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Effect of Thinning and Polling on the Yield of Cassava (*Manihot Esculenta* Crantz) Tubers under Agroecological Conditions of Yangambi City, Democratic Republic of the Congo

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ABSTRACT

A study on the cultivation techniques on cassava has been carried out in Yangambi. Four cultivation practices: polling, thinning, combination of polling and thinning and the control (neither thinning nor polling), have been applied on four selected varieties of cassava namely: N'sansi, Zizila, Butamu and a local one called Mbongo. The results obtained revealed that there is no significant differences between these techniques precisely on the tuber production of these varieties which are differently produced. These yields have been of 21.7 t/ha for Butamu; 28.6 t/ha for N'sansi; 20.2 t/ha for Zizila and 13.5 t/ha for Mbongo (the local variety). The overall results of this study show that polling and thinning combined techniques can be used for the improvement of the cassava productivity in Yangambi city.

. Key words: Manihot esculenta Crantz Yield, Cultural techniques, Yangambi city, Democratic Republic of the Congo.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is the most important subsistence culture in Sub-Saharan Africa because of its high production and its ability to grow on poor soils [1]. Cassava is important for food in tropical regions. However, it also represents a significant rural income source and especially for women in marginal areas. It was reported in the literature that cassava rank 5th in the world of crops after maize, rice, wheat, and potatoes [2].

In Democratic Republic of Congo (DRC), cassava is the staple food of more than 70% of the Congolese population that is amongst the largest producers in Africa after Nigeria, Mozambique and Tanzania [3]. This plant grows anywhere and is the most consumed food and the most marketed, covering about 45% of the total cultivated area of the country [4]. Despite the large areas used for its culture, the production is still insufficient to meet the real needs of the growing population and thus we notice an annual reduction in consumption per capita from 155.5 kg in 1969 to 1971 to 99.0 kg from 1981 to 1983 [5] .

The increase of yield in the cassava production is therefore a question with an urgent need. To solve this problem in DRC, the Cassava National Program (PRONAM) was created in collaboration with the International Institute of Tropical Agriculture of Ibadan (Nigeria) and had as goals to:

Provide to farmers more productive and more resistant material (cassava) to major diseases, and attacks of main pests (insects);

Develop cultivation techniques likely to yield cassava at their point of maximum profitability [6].

Amongst these recommended cultivation practices are found those that are more rational and likely to increase cassava productivity, as rotation, crop rotation, intake of fertilizers and polling.

It was observed that the feet with the first branching was the closest to the ground level, with a larger stem, abundant branches and a higher production in tubers [6].

Thinning and polling carried out at a favorable time would influence positively the yield of tuberous roots by increasing the biomass in promoting a strong branching which would increase the yield of tuberous roots.

Among the different cultivated varieties of cassava, there would be varieties that respond better to thinning and polling. Similarly, the number of stems per plant influences the vegetative capacity and probably also the performance. It can be noticed that the more there are stems by feet, the more these (stems) will be small. Yet the importance of the root collar diameter has a correlation with the tuberous root performance. It is observed that the more the diameter is large; the more the root weight per foot would be high. The biggest stem diameter is obtained when the port is unique.

MATERIAL AND METHODS

Study Area

The geographical coordinates of the experimental site taken from GPS are: 00°49'071 " North latitude and 024°27'502" East longitude. The average altitude is 460 m.

The weather in Yangambi city is of A_f type according to the Köppen classification. The monthly temperature varies in the surroundings around 24.5 °C and 26.3 °C. The warm period is from January to May with a temperature of more than 25 °C.

The study area is part of the Yakonde series as classified by INEAC, characterized by clay content rarely exceeding 30% in the first 60 centimeters of depth and a land slope of more than 3% with a pH that varies between 4.5 to 4.7 [7]. The ground on which the trial was performed was a fallow dominated by the following species: *Panicum maximum, Croton integrifolia, Mimosa invusa, Trema guineensis, Musanga cercopioïdes, Paspalum notatum, Rauwolfia vomitora, Morinda morindoides.*

Methods

The biological material consisted of four cassava varieties, of which three improved varieties which are: Butamu, Zizila and N'sansi as well a local variety: Mbongo.

The adopted experimental design was that of subdivided plots (Split-plot design) with four repetitions. Cultivation techniques below were adopted: polling alone, thinning alone, the combination of polling and thinning; neither polling nor thinning (a control).

Each repetition was subdivided into four main plots, each divided into four sub-plots. Spacing was 1m x 1m and cuttings of 20 to 25 cm were horizontally placed for a cutting by location. Each main plot within a repetition was separated from the next by a distance of 2 m, and a 3 m distance was kept between repetitions. The size of the plots, sub-plots, and repetitions of the test were respectively: 12 mx10 m, 3 m x 10 m, 110 m x 10 m and 110 m x 49 m. The thinning took place a month after planting. It was made up of one stalk by location amongst the stalks coming from the same cutting. At two months, the polling was performed in order to remove the terminal buds with the last three leaves. Four observations concerned the agronomic characteristics: plant height, height of the first branching and root collar diameter while the yield components including the number of tubers per plant, their length, diameter and average weight have been known only at the harvest. The height of plants and the one at the first branching as well as the length of tubers were taken using a tape measure while the stalk collar diameter and the one of tubers were taken using a caliper ruler. The number of tubers was obtained by direct counting while the weight was known by means of a scale of 120 kg capacity.

RESULTS AND DISCUSSION

Height growth of plants

The evolution of the height growth of plants was quarterly followed at 3, 6 and 9 months of planting is illustrated in figure 1.

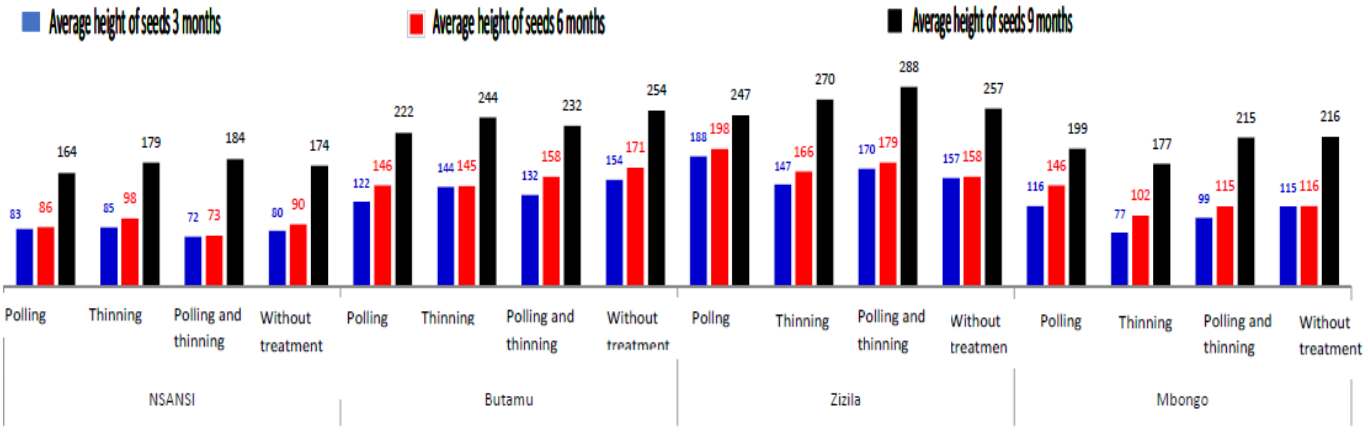

Figure 1: Cassava heights at 3, 6 and 9 months after planting (in cm)

The figure 1 revealed that the vegetative capacity varies with time from one variety to another regardless of the cultivation technique used. The height observed was greater at 9 months with Zizila and lower with N'sansi which doesn't exceed 2 m. Butamu variety and Mbongo the local one, get a height that oscillates around 2 m. The port, the variety, the heterogeneity of the soil, the health of plants could explain this situation.

Root collar diameter of stalks

The growth evolution of stems collar at 3, 6 and 9 months of planting is given in figure 2.

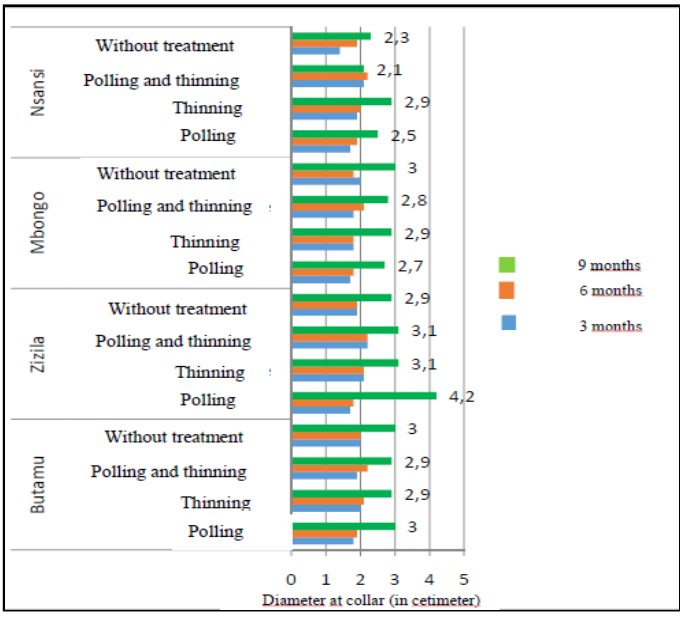

Figure 2: Root collar diameter of varieties according to the applied treatments

It is observed in figure 2 that the pace of stem growth at the collar has obviously been influenced by the cultivation techniques applied to cassava from 6 months; the greatest pace was observed at 9 months with Zizila by polling only (3.3cm), followed by Butamu (2.9 cm) and the smallest observed with Nsansi (2.4 cm). Therefore, it is shown that polling accelerates the growth in diameter of the stalk.

Height at the first branching

Data on the height of the first branching of different applied treatments on the plants are shown in figure 3.

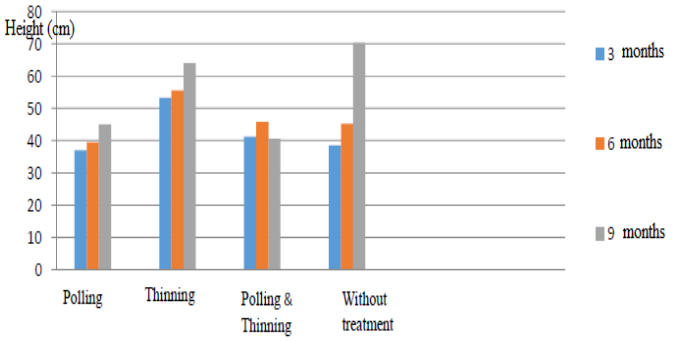

Figure 3: Height of the first branching in connection with the treatments applied

It is noticed in the figure 3 that polling alone provides a low height of branching at 3 months, causing a low branching while thinning alone increases the branching height which can be obtained by thinning associated with polling.

Average number of tubers per plant

The results of the observations on the number of tubers per plant are shown in table1.

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Table 1: Average number of tubers per plant

Varieties	Polling	Thinning	Polling & Thinning	Control	Mean
Nsansi	8.5	7	6.5	7.5	7.4
Zizila	7.5	6	7.25	7.25	7
Mbongo	3.25	2.5	3.25	3.75	3.2
Butamu	9	7	8	9	8.3
Mean	7.1	5.6	6.3	6.9	

Table 2: Tuber Length according to varieties and the applied treatments (cm)

Varieties	Polling	Thinning	PollingThinning	Control	Mean
Nsansi	36.6	34.8	30.3	33	33.7
Zizila	33.1	35.9	29.4	36.1	33.6
Mbongo	26.8	27.4	26.7	29.1	27.5
Butamu	28.2	23.9	26.5	25.7	26.1
Mean	31.2	30.5	28.2	31	

It was observed from the table 1 that the average number of tubers per plant varied according to varieties. The largest number of tubers was obtained from Butamu (8, 3) and the smallest from Mbongo (3, 2). The polled plants get more tubers (7, 1) than the thinned ones (5, 6) while their combination polling-thinning gets lesser tubers (6, 3) than the controlled ones (6,9). These differences could be attributed to the varieties and the environment. Indeed, the number of roots that turn into tubers depends on the variety, the environment and cultivation techniques [8].

Average length of tubers

The results of observations on the average length of tubers are given in table 2.

From table 2, it was noted that the average length of tubers varies depending on the variety. Nsansi and Zizila tubers get longer tubers than Mbongo the local variety which slightly exceeds Butamu. The heterogeneity of soils, intrinsic

characteristics related to the variety and the environment could explain these slight differences observed. The various treatments do not have enough effect on the length of tubers compared with the control which gives approximately the same length.

Average diameter of tubers

Data on the average diameter of tuber according to varieties and applied treatments are shown in table 3.

From table 3, it is noticed that cultivation practices have had more effect on Mbongo the local variety with an average diameter of 5.9 cm followed by Nsansi (5.4 cm). Zizila and Butamu get the smallest diameter. This situation could be attributed to the overall short length tubers observed in these tested varieties.

Tuber Production

Data on the production of tuber according to varieties in relation to the cultivation techniques are reported in table 4.

Table 3. The average diameter of tuber (cm).

Varieties	Polling	Thinning	PollingThinning	Control	Mean
Nsansi	5.2	5.7	5.2	5.2	5.4
Zizila	4.6	4.5	5.0	4.6	4.7
Mbongo	5.8	6.0	5.8	5.7	5.9
Butamu	5.3	4.6	4.1	4.4	4.7
Mean	5.3	5.2	5.1	5.0	

Table 4: Tuber production by variety and applied treatment (t/ha)

		Repetitions					
Varieties	Treatments	1	2	3	4	Total	Mean
Butamu	Polling	17.2	27.1	30.9	17.8	93	23.3
	Thinning	16.5	18.8	22.7	17.4	75.4	18.9
	Polling+ Thinning	13.9	24.2	31.8	15.3	85.2	21.3
	Control	15.6	28.8	31.3	18.3	94.0	23.5
	Sub-total	63.2	98.9	116.7	68.8	347.6	21.7
Zizila	Polling	28.2	35.4	32.5	22.0	118.1	29.5
	Thinning	32.8	27.7	22.3	11.1	93.9	23.5
	Polling+ Thinning	28.0	29.7	25.9	43.8	127.4	31.9
	Control	30.6	28.9	21.9	36.7	118.1	29.5
	Sub-total	119.6	121.7	102.6	113.6	457.5	28.6
Nsansi	Polling	16.1	28.0	21.2	18.1	83.4	20.9
	Thinning	13.7	19.7	10.3	16.3	60.0	15
	Polling+ Thinning	18.9	25.3	24.0	26.4	94.6	23.7
	Control	13.3	27.6	18.5	25	84.4	21.1
	Sub- total	62	100.6	74	85.8	322.4	20.2
Mbongo	Polling	9.8	11.7	18.3	13.1	52.9	13.2
	Thinning	12.1	10.9	15.2	12.7	50.9	12.7
	Polling+ Thinning	10.1	13.3	16.7	14.8	54.9	13.7
	Control	12.9	14.4	13.8	16.3	57.4	14.4
	Sub-total	44.9	50.3	64	56.9	216.1	13.5
Total		289.7	371.5	357.3	325.1	1343.6	
Mean		18.1	23.2	22.3	20.3		

It is noticed from table 4 that the tuber yield varied among varieties from 13.5 to 28.6t/ha. Zizila gets the yield of 28,6t/ha at the harvest and was in the first position followed by Butamu (21.7t/ha); Nsansi (20.2t/ha) and Mbongo (13,5t/ha).

These differences could be attributed to the variety, cultivation practices, soil heterogeneity, and the health status of plants, the environment and the ability of each foot to store synthesized reserves. It was reported that the yield depends on the synthetic capacity of leaves, the ability of plants to transport synthesized products of tubers and the ability of organs to store, to attract and accumulate products in a desirable form [9].

Similarly, the present study revealed that the yield also varied depending on the cultivation practices that give different yields (figure 4). It will be noted from this figure that polling associated with thinning gives 22,6t / ha and thinning alone gives the smallest yield 17,5t / ha. This is also related to the applied treatments to cassava and the variety.

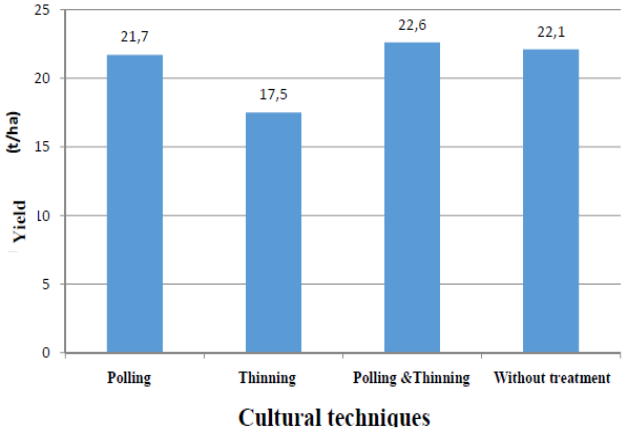

Figure 4: Yield in ton/ha depending on applied practice

Regarding these different values, the analysis of variance (ANOVA) was used to compare the numerical values of tuber production as follow:

- The results from table 4 show that there are no significant differences between the cultivation practices applied on the tested varieties as regards to the tuber production.
- Cultural practices applied to these varieties did not influence statistically the tuber production in the conditions of this test. Also, the statistical analysis did not show a significant difference for the interaction varieties and cultivation practices.
- However, we observed that there is significant difference between varieties as regards to the tuber production.

Newman-Keuls test [10] used to compare means revealed no significant difference between Zizila and Butamu that are different from Mbongo and Nsansi regarding production tubers, the statistical decision is shown below: Zizila>Butamu>Nsasi >Mbongo. Polling carried out at two months gave a lower yield than that obtained by KAMBALE [11] 26.8t/ha. This could be attributed to the soil value, climate and variety [12]. However, our results are clearly superior to those obtained by KAMBALE [11] by leaving only one stem is 6.5 t/ha but higher than 19,8 t/ha, that found on plants collected/harvested in 12 months [13, 14]. These investigations show that the combined polling and thinning while reducing the size of plants increases leaf biomass and production in tubers.

CONCLUSION

This study aimed to verify the hypothesis stating that polling and thinning could increase the yield of cassava tuberous roots. For this purpose, four treatments polling, thinning, combination of polling andthinning and control were applied on four cassava varieties depending on the type of their port namely Zizila (onupright), Nsansi (Medium port), Butamu (branched port), Mbongo local control following a 4 x 4 factorial design in split plot.

The observations were focused on the height of plants, height of the first branching, root collar diameter, number of tubers per plant, length and diameter of tubers and tuber production for each of the tested varieties.

The results show the ability of these selected varieties to grow with the use of different cultivation practices. In culture conditions, these varieties have shown a good vegetative development through a fast growth at the collar and a significant height growth with an increase of the photosynthetic area for all the varieties.

- Polling caused the decline of the panels i.e. the height of the first branching was lower in the feet that have been polled. The average height at the first fork was 40 cm, 70 cm in the plots that have been used as control;
- The yield of fresh roots was lower in thinned plots. Either 17 tons in this treatment against 22 tons in the polling treatment and 23 tons in plots where we applied both polling and thinning. The reduction of the stalk number led to the reduction of the biomass;
- Nsansi and Zizila varieties adapt better to this practice compared to Butamu and Mbongo because of their early branching, Butamu (sometimes less than 1 month) did not clearly show the influence of polling and/or thinning. With Zizila, the production is of 23.5 tons of cassava for the thinning alone and 32 tons for the polling and thinning combined techniques. With Nsansi, the production was of 15 tons for the thinning alone and 24 tons for the polling and thinning combined techniques. The margins are low with Butamu (19 tons for the thinning and 23.5 for the control) and Mbongo (13 tons with the thinning alone and 14 tons in for the polling and thinning combined techniques);
- Yields obtained depend on varieties and are different. Zizila under the conditions of this test is the most productive variety with an average of 28.6 tons followed by Butamu (21.7 tons), Nsansi (20.2 tons) and then Mbongo (13.5 tons).

Although there is no significant difference between the applied treatments on the tested varieties in the production of tubers, polling associated with thinning are more suitable digitally compared to those practices only which also increase cassava yield that confirms our hypothesis.

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