BirEx JOURNAL
Budapest International Research in Exact Sciences
Medical, Biological, Argiculture, Engineering
Science and other related areas
e-ISSN : 2655-7827
p-ISSN : 2655-7835
http://www.bircu-journal.com/index.php/birex

Influence of Temperature Couple and Steaming Time on the Viability of Plantain (Musa sapientum L.) Bulb in Kisangani, Democratic Republic of Congo

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Abstract: *The present study has for object to observe the influence of couple temperature and duration of the steaming on the rate of vitality of bulb of plantain in Kisangani in Democratic Republic of Congo. In the methodological framework, this study resorted to the steaming of plantain shoots likely to offer the dry heat as the flaming according to the couple temperature and duration to the steaming in the conditions in vitro at the following temperatures and durations: 50 °C; 80 and 100 °C during 1', 3 and 10'. The subjects were set up in a randomized block design. An agricultural greenhouse was set up in which the 3 blocks were arranged and the treatments were as follows: T01: control 1; T02; control 2; T03: control 3; T11: discharge steamed at 50 °C for 1'; T12: discharge steamed at 50 °C for 3'; T13: discharge steamed at 50 °C for 10'; T21: discharge steamed at 80 °C for 1'; T22: Discharge steamed at 80 °C for 3'; T23: Discharge steamed at 80 °C for 10'; T31: Discharge steamed at 100 °C for 1'; T32: Discharge steamed at 100 °C for 3'; T33: Discharge steamed at 100 °C for 10'. The substrate used was sawdust previously disinfected by boiling water at boiling temperature. He obtained the recovery rates of 90% (for the controls; the subjects steamed at 50 °C; 80 °C and 100 °C during 1'; at 80 °C and 100 °C during 3' and finally at 80 °C and 100 °C during 10') and 100% (for the control subjects; those steamed at 50 °C during 1 and 10'). Thus, the banana bulb subjected to 100 °C for 10' cannot lose its vitality.*

Keywords: *temperature; duration; steaming; bulb; Kisangani; Democratic Republic of Congo*

I. Introduction

Plantains, consumed in several forms, are central to the diet of the populations of intertropical regions. Depending on the country, in rural areas, plantains occupy between the first and fourth place in terms of food importance. Unlike dessert bananas, which are traded worldwide in a well-organized manner, plantain is not very present on international markets. Because of the potential for improved agronomic performance and food security issues in Africa, plantain cultivation is attracting increasing interest from government, agronomic research, and agribusiness companies (Kwa and Temple, 2019).

Research has begun to bear fruit. But research is not an end in itself. It needs to be positioned in a more encompassing framework that integrates the various aspects of the production-consumption chain. The socio-economic role of the different types of production chains has never been addressed on a global scale (Frison, 1999).

Moreover, unlike other food crops whose harvests are seasonal, bananas produce without interruption throughout the year. As such, bananas provide a stable, permanent and sustainable nutritional base, thus bridging the gap between seasonal crops and other crops. Another important aspect is the economic contribution of banana and plantain production in the villages as well as in the surrounding towns, bananas are a privileged source of income for millions of small producers, often the only source of income for many families. In some countries, bananas are not only a food crop. They are also an important source of fiber and bananas are fermented to produce alcohol (Frison and Suzanne, 1999).

The increase in demand for this commodity in the city would justify the development of production channels for the economic prosperity of peri-urban areas. However, banana and plantain trees have not always received the attention they deserve from researchers and development promoters. It is only in recent years that sustained efforts have been made, at the national and international levels, to catch up with this research backlog, and to address the main problems facing the development of these crops, particularly in terms of planting materials (Frison, 1999; Frison and Suzanne, 1999).

In the Democratic Republic of Congo, bananas are grown in all habitats (forest and savanna) and at different altitudes. Production is thus distributed throughout the country, on large and small farms. Cultivation is mainly practiced in home gardens, fallow land and open fields in the forest. Small-scale producers grow the plant mainly for self-consumption and for local markets. However, due to the ever-increasing population and urbanization in the country, bananas and plantains have also become an important cash crop that increases the household income of farmers. Apart from its use in human nutrition and its contribution to the income of farmers, there are several other uses of this crop. The fruits or other parts of the plant are used in animal feed, traditional medicine, and even in different socio-cultural contexts (Dhed'a et al., 2019).

In kisangani, the crop represents a major socio-economic-cultural importance as it is an integral part of a range of agrarian systems from hut farming to plantation agriculture. It is also used sliced and dried to make banana flour (Dhed'a et al., 2011; Dhedh'a et al., 2019).

Regardless of the importance of this crop, production is limited by several constraints, including insufficient planting material and the mastery of certain cultivation techniques (Swennen and Vuylsteke, 2001; Boyé et al., 2010; Ngo-Samnick, 2011; Manitu, 2012).

The development of banana cultivation requires an improvement in cultural practices and planting material (rejects). Farmers have great difficulty in obtaining sufficient planting material to increase the area under cultivation. There are several techniques of propagation of shoots. With natural propagation, practiced by the majority of farmers, it is difficult to obtain shoots in time and in sufficient quantity (Bakelana-ba-Kufimfutu and Mpanda, 2000).

To circumvent this bottleneck, the use of moderate heat, buckling, in situ on banana at least 4 months of planting has yielded favorable results by increasing the rejection power to over 200% (Molongo et al., 2015; Molongo et al., 2022). However, the notion of the influence of temperature and buckling time on the viability of the rejects has never been investigated in order to determine the optimal temperature for this technique.

For this reason, it was imperative to answer the main question according to which, what is the influence of couple temperature and duration to the steaming on the vitality of bulb of banana tree in the conditions ex situ?

Specifically, what is the day at 50% rejection under ex situ conditions?

This study tested the main hypothesis that even at a temperature of 100°C for 10'; the banana bulb would retain its vitality and specifically, a period of less than 20 days of day at 50% rejection under ex situ conditions would be recorded.

The overall objective of this study is to investigate the effect of temperature and steaming time on the vitality of ex situ plantain corms in order to determine the buckling temperature.

II. Materials and Methods

2.1 Research Site

The present study was conducted in the laboratory of the Institut Facultaire de Yangambi in Kisangani, Tshopo Province, and Democratic Republic of Congo. The geographical coordinates of the concession taken by GPS are the following: East longitude: 25° 9' 50"; North latitude: 0° 30'46"; an altitude of 399 m.

2.2 Materials

The material that was the object of this study was the plantain tree from a local cultivar taken from the farmers' fields in the Lubuyabera sector at PK 18, Buta road; type Faux corne, Ambulu. For this experiment, we used bayonet shoots with a diameter of about 7 cm and a length of 30 cm reduced to 15 cm, which are regularly used by farmers because of their high recovery rate as shown in Figure 1.

Figure 1. *Diet, Bayoneted Shoots of Angbulu Cultivar and Selection According to Corm Size*

The rejects were studied according to the temperatures and durations of the treatments. The illustration is engraved by figure 2.

Figure 2. *Oven and Steaming of Plantain Chips in the Laboratory of IFA Yangambi (DRC)*

Potassium Permanganate (70%) was used to disinfect the knife during the weaning operation of the plantain chips.

2.3 Methods

In the methodological framework, this study used the oven for the steaming of plantain shoots that could offer dry heat as well as flaming according to the couple of temperature and duration of steaming under in vitro conditions at the following temperatures and durations: 50 °C; 80 and 100 °C during 1', 3 and 10'.

The subjects were set up in a randomized block design. An agricultural greenhouse was set up in which the 3 blocks were arranged and the treatments were as follows: T01: control 1; T02; control 2; T03: control 3; T11: discharge steamed at 50 °C for 1'; T12: discharge steamed at 50 °C for 3'; T13: discharge steamed at 50 °C for 10'; T21: discharge steamed at 80 °C for 1'; T22: Discharge steamed at 80 °C for 3'; T23: Discharge steamed at 80 °C for 10'; T31: Discharge steamed at 100 °C for 1'; T32: Discharge steamed at 100 °C for 3'; T33: Discharge steamed at 100 °C for 10'.

The substrate used was sawdust previously disinfected by boiled water, the rejects were waxed by candle to inhibit the apical growth of the mother stem in an agricultural greenhouse; the rejects emitted were weaned as shown in Figure 3.

Figure 3. *Substrate Disinfection, Shoot Placement, Weaning in an Agricultural Greenhouse at IFA Yangambi (DRC)*

This study observed the following parameters: recovery rate (in %) = (Number of recovered shoots)/(Total number of planted shoots) x 100 (Molongo et al. 2022); height of weaned shoot using tape measure; diameter of weaned shoot corm using caliper; number of weaned shoot leaves and number of shoots emitted per bulb using counting.

The results were analyzed by Excel and IBM SPSS 20 software; single criterion analysis of variance was used for classification with sampling, the F Snedecor test was adopted in order to identify the significant difference between the means; the Tukey test in order to detect smaller significant difference and to group the treatments.

III. Discussion

3.1 Results

a. Recovery Rate

The recovery rate is presented by Figure 4.

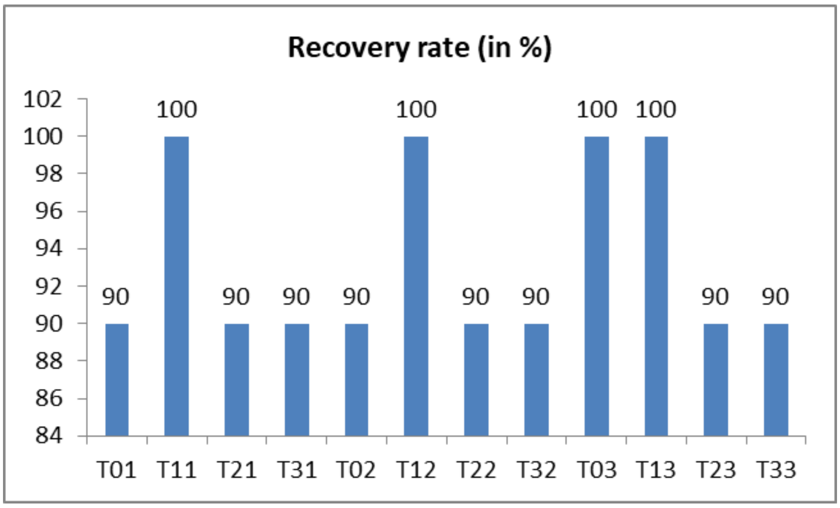

Figure 4. *Recovery Rate*

Figure 4 shows that some treatments gave a recovery rate of 90%, including controls and rejects steamed at 50-100°C for 1-10 minutes; still other controls and rejects steamed at 50-100°C for 1-10 minutes gave a recovery rate of 100%. Such recovery, especially for rejects steamed at 100°C for 10', confirmed that banana is resistant to heat injury due to its water enrichment.

b. Height of Weanlings

The height of weanlings is presented in Figure 5.

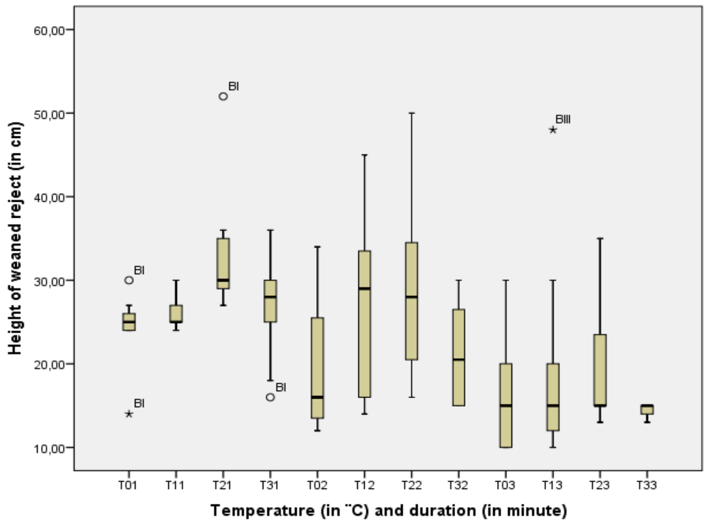

Figure 5. *Height of Weaned Shoots (in cm)*

From this experiment, it is clear that the height of weaned shoots varied between 14.50 cm and 33.22 cm respectively for shoots steamed at 100 °C for 10' and those steamed at 80 °C for 1 minute.

c. Corm Diameter of Weaned Offspring

The corm diameter is presented in Figure 6.

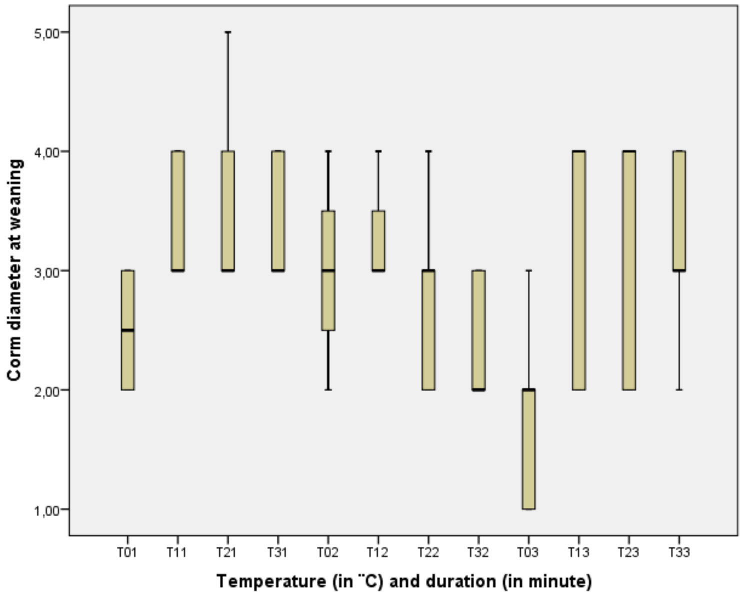

Figure 6. *Cormus Diameter (in cm)*

The results in this study showed that the average cormus diameter of weaned rejects ranged from 1.90 cm and 3.44 cm respectively for control and rejects subjected to steaming at a temperature of 80°C for 1 minute.

d. Number of Leaves per Weaned Shoot

Figure 7 shows the number of leaves per weaned shoot.

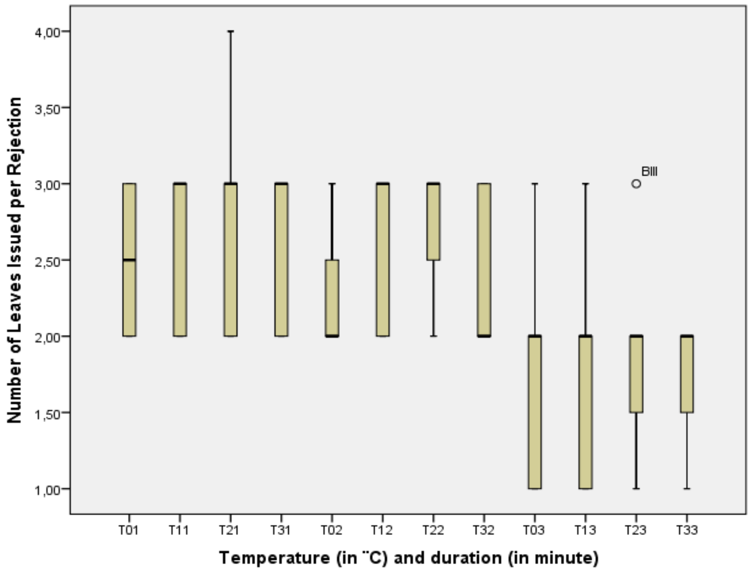

Figure 7. *Number of Leaves per Weaned Shoot*

During this experiment, it was observed that the weaned shoots were those with 2 and 3 leaves, i.e. those that were steamed at 100°C for 10 minutes. The result confirmed that the banana tree, even at 100°C for 10 minutes under heat, maintains its vitality and physiological activities, particularly foliage and photosynthetic activity.

e. Number of Shoots per Corm

The number of shoots per bulb is recorded in figure 8.

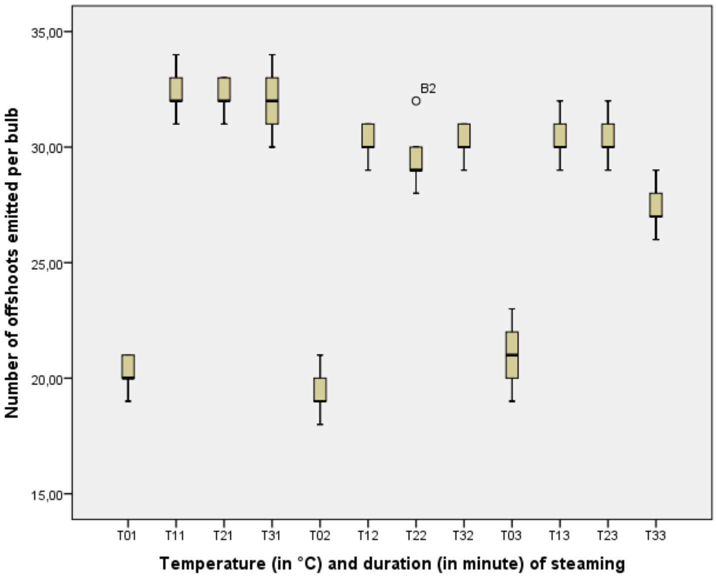

Figure 8. *Number of Offshoots per Corm*

Figure 8 showed that the bulbs that produced fewer rejects (19-21) were the control bulbs, but those that were steamed or subjected to heat, at temperatures ranging from 50°C to 100°C for 1 and 3 minutes, produced many rejects (27-32). This result confirms that dehydration of banana rejects from steaming is favorable for crop operation and rejection power in order to avoid loss of production time of propagating materials.

3.2. Discussion

The recovery rate varied between 90 and 100% for all treatments. Such a rate indicates the level of heat resistance of the banana tree on the one hand, and on the other hand, the level of rigor in the selection of planting materials during this study. It is observed that this capacity of resistance is related to the high content of water in the stip of the plant. This result confirms the hypotheses that banana could be classified as a megatherm plant, i.e., capable of maintaining its vitality under high temperature (Molongo et al., 2015; Molongo, 2022).

The recovery rate during this study was higher than 78.3% obtained by Molongo et al. (2022) but lower than 100%, the one obtained under optimal culture propagation conditions (Lassourdière, 2007). The conservation of the viability of banana planatin shoots during this study corroborates with the result obtained by the manipulation of the technique that consisted of trimming and immersing them in boiling water at 100°C for 30 seconds in order to eliminate nematodes, weevils or any other external parasite (Bizimana et al., 2012).

As for the recovery rate, Tukey's test concluded as follows depending on the temperature: 80°C Control 100°C 50°C however depending on the duration of the steaming, we retain 3' 1' 10'. This means that although there is a numerical difference in recovery rate in relation to temperature and steaming time, the results are similar.

The bulb diameter of the weaned shoots in this study following the post hoc test informed that the steamed subjects presented a similar diameter to that of the control subjects.

It was observed that the steamed rejects were generally taller than the controls. These results are in line with those obtained by Boyé et al. (2010) who observed that the analysis of the responses of banana plants showed that only the height of the individuals from the scaled offshoots was sensitive to water stress. Indeed, the 15-day water wake-up caused a significant increase in the height of banana plants from dehydrated scapes compared to the control banana. The one month water stress seems to induce an increase in the height of banana plants from plantain scions.

It has been shown that dehydration of one month of banana rejects has a beneficial effect on growth; this can be explained by a stimulation of metabolic processes. This justifies the increase in the size of banana plants from dehydrated rejects. This action could be exerted on the hormones that contribute to the growth and development of the shoots (Boyé et al., 2010).

Mazinga et al. (2014) noted that temperatures influence growth parameters such as height, leaf area and pseudotruncular diameter.

The seedlings were weaned while they had at least two to three true leaves to allow for proper physiological functioning of the plant. Regarding the number of leaves in both control and weaned seedlings, Tukey's test showed that the difference was not significant. The number of leaves in weaned plants was similar to that found by Bizimana et al. (2012), according to which weaning took place when the shoots reached the 3-leaf stage and they were transplanted into bags in the nursery.

It was observed that the start of shoot emission occurred after 15 days in the steamed shoots following dehydration but after 15 days, i.e. 25 days after the shoots were placed in the propagator in the controls; these results were almost similar to 18 days of bud initiation, which is faster for the 4-slit treatment than for the non-slit subjects, in which there is less competition between the buds.

In view of these results, it is confirmed that the slit subjects gave a higher number of rejections than the controls or the non-slit subjects following the excitation of the dormant eyes by heat. This response shows sufficiently that heat is one of the activators of the rejection power of plantain. This response is due to a factor that remains to be elucidated. These results corroborate with those according to which dehydration acts in the sense of lifting the dormancy of the apical meristem of the shoots by promoting a harmonious development of the banana plants by activation of the basal metabolic functions (Boyé et al., 2010).

The number of releases per bulb for control subjects ranged from 19 to 21 however the number of steamed releases per bulb ranged from 27 to 32 releases. This production ranged from 15 to 60 releases that a bulb can produce depending on the quality of the release and the variety, for approximately 4 to 5 months (Lescot and Staver, 2014). This production was far higher than 5 and 13 releases (Bonte et al., 1995; Meutchnieye, 2009; Koné et al., 2010; Lyadunga et al., 2020; Molongo et al. 2022); between 12 to 18 releases obtained at two months after the destruction of the apical meristem (Koné et al., 2011).

However, Noupadja et al. (2007) found 2 shoots for French rouge 03 and 6 shoots per bulb in the cultivar Mbaï. But the number of rejections was less than or equal to 44 rejections; 32 rejections and 30 rejections respectively for French, true and false horn types using the PIF technique (Molongo et al., 2023).

The increase in offshoots was due to the removal of the apical meristem that was inhibiting them; these results corroborate the thesis that the destruction of the meristem of banana plants leads to high offshoot production compared to controls. The number of offshoots increased with the age of the plantains. These results are in agreement with 10 to 12 shoots in 7 - 8 months and 12 shoots in 9 months (Boyé et al., op. cit).

It should be noted that all the techniques used had as a particularity the destruction of the meristem. These authors have suggested the presence of hormonal agents in plantain, notably gibberellic acid, which promotes the lifting of dormancy in young buds, and auxins, which inhibit their development (Koné et al., 2011).

In view of these results, it should be noted that steaming has improved the rejection capacity of plantain in the same way as flaming by lifting the dormancy that constitutes one of the constraints to the perennial production of plantain (Noupadja et al., 2007).

IV. Conclusion

The objective of the present study was to observe the effect of temperature and steaming duration on the viability of plantain (Musa sapientum L.) corms in Kisangani, Democratic Republic of Congo. The rejects were steamed according to the temperature and duration of steaming and the following results were obtained:

The recovery rate obtained was 90% notably in control subjects and in those who were steamed between 50 and 100 °C for a period of 1 to 10 minutes and other controls and other test rejects or those subjected to steaming between 50 and 100 °C for 1 and 10 minutes gave 100%.

The day at 50% rejection was less than 20 days be at 15 days after placement.

Considering the importance of cultivation and research, we suggest that the effect of temperature and steaming time on the rejection capacity of plantain ex situ be tested.

Acknowledgements

We express our gratitude to Professors Dowiya Benjamin, Ngama Faustin, Monzenga Jean-Claude, Solia Sylvain and Mamba Greg for their guidance and to our collaborators Guy Diko, Ebwa Joël, Guillain Bolondo, Angafahune Jérémie, Paul, Mbeli le Chimiste, Gustave Apilima Ngadoa, Felengamo Mandela, Pablo and Kitoko for their contribution; to Eric Ngbangu for his connection and to WAVE IFA Yangambi for his logistical support.

References

Bakelana-ba-Kufimfutu et Mpanda, 2000. Méthode de multiplication des bananiers par décorticage de la souche. Iinfomusa, Vol 9, N° 2 ; 26-27.

Bizimana S., Ndayihanzamaso P., Nibasumba A. et Niko N., 2012. Conduite culturale et Protection du Bananier au Burundi. Publication ISABU : Référentiel sur la culture du bananier ISABU Avenue de la Cathédrale BP 795 Bujumbura Burundi. 57p.

Bonte E., Verdonck R. et Gregoire L., 1995. La multiplication rapide de bananier et du plantain au Cameroun. Tropicultura, 13, 3, 109-116

Boyé M.A.D., Turquin L., Gnahoua J.B.G., Coulibaly D.R., Aké S. 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, 2010. Vol. 7, Issue 1: 767- 778. ISSN 2071 – 7024.

Dhed'a B., Moango A. et Swennen R., 2011. La culture des bananiers et des bananiers plantains en RD. Congo. Support didactique, Edition Saint Paul Afrique, Kinshasa. 85p.

Dhed'a D., Adheka, G., Onautshu, O., Et Swennen, R., 2019 : La culture des bananiers et plantains dans les zones agro-écologiques de la République Démocratique du Congo, Presse Universitaire UNIKIS, Kisangani, 72p.

Frison E. A. and SharrockS., 1999. The economic, social and nutritional importance of banana in the world in Les productions bananières : un enjeu économique majeur pour la sécurité alimentaire International symposium, Douala, Cameroon, 10-14 November 1998. Inibap, 21-35. DOI: 10.13140/RG.2.1.2820.9123.

Frison E.A., 1999. Allocution d'ouverture de M. le Secrétaire Général représentant le Ministre de la Recherche Scientifique et Technique ; Allocution d'ouverture du Centre technique de coopération agricole et rurale (CTA) in Les productions bananières : un enjeu économique majeur pour la sécurité alimentaire International symposium, Douala, Cameroon, 10-14 November 1998. Inibap, 9-15. DOI: 10.13140/RG.2.1.2820.9123.

Koné T., Koné M., Koné D., Kouakou T.H., Traore S. et Kouadio Y.J., 2010. Effet de la photopériode et des vitamines sur la micropropagation du bananier plantain (Musa AAB) à partir de rejets écailles de rang1. Journal of Applied Biosciences 26: 1675 – 1686 ISSN 1997–5902.

Koné T., Koné M., Koné D., Traore S. Et Kouadio J.Y., 2011. Multiplication rapide du bananier plantain (Musa spp. AAB) in situ : une alternative pour la production en masse de rejets. Agronomie Africaine 23 (1) : 21 – 31.

Kouamé N., Dick A., Assidjo N. et Anno A., 2014. Étude de la croissance du bananier plantain (Musa sp., AAB, cultivar Corne 1) dans les régions de Yamoussoukro et Azaguié (Côte d'Ivoire). Journal of Applied Biosciences, 76 : 6411–6424.

Kwa M. et Temple L., 2019. Le bananier plantain Enjeux socio-économiques et techniques, expériences en Afrique intertropicale. Éditions Quæ, CTA, Presses agronomiques de Gembloux. 199 p.

Lassoudière A., 2007. Le bananier et sa culture, Edition Quae Rd 10,778026, Versailles, cedex, France, 384p.

Lescot T., Staver C., 2014. Les bananes, les plantains et d'autres espèces de la famille des Musacées (Musaceae) in La multiplication de matériel de plantation de qualité pour améliorer l'état sanitaire et la productivité des cultures : Pratiques clefs pour les bananiers et les bananiers plantains. ISBN: 978-92 9255-015-8. Pp 17-35.

Lyadunga M., Mihigo R., Kasole H., Barhakenera B., Bugabo B. and Ntamwira B. 2020. Etude comparative de la production de rejets par la méthode de macropropagation des quatre variétés de bananiers (Musa spp.) à Mushweshwe [Comparative study of discard production by the macropropagation method of four varieties of banana (Musa spp.) in Mushweshwe]. International Journal of Innovation and Scientific Research ISSN 2351-8014 Vol. 47 No. 2 Mar. 2020, pp. 80-90.

Manitu M. Le secret de la culture intensive, édition intelligencia, 1ère rue Limete Médiatique/Kinshasa. 2012 ; 62.

Mazinga K., Useni S., Nyembo K., Kasongo L., Tshitungu B., Kapenda D., Mario G., Julien L., Baboy L. et Van K., 2014. Etude de l'acclimatation en serre de vitroplants de bananiers de la FHIA: «cas de FHIA-01 AAAB et FHIA23 AAAA». Journal of Applied Biosciences 73:5911– 5924 ISSN 1997–5902.

Meutchieye F., 2009. Fiche technique pour la multiplication des bananiers par la méthode de PIF plants issus des fragments des tiges. Manuel de formation pour les communautés rurales. Édition TerrEspoir Cameroun.15p.

Molongo M, Gbelegbe J, Ngalakpa H, Idikodingo F, Ambwa J, Walengo P, Mongbenga G, Bangambingo D, Angafahune J, Bolondo G, Ebwa J, Litucha A, Okungo A, Monde G and Songbo M, 2023. Influence of Planting Techniques from Stem Fragments (PIF) in Relation To Plantain (Musa Sapientum L.) Cultivar Types on Rejection Power in Gbadolite, Democratic Republic of Congo. Elixir Applied Botany 175 (2023) 56690 – 56696. ISSN : 229-712X.

Molongo M., 2022. Effet de flambage sur le pouvoir rejetonnant de bananier plantain (Musa sapientum L.) in situ et perspectives d'avenir de la technique en République Démocratique du Congo. Editions Universitaires Européennes. ISSN 9786203444346. 65p.

Molongo M., Magbukudua 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 Gbado-Lite, RD Congo. Annales de l'Institut Facultaire des Sciences Agronomiques de

Yangambi, Vol. 4(2), 2015 : 142-155© 2015 Publications scientifiques, IFA-Yangambi, République Démocratique du Congo.

Molongo M., Magbukudua J.P., Ngbangu G., Eboma W., Mongbenga G., Idikodingo F., Zua T., Ngor N., Songbo M. et Monde G., 2019. Effet de flambage sur le rendement de trois cultivars de bananier plantain (Musa sapientum L.) à Gbadolite en République Démocratique du Congo. Mouvements et Enjeux Sociaux, Revue de la chaire de dynamique sociale de Kinshasa. Numéro 111. Pp 21-27.

Molongo M., Ngbolua N., Muhammad R., Taffouo V., Songbo K., Litucha B., Okungo L. and Monde K., 2022. Effects of Compost and Buckling on the Rejection Capacity of Plantain (Musa sapientum L.) under the Eco-climatic Conditions of Gbado-Lite, Democratic Republic of the Congo. Britain International of Exact Sciences (BIoEx) Journal ISSN: 2686-1208 (Online), 2686-1216 (Print) Vol. 4, No. 3, 149-161.

Ngo-Samnick E.L., 2011. Production améliorée du bananier plantain. Cameroun (ISF Cameroun) et du Centre technique de coopération agricole et rurale (CTA). CTA – P.O. Box 380 – 6700 AJ Wageningen – Pays-Bas – www.cta.int. ISF Cameroun – BP 7105 - Douala-Bassa - Cameroun – www.isf-cameroun.org © CTA et ISF 2011 ISBN (CTA) : 978-92-9081-471-9.CTA-PO. 24 p.

Noupadja P., Tomekpe K. et Youmbi E., 2007. Evaluation d'hybrides tétraploïdes de bananiers plantains (Musa spp.) résistants à la maladie des raies noires créés au Cameroun. Fruits, 2007, vol. 62, p. 77–88. DOI: 10.1051/fruits:2007001.

Swennen R. et Vuylsteke D., 2001. Bananier (Musa L.) in Agriculture en Afrique Tropicale, Raemaekers, R.H., 2001, Direction Générale de la Coopération Internationale, Ministère des Affaires Etrangères, du Commerce Extérieur et de la Coopération Internationale, Bruxelles, Belgique, pp. 611- 637.