BIoEx - Journal
Britain International of EXACT Sciences Journal
Publish: | January - May - September |
E-ISSN: 2686-1208
P-ISSN: 2686-1216
http://biarjournal.com/index.php/bioex

# Proliferative Potential of Three Plantain Varieties In A Semi-Controlled Agro-Ecosystem At Gbado-Lite City (Nord Ubangi), Democratic Republic of the Congo

**Jospin B. Gbelegbe[1, 2], Jean B. Mokese[2], Jean-Bernard Z. Bosanza[2], Koto-Te-Nyiwa Jean-Paul Ngbolua[3, *]**
[1]Department of Plant science, Faculty of Agricultural Sciences, University of Gbado-Lite, P.O. Box 111 Gbado-Lite, Democratic Republic of the Congo
[2]Higher Institute of Agronomic Studies (ISEA) of Bokonzi, P.O. Box 67 Gemena, Sud-Ubangi, Democratic Republic of the Congo
[3]Department of Biology, Faculty of Science and Technology, University of Kinshasa, P.O. Box 190 Kinshasa XI, Democratic Republic of the Congo
Email: jpngbolua@unikin.ac.cd

***Abstract:***

*A study was conducted at Gbado-Lite city to assess the capacity of plantain macro-propagation by applying the PIF technique. To do this, the fragments of three types of banana trees: French, true horn and false horn were sown in a propagator containing sawdust. After germination, the seedlings were transplanted into polyethylene bags containing a mixture of clay and potting soil and installed under the shadehouse. With regard to the results obtained and statistical tests (at the 5% threshold), the significant difference between these three types of banana trees was only observed for the number of seedlings emitted by explant, the number of suckers weaned, the height of the plants at weaning and the mortality rate of plants in the nursery. Thus, emergence having taken place 2 weeks after sowing, after 46 days after resumption and 61 days after sowing, the French type was significantly different from two others with an average of 6 seedlings emitted and 4 suckers weaned per explant; the true and false horn being tied with 5 seedlings and 3 weaned suckers per explant. As for the height of the plants at weaning, the true horn (19.9 cm) was significantly higher than the other two (French: 17.7 cm and false horn: 19.6 cm). Finally, with 1.1% for True horn had a significantly lower mortality rate for plants in the nursery than the others (6.7% for French horn and 3.8 % for False horn). Although, the PIF technique influenced the suckering in a way strongly dependent on the cultivars, it can be popularized for these three types studied in order to promote banana cultivation in the agro-ecological conditions of Gbado-Lite.*

***Keywords:***
*PIF; banana tree; explant; propagator; sawdust*

## I. Introduction

Currently, the plantain banana is placed among commonly consumed products such as rice, wheat and maize, which all occupy the important ranks of food crops in terms of gross production value (Nguru, 2014). Its culture also represents an important food source for the populations of African countries, it has become an axis of great socio-economic importance from the point of view of food security and job creation (Mortinez and Saavedra, 1999; Orellana et *al*., 2002).

Bananas are unquestionably among the most important tropical fruits, and more than 400 million people in 120 developing countries depend on bananas, both as a staple food and as an important product for local and international trade, a source of income for all rural populations in the humid tropics of Africa (Songbo, 2019). In addition, the plantain is above all a food plant cultivated for its high-energy fruit, edible fresh or cooked and allows a very large supply of nutritious food rich in carbohydrates, minerals and vitamins that can fill nutritional deficiencies (Bakry *and al.*, 2006; Boye et *al.*, 2010).

In the Democratic Republic of the Congo, banana and plantain are the second most self-consumption crops compared to other crops and contribute greatly to the food security of the population (Esoma et Banza, 2018). In North Ubangi and more specifically in Gbadolite, bananas occupy a significant place among food crops and come in eighth position after cassava, maize, groundnuts, rice, cowpeas, soybeans and beans. It is a source of food, the manufacture of alcoholic beverages and income through the marketing of diets (IPAGRI, 2020). However, access to good quality seedlings is one of the major constraints when establishing a plantain crop (Cinna, 2014; Molongo et al, 2015, Ngo-Samnick, 2011).

Indeed, faced with the constant demand for this commodity and given the scarcity of the availability of rejection, several studies relating to it have been carried out, in particular: the cultivation of banana trees and plantain trees in the DR Congo (Dhed'a *and al.*, 2011); Buckling effect on sprout potency of some plantain (Musa sapientum L.) cultivars in GbadoLite, DR Congo (Molongo *and al.*, 2015) and use of coppicing and weaning process in relation to buckling moment on potency sprout of plantain (Musa sapientum L.) in Gbadolite (Eboma, 2017).

Thus, the present investigation experiments the multiplication of materials by using the PIF technique (Plants from stem fragments) in some types of plantain cultivars under the agricultural conditions of Gbado-Lite in order to choose the one that would behave the best.

## II. Material and Methods

### 2.1. Geographical Location

The experimental field was installed in the town of Gbado-Lite, commune of Gbado-Lite, Lite district, cell of Gbawele in the province of Nord-Ubangi in the Democratic Republic of Congo. The geographical coordinates of the experimental field indicated by GPS: Latitude: 04°17'00436" North, Longitude: 21°00'4722" East, Altitude: 403 m. The search covered the period from March 1 to June 30, 2022, i.e. 122 days.

The climate is tropical and the annual rainfall reaches 1600mm. Two seasons alternate, however, the dry season runs from November 15 to March 15 and the rainy season runs from March 15 to November 15. Insolation is low, 45% of total tropical energy radiation (Molongo *and al.*, 2021). The temperature varies according to the seasons. The average monthly air temperature is between 28° and 35°C; the monthly averages of the daily maximum temperatures finally increase during the dry season (30.5° to 38° in March) while the monthly average daily minimums are the lowest during half of the dry season (20° to 30°C in November ). The monthly relative insolation generally oscillates between 60 and 90% from March to November and between 50 and 70% from November to March, January being the sunniest month. The soil is generally sandy clay. The Ubangi river basin and the territory of Mobayi-mbongo encompasses the northern part of the city of Gbadolite. The dominant vegetations are the savannah and the equatorial forest which abound in several types of species of fauna and flora, and formed plateaus, hills and wooded savannah towards the South.

The city is crossed by several rivers. The most important are: in the city, Boyi River, Nzekele, Wakamba, Waka and Nzanguma, Ngandanga, Wambe, Mboroki–mbondo, Sokoro in the South which separates Molegbe/Mairie de Gbadolite) and Mobayi-mbongo (Mairie, 2016).

### 2.2. Materials

The biological materials used for this study consisted of the plantain shoots from three cultivars from peaseant fields and chosen according to their preference by the peasant farmers in the area, by consumers and their economic value.

### 2.3 Methodes

✓ **Experimental plan**

The experimental device used was that of complete randomized blocks with 3 repetitions and 3 treatments (from three types of banana trees grown in Gbadolite) T1 (French), T2 (Vrai Cornes) and T3 (Faux Cornes). The area of the propagator (sprouter): 9.75 m2 (6.5 m long and 1.5 m wide), 60 cm high; to plots (lines) 50 cm apart between them and the blocks separated by a masonry wall 10 cm thick. This was built under a hangar 1.50 m high. The fragments were subcultured at 20 cm x 20 cm spacings, at the rate of 10 fragments per plot (line), 30 fragments per block; i.e. a total of 90 fragments in the propagator containing the sawdust and built under a hangar (Cf. fig. 2).

After emergence, the plants were placed in polyethylene bags installed under the shadehouse, divided into 3 blocks each having 9 plots (lines). The area of the nursery: 35 m2 (i.e. 7 m long, 5 m wide).

✓ **Preparation of explants**

To carry out the PIF method, the six steps followed were those recommended by Kwa (2009) and Ngo-Samnick (2011): after the choice of suckers at the "Bayonet" stage (where apical dominance is not yet established), these were extracted from the mother plant followed by the removal of all the roots and the washing with water of the base of the rejection to remove all the particles of the earth.

The clean suckers underwent white trimming using a kitchen knife (that is to say, the bare bulb of the sucker by removing a thickness of more than at least 3 mm corresponding to the zone of potential infestation of nematodes until obtaining the white color) and decortication during which 3 to 5 layers of the leaf sheaths were removed one after the other all by cutting each time 2 mm above the line insertion on the rod (so as to avoid the risk of damaging the eye) and washing the explants with clean water. The explants thus obtained were placed on a support (white plastic bag) to undergo draining for 48 hours in the shade in a room where the air circulated easily, with no possible contact with the ground. Finally, the rejuvenation and incision consisted in the progressive reduction of the end of the pseudostem left after the decortication (being careful not to descend too much at the risk of destroying the peripheral buds) and after having identified the apical hill meristem (MAC), 2 crosswise incisions were made in the center of the explant to disorganize it and break the apical dormancy. A new drying of 30 minutes to 1 hour in the shade of the incised explants was done before placement in the propagator.


**Figure 1.** Preparation of explants: 1= extraction of suckers at bayonet stage; 2= blank trimming with the knife; 3= draining explants (3A=French; 3B=True horn and 3C=False horn

✓ ***Binding***

On 03/01/2022, the explants having undergone rejuvenation and application of the incisions were installed in compartments with spacings of 20 cm x 20 cm on the line at the rate of 10 explants per line, i.e. 30 explants per block for make a total of 90 explants and covered with a thickness of 3 to 5 cm sawdust. No hormones were added or mixed with the sawdust, either before or after seeding. The propagator was hermetically covered with transparent and resistant plastic bags, in order to create a microclimate for propagation. The germination tray was previously and sufficiently watered 24 hours before setting up. In order, the watering frequency was twice a week and regular.

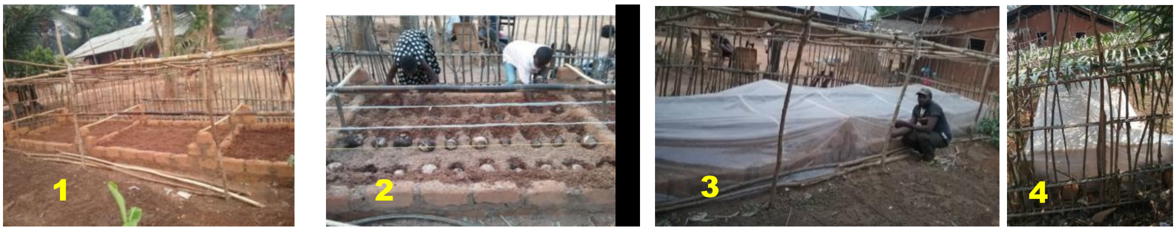


***Figure 2.*** *= Developed propagator; 2= tubing of explants; 3= hermetic cover of the propagator with transparent plastic bags; 4= shadehouse made from palm branches*

✓ **Weaning**

According to the data provided by Ngo-Samnick (2011) and the Institut Agronomique Néo-Calédonien (2012) according to which the first weaning occurs 30 to 40 days after sowing or seeding, the first weaning for this experiment took place on 04/05/2022, i.e. 36 days after sowing (21 days after recovery of the explants): the young plants with 3 to 5 leaves were carefully detached using a sharp knife (fig. 3). The other weanings took place after a sequence of 7 days until the 61st day after sowing, thus covering a period of 25 days. The seedlings were taken from the explants in the morning so that the air in the bell warmed up during the day.

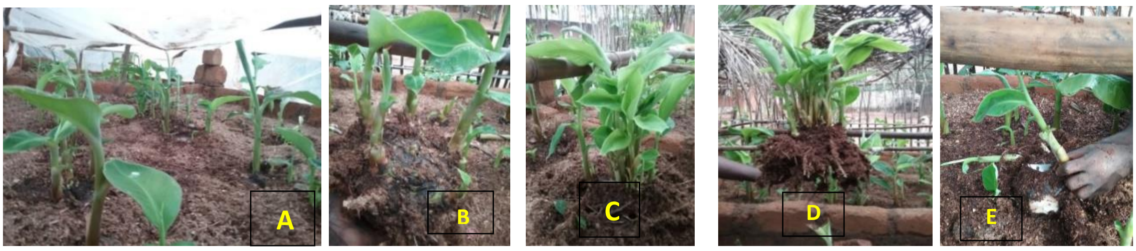


***Figure 3.*** *Emergence in greenhouse (A); Explant with seedlings: French tuft (B), True horn tuft (C) and False horn tuft (D); Weaning (E)*

✓ **Transplanting in the nursery**

The weaned seedlings were dressed and transplanted with all their roots into polyethylene bags, perforated with variable dimensions depending on the cultivar in order to allow good drainage inside the bag. The bags filled with potting soil were stored in beds and watered the day before transplanting. During transplanting, a hole was made in the center of the sachet at a sufficient depth so as not to cause the roots to bend. The seedling is introduced inside the hole, and the soil is lightly packed without compacting. Only the bulb was buried since if the seedling was too deep, it would take time to restart. The young plants were transplanted under shade at an ideal acclimatization temperature between 25 to 27°C and watered 4 times a week as pointed out by Ngo-Samnick (2011).

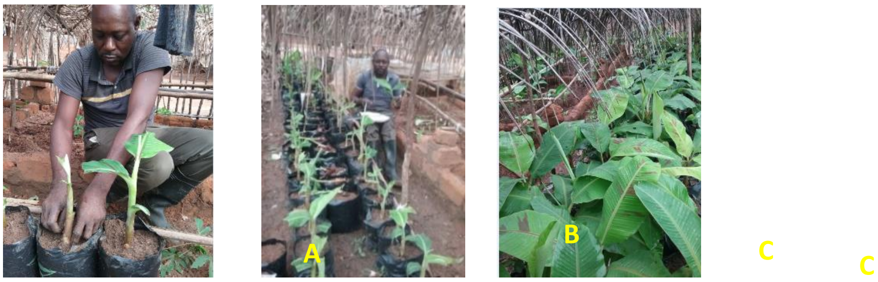


***Figure 4.*** *Transplanting (A); Arrangement of seedlings (B) and evolution of seedlings (C) in the nursery*

✓ **Parameters observed**

Observations included: emergence rate of explants, height and basal diameter of plants at weaning and nursery, number of leaves per plant at weaning and at nursery, number of plants per explant in propagator after 2 months, the weaning rate and the nursery mortality rate using the formula given by Dupriez and De Leener (2009):

✓ $TS\ (\%) = \frac{PS}{PE} \times 100$ Where TS is the weaning rate of the seedlings, PM represents the number of seedlings weaned and PR the total number of seedlings emitted in the tank;

✓ $TM\ (\%) = \frac{PM}{PR} \times 100$ Where TM is the plant mortality rate, PM reflects the number of dead plants and PR the total number of plants transplanted into the nursery

Statistical analyzes of the results, for significance tests, were performed using Statistix 8.0 software.

## III. Results and Discussion

### 3.1 Results

The results obtained in relation to the parameters observed (emergence rate of the explants, the height and the basal diameter of the plants at weaning and in the nursery, the number of leaves per plant at weaning and in the nursery, the number of plants per explant in the propagator after 2 months, the weaning rate and the mortality rate in the nursery) are presented in tabular form. The indicators of both growth and reproduction parameters for each type of banana plant subject to this experiment are summarized in Table 1.

**Table 1.** Synthetic indicators of different parameters analyzed

| | Treatments | | | | Statistics | | | |
|---|---|---|---|---|---|---|---|---|
| *Settings variables* | T1 (French) | T2 (True Horns) | T3 (False Horns) | *Overall average* | CV | Fisher | Probability. | LSD 0,05 |
| Emergence rate (%) | 100±0,0**a** | 100±0.0 **a** | 100±0.0**a** | 100 | - | - | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Number of seedlings emitted per explant* | 6±0.6**a** | 5±0.0**b** | 5±1.2**b** | 5±1.0 | 10.83 | 7.00 | 0.0494 | 1.3088 |
| *Number of suckers weaned per explant* | 4±0.6**a** | 3±0.6**b** | 3±0.0**b** | 4±0.7 | 14.32 | 5.20 | 0.0772 | 1.1948 |
| *Weaning rate* (%) | 66.03±1.94**a** | 70.8±7.84**a** | 67±19.94**a** | 67.85 | 15.77 | 0.17 | 0.847 | 24.245 |
| *Average number of sheets per sucker at weaning* | 3±0.00**a** | 3±0.00**a** | 3±0.58**a** | 3.11 | 10.71 | 1.000 | 0.444 | 0.756 |
| *Number of leaves per plant at the nursery* | 6±0,58**a** | 7±0.00**a** | 7±0.58**a** | 6.667 | 8.66 | 1.00 | 0.444 | 1.309 |
| *Diameter at suckers collar at weaning (mm)* | 1.56±0.12**a** | 1.5±0.30**a** | 1.6±0.15**a** | 1.567 | 13.29 | 0.31 | 0.751 | 0.472 |
| *Diameter at collet of plants in the nursery (mm)* | 2±0.00**a** | 2±0.29**a** | 2±0.29**a** | 1.889 | 13.95 | 0/40 | 0.694 | 0.597 |
| *Height at collar of suckers at weaning (Cm)* | 17,7±1,61**b** | 19,9±0,64**a** | 19.6±0.95**b** | 19.056 | 4.41 | 5.92 | 0.0638 | 1.907 |
| **Height at collar of plants in the nursery (Cm)** | 23.53±1.15**a** | 26.06±2.20 **a** | 24.96±1.01**a** | 24.856 | 6.64 | 1.87 | 0.267 | 3.643 |
| **Average number of dead plants in the nursery** | 1.67±0.58**a** | 0.33±0.58**b** | 2.00±1**a** | 1.33 | 43,30 | 7.000 | 0.049 | 1.303 |
| *Mortality rate in the nursery (%)* | 3.8a | 1.1a | 6.7a | - | - | - | - | - |

Legend: no significant difference between the mean of treatments followed by the same letters (a, b or c)

### 3.2 Discussion

The results of statistical tests show that there is no significant difference between these three types of cultivars for the following parameters: rate of emergence, rate of weaning, average number of leaves per plant (both at weaning and at nursery), diameter at collet of suckers at weaning, diameter and height at collet of plant in the nursery. On the other hand, the heterogeneity of the effects of the treatments was observed for the number of seedlings emitted by explants, the number of weaned suckers, the height at collet of the suckers at weaning and the mortality of the plants in the nursery.

With an emergence rate of 100% for all the treatments 15 days after placing the explants in the propagator, the result clearly shows that the macroscopic selection of the suckers tested was rigorous. These results are similar to those found by Esoma and Banza (2018), confirming that emergence occurs within two weeks after sowing.

According to the data on the average number of seedlings emitted by explants after 46 days after appearance of the seedlings and 61 days after sowing, it was observed that for the whole, an explant in this research condition emitted an average of 5 peeps, i.e. 6 at the French type, 5 at the true horn types and 5 at the false horn types. In isolation, some more prolific explants emitted up to 21, 22 and 17 plants respectively for French, False horn and True horn (Cf. figure 3).

With an average of 6 seedlings emitted per explant giving 4 weaned suckers after 46 days after recovery or 61 days after sowing, the French type differed significantly from two other types (true and false horn). In the express case, the highest average number was observed in explants from French-type bananas with 4 seedlings; on the other hand, the lowest number of weaned seedlings was 3 seedlings observed in the explants from bananas of the true and false horn type. These results are in agreement with those obtained by Kwa (2003, 2009, 2013), who also observed that the number of seedlings per explant varies according to the type of cultivar. Working on other types of bananas, Bangata *and al.* (2018) also showed that the numbers of seedlings weaned per plant fragment after 1 month vary from one cultivar to another, namely: 7 for cooking bananas (SABA), 6.2 for cooking bananas (Cardaba) , 5.1 for plantain (Ndongila), 6 for plantain (Bubi), 3.5 for dessert (Yangambi km5) and 1.8 for dessert (Gros michel). According to the New Caledonian Agronomic Institute (2012), from a shoot we are able to obtain 10 to 100 plantain plants depending on the cultivar and the experience of the handler. However, using an appropriate cultivar type in the PIF technique achieves mass production of suckers that are both smooth, moderately uniform, and in just 2.3-4 months (Cinna, 2014).

As for the height of the plants at weaning, the true horn (19.9cm) was significantly higher than the other two (French: 17.7cm and false horn: 19.6cm). Finally, the results relating to the mortality of the plants in the nursery reveal that the mortality rate of false horn is 6.7% (i.e. 6 out of 90 transplanted plants), followed by that of French which is 3.8% ( i.e. 5 out of 132 plant transplanted); true horn ends the list with 1.1% (i.e. 1 out of 95 plants transplanted). Statistically, the False horn showed a significantly higher mortality rate of plants in the nursery than the others (French and True horn).

In sum, the results obtained in the research showed that the technique derived from stem fragments (PIF) influenced the proliferation potential of plantain seedlings under semi controlled conditions of Gbado-Lite. However, this proliferation is highly dependent on cultivars. So, the French type explants stood out from the others (true and false horn types) by giving the number of higher seedlings. This confirms that the types of the cultivars respond differently to the PIF technique.

## IV. Conclusion

The overall objective of this work was to assess the capacity of plantain macro-propagation by applying the PIF technique (plants from stem fragments). To achieve this, the experimental device used was that of complete randomized blocks comprising 3 treatments (from three types of banana trees grown in Gbadolite) and 3 repetitions in a propagator containing sawdust.

This research showed that, dependently on cultivars, plants from stem fragment technique (PIF) influenced the proliferation potential of plantain seedlings under the agro-ecological conditions of Gbado-Lite. Although, the PIF technique influenced the suckering in a way strongly dependent on the cultivars, it can be popularized for these three types studied in order to promote banana cultivation in the agro-ecological conditions of Gbadolite.

Considering the aforementioned results, it becomes an absolute necessity that similar studies subsequently address the parameters not considered in this test, in particular the behavior of the suckers resulting from the PIF technique in the nursery on various substrates, in the fields, etc., with the possibility of extending them on other types of bulb plants.

## References

Bakry, F., Didier, C., Ganry, J., Bellec, le F., Lescot, T., Pinon, A., Rey, J.Y., Teisson, C. et Vannière, **H. (2006).** Les espèces fruitières. In Mémento de l'Agronome, p.p. 929 – 1021. CIRAD-GRET, Ministère des Affaires étrangères, (éds.), Montpellier, France,

Bangata B.M, Mobambo K.N, Kasongo N, Shungu D., Vuvu K., Vangu P., Omondi A., Staver C**. (2018).** Evaluation du potentiel prolifératif de six cultivars de bananier (cv, AAB, ABB et AAA) par macropopagation en République Démocratique du Congo, *Journan of Applied Biosciences 127 : 12770 - 12784*

Boye M., Turquin L., Gnahoua J.B.B., Coulibaly D.R., Akes et Anno A. (2010). Performances agronomiques de bananiers plantains Musa AAB cv corne 1 issus de rejets déshydratés pendant un mois. *Journal of Animal & plant sciences*, vol. 7, pp.767 – 778.

Cinna J.P., (2014). Fiche technique de la méthode PIF Programme ALTERBIO (INRA Antilles Guyane), Gladys LORANGER-MERCIRIS (Université des Antilles et de la Guyane), p.2

Dhed'a B., Moango, A. et Swennen R. (2011)**.** La culture des bananiers et les bananiers plantains en R.D. Congo, Support didactique, édition Saint Paul Afrique, Kinshasa, p.83.

Direction de l'agriculture (DAG), 2018. Fiche technique : La banane dessert et plantain Genre Musa, p.12

Dupriez H. et De Leener P. (2009)**.** Jardins et vergers d'Afrique, Terre et Vie, CTA, 360P.

Eboma **(2017).** Utilisation de procédé de recépage et sevrage en relation avec le moment de flambage sur le pouvoir rejetonnant de bananier plantain (Musa sapientum L.) à Gbadolite,

Esoma O. B. et Banza M. J. (2018). Analyse technique et économiques de la multiplication de bananier par la technique de plants issus de fragment de tige (PIF) à Lubumbashi, RD. Congo. *Afrique SCIENCE* 14(2):48 - 56

Institut Agronomique Néo-Calédonien (2012). Guide pratique Production de rejets de bananiers par la méthode P.I.F. (Plants Issus de Fragments de tiges). Association ARBOFRUITS

IPAGRI, **2020**. Rapport des activités agricoles.

Kwa M. (2003). Activation de bourgeons latents et utilisation des fragments de tige du bananier pour la propagation du masse de plants en conditions horticoles in vivo-fruit, PP 315 – 528.

Kwa M. (2009). La culture et la multiplication des plants de bananier (*Musa sp*), connaissances et techniques de base, CARBAP, RD. CONGO.

Kwa M. (2013). Technique horticoles de multiplication des masses de plantation, une innovation au service de développement, 19P.

Mairie de Gbado-Lite, Nord-Ubangi**, (2016)**. Rapport annuel.

Molongo M., Magbukudua J.-P., Mbango J.-P., Ngbangu G. et Monde G., (2015). Effet de flambage sur le pouvoir rejetonnant de quelques cultivars de bananier plantain (Musa sapientum L.) à GbadoLite, RD Congo.

Molongo, M., Ngbolua, J-P., Wayandiri, J-P., Ngbangu, G., Eboma, W., Mongbenga, G., Idikodingo, F. et Ngbuta, J., (2021). Etude de quelques indices biologiques de productivité de porc (*Sus domesticus* ; suideae) en élevage familial à Gbadolite en République Démocratique du Congo. Mouvements et enjeux sociaux. Numéro 118, juillet-septembre 2021. Kinshasa. pp15-22 ;

Ngo-Samnick E. L., (2011). Production améliorée du bananier plantain. Collection pro-agro, Pays-Bas.

Nguru M.K. (2014). Etude de la rentabilité du commerce des bananiers plantains en ville de Butembo

Mortinez R. et Saavedra R. (1999). Aspects socio-économiques de la culture du bananier plantain en Colombie.

Songbo, M. (2019). Relations entre le bananier plantain et le charançon de bulbe *Cosmopolites sordidus* Germar (Coleoptera *Curculionidae*) A Kisangani une perspective de lutte intégrée ; Thèse Présentée pour l'obtention du grade de Docteur en Sciences Agronomiques, Faculté de Gestion des Ressources Naturelles Renouvelables, Département d'Agronomie Générale, Université de Kisangani. 126p.