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Influence of substrate and length on the ability of root segments cuttings of *Ximenia americana* L. to regenerate

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Abstract
Ximenia americana L. is one of the most popular local edible fruit species in Cameroon. The aim of this work is to contribute to the domestication of *Ximenia americana* by root segments cutting (RSC). To this end, the favorable sampling period of cuttings for this species was indirectly determined by quantifying carbohydrate content in the laboratory, and the influence of substrate and length of root segment cuttings on the ability of this species to form adventitious buds and roots was also evaluated. The root system of adult mother trees was carefully excavated, and lateral root segments were removed and kept in the cooler until they reached the nursery. There, they were cut into cuttings of 10, 15 and 20 cm. The root segment cuttings were inserted vertically into four different substrate, sand/sawdust (sa/sw); black soil/sawdust (bs/sw); sawdust (sw) and black soil (bs). The experimental design used was a split-plot with 03 replicates in which the substrate is the main treatment and the length of the root segment cuttings the secondary treatment. The experimental unit was made up to 10 cuttings. Investigations all over the year, showed that vegetative rest period of *Ximenia americana* is from March to August, period were the whole sugars are at their highest level (21.45 mg/MS). The sand/sawdust mixture is the best substrate for budding and rooting, with 58.88±16.91% and 59±21.47% respectively. The 20cm cuttings showed the best budding (62.5±11.38%) and rooting (46±29.37%) rates. This low-cost vegetative propagation technique represents an important step in the domestication of this species.

Keywords: Cutting, budding, rooting, carbohydrate, *Ximenia americana*

1. Introduction
Ximenia americana L., known as 'Tchabboullé' in the Fulani language of northern Cameroon, is one of the most valuable local edible species in the Guinean savannah highlands of Adamawa [1]. In several african countries, the fruit is used as food for humans and animals, as a medicine, as a source of essential oil, and as an industrial component for other products [2]. All parts of the plant are used: fruit, leaves, roots and wood [3]. The fruit pulp is edible. It is used to produce a highly appreciated fermented drink. After extraction, the kernels produce an oil used in cooking [4]. The leaves are used to treat angina, colitis and flatulence ; the stem bark is used to treat a variety of illnesses, including fever, inflammation and painful condition [5]. The roots are used for venereal diseases, headaches, rheumatoid arthritis, sexual impotence, intestinal disorders, heartache, diarrhoea, fever and mental disorders [6].
Natural regeneration of the species in the savannah faces multiple environmental contengencies, including recurrent droughts, bush fires, overgrazing and anthropogenic pressures [7]. The lack of information on the domestication process of this species is a real challenge for users [8, 9]. Domestication of this species can contribute to improve the living standard of local populations and conserving their biodiversity. A number of invoices interact during the cutting process to influence the quality and recovery rate of cutting, including carbohydrates. In plants, the carbohydrates (sugars) synthesised by the leaves during photosynthesis constitute the major component of organic substances. They are the component of most organic compounds, and also act as a source of energy, a substance of support (cellulose, hemicellulose, gluco-proteins, etc.)

and reserve [10]. All parts of the plant can store carbohydrates, either temporarily in the leaves (storage during the day, used in conditions limiting photosynthesis or at night), or more permanently in the twigs, trunk and roots [11] have shown that carbohydrates and phytohormones (auxins) regulate bud break and root development in cuttings. Carbohydrates are a good source of carbon during embryogenesis, which improves the quality and quantity of somatic embryos produced [12]. In the vegetative cycle of the grapevine, starch concentration in roots and barks increases at budburst, flowering and until leaf fall [10].

In the Guinean savannah highlands of Cameroon, several works have focused on root segments cutting of species of socio-economic interest. These include those of [13, 14] on *Vitex doniana*, [15] ; [16] on *Bombax costatum* and *Vitex doniana*, [17] on *Sclerocarya birrea*, and [18] on *Detarium microcarpum* and *Securidaca longepedunculata*.

The main objective of the present work is to contribute to the domestication of *Ximenia americana* by root segment cuttings (RSC) under agro-ecological conditions of the Guinean savannah highlands. More specifically, the aim of the present work is to determine the favorable period for root segment cuttings collection of this species, and to evaluate the influence of substrate and length of cuttings on the ability of this species to newly form adventitious buds and roots.

2. Materials and methods

a. Study site

The study was carried out in the Guinean savannah highlands of Adamawa (ALT: 9047-1086m LN: 6° 00'- 8° 00'. LE 11° 30 - 15° 30'). The climate is Sudano-Guinean, with two seasons : a rainy season from April to October and a dry season from November to March [19]. The region's soils is mainly of red ferralitic structures developed on old basalts [20]. Vegetation ranges from shrub to tree savannah, dominated by *Daniellia oliveri* and *Lophira lanceolata* [21]. This vegetation is highly threatened by human activities. The region is composed of several ethnic groups among which the most common are : Fulanis, Mboums, Pérés, Koutines, Haoussas, Niza'as, and Dourous [19].

2.2. Methods

2.2.1. Determination of the favourable period for root segments cutting propagation

In the Guinean savannah highlands of Adamawa in Cameroon, the favorable period for root cutting excavation of *Ximenia americana* is not well known. As a result, root segments of this Olacaceae were collected from January to December 2021 from *X. americana* mothers trees, with a view to determining this exact period by quantifying carbohydrates, in particular total sugars, reducing sugars, glucose and fructose. According to the work of [22, 23] in Finland on *Populus tremula* cuttings, [10] in Switzerland on *Vitis vinifera*, have show a decrease in root and trunk starch content from bud break to flowering.

Every month, around 0.5 kg of root segments was sampled from 10 mother tree over the course of a year. After sampling, the root fragment samples were cut into pieces and dried at room temperature. After drying, they were grind to obtain a powder which was bagged, labelled (date, place of collection) and stored in the shade. Once the powder was obtained, chemical analyses were carried out at the University of Maroua's Biochemistry and Organic Chemistry Laboratory to quantify the various carbohydrates. The methods used were those of [24].

After identifying the favorable period for the collection of cuttings, the cuttings trial was set up.

2.2.2. Root segment cuttings

Description of the nursery and polypropagator

The cutting trial took place at the nursery of the the Laboratory of Biodiversity and Sustainable Development of the University of Ngaoundere, located near the river Bini (Alt: 1079 m; LN: 7°24'; LE: 13°32'). The polypropagator was placed under a modern shelter in a sheet metal shelter to provide shade. 06 sheets of transparent steel sheet were inserted in the roof to filter the light. The polypropagator, made from local materials in the shape of a parallepiped, was subdivided into 03 compartments. The framework was made of wood and covered with transparent polyethylene to ensure favorable conditions for the development of cuttings (Fig. 1). The relative humidity in the polypropagator is between 80% and 100%, while the temperature ranges from 23 °C to 28 °C [13]. From bottom to top, the following layers are arranged inside the polypropagators : a thin layer of fine sand, large pebble blocks, medium pebbles, gravel, sand and finally rooting substrates [9]. Inside the polypropagator, a PVC pipe is inserted to the corner of the polypropagator, enabling the water level to be gauged regularly.

Root segment cutting test

With the exact sampling period determined, the cuttings trial began in February 2024. The root systems of 35 phenotypically healthy adult plants of *Ximenia americana* were carefully excavated and root fragments were taken. These root segments were transported to the nursery, where they were cut into 10 cm, 15 cm and 20 cm long (The proximal end was marked). The root segment cuttings were placed in a vertical position in the following substrates : mixture of sand and sawdust (sa/sw), mixture of black soil and sawdust (bs/sw), black soil (bs) and sawdust (sw), previously placed in a polypropagator. Approximately 1 cm of the proximal end of the cuttings was exposed. The experimental design used was a split-plot with 3 replicates. The primary treatment consisted of substrates and the secondary treatment consisted of the length of the cuttings. The physicochemical characteristics of the abovementioned substrates were determined and recorded in Table 1.

Data collection and analysis

To determine the best time to collect root segment cuttings, the optical density of the various test samples was read using a Spectrophotometer at a wave length of 540 nm. The experimental set-up used for each carbohydrate was completely randomized, with the 12 months of the year as the factor.

In the case of root segment cuttings (RSC), data was collected on a weekly basis for budding parameters, from the date of appearance of the first bud, and covered the number of cuttings that budded, the number of leafy axes, the size of leafy axes, and the number of leaves per leafy axis. For rooting, it was carried out at the end of the experiment and covered the number of rooted cuttings, the number of roots per cutting and the length of adventitious roots formed.

The data collected were subjected to analysis of variance using Statgraphic plus 5.0 software. Significant means were separated using the Duncan Multiple Range Test. Microsoft Office 2010 Excel spreadsheet software was used to plot the graphs.

3. Results

3.1. Variation in mother tree carbohydrates over the year

During the year, total sugars are most concentrated in the plant from March to June, with an optimum in April-May, while reducing sugars are concentrated from March to August. Fructose shows 3 phases : March-June, August and October-

November. For the latter, the optimum is in June. Glucose, like the other reducing sugars, goes from March to August, with a peak in August. Generally speaking, it appears that the quantity of carbohydrates in this Olacaceae fluctuates throughout the year, but that the vegetative rest period is from March to June apart the glucose which rise to August (Fig. 1). Analyses of variance for total, reducing, glucose and fructose sugars show significant differences between the different months of the year (0.000<0.001).

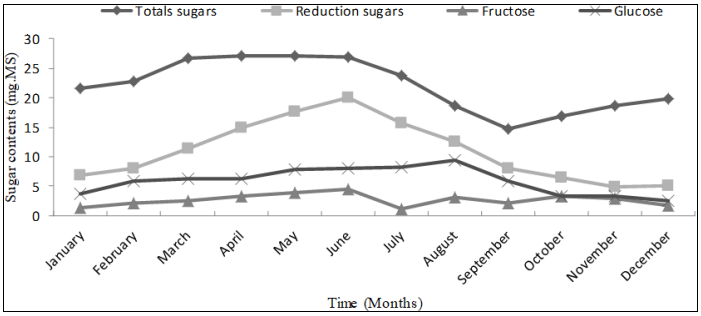

Fig 1: Carbohydrate content over the year

Concerning physico-chemical analyses of the substrates used, Hydrogen Potential (pH-water) of the substrates ranged from 4.3 in sawdust to 7.2 in sand/sawdust. Organic matter (OM) content varies from 5.64 in blacksoil to 44.25 in sawdust. Nitrogen (N) content ranges from 0.11 in black earth/sand to 1.26 in sawdust. The carbon/nitrogen (C/N) ratio fluctuates from 19 in the black soil substrate to 68 in the black soil/sawdust mixture. Calcium (Ca) content varies from 6 in the sand/sawdust mixture to 9.60 in the black soil/sawdust mixture. Magnesium (Mg) content varies from 1.60 in black earth/sawdust to 4.60 in sawdust. For potassium (P), it fluctuates from 0.58 in the black soil/sawdust mixture to 19.23 in the black soil. Sodium (Na) content varies from 0.25 in the black soil/sawdust mixture to 4.29 in the sawdust. Cation exchange capacity (CECpH7) ranges from 28 in the sand/sawdust to 60 in the sawdust. Saturation percentage ranges from 23 in sawdust to 94 in black soil (Table 1).

Table 1: Physicochemical composition of different substrates

Elements	Black soil	Black soil/Sawdust	Sand/Sawdust	Sawdust
pH-water	5.5	6.2	7.2	4.3
MO (%)	5.64	13.17	8.53	44.25
N tot. (%)	0.17	0.11	0.17	1.26
C/N	19	68	29	35
Calcium	8.80	9.60	6.00	8
Magnesium	3.28	1.60	2.56	4.6
Potassium	19.23	0.58	0.66	7.2
Sodium	2.61	0.25	0.34	4.29
CEC pH7	36.00	30.00	28.00	60
Saturation (%)	94	40	34	23

3.2 Budding of root segments cuttings

08 weeks after putting cuttings into culture, the first buds appeared (Fig. 2).

At the end of the trial (20 weeks), the budding rate varied from 43.33±7.07% for cuttings placed in sawdust to 58.88±16.91% for those inserted in the sand/sawdust mixture (Fig. 3). Analysis of variance indicates a significant difference between the different substrates (0.000<0.001).

The budding rate, depending on the length of the root segments cuttings (RSC), varied from 42.5±6.21% for 10cm cuttings to 62.5±11.38% for those of 20cm (Fig. 4). Analysis of variance shows a significant difference (0.0135<0.05).

Fig 2: Budded cuttings

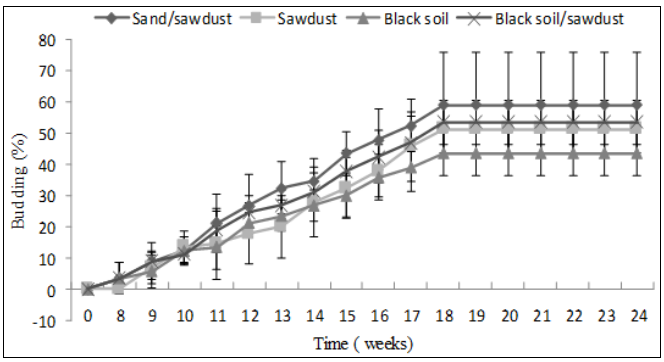

Fig 3: Budding rate versus time

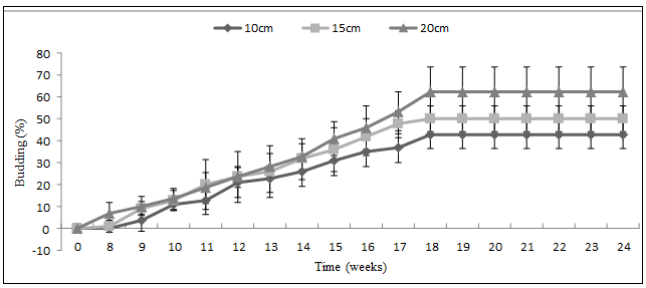

Fig 4: Budding rate according to time

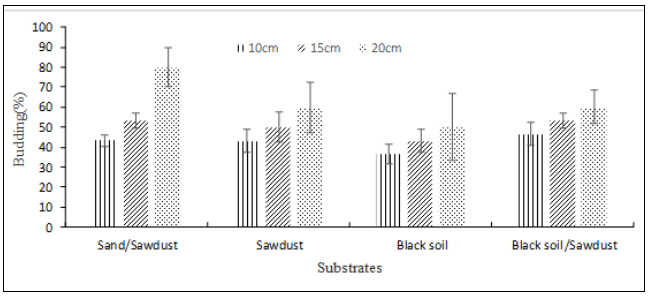

Fig 5: Budding rate according to substrate and length of cuttings

For the substrate*length interaction at the end of the trial, the budding rate ranged from 36.6±4.77% for 10cm cuttings

inserted in black soil to 80±9,77% for those of 20cm grown in sand/sawdust mixture (Fig. 5). There was a significant difference for this interaction (0.000<0.001).

Growth parameters of aerial axes

The number of aerial axes per cutting varied from 10±3 in cuttings grown in the black soil/sawdust mixture to 17±5 for those inserted in the sand/sawdust mixture (Table 2). Analysis of variance shows a significant difference (0.0002<0.001). The height of the aerial axes ranged from 25±6 cm in root segment cuttings (RSC) grown in black soil to 40.11±14.10 cm for those inserted in the sand/sawdust mixture (Table 2). Analysis of variance indicates a significant difference (0.0052<0.001). The number of leaves varied from 25.44±9 in RSC inserted in the black soil to 42±18 for those grown in the sawdust substrate (Table 2). The variation observed at this level is only apparent, as there is no significant difference (0.0972>0.05).

Table 2: Growth parametrs according to different substrates

Substrates	Number of aerial axes	Height of aerial axes (cm)	Number of leaves
Sand/sawdust	17±5b	40,11±14,10b	39.44±23.14a
Sawdust	15,11±3b	39,27±15b	42±18a
Black soil	10,33±4a	25±6a	25,44±9a
Black soil/sawdust	10±3a	26±7a	27.22±13a
Probability	0,0002	0,0052	0,0972

Means in the same column with different letters are statistically different at the 5% threshold.

For the effect of the length of the cuttings, the number of arial axes per cutting varied from 11±3.05 for cuttings of 10cm to 16±6 for those of 20cm (Table 3). Analysis of variance shows a significant difference (0.014<0.05). The height of aerial axes ranged from 28.03±9.05 cm for cuttings of 10cm to 39.08±16.29cm for those of 20cm (Table 3). Analysis of variance showed no significant difference (0.082> 0.05). The number of leaves varied from 29±12 for cuttings of 10cm to 37±15 for those of 20cm (Table 3). Analysis of variance showed no significant difference (0.4972> 0.05).

Table 3: Growth parameters according to the length of cuttings

Length	Number of axes	Height of aerial axes (cm)	Number of Leaves
10 cm	11±3,05a	28,03±9,05a	28,58±12a
15 cm	12,16±3,32a	30,21±10,46a	37±15a
20 cm	16±6b	39,08±16,29a	35,33±24a
Probability	0,0135	0,0822	0,4972

Means in the same column with different letters are statistically different at the 5% threshold

For the substrate*length interaction at the end of trial, the number of aerial axes per cutting varied from 10±4.35 for cuttings of 20cm grown in the black soil/sawdust mixture to 22.66±2.51 for those of the same size inserted in sand/sawdust substrate (Fig. 6). Analysis of variance showed a significant difference (0.0274<0.05).

The height of the aerial axes ranged from 12.33±1.52 cm for cuttings of 10cm grown in black soil to 28±6.24 cm for those of 20cm put in culture in the sand/sawdust mixture (Fig. 7). Analysis of variance revealed no significant difference (0.4962> 0.05).

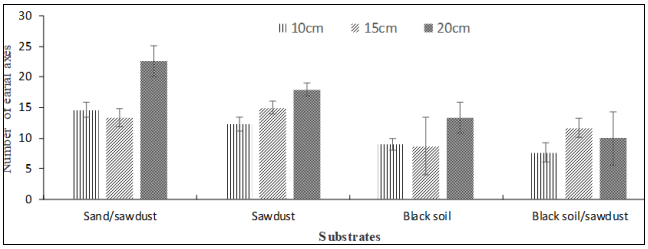

Fig 6: Interaction substrate*length on the number of aerial axes

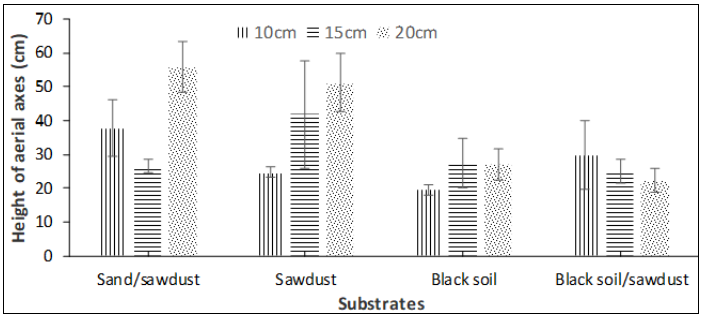

Fig 7: Substrate*length of cuttings interacrion on the height of aerial axes

The number of leaves varied from 16.33±1.52 for cuttings of 10cm grown in black soil to 36±16 for those of 15cm inserted in sawdust (Fig. 8). Analysis of variance showed no significant difference (0.3462> 0.05).

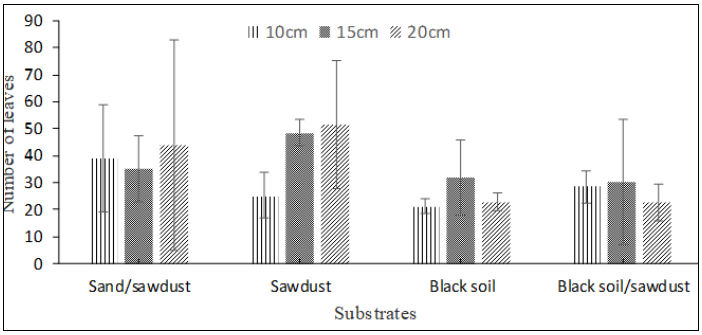

Fig 8: Substrate*lenght of cuttings interaction on the number of leave

3.3. Rooting of root segments cuttings

- **Rooting rate**

At the end of the trial, the wole cuttings of different lengths (10, 15 and 20cm) that had budded, developed adventitious roots in the various substrates (Fig. 9).

Fig 9: Rooted cutting

The rooting rate varied from 19±14% for cuttings inserted in black soil/sawdust to 59±21.47% for those placed in the sand/sawdust mixture (Table 4). Analysis of variance showed a significant difference (0.0001<0.001).

Table 4: Influence of substrate on rooting rate

Substrates	Sand/sawdust	Sawdust	Black soil	Black soil/sawdust	Mean
Rooting (%)	59±21.47c	41.11±18.33b	22.22±16a	19±14a	35.33±17.45

Means followed by the same letter are statistically identical at the 5% probability level.

For the effect of length of root segments cuttings (RSC), the rooting rate varied from 26±14% for cuttings of 10cm to 46±37% for those of 20cm (Table 5). Analysis of variance showed a significant difference (0.0111<0.05).

Table 5: Rooting rates according to the length of cuttings

Length (cm)	10	15	20	Mean
Rooting (%)	26±14a	34.16±22a	46±37b	35.38±24.33

Means followed by the same letter are statistically identical at the 5% probability level.

The rooting percentage ranged from 17±12% for 10cm and 20cm cuttings inserted in blacksoil/sawdust to 83.33±6% for those of 20cm placed in the sand/sawdust mixture (Fig. 10). Analysis of variance showed a significant difference (0.0328<0.05).

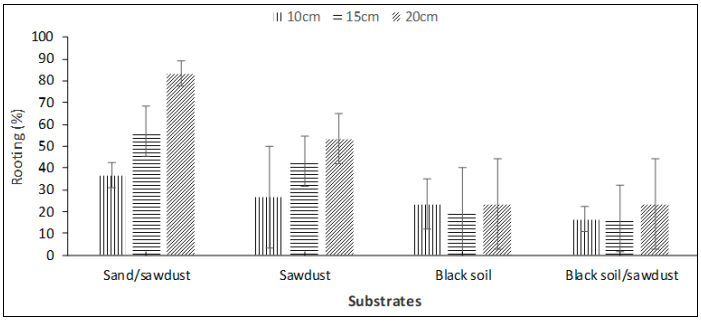

Fig 10: Rooting rate according to substrate*length of cuttings interaction

- **Effect of substrate on the number and length of roots**

The number of roots varied from 4.44±6 for cuttings inserted in black soil to 15±6 for those placed in the sand/sawdust substrate (Table 6). Analysis of variance indicated a significant difference among the substrates (0.000<0.001).

The length of the roots fluctuated from 7.8±5.40cm for cuttings inserted in the black soil to 23.13±7.05 cm for those placed in the sand/sawdust mixture (Table 6). Analysis of variance showed a significant difference (0.0001<0.001).

Table 6: Rooting parameters according to substrate

Substrates	Number of roots	Root length (cm)
Sand/sawdust	15±6b	23.13±7.05b
Sawdust	9.66±6a	17.05±9.55b
Black soil	4.44±6a	7.86±5.52a
Black soil/sawdust	7±3a	7.8±5.40a
Probability	0.0006	0.0001

Means in the same column with different letters are statistically different at the 5% threshold

- **Number and length of adventitious roots**

The number of roots in the rooted RSC ranged from 7±3.36 in the 10 cm cuttings to 11.33±8 for those of 20 cm (Table 7). A significant difference existed among the lengths of root segments cuttings (RSC) (0.0083<0.01).

The length of the roots varied from 9.79±5.42 cm for the 10cm cuttings to 17.7±11,11cm for those 20cm long (Table 7). There was no significant difference among the lengths RSC (0.1179 > 0.05).

Table 7: Effect of cuttings length on rooting parameters

Lengths	Number of roots	Root length (cm)
10 cm	7±3.36a	9.79±5.42a
15 cm	9±6a	14.41±9.81ab
20 cm	11.33±8b	17.7±11.11b
Probability	0.0083	0.1179

Means in the same column with different letters are statistically different at the 5% threshold

- **Substrate*cuttings length interaction on the number and length of adventitious roots**

The number of roots varied from 3±3 in 20cm cuttings grown in black soil to 21±6 for those of 20cm inserted in sand/sawdust mixture (Fig. 11). There was a significant difference for the interaction (0.0004<0.001).

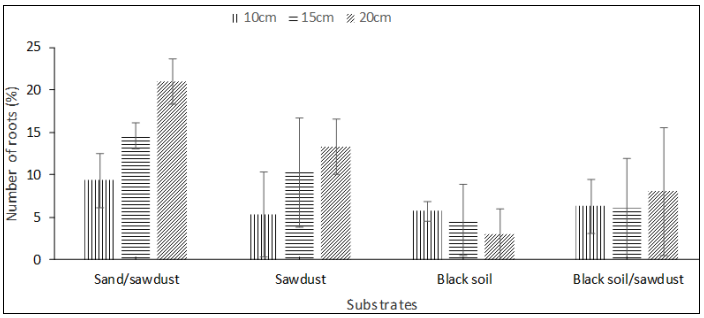

Fig 11: Number of roots by substrate and length of cuttings

Root length of rooted RSC ranged from 7.41±6.37 cm for 15cm cuttings grown in black/sawdust soil to 30.33±2.08 cm for 20cm grown in sand/sawdust (Fig. 12). There was no significant difference (0,3608>0.05).

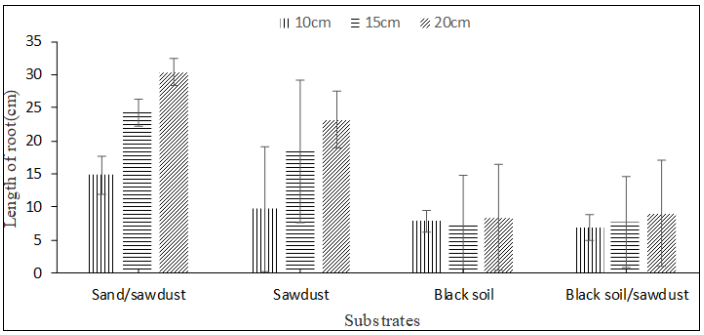

Fig 12: Length of adventitious roots according to substrate*length interaction

4. Discussion

- **Carbohydrate variations**

Results obtained from other authors on the importance of sugars in other species sufficiently corroborate the present results [25] in China found a high level (32.82% dry matter) of total sugars in cuttings from root segments of tetraploid

black locust before they were planted in May. In Egypt, Hussein (2008) noted a high level of total sugars in *Thunbergia grandiflora* in the dry season (March) at the base of the cuttings. In Finland, [23] reported high carbohydrate content varies from clone to clone. In hybrid poplar, carbohydrate concentration was highest in winter and lowest in early autumn. In general, suckering of root cuttings is efficient when carbohydrate levels are high. In Switzerland, [10] on *Vitis vinifera* noted that soluble carbohydrate levels rise from 2-3% of dry matter to 7-8% during December and the first two months of the year. The carbohydrate reserves observed in the various organs of *Vitis vinifera* are at their highest when temperatures fall periodically at leaf fall, and at their lowest just before flowering.

- **Budding of root segment cuttings**
  The quality of the substrate is crucial for the budding and rooting of root segments cuttings (RSC). Not only must it provide anchorage for the cutting, but it must also ensure good aeration of the cutting, while at the same time maintaining the moisture necessary for its survival during the pre-rooting and rooting periods [26]. The choice of substrate depends not only on local conditions and available ressources, but also on the plant's requirements.
- **These cuttings produced leafy axes after 08 weeks**
  This result is in contrast to that of [3] on the same species and under the same agroecological conditions, who did not obtained budding and rooting. The explanation is that the authors carried experiences in a different season. On the other hand, the present findings are similar to that of [1, 17] on *Vitex doniana* under the same ecological conditions. This could be explained by the difference in the period when the cuttings were taken (February for *Ximenia americana* and May for *Vitex doniana*) and the substrate used. In Merlot noir, total soluble carbohydrates levels fall from july to mid-october, before accumulating intensively until décember, when they drop again until bud-break [27].
- **Sand/sawdust substrate influences the budding rate of RSC**
  These results are different to those of [28] in Benin on *Daniellia oliveri*. These authors reported that the substrate does not influence the budding rate. In contrast, [29] reported that the sand/sawdust mixture is the best substrate for budding of *Securidaca longepedonculata*. Many factors may influence the behavior of cuttings such as genotype of each individual, period of carry up of the trial and the age and physiological state of the individuals [30]. The hypothesis that could explain this result is the physico-chemical composition of the substrate. Indeed, chemical analysis of the substrates revealed that the sand/sawdust mixture is low in exchangeable bases (Ca2+, K+, Mg2+ and Na+) compared with the other substrates, and has a high cation exchange capacity after sawdust. This substrate characteristics could lead to antagonisms, and increase the uptake of certain nutrients [31].
- **The 20 cm RSC budded more than the 10cm and 15cm after 19 weeks in culture**
  The same results are reported by [32] on *Detarium microcarpum* in Burkina Faso and [14] on *Vitex doniana* in Cameroon. These authors obtained better budding percentages with cuttings of the 20 cm. The 20 cm RSC showed better budding abilities. This could be explained by the accumulation of more carbohydrates in 20 cm RSC tissues. These findings are in agreement with those of [29] on *Securiaca longepedunculata* in the same ecological zone as ours. They reported that the sand/sawdust mixture is the best substrate for plant regeneration and the 20 cm length is the best.
- **Sand/sawdust substrate influences RSC growth parameters. This result contrasts those of [14, 3]**
  These authors observed that the substrate does not influence the number of aerial axes in *Vitex doniana* and *Lophira lanceolata*. The present result shows that the development of the number of aerial axes differs according to species and quality of substrate. The reasons are attributed to the water retention capacity, air circulation, pH and porosity of these substrates. The physico-chemical analysis of the sand/sawdust substrate showed that pH-water= 7.2; the percentage of saturation is low (34) after the sawdust substrate and has a low cation exchange capacity (CEC=28) among the other substrates
- RSC growth parameters play an important role in the survival of cuttings and the migration of carbohydrates from leaves that lead to root formation [33]. These factors affected tissue respiration and cell differentiation at the base of the cuttings [34]. The nitrate (NO_3) content of the substrate inhibits the uptake of potassium (K+) ions, which are essential for chlorophyll synthesis [35]. Let can therefore assume that *Ximenia americana* had a preference for sand/sawdust over others. This substrate has a moderate low nitrogen content (N=0.17) compared to sawdust (N=1.26). This result is contrary to those of [36] for which phosphorus and nitrogen are major fertilizing elements that ensure good performance for plant growth and yield.
- The lengths of root segment cuttings have almost no influence on growth parameters. This result has an explanations on the genotype and age of the mother tree, hormone concentration and phenological stage [37, 38]. The lengths of root segment cuttings have almost no influence on growth parameters. Our result is in agreement with that of [39] on *Quercus suber* who affirm that the average length of buds is not influenced by the variation in the concentration of glucose, fructose (20g/l) respectively (77,3% and 45,4%) which are low compared with those obtained with sucrose at the same concentra-tion (95,2%). This would explain why *Ximenia americana* has very precise sugar requirements, and provides good material to illustrate the inhibitory effet of excessive levels on bud development and vitality.
- **Rooting of root segment cuttings**
  The sand/sawdust mixture proved to be the best rooting substrate for this species. Porous substrates allow the adventitious roots of this Olacaceae to flourish. This result is in line with that of [40] on *Lovoa trichilioides* cuttings in forest zone. These authors tested two substrates, original soil and gravel, and found that the best rooting rate was observed in gravel (72±4.6%). Rooting of root segment cuttings depends on several factors, including the season in which the cuttings are collected, the age of the mother plants, the origin of the cuttings and the physico-chemical composition of the substrate [32, 14, 41]. Root initiation and growth, which require a high energy potential, depend mainly on carbohydrates [42, 43] have shown that the percentage of rooted buds, as well as the mean number of roots increases with sucrose cocentration, but the maximumdepends on the clone.
- **Long root segments cuttings could accumulate more carbohydrates and hormones needed for rooting**

Several studies reported similar fidings. In Burkina Faso, [32] on *Detarium microcarpum* observed that 20 cm RSC produced adventitious roots and high biomass compared to those of 10 cm. The same trend was observed by [14] on *Vitex doniana* in the Bini-Dang locality.

- The number as well as the length of roots formed varied significantly whatever the type of substrate and the different lengths of root segment cuttings. On the other hand, [44] on *Cola acuminata*, reported that the number and length of roots formed did not vary significantly whatever the type of substrate. *Ximenia americana* cuttings don't offer many requirements for rooting. However, the sand/sawdust substrate was better for rooting parameters than the other substrates tested.

5. Conclusion

The results of the present experiment showed that *Ximenia americana* has the ability to produce seedlings from root segments cuttings. The carbohydrate content of this Olocaceae in the wild March to August. What do you mean by the fluctuates throughout the year, peaking from March to August. Sand/sawdust proved the best substrate for budding and rooting (58.88±16.91% and 59±21.47%). The 20 cm RSC performed better in terms of budding (62.5±11.38%) and rooting (83.33±6%). To improve the technique for *Ximenia americana* root segments cuttings, it will be important to determine the carbohydrates responsible for the its budding and rooting.

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