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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

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Abstract:

The aim of this study was to evaluate the effect of compost and buckling on the plantain (Musa sp. cv. AAB, var Ngbangele) offshoot power under the conditions of Gbado-Lite in the Democratic Republic of the Congo. The experimental device chosen was that of complete randomized blocks comprising 3 repetitions and 4 plots 3 m long. The plots were arranged so that the flamed cultivars were adjacent depending on the substrates including T0: control substrate or unamended plot; T1: substrate from sawdust; T2: substrate from rice husk; T3: substrate from slush. Each plot contained 10 sample suckers of plantains. The greenhouse was installed after applying the buckling technique. It was observed that a bulb produced an average of 4 weaned suckers in the control bulbs; 8 suckers weaned on bulbs installed on substrates originating from slush; 9 suckers weaned on bulbs planted on substrates made from sawdust and rice husk. The releases installed on the control plot experienced a post-buckling recovery rate of 66.7%; those planted on sawdust and rice husk gave 83.3% and the subjects planted on the substrate from slush experienced a recovery rate of 80%; these results showed that the flame suckers adapted to the greenhouse conditions. In view of these results, it should be noted that this technique remains a major asset for the production of healthy suckers and in large quantities.

Keywords:
composts; vegetative propagation; buckling; plantain; gbado-lite; Democratic Republic of Congo

I. Introduction

The genus Musa sp. resume. AAB has more than 200 cultivated species worldwide. Bananas are native to Southeast Asia and are grown in more than 120 countries around the world (Jones, 2000). Bananas play a very important role in world food security because they are the staple food for millions of people in the world, and occupy in terms of production, the fourth position after in particular after rice, wheat and milk (Swennen et Vuylsteke, 2001).

Despite this significant production, the very rapid population growth observed leads to strong demand and consequently a constant production of bananas, the individual consumption of which is estimated at 20 kg/person/year (Yao et al., 2014). This demand is much higher than the supply, resulting from insufficient and seasonal production due to several constraints among which we list the depletion of arable soils, climate change, physiological, bacterial, viral, and fungal and unavailability of plant material in quantity and quality in order to sow the musical fields (Dhed'a et al., 2011).

To overcome this difficulty, some farmers use chemical fertilizers that improve crop productivity because of their immediate beneficial action on the productivity of food crops and these are one of the alternative solutions. However, their action is harmful to the soil, high cost and their unavailability make them almost inaccessible to small producers (Dupriez et De Leener, 2009; Kwey et al., 2015).

Rapid production of planting material is a major concern of many banana research programs. The propagation of the banana tree is done by suckering and has disadvantages such as the slowness in the multiplication of the fact that the number of suckers per plant is limited which rarely exceeds 3 and 5 in the plantain; the heterogeneity of the propagation material and finally the volume of the rejects leading to a significant cost of transport (Swennen, 1990; Mateille et Fonceille, 1989). The Plants from Stem Fragments (PIF) technique has undeniably taken off with farmers because it is easily reproducible. From one shoot, we are able to obtain 10 to 100 plantain shoots depending on the variety and the experience of the handler (Kwa, 2009; Ngo-Samnick, 2011).

In addition to the exogenous conditions that lead to the decline in banana production, it is also reported that its mode of multiplication, which is exclusively vegetative, also constitutes a limiting factor in the production of planting materials (Van Den Abeele et Vandenput, 1956; Vandenput, 1981). One of the greatest difficulties that agriculture encounters in the process of creating a banana tree is the necessary plant material, in sufficient quality and quantity, healthy and homogeneous to cover the planned area, the unsuitable cultivation techniques of production in particular to the insufficient fertilization of the soil for the multiplication of plant material; these constitute the source of unfortunate socio-economic consequences in rural areas (Kwa et Temple, 2019).

Nowadays, the use of compost remains one of the soil fertilization techniques, harmless, less expensive and its presence is not to be sought. By its quality on the cost and the presence is associated the remarkable productivity value. For this reason, this study seeks to evaluate the influence of heat or buckling in relation to composts on the potency of plantain in the conditions of agricultural greenhouse.

This research answers the following main question: does the application of heat or flambéing in relation to composts excite the potency of plantain ex situ.

In specific way, do banana plants subjected to heat or flambé adapt to greenhouse conditions?

This study verified the main hypothesis that the combined effect of heat in relation to composts would excite the offshoot power of plantain ex situ. Specifically, the aim is to check if flambéed banana plants would adapt to greenhouse conditions.

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II. Research Methods

2.1. Location of experimental site

This study was conducted in the Pangoma district in the commune of Gbadolite, the geographical coordinates of experimental fields using the ODK GPS application were as follows: 4°15'44" Latitude North and 20° 59'5" Longitude East, with an average altitude of 394, m.

The city enjoys an Aw2 type climate according to the Köppen classification. The soil is clayey-sandy, the rainfall is relatively abundant with an annual average greater than 1600 mm, estimated at 1800 mm. The insolation is low, 45% of total tropical energy radiation (Molongo et al., 2021; Ngbolua et al., 2014). The vegetation there consisted of the evergreen equatorial rain forest. Under anthropogenic action, it currently consists of savannahs where we find: Imperata cylindrica, Penisetum sp, Chromolaena odorata, Panicum maximum (Molongo et al., 2015).

2.2. Plant material

The plant material used consisted of a local plantain cultivar, of the false horn type (Wangala-wangala or Ngbangele). The choice fell on this cultivar because of the quality of its fruits which are well appreciated by the peasant farmers and by the traffickers of this commodity in Gbadolite. The material was obtained from a grower's fields and selected according to macroscopic examinations.

2.3. Methods

The study was conducted in a completely randomized block device comprising four treatments and three repetitions including T0: control or without amendment; T1: substrate from sawdust; T2: substrate from rice husk; T3: substrate from slush. In addition to the control holes filled with sand, the others were filled with different composts such as sawdust, rice husk and slush.

The 120 suckers were collected and trimmed finally, planted in a propagator 6 m long and 3 m wide amended according to the treatments. Each of the plots measuring 3 m and were separated by 50 cm. At the rate of 10 plantains shoots per plot and depending on the treatment. After 4 months of planting, the subjects were flambéed and the greenhouse was mounted on them where watering was regular.

Figures 1 and 2 show respectively the trimming technique as well as the cultivar and the artisanal agricultural greenhouse.

Figure 1. *Kidney Coppiced at 25 cm in Height and Trimmed; the Ngbangele Cultivar (False Horn Type)*

Figure 2. *Coppicing, Buckling and Installed Agricultural Greenhouse and Offshoot*

The observations related to the physical parameter in particular the temperature using the bimetal thermometer and the vegetative parameters including the rate of recovery before and after buckling by the following relationship: (Number of planted subjects-number of necrotic subjects)/(Total number planted subjects) x 100 (Bangata et al., 2018), the diameter of the cormus using a caliper; the height of the plant using a tape measure; monthly number of leaves per count, leaf length to width ratio, number of suckers weaned per count.

Data were analyzed using Excel and IBM SPSS Statistics 20 software. Single-criteria analysis of variance and Tukey's test were used to identify the difference between the treatments.

III. Results and Discussion

3.1 Results

a. Internal and external temperature of the Greenhouse

The temperatures were taken and the results are presented in Figure 3.

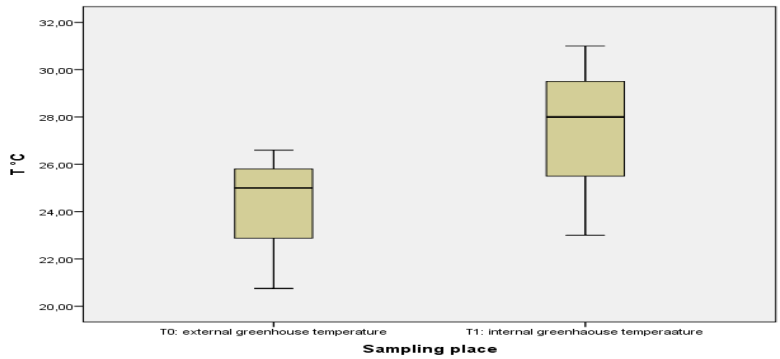

Figure 3. *The Internal and External Temperatures of the Greenhouse*

By opting for the three temperature samples and using the bimetal thermometer in this case at 8 o'clock; at 12 p.m. and 3 p.m.; an average internal thermal fluctuation of 22.6° C. respectively was observed; 31°C and 28.5°C. The average external temperatures were as follows: 20.75°C at 8 hours; 26.6°C at 12 p.m. and 25°C at 3 p.m.

b. The Recovery Rate before Buckling

The recovery rates were assessed and are presented in Figures 4.

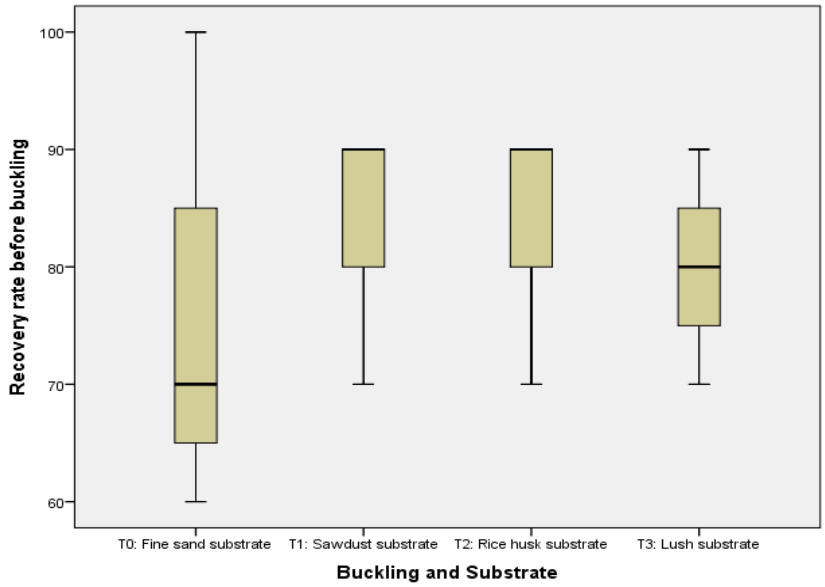

Figure 4. *Pre-buckling Recovery Rate (in %)*

It emerges from this figure that the recovery rates were observed at 76.6%; 83.3%; 83.6% and 80% respectively for the non-flamed subjects and planted on the control substrate or without amendment; for discharges installed and flamed on sawdust; for those planted and flambéed on the substrate coming from rice husk and finally from slush. These results showed that the composts, whatever their nature, gave a higher recovery rate than the controls. Tukey's test showed that there is no significant difference in recovery rate at the 0.05 probability threshold.

c. Corm Diameter of Suckers

The results relating to the diameter at the collar of the plant have been presented in Figure 5.

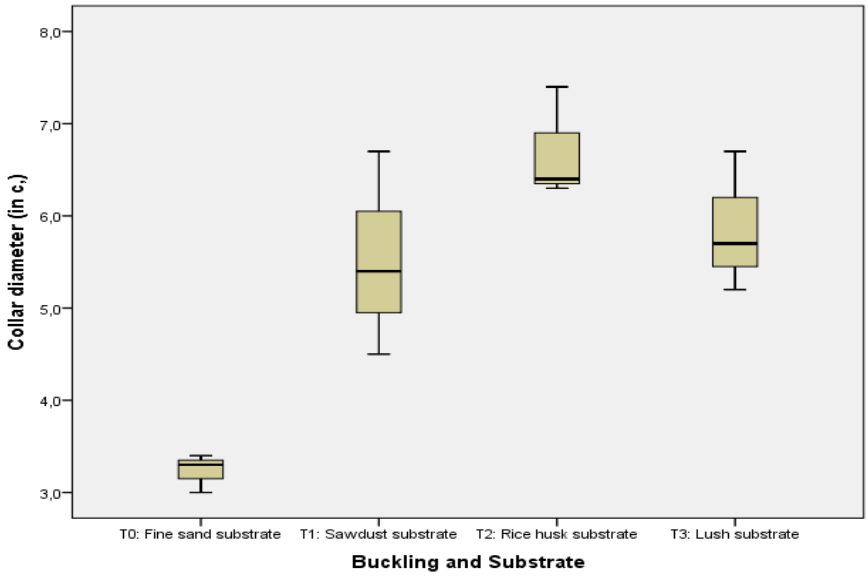

Figure 5. *Buckling Collar Diameter*

It was observed that the suckers installed on the unamended plot gave plants with a basal thickness of 3.2 cm; those installed on sawdust are 5.5 cm; 6.7 cm for plants planted on rice husk and 5.8 cm in diameter for those planted on slush substrate.

d. Plant Height when Buckling

The height of rejects was taken and the result is put in figure 6.

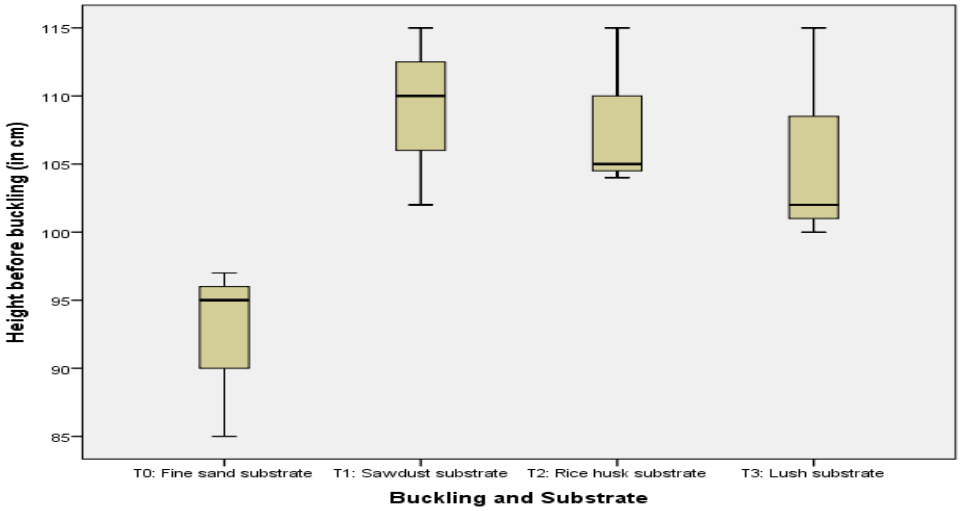

Figure 6. *Plant Height when Buckling (in cm)*

Figure 6 showed that the subjects reached a height of 92.3 cm; 109 cm 108 cm and 105 cm respectively for the shoots installed on the control substrate; on substrates derived from sawdust; rice husk and slush. In view of these results, it is accepted that the composts contributed to the growth of this plant.

e. Post-buckling Recovery Rate

Four months after planting, in addition to the controls, the suckers were coppiced and then flambéed. After 7 days, the post-buckling recovery rate and related results were recorded in Figure 7.

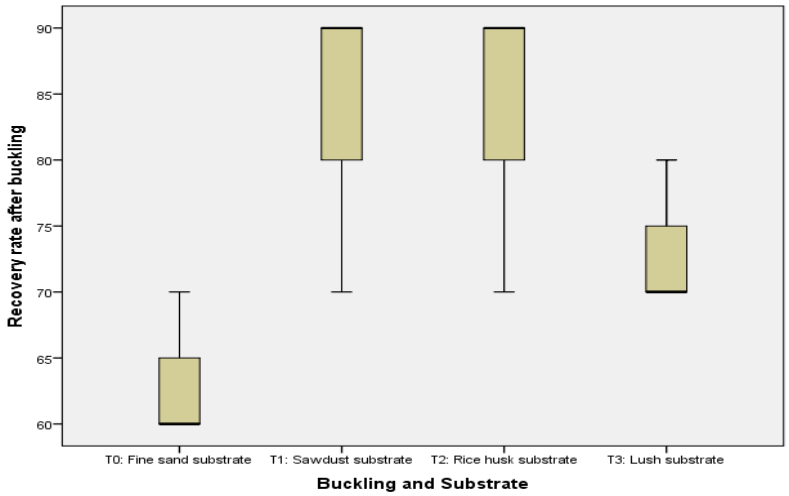

Figure 7. *Post-buckling Recovery Rate*

The releases installed on the control plot experienced a post-buckling recovery rate of 66.7%; those planted on sawdust and rice husk yielded 83.3% and plants planted on slush substrate experienced a recovery rate of 80%.

f. Monthly Number of Leaves Issued per Rejection

The leaves formed by the suckers were counted monthly during this study before buckling and the results are recorded in Figure 8.

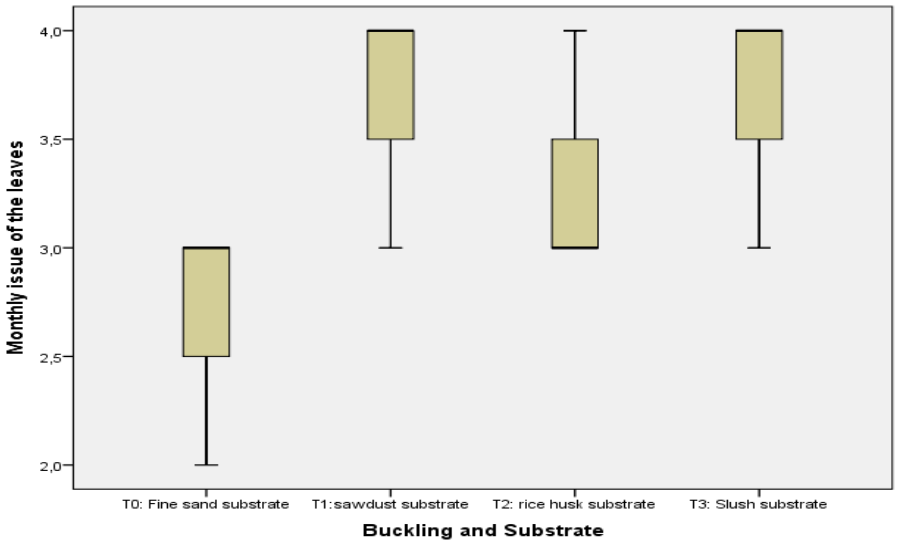

Figure 8. *The Monthly Number of Leaves per Rejection*

The results suggest that the subjects placed on the control substrates gave an average of 3 leaves per month; on the other hand, those which were flamed and installed on the composts emitted monthly 4 sheets.

g. Length to Width Ratio

The length to width ratio is shown in Figure 9.

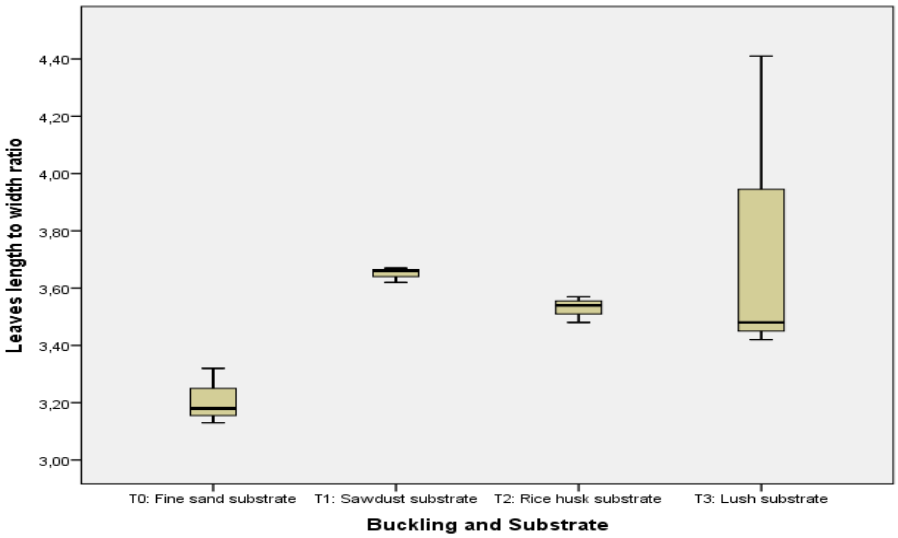

Figure 9. *Length to Width Ratio of Subject*

This study showed that the largest leaves were obtained from suckers planted on the substrate from sawdust (3.65), then from those planted on the substrate from rice husk (3.52), followed by plants installed on the substrate provided by the slush (3.45) and finally the control plants (3.16).

h. Average Number of Suckers Weaned per bulb

The rejections weaned by treatment were counted and the results are presented in figure 10.

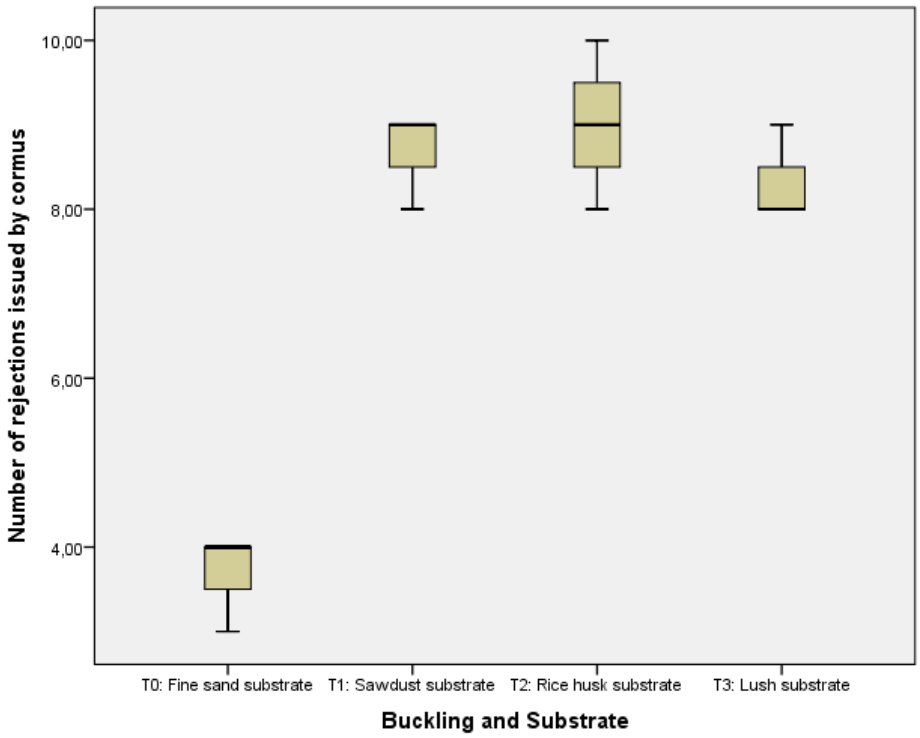

Figure 10. *Average Number of Suckers Weaned per Bulb*

With regard to the results presented in figure 10, it can be seen that on average a bulb emitted an average of 4 weaned suckers; 8 rejects; 9 rejections and 8 rejections under greenhouse conditions respectively for the control subjects; for those planted on substrate derived from sawdust; for the rice husk and for the substrate made from slush after one month after flambéing.

The analysis of variance with a single classification criterion using Duncan's test revealed a significant difference between the means of the treatments; Tukey's test drew the conclusion: T0 T3 T1 T2. Therefore, the best treatment under greenhouse conditions at Gbadolite was the substrate from rice husk and buckling; then that provided by sawdust and that from slush which are not different from each other but these were different from controls.

3.2 Discussion

The coefficients of variation of the recovery rate before buckling were less than 30%; which amounts to saying that the data were homogeneous and the Analysis of Variance with a single classification criterion and the Duncan test showed that there was no significant difference between the treatments at the probability threshold by 5% (Dagnelie, 1975; Lassoudière, 2007). Compared to the average recovery rate in relation to the substrates under Gbadolite conditions, it was observed that the best recovery rates were obtained in the subjects planted in the compost-amended furrows which provide a favorable environment for the good culture physiology than in controls. This rate was lower than that obtained under optimal multiplication and cultivation conditions where a recovery rate close to 100% was recorded (Lescot et Staver, 2014).

The results in relation to the corm diameter of the shoots showed that this varied with age and on the one hand with the size of the shoot and on the other hand with the different composts in such a way that they developed in soil with adequate structure. The analysis of variation with a single classification criterion at the probability threshold of 0.05 and Duncan's test showed that there is a significant difference between the treatments. This amounts to saying that during this study the best treatments were flamed rejects and installed compost from rice husks; then those installed on substrates based on sawdust and finally, those planted on substrates made from slush and flamed which turned out to be different from the controls which are the shoots planted on sand under greenhouse conditions and not flamed (Matembe 2019; Ngbolua et al., 2019).

The size of the corms of the subjects placed on the amended substrates was influenced by the administration of composts rich in mineral matter, in particular in Nitrogen, Phosphorus and Potassium, which are activating elements for the growth and development of the plant (Kouamé et al., 2014).

Substrates from sawdust, rice husk and slush are reported to give releases that are higher than the control releases. This difference is due to the enrichment of the soil following the slow decomposition of the sawdust and the mineral-rich chaff. The coefficients of variation values were less than 30%, which means that the data for this parameter were homogeneous (Dagnelie, 1975).

A reduction in the size and diameter of the pseudo-stems was observed in the control plants; this situation would be favored by the nutritional insufficiency because the unamended plot which is considered as a substrate poor in mineral elements, it is therefore unable to offer the plant the elements necessary for its physiology. On the other hand, growth also results from the combination of various phenomena, some like photosynthesis which causes an increase in available matter; others like respiration correspond to a disappearance of matter. Which suggests in this case that respiration increased faster than photosynthesis with temperature; this situation leads to a decrease in the growth rate of the control vivo-plants (Swennen et Vuylsteke, 2001).

This study showed that growth and other vegetative parameters depend closely on the treatments given to plantains and the environment in which the plants develop. These observations seem to correlate with the results according to which the growth of the plantain in the plots amended with fertilizers was in all cases superior to those which did not benefit from the fertilizers. Also, growth is a biological phenomenon of increasing size over time by granting the plant the appearance of new tissues; for this reason, plantains in plots amended with compost were in all cases superior to those planted in plots without amendment under greenhouse conditions (Molongo et al., 2015).

It was observed that the recovery rate of subjects planted on sand, poor in biogen, was less than 78.3%. This is to say that sand is not a good substrate for cultivation than other substrates which gave a rate higher than 78.3%. The results showed that sawdust decomposition and rice husk decomposition contributed 25% recovery rate, however slush contributed 16.6%. This organic amendment was able to modify or improve the physical, chemical, biological or mechanical characteristics of the soil (Lescot et Staver, 2014).

The plant during this study emitted 3-4 leaves within 7 days. On this, it is concluded that the emission of the leaves remains independent of this technique. It amounts to saying that the best substrate for this study was that derived from sawdust, then that of rice husk and finally that of slush; which amendments have given plants with wider leaves in order to allow the plant to perform its physiological activities correctly, in particular photosynthesis. The growth and development of a cultivated plant essentially depends on the gradual increase in its leaf area. The latter allows the plant to use solar energy more efficiently during photosynthesis. The capture of solar radiation by the leaf surface is influenced by the size, shape, age, angle of insertion on the trunk, vertical separation and horizontal arrangement of the leaf. In the case of banana, radiation intervenes indirectly through temperature (Ngo-Samnick, 2011).

The internal temperature, from 25 to 32 °C, was higher than that of the exterior because the greenhouse was responsible for the conservation of this thermal fluctuation; however, that of the exterior was agitated by environmental factors (Ngo-Samnick, op. cit).

The temperature varied depending on the climate state and the time when the temperature was taken. This is low in the morning, it is high at noon and finally it drops in the afternoon. Such a temperature remains one of the activating agents of dormant eyes bud burst on banana corms and stimulated certain vegetative parameters. By comparing the temperature fluctuations during this study according to the banana temperature requirements, this made it possible to verify the ability of this cultivar to adapt to the conditions of the Gbadolite region. In view of these results, it emerges that this cultivar seems to tolerate temperature fluctuations well, which stimulates its offsetting power.

The number of suckers per bulb for the subjects treated was between 5 and 10; but less than 15 and 60 buds that a bulb can thus produce depending on the quality of the shoot and the variety, for about 4 to 5 months (Matemmbe, 2019). The results of this study showed

that planting bed amendment in relation to buckling under greenhouse conditions is one of the major assets for the production of suckers.

The suckers were weaned after one month after buckling when they reached about 30 to 50 cm in height with a maximum of 3 good leaves forming. This practice met the thesis according to which in the natural climatic conditions of lower Côte d'Ivoire, the plants reach, two months after the transfer of phytoregulators, 30 to 40 cm in height for eight leaves; they can then be transferred definitively to the field (Lescot et Staver, 2014).

In view of these results, the analysis of variance with one classification criterion and the ppds showed that the subjects installed on the amended substrates in greenhouse conditions were not different from each other, but were different from the controls (Kouamé et al., 2014). This amounts to saying that the combined effect of organic matter and moderate heat has an influence on plantain offshoots because they are likely to break the dormancy of the buds in greenhouse conditions and offer mineral substances to the plant for its growth and development (Kwey et al., 2014).

It is also noted that the solar energy which penetrates and increases in the greenhouse is absorbed by the plants, the ground, and the various structures. As a result, this energy is trapped by this structure and it remains favorable to this crop, thanks to the maintenance or increase in air and soil temperature when outside temperatures are low (Kwey et al., 2014).

IV. Conclusions

This study was conducted to observe the combined effect of the use of composts and flambéing on the potency of plantain banana under greenhouse conditions in Gbadolite, Nord-Ubangi in the Republic of Congo.

This study produced the following results:

1. It was observed that a bulb emitted an average of 4 weaned suckers on the control bulbs; 8 suckers weaned on bulbs installed on substrates originating from slush; 9 suckers weaned on bulbs planted on substrates made from sawdust and rice husk. In view of the above, on average, 6 subjects were recorded; 8; 9 and 8 subjects who adapted after the buckling by treatment and in relation to the repetitions;
2. The discharges installed on the control plot experienced a post-buckling recovery rate of 66.7%; those planted on sawdust and rice husk yielded 83.3% and subjects planted on slush substrate experienced a recovery rate of 80%; these results showed that the flame suckers adapted to the greenhouse conditions.

As banana is a crop of great socio-economic and scientific importance, the following suggestions were made: study the influence of the ante buckling of corms on the suckering power of plantain under greenhouse conditions.

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References

Bangata B, Mobambo K, Kasongo M, Shungu D, Vuvu K, Vangu P, Omondi, A et Staver C, 2018. Evaluation du potentiel prolifératif de six cultivars de bananier (cv. AAB, ABB, et AAA) par macropropagation en République Démocratique du Congo. Journal of Applied Biosciences 127: 12770-12784 ISSN 1997-5902Ngbangu, G.,

Idikodingo, F., Mongbenga, G., Eboma, W., Molongo, M., Zuangbo, I., Ngbolua, J-P., Zua, T., Songbo, M., Monde, G., 2019 influence de l'origine des composts à froid sur le rendement de l'amarante (Amarantus hybridus L.; Amarantaceae) et de la tomate (Lycopersicum esculentum M.; Solanaceae) dans les conditions agro-écologiques de Gbado-Lite en République Démocratique du Congo. Numéro 111. Pp 63-69.

Dagnelie, P., 1975. Théories et méthodes statistiques. Applications agronomiques. Volume 1, Gembloux. 463p.

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

Dupriez H et De Leener P, 2009. Jardins et verger d'Afrique. 2ème édition terre et vie, rue Delvaux p. 13-1400, Nivelles, p. 360.

Jones DR, 2000. Introduction to banana, Abaca and Ensete. CABI, London, Walling ford Ensete. CABI, London, Wollong ford, UK, pp 1-31.

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 (Cote 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. 199p.

Kwa M, 2009. La culture et la multiplication des plants de bananier (Musa sp.), Connaissances et techniques de base, CARBAP, RD Congo, 13p.

Kwey M, Useni S, Nyembo K, Kasongo L, Tshitungu B, Kapenda D, Julien L, Baboy L et Van Koninckxloo M, 2014. Étude de l'acclimatation en serre de vitroplants de bananiers de la FHIA: «cas de FHIA-01 AAAB et FHIA- 23 AAAA» Journal of Applied Biosciences 73:5911 – 5924.

Kwey MM, Banze, SK et Mukalay BJ, 2015. Etude de cas sur l'impact des amendements organiques vis-à-vis de la salinité en culture de bananier. Afrique SCIENCE 11(3) (2015) 152 - 160 152 ISSN 1813-548X, http://www.afriquescience.info.

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

Lescot T et 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.

Mateille T et Fonceille B, 1989. Techniques de production de vitro-plants de bananier cv. 'Poyo'. P.H: M, -Revue Horticole Y, no 294. Côte d'Ivoire. Pp 39-45.

Matembe S, 2019. Effets de flambage et de composts sur le pouvoir rejetonnant de bananier plantain (Musa sapientum L.; Musaceae) dans les conditions de serre à Gbadolite en République Démocratique du Congo. Mémoire, Faculté des Sciences Agronomiques, département de Phytotechnie, Université de Gbadolite. Inédit, 52 p.

Molongo M, Koto-Nyiwa N, Abote D et Taffouo VD, 2021. Influence du matériel semencier sur la croissance et le rendement de l'igname (Dioscorea cayenensis L.) dans une zone agro-écologique de la république Démocratique du Congo. Revue internationale, Agronomie Africaine, 33 (2): 119 – 132 (2021).

Molongo M, Magbukudua JP, 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 JP, 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. Numéro 111. Pp 21-27.

Ngbolua K, Mafoto A, Molongo M, Magbukudua JP, Ngemale GM, Masengo C, Kondjo P, Yabuda H, Zama J et Veke, F, 2014. Evidence of new geographic localization of Okapia johnstoni (Giraffidae) in Republic Democratic of the Congo: The rainforest of « Nord Ubangi » District. Journal of advanced botany and zoology, volume 2/issue 1. ISSN: 2348-7313.

Ngbolua KN, Zuangbo I, Molongo M, Masengo C, Djolu D, Yabuda H, Ngiala B, Gbolo Z, Monde Go, 2019. Effect of Agricultural Residues Based-Compost on the Yield of Amarantus hybridus L. (Amaranthaceae) in Gbado-Lite City, Nord-Ubangi (Democratic Republic of the Congo) Budapest International Research in Exact Sciences (BirEx) Journal 1 (4): 53-61.

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.

Swennen R. 1990. Plantain cultivation under West African conditions. A reference manual. International institute of tropical agriculture, Ibadan Nigeria, 24p.

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.

Van Den Abeele M et Vandenput R, 1956. Les principales cultures du Congo Belge. 4ème édition, Bruxelles. 880 p.

Vandenput R, 1981. Les principales cultures d'Afrique Centrale, presse de l'imprimerie LESAFRE, Tourhai - Bruxelles. 1257 p. Yao AK, Koffi MD, Irié IZ et Niamke SL, 2014. Conservation de la banane plantain (Musa AAB) à l'état vert par l'utilisation de films de polyéthylène de différentes épaisseurs. Journal of Animal &Plant Sciences, 2014. Vol.23, Issue 3: 3677-3690 Publication date 23/12/2014, http://www.m.elewa.org/JAPS; ISSN 2071-7024.