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Study of the Natural Rejection Capacity of Six Plantain Cultivars (*musa spp.*), Collected in Five Areas of Maniema Province under Kindu Conditions

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ABSTRACT

To evaluate the natural rejection capacity of six plantain cultivars collected in five territories in the province of Maniema, in the Democratic Republic of Congo. The trial was conducted using an experimental system of subdivided plots and observations were made on the number of naturally formed shoots, the diameter, the height of the pseudo-trunk and the leaf area of the plant. The correlation between the number of shoots and these three parameters was calculated. The results obtained were as follows: 8.17 ± 2.72 shoots were produced in the control, 8.50 ± 2.62 in the sawdust and 8.26 ± 2.68 in the decomposed rice husks. The averages per cultivar for all fertilisers and per cultivar were 9.37 ± 0.11 for C_6 (Otangala); followed by 8.76 ± 0.65 for C_4 ((Mbonjilo) ; 8.43 ± 0.12 for C_5 (Kambelekete) ; 8.03 ± 0.48 for C_1 (Kyankola)$_1$; 7.89 ± 0.19 for C_3 (Mbudi 2) and 7.37 ± 0.48 for C_2 (Mbudi 1). It was found that these numbers of rejections do not differ statistically between fertilisers and between cultivars. The correlation coefficients are therefore generally low or mogged, negative or positive. The data are heterogeneous within fertilisers and homogeneous within each cultivar.

1 Introduction

1.1 Issues

Plantains, consumed in a variety of forms, make an effective contribution to the diets of people in tropical and inter-tropical regions. In rural areas, plantains rank between first and fourth in terms of dietary importance. Unlike dessert bananas, which are the subject of a well-organised world trade, plantain has little presence on international markets. The socio-economic and nutritional importance of bananas (dessert bananas and plantains) is considerable (Dhed'a *et al.*, 2010).

Plantain is grown in around 40 countries in tropical and subtropical regions across five continents (*Jenny et al*., 2002), and is not only a staple food for over 400 million people in the developing countries of South America, South-East Asia and Africa, but also a real source of income. It is the world's fourth most important agricultural product after rice, wheat and maize. It ranks first in fruit production, with just over 145 million tonnes produced worldwide in 2011 (Ganry *et al.*, 2012). In DR Congo, plantain is one of the main self-consumption crops in several provinces, mainly Maniema, where it helps to improve food security along with cassava, rice, maize and palm oil. These crops are also an important source of household income (Mobambo *et al*., 2011).

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

Six of these plantains are the most popular and cultivated: Kambelekete (Amakake), Mbudi I (Ikpolo rouge), Bonjilo "Bosakarakaka 1"; Kyankola (Magoma I); Mbudi II (Ikpolo rouge); Otangala; (Egbe-O-Mabese I).

Given this situation, there is a need to learn more about these six cultivars by carrying out a number of studies, in particular to assess their productivity, natural rejection, nutritional value, behaviour with regard to diseases and insect pests, and so on. This assessment would, among other things, provide agronomic and nutritional information on these cultivars and enable them to be classified. One of the constraints of banana cultivation, especially those linked to the extension of the crop, is its low rate of multiplication. So, before considering the various propagation methods that can be used for macropropagation, it was necessary to assess the natural rejection potential of the six plantain cultivars most widely grown and appreciated by farmers in five areas of Maniema province at the Kindu University experimental station. This study is based on the fact that, given that each banana cultivar has its own characteristics and that each organic fertiliser has a different capacity to enrich the soil, it is obvious that the natural rejection power of these six plantain cultivars will not be the same.

2. Materials and methods

2.1 Study environment

The experiments were conducted in the concession area of the University of Kindu, more specifically in the

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experimental site of the phytotech department located at Camp Lwama I with the following geographical coordinates (S 02°56.525°; E 025°53.118); Altitude 469 m) in the town of Kindu, Maniema province in the Democratic Republic of Congo.

The Kindu University concession has a relief that is typical of the central Congolese basin, with very few irregularities and clayey-sandy and sandy-clay soils that are ideal for growing all kinds of crops, from market garden produce to food crops and industrial crops.

The DR Congo has several different climatic zones. Unlike 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 country (Ngongo *et al.*, 2009; Solia, 2016). Located in the equatorial zone, the study area benefits from 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, annual rainfall varies between 1,500 and 2,000 mm, with an average of 1,750 mm (Vanden put, 1981). The study sites are located in the same Aw-type climate zone. This is the corresponding humid tropical type according to Köppen's classification (Solia, 2016). This province has two main seasons:

- The B season is the rainy season from August to December, while the A season runs from January to mid-May;
- The dry season, which lasts from mid-May to mid-August, with fog during the finest mornings. This season has a short duration in the environment (FAO, 2010).

The study site is located in the dense rainforest of the plain and savannah, which extends along 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 Guinean-Congolese region. The massif in the study area is located in the north-eastern part of the Central African rainforest. The vegetation in the Kindu University concession has long been subject to anthropogenic pressures, and comprises trees with a neoformed physiognomy rich in plenary species that are not very exotic, but also shrubs and bushes. Plant species include *Elaeis guineensis*, *Puararia javanica*, etc. We should also mention in passing that the surrounding savannah and bush dominate the whole town.

2.2 Plant material

The plant material used in this study consists of offshoots of the six most popular plantain cultivars grown and collected in the Kindu region, whose characteristics are presented below. These are the cutivars Kyankola (magoma 1); Mbudi 1 'Ikpolo rouge'; Mbudi II 'Ikpolo rouge'; Otangala 'Egbemabese'; Kambelekete 'Amakake'; Bonjilo 'Bosakarakaka 1'. The characteristics and photographic illustrations are shown in Figure 1:

3. Methodology

3.1 Experimental set-up and treatments

The experimental set-up adopted for this research was that of plots subdivided into two (the split plot) with replicates arranged in elongated plots. Each cultivar in each fertiliser was replicated ten times. A total of eighteen treatments were tested for each cultivar: without fertiliser, under sawdust and under decomposed rice husks.

3.2 Conduct of the test

A 40 x 60 m field was set up on the experimental site of the Department of Plant Science at Kindu University, in the Lwama 1 district.

3.3 Harvesting shoots

The shoots were harvested from banana plants showing no visible symptoms of various diseases in the collection field set up following the morphological characterisation study in five territories of Maniema province. The shoots harvested were of different ages and sizes, but were bayonet-shaped, and concerned the six most popular and cultivated cultivars.

3.4 Preparing and caring for bulbs

The bulbs were first cleaned under running water. Then, all the roots were completely removed, along with the leaf seeds, one after the other, until the apical meristem had opened up. The bulbs were then placed in a dry place in the shade for 48 hours to allow them to dry out and begin to heal.

3.5. Planting

The prepared shoots were planted in a 40 x 60 cm field at the experimental site of the Department of Plant Science at Kindu University.

Overall, six of the cultivars most appreciated by farmers and consumers were selected for further work. Each cultivar was replicated ten times to assess its natural rejection capacity under different treatments. The plant spacing was 3 x 3 m and the planting depth was 40 cm. For the two altered plots, the holes were filled with sawdust and decomposed bales. Before planting, we measured the diameter of the shoots: maintenance consisted of weeding and leaf removal.

4. Observations

Observations were mainly made on the diameter at the collar, measured using a calliper; the height of the pseudo-tone, measured using a measuring tape; the leaf surface of the mother plants and the number of shoots formed on each mother plant, depending on the fertiliser and cultivar, determined by counting the number of shoots at flowering of the mother plant.

4.1. Statistical analysis

Means and standard deviations, coefficient of variation and analysis of variance were submitted using R software version 6.4.0 (Cornillon et *al.,* 2008). Correlation coefficients were calculated between diameter and number of shoots; pseudotrunk height and number of shoots; and leaf area and number of shoots.

5. Delivery of results

5.1 Number of discharges formed

The average values for the number of rejections per cultivar under different fertilisers are presented in Table 1, while the results of the multifactorial statistical analyses are within each factor and are recorded in Tables 2 and 3.

The table1 shows that the number of shoots formed naturally varied from one type of fertiliser to another and from one cultivar to another. Sawdust was slightly more favourable to the formation of the most vigorous banana shoots for all cultivars.

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The analysis of variance table shows that there were no significant differences between the fertilizers in terms of the number of shoots formed under the control, sawdust and rice husk.

The analysis of variance table shows that there are no significant differences between cultivars in terms of the number of shoots formed.

5.2 Study of correlations

5.2.1. Diameter and number of discharges formed

Table 4 shows the results of the correlation coefficient between the diameter of the mother plant and the number of shoots formed under different fertilisers and by cultivar.

Table 4 of the analysis of variance shows that the relationship between mother plant diameter and the number of shoots formed was weak (r<0.5) or moderately negative or positive. In addition, there were no significant differences between fertilisers and cultivars. The correlations were not significant.

5.2.2 Correlation between stem height and number of shoots.

The correlation values between pseudo-trunk height and number of shoots under different cultivars and different fertilizers are presented in Table 5.

The analysis of variance table shows that there are no significant differences between the fertilisers (rice husk and sawdust, as well as the control) and the correlations are not significant. The correlation coefficients between the height of the pseudo-trunk of the mother plant and the number of naturally formed shoots were both positive and negative.

5.2.3. Correlation between leaf area and number of shoots.

The correlation coefficients between leaf area and the number of shoots under various fertilizers and according to cultivar are shown in Table 6.

The results of this table show weak and moderate positive and negative relationships between leaf area and the number of shoots formed for the different cultivars. Also, there are no significant differences between the fertilisers and even the correlations are not significant.

6. Discussion of the results

Considering the mean values under various fertilisers, it can be seen that these evolve in an increasing manner, respectively 8.17 ± 2.72 for the control, followed by 8.50 ± 2.62 under sawdust and 8.26 ± 2.68 for decomposed rice husks. All the fertilisers were heterogeneous, with coefficients of variation greater than 30%. These results are superior to those obtained by Lokossou *et al* (2012). In fact, these authors recorded an average number of plantain shoots of 2.75 at 12 months after planting in plots under pure cultivation between planting and natural rejection. These differences are due partly to the cultivars used and partly to growing conditions.

The highest number of offshoots of plantain seedlings was observed in the plantaincowpea association, which is linked to the improvement in soil nutrient status by cowpea. Cowpea is used in various crop associations or rotations for its contribution to soil fertility management through its ability to fix atmospheric nitrogen (Dètongnon *et al.*, 2004).

As for the averages per cultivar for all fertilisers, the number of shoots was 9.37 ± 0.11 for C_6 (Otangala) ; followed by 8.76 ± 0.65 for C_4 ((Mbonjilo) ; 8.43 ± 0.12 for C_5 (Kambelekete) ; 8.03 ± 0.48 for C_1 (Kyankola)$_1$; 7.89 ± 0.19 for C_3 (Mbudi 2) and 7.37 ± 0.48 for C_2 (Mbudi 1).. At 12 months, the plantain-cowpea combination had an average number of shoots of 2.75, slightly higher than the average number of shoots of 2.56 obtained in the pure plantain plot. A comparison of our results with those obtained by Dètongnon *et al (*2004) shows that the cultivars under observation produced more shoots naturally without stimulation. The average number of shoots formed during our experiment ranged from 7.37 to 9.37 for all cultivars. In fact, Dètongnon *et al* (2004) found that the average number of shoots in plots planted with the plantain-manioc combination was less than 1 12 months after planting. These differences can be explained by the genetic characteristics of each cultivar tested and the environment in which the experiments were conducted.

Mbombo(,2014), found in *in situ* culture that the bulbs of Gros Michel, Figue Rose and Yangambi Km 5 produced an average of 5.8 shoots, whereas the average number of shoots produced by the *ex situ* technique was 17.6. In addition, the average number of shoots produced by Gros Michel for both propagation techniques was 9.4. This figure was 10.6 and 15.1 respectively for Figue Rose and Yangambi Km 5. It should be noted that the number of shoots produced ex-situ is higher than that obtained in this study. This difference is attributable to the type of cultivar and the type of experiment.

If we consider the coefficient of variation as a whole (within cultivars), we see that the data are homogeneous, since the coefficients of variation are all below 30%. On the other hand, the data are heterogeneous for fertilisers in the case of controls, sawdust and rice husk on the one hand, and C_1 and C_6 for cultivars on the other, as the coefficients of variation are all greater than 30%.

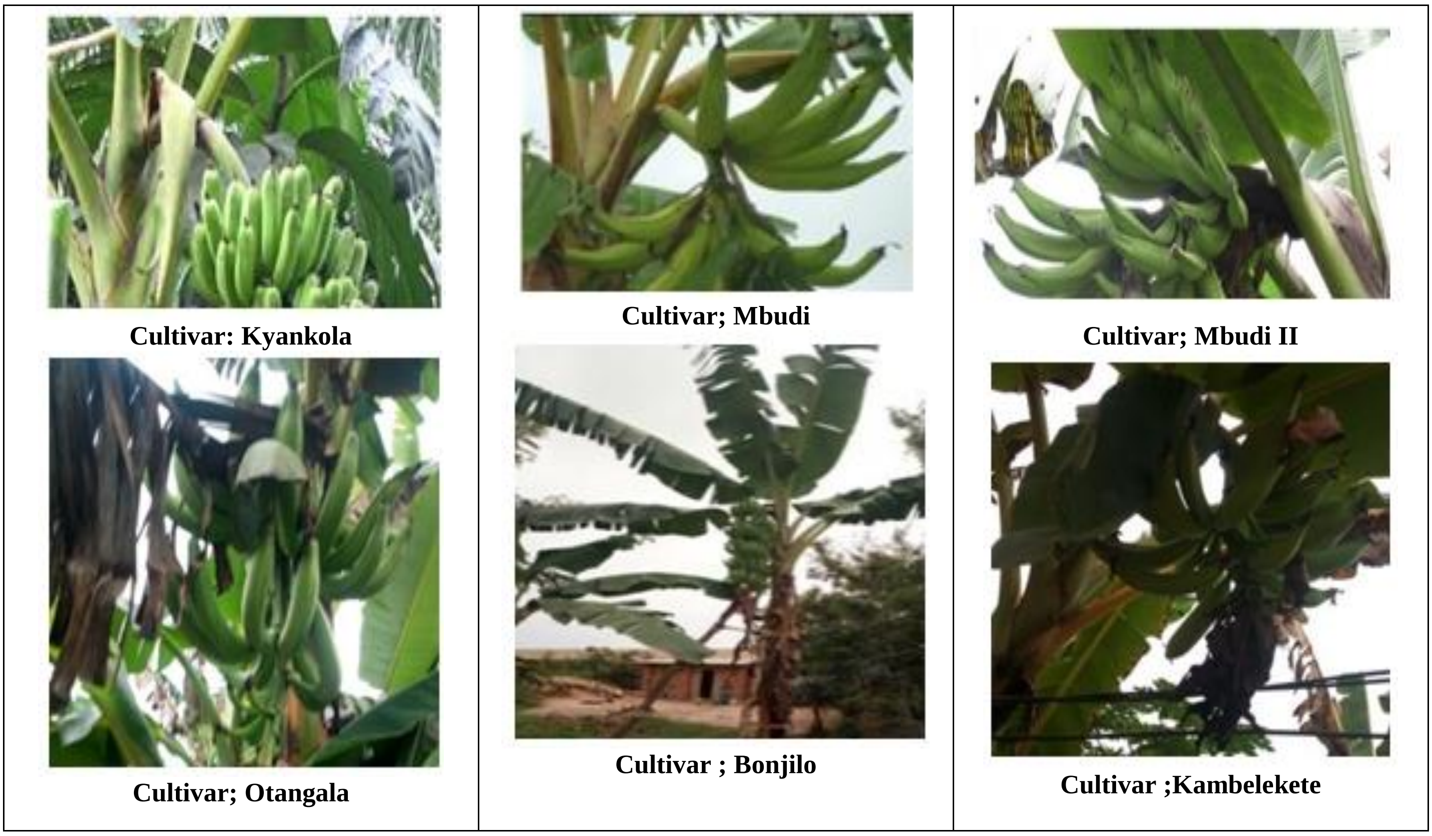
The correlations between the number of shoots and diameter, pseudotrunk height and leaf area were both positive and weakly negative for all cultivars under any treatment.

7. Conclusion

The aim of this study was to assess the ability of the six most popular plantain cultivars collected in five territories of the province of Maneme, under the conditions of the Kindu region, to produce shoots. To do this, the number of naturally formed shoots was measured at 12 months of age for all the cultivars tested and as a function of fertiliser. The trial was conducted using an experimental split-plot design. Observations were made on the number of naturally formed shoots under two fertilisers, sawdust and decomposed rice husks, compared with the control.

The results indicated that 8.17 ± 2.72 were produced for the control, 8.50 ± 2.62 under sawdust and 8.26 ± 2.68 for decomposed rice husks. These numbers did not differ statistically between fertilisers. The averages per cultivar for all fertilisers respectively showed that the number of shoots per cultivar was 9.37 ± 0.11 for C_6 (Otangala) ; followed by 8.76 ± 0.65 for C_4 ((Mbonjilo) ; 8.43 ± 0.12 for C_5 (Kambelekete) ; 8.03 ± 0.48 for C_1 (Kyankola)$_1$; 7.89 ± 0.19 for C_3 (Mbudi 2) and 7.37 ± 0.48 for C_2 (Mbudi 1). These values do not differ statistically between cultivars.

All the results obtained indicate that the six cultivars tested have a similar rejection power ranging from 7 to 9 under different fertilisers.



Cultivar: Kyankola
Cultivar; Mbudi
Cultivar; Mbudi II
Cultivar; Otangala
Cultivar ; Bonjilo
Cultivar ;Kambelekete

Figure 1. Photos of the six cultivars under study

Table 1. Average values for the number of shoots per cultivar under various experimental fertilisers

Cultivars	Indicator	Sawdust	Rice ball	Amounts	Averages	Spreads	CV (%)
C1	7,50	8,17	8,43	24,10	8,03	0,48	5,96
C2	7,50	7,33	7,29	22,12	7,37	0,48	6,49
C3	7,67	8,00	8,00	23,67	7,89	0,19	2,44
C4	8,50	9,50	8,29	26,29	8,76	0,65	7,40
C5	8,50	8,50	8,29	25,29	8,43	0,12	1,47
C6	9,33	9,50	9,29	28,12	9,37	0,11	1,20
Amounts	49,00	51,00	49,57				
Averages	8,17	8,50	8,26				
Spreads	2,72	2,62	2,68				
CV (%)	33,31	30,87	32,42				

Table 2. Comparison of average values for the number of rejects in fertilisers

Fertiliser	Indicator	Sawdust	Rice husks	P- value
Number of rejects	8,17 ± 2,72 [a]	8,50 ± 2,62[a]	8,26 ± 2,68 [a]	0.8615[NS]

Table 3. Comparison of average values for the number of shoots formed in cultivars.

Cultivar	C1	C2	C3	C4	C5	C6	p - value
Discharges	8,03 [a]	7,37[a]	7,89[a]	8,76[a]	8,43[a]	9,37 [a]	0,2548[NS]

Table 4. Coefficient of correlation between crown diameter and number of shoots s formed and analysis of variance

Cultivars	Witnesses		Sawdust		Rice ball	
	r	P- value	r	P- value	r	P- value
C1	- 0.4259	0.2196	- 0.3772	0.2825	- 0.0811	0.8237
C2	- 0.1980	0.5833	0.4441	0.1985	0.0378	0.9174
C3	- 0.7346	0.0155	0.2331	0.5169	0.3992	0.2530
C4	0.5931	0.0707	0.04747	0.8964	0.3927	0.2615
C5	- 0.1771	0.6244	-0.3764	0.2837	- 0.2932	0.4109
C6	0.2515	0.4833	- 0.4905	0.1500	- 0.1609	0.6568

Legend: from C 1 to C 6: Cultivar 1 to Cultivar 6

Table 5. Correlations between Pseudo-trunk height and number of shoots

Cultivars	Indicator		Sawdust		Rice ball	
	r	P -value	r	P -value	r	P -value
C1	0.3696	0.2931	-0.1243	0.7322	-0.1103	0.7616
C2	-0.0768	0.8329	0.4860	0.1544	0.2910	0.4145
C3	0.3357	0.3429	0.1352	0.7096	0.1312	0.7178
C4	0.1467	0.6857	0.1110	0.7600	-0.0357	0.9218
C5	-0.0802	0.8256	-0.5614	0.09122	0.1915	0.5959
C6	0.3230	0.3626	-0.5315	0.1138	-0.3649	0.2998

Table 6. Correlations between leaf area and number of shoots

Cultivars	Indicator		Sawdust		Rice ball	
	R	P- value	r	P -value	r	P- value
C1	-0.3244	0.3604	0.3918	0.2628	- 0.5604	0.8778
C2	-0.3832	0.2743	0.0021	0.9953	0.0959	0.792
C3	-0.5078	0.134	0.1035	0.7759	0.1528	0.6733
C4	0.6204	0.05561	0.1241	0.7326	0.2509	0.4844
C5	-0.5302	0.1149	0.3817	0.2763	0.4508	0.191
C6	- 0.0919	0.8006	0.2498	0.4863	- 0.3571	0.3111

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