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Root segments cuttings of *Vitex doniana* Sweet: effect of origin and alignment

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ABSTRACT

Vitex doniana (Verbanaceae) is one of the most popular local species among farmers in the high Guinean savannah of Cameroon. Unfortunately, it is under anthropogenic pressure and this tends to reduce its population. The objective of this work was to study the effect of the origin and the alignment of the cuttings of the root segments on budding and rooting. The origin of the cuttings (Dang, Poli) constituted the main treatment and their alignment in the substrate represented the secondary treatment. The cutting of the root segments was carried out according to an experimental device in split-plot with three replications. The experimental unit consists of 10 cuttings. A total of 180 cuttings of root segments (2×3×3×10) were handled. It emerged from this study that cuttings from root segments of different origins reacted differently to vegetative propagation by cuttings. Cuttings from Poli budded better (67.77±26.82%) than those from Dang (36.66±12.24%). The analysis of variance showed a significant difference (0.0001<0.001) with regard to the origin of the cuttings. The alignment of the cuttings in the substrate also affected budding. The vertical and oblique alignment had the best budding rates (63.33%). The buds appeared mainly at the proximal pole of the cuttings (44.44±26.6%). As for rooting, the cuttings from Poli took better root (57.41±9.32%) than those from Dang (26.35±6.2%). These results contribute to the optimization of the domestication strategies of this species. The domestication of this species of socio-economic interest could contribute to improving the living conditions of local populations.

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Keywords: *Vitex doniana*, Origin, alignment, Cuttings, Root, Substrate.

INTRODUCTION

The tropical dry forests constitute an exceptional reservoir of biodiversity. They provide ecosystem goods (fruit, fodder, medicine, etc.) and ecological services (Schreckenberget al., 2006). The degradation of this biodiversity generated by anthropogenic activities gives rise to a feeling of concern at the environmental, social and

economic consequences that could result from it (Balvanera et al., 2006; Cardinale, 2012).

In Cameroon in general and in the Northern part in particular, ecosystems are diversified and rich in species of socio-economic interest with plants such as *Vitex doniana* (Verbanaceae), which are among the most popular local species to peasants

(Tchiégang-Megueni et al., 2001; Mapongmetsem and Laissou, 2010). Indeed, *V. doniana* is a tree that is widely used in several regions of Africa for its multiple qualities. Unfortunately, this species still lives in the wild and is under various pressures (Mapongmetsem et al., 2000). Given its importance to rural communities, this plant deserves more attention in order to maximize the potential it represents.

Therefore, the low cost vegetative propagation technique such as cuttings of root segments appears as one of the viable solutions for the multiplication of endangered species (Meunier et al., 2008, Mapongmetsem et al., 2012). It makes the exact copy of the parental characters and has advantages following the production of plants identical to the parental generation, the rapid production of plants, especially in species whose multiplication by seed is difficult or poor (Hannah and Jan, 2003). A perfect mastery of both exogenous and endogenous factors will facilitate the multiplication of this plant by cuttings under polypropagator. Several studies carried out with this in mind (Mapongmetsem et al., 2016; Fawa, 2015) have focused on various aspects. The lack of scientific information on the origin and alignment of cuttings of root segments in the substrate is a major handicap. Hence the work objective which was to study the effect of the origin and the alignment of the cuttings of root segments in the substrate on budding and rooting.

MATERIALS AND METHODS

Description of Study site

Sampling of *Vitex doniana* root segment cuttings took place in two agro-ecological zones: the highland Guinean savannah zone more precisely in Dang and the Sudano-Sahelian zone more precisely in Poli.

The Eastern Sudano-Sahelian zone includes between 8°36" to 12°54" north latitude, and 12°30" to 15°42" east longitude. It covers the North and Far North regions of

Cameroon. Poli belongs to this zone, the prevailing climate is of the Sudanian type with a humid nuance. It is characterized by two distinct more or less contrasting seasons. A dry season ranging from 6 to 7 months from November to April, a rainy season which extends over 4 to 5 months from May to October. The average temperature ranges from 27°C for the coolest months to 32°C for the hottest months. The soil is made up of ferralitic structures, hydromorphs and planosols with thick horizons.

The vegetation looks like a clear forest reminiscent of the plant formations of the Adamawa plateau. The most common ligneous species are: *Isobertinia doka*, *Anogeissus leiocarpa*, *Terminalia laxiflora*, *Piliostigma thonningii* (PDC, 2014).

Sampling design

The removal of the *Vitex doniana* root fragments consisted in carefully excavating a few carefully chosen mother plants (healthy individuals, present tree), from the first hours of the morning to minimize cell dehydration. The fragments of lateral roots taken were cut using a 20cm cutting pruner, a dimension favorable for the budding of *Vitex doniana* root (Mapongmetsem et al., 2017). The root segment cuttings were brought to the nursery using a cooler containing pieces of ice. At the nursery, the root segment cuttings from Dang and Poli were cultivated in the polypropagator, containing previously prepared substrate composed of the black earth/sawdust mixture (50/50) which is best for budding the cuttings of root segments of *Vitex doniana* (Mapongmetsem et al., 2012). These roots segments cuttings were arranged in a vertical, horizontal and oblique alignment. The test was watered daily morning and evening using a sprayer which delivered the water in very fine droplets. The evaluation of the test was carried out weekly as soon as the first buds appeared.

The experimental device used is split-plot with three replication, in which the origin of the cuttings (Dang, Poli) constitutes the main treatment and the alignment of the cuttings in the substrate represents the secondary treatment. The experimental unit consisted of 10 cuttings. A total of 180 roots segment cuttings ($2 \times 3 \times 3 \times 10$) were handled.

Data collection and statistical analysis

Data collection was done weekly when the first buds appeared. The number of cuttings having budded, pole of appearance of buds, the number of leaves, the number of aerial axes, the height of the aerial axes, the number of cuttings having emitted roots, the number of roots, the length of the root were evaluated.

The data collected was analyzed using Statgraphic plus 5.0 software which was used to perform the analysis of variance. Duncan Multiple Range's Test was used to separate the significant means.

RESULTS

Budding of root segments cuttings

The cuttings of *Vitex doniana* root segments were cultivated on August 01, 2018 and the first aerial shoots appeared on September 10, 2018, 6 weeks after their cultivation.

Effect of origin of cuttings

Eighteen weeks after the cuttings were cultivated, the budding rate varied from $36.66 \pm 12.24\%$ in root segment cuttings from Dang to $67.77 \pm 26.82\%$ in those from Poli (Figure 1). The analysis of variance indicated a significant difference between the origins ($0.0001 < 0.001$).

Effect of cuttings alignment

Concerning the alignment of the root segment cuttings in the substrate, the budding rate oscillates between $30 \pm 8.94\%$ in roots segments cuttings inserted in horizontal

alignment at $63.33 \pm 22.5\%$ and $63.33 \pm 28.04\%$ in those inserted in a vertical and oblique alignment (Figure 2). The analysis of variance indicated a significant difference ($0.0004 < 0.001$). The alignment of the cuttings of root segments influenced budding.

*Effect of the interaction between the origin * alignment of the cuttings of root segments*

Concerning the interaction between the origin*alignment of the root segment cuttings, at the end of the test, budding rate varied from $23.33 \pm 5.65\%$ in cuttings of root segments from Dang inserted in the substrate in alignment horizontal at $86.7 \pm 15.27\%$ in those of Poli, inserted into the substrate in an oblique alignment (Table 1). The analysis of variance did not indicate a significant difference ($0.0855 > 0.05$). The origin and alignment of the combined cuttings did not influence the budding of the cuttings of root segments.

Polarity of buds

Origins effect on parts of bud appearance

In general, the rate of appearance of buds on cuttings of root segments varied from $0.55 \pm 0.39\%$ at the distal pole to $44.44 \pm 26.6\%$ at the proximal pole (Table 2). The pole of appearance of the buds at the proximal pole obeys the budding of the cuttings of root segments. The analysis of variance showed a significant difference for the buds that appeared at the proximal pole ($0.0039 < 0.01$) and on the middle part ($0.0279 < 0.05$) of the cuttings from the two localities.

Influence of the insertion of cuttings in the substrate on the appearance of buds

Regarding the arrangement of the cuttings of root segments in the substrate, the rate of appearance of buds varied from $0.5 \pm 0.32\%$ at the distal pole to $44.22 \pm 18.71\%$ at the proximal pole (Table 3). The cuttings inserted vertically into the substrate had a budding rate of $61 \pm 23.16\%$ at the proximal pole. The analysis of variance presented a significant difference for the proximal pole

($0.0001 < 0.001$) and the middle part ($0.023 < 0.05$) for the three types of insertion of cuttings into the substrate.

Rooting cuttings from root segments

At the end of the trial, at 18 weeks after their cultivation, several cuttings of root segments from all positions and from all origins had taken roots (Figure 3).

Influence of the origin of the cuttings

At the 18th week, the percentage of cuttings of root segments rooted according to origin varied from $26.35 \pm 6.2\%$ for cuttings of root segments from Dang to $57.41 \pm 9.32\%$ for those from Poli (Figure 4). The analysis of variance indicated a significant difference ($0.026 < 0.05$). The origin of the cuttings influenced rooting.

Effect of the alignment of the cuttings in the substrate

At the end of the trial (18th week), the rooting rate fluctuated from $26 \pm 8.94\%$ in root segment cuttings inserted in a horizontal

alignment in the substrate to $53.35 \pm 7.20\%$ and $50.31 \pm 11.2\%$ inserted respectively in an oblique and vertical alignment in the sand/sawdust substrate (Figure 5). The analysis of variance indicated a significant difference ($0.002 < 0.01$). The oblique alignment in the substrate improved the rooting rate of the cuttings.

Influence of the origin interaction * alignment of the cuttings in the substrate

The rooting assessment occurred at the end of the trial that is to say at the 18th week. The percentage of cuttings rooted according to the source and the method of insertion in the sand/sawdust substrate varies from 21.34 ± 5.77 in cuttings inserted in a horizontal alignment for cuttings from Dang to 83.61 ± 11.27 in those inserted in an oblique alignment for cutting originating in Poli (Table 4). The analysis of variance shows no significant difference ($0.085 > 0.05$). The alignment of the cuttings did not influence the rooting rate.

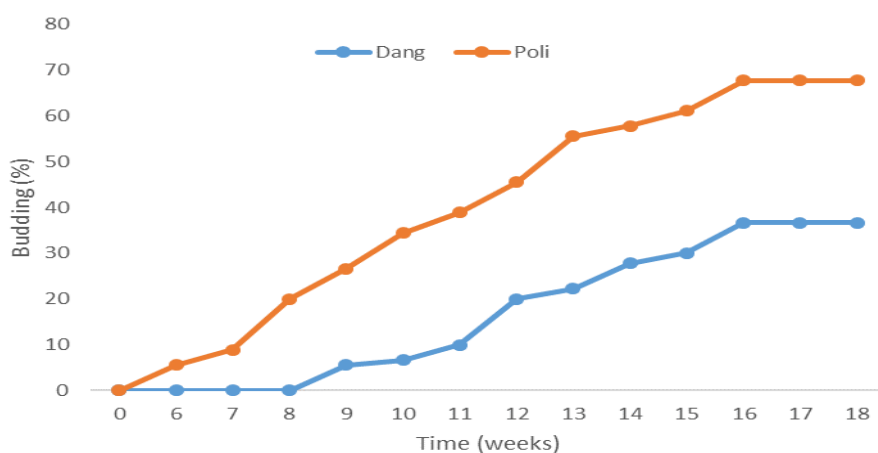


Figure 1: Variation of the percentage of budding according to the origin of the cuttings of the root segments.

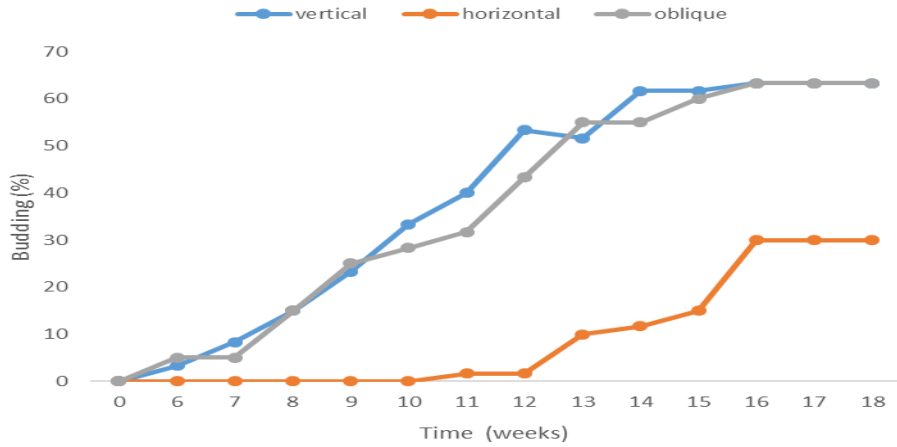


Figure 2: Percentage of budding depending on the alignment of the root segment cuttings in the substrate.

Table 1: Rate of budding as a function of the origin and alignment of the cuttings in the substrate.

Origin of cuttings	Alignment of cuttings in the substrate		
	Vertical	Horizontal	Oblique
Poli	80±12.70%	36.66±4.35%	86.66±15.27%
Dang	46.66±2.78%	23.33±5.65%	40±9.10%

Table 2: Rate of appearance of buds on the different parts of cuttings according to origins.

Origin of cuttings	Part of appearance of buds on cuttings			
	PP	MP	PPM	DP
Dang	32.22±17.15a	2.22±1.57a	2.22±1.21	00±00
Poli	52.66±36.05b	7.77±6.66b	2.22±1.36	1.11±0.78
Means	44.44±26.6	4.99±4.1	2.22±1.57	0.55±0.39
Probability	0.0039	0.0279	1.000	0.3370

Means followed by the same letter are statistically identical ($p < 0.05$).

PP= Proximal pole, MP= Middle part, PPM= Proximal pole and Middle part, DP= Distal pole.

Table 3: Rate of budding according to the polarity of the cuttings according to the alignment.

Alignment of the cuttings	Part of appearance of buds on cuttings			
	PP	MP	PPM	DP
Horizontal	13.33±5.16a	10±6.32c	5±2.5	1.66±0.96
Oblique	58.33±27.83b	3.33±1.92b	1.66±1.66	00±00
Vertical	61±23.16c	1.66±1.92a	00±00	00±00
Means	44.22±18.71	4.99±3.38	2.22±2.22	0.5±0.32
Probability	0.0001	0.023	0.1393	0.3966

Means followed by the same letter are statistically identical ($p < 0.05$).

PP= Proximal pole, MP= Middle part, PPM= Proximal pole and Middle part, DP= Distal pole.

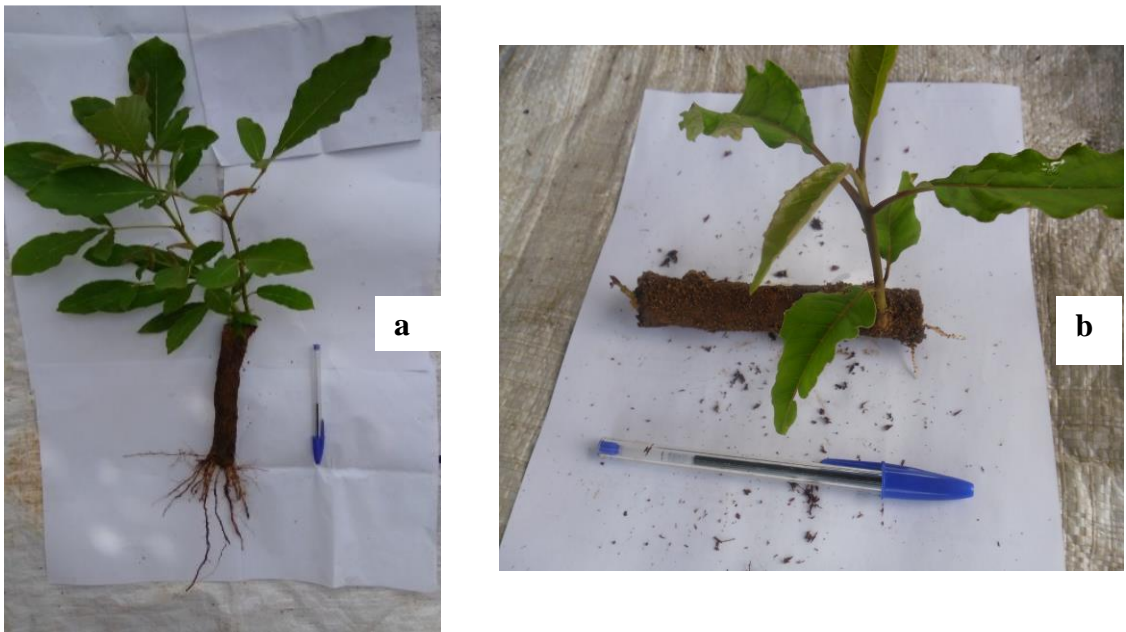


Figure 3: Cuttings of root segments with adventitious roots depending on the alignment (vertical cutting (a); horizontal cutting (b)).

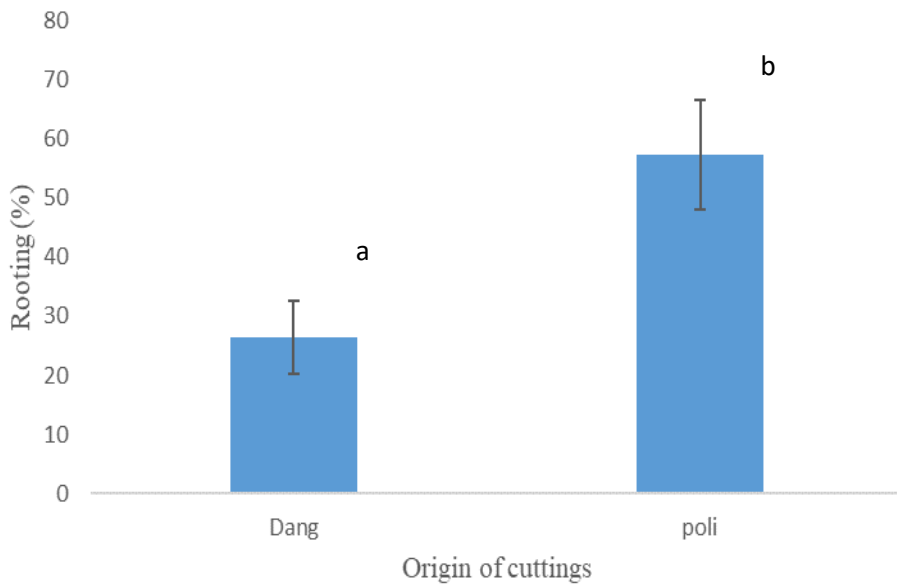


Figure 4: Percentage of rooting of cuttings according to their origins.

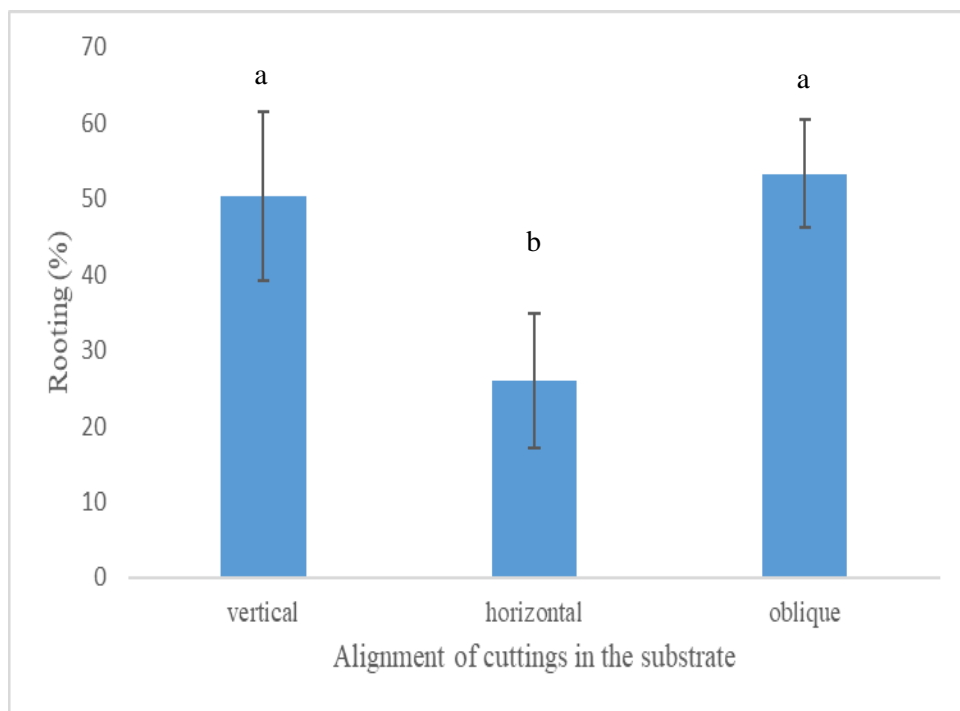


Figure 5: Percentage of rooting according to the alignment of the cuttings in the substrate.

Table 4: Rooting of cuttings depending on the origin and alignment of the cuttings.

Origin of cuttings	Alignment of cuttings in the substrate		
	Vertical	Horizontal	Oblique
Dang	38.66±5.32%	21.34±5.77%	37.39±6.29%
Poli	70±2.46%	33.86±2.48%	83.61±11.27

DISCUSSION

Budding of cuttings

The budding time in this species was 6 weeks. Similar results are reported on *Lophira lanceolata* (Fawa, 2015) and on *Vitex doniana* (Mapongmetsem et al., 2016) in the same locality as ours. The origin significantly influenced the budding rate. Root segments tend to bud more depending on their ecological origin. This situation could be explained by the fact that budding is influenced by the interaction of endogenous and environmental factors (Tchoundjeu et al., 2002). Dang and Poli belong to different agro-ecological zones. Along the same line,

Boutherin and Bron (2002) reported that budding depends on the genotype of each individual, the period of setting up the trial, the age and the physiological state of the individuals. This ability is believed to be related to the period of carbohydrate accumulation in Poli cuttings. These carbohydrates play an important role in the budding process of cuttings and the growth of newly formed adventitious buds as reported by Akouethe et al. (2014) on three species: *Haematostaphis bateri*, *Lannea microcarpa* and *Sclerocarya birrea*. These results also flow in favor of the ecological and soil conditions of each cutting area.

The alignment of the cuttings of root segments influence the budding. The result obtained in this species was similar to that of Ghani and Calahan (1991), on *Prunus avium*. They reported that the vertical alignment is best for budding. In Burkina Faso, Ky-Dembélé et al. (2010) reported similar results on *Detarium microcarpum*. Indeed, when the cutting is inserted vertically or obliquely in the substrate, 1 cm from the proximal end is exposed. In our case, exposure would be the exogenous factor that would have most influenced budding.

The appearance of buds or roots is very often polarized, the pole located near the end of the roots will rather induce roots while the pole located in the direction of the collar will induce the buds (Boutherin and Bron, 2002). The pole of appearance of the buds in the proximal alignment obeys the budding of the cuttings of root segments. In the Guinean savannah highlands, Oumarou et al. (2018) reported similar results on *Securidaca longepedunculata*. In Burkina Faso, Harivel et al. (2006) showed that 90% of leafy shoots develop at the proximal end and adventitious roots at the distal end in *Faidherbia albida*.

Rooting cuttings

The origin of the cuttings of root segments influenced the roots. This is also the result of the work of Hussain et al. (2018) on the cuttings of *Rubus* spp. collected at different times of the year. The development of adventitious roots is slow compared to the emission of buds. In fact, the buds produced the sugars and hormones responsible for the formation of adventitious roots through the process of photosynthesis (Mapongmetsem et al., 2017; Ky-Dembélé et al., 2010). The synthesized carbohydrates circulate from the leaves through the sap produced towards the distal pole of the cuttings where they induce the formation of adventitious roots. The oblique alignment in the substrate favors the rooting of the cuttings. The alignment of cuttings in the substrate influences the growth of adventitious roots. Wachowski et al. (2014) reported that the new formation of the roots is dependent on the emergence of leafy shoots

which by photosynthesis produce the carbohydrates which favors the initiation of the roots.

Conclusion

The aim of this work was to study the effect of the origin and alignment of cuttings from root segments on the ability to neoform buds and adventitious roots. It turned out that *Vitex doniana* has good new formation skills for buds and adventitious roots. The cuttings of root segments from different origins react differently to vegetative propagation. Cuttings from Poli bud better than those from Dang. The alignment of the cuttings of root segments in the substrate also affected budding and rooting. The oblique and vertical alignment are those which are best suited for testing cuttings. The buds appeared mainly at the proximal pole of the cuttings of root segments. Cuttings from Poli rooted better than those from Dang. The vertical and/or oblique alignment promoted the rooting of cuttings from root segments.

COMPETING INTERESTS

The authors confirm that there is no conflict of interest for the publication of this article. They all agree that it be published in this journal.

AUTHORS' CONTRIBUTIONS

GF: Took part in the design of the study and the production; Analysis and interpretation of the results. BA: Took part in the field work and laboratory. JBB: Took part in the field work and laboratory. ZO: Took part in the field work and laboratory. PMM: Took part in the design of the study and the production; Analysis and interpretation of the results; Project designer.

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