International Journal of Multidisciplinary Research and Publications
ISSN (Online): 2581-6187

Offspring Power of Two Varieties of *Xanthosoma sagittifolia* (L.) Schott Subjected to the PIF Method under Goma Conditions

Tshipamba, T. O[1]; Lubunga, K. B[1]; Mubenga, K. O[2]; Solia, E. S[3]; Okungo, L. A.[3]
[1]Faculty of Agronomic Sciences, at the La Sapientia Catholic University of Goma, B.P. 50, Goma, Democratic Republic of Congo. Email: oliviertshipamba81@gmail.com
[1]Faculty of Agronomic Sciences, at the La Sapientia Catholic University of Goma, B.P. 50, Goma, Democratic Republic of Congo. Email: balthazarkapasa@gmail.com
[2]Faculty of Renewable Natural Resources Management, at Kisangani University. B.P. 2012, Kisangani, Democratic Republic of Congo. Email: kankonda65@yahoo.fr
[3]Faculty Institute of Agronomic Sciences, B.P. 1232, Yangambi, Democratic Republic of Congo.
Email: sylvainsoliaac@gmail.com
[3]Faculty Institute of Agronomic Sciences, B.P. 1232, Yangambi, Democratic Republic of Congo. Email: albertokungo@yahoo.fr

***Abstract*—** *To contribute to the resolution of the problem relating to the low availability of propagation material in Xanthosoma sagittifolia (L.) Schott (Caribbean cabbage, Malanga or Macabo), the offsetting power of two varieties (green and violet) was evaluated by the method PIF under Goma conditions using bio-char (crushed charcoal) as a substrate. The experiment was carried out according to the experimental pairing device (couples method) comprising 2 treatments of 40 bulbs, corresponding to 40 repetitions for each treatment. The observations made during this investigation were mainly focused on the rate of recovery of the mother bulbs, the number of offspring, the diameter at the neck of the offspring formed during weaning and the longevity of the mother bulbs in the propagator. The results obtained showed that:*

1. *The recovery rate for mother bulbs was 100% regardless of the variety;*
2. *La The green variety produced more offspring than the purple variety with an average of 21.93 ± 1.13 versus 17.65 ± 1.38. These results indicate that the number of offspring produced does indeed depend on the variety tested ($\chi 2 = 4922.58$; $P < 0.0001$);*
3. *The bulbs of the green variety have a longer lifespan than the purple variety in the propagator with an average of 226 ± 54 days compared to 216 ± 7 days for the green variety.*

The results obtained from this analysis indicate that the longevity of the bulbs does indeed depend on the variety tested ($662 = 89663.20$; $P < 0.0001$);

4. *The green variety was found to perform better under Goma conditions compared to the purple variety in terms of vigor of formed offspring.*

***Keywords*—** *Offspring power, Varieties, Longevity, Xanthosoma sagittifolia, PIF method.*

I. INTRODUCTION

Xanthosoma sagittifolia (L.) Schott (Caribbean Cabbage), is one of the main plants with roots and tubers that can play several roles in human nutrition. It is consumed by over 400 million people worldwide (Bown, 2000). According to Onwuem (1999) in Gorgon (2021), *X. sagittifolia* is preferred as a food given the energy value of its corms and the nutritional value of its leaves. Corms are higher in protein than sweet potatoes, cassava, potatoes and yams. They contain 2 to 4% protein and its carbohydrates are easily digestible due to the small size of the starch seeds (Agueguia *and al*., 2007). In addition, *X. sagittifolia* is adapted to the agro-ecological conditions of the humid tropics where it can give an acceptable yield even in soils unsuitable for other crops (Van Den Put, 1981; Messiaen, 1989; Janssens, 2001; Carburet *and al*., 2007). Tubers are also rich in vitamins (A, B, C, etc.) and mineral salts, including calcium and iron, necessary for maintaining good health (Amagloh and Nyarko, 2012; Traoré, 2016). Despite these advantages, the large-scale cultivation of *X. sagittifolia* encounters a problem of lack of propagation material in sufficient quality and quantity for its expansion. This is explained by the mode of growth of the plant for which the pronounced dominance of the terminal bud inhibits the development of lateral buds (Van Den Put, 1981; Okungo, 2008). As a result, the multiplication rate is low, as a plant harvested at maturity usually only produces a single cutting. The same number of cuttings is thus returned each year and the cultivated area generally remains the same in each cropping season (Messiaen, 1989; Okungo, 2008). The PIF (Stem Fragment Plants) method has been developed to regenerate difficult-propagating plants. It allows, in a propagator, to activate dormant buds and to produce ex situ a large quantity of healthy planting material. This method is currently used with success for the propagation of banana, a monocotyledonous plant with the same botanical characteristics as *X. sagittifolia* (Kwa Moïse, 1998; Meutchieye, 2009). According to a study conducted in Kisangani by Tshipamba *and al*. (2019), *X. sagittifolia* responds positively to this method of multiplying propagation material. Given that there are several varieties of *X. sagittifolia* and considering the difficulty linked to the insufficiency of propagation material in this crop, the main objective of the present study is to compare the shoot-out power of the bulbs of two varieties of *X. sagittifolia* (green and violet) tested on the bio-char (crushed charcoal). The hypothesis underlying

Tshipamba, T. O; Lubunga, K. B; Mubenga, K. O; Solia, E. S; and Okungo, L. A., "Offspring Power of Two Varieties of Xanthosoma sagittifolia (L.) Schott Subjected to the PIF Method under Goma Conditions," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 4, Issue 3, pp. 16-20, 2021.

this investigation is that the sprouting power of *X. sagittifolia* bulbs varies depending on the variety tested, since each variety has its own genetic makeup.

II. Material and Methods

Study Environment

This study was carried out in Goma, on the grounds of the Catholic University La Sapientia. The geographical coordinates of the experimental site taken with the GPS are as follows: 74 ° 11'16 "S; 98 ° 17'28.1'' E; 1474 m altitude (Figure 1).

The city of Goma enjoys a tropical high altitude climate of the type Cf of the Köppen classification. The annual rainfall is 1250 mm and the average monthly temperatures vary between 20 and 25 ° C. The soil is of the andosol type resulting from volcanic eruptions (Kulimushi, 2011).

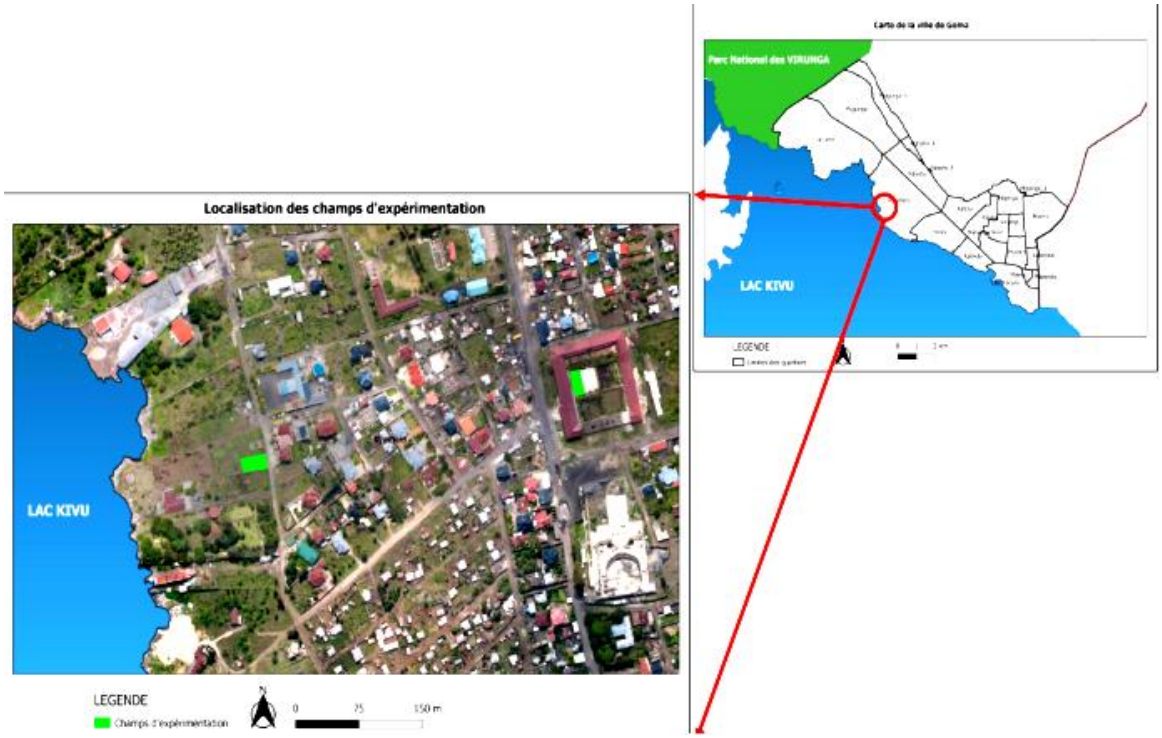

Fig. 1. Location of the study site

Material

During the performance of this test, the unsheathed and decapitated bulbs of *X. sagittifolia* of both varieties were used as propagation material. Experienced varieties present the following morphological characteristics: green leaves, green petioles and white tubers for the first and green leaves, purple petioles and purple tubers for the purple variety.

Methods

The multiplication was carried out in a propagator. The propagator superstructure was constructed from local materials including rafters and shuttering boards. The dimensions of the propagator were 6 m long, 5 m wide and 2.5 m high. Then, this superstructure was covered with a transparent plastic sheet to retain heat. To reduce the strong light, the propagator was installed under a shade made of trees of *Jacaranda mimosifolia* D. Don.

Inside the propagator, the propagation compartments were 3 m long, 1.20 m wide and 0.30 m deep. Each compartment was filled with crushed charcoal (bio-char) as a substrate. Forty bulbs of *X. sagittifolia* were planted in each compartment, making a total of 80 bulbs used for this study. The experimental device used was the pairing method or the couples method (particular case of complete randomized blocks) comprising two treatments of 40 bulbs, corresponding to 40 repetitions per treatment.

Before their installation, the bulbs were stripped and beheaded. Decapitation of the bulbs removes the apical dominance of the terminal bud, which breaks the dormancy of the lateral buds. Then the bulbs were left to dry in a shady spot for a week to promote recovery. Thirty days after planting, the first offspring formed were weaned. Weaning continued at a biweekly frequency to avoid reestablishing the apical dominance imposed by the first bud break-out. To wean, a sharp, pointed knife was used. It was enough to exert a slight pressure on the offspring and it was separated from the bulb mother. Maintenance care included maintaining cleanliness in and around the propagator and watering the regeneration compartments daily to keep the substrate moist.

The observations made during this test were made on the recovery rate of the mother bulbs, the number of shoots, the diameter at the neck of the shoots formed (vigor) and the longevity of the mother bulbs in the propagator. This study covered a period of 28 weeks, from March 24 to September 24, 2020. The generalized linear model was considered for the

Tshipamba, T. O; Lubunga, K. B; Mubenga, K. O; Solia, E. S; and Okungo, L. A., "Offspring Power of Two Varieties of Xanthosoma sagittifolia (L.) Schott Subjected to the PIF Method under Goma Conditions," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 4, Issue 3, pp. 16-20, 2021.

statistical analysis of the data. The numbers of offspring formed on the bulbs of the two varieties were compared using a Poisson distribution with a logarithmic linkage function using SPSS 25.0 software (IBM SPSS Statistic, 2019). The significance level was set at 0.05.

III. Results

Recovery rate of mother bulbs

The data relating to the rate of recovery of mother bulbs according to the varieties tested are given in table 1.

TABLE 1. Rate of recovery of mother bulbs according to the varieties tested

Make out	Green variety	Purple variety
Number of bulbs planted	40	40
Number of bulbs having resumed	40	40
Pourcentage (%)	100%	100%

The results of this table reveal that all bulbs planted resumed for all varieties tested in general.

Number of offspring formed

The data relating to the number of offspring formed according to the varieties tested are given in Table 2.

TABLE 2. Number of offspring emitted according to the variety

Variety	Average	Confidence Interval (95%)		Hypothesis test		
		Inferior	Superior	χ^2	dl	*P*
Green	21.93 ± 1.13	19.82	24.26	4922.58	1	<0.0001
Violet	17.65 ± 1.38	15.14	20.58			

The results obtained show that the green variety produced more offspring than the purple variety with an average of 21.93 ± 1.13 against 17.65 ± 1.38. These results indicate that the number of offspring produced depends on the variety tested ($\chi 2 = 4922.58$; $P < 0.0001$).

Longevity of mother bulbs in the propagator

The data relating to the longevity of the mother bulbs according to the varieties tested are given in table 3.

TABLE 3. Longevity of mother bulbs depending on the variety

Variety	Average	Confidence Interval (95%)		Hypothesis test		
		Inferior	Superior	χ^2	dl	*P*
Green	225.65 ± 4.88	216.28	235.42	89663.20	1	<0.0001
Violet	216.23 ± 7.08	202.78	230.56			

Analysis of this table shows that the green variety lived longer compared to the purple variety with an average of 225.65 ± 4.88 days versus 216.23 ± 7.083 days. The results obtained from this analysis indicate that bulb longevity depends on the variety tested ($\chi 2 = 89663.20$; $P < 0.0001$).

Evolution of the vigor of offspring formed after weaning

Figure 2 below illustrates the evolution of the vigor of offspring during weaning.

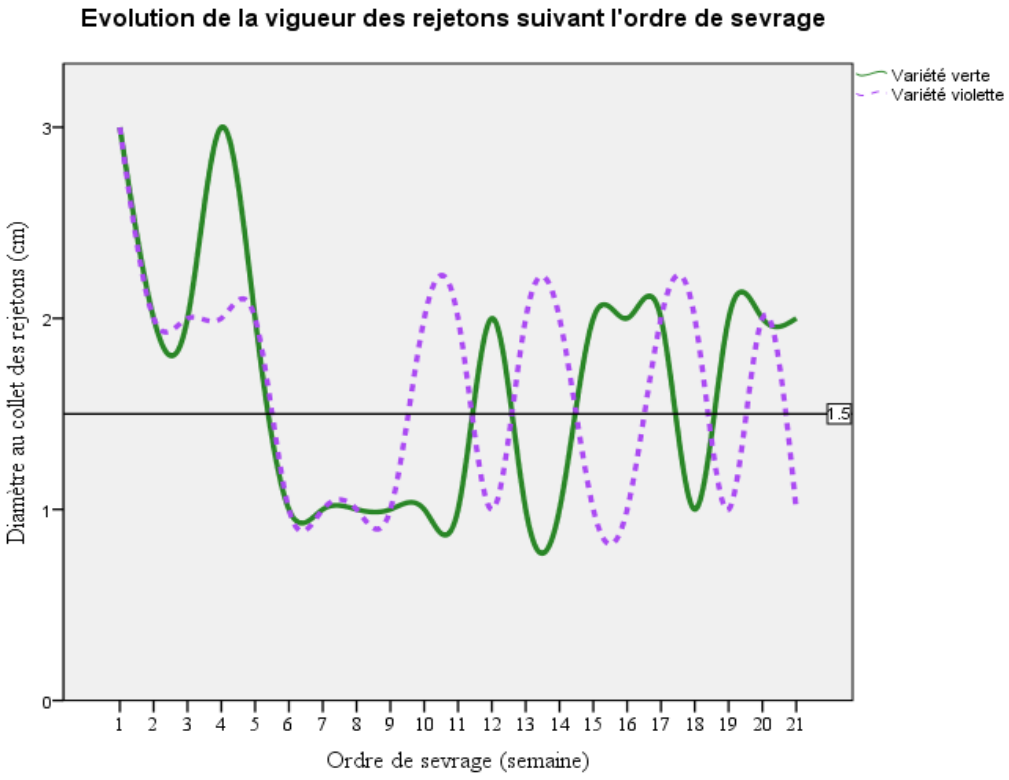

Fig. 2. Evolution of the vigor of the offspring according to the order of weaning

Tshipamba, T. O; Lubunga, K. B; Mubenga, K. O; Solia, E. S; and Okungo, L. A., "Offspring Power of Two Varieties of Xanthosoma sagittifolia (L.) Schott Subjected to the PIF Method under Goma Conditions," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 4, Issue 3, pp. 16-20, 2021.

The results of Figure 2 indicate that the vigor of offspring formed remains above average (1.5 cm), but a decrease in the vigor of offspring formed from the 5th weaning was observed for both varieties tested. Then there is a slight increase in this vigor around the 11th weaning, which continued until the last weaning.

Evolution of the number of offspring formed following the weaning order

Figure 3 below shows the evolution of the number of offspring formed during weaning.

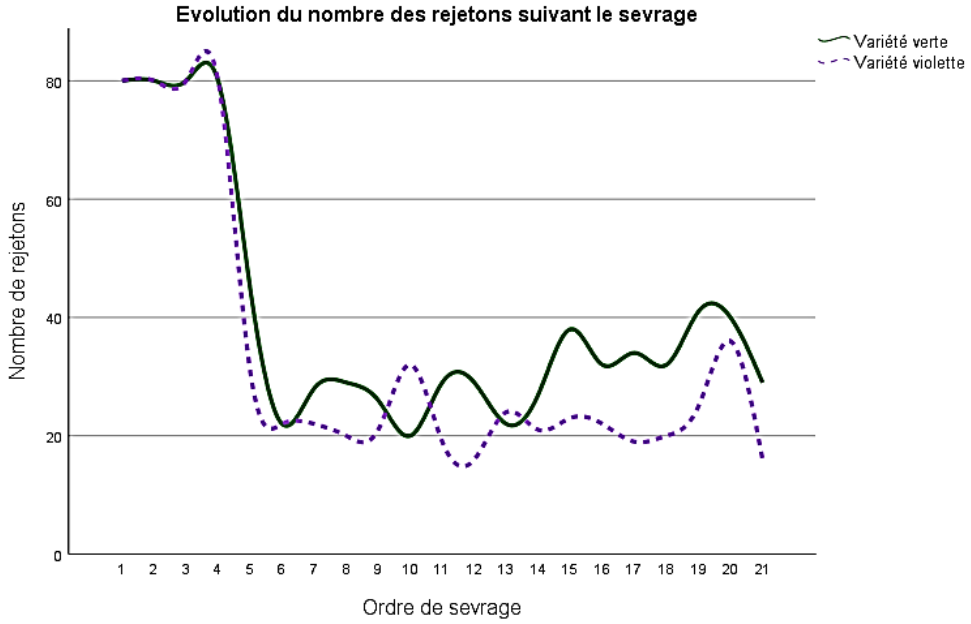

Fig. 3. Evolution of the number of offspring after weaning

From the analysis of Figure 3, it appears that the number of offspring formed decreased following weaning and depending on the varieties tested. Generally speaking, this number decreased from the fifth to the last weaning. However, there is a slight superiority of the green variety over the purple variety.

IV. Discussion

The results relating to the rate of recovery of mother bulbs show that all the bulbs planted have recovered regardless of the variety tested (Table 1). Similar results were obtained by Okungo *and al*. (2017) and Tshipamba *and al*. (2019). Indeed, the bulbs of *Xanthosoma sagittifolia* (L.) Schott normally recover without much problem, except in the case of prior attacks as pointed out by Van Den Put (1981) and Janssens (2001). The results obtained on the number of offspring formed indicated that the green variety produced more offspring than the purple variety (Table 2). These results suggest that the number of offspring produced does indeed depend on the variety tested ($\chi 2 = 4922.58$; $P < 0.0001$). These results can be explained by the genetic potential of the varieties studied. Indeed,

Mazliak (1972) asserts that the reaction of a plant to any physiological phenomenon is both under the control of endogenous (genetic and hormonal) and exogenous (temperature, light, soil reaction, humidity) factors. Similarly, Okungo *and al*. (2017) state that the number of shoots formed depends on the number of buds present on the bulb in relation to its diameter. However, the numbers of offspring formed remain lower than those obtained in a previous study (Tshipamba *and al*. (2019). Indeed, in the aforementioned study, an average of 34 offspring was obtained with the purple variety after 24 weaning. . This performance can be explained by the number of weanings carried out. Let us recall that this trial tested two varieties of *X. sagittifolia* (green and purple) with 21 weanings. We also believe that the environment would also have influenced and explained these differences Indeed, Goma and Kisangani do not benefit from the same ecological conditions. The results obtained made it possible to verify our initial hypothesis. Indeed, the green variety contributes significantly to improving the production of offspring in this crop with a view to its extension.

Compared to the longevity of the experienced bulbs, the results obtained showed that the green variety lived longer compared to the purple variety (225.65 ± 4.88 against 216.23 ± 7.08). This indicates that the longevity of the bulbs does indeed depend on the variety tested ($\chi 2 = 89663.20$; $P < 0.0001$) (Table 3). This situation can be explained by the quantity of organic substances, in particular the carbohydrates contained in the bulb. In addition, the response to the stresses caused by withdrawal has not been the same. The bulbs of the green variety which produced more offspring and suffered more stress had a longer lifespan. Regarding the evolution of the vigor of the offspring formed, it was observed a decrease in this vigor for all the varieties tested from the 5th weaning, and which, subsequently, increased slightly around the 11th

Tshipamba, T. O; Lubunga, K. B; Mubenga, K. O; Solia, E. S; and Okungo, L. A., "Offspring Power of Two Varieties of Xanthosoma sagittifolia (L.) Schott Subjected to the PIF Method under Goma Conditions," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 4, Issue 3, pp. 16-20, 2021.

weaning until 'to the last (Figure 2). This result can be explained by the depletion of nutrient reserves (carbohydrates) contained in the bulbs (Okungo, 2012). However, we do not know if this decrease in vigor can affect the productivity of plants from offspring formed after the 11th week. By comparing this result with those obtained by Tshipamba et al. (2019), the same trend is observed. However, it should be noted that the green variety proved to be more suitable than the purple variety.

Compared to the results obtained on the evolution of the number of offspring formed, it was indicated that this number decreased according to the order of weaning and according to the varieties tested. It generally decreased from the fifth to the last weaning (Figure 3). This reduction is justified by the stress undergone by the plants during weaning and the progressive decrease in the nutrient reserves of the bulbs. Indeed, Maginiac (1974) affirms that the weaning of the offspring leaves wounds in the places where they were attached; this causes stress in the plant. In addition, after receping, the bulbs are no longer supplied with organic substances from chlorophyll assimilation, only use the organic substances stored and destined to be exhausted.

V. CONCLUSION

The object of the present investigation was to compare the offspring power of two varieties of *Xanthosoma sagittifolia* (L.) Schott (Caribbean cabbage) subjected to the PIF method under Goma conditions, using bio-char as a substrate. To do this, a test was carried out in the grounds of the Catholic University of La Sapientia using an experimental pairing device (couples method) comprising 2 treatments of 40 bulbs, corresponding to 40 repetitions per treatment. The observations made during this study were mainly focused on the rate of recovery of the mother bulbs, the number of shoots, the diameter at the neck of the shoots formed and the longevity of the mother bulbs in the propagator. Bulbs stripped and decapitated before planting were placed on the same day for the entire trial.

It emerges from all the results obtained that the green variety was more efficient from the point of view of offspring power compared to the purple variety because it significantly improves the multiplication rate in *X. sagittifolia* (L.) Schott and constitutes solutions to the problem of insufficient propagation material in this culture.

REFERENCES

[1] Agueguia, A., Fontem, D. A., Bikomo Mbonomo, R., Mboua, J.C., Mouen, M., Ndzana, X., Tchuanyo, M. et ZOK, S., 2007. Taro and Macabo: two tubers unlike any others http/w.w.w.fao.org/inpho/content/documents/library/move rep/5.

[2] Amagloh F.K., Nyarko ES., 2012. Mineral nutrient content of commonly consumed leafy vegetables in northern Ghana. African Journal Food Agriculture Nutrition Development. 12(5): 6397-6408.

[3] Bown, D., 2000. Aroids Plants of the Arum family. Timber Press, Portland, OR. 470 p.

[4] Carburet, A., Lebot, V., Ravaillac, P. et Vernier, P., 2007. *Other starchy plants. In: Memento of the agronomist*. CIRAD/GRET. Jouve. Paris. France. pp.831-864

[5] Gorgon Igor T., Olga Diane Y., Ephrem Kosh K., Raba A. & Kouami K., 2021. Comparative study of growth and productivity in Taro (*Colocassia esculenta* L.) and the Macabo (*Xanthosoma Sagittifolium* et *X. Anthosoma* Sp) cultivated under pedoclimatic conditions in the town of Mbaïki (Lobaye) in the Central African Republic. European Scientific Journal, ESJ, 17(1), 1.

[6] Janssens, M., 2001. The Taro (*Colocasia et Xanthosoma*) in Reamaekers. H.R. (Ed). Agriculture in tropical Africa. DGCL. Ministry of Foreign Affairs, Trade and International Cooperation. Bruxelles pp254-290.

[7] Kulimushi, E., 2011. Comparative trial of the use of Dithane M 45 and extracts based on garlic bulbs on the control of fungal and bacterial diseases of potatoes in Goma: case of downy mildew « Phytophtora infestans Mont de Bary » and bacteriosis "Pseudomonas solanacearum E.F. Smith" in Annales the Goma Uniersity, Vol 3, N ° 3, Goma / DR Congo.

[8] Kwa, M., 1998. Study of techniques for multiplication of plant material in vivo. in: Technical report 1996-1997. Doc. Internal. CRBP. Njombe. Cameroon. pp. 96-100.

[9] Maginiac, E., 1974. Plant physiology. DUNOD-GAUTHIER journal centers; Villard, boulevard de l'Hôpital, Paris, vol. 12, n ° 4.

[10] Mazliak P., 1972. Plant physiology, II. Growth and development. Herman, Paris. 142p Messiaen, C.M., 1989 The tropical vegetable garden. ACCT and CILF "living techniques" collection. 2nd ed. Recast. 580p.

[11] Meutchieye, F., 2009. Technical sheet of banana multiplication by the PIF method. Plants grown from stem fragments. Training manual for rural communities. Cameroon. 15p.

[12] Niba, LL., 2003. Processing effects on the susceptibility of starch in some dietry starch sources.International Journal of Food Science and Nutrition 54: 97-109.

[13] Okungo, A.L., 2008. Study of receping and weaning processes as a method of rapid multiplication of propagation material in Taro Macabo (*Xanthosoma sagittifolium* (L.) Schott. DES Memory inédit IFA-YANGAMBI 63p.

[14] Okungo, A.L., 2012. Methods of rapid multiplication of Mahole (*Xanthosoma sagittifolium*) and evaluation of propagation material obtained under the agro-ecological conditions of Kisangani. Unpublished doctoral thesis, IFA-Yangambi, 182 p

[15] Okungo, A.L., Ramazani, A., Solia, E., Mwamba, K. and Dhed'a, D., 2017. Study of receping and weaning processes as methods of rapid multiplication of propagation material in Macabo (*Xanthosoma sagittifolium* (L.) Schott) in Kisangani. Annals of IFA-YANGAMBI, No. 1 (1).

[16] Traoré E.R., 2016. Study of the agro-morphological variability of a taro collection (Colocasia esculenta (L.) Schott) from the Sudanese and Sudano-Guinean domains of Burkina Faso. DEA, The Ouagadougou University, Burkina Faso, 54 p.

[17] Tshipamba, T.O., Kankonda, M.O., Mukandama, N.N.J-P. and Okungo, L.A., 2019.Influence of Bulb Size on Macabo (*Xanthosoma sagittifolium* (L.) Schott) Propagation by the Kisangani PIF Method. *Elixir Agriculture 132 (2019) 53298-53302*/ISSN 2229-712x. pp 53298-53302.

[18] Van Den Put, R., 1981. *Main crops in Central Africa*. Ed. LASAFFRE. Tournai. Belgique.1552p.

Tshipamba, T. O; Lubunga, K. B; Mubenga, K. O; Solia, E. S; and Okungo, L. A., "Offspring Power of Two Varieties of Xanthosoma sagittifolia (L.) Schott Subjected to the PIF Method under Goma Conditions," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 4, Issue 3, pp. 16-20, 2021.