[20] Raga, D. and Denu, D. (2017). Population density of *Cordia africana* Lam. across land use gradients in Jimma Highlands, southwest Ethiopia. International Journal of Sciences: Basic and Applied Research 35: 157-166.

[21] Santoso, B.B. and 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.

[22] Teklay, A., Abera, B. and Giday, M. (2013). An ethnobotanical study of medicinal plants used in Kilte Awulaelo District, Tigray Region of Ethiopia. Journal of Ethnobiology and Ethnomedicine 9: 65.

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

[24] Waziri, M.S., Kyari, B.A., Ibrahim, M., Apagu, B., Yunana, B., Askira, M.N. and 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.

[25] Weatherspark.com. Climate and average weather year round in Babanki. https://weatherspark.com/y/65571/Average-Weather-in-Babanki-Cameroon-Year-Round. Accessed 24.12.2022.