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Research Paper

Rooting and Sprouting of *Vitex diversifolia* Bak. Stem Cuttings as Influenced by Crown Position

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ABSTRACT: *This study was aimed at testing the effect of crown position on rooting and sprouting characteristics of Vitex diversifolia Bak. cuttings. The plant material was collected for lower-, mid-, and upper-third of the crown and raised in a non-mist propagator for four months. Cuttings from the upper-third crown position exhibited a significantly lower (56.0 %) rooting rate than counterparts from the lower- (69.5 %) and mid- (78.5 %) crown positions. Similarly, there was a 42.5% margin of decline in sprouting to the lower-third from the other two treatment levels which were neither different for rooting nor sprouting percentage. In contrast, number of roots (3.90 ± 0.48; 3.50 ± 0.70; 4.10 ± 0.64), number of shoots (2.33 ± 0.65; 2.60 ± 0.48; 3.4 ± 0.79), root length (13.38 ± 1.45 cm; 14.96 ± 2.24 cm; 13.70 ± 1.21 cm), root diameter (0.15 ± 0.02 mm; 0.17 ± 0.03 mm; 0.19 ± 0.03 mm), and root fresh weight (1.03 ± 0.17 g; 1.03 ± 0.23 g; 1.19 ± 0.16 g) were unaffected by crown position. The results suggest that crown position is an important determinant of vegetative propagation success in Vitex diversifolia. Ideally, using cuttings lower down in the crown is encouraged.*

KEYWORDS: *Crown Position, Cutting Propagation, Rooting, Sprouting, Vitex diversifolia*

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I. INTRODUCTION

Vitex is the largest genus of the family Verbenaceae. It is made up of approximately 270 species, generally trees and shrubs, distributed in tropical, subtropical, and temperate regions of the world [1]. With anti-inflammatory, antibacterial, and hepatocuractive properties, the *Vitex* plant is valued for its use in traditional medicine. For instance, leaves and seeds of *Vitex negundo* constitute a cure for rheumatism and inflammatory joint conditions [2], leaves of *Vitex madiensis* are used to prevent malaria [3], and the bark of *Vitex diversifolia* is effective against tooth and skin diseases, headache and intestinal bilharzias [4]. There is a wide array of other uses embedded in other members of the genus.

The Cameroon Highlands ecoregion comprises of highland forests and grassland patches mainly above 900 m elevation scattered along the border area between Cameroon and Nigeria. Along an altitudinal gradient, the vegetation changes from submontane to montane forests and ultimately subalpine grassland. Apart from having one of the highest levels of endermism among vascular plants in Africa [5], the forests provide a wide range of ecosystem services. Most of the forest that once totally covered the western Cameroon Highlands has been lost to unsustainable human activities like harvest of trees and tree parts for medicine, fires established by farmers and graziers, and collection of firewood and construction materials [5] [6] [7] [8] [9]. The forests are found on fertile volcanic soils, which in combination with adequate rainfall, have attracted a high population of farmers and other inhabitants with counterproductive tendencies. Currently, the forest remnants are in themselves under enormous pressure and threat.

Vitex diversifolia Bak. is an important component of the western Cameroon Highlands biome [10]. It presents itself as a shrub or small tree up to 8 m high with a short bole and an open crown in grassland, wooded grassland or dense woodland habitats at elevations ranging from 1,000 to 1,800 m [11] [12]. In tropical Africa, its distribution spans from Senegal to Cameroon and as far as Egypt and Sudan [11]. The species is amongst the most exploited of the genus in Cameroon. Aside from medicine, it is used for fuel and to make charcoal [13]. Moreover, the leaves yield an essential oil of such sweet and penetrating fragrance that it has been recommended for commercial development [14]. There is a need for mass production of quality planting stock of desirable species to rehabilitate the western Cameroon Highlands. Discovering a simple, cost effective but efficient means is a promising option for meeting this end.

Vegetative propagation is a practical means for mass production of high quality regeneration stock. Unlike with sexual propagation, the new independent plant produced through vegetative means is a clone in which desirable traits of the donor plant are preserved. Stem cutting is the most common of vegetative propagation methods for herbaceous and woody plants. Reasons for the popularity generally revolve around the low cost [15] and ease [16] associated with the the technique. The success of cutting propagation may be confounded by the age of the donor plant [17], crown position [18], growth medium [19], type of cutting [20], phytohormones [21], size of the cutting and health of the donor plant [22] among others. Furthermore, the responses of the cuttings to some of these factors are confounded by species [23]. In this study, the effect of crown position of origin on rooting and sprouting characteristics of *Vitex diversifolia* was investigated.

II. MATERIALS AND METHODS

2.1 Plant material

Stem cuttings of *Vitex diversifolia* were collected from twelve healthy trees in disturbed forest patches in Tubah Sub-Division (4°50’ – 5°20’N, 10°35’ – 11°59’E; 950 – 1500 m asl) of the North West Region of Cameroon. There were five cuttings each from the lower-, mid-, and upper-third locations of the crown. Tubah is located some 15 km from Bamenda, the administrative headquarter of the North West Region. The contribution of degraded forest and grassland vegetation in Tubah to the overall reduction of the biota of the Bamenda - Banso Highlands fraction of western Cameroon Highlands is overwhelming. The material from each crown position was bulked and sealed in a leak-proof polythene bag. They were then transported to the RETAFO nursery in Bamenda III Sub-Division.

2.2 Study site

Bamenda III is a municipality which forms part of the Bamenda metropolis. The latter is characterized by a wet season that runs from April to October and a dry season from November to March. With an annual rainfall of 2567 mm, the month with the highest number of rainy days is July with 28.20 days; in contrast, December with 1.13 rainy days ranks lowest. January is the driest month with 9 mm while an average of 380 mm of precipitation occurs in September making it the wettest. In the course of the year, relative humidity varies from 38.85 % in January to a peak of 90.29 % in August. The mean annual temperature is 21.6 °C. The warmest and coldest months of the year are February and July with average temperatures of 21.6 °C and 17.6 °C, respectively [24].

2.3 Experimental design

Cuttings of similar diameter were resized to a length of 20 cm and given a slanting cut at the distal end. Twenty cuttings from each of the three crown positions were dipped in a 1:1 v/v mixture of aloe vera gel and coconut water for 1 minute before being set to a depth of 4 cm into coarse sand in a non-mist propagator. There were two propagators, each representing a replication in which all three treatments were randomly assigned. A light overhead watering was given immediately after planting to get the cuttings settled. The propagator consisted of a large wooden box sealed with polythene sheet. A water table made up of successive layers of fine sand, stone, and gravel was created underneath the substrate. A PVC tube installed through the substrate into the water table made it possible for the water level in the propagator to be gauged. When irrigating, water was allowed to replenish the water table up to the upper limit of the uppermost (gravel) layer so that the substrate was kept moist. A wooden frame was constructed over the box and then the entire set-up was enclosed in polythene sheet to maintain a humid environment around the cuttings. Whenever the propagator was opened to inspect the cuttings and/or check the water status of the substrate, 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.

2.4 Data collection

Four months after the initiation of the experiment, the number of cuttings that formed roots and sprouted were counted for calculation of rooting and sprouting percentage as per equation 1:

$$\text{Percent rooting/sprouting} = \frac{\text{Number of cuttings rooted/sprouted}}{\text{Number of cuttings planted}} \times 100 \qquad (1)$$

Five cuttings were then randomly chosen from each treatment × replication for further data collection. The number of shoots was recorded. The cuttings were carefully uplifted and the root system rinsed free of substrate. Roots were counted after which root system length, diameter of main root, and root fresh weight were determined.

2.5 Statistical analysis

The data were examined graphically for normality using probability plots for residuals and homogeneity of variance using scatter plots. The effect of crown position on rooting and sprouting traits was tested with ANOVA on the untransformed data. The linear model was as presented in equation 2:

$$Y_{ijk} = \mu + T_i + R_j + TR_{ij} + \varepsilon_{(ij)k} \quad (2)$$

where μ is the overall mean, *T* is the fixed effect of crown position, *R* is the random effect of replication, and Ɛ is the experimental error.

Scheffe's test was used for separation of means of parameters with a significant ANOVA result. All the analyses were performed in Data Desk 6.01 at $\alpha = 0.05$.

III. RESULTS AND DISCUSSION

Percent rooting and percent sprouting were markedly influenced by the crown position of stock plants from which cuttings were taken (Table 1). Values of both traits were significantly reduced by the upper-third crown position (Table 2). On the other hand, the ANOVA did not detect as significant the differences between the lower- and mid-third crown position treatments for either of the parameters. The findings presented here corroborate those of other investigators. In a study on jack pine (*Pinus banksiana*), cuttings from mid to lower crown positions generally rooted more readily than those of upper crown origin. Although the rooting potential was adversely affected by age of the donor plant, the trend of response to crown position was somewhat consistent [25]. Similarly, Hakamata et al. [26] found greater percent rooting of Japanese black pine (*Pinus thunbergii*) in cuttings from the lower (74.7%) than upper crown (34.7%) as was also the case in fraser fir (*Abies fraseri*) [27]. Likewise, percent rooting and sprouting of teak (*Tectona grandis*) and shisham (*Dalbergia sissoo*) were highest in mid followed by basal and least in upper crown position cuttings [28] [29]. However, the trends reported here are not universal. While percent rooting of eastern red cedar (*Juniperus virginiana*) cuttings was unaffected crown position [30], that of iroko (*Milicia excelsa*) was greater for cuttings from apical than basal crown positions [31]. The inconsistency in response patterns is likely indicative of a species related constraint on crown position control of rooting and sprouting.

Table 1: ANOVA p-values for the effect of crown position (Pos.), replication (Rep.) and their interaction on rooting and sprouting parameters

Source	Pos.	Rep.	Pos. × Rep.
Percent rooting	0.0393	0.0584	0.6875
Percent sprouting	0.0238	0.0823	0.6974
No. of roots	0.6316	0.4204	0.6758
No. of shoots	0.5010	0.0882	0.3427
Root length	0.9459	0.2560	0.0554
Root diameter	0.7378	0.7456	0.3991
Root fresh weight	0.6992	0.4319	0.2749

In the present study, the reason(s) underpinning the differences in the percentages of rooting and sprouting with crown position of cuttings was not investigated. It is, however, possible that the amounts of growth-promoting and rooting-inhibiting substances varied with the crown position of cutting origin. In dawn redwood (*Metasequoia glyptostroboides*), for example, a high rooting ability of lower crown cuttings was associated with high levels of hormones therein [32]. In contrast, low levels of rooting inhibiting substances have been recorded at lower crown positions in other instances [33]. Alternatively, the different crown positions from which the cuttings were taken might differ in physiological maturity. This assertion is substantiated a demonstration of an approximately 26% more rooting in lower than mid and top crown cuttings of black spruce (*Picea mariana*) [34]. While the cuttings from the lower crown regained an almost juvenile appearance after rooting, those from the top of the crown maintained symptoms of advance maturation. The ability of plants propagated by vegetative means to phenotypically express maturation-related traits of the mother plant is well documented [17] [35] [36] [37]. Differences in physiological and anatomical factors can influence the level of available mineral nutrients, growth regulators, and carbohydrates along the plant axis and obviously cuttings. Browne et al. [25] reported higher nitrogen and boron contents in upper than lower crown positions and higher copper and manganese levels in the lower crown of jack pine. The importance of low nitrogen levels for root initiation has been highlighted [38].

Table 2: Mean ± SE of rooting and sprouting parameters as affected by crown position

Parameter	Lower crown	Mid crown	Upper crown	Overall mean
Rooting %	69.50[a]	78.50[a]	56.00[b]	68.00
Sprouting %	80.00[a]	75.00[a]	35.00[b]	63.33
No. of roots	3.90 ± 0.48[a]	3.50 ± 0.70[a]	4.10 ± 0.64[a]	3.83 ± 0.61
No. of shoots	2.33 ± 0.65[a]	2.60 ± 0.48[a]	3.40 ± 0.79[a]	2.78 ± 0.64
Root length (cm)	13.38 ± 1.45[a]	14.96 ± 2.24[a]	13.70 ± 1.21[a]	14.01 ± 1.63
Root diameter (mm)	0.15 ± 0.02[a]	0.17 ± 0.03[a]	0.19 ± 0.03[a]	0.17 ± 0.03
Root fresh weight (g)	1.03 ± 0.17[a]	1.03 ± 0.23[a]	1.19 ± 0.16[a]	1.08 ± 0.19

Number of roots and shoots, and length, diameter, and fresh weight of root were unaffected by treatments (Table 1). In line with our results, root length, root weight, and number of branches of sage (*Salvia officinalis*) cuttings did not respond to crown position, at least, in the dry season segment of the study of Zigene et al. [39]. Perhaps the effect of crown position on rooting and sprouting characteristics is also controlled by environmental conditions. Crown position have been found to influence these attributes in other studies however. The discrepancy in findings may be due to variability in experimental procedures as well as the timing and duration of experiments.

IV. CONCUSION

Generally it was observed that crown position had an effect on propagation ability of Vitex diversifolia. Upper canopy cuttings demonstrated lower propagation ability. Therefore, the mid to lower crown positions can be recommended for the development of Vitex diversifolia plantlets using stem cuttings. It, however, remains to be determined if the crown position effects observed in a propagator are obtainable under more variable field conditions.

REFERENCES

[1]. Devi, W.R. and Singh, C.B. (2014). Chemical composition, anti-dermatophytic activity, antioxidant and total phenolic content within the leaves essential oil of *Vitex trifolia*. International Journal of Phytocosmetics and Natural Ingredients 1(1): 5-10.

[2]. Callmander, M.W., Phillipson, P.B. and Schatz, G.E. (2014). Towards a Revision of the Genus *Vitex* L. (Lamiaceae) in Madagascar I: A Distinctive New Species from Northeastern Madagascar. Candollea 69(2): 141-147.

[3]. Ondo, J.P., Lekana-Douki, J.B., Bongui, J.B., Zangedou, E.S., Zatra, R., Toure-Ndouo, F.S. and Elomri, A. (2012). In vitro antiplasmodial activity and cytotoxicity of extracts and fractions of *Vitex madiensis*, medicinal plant of Gabon. Tropical Medicine and International Health 17(3): 316-321.

[4]. Zerbo, P., Millogo Rasolodimby, J., Nacoulma Ouedraogo, O. and Van Damme, P. (2011). Plantes médicinales et pratiques médicales AU Burkina Faso: Cas des Sanan. Bois et Forets Des Tropiques 307(41).

[5]. Ndenecho, E.N. (2011). Local livelihoods and protected area management: biodiversity conservation problems in Cameroon. Langaa RPCIG, Bamenda, Cameroon.

[6]. Assi-Kaudjhis, C. (2012). Vegetation evolution in the mountains of Cameroon during the last 20 000 years: pollen analysis of lake Bambili sediments, forest ecosystems - more than just trees. In: Blanco, J.A. (ed.), Forest Ecosystems-more than Just Trees. Rijeka, Croatia: InTech Publishers.

[7]. Kometa, S.S. (2013). Wetlands exploitation along the Bafoussam – Bamenda road axis of the Western Highlands of Cameroon. Journal Human Ecology 41(1): 25-32.

[8]. Sedláček, O., Mikeš, M., Albrecht, T., Reif, J. and Hořák, D. (2014). Evidence for an edge effect on avian nest predation in fragmented afromontane forests in the Bamenda-Banso Highlands, NW Cameroon. Tropical Conservation Science 7(4): 720-732.

[9]. Melle, E.M., Nkwatoh, A.F., Achiri, A.B. and Hele, T.N. (2016). The unsustainable exploitation of wildlife-habitat resources in Tubah Sub-divisin, North West Region, Cameroon. International Journal of Current Research in Biosciences and Plant Biology 3(8): 32-38.

[10]. Lambi, C.M. and Ndenecho, E.N. (2010). Ecology and natural resource development in the western Highlands of Cameroon: Issues in natural resource management. Langaa RPCIG, Bamenda, Cameroon.

[11]. Arbonnier, M. (2004). Trees, shrubs and lianas of West African dry zones. CIRAD Montpellier, France/Margraf publishers, Weikersheim, Germany/Muséum Nationale d'Histoire Naturelle (MNHN), Paris, France.

[12]. Ruffo, C.K., Birnie, A. and Tengnas, B. (2002). Edible wild plants of Tanzania. Regional Land Management Unit, Nairobi.

[13]. Ndenecho, E.N. (2009). Cropping systems and post-cultivation vegetation successions: agro-ecosystems in Ndop, Cameroon. Journal of Human Ecology 27(1): 27-33.

[14]. Tropical Plants Database, Ken Fern. tropical.theferns.info. 2022-10-02. <tropical.theferns.info/viewtropical.php?id=Vitex+madiensis>.

[15]. 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(1): 6-11.

[16]. 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 Sciences l6(4): 1042-1051.

[17]. 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(10): 91-97.

[18]. Chung, D.Y. and Lee, K.J. (1994). Effects of clones, ortet age, crown position, and rooting substance upon the rooting of cuttings of japanese larch (*Larix leptolepis* S. et Z. Gordon). Journal of Korean Society of Forest Science 83(2): 205-210.

[19]. 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(4): 373-387.

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

[21]. 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).

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

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

[24]. Climate-Data.org. Bamenda climate (Cameroon): data and graphs for weather and climate in Bamenda, available at: https://en.climate-data.org/africa/cameroon/northwest/bamenda-2905/ (accessed 5 December 2022).

[25]. Browne, R.D., Davidson, C.G. and Gobin S.M. (1996). Effects of crown position and plant age on rooting of jack pine long shoot cuttings. Tree Planter's Notes 47(3): 100-104.

[26]. Hakamata, T., Hiraoka, Y., Yamamoto, S. and Kato, K. (2016). Effect of family, crown position, number of winter buds, fresh weight and the length of needle on rooting ability of *Pinus thunbergii* Parl. cuttings. iForest 9(3): 370-374.

[27]. Rosier, C.L., Frampton, J., Goldfarb, B., Wise, F.C. and Blazich, F.A. (2005). Stumping height, crown position, and age of parent tree influence rooting of stem cuttings of fraser fir. HortScience 40(3): 771-777.

[28]. Husen, A. and Pal, M. (2003). Clonal propagation of *Tectona grandis* Linn. f. by leafy stem cuttings: effects of branch position and auxin treatment on the rooting ability. Proceedings of the International Conference on Quality Timber Products of Teak from Sustainable Forest Management. Peechi, Kerala State, India, 2-5 December 2003.

[29]. Husen, A. (2004). Clonal propagation of *Dalbergia sissoo* Roxb. by softwood nodal cuttings: effects of genotypes, application of IBA and position of cuttings on shoots. Silvae Genetica 53(2): 50-55).

[30]. Henry, P.H., Blazich, F.A. and Hinesley, L.E. (1994). Vegetative propagation of eastern red cedar by stem cuttings. HortScience 27(12): 1272-1274.

[31]. Ofori, D., Newton, A.C., Leakey, R.R.B. and Grace, J. (1997). Vegetative propagation of Milicia excelsa by leafy stem cuttings: Effects of maturation, coppicing, cutting length and position on rooting ability. Journal of Tropical Forest Science 10(1): 115-129.

[32]. Ogasawara, K. and Shidei, T. (1966). Studies on the cuttings of forest trees. Special relationship between the rooting responses of cuttings and the balance of phytohormones in cuttings. Bulletin of the Kyoto University Forests 35: 19-38.

[33]. Hashizume, H. and Taniguchi, S. (1981). Vegetative propagation of the family of Hinoki (*Chamaecyparis obtusa* Endl.) plus tree using physiologically immature cuttings from the scion stool of the low-cut style and some studies on the relationship between the physiological aging of cuttings and rooting ability. Bulletin of the Tottori University Forests 13: 1-17.

[34]. Tousignant, D., Villeneuve, M., Rioux, M. and Mercier, S. (1995). Effect of tree flowering and crown position on rooting success of cuttings from 9-year-old black spruce of seedling origin. Canadian Journal of Forest Research 25: 1058-1063.

[35]. Hutchinson, K.W., Sherman, C.D., Weber, J., Smith, S.S., Singer, P.B. and Greenwood, M.S. (1990). Maturation in larch. II. Effects of age on photosynthesis and gene expression in developing foliage. Plant Physiology 94: 1308-1315.

[36]. Ambebe, T.F. and Dang, Q.L. (2009). Limits to tree growth and the age-related decline in aboveground forest productivity. In: Karam, W.P. (Ed.). Tree growth: Influences, Layers and Types. Nova Science Publishers, New York: 109-120.

[37]. Hartmann, H.T., Kester, D.E., Davies, F.T. and Geneve, R. (2011). Plant propagation: principles and practices, 8th ed., Prentice Hall, Upper Saddle River, NJ.

[38]. Blazich, F.A. (1988). Mineral nutrition and adventitious rooting. In: Davis, T.D., Haissig, B.E., Sankhla, N. (Eds). Adventitious root formation in cuttings. Portland, OR: Dioscorides Press: 61-69.

[39]. Zigene, Z.D. and Kassahun, B.M. (2016). Effect of cutting size and position on propagation ability of Sage (*Salvia officinalis* L.). International Journal of Advanced Biological and Biomedical Research 4(1): 68-76.