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Plantain (Musa spp.) Growth Parameter Under Kindu Conditions

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ABSTRACT

To contribute to the resolution of the problem relating to the growth of plantain (Musa spp.), the growth parameter of plantain was evaluated under Kindu conditions using the Fertilizers (Control, Sawdust and rice husks) as substrate. The experiment was conducted in the experimental device installed in the concession of the University of Kindu, department of phytotechnics comprising 6 treatments, corresponding to ten repetitions for each treatment. The observations made during this investigation focused mainly on the diameter at the collar (cm), Height of the pseudostem (m) and the leaf area).The results obtained showed that:The height of the pseudostem, the diameter at the collar and the leaf area varied from one cultivar to another and according to the fertilizers used;

- Sawdust was the best fertilizer, compared to rice husks and controls;
- the Mbonjilo C4 cultivar is the tallest cultivar, from the point of view of the collar diameter it is the Mbudi 1 cultivar, on the other hand from the leaf area point of view it is the Mbonjilo cultivar which has the most open leaves.

1. Introduction

1.1 Problem

Plantains, consumed in several forms, are central products in the diet of populations in intertropical regions. Depending on the country, in rural areas, plantain occupies between first and fourth place in terms of dietary importance. Unlike the dessert banana, which is the subject of a well-organized world trade, the plantain is not very present on the international markets (Anonymous, 2001).

Worldwide, bananas (dessert bananas and plantains) are the main fresh fruit, subject to significant international trade. Its socio-economic and nutritional importance is considerable (Dhed'a et al., 2010).

In DR Congo, plantain is one of the main crops for self-consumption of the population, mainly in the Province of Maniema, where it contributes to the improvement of food security like cassava, rice or maize and olive oil. of palm. They are also an important source of income for households (Mobambo et al., 2011).

Cultivated bananas (plantains) are a food source for millions of people around the world. Its cultivation having spread to more or less in 40 countries in tropical and subtropical regions across five continents (Jenny et al., 2002) and is not only a staple food for more than 400 million people in developing countries in South America, Southeast Asia and Africa, but also a real source of income (Teycheney et al., 2007). It is the fourth agricultural product in terms of world production after rice, wheat and corn. It ranks first in fruit production, with just over 145 million tonnes produced in 2011 worldwide (Ganry et al., 2012).

In a study based on the morphological diversity of plantains in the province of Maniema (Kasongo, Kailo, Kibombo and Pangi territories), Tambwe (2019) listed 19 banana cultivars distributed as follows: 4 plantains of the French type, 3 false horn, 2 real horn, 6 banana trees of the dessert type and 4 cooking plantains.

Among the plantains, there are six that are most popular and cultivated, these include: cultivars Kambelekete (Amakake), Mbudi I (Ikpolo red), Bonjilo "Bosakarakaka 1"; Kyankola (Magoma I); Mbudi II (Red Ikpolo); Otangala; (Egbe-O-Mabese I).

From this situation, it is necessary to deepen the knowledge on these six cultivars by making an agronomic and nutritional evaluation. This evaluation would allow, among other things, to know them agronomically and nutritionally and even classify them.

2. Materials and Methods

2.1. Study environment

The experiments took place within the confines of the University of Kindu more precisely on the experimental site of the department of phytotechnics located at camp Lwama I with geographical coordinates (S 02°56.525°; E 025°53.118); Altitude 469 m) in the town of Kindu, province of Maniema in the Democratic Republic of Congo.

The concession of the University of Kindu presents a relief characteristic of the central Congolese basin with very little unevenness with a soil of the clay-sandy and sandy-clay type which allow the practice of all kinds of crops, both market gardening and food or industrial.

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The DR Congo comprises several different climatic zones. Contrary to what happens in regions far from the equator where variations in average temperature distinguish the seasons, it is above all rainfall that creates seasonal differentiation in most of the national territory (Ngongo et al., 2009; Solia, 2016). Located in the equatorial zone, Kindu enjoys an equatorial climate: the average monthly temperature varies between 22.5 and 29.3°C, with an annual average close to 25°C. As is the case throughout the central forest basin area; annual rainfall varies between 1500 – 2000 mm, with an average of 1750 mm (Vanden put, 1981). The study sites are located in the same Aw2 type climatic zone. It is of the corresponding humid tropical type according to the Köppen classification (1936 in Solia, 2016). This province has two to three major seasons, namely:

- Rainy season which begins from August to December and which constitutes season B, while season A begins from January until mid-May;
- Dry season, which extends from mid-May to mid-August accompanied by fog during the thinnest morning. This season has a short duration in the middle of Kindu (FAO, 2010).

The study sites are located in the middle of the dense humid plain and savannah forest which extends on the left and right banks of the Congo River. The vegetation of Africa established by White (1983), indicates that the study sites are located in the Guineo-Congolese region. The massif of the study area is located in the northeastern part of the dense rainforest of Central Africa. The vegetation of the concession of the University of Kindu; having undergone anthropic pressures for a long time, it comprises trees and a neoformed physiognomy rich in full species not very exotic but, shrubs and shrubs. Among the plant species, we cite: Elaeis guineensis, Pueraria javanica, etc. it should also be noted in passing that the presence of surrounding savannah and bush dominates the whole city.

2.2. Plant Material

The plant material used in this study consists of suckers from the six most popular plantain cultivars grown and collected in the Kindu region, the characteristics of which are presented below. These are the Kyankola cutivars (magoma 1); Mbudi 1 “Red Ikpolo”; Mbudi II “Red Ikpolo” Otangala “Egbemabese”; Kambelekete “Amakake”; Bonjilo “Bosakarakaka 1”. The characteristics and photographic illustrations are as follows:

3. Methods

3.1. Introduction

Data collection was mainly aimed at agronomic and nutritional evaluations.

Then, the study was conducted in two stages, namely the socio-economic surveys in four territories of the province of Maniema and the field evaluation of the most interesting cultivars in the city of Kindu.

3.2. Socio-Economic Surveys

The breakdown was as follows:

- Kailo territory: Ambwe, Beia, Wasongola and Bangengele;
- Territory of Kibombo: Matapa, Aluba, Bakongola and Ankutchu;
- Territory of Kasongo: Wazimba, Maringa, Wakabongo and Mamba-Kasenga and finally;
- Territory of Pangi: Sanga, Djuwa, Mokandilwa and Lukundji.

These different villages were selected, along an axis (for territories with a single main axis) and this according to a village after every 20 km, or along different directions (for territories with several main axes).

The methodology used in this work is based on the Bioversity-CIALCA survey questionnaire, which consists of reasoned sampling; given the size of the province. At first, it is a question of choosing in each selected village, a group composed of 30 men and another composed of 30 women, for a participatory survey in focus group. The purpose of this survey was not only to assess the general knowledge of farmers on agriculture and livestock, but also to determine their knowledge of the varietal diversity of bananas and plantains present in their village.

At the end of the participatory surveys, a list containing all the banana and plantain cultivars known by the farmers is drawn up. On the basis of this list, the cultivars of banana trees and plantain trees found in the villages were the subject of direct observation. The suspected new cultivars are identified and sampled for cultivation in the characterization field of the Faculty of Agronomic Sciences of the University of Kindu, for a complete characterization according to the descriptor of Bioversity International (INIBAP, 2001). They include the main descriptors for the variety passport data. A digital photo package is taken of a mature plant including, among other things, a photo of the whole plant with inflorescence taken obliquely to the bunch stem and a zoom on the fingers.

In addition, the clumps of each cultivar were counted in the fields of the 5 households surveyed in the different villages to determine the most common cultivars in the study sites. In addition, other questions were asked to the head of the household on the name in local dialect of each cultivar, the meaning of this name, the origin of the cultivar, its positive and negative characteristics as well as its use. Other questions relating to the criterion for choosing cultivars in each household, the appreciation of farmers for the different cultivars, as well as some agronomic practices such as; practices in fallow land and agroforestry systems were also asked of the head of each household (CIALCA-Bioversity diagnostic survey questionnaire, Annex 2).

3.3. Agronomic Evaluation of Six Plantain Cultivars Collected in Collection at the Experimental Station of the University of Kindu

The agronomic evaluation consisted in determining the productive and pathological potentialities and the natural multiplication rate of the six cultivars. The trial included two factors including: the type of organic fertilizer with three levels (control, decomposed sawdust and decomposed rice husks) and the cultivars with six levels corresponding to the six cultivars collected.

3.3.1. Experimental device and treatments

The experimental device adopted is that of plots subdivided into two (the split plot) with repetitions arranged in elongated plots. Each cultivar in each fertilizer was replicated ten times (Figure 1).

3.3.2. Conduct of the Test

A 40 x 60 m collection field was set up within the experimental land of the Department of Phytotechnics of the University of Kindu, located in the Lwama 1 district. Overall, six cultivars most appreciated by farmers and consumers were been collected. Each cultivar was repeated ten times under each type of fertilizer, thus making an agronomic and nutritional evaluation. The spacings adopted were 3 x 3 m. Maintenance care consisted of weeding, stripping, mulching and staking.

3.3.3. Growth Assessment

The observations made were mainly focused on the following parameters: the length of the pseudostem, the diameter at the collar, the number of leaves and leaf area (the length and width of the leaves affected by a corrective factor). These parameters were taken at harvest.

Neck diameter and pseudostem length were measured using a measuring tape and caliper, respectively. Regarding the length and width of the sheets, we retained the penultimate sheet to make these measurements from the sheath to the top and the widest width using a tape measure. The product of the length by the width affected by a corrective factor (0.47) gives the leaf area.

To. Pseudo trunk height

The average values of pseudostem height of the different cultivars, of the different treatments, are presented in Table 1, while the results relating to the multifactorial statistical analyzes are within each factor and are recorded in Table 4.

This table1 shows that the height of the pseudostem varied from one type of fertilizer to another. Sawdust gave the most vigorous banana plants of all cultivars. By considering the general averages of the height of the pseudostem (m) under various fertilizers, we note that the latter evolve in an increasing manner, respectively 3.06 ± 0.73 m for the controls, followed by 3.15 ± 0, 69 m under rice husk and 3.37 ± 0.74 m under sawdust.

As for the general averages compared to the cultivars for all the fertilizers, we note respectively 3.34 ± 0.55 m for C6; followed by 3.24 ± 0.71 m for C1; 3.20 ± 0.61m for C5; 2.91±0.75m for C4; 2.86 ± 0.81 m for C2 and 2.79 ± 0.82 m for C3. By comparing the different cultivars, we notice that it is the cultivar C6 (Otangala) which has the longest plants, followed respectively by C1 (Kyankola); C5 (Kambelekete); C4 (Mbonjilo); C2 (Mbudi 1) and finally, C3 (Mbudi 2). Considering the CV as a whole (within fertilizers and cultivars), we notice that the data are homogeneous, because the coefficients of variation are all below 30%.

b. Collar Diameter

The average collar diameter values under different cultivars and under different fertilizers are shown in Table 2, while the results relating to the multifactorial statistical analyzes are given in Table 4.

This table shows that the collar diameter varied from one type of fertilizer to another. Sawdust gave the most vigorous banana plants of all cultivars. By considering the general averages of diameter at the collar (cm) under various fertilizers, we note that the latter evolve in sawtooth, respectively 35.48 ± 11.22 cm for the controls, followed by 32.96 ± 12.74 cm under rice husk and 46.97 ± 23.43 cm under sawdust.

As for the general averages compared to the cultivars for all the fertilizers, we note respectively 39.87 ± 15.88 cm for C2, followed by 39.57 ± 18.00 cm for C3, 39.33 ± 20.07 cm for C6, 38.97 ± 20.16 cm for C5, 36.83 ± 17.56 cm for C1 and 36.23 ± 15.11 cm for C4.

By comparing the different cultivars, we notice that it is the C2 cultivar (Mbuli 1) which has the most vigorous plants, followed respectively by C3 (Mbudi 2); C6 (Otangala); C5 (Kambelekete); C1 (Kankola) and finally, C4 (Mbonjilo). Considering the CV as a whole (within fertilizers andcultivars), we notice that the data are heterogeneous, because the coefficients of variation are all greater than 30%.

vs. LEAF AREA

The average values of leaf area under different cultivars and under different fertilizers are compiled in Table 3, while the results relating to the multifactorial statistical analyzes are recorded in Table 4.

It appears from this table that the leaf area varied according to one type of fertilizer to another. Sawdust gave banana plants with the most flourishing leaves of all cultivars. By considering the general averages of leaf area (cm2 under various fertilizers, we note that these evolve in an increasing way, respectively 60.64 ± 18.68 cm2 for the controls, followed by 65.23 ± 18.38 cm2 under bale of rice and 69.97 ± 21.54 cm2 under sawdust.

As for the general averages compared to the cultivars, for all the fertilizers, we note respectively 69.56 ± 19.42 cm2 for C4, followed by 69.05 ± 17.87 cm2 for C3; 66.17 ± 24.80 cm2 for C6; 65.30 ± 16.26 cm2 for C5; 63.43 ± 21.64 cm2 for C1 and 58.17 ± 17.21 cm2 for C2. By comparing the different cultivars, we note that it is the C4 cultivar (Mbonjilo) which has the largest leaf areas, followed respectively by C3 (Mbudi2); C6 (Otangala); C5 (Kambelekete); C1 (Kankola) and finally, C2 (Mbudi 1).

Considering the CV as a whole (within fertilizers and cultivars), we note that the data are heterogeneous for fertilizers, with regard to controls and sawdust on the one hand and C1 and C6, for the cultivars on the other hand, because the coefficients of variation are all greater than 30%, while the data are homogeneous for the rice husk fertilizer and the cultivars (C2, C3, C4 and C5), because the coefficients of variation are all less than 30%.

Discussion

The results relating to the growth of plantains show that all the suckers planted resumed regardless of the cultivars tested (Table 1). Similar results were obtained by Belfakin et al., (2013) and de Tambwe et al., (2022). In fact, plantain (Musa spp) shoots resume normally without many problems, except in the case of previous attacks as pointed out by Van Den Put (1981) and Janssens (2001).

2.2.4. Statistical Syntheses

The comparison within the factors (primary and secondary) for the vegetative parameters is recorded in table 4.

Table 4. Comparison of average statistical summary values of collar diameter, pseudostem height and leaf area within the main factor (fertilizer)

It appears from this summary table of the analysis of variance that there are very highly significant differences between fertilizers, with regard to the diameter at the collar. While for pseudostem height and leaf area, the difference is significant.

The analysis of variance table reveals that there are no significant differences between the cultivars, with regard to the diameter at the collar, the height of the pseudostem and the leaf area.

Conclusion

In this phase of experimentation, we evaluated the productivity of the six cultivars in three formulas of fertilization including, an unfertilized plot and two plots respectively fertilized with rice husks and sawdust.

The trial was conducted using an experimental device of subdivided plots (split plot): In this article, we have limited ourselves to the presentation of partial results relating to productivity; They relate in particular to the growth parameters: (diameter at the collar (cm), height of the pseudostem (m) and the leaf area).

The results obtained on the productivity of six cultivars are as follows:

a)Growth parameters

Pseudostem height, collar diameter and leaf area varied from cultivar to cultivar and according to the fertilizers used;

- Sawdust was the best fertilizer compared to rice husks and controls;
- The Mbonjilo C4 cultivar is the largest cultivar, from the point of view of the collar diameter it is the Mbudi 1 cultivar, on the other hand from the leaf area point of view it is the Mbonjilo cultivar which has the most open leaves

Figure 1 . Kyankola

Figure 2 . Mbudi

Figure 3 . Mbudi II

Figure 4 . Otangala

Figure 5 . Bonjilo

Figure 6 .Kambelekete

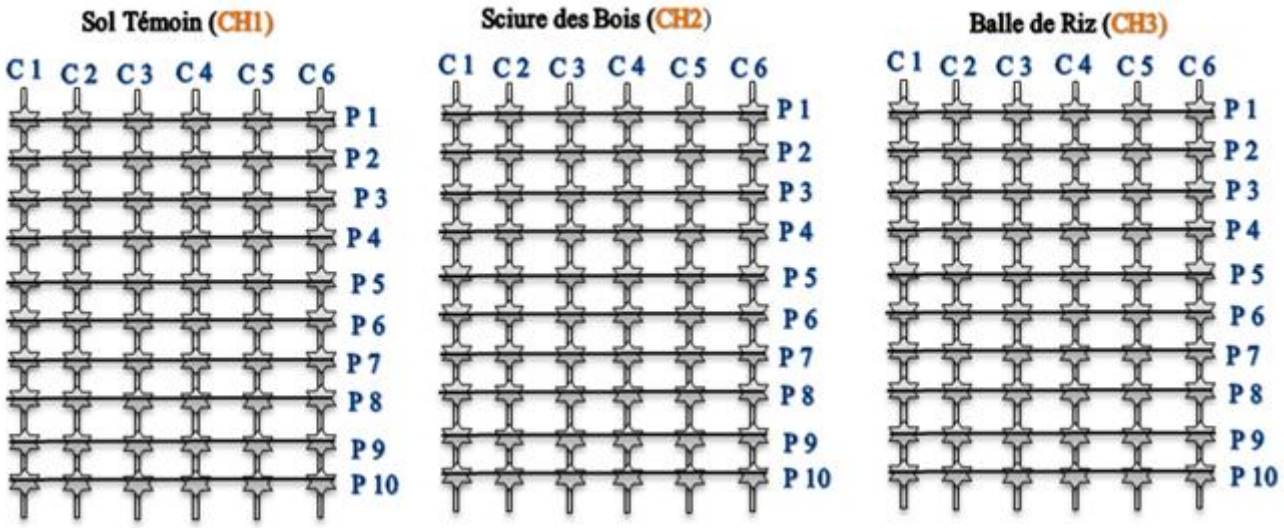

Figure 7. Dispositif expérimental

Legend: from C 1 to C 6: Cultivar 1 to Cultivar 6; from P1 to P10: Feet 1 to Feet 10 and from CH 1 to CH 3: Fields 1 to Fields 3.

A total of eighteen treatments were tested for each cultivar: without fertilizer, under sawdust and under decomposed rice husks.

Table1. Mean values of pseudostem height (m) under various fertilizers

Cultivars	Témoin	Balle de riz	Sciure de bois	Sommes	Moyennes	Ecart types	CV (%)
C1	3,24	3,16	3,43	9,83	3,24	0,71	21,89
C2	2,86	2,95	3,12	8,93	2,86	0,81	28,49
C3	2,79	3,04	3,20	9,03	2,79	0,82	29,56
C4	2,91	3,16	3,23	9,3	2,91	0,75	25,81
C5	3,20	3,34	3,64	10,18	3,20	0,61	19,07
C6	3,34	3,28	3,63	10,25	3,34	0,55	16,36
Sommes	8,34	18,93	20,25				
Moyennes	3,06	3,15	3,37				
E–Types	0,73	0,69	0,74				
V (%)	23,82	21,90	21,93				

Table 2. Collar diameter (cm) of different cultivars and under different fertilizers.

Cultivars	Témoin	Balles de riz	Ciurede bois	Sommes	Moyennes	Ecart types	CV (%)
1	2,90	33,20	4,40	10,50	6,83	7,56	47,67
2	36,15	34,55	48,90	19,60	39,87	15,88	9,84
3	35,80	35,70	47,20	18,70	9,57	8,00	5,48
4	6,70	30,70	41,30	08,70	6,23	5,11	1,69
5	5,00	29,00	2,90	16,90	8,97	0,16	1,74
6	6,30	34,60	47,10	18,00	9,33	0,07	1,02
Sommes	12,85	197,75	281,80				
Moyennes	5,48	32,96	46,97				
Ecart types	1,22	12,74	23,43				
CV (%)	1,63	38,67	9,88				

Table 3. Leaf area (cm2) of different cultivars and under different fertilizers

Cultivars	Témoin	Balles de riz	Ciures de bois	Sommes	Moyennes	Ecart- types	CV (%)
C1	55,80	66,07	68,41	190,28	63,43	21,64	34,12
C2	56,67	58,70	59,14	174,52	58,17	17,21	29,59
C3	68,10	66,38	72,65	207,14	69,05	17,87	25,88
C4	64,79	70,40	73,49	08,68	69,56	19,42	27,92
C5	59,43	63,84	72,63	95,89	65,30	16,26	24,89
C6	59,05	66,00	73,47	98,52	66,17	24,80	37,48
Sommes	363,84	391,39	419,80				
Moyennes	60,64	65,23	69,97				
Ecartypes	18,68	18,38	21,54				
CV (%)	30,80	28,18	30,78				

Table 4. Comparison of mean values of collar diameter, pseudostem height and leaf area within secondary factor (cultivars)

Fertilisants	Diamètre au collet	Hauteur de pseudo-tronc	Surface foliaire
Témoins (sans fertilisants)	$35,50^{a}$	$3,06^{a}$	$60,64^{a}$
Balles de riz	$33,00^{a}$	$3,15^{a}$	$65,23^{b}$
Sciure de bois	$47,00^{b}$	$3,37^{b}$	$69,97^{b}$
p-values	0,00001***	0,048*	0.03549*

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