e-ISSN 2795-4362
p-ISSN 2795-4340

10.5281/zenodo.10649433 Vol. 07 Issue 01 Jan - 2024 Manuscript ID: #01051

Effects of substrate and mycorrhizal inoculum on stem segment cuttings of *Pterocarpus erinaceus Poir*. (Fabaceae) in the Guinean savannah highlands of Cameroon

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Abstract

Pterocarpus erinaceus **Poir is a woody species of the Sudano-Guinean to Sudano-Sahelian zones with very high food, medicinal and commercial potential leading to the overexploitation. This study aimed to contribute to the domestication of this species using stem segment cuttings. The sand/sawdust and black soil/sawdust substrates were inoculated with 0.10, and 20 g of mycorrhizae. The split plot with 4 repetitions was used as the experimental method and set at 10 cuttings per unit. The experience revealed that the appropriate substrate and dose of mycorrhizae for the budding of stem segment cuttings (SSC) were the sand/sawdust mixture (25.00 ± 18.34 %) and 10 g (23.75 ± 5.63 %) respectively. Satisfactory result was recorded in 10 g (4.18 ± 2.52 cm) dose of mycorrhizae for the height of the aerial axes with abundant number of leaves per aerial observed in the sand/sawdust substrate (2.36 ± 0.48). Concerning the rooting ability of the cuttings, adequate substrate for the number of newly formed roots is the sand/sawdust mixture (25.00 ± 18.34 %) while the dose of 10 g of mycorrhizae favoured the appearance of roots (23.75 ± 14.07 %). The best substrate for the length of newly formed roots is the sand/sawdust mixture (10.64 ± 7.14 cm) and 10 g of mycorrhizae improved the length (9.82 ± 6.40 cm) for Senegal rosewood. Given the above results, we can admit that the improvement of certain parameters (budding, rooting) in P. erinaceus is possible by vegetative propagation.**

Keywords

Pterocarpus erinaceus**, Domestication, Vegetative propagation, Stem Segment Cuttings, Inoculum mycorhizian.**

1. INTRODUCTION

The Congo Basin is the second largest tropical forest ecosystem after the Amazon. For several decades, they have been at the heart of international climate change issues [1]. They fulfill essential social and cultural functions for local and indigenous populations, and contribute to the nutrition of 40 million people living in urban centers near these forest domains [2;3]. Therefore, the socio-economic, demographic, and ecological changes experienced by Sahelian countries in recent decades have affected natural ecosystems and their management [4]. Thus, in the Sudano-Guinean zone, the population of many indigenous woody species of major importance has declined. The most important causes are climatic hazards and anthropic pressures (deforestation, overexploitation of natural resources, agriculture, overgrazing, and bushfires) which are increasing in these regions [5;6]. Thus, since the beginning of the 20th century, the degradation of tropical forests in terms of both surface area and density has led to an enormous loss of plant and animal biodiversity. Soil degradation is accelerating worldwide [7] and desertification is not only occurring in semi-arid regions but also locally in the sub-Guinean and Central African regions.

The domestication of these species and the fight against the desertification of the environments to which they are attached will be facilitated by controlling their vegetative regeneration methods [8;9]. However, natural regeneration of some of these species is often difficult because of the non-availability of seeds, the difficulty of resisting young seedlings in the dry season, and the conservation of their germination capacity [10;11;12]. In addition, vegetative propagation, which is faster and less expensive [8], appears to be an alternative [13;14]. This is the case of *Pterocarpus erinaceus*, which is a woody species of great socio-economic interest that provides a heavy (density 0.9) yellowish or reddish-pink wood and termite resistant. It is also an excellent fodder with a high protein content (19 %), and can be used in many ways in traditional medicine: the leaves are used in abortifacient mixtures and as a febrifuge. The bark is used for the treatment of ringworm of the scalp, for dressings against chronic ulcers, and against gonorrhea. Gargles made from *P. erinaceus* bark are used for oral and dental problems [15]. The interest of this species in the rural environment has led to the overexploitation in the wild as reported in several studies [16;17;18;19;20] and classified as critically endangered species by the [21]. To maintain the sustainability of this species, the stem segment cuttings (SSC) seem to be better as direct seeding gives very poor results because the young shoots perish during the dry season [10;22]. To improve this regeneration by SSC, the mycorrhizal association is often recommended in the nursery because according to [23], the use of endomycorrhizal inoculums during cuttings improves rooting. Similarly, [24] and [25] report on *Viburnum dentarum* and *Sciadopitys verticillata* respectively that mycorrhizal inoculums increased rooting, callus size, and survival of cuttings of these species.

Contributing to the domestication of *Pterocarpus erinaceus* by stem segment cuttings is the general objective of this study. Specifically, it is to evaluate the influence of some exogenous factors on the predisposition of stem segment cuttings (SSCs) to neoform buds and roots, to evaluate the effect of substrate on the neoformation of adventitious buds and roots on the stem segment, to study the influence of mycorrhizal inoculum on rhizogenesis and callogenesis of the SSCs, to determine the best dose of mycorrhizae for the neoformation of buds and roots by the SSCs.

2. MATERIALS AND METHODS

Material

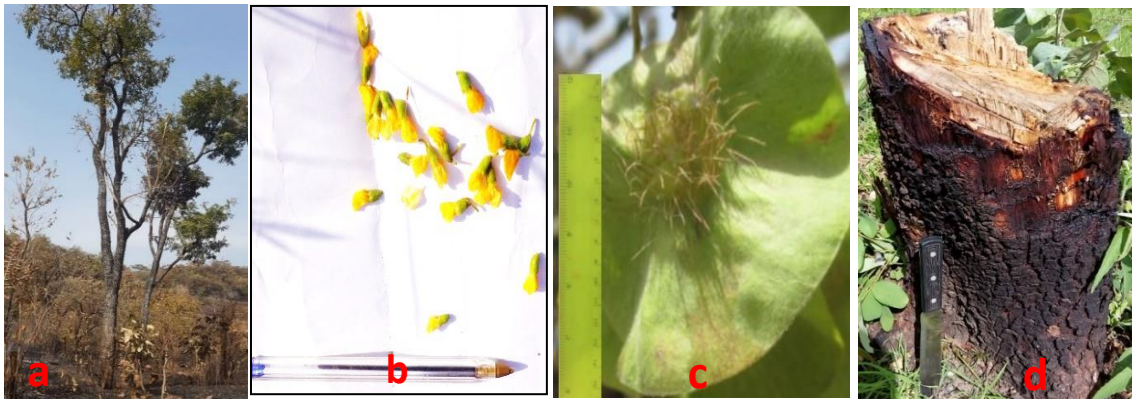
a. Description of the experimental area

The investigations on the cutting of *Pterocarpus erinaceus* took place in the Guinean savannahs highlands periodically burnt and grazed, especially in the locality of Bini-Dang (ALT:

1079 m; LN: 7°40'59.33"; LE: 13°55'02.52"). This area is subject to a Guinean climate characterised by two seasons: a dry season from November to March and a rainy season that starts in April and ends in October. The human population of the locality consists mainly of herders (Bororo and Peulh) and farmers (Mboum, Dii, and Gbaya) [26]. This area is covered by shrub-to-tree savannahs dominated by *Daniellia oliveri* and *Lophira lanceolata* [27].

b. Description of stem segment collection site

The *Pterocarpus erinaceus* stem cuttings (Fig. 1a, b, and c) used in this work were taken from mature trees considered healthy in the savannah of the Wack locality (altitude: 1079 m; latitude: 7°67'71.27" N; longitude: 13°55'56.63" E). The cuttings consisted of the stump sprouts of adult trees that had been rejuvenated to 25 cm above the ground (Fig. 1d). The orientation of the leaves allowed for marking the base-apex polarity [13]. Stem segments collected from the savannah with a diameter of 0.1-0.3 cm were kept in a cooler containing ice cubes to avoid dehydration during transport from the savannah to the nursery and to keep the cells turgid. However, precautions had to be taken to ensure that the cuttings did not come into contact with the ice cubes to avoid the physiological death of the cuttings [13].



Legend: *Pterocarpus erinaceus* plants (a), inflorescences (b), fruit (c), and tree stump 25 cm above ground (d).

Figure 1: Morphological representations of the different parts of *Pterocarpus erinaceus*

c. Description of nursery and chassis

The Laboratory of Biodiversity and Sustainable Development of the University of Ngaoundere used in our previous studies [28], near the Bini River, was used as an experimental site. Shading is provided by a modern shed covered with corrugated sheets where six (06) transparent sheets are inserted on each side of the roof to filter the light. The temperature inside the frame was approximately 23-27°C. The chassis is parallelepipedic in shape, built from local material, and subdivided into 4 compartments. This wooden box is covered with a 1 mm thick transparent polyethylene film to maintain a moderate temperature, humidity, and light intensity favorable for the best development of the cuttings [27;29]. Inside the box, the following layers are arranged from the bottom to the surface: a small layer of fine sand, large-calibre pebbles, medium-calibre pebbles, gravel, fine sand and finally the growing medium. The raised materials are soaked in water where the level is limited to the 2nd layer of sand [13;14;30]. The different substrates occupy the upper part of the slick and the cuttings absorb the water by capillary action. A PCV pipe is inserted at the corner of each compartment and allows the water level in the frame to be gauged regularly [13].

Methodology

a. Description of the test

On arrival at the nursery, the roots taken from the field are segmented with secateurs into 5 cm micro-cuttings, which are introduced vertically into the substrate consisting of a mixture of black soil/sawdust (Bs/Sw) and sand/sawdust (Sa/Sw). Each location of the stem segment cuttings was seeded with a dose of mycorrhizae (10 g, 20 g) or not (no mycorrhizae or control). The cuttings were watered twice a day, in the morning and the evening, using a sprayer that delivers water in fine drops. Evaluations were carried out weekly until the end of the trial. To consider a cutting as rooted, it was necessary if and only if the length of the new root was greater than or equal to 1 cm, otherwise it was carefully reinserted into the substrate [28]. Rooted cuttings were placed in perforated black polyethylene bags for acclimatization trials. Cuttings and dead leaves were systematically removed [28].

b. Experimental design

The experimental design used was a split-plot or factorial design with 4 replicates (Fig. 2a). The black soil/sawdust mixture and the sand/sawdust mixture were considered the main treatment, while the mycorrhizal inoculum (0 g, 10 g and 20 g) was considered the secondary treatment. The cuttings (Fig. 2b) that did not receive the mycorrhizal inoculum (Fig. 2c) represented the control. For each trial described in this work, the different compartments of the polypropagators represented the replicates. The experimental unit was set at 10 cuttings because of the rarity of the species in the area. This rarity justifies the interest in the present domestication trial. A total of 240 cuttings (10×4×3×2×1) were handled.

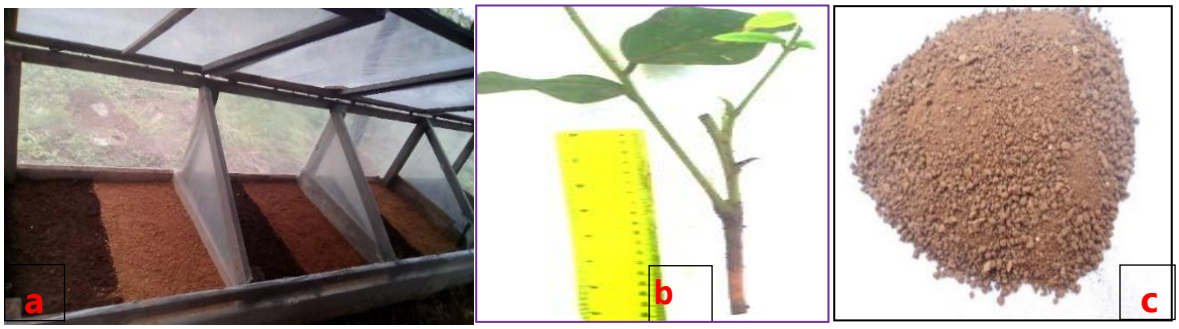


Figure 2: Polypropagator (a), *Pterocarpus erinaceus* stem cutting (b) and mycorrhizal inoculum (c)

c. Data collection and processing

Data were collected weekly until the end of the experiment. During each weekly evaluation, a number of parameters were collected, namely: the number of cuttings having neoformed buds, the number of aerial axes formed, the number of leaves per aerial axis, and the height of leafy axes. At the end of the trial, data were collected on the number of rooted cuttings, the number of neoformed roots per cutting, the length of neoformed roots and the number of dead cuttings. Statistical analyses were performed on the variance (ANOVA). The separation of significant means was done using the Duncan Multiple Range Test. The statistical analysis program used was Statgraphics Centurion 2016 and Microsoft Office 2010 and 2016 were used for writing (Microsoft Word 2016), calculations, histograms and curves (Microsoft Excel 2010).

3. RESULTS

Budding of root segment cuttings

The success of stem segment cuttings is controlled by several exogenous factors such as temperature, relative air humidity, rooting substrate, and symbiotic action with other biofertilizers. Stem segment cuttings (SSC) of *Pterocarpus erinaceus* started to emit the first buds in the 3rd month after planting (Fig. 3a). However, for the SSC propagation of this species, the beginning of budding is synonymous with the beginning of root callus formation (Fig. 3b)

Figure 3: Leafy cuttings of *Pterocarpus erinaceus* (a) and callus formation before rooting (b)

a. Substrate effect

At the 25th week after planting, the percentage of budding in *Pterocarpus erinaceus* varied from 14.16 ± 4.60 % in the substrate made of the black soil/sawdust mixture (Bs/Sw) to 25.00 ±

18.34 % in the sand/sawdust mixture (Sa/Sw) (Fig. 4). This variation is only apparent, as the analysis of variance does not show a significant difference between the substrates (0.11 > 0.05).

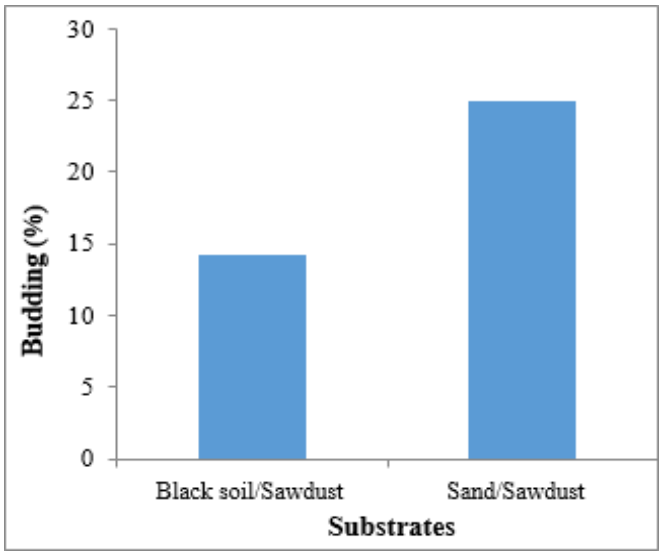
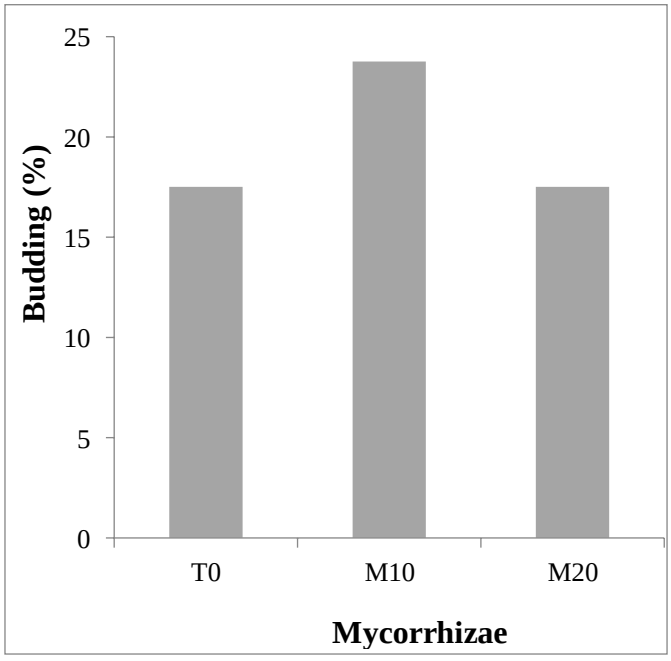


Figure 4: Budding of stem segment cuttings depending on the substrate

b. Effect of mycorrhizae

In *Pterocarpus erinaceus*, the percentage of budding at the end of the experiment varied from 17.5 ± 5.63 % in control cuttings and those inoculated with 20 g to 23.75 ± 5.63 % in also those inoculated with 10 g of mycorrhizae (Fig. 5). This fluctuation is not established in this species as the analysis of variance does not show a significant difference between mycorrhiza doses (0.66 > 0.05



Legend: T0 = Control; M10 = Mycorrhiza 10 g; M20 = Mycorrhiza 20 g

Figure 5: Budding of *Pterocarpus erinaceus* stem segment cuttings following mycorrhizal inoculums

c. Effect of substrate*mycorrhizal inoculum interaction

Regarding the substrate*mycorrhizal inoculum interaction, the percentage of budding in Pterocarpus erinaceus ranged from 7.5 ± 5 % in control cuttings as well as in cuttings inoculated with 20 g of mycorrhizae associated with the black soil/sawdust substrate to 27, 5 ± 7.97 % in cuttings mycorrhizal with 10 g inserted in the black soil/sawdust substrate as well as in control cuttings and those mycorrhizal with 20 g grown in the sand/sawdust substrate (Table 1). The fluctuation observed is only apparent in this species because the analysis of variance reveals that the substrate*inoculum interaction is not significant in this Fabaceae (0.16 > 0.05)

Table 1: Percentage of budding according to substrate*mycorrhizal inoculum interaction

Substrates/Dose (g)	T0	M10	M20	**Mean**
Sand/Sawdust	27.5 ± 22.17	20.0 ± 7.97	27.5 ± 17.07	**25 ± 15.73**
Black soil/Sand	7.50 ± 50	27.5 ± 7.97	7.5 ± 5	**14.16 ± 5.99**
Mean	**17.5 ± 11.11**	**23.75 ± 7.97**	**17.5 ± 11.03**	**19.58 ± 10.86**

Legend: T0 = Control; M10 = Mycorrhiza 10 g; M20 = Mycorrhiza 20 g

Growth parameters on the budding of *Pterocarpus erinaceus*

Effect of Substrate on growth parameters of stem segment cuttings

a. Number of aerial axes per stem segment cutting

Until the 25th week of the experiment, the number of aerial axes did not vary in this Senegalese rosewood (*Pterocarpus erinaceus*). It is one (01) axis. This result suggests that uninodal stem segment cuttings only produce one aerial shoot or that the conditions were not sufficient to stimulate their multiplication.

b. Height of aerial axes per stem segment cutting

In the 25th week of the experiment in *Pterocarpus erinaceus*, the height of the aerial axes ranged from 2.58 ± 0.83 cm in the cuttings inserted in the black soil/sawdust substrate to 3.91 ±2.58 cm in the sand/sawdust substrate (Table 2). The analysis of variance did not show a significant difference between the substrates (0.27 > 0.05). This result indicates that the substrates did not influence the height of the aerial axes.

c. Number of leaves per stem segment cutting

At the end of the experiment, the number of leaves per stem segment cutting in Vene (*Pterocarpus erinaceus*) ranged from 1.5 ± 0.46 in the black soil/sawdust substrate to 2.36 ± 0.48 in the sand/sawdust substrate (Table 2). The analysis of variance does not show a significant difference between the substrates (0.21 > 0.05).

Table 2: Growth parameters of stem segment cuttings of the species according to the substrate

Substrates/Parameters	Axis height (cm)	Number of leaves
Sand/Sawdust	3.91 ± 2.58	2.36 ± 0.48
Black soil/Sawdust	2.58 ± 0.83	1.5 ± 0.46
Mean	**3.24 ± 1.70**	**1.70 ± 0.47**

Effect of mycorrhizal inoculum on growth parameters of stem segment cuttings

a. Number of aerial axes per stem segment cutting

The number of aerial axes per stem segment cuttings did not change when treated with mycorrhizal inoculum. It was equal to one (01) in *Pterocarpus erinaceus* until the end of the experiment.

b. Height of aerial axes per stem segment cutting

Concerning the treatment of stem segment cuttings with mycorrhizal inoculums, the height of the aerial axes fluctuated in *Pterocarpus erinaceus* from 2.31 ± 1.02 cm in the control cuttings to 4.18 ± 2.52 cm in the cuttings that received 10 g mycorrhizae (Table 3). The analysis of variance shows no significant difference between the cuttings (0.45 > 0.05).

c. Number of leaves per leafy axes of stem segment cuttings

The number of leaves in *Pterocarpus erinaceus* ranged from 1.66 ± 0.61 in the control cuttings to 2.12 ± 0.56 in the cuttings receiving 10 g of mycorrhizae (Table 3). However, the analysis of variance showed no significant difference between the cuttings (0.85 > 0.05).

Table 3: Growth parameter of stem segment cuttings of the species according to mycorrhizal inoculum

Mycorrhizae/Parameters	Axis height (cm)	Number of leaves
M20	3.25 ± 1.02	2.00 ± 0.56
M10	4.18 ± 2.52	2.12 ± 0.56
T0	2.31 ± 1.02	1.66 ± 0.61
Mean	**3.24 ± 1.52**	**1.92 ± 0.57**

Legend: T0 = Control; M10 = Mycorrhiza 10 g; M20 = Mycorrhiza 20 g

Effect of substrate*mycorrhizal inoculum interaction on growth parameters of stem segment cuttings

a. Number of aerial axes per stem segment cutting

Concerning the substrate*mycorrhizal inoculum interaction of the stem segment cuttings, the number of aerial axes did not change. It was equal to one (01) in *Pterocarpus erinaceus*, until the end of the experiment.

b. Height of aerial axes per stem segment cutting

The Senegalese rosewood (*Pterocarpus erinaceus*), bud height varied from 1.75 ± 1.45 cm in control cuttings grown in the black soil/sawdust mixture to 4.62 ± 1.45 cm in those grown in the sand/sawdust mixture inoculated with 10 g mycorrhizae (Table 4). The analysis of variance did not indicate a significant difference (0.92 > 0.05) despite the variation observed.

Table 4: Height of aerial axes according to substrates and mycorrhizal inoculums

Mycorrhiza doses (g)/Substrate	T0	M10	M20	**Mean**
Sand/Sawdust	2.87 ± 1.45	4.62 ± 1.45	4.25 ± 1.70	**3.91 ± 1.53**
Black soil/Sawdust	1.75 ± 1.45	3.75 ± 1.19	2.25 ± 1.45	**2.39 ± 0.38**
Mean	**2.31 ± 1.45**	**4.18 ± 1.32**	**3.25 ± 1.57**	**3.15 ± 0.95**

Legend: T0 = Control; M10 = Mycorrhiza 10 g; M20 = Mycorrhiza 20 g

c. Number of leaves per aerial shoot

In *Pterocarpus erinaceus*, the number of leaves fluctuated from 1.0 ± 0.79 in the control cuttings grown in the black soil/sawdust mixture to 2.5 ± 1.70 in the sand/sawdust substrate inoculated with 20 g of mycorrhiza (Table 5). The analysis of variance did not indicate a significant difference (0.79 > 0.05) despite the variation observed.

Table 5: Number of leaves per foliage axis as a function of substrate*mycorrhizal inoculum Interdependence

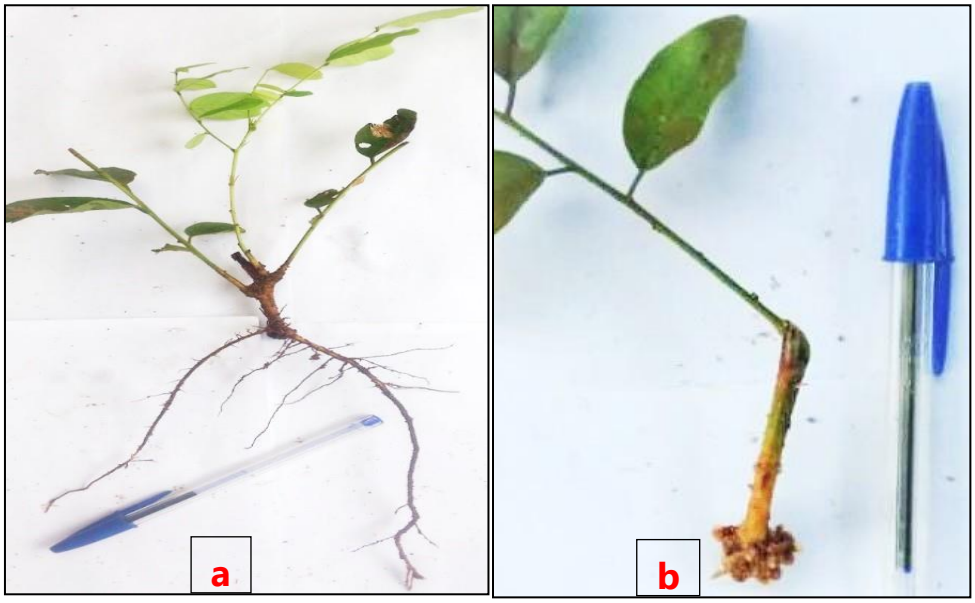
Mycorrhiza doses (g) / Substrate	T0	M10	M20	**Mean**
Sand/Sawdust	2.33 ± 1.52	2.25 ± 1.25	2.5 ± 1.00	**2.36 ± 1.25**
Black soil/Sawdust	1.0 ± 0.1	2.00 ± 0.81	1.25 ± 1.00	**1.41 ± 0.60**
Mean	**1.66 ± 0.76**	**2.125 ± 1.03**	**1.87 ± 1.00**	**1.88 ± 0.92**

Legend: T0 = Control; M10 = Mycorrhiza 10 g; M20 = Mycorrhiza 20 g

Rooting of stem segment cuttings

Effect of Substrate on growth parameters of stem segment cuttings

After 25 weeks of testing, a total of 39.16 ± 4.6 % of stem segment cuttings (SSCs) in *Pterocarpus erinaceus* had developed new roots (Fig. 6)



Legend: a = Neo-root formation; **b** = Clusters of scarring calluses

Figure 6: Rooted leafy cuttings and callus formation before rooting in *Pterocarpus erinaceus*

a. Rooting rate of stem segment cuttings

At the 25th week after planting, the rooting rate of *Pterocarpus erinaceus* ranged from 14.16 ± 4.6 % in the black soil/sawdust mixture to 25.00 ± 18.34 % in the sand/sawdust substrate (Table 6). The analysis of variance did not show a significant difference between the rooting mixture (0.11> 0.05).

b. Number of neoformed roots per stem segment cutting

Up to the 25th week of the experiment, the number of neoformed roots in *Pterocarpus erinaceus* ranged from 0.69 ± 0.15 in the black soil/sawdust substrate to 1.34 ± 0.61 in the sand/sawdust mixture (Table 6). This fluctuation is established because the analysis of variance shows a significant difference between the substrates (0.008 < 0.01).

c. Length of roots neoformed by cutting stem segments

In *Pterocarpus erinaceus*, the length of roots neoformed by stem segment cuttings (SSC) at the end of the experiment (25th week) fluctuated from 6.81 ± 2.56 cm in the black soil/sand mixture to 10.64 ± 7.14 cm in the sand/sawdust mixture (Table 6). This disparity is confirmed by the analysis of variance, which shows a significant difference between the substrates (0.03 < 0.05).

Table 6: Growth parameter of neoformed roots of *Pterocarpus erinaceus* with the substrate

Substrates/Parameters	Rooting rate (%)	Number of roots	Root length (cm)
Sand/Sawdust	25.00 ± 18.3	1.34 ± 0,61	10.64 ± 7.14
Black soil/Sawdust	14.16 ± 4.6	0.69 ± 0,15	6.81 ± 2.56
Mean	**19.58 ± 11.45**	**1.01 ± 0.56**	**8.72 4.85**

Effect of mycorrhizal inoculum

a. Rooting percentage of stem segment cuttings

In the Senegalese rosewood, the rooting rate at the 25th week fluctuated from 17.5 ± 5.63 % in control cuttings and cuttings inoculated with 20 g of mycorrhizal inoculum to 23.75 ± 14.07 % in cuttings inoculated with 10 g of mycorrhizae (Table 7). The analysis of variance reveals that the action of mycorrhizal inoculums is not significant (0.66 > 0.05) for root neoformation.

b. Number of neoformed roots per stem segment cutting

At 25 weeks, the number of neoformed roots in Senegalese rosewood varied from 0.55 ± 0.18 in the control cuttings to 1.30 ± 0.37 in those inoculated with 10 g of mycorrhiza (Table 7). This fluctuation is established because the analysis of variance shows a significant difference between treatments (0.02 < 0.05). In view of these results, we can say that inoculation of cuttings with mycorrhizae has a positive effect on the number of neoformed roots.

c. Length of neoformed roots per stem segment cutting

At the final evaluation of the trial, the length of neoformed roots per stem segment cutting in Senegalese rosewood fluctuated from 6.64 ± 3.14 cm in the control cuttings to 9.82 ± 6.40 cm in the cuttings that received 10 g of mycorrhizae (Table 7). The analysis of variance did not show a significant difference between root lengths (0.72 > 0.05).

Table 7: Growth parameter of neoformed roots of *Pterocarpus erinaceus* as a function of mycorrhizal inoculums

Mycorrhizae/Parameters	Rooting rate (%)	Number of roots	Root length (cm)
T0	17.5 ± 5.63	1.19 ± 0.84b	6.64 ± 3.14
M10	23.75 ± 14.07	1.30 ± 0.37a	9.82 ± 6.40
M20	17.5 ± 5.63	0.55 ± 0.18c	9.72 ± 3.14
Mean	**19.58 ± 8.44**	**1.01 ± 0.46**	**8.72 ± 4.22**

Legend: T0 = Control; M10 = Mycorrhizae 10 g; M20 = Mycorrhizae 20 g

Effect of substrate*mycorrhizal inoculum interaction

a. Percentage rooting of stem segment cuttings

After 25 weeks of the experiment, the rooting rate of *Pterocarpus erinaceus* according to the substrate*mycorrhizal inoculum interaction varied from 7.5 ± 7.97 % in the cuttings with 20 g mycorrhizae and the control cuttings grown in the black soil/sawdust mixture to 27.5 ± 5.00 % in cuttings mycorrhizal with 10 g in the black soil/sawdust substrate as well as in cuttings mycorrhizal with 20 g and controls grown in the sand/sawdust mixture (Table 8). The analysis of variance does not show a significant difference (0.16 > 0.05).

Table 8: Rooting rates according to substrate*mycorrhizal inoculum interaction of *Pterocarpus erinaceus*

Mycorrhiza doses (g) /Substrate	T0	M10	M20	**Mean**
Sand/sawdust	27.5 ± 22.17	20.00 ± 7.97	27.5 ± 17.07	**25 ± 15.73**
Black soil/Sawdust	7.5 ± 5	27.5 ± 7.97	7.5 ± 5	**14.16 ± 5.99**
Mean	**17.5 ± 11.11**	**23.75 ± 7.97**	**17.5 ± 11.03**	**19.58 ± 10.86**

Legend: T0 = Control; M10 = Mycorrhiza 10 g; M20 = Mycorrhiza 20 g

b. Number of roots formed by stem segment cuttings

At the end of the experience (25 weeks), the number of adventitious roots per cutting in *Pterocarpus erinaceus* ranged from 0.25 ± 0.26 in uninoculated cuttings (i.e. the control) grown in the black soil/sawdust mixture to 1.75 ± 0.26 in cuttings inoculated with 20 g grown in the sand/sawdust (Table 9). The analysis of variance did not indicate a significant difference (0.23 > 0.05) despite the variation observed. Thus, the combined action of the two treatments did not affect the adventitious root emission of the cuttings of this species.

Table 9: Number of roots according to substrate*mycorrhizal inoculum interaction of *Pterocarpus erinaceus*

Mycorrhiza doses (g) /Substrate	T0	M10	M20	**Mean**
Sand/Sawdust	0.86 ± 0.58	1.4 ± 0.48	1.75 ± 0.5	**1.33 ± 0.52**
Black soil/Sawdust	0.25 ± 0.26	1.2 ± 0.24	0.6 ± 0.26	**0.68 ± 0.25**
Mean	**0.55 ± 0.42**	**1.3 ± 0.36**	**1.17 ± 0.38**	**1.00 ± 0.38**

Legend: T0 = Control; M10 = Mycorrhiza 10 g; M20 = Mycorrhiza 20 g

c. Root length of stem segment cuttings

At the end of the experiment (25 weeks), the length of neoformed roots in *Pterocarpus erinaceus* following the interaction of substrate and mycorrhizal inoculum fluctuated from 4.83 ± 4.44 cm in the control cuttings grown in the black soil/sawdust mixture to 12.32 ± 5.87 cm in the 20 g cuttings inserted in the sand/sawdust mixture (Table 10). This variation is not established by analysis of variance (0.95 > 0.05), despite the difference observed. This result suggests that the combination of these two factors was not beneficial for the growth of neoformed roots.

Table 10: Root length of *Pterocarpus erinaceus* following substrate*mycorrhizal inoculum interaction

Mycorrhiza doses (g) /Substrate	T0	M10	M20	**Mean**
Sand/sawdust	8.46 ± 4.44	11.15 ± 8.45	12.32 ± 5.87	**10.64 ± 6.25**
Black soil/Sawdust	4.83 ± 4.44	8.49 ± 4.4	7.12 ± 4.44	**6.81 ± 4.42**
Mean	**6.64 ± 4.44**	**9.82 ± 6.42**	**9.72 ± 5.15**	**8.72 ± 5.33**

Legend: T0 = Control; M10 = Mycorrhiza 10 g; M20 = Mycorrhiza 20 g

DISCUSSION

Budding of stem segment cuttings

The rather long period for the onset of budding of *Pterocarpus erinaceus* stem segment cuttings (SSC) could be explained by different factors: age of mother plants, age of stump sprouts, collection season, the endogenous sugar content of SSC and genotype. Similarly, [31] report that the latency for budding varies between species. The different substrates did not influence the budding of the stem segment cuttings (SSC). The results obtained corroborate those of [6] on *P. erinaceus* who reported that the substrate did not influence SSC budding ability. [13] report similar results on uninodal cuttings of *Vitex doniana*. In this species, the date of appearance of leafy shoots did not vary between substrates. This can be explained by the porosity and the ability to maintain the necessary moisture to promote the budding of cuttings on these substrates. However, in Senegal, [32;33] showed that mycorrhizal inoculums improved the budding of cuttings. These authors reported that *Acacia holosericea* associated with ectomycorrhizal fungi, of the genus *Pisolithus* and *Sleroderma*, showed in a controlled environment a much higher juvenile growth in than *A. holosericea* in a non-inoculated environment. These results do not corroborate those of [28] who reported that on substrates generally lacking natural inoculum, the level of fertility was very high. Plant growth was rapid, but there was little or no colonisation of the roots by mycorrhizal fungi. These results indicate that the combined effect of substrate*mycorrhizal inoculum did not influence bud formation.

Rooting of stem segment cuttings

The rooting rate obtained in this Venus is similar to that obtained by [34] where they obtained a rate of 37 % on the same species. Remarkably, scar callus formation precedes root formation in stem segment cuttings in this species. Many authors report that callogenesis is a precursor to rooting: [35] on *Hedera helix* and [36] on *Ceiba pentandra*. In some cases, the late appearance of roots may be due to the formation of a thick callus that is considered a mechanical barrier to rooting [37]. The separation of budding and rooting in time is justified by the fact that leafy shoots through photosynthesis supply the cuttings with carbohydrates, thus stimulating root formation [32]. The rooting of tropical species varies according to the different growing substrates [13]. However, the authors show that their rooting is more favourable in some substrates than in others. Reliable information is hard to come by. Nevertheless, it seems that there is a relationship between the water content of the substrate and that of the cutting. For example, different substrates are known to affect the water supply of cuttings [38;39] and to affect the photosynthesis and stomatal conductance of cuttings [40]. Moreover, these results are different from those obtained on *Vitex doniana* by [13] in the same locality where the best substrate was the black soil/sawdust mixture. The quality of the substrate is a very important parameter for the success of the rooting process of the cuttings and the requirements of the species for the different substrates depend on their hydromorphic or xeromorphic character [39;41]. Similarly, in *Dacryodes edulis*, sawdust induced the best rooting [42].

CONCLUSION AND PERSPECTIVES

At the end of this work, where the aim was to carry out a vegetative propagation test using cuttings of *Pterocarpus erinaceus* stem segments, we can say that the cuttings of *P. erinaceus* root segments have a good ability to form leafy shoots despite a long lag time. The best substrate for budding was the sand/sawdust mixture (25.00 ± 18.34 %) while the 10 g dose of mycorrhizae favored budding (23.75 ± 5.63 %). The number of aerial shoots did not vary (01 axes) during this experiment. The high heights (3.91 ± 2.58 cm) were obtained in the sand/sawdust mixture while the medium dose (10 g) increased the height increment (4.18 ± 2.52 cm). The highest number of leaves per aerial axis was observed in the sand/sawdust substrate (2.36 ± 0.48) and regarding inoculation with mycorrhizae, the 10 g dose of mycorrhizae was again the best (2.12 ± 0.56). Furthermore, the best rooting rate was

obtained in the sand/sawdust mixture (25.00 ± 18.34 %) and the highest rooting percentage was obtained in the cuttings inoculated with 10 g of mycorrhizae (23.75 ± 14.07 %). It should also be noted that the best substrate for the number of neoformed roots was the sand/sawdust mixture (1.34 ± 0.61), while the 10 g dose of mycorrhizae better- optimised root development (1.30 ± 0.37). The best substrate for neoformed root length was the sand/sawdust mixture (10.64 ± 7.14 cm) while the 10 g dose was more favorable for root length growth (9.82 ± 6.40 cm) for Senegalese Rosewood. Given the above, it can be said that vegetative propagation is one of the alternatives for the cultivation and perpetuation of *P. erinaceus.* The domestication of this species via stem cuttings and its association with mycorrhizal inoculum should be advised and popularised among farmers concerned about the good recovery of their cuttings in the field and its sustainability, given the multiple socio-economic interests of this Fabaceae. In addition, it would be desirable to carry out a study of the organs (anatomical, histological, etc.) involved in the vegetative propagation of this species to determine the appropriate period for its cutting, to test other modes of vegetative propagation (suckering, layering, etc.) with the inoculum of the mycelium.) with mycorrhizal inoculum in this species and then extend it to other woody plants, to conduct cutting trials of this species in the SSC sampling medium, to follow the explants produced until fruiting to assess the effect of the mycorrhizal inoculums.

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