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# Assessment of Megaphrynium Macrostachyum (Benth & Hook) Planting Materials in Kisangani, D.R.Congo

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**Abstract:** *This study aimed to contribute to the domestication of Megaphrynium macrostachyum by identifying the planting materials in order to avoid its disappearance, due to forests anthropic pressure. Planting trial of this forest plant species (M macrostachyum) in relation to propagation materials was established in two sites (Kisangani and Abunakenge), in order to identify the best propagation method for its cultivation which poses fewer problems of seed germination and regular of rhizome fragments sprout, survival rate as well as juvenile plants growth. The results demonstrated that, M. macrostachyum seeds were generally characterized by embryonic dormancy, thus leading to very late germination ranging from 6 to 7 months; while rhizome fragments present fewer sprout problems (1 to 2 months). Cuttings (rhizome fragments) proved to be the most suitable propagating material for M. macrostachyum cultivation, because it poses fewer sprout problems. However, its generative multiplication (seeds) is also possible, only there is a dormancy problem that need to be resolved.*

**Keywords:** *Domestication, M. macrostachyum, planting material, Kisangani*

## I. Introduction

Forests provide goods and services that are essential for 1.2 billion people worldwide. In Africa, 60 to 80% of poor people depend directly on natural resources for their survival (Betti et al., 2016). In the Congo Basin countries, forests generally refer to timber and, to some extent, firewood and hunting. Other non-timber forest products (NTFPs), also called “hidden harvests”, are neglected and their contribution to the national economy (gross domestic product) is often poorly appreciated due to a lack of reliable statistical data, such as *M. macrostachyum* (Massamba, 2013). However, “hidden harvests” have always been and continue to be an important component of the culture of African populations. They are part of their "traditional" lifestyles and they remain essential and indispensable to the quality of life of many households, both in rural and urban areas (Ngonzo et al., 2008). In addition, "hidden harvests" contribute to address poverty, food balance and food security of populations in urban and rural areas (Tchatat and Ndoye, 2006).

In African tropical forests, at the level of certain primary or secondary formations, *Marantaceae* constitute the majority of species in the herbaceous layer (Dhetchuvi, 1996). The *Marantaceae* family groups together with monocotyledonous plants includes 400 species grouped into 30 genera. These are rhizomatous herbaceous plants, which are sometimes epiphytes, from subtropical to tropical regions. In this family, we can cite the genus *Megaphrynium* to which the species *Megaphrynium macrostachyum belongs*, not cultivated but it is used as food plants or for their large variegated leaves (Termote et *al.*, 2010).

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In the villages bordering the tropical rainforest area, marantaceae are used, whether in food (vegetable), in the construction of houses (leaves and stems) and in various other uses such as basketry (stem) or packaging (leaves). Among the resources based on wild plants that are still little studied but widely used by certain communities, *Megaphrynium macrostachyum* is one of them. This species is consumed in large quantities in the city of Kisangani and its surroundings depending on the harvest season. Furthermore, this resource constitutes the food of many animals, especially large mammals (White, 1995).

Currently, it is difficult to quantify consumption and even less to assess the sustainability of its harvests and its marketing. According to Tjiptono in Marlizar (2020) marketing performance is a function that has the greatest contact with the external environment, even though the company only has limited control over the company's environment. In the world of marketing, consumers are assets that must be maintained and maintained their existence in order to remain consistent with the products we produce (Romdonny and Rosmadi, 2019).

Given its aforementioned importance, there is strong anthropic pressure on the different products derived from this species to the point that the harvest threatens to exceed the productive capacity of natural ecosystems, in these non-timber forest products. It is necessary and important to consider their production in agrosystems now.

It is with this in mind that the present study was recommended to answer the question *Can M. macrostachyum* multiply vegetatively (fragment of rhizome) and/or generatively (seed)?. From this question was developed the following hypothesis: *M. macrostachyum*, a perennial plant, can multiply both vegetatively and generatively in agrosystems;

The objective assigned by this study was to contribute for determining whether *Megaphrynium macrostachyum*, an understudied plant, can multiply both generatively and/or vegetatively.

## II. Research Methods

### 2.1 Location

The study was carried out in two sites, one was the IFA campus, at the medical plateau in Makiso commune of Kisangani and the other in Professor Litucha concession located in Abunakenge village, Kandangba axis, in the Lubuya-Bera Sector. Geographical coordinates of these two sites were taken using Global positioning system (GPS Mark Garmin 62s) as follows:

IFA site: 25°09'53,22258" East longitude and 0°30'40,16688" North latitude and an average altitude of 400m, for that of Abunakenge: 25°18'56.23" East longitude and 0°36'59.27" North latitude and an average altitude of 432m.

### 2.2 Materials

Seeds and rhizome fragments served as test materials for the propagation of *Megaphrynium macrostachyum*, a species belonging to the Marantaceae family and the genus *Megaphrynium*. Figures 1 and 2 illustrate these propagating materials.

***Figure 1.*** *Seeds of M. macrostachyum*

***Figure 2.*** *Rhizomes fragments of M. macrostachyum*

**2.3 Methods**

The experimental design used was a special case of randomized blocks having 4 blocks of two treatments (pairing or couple method) and each block had two plots, one was planted with rhizomes and the other with seeds, respectively in the experimental sites (Kisangani and Abunakenge)

**a. The Experimental Design**

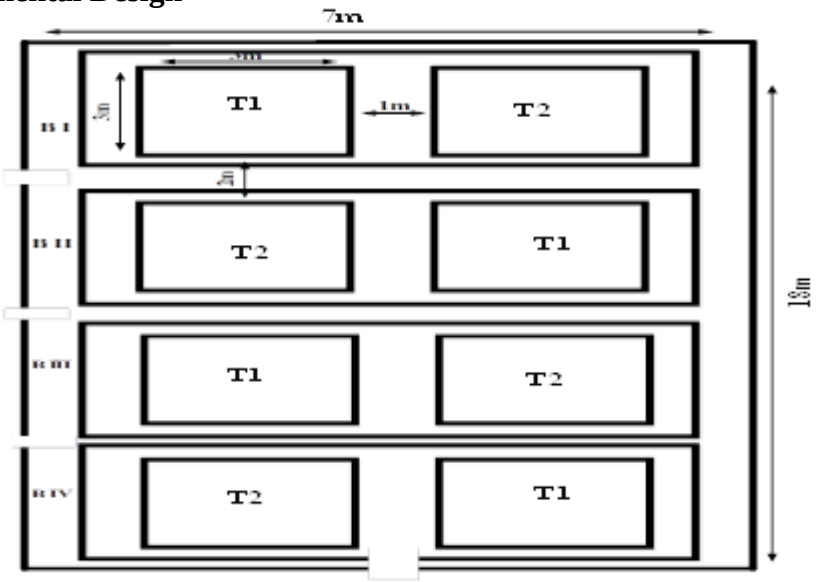


***Figure 3.*** *Experimental design*

**Legend:** B.I, B.II, B.III, B. IV. Are blocks

**T1:** Rhizomes fragments of *Megaphrynium macrostachyum*

**T2:** Seeds of *Megaphrynium macrostachyum*

The test included a single factor, namely *Megaphrynium macrostachyum* propagating material, and constituted two variants, namely rhizomes fragments and seeds of *Megaphrynium macrostachyum.*

The total area of the experimental field was: 126$m^2$ (18m x 7m), subdivided into four blocks of (7m x 3m) or 21$m^2$, the paths between the blocks measure 2m, between plots 1m and the area of a plot was (3mx3m) or 9$m^2$.

**b. Methodology**

Soil preparation started by mowing the vegetation followed by grubbing; a two-stage ploughing, the first superficial and the second deeper, was carried out shortly before planting in order to encourage seeds germination or the fragments of rhizomes sprout.

The collection of propagules was made on clumps of *Megaphrynium macrostachyum plants* found in Professor Litucha's concession. It consisted of clearing the base of the clump in order to expose the rhizomes. The ripe or reddening seeds were harvested manually on clumps found in the same concession. Seeds were harvested on bunches by detaching them one by one.

The rhizomes were planted in holes made for this purpose and spaced: 0.5mx0.6m or 30 fragments/plot of 9 $m^2$. Planting took place on June 28$^{th}$, 2022; the sowing of the unpulped seeds using two seeds per hole at the same spacings as those used for the rhizome fragments (0.5mx.0.6m) or 60 seeds/plot of 9$m^2$, was done on the same planting date.

**c. Observations**

The observations concerned the vegetative parameters (Start of sprout or germination of seedlings, Days to 50% sprout or germination, sprout or germination rate, number of tufts/shoots or plants/plot, height growth, and number of tillers/tuft) of *Megaphrynium macrostachyum* .

**d. Duration of the Experiment**

The experiment took place from June 2022 to November 2023 on the sites chosen as experimental fields, one of which was in Kisangani (In the park Agro-forestry of IFA-Yangambi) and the other in the village Abunakenge ( In the concession of Professor Litucha).

**e. Statistical Analysis of the Results**

Following intervals considered regarding the coefficient of variation:

- 0% – 10%: very homogeneous;
- 11% - 29%: homogeneous;
- > 30%: heterogeneous.

## III. Results and Discussion

### 3.1 Beginning of Germination and Sprouting of *M. Macrostachyum Seedlings*

Results related to number of days from which the sprouting and/or germination of two types of planting materials are presented on Figure 4.

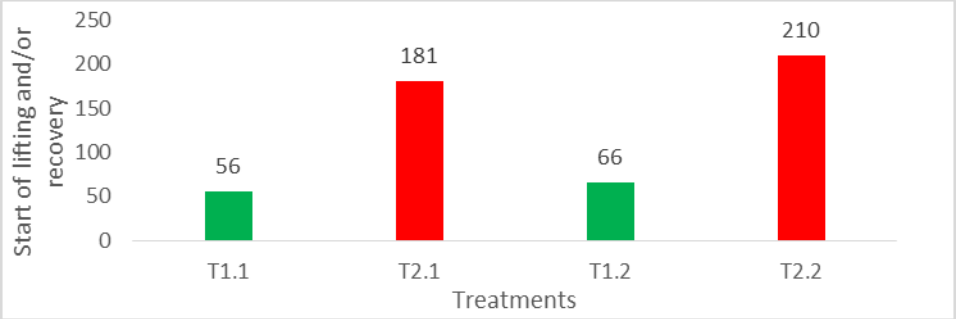


***Figure 4.*** *Germination and sprouting of Megaphrynium planting material*

**Legend:** **T** $_{1.1:}$ rhizomes fragments at site 1 (Kisangani);
**T** $_{2.1:}$ seeds at site 1 (Kisangani)
**T** $_{1.2:}$ rhizome fragments at site 2 (Abunakenge);
**T** $_{2.2:}$ seeds at site 2 (Abunakenge)

Results in Figure 4 show that it was approximately 56-60 days after their planting date that the rhizome fragments started sprouting, while the germination began at least from 180 days. These results demonstrate dormancy in *Megaphrynium macrostachyum* seeds, thus justifying their slow and irregular germination, unlike rhizome fragments which start their recovery early, in less than two months after planting. Statistical analysis indicates that rhizome fragments with coefficient of variation (CV) of 12.58% and 13.55% which is below 30%, respectively for our two sites (Kisangani and Abunakenge) reveal an homogeneity in the distribution of mean regarding durations of the sprouting, and a strong homogeneity of mean values compared to the start of seed germination in Kisangani and Abunakenge with CV of 1.67% and 4.48% likewise below 30%.

### 3.2 Days to 50% of Seeds Germination or Rhizome Fragments Sprouting

The result relating to the number of days during which one of two types of planting material reached 50% seedlings germination or sprouting is shown in the Figure 5.

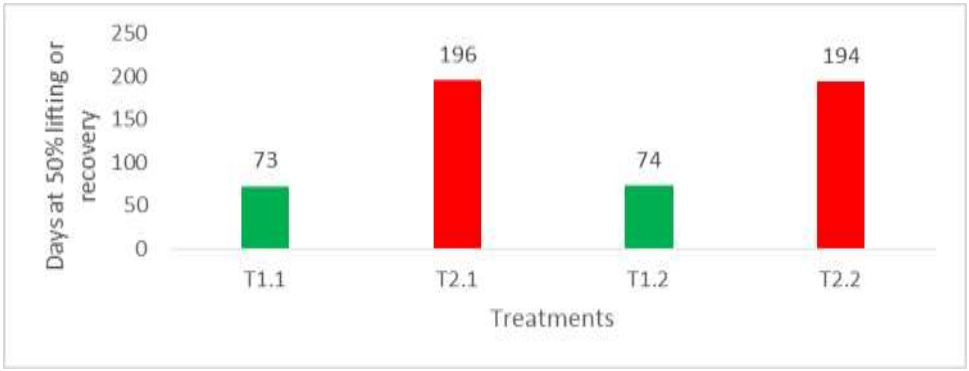


***Figure 5.*** *Days to 50% of germination or rhizome fragment sprouting*

**Legend:** **T** $_{1.1:}$ rhizome fragments at site 1 (Kisangani);
**T** $_{2.1:}$ seeds at site 1 (Kisangani)
**T** $_{1.2:}$ rhizome fragments at site 2 (Abunakenge);
**T** $_{2.2:}$ seeds to site2 (Abunakenge)

Results in Figure 5 show that it was 73 and 74 days after planting date that 50% of rhizome fragments sprouted T1.1 and T1.2 sites respectively. These results demonstrate the

gap between morphological and physiological maturity (dormancy) in *Megaphrynium macrostachyum* seeds, thus justifying their slow and irregular germination. Considering the seeds, germination rate reached 50% after about 196 and 194 days for T2.1 and T2.2 sites respectively and remained below 100% until the end of the experiment.

Student's test showed that there is a significant difference between the two types of propagating materials ($p=0.012<0.05$; and $p=0.037<0.05$) with regard to Days to 50% germination or rhizome fragments sprouting.

### 3.3 The Total Germination Rate and Rhizome Fragment Sprouting of *Megaphrynium Macrostachyum* in Relation to Propagules Types (Rhizomes and Seeds)

Results relating to the total seeds germination rate and/or rhizome fragments sprouting rate of *M. macrostachyum* are presented in Figure 6 while the raw data are recorded in the table in the appendix.

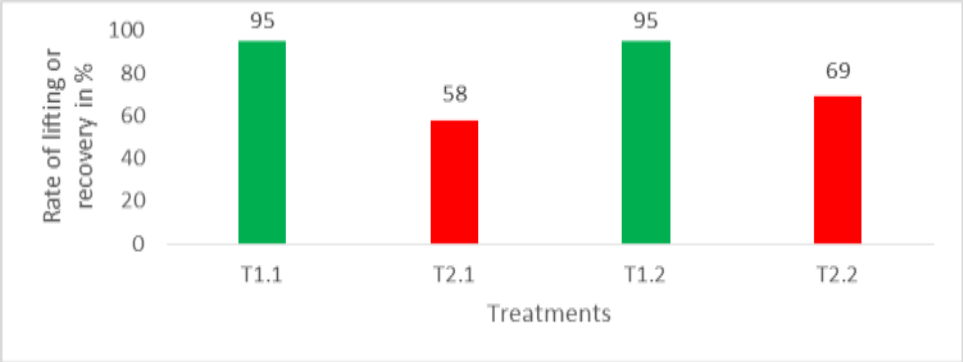


***Figure 6.*** *Total Germination and sprouting rate of M. macrostachyum*

**Legend:** **T $_{1.1:}$** rhizomes fragments at site 1 (Kisangani);
**T $_{2.1:}$** seeds at site 1 (Kisangani)
**T $_{1.2:}$** rhizome fragments at site 2 (Abunakenge);
**T $_{2.2:}$** seeds to site2 (Abunakenge)

Figure 6 generally shows that the natural ability to produce more or less plants after planting (seeds or rhizome cutting) varied according to the types of materials tested. The multiplication of plant by rhizome provided an identical sprouting rate in our two sites (Kisangani and Abunakenge) respectively of 95% and 95%. Multiplication by seeds presented germination rate ranging from 58% (Kisangani) to 69% (Abunakenge).

Comparing the two types of materials tested, it emerges that the rhizomes have the capacity to produce more *Megaphrynium macrostachyum seedlings* from their cuttings than sowing seeds.

Factor site did not numerically influence the seed germination rate neither rhizome fragments sprouting. This demonstrates that this factor is a specific characteristic that varies very little in situ depending on the prevailing environmental conditions. Indeed, in the Abunakenge site the sown seeds presented a germination rate of 69% slightly higher than that of Kisangani which was 58%. Ultimately, in Kisangani site the two treatments (seeds, rhizoms) average was 95% for rhizomes and 58% for seeds, while the Abunakenge site for its part presents an average rate of 95% for rhizomes and 69% for seeds.

The Student test showed that there was a significant difference between the two propagation materials ($p=0.028<0.05$; and $p=0.0015<0.05$) with regard to germination or sprouting after cutting of rhizome fragments and seeds sowing.

### 3.4 Number of *Megaphrynium Macrostachyum Clumps* from Rhizomes and Seeds

Results relating to the number of *Megaphrynium macrostachyum clumps* per plot are presented in Figure 7. The raw values are in the table in the appendix.

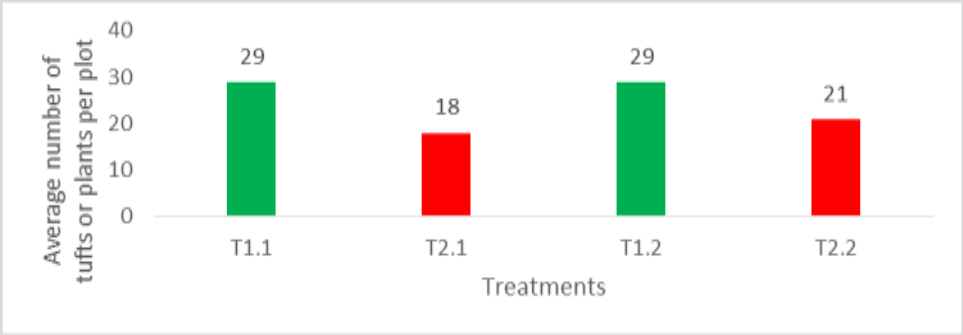


***Figure 7.*** *Average number of Megaphrynium macrostachyum tufts per plot*

**Legend:** **T** $_{1.1:}$ rhizomes fragments at site 1 (Kisangani);
**T** $_{2.1:}$ **seeds** at site 1 (Kisangani)
**T** $_{1.2:}$ rhizome fragments at site 2 (Abunakenge);
**T** $_{2.2:}$ **seeds** at site 2 (Abunakenge).

Figure 7 shows that the average number of tufts of *M. macrostachyum* varied depending on the nature of propagating material used to sow each experimental unit during experimentation in two experimental fields.

The rhizomes produced an average of 28.5 tufts per plot, both at the Kisangani site (in the range of 26-30) and at Abunakenge (in the range of 27-30).

For seeds, the number of *M. macrostachyum* tufts from sowing varied from 7-24 tufts with an average of 17.5 tufts per plot in Kisangani, and an average of 20.75 tufts per experimental unit with a variation (in the range 18-24). On average, the two sites (Kisangani and Abunakenge) revealed similar production of tufts number per plot in relation to rhizomes planting.

Comparing the two types of propagation materials tested, based on the average number of tufts per plot ($9m^2$), the superiority of rhizome fragments (28.5 tufts) over seeds (19.12 tufts) germination.

Regarding tufts number distribution per plot around the central average, it was homogeneous for rhizomes in Kisangani (CV of 6.7% <30%) and Abunakenge (4.5% <30%). For seeds, it was sometimes homogeneous (CV of 12% <30%) in Abunakenge, sometimes heterogeneous (CV of 42.4% >30%) in Kisangani site.

Student's test showed a significant difference between the two propagating materials ($0.028<0.05$; and $0.0015<0.05$) in relation to tufts number per experimental unit in our two sites (Kisangani and Abunakenge).

### 3.5 Height Growth (Cm) of *Megaphrynium Macrostachyum Plant* from Rhizomes and Seeds

Results obtained on the average height growth of *M. macrostachyum plants* (12 months after sowing and cutting) from rhizomes and seeds are presented in Figure 8.

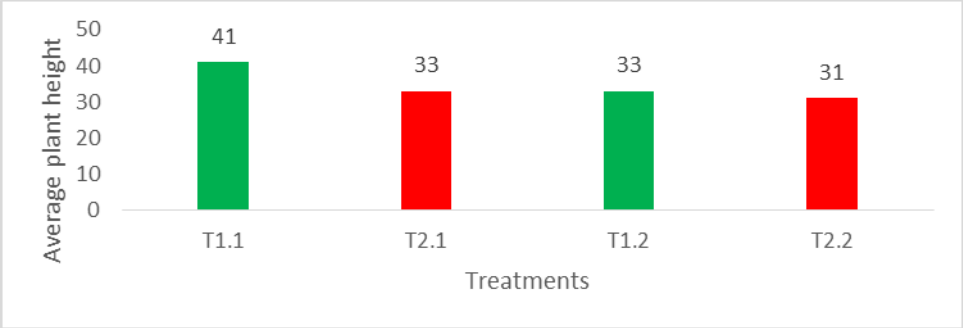


***Figure 8.*** *Height growth of M. macrostachyum plants.*

**Legend: T** $_{1.1:}$ rhizomes fragments at site 1 (Kisangani);
**T** $_{2.1:}$ seeds at site 1 (Kisangani)
**T** $_{1.2:}$ rhizome fragments at site 2 (Abunakenge);
**T** $_{2.2:}$ seeds to site2 (Abunakenge)

Analysis of the data shown in Figure 8 indicates that in general, within twelve months after seeds and rhiwom fragment planting, the average height of plants varied depending on the type of propagating material from which they came and on the experimental site for the same type of propagule.

In the Kisangani site, *M. macrostachyum* plants height growth varied from 27 to 50cm for rhizome planting and from 22.5 to 45cm for plants from seed sowing. At the Abunakenge site, the height growth varied from 33.4 to 36cm for rhizome planting and 28.5 to 35.5cm for plants from seed.

Comparing the two types of tested materials based on produced plants height growth, those from rhizomes were slightly taller (30.2cm-43cm) than those from seeds (25.5cm-40.25cm).

The coefficient of variation indicates a homogeneous average plants height distribution (CV = 25.54% < 30%) for rhizome fragments, but heterogeneous (30.60%≥30%) for seeds in the Kisangani site. On the other hand, for the Abunakenge site, the rhizomes and seeds reveal that there is homogeneity in the average plants height distribution with CVs 8.19% < 30% and 10.69% < 30% respectively.

Student test showed no significant difference between the two treatments in Kisangani and Abunakenge (0.33>0.05; and 0.26>0.05) concerning the average plants height growth of *M. macrostachyum.*

### 3.6 The Number of Shoots per Clump/Tufts

The results relating to the average number of shoots produced per clump of *M. macrostachyum* from rhizomes and seeds in the Kisangani and Abunakenge sites are presented in Figure 9, the raw values are recorded in the table in the appendix.

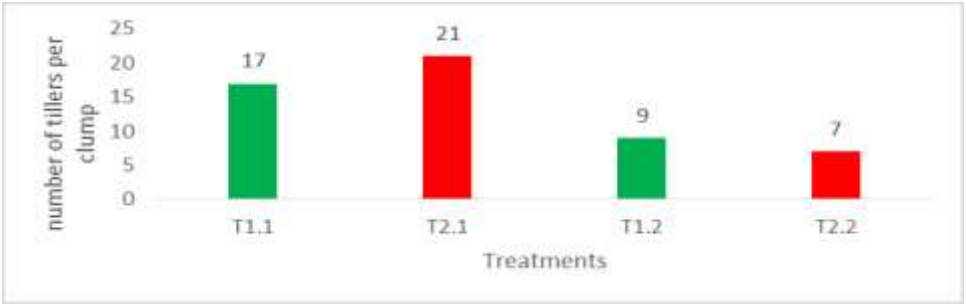


***Figure 9.*** *Average number of shoots per clump of M. macrostachyum*

**Legend:** $\mathbf{T}_{1.1}$: rhizomes fragments at site 1 (Kisangani);
$\mathbf{T}_{2.1}$: seeds at site 1 (Kisangani)
$\mathbf{T}_{1.2}$: rhizome fragments at site 2 (Abunakenge);
$\mathbf{T}_{2.2}$: seeds to site2 (Abunakenge)

Results shown in Figure 9 on the average shoots number per clump of *M. macrostachyum* observed in Kisangani, indicate that it varied in the range of 17 (shoots per rhizome) to 21 (shoots per seed). Furthermore, for the Abunakenge site, planting rhizome fragments and sowing seeds in this field produced fewer stems per clump, respectively of the order of 9 and 7 tillers/shoots per clump.

Comparing the two planting materials, no significant differences emerge with regard to the average number of shoots per clump induced by rhizome fragments (13) and by seeds (14). There is a homogeneity in the values of the number of tillers per clump for the multiplication by sowing of seeds for the experimental fields (1.62<30%) installed in Abunakenge and Kisangani (0.98%<30%).

The plots on which the rhizome fragments were cut showed heterogeneity with regard to the distribution of values of the number of shoots per clump for the experimental field of the Kisangani site (CV=32.00%>30%), and homogeneity for that of the Abunakenge site (CV=18.37% <30%).

The student test showed that there is no significant difference between the two treatments in Kisangani (0.19>0.05); while at the Abunakenge site the test reveals a significant difference between the two propagation materials 0.04<0.05) concerning the number of shoots per clump of *M. macrostachyum*

### 3.7 Discussion

The cultivation of *Megaphrynium macrostachyum* in relation to propagating materials (fragments of rhizomes) and (seeds) in Kisangani and Abunakenge aimed to determine whether *M. macrostachyum* can be propagated generatively and/or vegetatively. This was continuity of research already initiated by some researchers on the domestication of this forest resource with a view to its sustainability, availability and biodiversity conservation. According to Limala (2024), phenotypic characterization of some accessions of *Megaphrynium macrostachyum (Benth&Hook.) Milne-Redh* (Marantaceae) in the bimodal and monomodal rainfall forest agroecological zones of Cameroon, despite the importance of the species, very few scientific studies have been carried out. However, Ngama (2007), in a study conducted on traditional vegetables, attempted to develop certain cultivation techniques that would allow the production of M. *macrostachyum* in gardening conditions. Lejoly, (1969) and Gilbert (1984) arrived at the result that *M. macrostachyum*, like an undergrowth plant, has the ability to easily extends through bordering forest gaps.

Comparing the current results with those up cited researchers, they show that the shaded environment seems to be better indicated for the vegetative development of *M. macrostachyum.* However, this forest species can also grow in open environments (forest gaps); the study of Kukupula (2009), on this plant in its natural environment, in response to the effects of its exploitation, confirms these observations.

Brugière *et al.* (2000); Bmcic, (2002); Vande Weghe (2004), noted that the preferred propagation mode of *M. macrostachyum* was vegetative by diffusion of perennial underground stems or rhizomes. However, its multiplication from seeds presented a certain difficulty due to dormancy; and leaded to a very slow and irregular plant development (Brncic, 2002; Gillet, 2013). The observations made during current study corroborated with those reported previously. Indeed, results showed that multiplication by rhizome fragments was simple and rapid, because after at least 56 days cutting sprouted, and results in a

sprouting rate of 95%, unlike seed germination which occurred after at least 181 sowing days, and displayed a maximum germination rate of 69%.

Finally observed results allow to conclude that they have confirmed those already published previously by other researchers.

## IV. Conclusion

With the aim of identifying the types of propagation material most suitable for the cultivation of *Megaphrynium macrostachyum* , which ensure its good development, and which pose fewer problems for the regular germation, survival and juvenile growth of this spontaneous species; this part of the study on cultivation trial of *M. macrostachyum* in relation to the types of planting material was carried out in the two sites (Kisangani and Abunakenge) in Kisangani, DRC. The experimental design used was a special case of randomized blocks having 4 blocks of two treatments (pairing or couple method) and each block had two plots of which the planting of one was done by rhizomes fragments and the other by the seeds.

The treatments were compared on the basis of the following parameters: beginning germination and/or sprouting; days to 50% germination and/or sprouting; germination and/or sprouting rate; number of tufts/clumps per plot; plant height growth; and finally number of tillers/shoots per tuft

Results allowed to conclude that:

- *M. macrostachyum* , has the ability to produce *M. macrostachyum* plantlets both vegetatively (fragments of rhizomes) and generatively (seeds) after they are planted in soil.
- Rhizome fragments ensure rapid sprout (56-60 days), high (95%) compared to seeds which germinate late (181-188 days) and weakly (69%), thus demonstrating a dormancy problem;
- Rhizome fragments promote juvenile growth of the seedlings (height, number of tillers, number of tufts.)
- In the agro-ecological conditions in Kisangani and Abunakenge trials, rhizome fragments are the best propagating materials for this wild plant (M. *macrostachyum),* while the generative route is also possible in agrosystems.

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