SCIENCE SET
OPEN ACCESS PUBLISHERS

ISSN: 3064-9846
Research Article

Journal of Agricultural, Earth and Environmental Sciences

Vegetative Multiplication of *Pterocarpus erinaceus* in the Guinean Savannah Highlands (Adamaoua-Cameroon): Effect of Provenance and Arrangement of Stem Segments Cuttings

Abdoulaye Herbert[1, 3*], Oumarou Haman Zephirin[2, 3], Fawa Guidawa[3], Manfothang Dongmo Ervis[1], Wangbitching Jean-De-Dieu[3], Binwe Jean-Baptiste[3], Megueni Clautilde[3] & Mapongmetsem Pierre Marie[3]

[1]*Department of Forestry, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon*

[2]*Department of Plant Sciences, Faculty of Science, University of Bamenda, Cameroon*

[3]*Department of Biological Sciences, Faculty of Sciences, University of Ngaoundere, Cameroon*

[*]**Corresponding author:** Abdoulaye Herbert, Department of Forestry, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon. Department of Biological Sciences, Faculty of Sciences, University of Ngaoundere, Cameroon P.O.BOX: 96 (Dschang) Cameroon

Submitted: 11 October 2023 **Accepted:** 17 October 2023 **Published:** 25 October 2023

https://doi.org/10.63620/MKJAEES.2023.1016

Citation: *Abdoulaye, H., Haman Zephirin, O., Guidawa, F., Dongmo Ervis, M., Jean-De-Dieu, W., Jean-Baptiste, B., Clautilde, M., & Mapongmetsem, P. M. (2023). Vegetative Multiplication of Pterocarpus erinaceus in the Guinean Savannah Highlands (Adamaoua-Cameroon): Effect of Origin and Arrangement of Stem Segments Cuttings. J of Agri Earth & Environmental Sciences 2(4), 01-10.*

Abstract

*Pterocarpus erinaceus is one of the tree species found in the Guinean savannah highlands and in the Sudano-Sahelian zones of Cameroon, which have great potential for fodder, medicinal, cultural and commercial purposes. This species still lives in the wild and is overexploited. The main objective of this work is to evaluate the effect of the origin of the cuttings and their method of insertion into the substrate using a low-cost technique, stem segment cuttings (SSC). To carry out this work in the nursery, young stem shoots taken from the Figuil and Wack savannahs and kept cold until their arrival in the nursery were cut into 5 cm cuttings and then inserted vertically and obliquely into the rooting substrate. A split-plot experimental design with 4 replications was set up. The results show that the best provenance for SSC in relation to budding remains the Guinean high savannah zone (Wack), at 43.75 %, and that the oblique arrangement is the best for SSC budding (36.25 %). Satisfactory results for the origin*arrangement interaction of the cuttings were obtained for those from Wack associated with the oblique arrangement (47.5%). The greatest growth in height was obtained in the Wack SSCs (2.55 cm) with a significant ANOVA (0.001 < 0.01). The highest rooting percentage of the cuttings was recorded in the Wack cuttings (25.0 %) and the oblique position obtained a better rooting rate (16.25 %). It should be noted that the Guinean savannah highlands origin and the oblique position are better for the SSCs. These results show that it is possible to improve certain parameters in P. erinaceus by vegetative propagation.*

Keywords: Domestication, *Pterocarpus erinaceus*, Stem Segments Cutting, Guinean Savannahs Highlands, Sudano-Sahelian Zone

Introduction

In Africa, clear forests are the result of the degradation of dense dry forests and are maintained in this state through bush fires and the existence of a sufficiently long dry season [1]. These open forests provide many animal and plant resources, and are sources of food, medicines, fuelwood and timber for local populations [2]. In rural areas, people have empirical knowledge about trees that is passed down from generation to generation. Trees play several roles through their products and play a very important role in people's lives [3-5]. These tropical and subtropical forests were destroyed at a rate of 7 million hectares per year between 2000 and 2010, leading to the extinction of plant species in their natural ecosystems [6]. The loss of these resources could lead to a weakening of local potential and the capacity of communities that depend on them to obtain income and food. Despite the crucial role played by woody species in socio-economic development and in responding to the multiple needs of populations and on questions of sustainability, the high rate of deforestation on the African continent remains worrying [7].

Pterocarpus erinaceus Poir, a species which is endemic to the Sahelo-Sudanian and Sudano-Guinean zones, is one of the most exploited species [8-10]. This species occupies semi-arid to sub-humid wooded savannahs in regions where annual rainfall is between 600 and 1200 mm, with an average annual temperature of 32°C. It can survive annual bushfires (see box). It can survive annual bushfires [11]. This species is much sought after by craftspeople in Burkina Faso for making musical instruments such as the balafon and the djembe [8]. They provide important ecological and socio-economic functions for rural and urban populations. For the most part these ecosystems are made up of plant genetic resources that are subject to strong pressures that threaten them with extinction in the long term. However, with demographic pressures on *P. erinaceus* becoming increasingly pronounced, the species is threatened with extinction [12]. The species occurs in natural populations in the Sudanian and Guinean zones of Cameroon and Benin. Vene (*P. erinaceus*) has a high economic value, being a major source of fuelwood and fodder for livestock in pastoral communities throughout its range. This Fabaceae thus contributes daily to meeting the needs of the local population, and is widely used in traditional medicine [10]. The preference of *P. erinaceus* for energy wood is due to its excellent calorific properties. The energy value of the wood is around 21,000 kJ/kg [13]. According to some farmers, its fodder can be used to invigorate weak or sick animals. Its leaves are rich in protein and make good fodder for herbivores, promoting good health, weight growth and milk production [14].

However, the lack of a good knowledge of this plant, the intensification of the marketing of its by-products, the ineffectiveness of forest ecosystem management plans and its many uses in the local pharmaceutical industry are a major cause of the sharp decline in its population [15]. Despite the importance of this species in rural areas, it is still exploited in the wild. Aside from the trials on *Pterocarpus erinaceus* stem cuttings in Togo, Niger and Benin, which attempted to conclude that it was impossible or difficult to root the cuttings despite the application of rooting hormones and the work of, which indicates that a relatively low proportion of cuttings of the species (37 %) can be rooted, and that of, which indicates a high proportion (87 %) using macro-cuttings combined with IAA[16-19]. Otherwise, work on the plant is rare. Of all these studies, none focuses on the effect of the origin of stem segment cuttings (SSCs) and their arrangement in the nursery. Hence the general objective of the present work, which is to contribute to the domestication of *P. erinaceus* by SSC. More specifically, the aim is to determine the best origin of SSCs to improve rooting and to determine the best arrangement of SSCs to improve rooting.

Materials and Methods

Material

Description of the Experimental Area

Research on *Pterocarpus erinaceus* cuttings was carried out in the Guinean highland savannahs, which are periodically burned and grazed, particularly in the Bini-Dang area. (Fig.1) (altitude: 1079 m; latitude: 7°40'59, 33" North; longitude: 13°55'02.52" East). This area is subject to a Guinean climate characterized by two seasons: a dry season from November to March and a rainy season which begins in April and ends in October. The human population of the locality is mainly made up of breeders (Bororo and Peulh) and farmers (Mboum, Dii and Gbaya) [20]. This region is covered with shrub to tree savannahs dominated by *Daniellia oliveri* and *Lophira lanceolata* [21].

Description of the Stem Segment Sampling Site

The stem cutting segments of *Pterocarpus erinaceus* (Fig.2a, b and c) used in this work come (Fig.1) from adult trees in the savannah of the locality of Wack (altitude: 1079 m; latitude: 7°67'71.27" North; longitude: 13°55'56.63" East) and on the other hand on the adult trees of the savannah in the locality of Figuil (altitude: 200 m ; latitude: 9°76'05.32" North; longitude: 13°95'99.74" East). The cuttings consisted of stump cuttings from adult trees that had been rejuvenated to 25 cm above ground level. (Fig. 2d). The orientation of the leaves made it possible to mark the base-apex polarity [22]. Stem segments collected from the savannah with a diameter of 0.1 to 0.3 cm were kept in a cooler containing ice cubes to avoid dehydration during transport from the savannah to the nursery and to maintain the cells turgid. But it was necessary to ensure that the cuttings were not in contact with the ice cubes to avoid the physiological death of the cuttings [22].

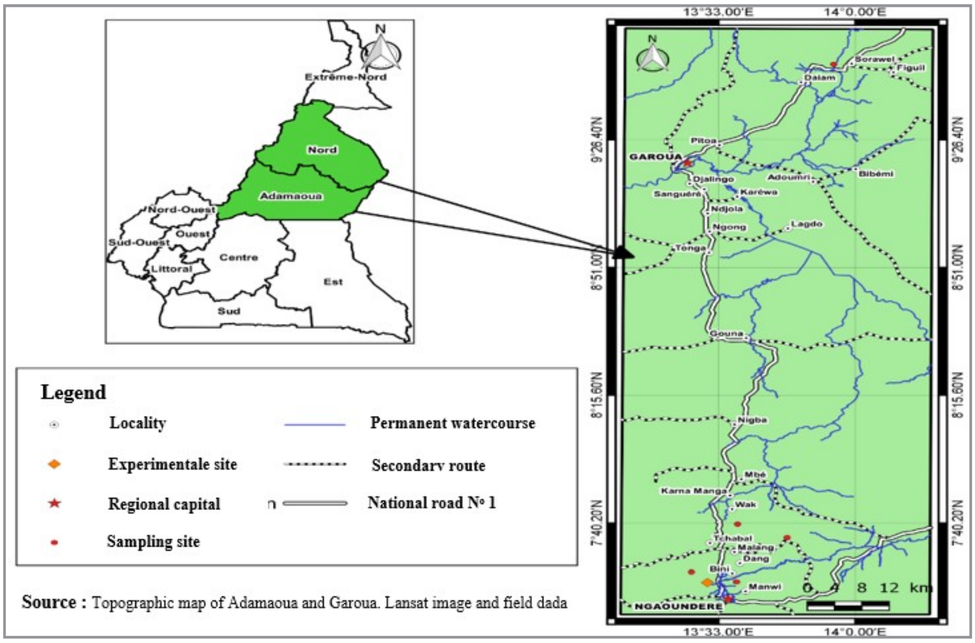

Figure 1: Map of the location of the study and sampling area

Figure 2: Adult plants of *Pterocarpus erinaceus* (a), inflorescences (b), fruit (c) and tree stump 25 cm from the ground (d)

Presentation of the Nursery and the Polypropagator

The trials took place in the nursery of the Laboratory of Biodiversity and Sustainable Development of the University of Ngaoundere, near the Bini river. Shading is provided by a modern shed covered in undulated sheet metal where six (06) transparent sheets are inserted on each side of the roof, filtering out the outside light. The temperature inside the frame was around 23-27°C. The polypropagator (Fig. 3a) is built from local materials and subdivided into 4 compartments. The polypropagator is shaped like a parallelepiped. This wooden box is covered with a transparent polyethylene film 1 mm thick to maintain a moderate temperature, humidity and light intensity conducive to the best development of the cuttings [23, 24]. From bottom to top, the following layers are arranged: a thin layer of fine sand, large blocks of pebbles, medium pebbles, gravel, sand and finally the rooting substrate [22, 24]. All this material is immersed in water whose height is limited to the 2nd layer of sand. The different substrates occupy the upper part of the tablecloth and the cuttings absorb water by capillary action. A PCV pipe is inserted at the corner of each compartment and makes it possible to regularly gauge the water level in the chassis [22].

Methodology

Description of the Test

Once under the shed, the segments taken from the field are cut using pruning shears into 5 cm cuttings (Fig. 3b), which are introduced vertically and obliquely into the substrate made up of the sand/sawdust mixture (Fig. 3c) with 20 g of mycorrhizal inoculum. For this trial, the stem segment cuttings (SSC) came from two different agroecological zones previously rejuvenated, notably the Guinean savannah highlands zone (Wack) and the Sudano-Sahelian zone (Figuil).

The experimental design used was a Split-plot or a factorial design with 4 repetitions. The provenance of the cuttings was considered the main treatment while the arrangement of the cuttings in the substrate was the secondary treatment. The experimental unit was 10 cuttings due to the low availability of stump shoots in the sampling areas. A total of 160 cuttings were used for this experiment.

For this test, the cuttings were watered twice a day, morning and evening, using a sprayer which delivers fine drops of water [22]. The evaluations were carried out weekly from the date of the first budding until the end of the trial. A cutting is considered rooted if the length of the root is ≥ 1 cm, otherwise it was reinserted into the substrate [25]. The rooted cuttings were placed in polyethylene bags containing arable soil and then left to acclimatize. Cuttings and dead leaves were removed systematically.

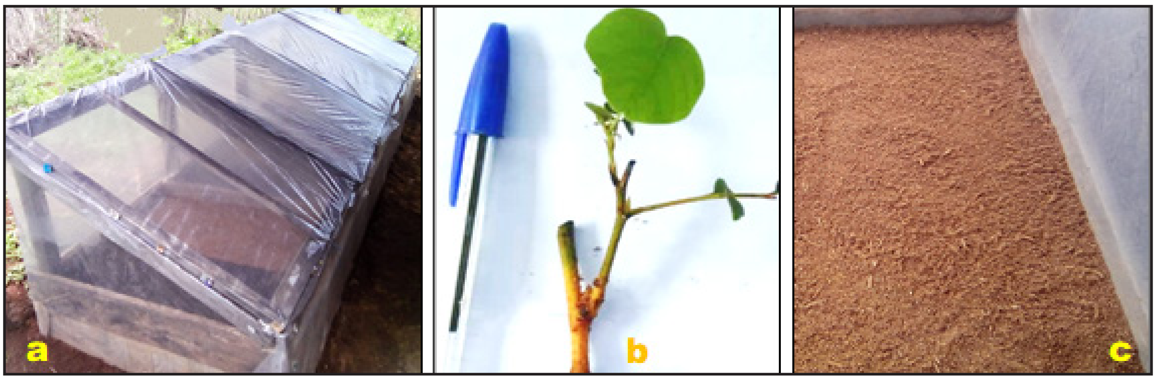

Figure 3: Polypropagator (a), *Pterocarpus erinaceus* cutting (b) and rooting substrate (c)

Data Collection and Processing

Data collection was done weekly until the end of the experiment. The data collected during each evaluation focused on the number of budded cuttings, the number of aerial axes formed, the number of leaves per aerial axis, the height of the leafy axes, the number of rooted cuttings, the number of newly formed roots per cutting and the length of the newly formed roots. The statistical analyzes carried out focused on variance (ANOVA). Separation of significant means was done using the Duncan Multiple Range Test. The statistical analysis software used was Statgraphics Centurion 2016, and Microsoft Office 2016 was used for drafting (Word 2016), then calculations, histograms and curves were produced using Microsoft Excel 2010.

Results and Discussion

Budding of *Pterocarpus erinaceus* Stem Segment Cuttings

The success of stem segment cuttings was controlled by several exogenous factors such as temperature, relative air humidity, agroecological zone, and the arrangement of the cuttings in the rooting substrate.

Figure 4: Leafy cutting of *Pterocarpus erinaceus* (a) and callus formation before rooting (b)

Effect of Provenance

At 22 weeks after cultivation of *Pterocarpus erinaceus*, the rate of budding varied from 21.25 ± 17.26 % for cuttings from Figuil to 43.75 ± 8.06 % for those from Wack (Fig. 5). In Pterocarpus erinaceus, this variation was not established, as the analysis of variance showed no significant difference between the provenances of this species (0.07 > 0.05).

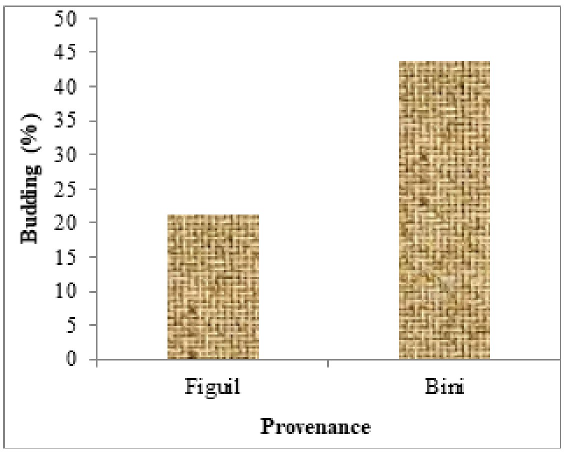

Figure 5: Evolution of the budding rate of *Pterocarpus erinaceus* depending on the origin

Effect of Arrangement of Stem Segment Cuttings

The percentage of budding in *Pterocarpus erinaceus* at the end of the experiment varied from 28.75 ± 18.07 % for cuttings arranged vertically to 36.25 ± 8.06 % for those arranged obliquely (Fig. 6). This fluctuation is not established for this species since the analysis of variance does not show any significant difference between the arrangements of the cuttings (0.52 > 0.05).

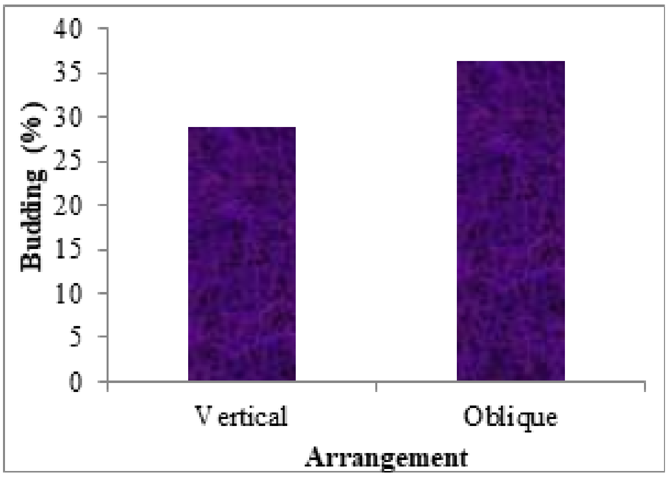

Figure 6: Evolution of the budding rate of P*terocarpus erinaceus* following the arrangement of the cuttings

Effect of the Provenance* Arrangement of Cuttings Interaction

Concerning the interaction between origin and arrangement of cuttings, the percentage of budding in *Pterocarpus erinaceus* varied from 17.5 ± 11.41 % for cuttings from Figuil associated with the vertical arrangement to 47.5 ± 11.41 % for those from Wack combined with the oblique arrangement (Table 1). The fluctuation observed is only visual in this species because the analysis of variance reveals that the provenance*cuttings arrangement interaction is not significant in *P. erinaceus* (1.00 > 0.05). These results suggest that the combination of these two factors does not influence the appearance of leafy shoots in these two species.

Table 1: Evolution of budding according to the interaction of provenance*arrangement

Provenance / Arrangement	Oblique	Vertical	Mean
Wack	47.5 ± 11.41	40.00 ± 14.14	43.75 ± 12.77
Figuil	25.00 ± 20.00	17.5 ± 15.00	21.25 ± 17.5
Mean	36.25 ± 15.57	28.75 ± 14.57	32.5 ± 0.31

Growth Parameters On the Budding *Pterocarpus erinaceu*

Effect of Provenance

Number of Aerial Axes Per Stem Segment Cutting: Until the 22nd week of the experiment, the number of aerial axes did not vary (01) in *Pterocarpus erinaceus*. Consequently, after the statistical analyses, the same results for the budding rate were obtained on the one hand and on the other hand the provenance did not influence the emission of leafy axes.

Height of Aerial Axes Per Stem Segment Cutting

The number of aerial axes of *Pterocarpus erinaceus* varied between 1.24 ± 0.84 cm for the Figuil provenance and 2.55 ± 0.24 cm for the Wack provenance up to the 22nd week of the experiment (Table 2). This oscillation is justified by the analysis of variance, which shows a significant difference between the provenances (0.001 < 0.01).

Number of Leaves Per Stem Segment Cutting

In the final evaluation of the experiment, the number of leaves per stem segment cutting of *Pterocarpus erinaceus* ranged from 1.22 ± 0.3 for cuttings from Figuil to 1.71 ± 0.27 for those from Wack (Table 2). Analysis of variance showed a statistically insignificant difference between the origins of the cuttings (0.23 > 0.05).

Table 2: Growth parameters of *Pterocarpus erinaceus* stem segment cuttings according to their provenance

Parameters studied	Height of leafy shoots (cm)	Number of leaves
Wack	2.55 ± 0.24a	1.71 ± 0.27
Figuil	1.24 ± 0.84b	1.22 ± 0.3
Mean	1.89 ± 0.54	1.46 ± 0.15

Effect of Arrangement of Cuttings

Number of Aerial Axes Per Stem Segment Cutting

With regard to the arrangement of stem segment cuttings in the budding substrate, the number of aerial axes (01) did not vary in *Pterocarpus erinaceus* until the end of the experiment.

Height of Aerial Axes Per Stem Segment Cutting

Regarding the arrangement of *Pterocarpus erinaceus* stem segment cuttings, the height of the aerial axes varied from 1.74 ± 0.18 cm for cuttings arranged obliquely to 2.05 ± 0.95 cm for those arranged vertically (Table 3). This fluctuation is refuted by the analysis of variance, which shows no significant difference between the cuttings (0.35 > 0.05). Consequently, the arrangement of the cuttings does not considerably influence the height of the aerial axes in this Fabaceae.

Number of Leaves Per Stem Segment Cutting

In relation to the method of inserting the cuttings into the substrate, the number of leaves per cutting varied in *Pterocarpus erinaceus* from 1.30 ± 0.27 for cuttings arranged vertically to 1.63 ± 0.63 for those arranged obliquely (Table 3). However, the analysis of variance showed no significant difference between the arrangements of the cuttings (0.41 > 0.05). Consequently, the mode of insertion of the cuttings had no impact on the number of leaves per leafy shoot in this Fabaceae.

Table 3: Growth parameters of Pterocarpus erinaceus stem segment cuttings according to the method of insertion of stem segment cuttings

Parameters studied	Height of leafy shoots (cm)	Number of leaves
Verticale	2.05 ± 0.95	1.30 ± 0.27
Oblique	1.4 ± 0.18	1.63 ± 0.63
Mean	1.02 ± 0.69	5.02 ± 3.05

Effect of The Provenance* Arrangement of Cuttings Interaction

Number of Aerial Axes Per Stem Segment Cutting

In relation to the provenance*arrangement of stem segment cuttings in the budding and substrate interaction, the number of deciduous axes (01) did not vary in *Pterocarpus erinaceus* until the final evaluation.

Height of Aerial Axes Per Stem Segment Cutting

In Senegal rosewood (*Pterocarpus erinaceus*), bud height varied from 1.07 ± 0.75 cm in cuttings taken from Figuil and inserted obliquely to 2.69 ± 0.27 cm in those taken from Wack and placed vertically (Table 4). Analysis of variance did not indicate the existence of a significant difference (0.91 > 0.05), despite the variation observed.

Table 4: Height of the aerial axes of *Pterocarpus erinaceus* following the interaction provenance*arrangement of the cuttings

Provenances / Arrangement	Oblique	Vertical	Mean
Wack	2.41± 0.27	2.69 ± 0.12	2.55 ± 0.19
Figuil	1.07 ± 0.75	1.41 ± 0.32	0.33 ± 0.53
Mean	1.74 ± 0.51	1.41 ± 0.22	1.44 ± 0.36

Number of Leaves Per Stem Segment Cutting

In *Pterocarpus erinaceus*, the number of leaves fluctuates from 0.95 ± 0.73 in cuttings from Figuil and inserted obliquely to 1.76 ± 0.41 in those taken in the Guinean savannah highlands (Wack) and positioned vertically (Table 5). The analysis of variance did not indicate the existence of a significant difference (0.57 > 0.05), despite the variation observed. The combination of these two parameters did not influence the aboveground biomass (number of leaves).

Table 5: Number of leaves per aerial axis of Pterocarpus erinaceus following the provenance*arrangement of cuttings interaction

Provenances / Arrangement	Oblique	Vertical	Mean
Wack	1.66 ± 0.23	1.76 ± 0.41	1.71 ± 0.32
Figuil	0.95 ± 0.73	1.5 ± 0.39	1.22 ± 0.56
Mean	1.30 ± 0.5	1.63 ± 0.40	1.46 ± 0.44

Rooting *Pterocarpus erinaceus* Stem Segment Cuttings

Effect of Provenance of Cuttings

At the end of these 22 weeks of testing, 30 ± 7.73% of the cuttings produced new roots (Fig. 7).

Figure 7: Leafy and rooted cutting of *Pterocarpus erinaceus* in oblique position

Rooting Percentage of Root Segment Cuttings

Adventitious roots appeared in *Pterocarpus erinaceus* in the Figuil provenance and in the Wack provenance during the 3rd month after the cuttings were grown. 22 weeks after planting, the rooting percentage of the cuttings varied from 5.0 ± 0 % for Figuil cuttings to 25.0 ± 7.73 % for Wack cuttings (Fig. 8). This variation is apparent because the analysis of variance shows that there is no significant difference between the origins of the cuttings (0.09 > 0.05).

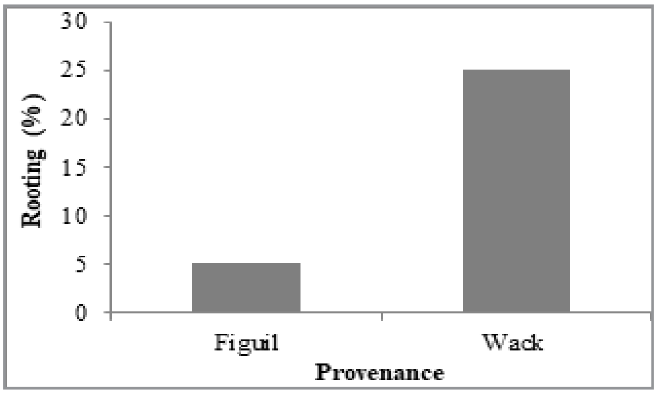

Figure 8: Rooting rate of cuttings of stem segments of *Pterocarpus erinaceus* depending on the provenance

Number of Newly Formed Roots Per Stem Segment Cutting

Up to the 22nd week of the experiment, the number of newly formed roots in *Pterocarpus erinaceus* oscillated from 0.62 ± 0.3 in the Figuil cuttings to 1.07 ± 0.9 in the Wack provenance. For the number of newly formed roots in this Fabaceae, the analysis of variance showed no significant difference between the origins of the cuttings (0.34 > 0.05).

Length of Roots Newly Formed by Stem Segment Cuttings

In *Pterocarpus erinaceus*, the length of newly formed roots fluctuates from 5.12 ± 4.01 cm for the cuttings taken in Figuil to 14.95 ± 4.01 cm for those from the Wack village (Fig. 9). This disparity is only apparent given that the analysis of variance does not show a significant difference between the provenances (0.1 > 0.05).

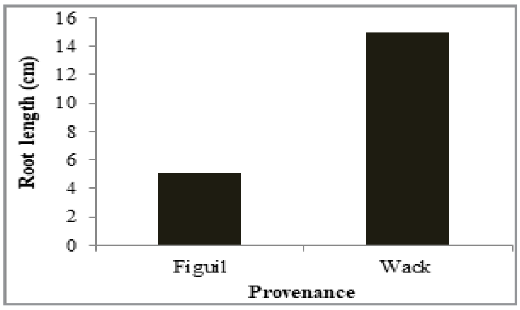

Figure 9: Length of *Pterocarpus erinaceus* roots depending on provenance

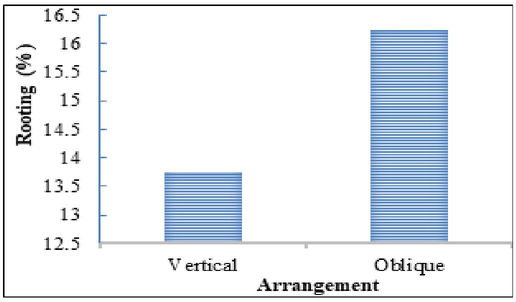

Figure 10: Evolution of the rate of adventitious roots of *Pterocarpus erinaceus* depending on the provenance

Effect of Arrangement of Cuttings

Rooting Percentage of Stem Segment Cuttings

The rooting percentage at the final evaluation of the experiment varies from 13.75 ± 7.73 % in cuttings inserted vertically to 16.25 ± 7.73 % in those oriented obliquely (Fig. 10). The analysis of variance reveals that the mode of insertion of the cuttings is statistically insignificant (0.82 > 0.05).

Number of Roots Per Stem Segment Cuttings

Regarding the mode of insertion of *Pterocarpus erinaceus* stem segment cuttings into the rooting substrate, the number of newly formed roots varied for both positions, averaging 0.84 ± 0.81 for vertically arranged cuttings and 0.85 ± 0.3 for obliquely inserted cuttings. Analysis of variance revealed that the method of inserting the cuttings into the substrate was statistically insignificant for this Fabaceae (0.97 > 0.05). Consequently, the method of inserting stem segment cuttings into the rooting substrate did not influence the number of newly formed roots in this species of socio-economic interest.

Length of Roots Newly Formed by Stem Segment Cuttings

The length of newly formed roots fluctuates from 9.30 ± 4.01 cm in an oblique position to 10.78 ± 4.01 cm in a vertical position (Table 6). This variation is only apparent since the analysis of variance does not indicate a significant difference between the modes of insertion (0.79 > 0.05)

Table 6: Fluctuation in the length of newly formed roots in Pterocarpus erinaceus following the arrangement of cuttings

Parameters studied	Oblique	Vertical	Mean
Length of root (cm)	9.30 ± 4.01	10.78 ± 4.01	10.04 ± 4.01

Effect of the Provenance*Arrangement of Cuttings Interaction

Rooting Percentage of Stem Segment Cuttings

The rooting rate in *Pterocarpus erinaceus* following the provenance*arrangement of the cuttings interaction varies from 5.0 ± 5.77 % in the cuttings from Figuil inserted vertically and obliquely to 27.5 ± 10.94 % in the cuttings taken in the locality of Wack and which are positioned obliquely (Table 7). Despite the remarkable difference noted, the analysis of variance reveals that the provenance*arrangement of cuttings interaction is not significant (0.82 > 0.05). This result indicates that the provenance*disposition interaction did not impact the rooting rate of the cuttings.

Table 7: Oscillation of the rooting percentage of *Pterocarpus erinaceus* following the interaction of provenance*arrangement of the cuttings

Provenances / Arrangement	Oblique	Vertical	Mean
Wack	27.5 ± 10.94	22.5 ± 20.61	25.00 ± 15.77
Figuil	5.0 ± 5.77	5.0 ± 5.77	5.0 ± 5.77
Mean	16.25 ± 8.35	13.75 ± 13.19	15.00 ± 10.77

Number of Roots of Stem Segment Cuttings

The number of adventitious roots in *Pterocarpus erinaceus* varies from 0.5 ± 0.57 in cuttings from Figuil positioned vertically to 1.18 ± 0.94 in those from the locality of Wack arranged vertically (Table 8). This observed variation is not established because the analysis of variance does not present a significant difference for their interaction (0.61 > 0.05).

Table 8: Variation in the number of newly formed roots following the interaction of provenance*arrangement of the cuttings

Provenances / Arrangement	Oblique	Vertical	Mean
Wack	0.96 ± 0.46	1.18 ± 0.94	1.07 ± 0.7
Figuil	0.75 ± 0.46	0.5 ± 0.57	0.62 ± 0.51
Mean	0.85 ± 0.46	0.16 ± 0.75	0.84 ± 0.60

Length of Roots Newly Formed by Stem Segment Cuttings

For *Pterocarpus erinaceus* suggests that the combination of these two parameters had no effect on the erinaceus, the length of newly formed roots following the origin*disposition of the cuttings interaction fluctuated from 3.75 ± 5.68 cm in cuttings from the Sudano-Sahelian zone (Figuil) inserted vertically to 17.81 ± 15.42 cm in cuttings taken from the Guinean Savannahs Highlands, in this case the Wack savannah and arranged vertically in the rooting substrate (Table 9). Despite the fluctuation observed, the analysis of variance shows that the association of these two factors (origin and layout) is not significant (0.47 > 0.05). This result growth of newly formed roots.

Table 9: Length of newly formed roots in *Pterocarpus erinaceus* following the interaction of provenance*arrangement of the cuttings

	Oblique	Vertical	Mean
Wack	12.10 ± 5.68	17.81 ± 15.42	14.95 ± 10.55
Figuil	6.5 ± 5.68	3.75 ± 5.68	5.12 ± 5.68
Mean	9.3 ± 5.68	10.78 ± 10.55	1.08 ± 0.75

Discussion

Our budding rate in general does not corroborate the results obtained by [19] in Benin on the same species (> 70 %) but it should be noted that these authors used macro-cuttings associated with a high dose of IAA.

Compared to the provenance, the different localities did not influence the budding of stem segment cuttings. Similar results are reported by for *Bombax costatum* where the best provenance was the locality of Karna manga, representing the Guinean Savannah Highlands zone [26]. In these species the date of appearance of leafy shoots varies depending on the agroecological zones. This could be explained by the difference between the pedoclimatic conditions and the period of sampling of the suckers of strains existing in their sampling environment, as well as the sugar level contained in the cuttings and the genotype of these species. With regard to the mode of insertion, the exposure of approximately 2 cm of the proximal end to the ambient environment in cuttings placed vertically and the 45° inclination of cuttings inserted obliquely would play a primordial role in the circulation of carbohydrates and the budding of stem segment cuttings. However, in Burkina Faso noted a significant budding rate on *Detarium microcarpum* in cuttings grown in a vertical position in the substrate. The results do not corroborate those of in the same country as the previous author, where total desiccation of *Bombax costatum* cuttings inserted horizontally in the substrate was recorded [27, 28]. However, it should be borne in mind that these authors used two positions (vertical and horizontal). Our results are similar to those of who worked in the same region on *Bombax costatum, Detarium microcarpum* and *Securidaca longepedunculata* where the best position was the oblique arrangement [29].

The results on the height of the aerial axes indicate that the area of origin of the cuttings influenced the height of the leafy axes. Furthermore, in the same study area obtained similar results for *Bombax costatum*, where the provenance matches the results for *P. erinaceus*, but this is not the case for the size of the aerial shoots. However, these authors worked on root segment cuttings [26]. The results on the number of leaves indicate that the differentiation of agro-ecological zones only influenced new leaf formation. Furthermore, in the same study area, obtained similar results on *Bombax costatum* where the best provenance for number of leaves was obtained [26]. leaves agreed with the results on Senegal Rosewood (*P. erinaceus*), i.e. the Guinean Savannah Highlands zone. However, previous authors have worked on root segment cuttings.

Our rooting rate in general does not agree with those obtained by in Benin on the same species (> 87 %) but it should be noted that these authors used macro-cuttings associated with IAA at a high dose [19].

Regarding the rooting rate depending on provenance, our results corroborate those of who worked on *Bombax costatum* in the same area and who reported that the provenance of the Guinean Savannah Highlands was the best compared to that of the Sudano-Sahelian zone [26]. The result on the number of newly formed roots indicates that the effect of provenance of stem segment cuttings was not influenced in *P. erinaceus*. The low rooting rate in the Sudano-Sahelian provenance is justified by the low budding rate recorded in this provenance because the carbohydrates synthesized during photosynthesis are favorable to the emission of new roots. These observations are consistent with those obtained on *Bombax costatum* by in the same study area [26]. They reported on the number of adventitious roots that the origin of the Guinean Savannah Highlands (Karna-manga) was the best compared to that of the Sudano-Sahelian zone (Gamba) using the root segments cuttings (RSC).

In relation to the layout of the SSC, our results on the rooting rate do not agree with those reported by in Burkina Faso, where the author obtained a zero-rooting rate in the species *Bombax costatum* placed horizontally in the substrate, and for the number of roots, the method of planting stem segment cuttings in the rooting substrate did not influence the number of newly formed roots in this species of socio-economic interest [28]. The observations on the interaction of the two factors corroborate those obtained on *Bombax costatum* and *Securidaca longepedunculata* by in the same study area as the present study [29]. This author reports that the oblique layout of the Guinean Savannahs Highlands is the best compared to that of the Sudano-Sahelian Savannahs in terms of the number of adventitious roots on root segments cuttings (RSC). Our results on the length of newly formed roots are in contrast to those obtained on *Bombax costatum, Detarium microcarpum* and *Securidaca longepedunculata* by [29]. The author shows that the method of inserting the cuttings influences the elongation of the roots.

Conclusion and Perspectives

The aim was to carry out a vegetative propagation (VM) test using stem segment cuttings (SSC) of *Pterocarpus erinaceus* on the effect of the provenance and arrangement of the root segment cuttings. This work shows that *P. erinaceus* has a good capacity to form new leafy shoots using stem segment cuttings (SSC). The best results were obtained from cuttings from the Guinean Savannah highlands (Wack zone), with a rate of 43.75 %, and the best position for budding was oblique (36.25 %). The highest number of leaves per aerial axis is recorded in the Wack savannah provenance (1.71 ± 0.27) and in cuttings inserted obliquely (1.63 ± 0.63). The significant height of the shoots (3.34 ± 0.42 cm) is obtained from the Wack zone (2.55 ± 0.24 cm). Furthermore, for the rooting of SSCs, the best results are obtained from cuttings coming from the Guinean Savannah Highlands (Wack savannah) with a percentage of 25.0 % and the best mode of insertion of SSCs for rooting. is the oblique position (16.25 %) for this Fabaceae. Vegetative propagation (VM) is therefore an alternative to the cultivation and preservation of this plant species of socio-economic interest. The domestication of *P. erinaceus* by stem segments cutting is recommended for farmers concerned about a good recovery of their cuttings in the field and its productivity, given the multiple interests abounding in this species. Thus, it would be wise to carry out an anatomical and histological study of the organs involved in the vegetative multiplication of this species in order to determine the appropriate period for its cuttings; Test other ranges of cutting lengths in this species then extend it to other woody plants; conduct cutting trials of this species in the cuttings collection medium (SSC).

References

1. Bellefontaine, R., Gaston, A., & Petrucci, Y. (2000). Management of natural forests of dry tropical zones. FAO Conservation Guides, 32. FAO. https://www.fao.org/docrep/003/X6020E/X6020E00.HTM
2. Goussanou, C., Tenté, B., Djègo, J., Agbani, P., & Sinsin, B. (2011). Inventory, characterization and management method of some non-timber forest products from the Donga watershed. Annals of Agricultural Sciences, 14, 77–99.
3. Sarr, O., Bakhoum, A., Diatta, S., & Akpo, L. E. (2013). The tree in the Sudano-Sahelian environment in the Groundnut Basin (Central Senegal). Journal of Applied Biosciences, 61, 4515–4529.
4. Gning, O., Sarr, O., Gueye, M., Akpo, L. E., & Ndiaye, P. M. (2013). Socio-economic value of the tree in a Malinké environment (Khossanto, Senegal). Journal of Applied Biosciences, 70, 5617–5631.
5. Ndiaye, I., Camara, B., Ngom, D., & Sarr, O. (2017). Specific diversity and ethnobotanical use of woody trees following a North-South rainfall gradient in the Senegalese peanut basin. Journal of Applied Biosciences, 113, 11123–11137.
6. Adomou, A. C., Dassou, G. H., Houénon, G. H. A., & Alladayè, Y. Y. (2017). Understanding the plant resource needs of local populations for sustainable management of the Bahazoun forest in South Benin (West Africa). International Journal of Biology and Chemical Sciences, 11, 2040–2057.
7. Fernane, A., & Hannachi, M. (2021). Place de la datte dans le commerce des fruits et légumes dans le monde et en Algérie (Doctoral dissertation, Université Mouloud Mammeri). https://www.fao.org/docrep/015/i2492e/i2492e.pdf
8. Adjonou, K., Ali, N., Kokutse, A. D., & Kokou, K. (2010). Study of the dynamics of natural populations of Pterocarpus erinaceus Poir. (Fabaceae) overexploited in Togo. Woods and Forests of the Tropics, 306, 33–43.
9. Ouedraogo, A., Adjima, T., Hahn-Hadjali, K., & Guinko, S. (2006). Diagnosis of the state of degradation of populations of four woody species in the Sudanian zone of Burkina Faso. Sécheresse, 17, 485–491.
10. Sylla, S. N., Samba, R. T., Neyra, M., Ndoye, I., Giraud, E., et al. (2002). Phenotypic and genotypic diversity of rhizobia nodulating Pterocarpus erinaceus and P. lucens in Senegal. Systematic and Applied Microbiology, 25, 572–583.
11. Arbonnier, M. (2004). Trees, shrubs and lianas of West African dry zones. Editions Quae.
12. Glèlè Kakaï, R., Sinsin, B., & Palm, D. (2009). Dendrometric study of Pterocarpus erinaceus Poir. natural formations of the Sudanian zone in Benin. Agronomie Africaine, 20, 245–255.
13. PROTA/Backhuys P. /CTA W. (2008). Lumber 1; Plant resources of tropical Africa 7 (1).
14. Segla, K. N., Adjonou, K., Radji, A. R., Kokutse, A. D., Kokou, K., et al. (2015). Socioeconomic importance of Pterocarpus erinaceus Poir. in Togo. European Scientific Journal, 11, 199–217.
15. Guedje, N. M., Lejoly, J., Nkongmeneck, B. A., & Jonkers, W. B. J. (2003). Forest ecology and management, 177, 231–241.
16. Kokou, K., Adjonou, K., Segla, K. N., Rabiou, H., Bationo, A. B., et al. (2015). Pterocarpus erinaceus Poir. in West Africa: Use, stand structure, wood quality, harvesting standards and silviculture in Burkina Faso, Niger, and Togo. Fiche technique, 28.
17. Bodjrènou, R. T., Houètchégnon, T., Kéita, N. T., & Ouinsavi, C. (2018). Effects of naphthalene acetic acid, type of substrate and size of cuttings on Pterocarpus erinaceus Poir stem cuttings (Fabaceae). European Scientific Journal, 14, 297–316.
18. Ky-Dembele, C., Traoré, F. T., Koné, B., Bayala, J., Kalinganiré, A., et al. (2015). Regeneration of fodder trees: Is cuttings a possible option in the Sahel? Sahel Agroforestry, 4.
19. Ouinsavi, C., Sourou, B., Houètchégnon, T., Wédjangnon, A., Dossa, B., et al. (2021). Effect of cuttings diameter and indole acetic acid on rooting of Pterocarpus erinaceus Poir. stem cuttings. International Journal of Agroforestry and Silviculture, 7, 001–010.
20. Fawa, G., Tchingsabé, O., & Mapongmetsem, P. M. (2015). Development of non-timber forest products from the lo-

cality of Mayo-Rey (North Cameroon). Proceedings of the international conference: Biodiversity and global changes, University of Ngaoundéré, Cameroon, 147–151.
21. Brenan, J. P. (1978). Some aspects of the phytogeography of tropical Africa. Annals of the Missouri Botanical Garden, 437-478.
22. Mapongmetsem, P. M., Djoumessi, M. C., Tonleu Yemele, M., Doumara, G. D., Fawa, G., et al. (2012). Domestication of Vitex doniana Sweet (Verbenaceae): Influence of the type of substrate, hormonal stimulation, leaf surface and node position on the rooting of uninodal cuttings. Journal of Agriculture and Environment for International Development - JAEID, 106, 23–45.
23. Leakey, R. R. B., Schreckenberg, K., & Tchoundjeu, Z. (2003). The participatory domestication of West African indigenous fruits. International Forestry Review, 5, 338–347.
24. ICRAF. (2012). The rooting propagator. Technical sheet. World Agroforestry Centre - West and Central Africa, 4.
25. Atangana, A., Khasa, D., Chang, S., Degrande, A., Atangana, A., Khasa, D., ... & Degrande, A. (2014). Participatory Domestication of New Crops using Agroforestry Techniques. Tropical Agroforestry, 111-148.
26. Oumarou, H. Z., Hamawa, Y., Tsobou, R., Dangai, Y., Binwe, J.-B., et al. (2019). Vegetative propagation of Bombax costatum Pellegr. & Vuillet (Malvaceae) by root segments cuttings: Effects of mother tree diameter and origin of cuttings. American Journal of Agriculture and Forestry, 7, 248–258.
27. Ky-Dembele, C., Mulualem Tigabu, J., Bayala, P., Savadogo, J., Issaka Boussim, et al. (2010). Clonal propagation of Detarium microcarpum from root cuttings. Silva Fennica, 44, 775–786.
28. Guidawa, F., Zéphirin, O. H., Rodrigue, M. A. D., Baptiste, B. J., & Marie, M. P. (2023). Root Segment Cuttings of Bombax costatum Pellegr. & Vuillet: Effects of Diameter and Alignment. Asian J. Res. Agric. Forestry, 9(3), 103-111.
29. Oumarou, H. Z. (2021). Study of the vegetative multiplication of three agroforestry species in the high Guinean savannahs of Adamaoua, Cameroon. Doctoral thesis/Ph.D., Faculty of Sciences, University of Ngaoundéré-Cameroon.