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Domestication Trial of Synsepalum Stipulatum (Radlk.) Engl. in The Humid Tropical Climate of Kinshasa

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Cover Page Footnote

We would like to thank the Assistant Azangidi Mapwama for the elaboration of the map of the nursery experimentation environment.

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DOMESTICATION TRIAL OF *SYNSEPALUM STIPULATUM (RADLK.) ENGL.* IN THE HUMID TROPICAL CLIMATE OF KINSHASA

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ABSTRACT

The present study deals with the domestication trial of *Synsepalum stipulatum (Radlk.) Engl*. in the humid tropical climate of Kinshasa and aims at contributing to the domestication of the species. To achieve this, proceeded with two methodological approaches: observation and experimentation. The results obtained show that the effect of three seeds treatments: drying of the seeds on the sun, seeds unpulped in the bag kept under the shade for 14 days and no treatment on the germination of *Synsepalum stipulatum* seeds was evaluated on two types of substrates: potting soil and clay soil. The absence of seed treatment resulted in very high germination rates in potting soil (75 %) and significantly longer germination times (41 days in potting soil and 67 days in clay soil). Overall, germination was better (rate and emergence) in the potting soil (53.3 %) and poor in the clay soil (20 %). The monthly growth analysis in height is estimated at 16.2 ± 1.2 cm while that in diameter was estimated at 0.3 ± 0.0 cm. The fruit of the species contains elements riches in carbohydrates and very few lipids and proteins whose energy value was evaluated at 422.1 ± 0.6 calories per 100 grams of edible parts. Therefore, it is important to consider the promotion of the species in view of its nutritional value.

Keywords: Domestication, *Synsepalum stipulatum*, energy intake, phenological monitoring, humid tropical climate.

INTRODUCTION

The functioning of forest ecosystems in the Democratic republic of Congo remains complex and insufficiently understood. The wide range of species found in these ecosystems makes it difficult to understand how they function and, ultimately, how they can be managed sustainably (Blanc, 2002; De Wasseige et al., 2009). However, there is great plant diversity, with just over 10,000 species of Angiosperms, of wich around 3,000 are endemic (ATIBT, 2006).

However, ecosystems are coming under increasing pressure, with a decline in these forest formations. In the DRC, these natural forests are subject to selective logging, which consists of removing only trees of the few species whose commercial value justifies their exploitation, and is not accompanied by any measures to encourage the renewal of the numbers exploited. However, it is essential to promote the death of valuable of maintaining the carrying capacity of populations for sustainable forestry and eveen the long-term maintenance of large forest areas (Boyemba, 2011).

Domesticating a tree means taking it from its wild state to a state where it undergoes a certain selection and special management. It also means improving the tree so that it better meets the needs and desires of man. In this sense, domestication plays a very important role

in reducing poverty, as it provides farmers with local forest products that are used daily for food, medical care and constructions.

Reforestation and afforestation involve choosing species that meet certain criteria, including adaptation to environmental conditions, speed of growth and resistance to disease and insect attack (Anonymous, 1993; Kidikwadi et al., 2021).

Unfortunately, the data available on nursery crops is fragmentary or rare in the DRC. With the aim of successfully undertaking the reforestation and afforestation process, the Systemic, Biodiversity, Nature Conservation and Endogenous Knowledge Laboratory of the Environmental Sciences and Management Department of the University of Kinshasa has undertaken experimental trials of seedlings and cuttings of dozens of species that are fairly common in pre-forest fallow land or forest relicts on the outskirts of Kinshasa (Kidikwadi et al., 2021).

Congolese forests harbor various potentialities that can be valorized. The forest flora has several species for food use, very often little or unknown. One species, *Synsepalum stipulatum*, with edible fruits is known in certain regions of Congo such as Mongala. Encountered in a residential plot in Kinshasa, *Synsepalum stipulatum* produces fruits that are consumed and sold in the city's markets.

In order to enhance the value of the fruits of this species, domestication trials were undertaken and the results obtained are the subject of this note.

The aim of this article is to contribue to the domestication of the species in the humid tropical climate of Kinshasa, with a view to setting up a policy for the sustenaible management and conservation of the species through regenerative propagation for food proposes.

The specifics objectives were to produce seedlings of the species, to determine the nutritional value of the fruit studied, to determine the germination and the emergence rate and measure the height and diameter growth of seedlings of the species.

MATERIALS AND METHODS

Plant Material

The species *Synsepalum stipulatum* is a shrub, rarely liana, sometimes with twig or spines produced by sympodial growth; calyx crystals often present as well as tannins, triterpenes and syanogenetic compounds; well developed elongated laticifers, with white latex. Hairs bifid, brownish, T-shaped, but with one branch sometimes reduced. Leaves simple, alternate, stipules present, but soon deciduous or absent. Inflorescences in axillary glomerules or inserted on the stem, or solitary flowers. Flowers bisexual or unisexual by abortion of the stamens; calyxes with 4-8 sepals or 4-8 lobed, arranged in 2 series; stamens inserted on the petals themselves and in numbers equal to or double that of the corolla lobes; staminodes sometimes present, anther bilocular, longitudinally opening; ovary superect, 5-locular or more, ovule 1 per lodge. Berries or more rarely capsulated, seeds with leathery, shiny husks. Small tree with similar edible fruits, but the bicolored leaves are distinctly broad, with 14 veins about (Aubréville, 1961). The species *Synsepalum stipulatum* is confined to tropical Africa. It occurs in southern Nigeria to Central Africa, Gabon and D.R. Congo (Lammens et al., 2008).

Figure 1: Ripe fruit of *Synsepalum stipulatum*

Figure 2: Tree bearing the fruits of *Synsepalum stipulatum.*

Figure 3 : Seedlings of *Synsepalum stipulatum* aged 4 months in the nursery.

Pantropical family, mostly in lowland rainforests. The species *Synsepalum stipulatum* occurs in the Democratic Republic of Congo (Oubangui), in tropical Africa, rendered and disseminated by zoochory andepizoochory (Aubréville, 1961).

The species has several names: Fonga (in Lingala) and Candestin (in French). *Synsepalum stipulatum* is used to make planks and axe handles. It can also provide good quality charcoal. The sweet pulp of the fruit is edible, and is used in the manufacture of jams and jellies. An aqueous infusion of the bark is applied as drops to treat earaches, and a decoction of the bark is taken as a galactagogue (Lammens et al., 2008). The material here is the fruit and the seeds. The fruit as the material used for the analysis of the chemical composition: dosage of mineral elements. The seeds, as material for the production of plants in nursery.

Figure 4 shows the environment in which we carried out the experimental trials, which is the Systemic, Biodiversity, Nature Conservation and Endogenous Knowledge laboratory at the University of Kinshasa.

Methodological Approach

To conduct this study, we used two approaches: observation and experimentation in the field and in the laboratory of Systemic, Biodiversity, Conservation of Nature and Endogenous Knowledge at the Department of Environmental Sciences at the Faculty of Science and Technology of the University of Kinshasa. This methodological approach was used by Kamienge et al., (2020).

Observations in the field consisted of monitiring the phenology of the species under study to determine the different periods of flowering, fruiting, maturation, defoliation, leaves renew and floral bud. At the nursery, these observations consisted of monthly measyrements of the following parameters : growth in diameter and stem height of *Synsepalum stipulatum* seedings over seven months of observation with the aim of domestication in a humid tropical climate type AW4 according to the Köppen classification.

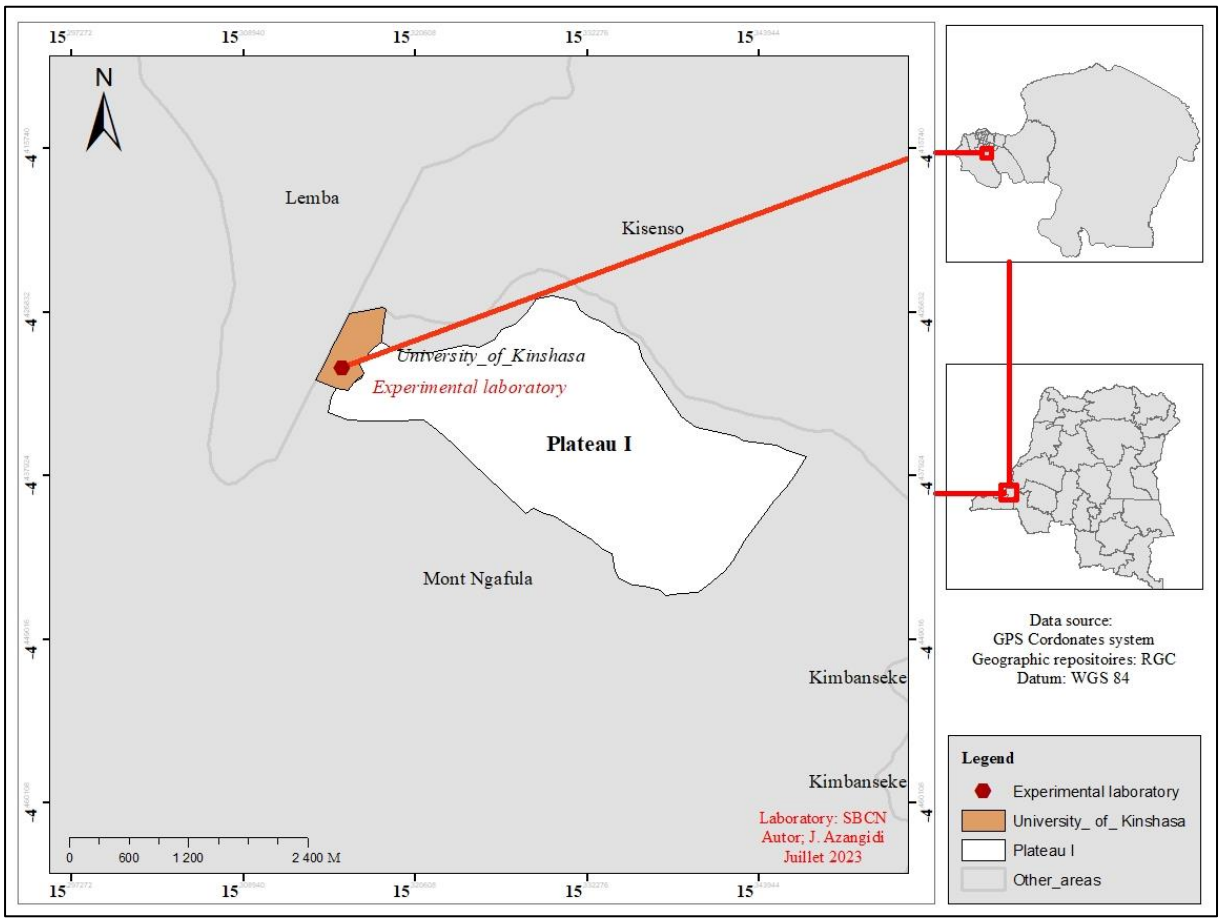

Figure 4 : Location of the study site in the city of Kinshasa, Democratic republic of Congo.

This climate is characterised by two alternating seasons : a long rainy season running from mid-september to mid-may, interspersed with a short dry season between january and february, and a dry season running from mid-may to mid-september (Pauwels, 1993; Biloso et al., 2018). Average annual rainfall is 1,400 mm, and the average annual temperature is 25°C (Pauwels, 1993).

Material Collection

The botanical samples were collected from a plant cultivated in a residential plot made it possible to identify this species, analyze the chemical composition of fruits and obtain mature seeds for germination in a nursery, in order to carry out phenological observations. Let us recall that the species *Synsepalum stipulatum* is a shrub. Leaves simple, alternate, stipules present, but quickly deciduous or absent. Inflorescences in axillary glomerules or inserted on the stem, or solitary flowers. Flowers bisexual or unisexual by abortion of the stamens. The sweet pulp of the fruit is edible. The seeds were kept in transparent polyethylene bags under the shade for 14 days before sowing.

Methods of Carrying out the Sowing

The experimental phase consisted in sorting the seeds before sowing; these seeds were subjected to different treatments, including: sun-dried seeds and others not pulped kept under the shade. The sowing was carried out in polyethylene bags. This technique is very common for the sowing of trees by seeds. Each bag received a seed, the depth of 5 cm in nevertheless, bags of 20 cm in diameter and 10 cm in height.

We proceeded to the filling of the soils and sands in the bags until 4/5 of its height. These bags were pierced with a few holes to facilitate the flow of water during watering and aeration of the bag. The bags were filled with potting soil and planted under the shade of Elaeis guineensis. The watering was done in the morning and evening and then brought back every two days.

Experimental Device

A 9 m^2 plot was experimentally set up in a block design (Figure 4). In each block, we have 60 polyethylene bags filled with potting soil (composed of black soil) and clay soil. This randomized complete block experimental set-up was installed in the experimental garden of the Systemic, Biodiversity, Conservation of Nature and Endogenous Knowledge Laboratory. The nursery was placed under a 2.5 m high shade. A total of 60 seeds were tested in the germoir, 30 of which were treated and 30 untreated, as shown in Figure 4. 30 of the treated seeds were dried under the sun. The untreated seeds were sown directly in the bags filled with potting soil and those treated in the clay soil. We specify that the seeds were sown at a depth of 5 cm according to the seed morphology and each experimental unit contained one seed.

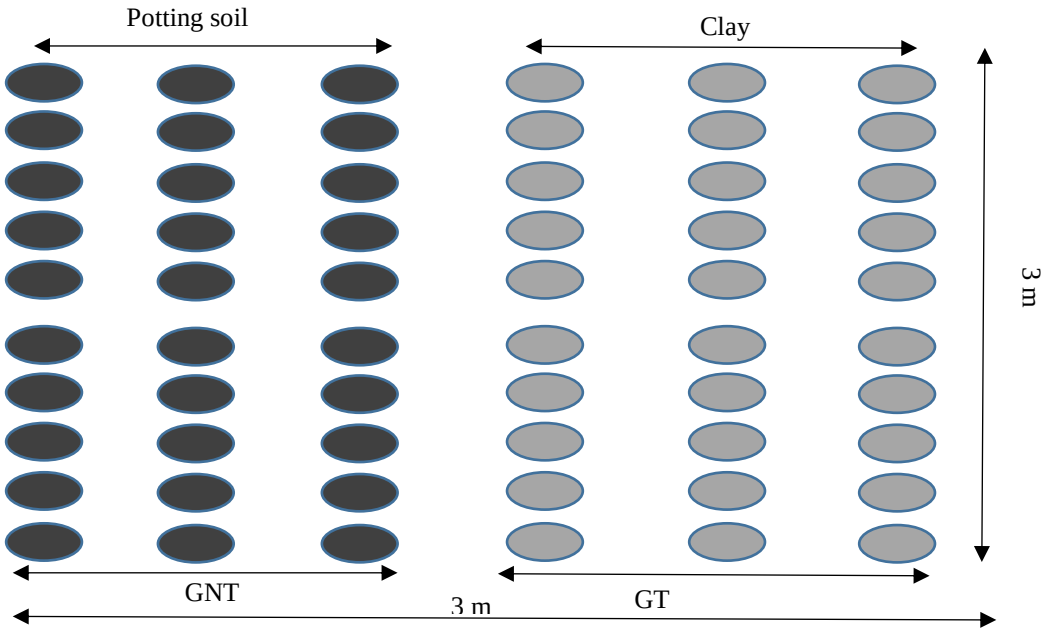

Figure 5 : Experimental set-up in a *Synsepalum stipulatum* nursery.

Legend: GNT: Untreated seeds; GT: Treated seeds (sun-dried.

The spot observations consisted in taking measurements of the observed individuals, i.e. the diameter, the height and the number of leaves. They were carried out in the nursery of the Laboratory of Systemic, Biodiversity Conservation of Nature and Endogenous Knowledge during 7 months of observation.

Data Processing and Interpretation

The determination of germination rate was calculated using the following formula: T= G/N with G= number of germinated seeds and N= number of germinated seeds per treatment (Ouédraogo et al., 2006; Ahoton et al., 2009; Kidikwadi et al., 2021). The multivariate analysis makes it possible to appreciate the correlation that exists between the parameters studied, in

particular the potting soil and the clay soil used for sowing.

To verify the relationship between the two substrates used for seeding, we calculated the Bravais-Pearson coefficient by establishing the correlation diagram (scatterplots) that will suggest the existence and nature of any relationship. The correlation coefficient (r) is best interpreted only after translating it into the coefficients of determination (R^2). The latter indicates the degree of reciprocal dependence between the two substrates by transforming the correlation r into a coefficient of determination by squaring it. When the value of r is greater than 0, there is a very close positive correlation with four possible cases: 0.9 to 1.00: strong correlation/very close correlation; 0.70 to 0.89: good correlation/strong correlation; 0.45 to 0.69: medium correlation/consistent correlation; 0.20 to 0.44: weak correlation/negligible correlation); if r is equal to 0, there is no relationship between the two variables; and finally, when r is less than 0, there is a negative correlation between the two variables (Biloso et al., 2018).

The data obtained were analyzed using Excel 2016 and Past 3 software. Analysis of variance (ANOVA) is a statistical method used to compare several independent groups of observations with respect to their mean (Ahoton et al., 2009). The F-test comparing variances gives the probability that the variances observed on the samples are identical. If p-value < 0.05, we conclude that the difference is significant, the difference is very significant when p-value < 0.01 and when p-value > 0.05, there is no significant difference (Kidikwadi et al., 2016; Biloso et al., 2018).

RESULTS AND DISCUSSION

The results presented concern the phenological chronogram of the species, germination time, emergence rate and type of germination, growth in height and diameter.

Phenological Chronogram

The phenological chronogram of the species *Synsepalum stipulatum* is presented as follows: the flowering begins in January and ends in March; the stage of the fruiting which begins in April until June; the maturation begins in July and it ends in October; the defoliation begins at the beginning of September and the leaves renew themselves towards the middle of September. The floral bud begins in November and ends in December.

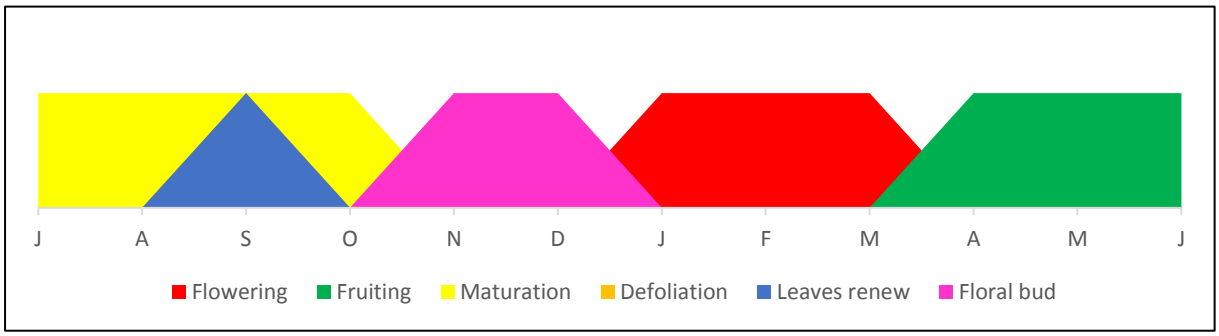

Figure 6 : Phenological monitoring of the species *Synsepalum stipulatum*.

Legend: J: July; A: August; S: September; O: October; N: November; D: December; J: January; F: February; M: March; A: April; M: May; J: June

Germination Rate

It follows from the observations made on the germination during seven months that the proportion is high for the seeds sown in the compost (T0 untreated seeds : 75 %, T1 sun-dried seeds : 50 and T2 seeds packed in the bag : 35 %) than those sown in the clay soil (T0: 20 %, T1: 25 % and T2: 15 %). The germination rate was evaluated at 73.3 %. It is observed that the potting soil responds better to germination than the clay soil. The statistical analysis of the applied correlation coefficient (r = 0.3711) highlights the weak correlation of germination between the clay soil and the potting soil.

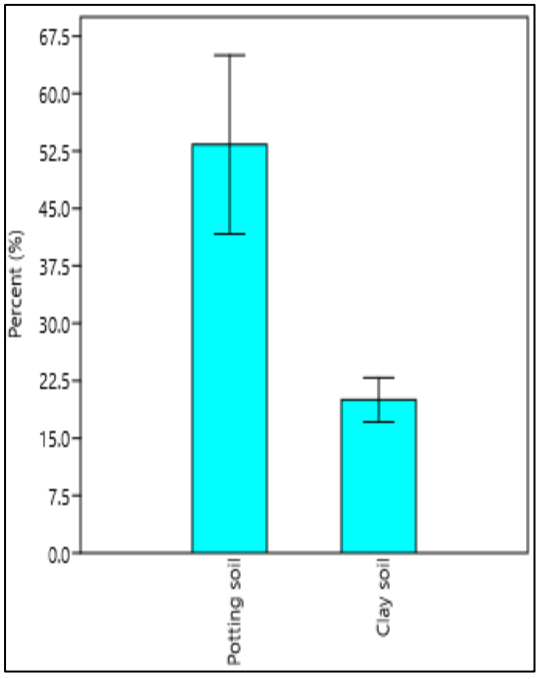

Figure 7 : Germination rate of *Synsepalum stipulatum* in potting soil and clay soil.

Evolution of Emergence as a Function of time

The analysis of seed emergence as a function of time shows that there is a low degree of dependence between treatments and emergence rate with R^2 = 0.25. Seeds germinated 41 days after sowing. The interval of emergence is 2 days and therefore the germination time was 41 days. Analysis of variance revealed that the treatments applied to *Synsepalum stipulatum* seeds had no significant difference in lift rate with ANOVA (F = 1.596; df = 4.322; p = 0.2041).

Dynamic Evolution of Growth in Height (cm)

It should be noted from this analysis that the average monthly growth in height of the seedlings during 7 months of observation varies between 6.8 and 25.7 cm with an average of 16.2 ± 1.2 cm. The analysis of the evolutionary dynamics of growth in height shows that there is a very close relationship of dependence of growth between the height and the duration with R^2= 0.9184. Statistical analysis with ANOVA (F = 294.3; df = 6 and p-value = 0.000) showed that the heights of the seedlings were very significantly different in each month.

Growth rate in Diameter

It follows from the analysis of monthly growth in diameter that the growth varies between 0.2 and 0.4 cm with a growth evaluated at 0.3 ± 0.0 cm. The analysis of evolutionary dynamics of growth in height shows that there is a close relationship of dependence between diameter and duration with R^2 = 0.8438. Statistical analysis with ANOVA (F = 122.3; df = 6 and p-value = 0.000) shows that there is very significant difference in diameter growth between the months observed.

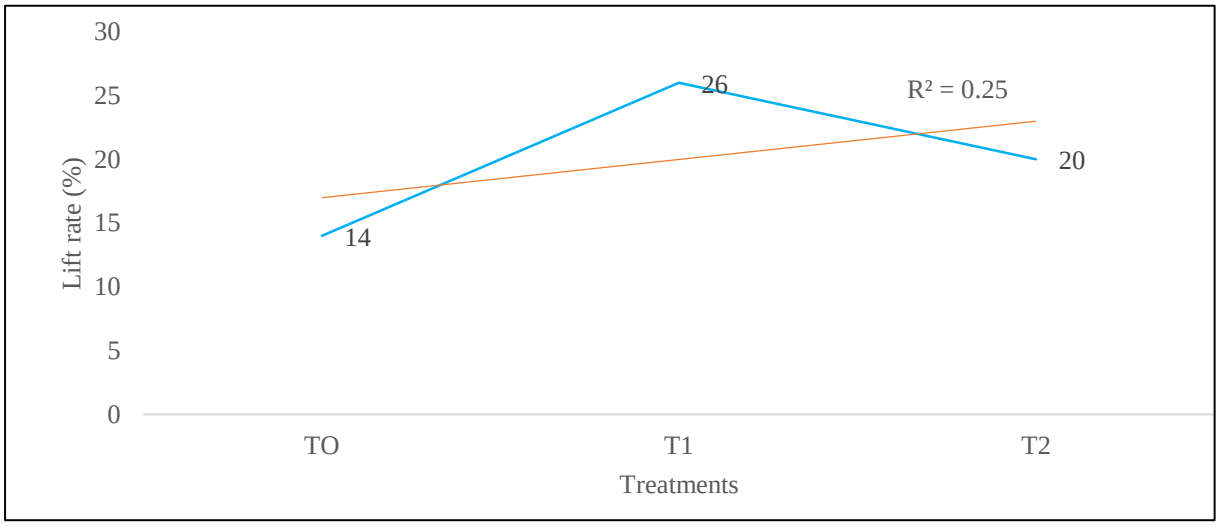

Figure 8 : Evolution of *Synsepalum stipulatum* seed emergence rate as a function of time.

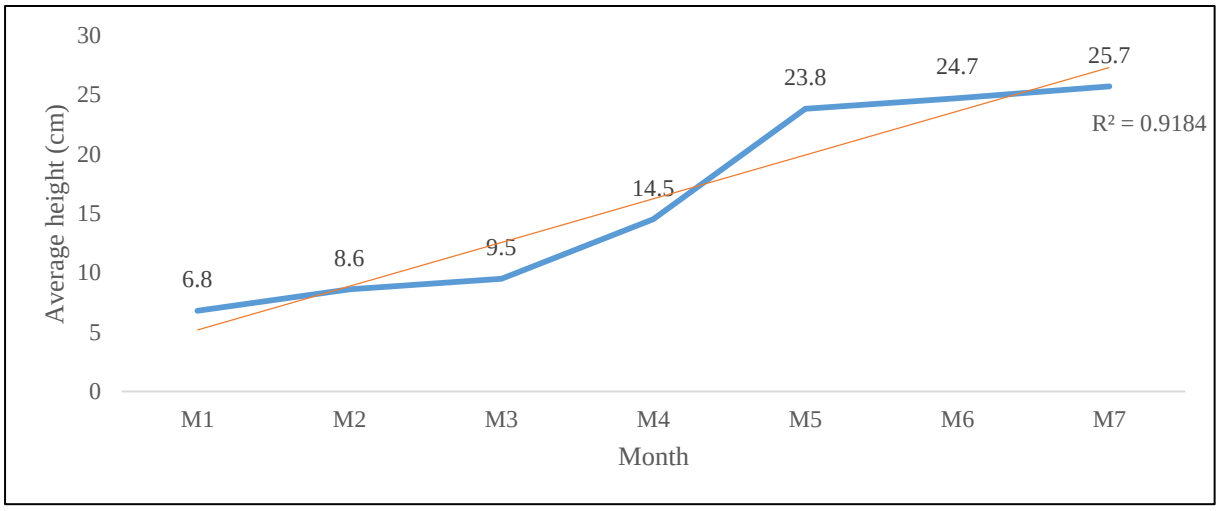

Figure 9 : Evolutionary dynamics of average growth in height of *Synsepalum stipulatum* (cm).

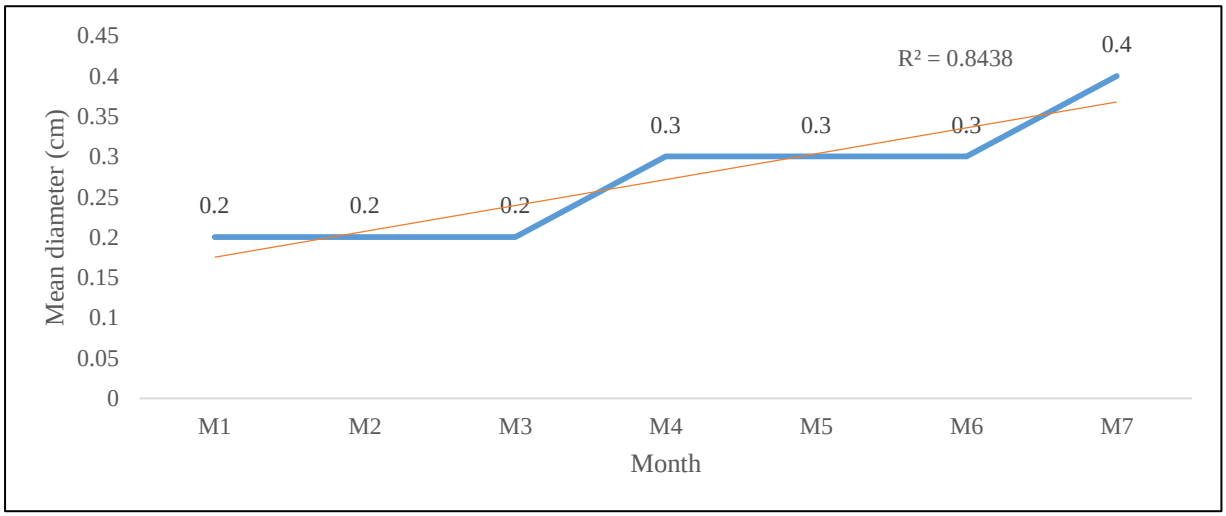

Figure 10 : Evolutionary dynamics of growth in diameter of *Synsepalum stipulatum* (cm).

Legend: M1: 1st month; M2: 2nd month, M3: 3rd month; M4: 4th month; M5: 5th month; M6: 6th month and M7: 7th month

DISCUSSION

The results obtained in this study are analyzed and discussed with previous work on local rainforest species.

The phenological chronogram of the species *Synsepalum stipulatum* is presented as follows: the flowering begins in January and ends in March; the stage of the fruiting which begins in April until June; the maturation begins in July and it ends in October; the defoliation begins at the beginning of September and the leaves renew themselves towards the middle of September. The floral bud begins in November and ends in December. This shows that the period of development of each phenological stage of the species is not identical. This development varies from one species to another, although the ecological conditions may be identical. This can be explained by internal and external factors, because the phenology of a species is controlled by many factors, the precise action of many of these factors is still poorly known. Kidikwadi et al., (2021) reported that the interaction of these factors can provoke a physiological reaction in the tree that results in a phenological manifestation. These factors can be extrinsic (climate, microclimate, geographical environment, edaphic or intrinsic factors (physiological, genetic, etc.).

Two forest species, *Prioria balsamifera*, a mature evergreen and semi-evergreen rainforest species and *Millettia laurentii*, a semi-evergreen or secondary mature rainforest species. Our species is found in semi-evergreen rainforest. All three have made domestication attempts. The results obtained are thus comparable and are as follows: the germination rate of *Synsepalum stipulatum* amounts to 73.3 % of germinated seeds, *Prioria balsamifera* to the proportion of 88 % (Kidikwadi, 2018) and *Millettia laurentii* equal to 95 % (Belesi, 1991).

Observations in the nursery show that *Synsepalum stipulatum* seeds have epigeal germination. Compared with the germination of two other species, namely *Pentaclethra macrophylla*, *Millettia laurentii* which are 2 to 7 days and *Pterygota bequaertii* which are 21 to 47 days (Kamienge et al., 2020), *Synsepalum stipulatum* seems to have a slow germination because its germination goes up to 41 to 67 days. This difference may be explained by the leathery epicarp of its seeds, but also the quality of the fruits picked from the tree.

The examination of the monthly growth in height of *Synsepalum stipulatum* shows that the growth in height of the seedlings during 7 months of observation varies between 6.8 and 25.7 cm with an average of 16.2 ± 1.2 cm. This result revealed that the species grows rapidly because it is forest-dwelling, and its experimental trial in a nursery in an ecologically favourable condition can only contribute to its growth. The work carried out by Kidikwadi et al., (2021) showed that climatic factors influence plant growth include soil moisture content, weather, temperature, light,…

The monthly growth analysis in diameter shows that the diameter varies between 0.2 and 0.4 cm with a mean estimated at 0.3 ± 0.0 cm. The regular supply of water in the soil is one of the factors that contributes favourably to the growth of a plant, as the substrates used (clay and potting soil) have the capacity to retain water easily. Phenology depends on internal and external factors. Internal factors are for example genetic predisposition or state of health, external factors consist of local day and night temperatures, precipitation, length of days (photoperiodism), weather conditions. Plants can adapt to some extent to their environment and its changes (Brügger and Vassella, 2003).

CONCLUSION

The study on the domestication trial of *Synsepalum stipulatum* contributed

to the domestication of the species under local conditions in Kinshasa. The results obtained show a high germination rate. This germination, although high, seems to be slow. The analysis of monthly growth in height is rapid while that in diameter is slow. The fruit of the species contains elements rich in carbohydrates and very few lipids and proteins whose energy value is evaluated at 422.1 ± 0.6 calories per 100 grams of edible parts. The above results seem to be indicative of the domestication program and the transformation of the fruit into other finished products, given its food interest.

AUTHORS CONTRIBUTION

PD* conducted the research. SB helped with phenological monitoring and the determination of the chemical composition of fruits in the Biochemistry laboratory. JK helped with the observation and monitoring of seedlings in the nursery. EK helped with writing. HB and CL provided guidance and read this article as a whole.

CONFLICT OF INTEREST

The authors have certified on their honour that there is no conflict of interest that could prevent the publication of this article by third parties.

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