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Effect of Flaming Period on the Rejection Power of Plantain (Musa Sapientum L.) in Situ at Gbadolite in the Democratic Republic of Congo

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Abstract: *The present study was carried out to observe the effect of buckling periods on the rejection power of plantain (Musa sapientum L.) in situ at Gbadolite in the Democratic Republic of Congo. The experimental set-up chosen was that of randomized complete blocks comprising 4 blocks and 4 treatments arranged in single rows; the subjects were planted at distances of 3 m x 3 m. The treatments were as follows: T0: Untreated or non-flambé subject; T1: Flambé subject at 2 months from planting; T2: Flambé subject at 4 months and T3: Flambé subject at 6 months from planting. Each plot consisted of 10 plants. Flambéing was carried out according to the flambé period, by mowing and assembling the dry phytomasses around the test plants, and finally, incineration by running fire or moderate heat, "flambage" during the cool moment to avoid plant death due to temperature rise. It was observed that the temperature varied between 27.17°C and 28.95°C before flaming and between 72.50°C and 73.25°C during flaming. An average of 6 shoots per bulb were counted for the controls, and 15, 18 and 23 shoots for the flamed corms at 2, 4 and 6 months of planting, respectively, under in situ conditions. In this study, the flaming process, in relation to the period of its application, increased the rejection rate to 150%, 200% and 283.33% respectively for subjects flamed at 2, 4 and 6 months. Examination of all the parameters studied reveals that the agro-ecological zone of Gbadolite in the Democratic Republic of Congo, with uni-modal rainfall, clayey-sandy soil, with the flaming technique constitutes in combination with the period of application one of the factors activating the rejection power of plantain.*
Keywords: *buckling; age; rejection; plantain; gbadolite; democratic republic of congo*

I. Introduction

The banana plant is so important that its many uses are uncounted, giving it a central place in the farming systems of many regions (Gatsinzi, 1987).

Banana-based production systems in the Great Lakes region are fundamental to the many subsistence systems, occupying an essential place in the diet and contributing to the national economy. As an important source of vitamins and minerals, and accounting for more than half of daily calorie consumption, they make a major contribution to the food security and nutrition of millions of people. Proceeds from banana sales are often used to finance schooling and health expenses, and also serve as a bank deposit, enabling the rural poor to contribute to social and community activities. Combined with other crops, they help prevent soil erosion in fragile ecosystems while requiring less labor, an important consideration for people living with HIV (FAO, 2012).

Bananas rank fourth in the list of important foodstuffs after rice, wheat and milk. Their sugar-rich flesh is a nutritious food (Swennen and Vuylsteke, 2001, Kumar, 2017). In addition to human consumption, bananas are a source of carbohydrates. The by-products are used to feed domestic animals and make household and craft items such as carpets, baskets, curtains and under-dishes (Besse, 1969).

As cultivated banana plants are triploid, they are generally propagated vegetatively (FAO, 1996). This method of propagation is very limited for large plantations (De Langhe, 1961). One of the major constraints limiting the expansion of plantain cultivation is the lack of planting material (Boyé et al., 2010; Ngo-Samnick, 2011; Manitu, 2012).

The rapid multiplication of banana planting material requires the development of appropriate techniques to encourage the production of offshoots with a view to planting the field. For this reason, several methods have been tested to overcome these constraints, including the normal multiplication method, which consists in removing the basic shoots from the mother plants and planting them elsewhere, a simple technique but with a major drawback: the very low rate of multiplication material; pseudo-trunk bending; ridging; true or false decapitation, which consists in removing apical dominance to increase the shoots rate (De Langhe, 1961; Dhed'a et al., 2011).

Molongo et al. (2015) and Molongo (2022) evaluated the performance of moderate heat or flaming on rejection power, and the results showed that flaming has a significant rejection effect that can increase rejection by more than 100% compared with the control.

The present study investigated the influence of the buckling period on the rejection power of plantain in situ.

This study seeks to answer the main question: what is the optimum buckling period for plantain in situ?

Specifically, is the rejection power proportional to the period during which the technique is applied in situ?

It seems that the optimum period for applying this technique would be at least four months after planting, and that the rejection power would be proportional to the buckling period.

II. Review of Literature

2.1. Study Site

The three trials were tested in Gbadolite, in the province of Nord-Ubangi, in the Democratic Republic of Congo.

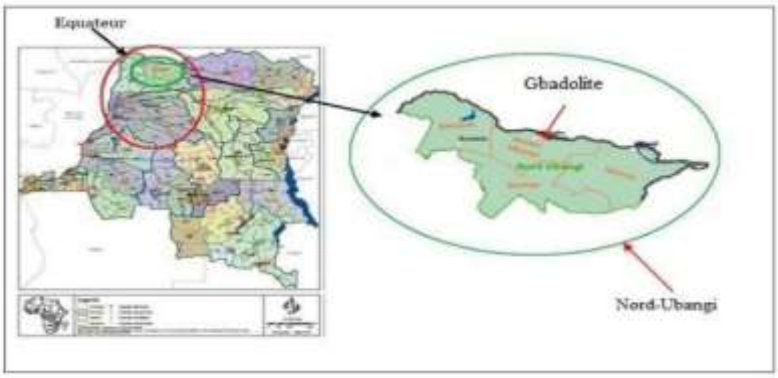

Figure 1. *Town of Gbadolite (Ngemale, 2015)*

The town's geographical coordinates were as follows: 4°15'44" Latitude North and 20° 59'5" Longitude East, with an altitude of 394.02 m. The topography of the town of Gbadolite is made up of plateaux, hills and plains, and the climate is Aw2 according to Köppen's classification (FACET, 2010).

The soil is clayey-sandy, rainfall is relatively abundant with an annual average of over 1,600 mm, insolation is low, representing 45% of total tropical energy radiation (Molongo et al., 2015). Direct solar radiation intensity is 25 g calorie/cm²/minutes (Molongo et al., 2019).

The vegetation of the town of Gbado-lite was constituted by equatorial evergreen rainforest following the anthropogenic effects exerted on this forest, the vegetation is reworked by savannah dominated by Imperata cylindrica, Pennisetum sp, Chromolaena odorata, Pannicum maximum, Mimosa pudica (Molongo et al., 2022).

2.2. Materials

For this study, the local cultivar Wangala-wangala or Ngbangele, type faux-corne, was chosen as test material.

The Wangala-wangala or Ngbangele cultivar and its diet are shown in Figure 2.

Figure 2. *Ngbangele or wangala-wangala diet, false horn type (Molongo et al., 2022)*

III. Research Method

3.1 Experimental set-up

The experimental field was set up on a grassy savannah with a width and length of 30 m and 72 m respectively, i.e. 2160 m2 colonized by grasses and legumes. The experimental set-up chosen was that of randomized complete blocks comprising 4 blocks and 4 treatments arranged in single rows. Subjects were planted at distances of 3 m x 3 m. The blocks were separated by a 6 m strip, half of which was occupied by a non-test subject, namely the French Yongo cultivar.

Following the flaming period, the shoots were received 15 cm from the ground, and the almost dry phytommasses were piled up under the feet of the test banana trees in a 20 cm layer with a 50 cm radius during the cool season, especially in the evening around 4 p.m. local time, in order to avoid fire and hyperthermia, which are limiting factors for the vitality of plantain bulbs. The final step is to ignite or flambé the bulb using a match, taking care to record the temperature before and during flambéing. The duration of flaming was estimated at 3 minutes.

The treatments were as follows: T0: Untreated or non-flambé subjects, i.e. no flambéing; T1: Flambéed subjects at 2 months after planting; T2: Flambéed subjects at 4 months after planting; T3: Flambéed subjects at 6 months after planting.

Each plot consisted of 10 plants, of which 7 were selected as samples, i.e. 70% of the population. The cultivation techniques used included staking, hole-digging, planting, weeding and ridging. Figure 3 shows the flaming techniques used at Gbadolite in the Democratic Republic of Congo.

Figure 3. *Strip radius, height and width.*

3.2. Observed parameters

The following parameters were observed: ante-buckling temperature and temperature at buckling using a bimetal (mercury) thermometer; diameter of the pseudo-trunk base of the mother shoot using a caliper; height of the mother stem using a tape measure; leaf length to width ratio and number of shoots formed per bulb.

3.3. Statistical methods

Data from this study were analyzed using SPISS Statistics IBM 20 software. Single-criterion Analysis of Variance classification was performed using the Snedecor F test for significant difference (Spiegel, 1992) and the Tukey test.

IV. Results and Discussion

4.1 Soil temperature before buckling

Pre-buckling temperatures were taken and the results are shown in figure 4.

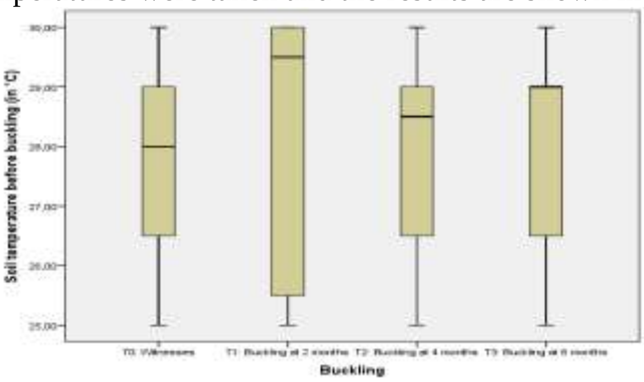

Figure 4. *Ante-post buckling temperature.*

This study shows that the pre-buckling soil temperature varied between 27 and 28°C under in situ conditions at Gbadolite.

4.2 Buckling temperature

The temperature at buckling was observed and the results are shown in figure 5.

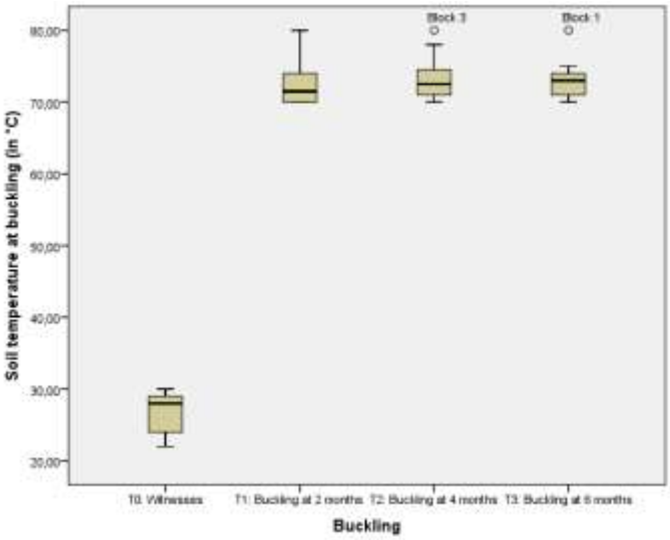

Figure 5. *Buckling temperature (in °C).*

The results for this parameter show that the buckling temperature varies between 72 and 73°C at buckling, compared with 26°C for the controls.

4.3 Pseudotrunk diameter

Pseudotruncated diameter was measured and the results are shown in figure 6.

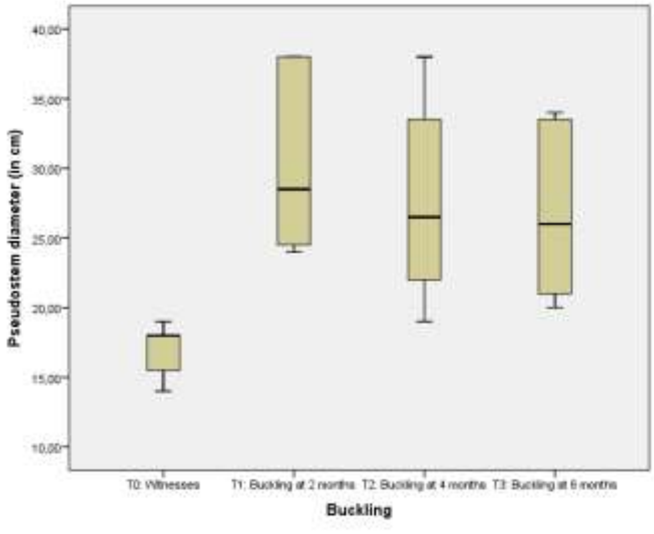

Figure 6. *Pseudostem diameter (in cm)*

It can be seen from this figure that the mother stems were 17.00 cm; 30.33 cm; 27.58 cm and 26.67 cm in diameter respectively for the control subjects and the subjects flamed in situ at 2 months, 4 months and 6 months after planting.

4.4 Height of mother stem before buckling

The height of the mother stem was observed and the results are shown in figure 7.

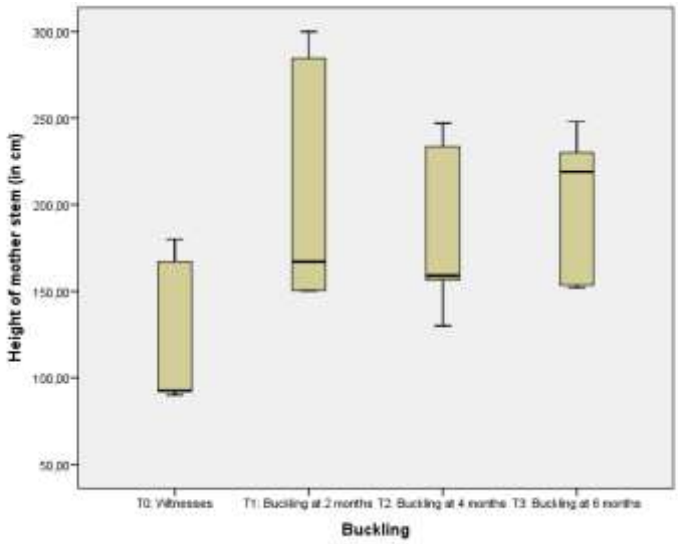

Figure 7. *Height of mother stem (in cm)*

From the results in Figure 7, it can be seen that the height of the mother stem varied between 119.00 cm for controls; 202.17 cm for flamed plants at 2 months; 184.25 cm and 201.75 cm for flamed plants at 4 and 6 months of planting respectively.

4.5 Length-to-width ratio

The ratio of leaf length to width was assessed and the results are shown in figure 8.

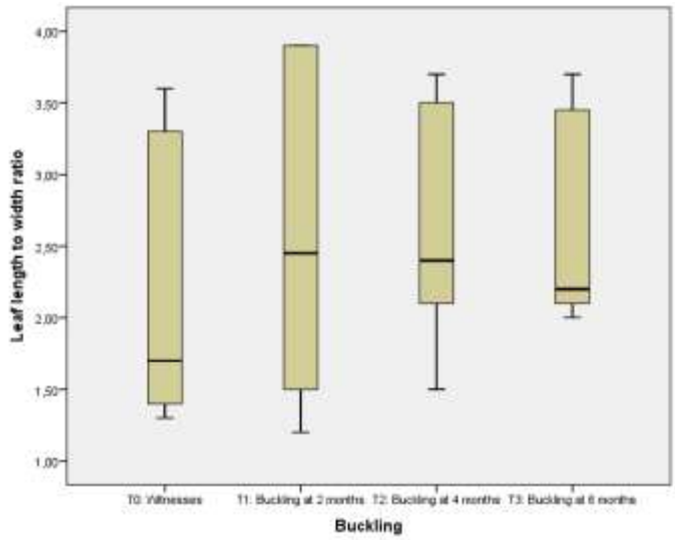

Figure 8. *Length-to-width ratio*

The leaf length to width ratio ranged from 2.18 to 2.63. In other words, the control subjects had narrower leaves than the flamed subjects.

4.6 Number of shoots per bulb

The shoots were counted and the results are shown in figure 9.

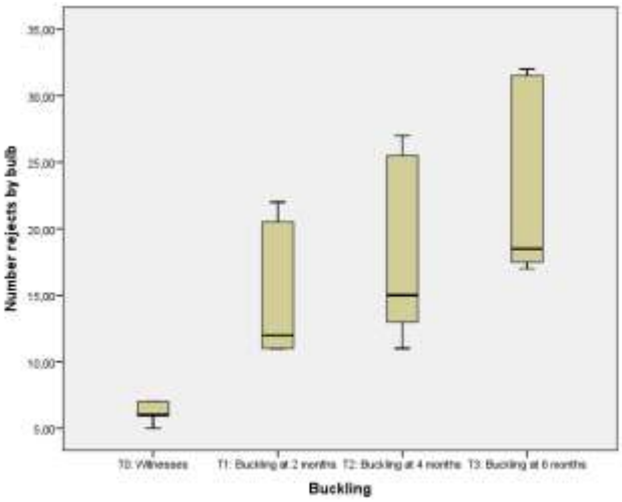

Figure 9. *Number of shoots per bulb*

An average of 6 shoots per bulb were counted for controls, and 15, 18 and 23 shoots for flambe corms at 2, 4 and 6 months of planting respectively, under in situ conditions in Gbadolite, Democratic Republic of Congo.

4.7. Discussion

Soil temperature before flaming varied between 27.25°C and 28.25°C; temperature higher than 27°C; that recorded in the evening during cool moments by Molongo et al. (2022).

During buckling, it emerged that the temperature varied between 72.50°C and 73.00°C, a temperature lower than 77.67°C observed by Molongo et al. (2019). Whatever the temperature fluctuation, it could not damage the plant because it is waterlogged, which enabled it to withstand this temperature range; for this reason, banana can be classified as a megatherm plant (Molongo, 2022).

In terms of vegetative parameters, the basal diameter of the pseudo-trunk, the height of the mother stem, the vegetative index and the ratio of length to leaf width of the test subjects were greater than those of the controls. This was due to the combined effect of heat and mineral matter, which contributed to the mobilization of growth regulators in line with the physiological processes of plant growth and development due to the setting of growth cell bases as noted by Dhed'a et al. (2011).

It was observed that more shoots were counted on the flambé strain than on the control; the shooting power was proportional to the planting period. This is justified by the fact that at this age, i.e. after 4 months of planting, the banana plant has developed its corm sufficiently to produce many dormant eyes that can be budded under the influence of flambé to give rise to shoots as planting material (Swennen and Vuylsteke, 2001; Molongo et al., 2022).

In this study, it was observed that the period of application of the technique contributed to the increase in rejection rates to 150.00%; 200.00% and 283.33% respectively for subjects flamed at 2, 4 and 6 months in the agro-ecological conditions of Gbadolite. The single-criterion analysis of variance classification without sampling and the Snedecor F test at the 5% probability threshold showed a significant difference between treatments, and the Tukey post hoc test concluded as follows: T0 T1 T2 T3. This means that the best treatment period was that of 6 months, which is no different from that of 4 months of planting; it is no different from that of 2 months of flaming after planting, and these are different from controls. From 4 months onwards, at this age, plants have developed corms with many eyes whose dormancy has been lifted by flaming, and which have evolved into shoots used as planting material.

The number of shoots in our conditions was less than 33 and 34 respectively for flambé subjects (Molongo et al., 2015); but greater than 3 and 9 plants per strain (Meutchieye, 2009; Lokossou et al., 2012). In addition, we note that the best response of cormus to this technique, notably at 6 months of application, provided the number of shoots between 21 and 32 shoots, a result superior to 7 shoots obtained after 6 months by vegetative propagation in the field but less than 40-60 vivo plants and still far less than 1000 obtained at 6 months in in vitro culture (Kouassi et al., 2005).

The best period for applying the technique in this study was 6 months, but it can be applied even to 4 months of planting, according to statistical analysis of the results under our agricultural conditions. This technique not only provoked the induction and bud break of numerous dormant buds, but also constituted a thermotherapeutic control against bio-aggressors, in particular banana black weevils, Cosmopolites sordidus, as stipulated by Aubertot et al. (2006), on the one hand, and Appert and Deuse (1982) and Autrique and Perreaux (1989), on the other, which must be destroyed by burning plant debris, in particular infested roots.

V. Conclusion

A study was carried out to determine the optimum period for in situ flaming on the rejection power of plantain under the agro-ecological conditions of Gbadolite in the Democratic Republic of Congo.

The results suggest the following situation:

- An average of 6 shoots per bulb were counted for the controls, 15 shoots; 18 and 23 shoots for the flamed corms respectively at 2, 4 and 6 months of planting under in situ conditions;
- The following vegetative indices were obtained: 5.83 for controls; 6.57; 9.00 and 9.8 for flamed plants at 2, 4 and 6 months respectively;
- This shows that the optimum period for using this technique to produce shoots as planting material is 6 months after planting.

The following suggestions were made:

- That such a study be carried out under in vitro conditions to screen for the growth hormone responsible;
- That observation of the effect of temperature and steaming time on the vitality of plantain corms be at the heart of this investigation;
- A study of the response of plantain types to buckling should be carried out.

References

Appert J. et Deuse J., (1982). Les ravageurs des cultures vivrières et maraichères sous les tropiques. Maisonneuve et Larose et A.C.C.T., Paris, 420p.

Aubertot J.N., Colbach N., Félix I., Munier-Jolain N., Roger-Estrade J., (2006). La composante biologique in Doré T., Martin P., Ney B., Roger-Estrade J., Coord. L'agronomie aujourd'hui. Edition Quae. Pp 199-224.

Autrique A. et Perreaux D., (1989). Maladies et ravageurs des cultures de la région de grands lacs d'Afrique centrale. Place du champ de Mars, 5 Boite 57 B. 1050 Bruxelles. 232 p.

Besse, J., (1969). L'alimentation du bétail, Bussière, Saint-Amand (Cher). 365p.

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. http://www.biosciences.elewa.org/JAPS; ISSN 2071–7024.

De Langhe, E., (1961) : La taxonomie du bananier plantain en Afrique Equatorial. Le journal de l'Agriculture Tropicale et de Botanique appliquée. T.V. n°10, Bruxelles, 418p.
Dhed'a B., Moango A. et Swennen R., (2011). La culture des bananiers et bananiers plantains en R.D. Congo. Support didactique, Edition Saint Paul Afrique, Kinshasa. 83 p.
FACET, (2010). Étendue et perte du couvert forestier en République démocratique du Congo. Publié par l'université d'État du Dakota du Sud, Brookings, Dakota du Sud, États-Unis d'Amérique ISBN : 978-0-9797182-5-0.
FAO, (1996). Rôle de la recherche dans la sécurité alimentaire mondiale et développement agricole. Rome. 45p.
FAO, (2012). Les systèmes de production bananiers en danger répondre efficacement à la maladie du flétrissement du bananier dans la région des grands Lacs Burundi, l'Ouganda la République Démocratique du Congo, le Rwanda et la Tanzanie. 4p.
Gatsinzi F., (1987). Les principales maladies et ravageurs du bananier au sein du C.P.G.L., in séminaire sur les maladies et les ravageurs des principales cultures vivrières d'Afrique centrale. Place du champ de Mars 5. Bruxelles. Pp 197-198.
Gold C-S. et Messiaen S., (2000). Le charançon du bananier. Parasites et ravageurs des Musa. Réseau international pour l'amélioration de la banane et de la banane plantain, Parc Scientifique Agropolis II, 34397 Montpellier Cedex 5. Tel : 33-(0)4 67 61 13 02 - Fax : 33-(0)4 67 61 03 34 - e-mail : inibap@cgiar org - Internet : http://www inibap org. Fiche technique n°4. 4p.
Kouassi K., Gnonhouri G., Yao N., Kobenan K., Assiénan A., (2005). Bien cultiver la banane plantain en Côte d'Ivoire. CNRA. 4p.
Kumar P., Arun V. et Lokeswari TS., 2017. Cloning of BBTV (Banana Bunchy Top Virus) components and screening of BBTV using functionalized gold nanoparticles. 3 Biotech (2017) 7:225 DOI 10.1007/s13205-017-0849-8.
Lokossou, B., Affokpon, A., Adjanohoun, A., C.B.C.S. Dan, C.B.S et Mensah, GA, (2012). Evaluation des variables de croissance et de développement du bananier plantain en système de culture au sud-Benin. Bulletin de recherche agronomique du Benin (BRAB) numéro spécial agriculture & forêt-Novembre 2012 BRAB en ligne (one line) sur site web http//.www.slire.net.INSSsur papier (on hard copy) : 1025-2355 et INSS en ligne (one line) : 1840-7099.
Manitu M., (2012). Le secret de la culture intensive, édition intelligencia, 1ère rue Limete Médiatique/Kinshasa. 62p.
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. Edition TerrEspoir Cameroun. 15p.
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., 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 Gbado-Lite, RD Congo. Annales de l'Institut Facultaire des Sciences Agronomiques de Yangambi, vol.4(2), 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., Ndour 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. Revue de la Chaire Dynamique Sociale, Mouvements et Enjeux Sociaux. Numéro 111, 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.

Ngemale G.M., (2015). « Carte de la ville de Gbadolite » 2015. Consulté le 10/06/2022. https://www.researchgate.net/figure/Ville-de-Gbadolite-CNgemale_fig1_283071727.

Ngo-Samnick E., (2011). Production améliorée du bananier plantain. CTA-PO. Box 380-6700, AJ Wageningen. 24 p. www.cta.int 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.

Spiegel M-R., (1992). Probabilités et statistique. Cours et problèmes, McGraw-Hill, 28 rue Beaunier, Paris. 381p.

Swennen R. et Vuylsteke D., (2001). Le bananier in Raemarkers. RH., agriculture en Afrique Centrale. Rue de petites carnes 15 Karne Lietintraat 15, Bruxelles, 611-637.