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Research Paper

Comparative study of the effects of leaf-picking methods on tuberous root yield of cassava (Manihot esculenta Crantz var Obama II) in the hinterland of Kisangani, Democratic Republic of Congo.

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ABSTRACT
The study focuses on the conventional method of leaf picking during the cassava crop cycle to reduce the depressive effect on tuber yield. The variety Obama II was used as a test cultivar in an experimental set-up with four treatments: zero picking (T0), light picking (3-5 fully expanded leaves), moderate picking (6-9 leaves) and coarse picking (+ 9 leaves). Results showed that two picking treatments resulted in a 9.73% and 33.69% decrease in tuber yields for light picking (T1) and moderate picking (T3) respectively, while moderate picking (T2) resulted in a 4.22% increase in yield. Analysis of variance (ANOVA) for tuber yield showed no significant difference between treatments, and leaf production was negatively correlated with tuber yield (r = 0.5). Light (T1) and moderate (T2) picking were found to better balance leaf and tuberous root production, while coarse picking (T3) further reduced tuberous root yield.

Key words: leaf-picking modality, yield, tuberous roots, cassava.

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I. INTRODUCTION

Cassava (Manihot esculenta Crantz), an important crop, produced 276 million tonnes in 2013, of which 6% in the Democratic Republic of Congo, serving 300 to 500 million people worldwide, contributing to global food security (Nteranya et al., 2015). The Democratic Republic of Congo attracts farmers with more than half of its subcultures, with 70% of tuberous roots and 80% of leaves permanently consumed (Mahungu et al., 2015). Cassava is grown for its beneficial products in African countries such as Congo and the Central African Republic, leading to leaf collection in rural areas of Congo (FAO, 2013). Studies by Dahniya (1980), Lutaladio et al, (1980), Sandifolo et al, (2010), Litucha (2011), and Mahungu et al (2015) show variable leaf collection, requiring a conventional and standard harvesting method during the cultural cycle.

Dahniya (1980) and Sandifolo et al. (2010) referred to leaf harvesting as leaf stripping for one, and topping and recropping for the other. Litucha (2011) defined leaf harvesting as apical cutting of 20 cm of stems or shoots, containing terminal buds and fully developed young leaves suitable for consumption as vegetables. These studies underline the importance of leaf harvesting in plant production.

Marielle et al.'s (2020) study of the yield of three improved cassava varieties in Nigeria, based on organic fertilizers and leaf harvesting, revealed a loss of 50% (11.09 t/ha), 47% (12.73 t/ha) and 34% (13.82 t/ha) of fresh roots for varieties IBA010040, IBA980581 and IBA071393.

In addition, numerous studies have been carried out on cassava leaf and tuberous root production in the same field, including those by Dahniya (1980), Lutaladio and Ezumah (1982), Sandifolo et al. (2010), Litucha (2011), Mahungu et al. (2015) and Marielle et al. (2020), highlighting the following facts:

- The depressive effect of leaf picking during cropping cycles affects tuberous yield and production, depending on picking method, cultivar and cropping conditions such as fertility, sun and rainfall ;

- Tuberous leaves and roots are two well-used products with opposing requirements in terms of density, type of fertilizer, harvesting time, etc.
- Variations in tuberous yield and production depend on the method, frequency and frequency of harvesting.

The study by Dahniya (1980) revealed that leaf harvesting during the crop cycle reduced tuberous root yield by 56-76%, 34-62% and 15-32% on the TMS30211 variety respectively at intervals of 1, 2 and 3 months. Tuberous root production is less affected by the harvesting of terminal buds (topping or pollarding) than by that of shoots at the base of the plant (portions of stems, branches, with more or less open leaves). The closer the leaf-picking intervals, the smaller the number of tuberous roots, resulting in smaller dimensions and lower total yield.

Naku et al. (1986), assessing average tuberous root production per plant as a function of picking frequency coupled with cutting type, found that bimonthly and monthly picking resulted in fresh tuberous root yield losses in the order of 21.52 to 42.81%; 49.87 to 68.32% and 20 to 74% on plants from apical, medial and basal cuttings respectively.

Naku et al (1986) found that bimonthly and monthly picking resulted in fresh tuberous root yield losses of 21.52 to 42.81%; 49.87 to 68.32% and 20 to 74% on plants from apical, medial and basal cuttings respectively.

Based on these considerations, the present study aims to develop a method for harvesting cassava leaves during the crop cycle that is both conventional and less likely to depress the yield and productivity of tuberized cassava roots.

The aim of this study is to answer the question: how can we develop a leaf-picking method during the crop cycle that will reduce the depressive effect of picking on cassava tuberous root yield and provide a conventional basis for comparing tuberous root yields between different cultivars, trials and fields?Specifically, to answer the following questions:

- How is cassava tuberous root yield related to harvesting methods during the crop cycle?
- Which of the leaf-picking methods studied, by minimizing the depressive effect of this practice, produces more tuberous cassava roots in terms of quantity and quality during the crop cycle?

The general hypothesis is to adopt a harvesting method based on the number of fully opened tender leaves on the portion of stem or shoot to be harvested.

The specific hypotheses are as follows:

The yield of tuberous cassava roots decreases with the increase in the number of fully expanded tender leaves on the portion of stem or shoot to be harvested in each passage during the crop cycle, depending on the leaf-picking modality adopted.

Of the leaf-picking methods tested, light leaf-picking, i.e. picking shoots or portions of the stem with 3 to 5 open leaves, minimized the depressive effect of this practice on tuberized cassava root yield, and ensured higher production of these roots in terms of quantity and quality than the other two methods.

The aim of this study is to develop a conventional leaf-picking modality defined in terms of the number of open leaves on harvestable portions of the stem or shoots, which is likely to minimize the depressive effect of this practice on tuberous root yield, and to serve as a basis for comparing leaf yields between different cultivars, trials and fields.

II. MATERIALS AND METHODS

Environment

This study was carried out in the village of BAKILO located at kilometre point 41 of the city of Kisangani, route nationale 4, in the concession of the Institut Facultaire des Sciences Agronomiques de Yangambi. The geographical coordinates of the experimental site taken with GPS are 00°28.583' longitude North; 025°31.634' latitude East at 482m altitude.

The climate of the experimental site is that of the city of Kisangani, which is equatorial continental hot and humid of the Af type according to Köppen's classification of Thornwaite's class B (Alongo et al., 2013). Its average temperature hovers around 25°C according to Van Wambeke and Libens (1957), rainfall is abundant (1800 mm on average) and distributed throughout the year according to two more or less rainy seasons, one very rainy running from September to November, the other less humid, relatively short, running from March to May.

The trial period ran from May 15, 2022 to April 15, 2023. Table 1 shows the climatic data for the trial period.

Table 1: Climatic data during the trial period

Mounths & Years	Precipitation (mm)	Temperature (°C)		
		Max	Min	Average
May 2022	2	33	20,5	26,75
June 2022	0	32,5	18,6	25,55
July 2022	95	30,1	19	25,05
August 2022	0	32,8	19	25,9
September 2022	0,4	33	19,5	26,25
October 2022	99	33,5	19,5	26,5
November 2022	10	31,5	20	25,75

December 2022	0	34,5	17	25,75
January 2023	0	33,5	19	26,25
February 2023	0	34,5	19	26,75
March 2023	0	34,5	19	26,75
April 2023	10	28	11,5	19,75
TOTAL	**216,4**	**391,4**	**221,6**	251
Average	**18,03**	**32,6**	**18,47**	25,55

Source: Kisangani weather station, designator 64040.

The soil at the experimental site belongs to the ferralitic soil family and to the oxysol order according to the soil taxonomy, and to the Ferralsols group according to the FAO-UNESCO classification (Kombele, 2004). The experimental site was a fallow dominated by the following plant species: *Musanga cecropioides, Pueraria javanica, Urena lobata, Megaphrynium macrostachyum et Bacteria nigritana*.

Material

The biological material used in this experiment consisted of cassava (Manihot esculenta Crantz) cuttings of the Obama II variety.According to SENASEM RDC (2019), this variety is of Nigerian geographical origin, and its genetic origin is IITA in 2015, of which INERA M'VUAZI is the breeder and responsible for its maintenance.

Methods

The experimental site was chosen on the basis of safety and socio-economic factors (availability of manpower and plant materials, accessibility, etc.). The choice of site was based on the following factors: previous crops, relief and location. For the preparatory work, we proceeded successively to demarcate the land, clear, stump and clear. The cuttings came from a lumberyard close to the experimental site in the village of BAKILO. After harvesting the stems, we stored them under shade for two weeks, then cut them into cuttings of 20 to 25 centimetres each with an average of 4 to 6 nodes.

The experimental set-up used for our study was that of a Latin square with 4 replicates, each comprising 4 treatments. The treatments compared were as follows:T0: Controls (zero harvesting); T1: Light leaf harvesting, i.e. harvesting the apical parts of stems or shoots with 3 to 5 fully expanded leaves; T2: Moderate leaf harvesting, i.e. harvesting the apical parts of stems or shoots with 6 to 9 fully expanded leaves; and T3: Coarse leaf harvesting, i.e. harvesting the apical parts of stems or shoots with 10 to 15 fully expanded leaves.

The total surface area of the experimental field was 47.5m x 47.5 m, i.e. 2256.25 m², and that of the plots 1 are (10m x 10m). Blocks and plots were separated by 1.5m aisles.We adopted 1m x 1m spacing for cuttings.The experimental set-up is shown in figure 1.

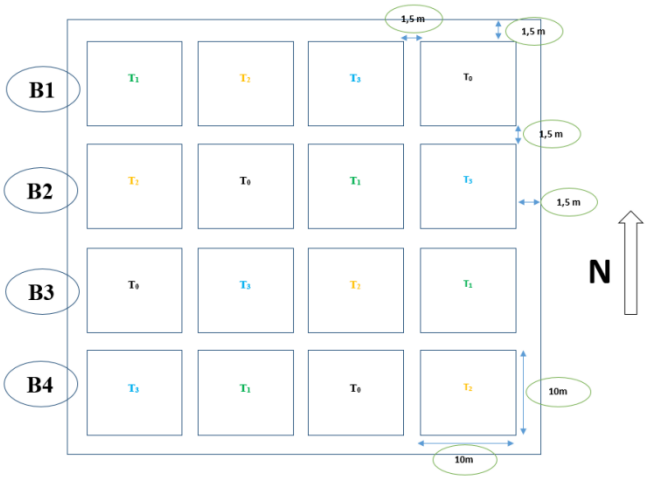

Figure 1: Experimental trial set-up

Legend: T1: Light leaf plucking, T2: Moderate leaf plucking, T3: Coarse leaf plucking, T0: Control (zero leaf plucking).

ObservationObservations were made on the following parametersaverage total number of tuberous roots per cassava plant, average number of marketable cassava tuberous roots per cassava plant, average diameter of marketable tuberous roots, average length of marketable tuberous roots, average yield of marketable cassava

tuberous roots (t/ha), average yield of cassava tuberous roots (t/ha), regression line between yield of tuberous roots and cassava leaves.

Data were encoded using Excel software.For statistical analysis, R consol 4.3.2 was used. The Shapiro test was used to test the normality of the data, and a single-criterion analysis of variance was used to reveal differences (F-test) at the 5% threshold between treatments. The relationship between leaf yield and tuberized root production was measured using a coefficient of determination (R^2).

III. RESULTS AND DISCUSSION

Effect of leaf-picking modality on the average number of tuberous cassava roots per plant

Figure 2 shows the results in relation to the total number of tuberous roots per plant, according to each modality used in the trial.

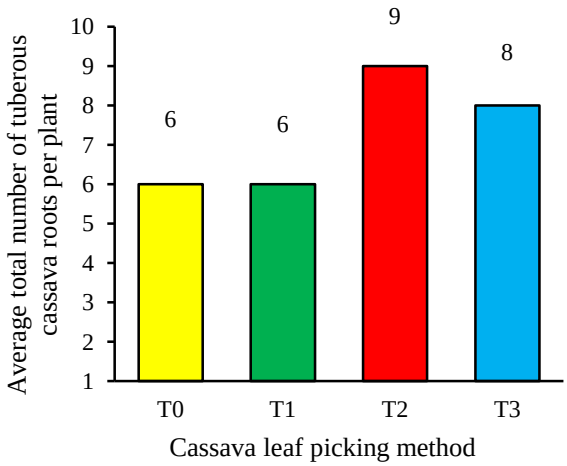

Figure 2: Total average number of tuberous roots per cassava plant.

Legend: T1: Light leaf picking, T2: Moderate leaf picking, T3: Coarse leaf picking and T0 Control (zero leaf picking).

Looking at Figure 7, we can see that the average total number of tuberous roots per plant varied between 6 and 9, depending on the harvesting method applied to the experimental units. In terms of the average total number of tuberous roots per plant induced, the different modalities rank in ascending order as follows: T0 (6) = T1 (6) < T3 (8) < T2 (9). We note that the plants subjected to moderate picking during the crop cycle (T2) produced the highest average number of tuberous roots per plant, i.e. 9 on average. This puts them in first place.

Effect of leaf-picking method on the number of marketable tuberous roots per plant

Data on the number of marketable tuberous roots are shown in Figure 3.

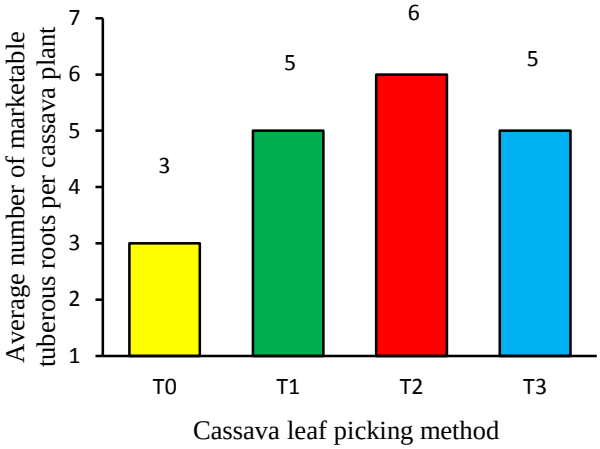

Figure 3: Average number of marketable cassava tuberous roots per plant.

Legend: T1: Light leaf picking, T2: Moderate leaf picking, T3: Coarse leaf picking and T0 Control (zero leaf picking).

With regard to marketable tuberous roots, Figure 3 shows that the average number of tuberous roots per plant generally followed the same trend.Based on the average number of marketable tuberous roots per cassava plant recorded during our experiment, the harvesting methods are ranked in descending order as follows:T2 (6) > T3 (5) = T1 (5) > T0 (3).In terms of percentage, the ratio between the number of marketable tuberous roots and the total number of tuberous roots obtained per cassava plant ranks the treatments in descending order as follows:T1 (71.4%) > T2(66.7) > T3 (62.5%) > T0 (50%). The moderate picking modality produced more marketable tuberous roots than all the others, with a rate of 66.67% of the total number of tuberous roots produced per plant.Effect of leaf-picking modality on marketable tuberous root diameter

The results for tuberous root diameter (marketable and non-marketable) are shown in figure 4.

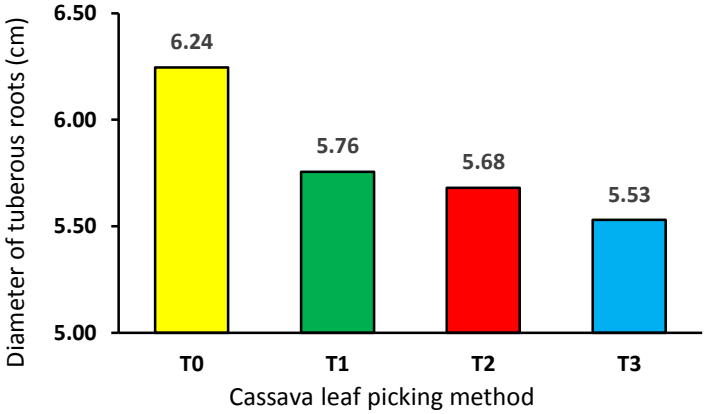

Figure 4: Average diameter of marketable tuberous roots.

Legend: T1: Light leaf plucking, T2: Moderate leaf plucking, T3: Coarse leaf plucking and T0 Control (zero leaf plucking).

Examination of the data in Figure 4 shows that the average size of marketable tuberous roots varied little from one modality to another, within a range of 5.53 to 6.24 cm in our trial. This indicates that this parameter is a varietal characteristic that varies within a given range according to individual aptitudes and field soil heterogeneity.Based on the size of the marketable tuberous roots harvested, the different harvesting modalities are ranked in ascending order of size as follows:T3 (5.53 cm) < T2 (5.68 cm) < T1 (5.76 cm) < T0 (6.24 cm).These results suggest that the practice of leaf picking during the crop cycle tends to reduce the average diameter of tuberous cassava roots.

Effect of leaf-picking modality on marketable tuberous root length

Figure 5 shows the average length of marketable tuberous cassava roots.

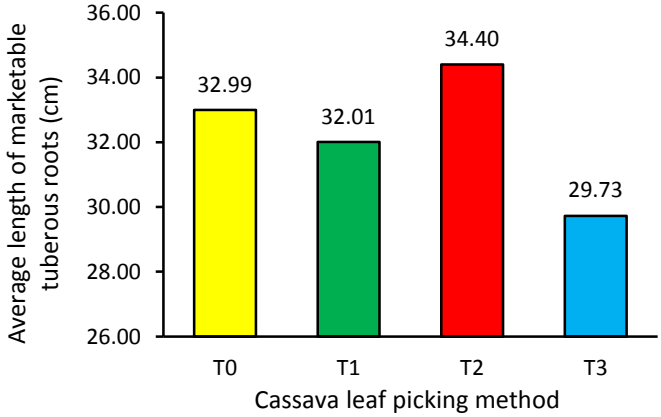

Figure 5: Average length of marketable tuberous roots.

Legend: T1: Light leaf plucking, T2: Moderate leaf plucking, T3: Coarse leaf plucking and T0 Control (zero leaf plucking).

Examination of the data in Figure 5 generally shows that the average length of tuberous roots varied little according to the harvesting modalities applied, ranging from 29.73cm to 34.40cm.As in the case of average tuberous root size, this yield component also remains a varietal characteristic, varying only slightly under the

same growing conditions.Based on the size of the tuberous roots harvested, the different harvesting modalities are ranked in ascending order of size as follows:T3 (29.73 cm) < T1 (32.01 cm) < T0 (32.99 cm) < T2 (34.40 cm). The results recorded in our trial show that the practice of leaf picking has a different impact (either positive or negative) on the average length of tuberous cassava roots.Effect of leaf-picking method on marketable tuberous root yield

Data relating to marketable tuberous root yield are shown in figure 6.

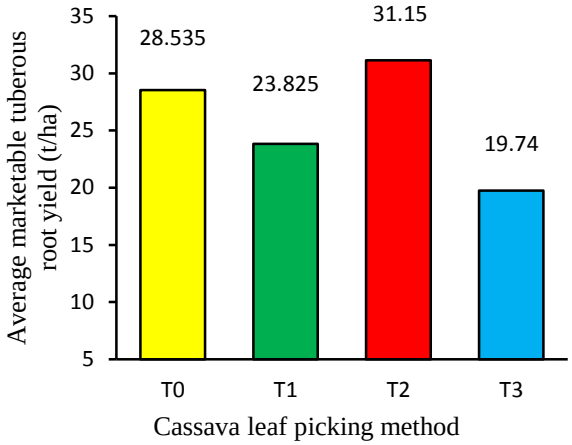

Figure 6: Average marketable cassava tuberous root yield (t/ha).

Analysis of Figure 6 shows that the average marketable tuberous root yield varies between 19.74t/ha and 31.15t/ha for all treatments tested. The treatments are ranked in descending order of average marketable tuberous root yield as follows:T2 (31.15t/ha) > T0 (28.54) > T1 (23.83t/ha) > T3 (19.74t/ha).The superiority of T2 (moderate picking) is due to the number of marketable tuberous roots, their length and size, which it produced compared with the other modalities.The moderate picking modality produced more marketable tuberous roots than the other modalities.This result shows that the application of this modality (T2: moderate picking) in cassava cultivation enables farmers to produce more good-quality tuberous roots likely to bring in a large income if the harvest is marketed.

Effect of leaf-picking modality on total tuberous root yieldThe average total tuberous root yield obtained by each treatment tested is shown in Figure 7.

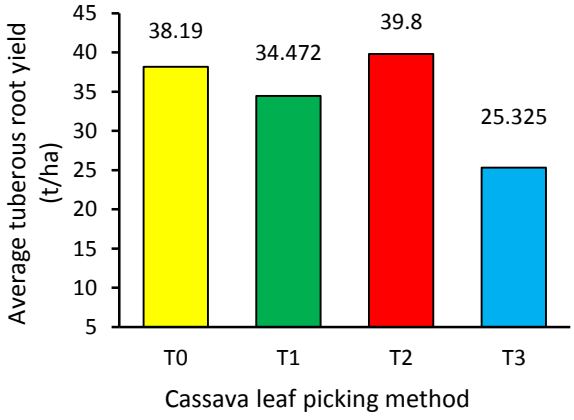

Figure 7. Average yield of tuberous cassava roots (t/ha).

Legend: T0: zero picking; T1: light picking, T2: moderate picking, T3: coarse picking.

Generally speaking, the average yield of tuberous cassava roots varied from one harvesting method to another, ranging from 25.325 to 39.8 t/ha.The different harvesting methods tested and compared in terms of average yield of tuberous cassava roots are ranked in descending order as follows:T2 (39.8 t/ha) > T0 (38.19 t/ha) > T1 (34.472 t/ha) > T3 (25.325 t/ha).T2's superiority over the other treatments in terms of tuberous root yield is explained by the fact that it enabled the plants to produce more tuberous roots per plant (figure 2) and of greater length and size (figures 4 and 5). Compared with the control (T0), apart from moderate leaf-picking, which

increased tuberous root yield by 4.22%, the other two leaf-picking methods (T1 and T3) resulted in yield reductions of 9.73% (light leaf-picking) and 33.69% (coarse leaf-picking).

The analysis of variance (ANOVA) for tuberous root yield showed that there were no significant differences between treatments, despite the numerical differences that emerged.

This result confirms our general hypothesis, as the light picking modality (picking of 3 to 5 fully opened tender leaves on the portion of the stem or shoot to be harvested) reduced the depressive effect of picking on tuberous root yield in our case of the Obama II cultivar. However, these results do not confirm the two specific hypotheses, as moderate picking (T2) gave a higher yield than light picking (T1) and the control or zero picking (T0). This means that cassava tuberous root yield does not decrease with the increase in the number of open tender leaves on the part of the stem or shoot to be harvested in each pass of the crop cycle.Also, T1 (light picking) is not the picking modality that gives the highest yield of tuberous roots, either in quantity or quality (marketable tuberous roots).

Relationship between leaf-picking modality and tuberous root production

Figure 8 shows tuberous root yield in relation to cassava leaf yield.

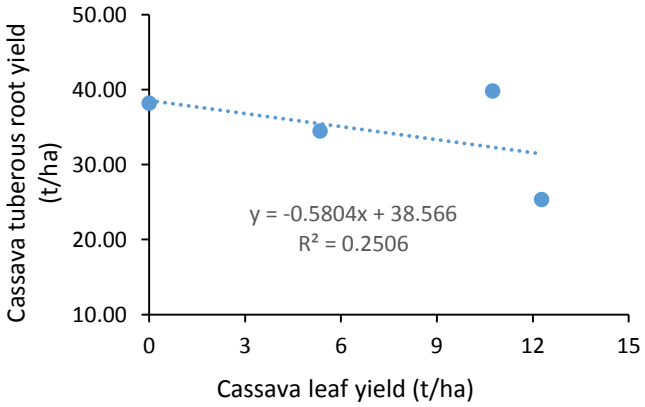

Figure 8: Regression line between cassava tuberous root yield and cassava leaf yield.

Figure 8 shows, for cassava tuberous root production coupled with leaf yield, that considering a starting cassava tuberous root yield of the order of 38.566 t/ha, each unit increase in cassava leaf production (1t/ha) is associated with a decrease in tuberous root yield of the order of 0.5804t.Leaf production is negatively correlated with cassava tuberous root yield (r = 0.5).

From the numerical data recorded and the results of the statistical analyses carried out, it can be seen that tuberous root yield evolves in the opposite direction to the increase in cassava leaf production.In other words, as cassava leaf yield increases, tuberous root yield decreases. This confirms the first specific hypothesis of our study.

IV. DISCUSSION

The average number of 8 tuberous roots per plant found under the coarse-picking modalities (T3) is identical to that indicated in the SENASEM RDC varietal catalog (2019), while that of 9 induced by T2 is higher than this reference value. Cultivation conditions (soil fertility, rainfall, cultivation care, health status, etc.) justify the differences in average number of tuberous roots per plant observed between our trial and that reported in the varietal catalog.

In his study on the influence of picking frequency coupled with the level of secondary infection, Litucha (2011) harvested an average of 4 to 5 marketable tuberous roots per plant on Mbongo cultivar plants not subjected to picking.This number is higher than the 3 found in our trial with the Obama II variety. Similarly, for monthly picking, our results (5 to 6 tuberous roots per plant) are higher than those of 1 to 3 reported by Litucha (op.cit) and within the range of 3 to 6.5 recorded by Owor et al. (2004) in Uganda. These comparisons show that the average number of plants produced per plant depends on the genetic potential of the cultivar used and on cultivation conditions (soil fertility, health of propagation material used, frequency of leaf harvesting, etc.).

By subjecting the Mbongo cultivar to monthly and bimonthly leaf picking during the crop cycle, Litucha (2011) harvested tuberous roots 5.5cm in diameter for the 2 frequencies; a size equal to that of tuberous roots produced under T3 (5.53cm) and close to that recorded under T2 (5.68cm) and T1 (5.76cm) during our study using the Obama II variety.On the other hand, for plants not subjected to leaf collection (T0:6.24cm), tuberous roots produced by those of the Obama variety are slightly larger than those supplied by plants of the Mbongo cultivar (5.7cm) exploited by Litucha (op.cit).With the exception of the length of marketable tuberous roots recorded under T3 (29.73cm), the lengths of marketable tuberous roots from the 3 other leaf-picking

modalities tested (T0, T1, T2) are all greater than those of 28 to 30.5cm found by Litucha (2011) with the Mbongo variety subjected to the different leaf-picking frequencies. These differences between our results and those of the predecessor can be explained in the same way as for the number of tuberous roots mentioned above.Our results show that the harvesting modality affects tuberous root yield differently, sometimes positively (T2), sometimes negatively (T1 and T3).This finding is in line with that of Lutaladio et al. (1980), who observed that, under the same conditions, the yield of tuberous roots could be reduced.

Comparing our results with those of Dahniya (1980), Lutaladio et al (1980), Sandifolo et al (2010) and Litucha (2011), Mahungu et al (2015), the yield losses of recorded under modalities T1 (9.7%: light picking) and T3 (33.69%:coarse picking) fall within the range of tuberous root yield losses reported by our aforementioned predecessors during their trials devoted to cassava leaf and tuberous root production in the same field ranging from 21.52% to 94%. The loss in tuberous root yield under modality T3 (33.69%) is approximately equal to that found by Marielle et al. (2020), which was 34% using variety IBA071393 in south-west Nigeria. The T0 yield (38.19 t/ha) found in our trial is higher than that recorded by Lutaladio et al. (1980), which was 14.5 and 30.2t/ha for varieties Kangu and 02864 respectively.

Lutaladio et al (1980) tested the effect of repeated (frequent) picking and monthly picking during the crop cycle on the local variety KANGU and the improved cultivar 02864 in central Kongo.Repeated picking resulted in losses of 66% for the local variety and 49% for the improved variety, while monthly picking resulted in tuberous root yield losses of 24.13% and 16.56% for the local KANGU variety.

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References

[1]. Alongo, S., Visser, M., Drouet, T., Kombele, F., Colinet, G. & Bogaert, J. 2013. Effets de la fragmentation des forêts par l'agriculture itinérante sur la dégradation de quelques propriétés physiques d'un Ferralsol échantillonné à Yangambi, RD. Congo. TROPICULTURA, 2013, 31, 1, pp 36-43. Yangambi, RD. Congo.

[2]. Dahniya, M.T. 1980 : Effets de l'effeuillage et de l'écimage sur les rendements en feuilles et en racines du manioc et de patate douce. In Terry E.R., Oduro K.A. et Caveness F. (Rédacteurs). Plantes – racines tropicales : Stratégies de recherche pour les années 1980. Compte rendu du premier symposium triennal de la Société internationale pour les plantes – racines tropicales. Direction Afrique. Organisé du 8 au 12 septembre 1980 à Ibadan, Nigeria, pp 145 – 150.

[3]. FAO, 2013. http://www.fao.org/wairdocs/, consulté le 08/06/2022 à 16H51. Ngonde N.R., S.D.: Paper 11: Root and tuber crops in DRC: Importance for Food Security and Contribution to improvement of statistic.

[4]. Jansens, M. 2001. Plantes à racine et à tubercules, in Raemakers, R.H (éd). Agriculture en Afrique tropicale. Direction internationale de la coopération internationale, Bruxelles, Belgique, p163.

[5]. Kombele B. F. 2004. Diagnostic de la fertilité des sols dans la cuvette centrale congolaise. Cas des séries Yangambi et Yakonde. Thèse de doctorat, Faculté Universitaire des Sciences Agronomiques de Gembloux.

[6]. Litucha, B.M. 2011. Effet de la cueillette des feuilles et du niveau d'infection secondaire de la culture par la mosaïque africaine du manioc sur la production (cultivar Mbongo) dans les conditions agro- écologiques de Kisangani. Thèse de doctorat, I.F.A Yangambi, R.D. Congo.

[7]. Lutaladio N.B. & Ezumah, H.C. 1980. La récolte des feuilles de manioc au Zaïre, in plantes racines tropicales. Stratégies de recherches pour les années 1980, pp142-144.

[8]. Lutaladio, N.B. & Ezumah, H.C. 1982. Récolte des feuilles de manioc au Zaïre, Symposium triennal sur les plantes-racines de la Société internationale pour les plantes-racines tropicales - Direction Afrique, sept. 1980, Ibadan, pp 8-12.

[9]. Mahungu, N., Ndonda, A., Frangoie, A. & Moango, A. 2015. Effet du labour et du mode de bouturage sur les rendements en racines et en feuilles de manioc dans les zones de savane et de jachères forestières de la République Démocratique du Congo, 33(3), pp 176-185.

[10]. Moita-Nassy, M., Hauser, S., Egwekhide, M., Batawila, K., Kulakow, P. & Abberton, M. 2020. Rendement en feuilles et racines de trois variétés améliorées de manioc (Manihot esculenta Crantz) en réponse aux fertilisants organo-minéraux et à la récolte des feuilles au Sud-Ouest du Nigeria, Institut International d'Agriculture Tropicale (IITA), Unité d'agronomie, Système Racines et Tubercules, BP 5320, Etat d'Oyo, Ibadan, Nigeria. In Université de Lomé (Togo), Faculté des Sciences, Département de Botanique, Laboratoire de botanique et écologie végétale (LBEV), BP 1515, Lomé Togo, édition 2020, pp1435-1436.

[11]. Naku M., Ruhigwa B. & Mwangalalo K. 1986. Etude de l'influence du type de bouture et de la récolte des feuilles sur la qualité des tubercules de manioc (var. 146). Annales de la faculté d'agronomie de Yangambi, 7(1): 13-18.

[12]. Nteranya Sanginga & Mbabu, A. 2015 : Racines et Tubercules (Manioc, Igname, Pomme de Terre et Papate Douce), Nourrir l'Afrique, Groupe de la banque africaine de développement, Union Africaine, Nations Unies, Commission économique pour l'Afrique, Centre international de conférences Abdou Diouf, Dakar Sénégal, p5-6.

[13]. Owor B., Legg J.P., Okao – Okuja G., Obonyo R. & Ogega – Latigo W., 2004. The effect of cassava mosaic geminivirus ou symptum severity, growth and rootyield of cassava masaic diesease – susceptible cultivar in Uganda. Ann. Appl. Biol. 145 : 331-333.

[14]. Philippe V., Boni N. & Nadine Zakhia-Rozis., 2018. Le manioc, entre culture alimentaire et filière agro-industrielle ; Éditions Quæ, CTA, Presses agronomiques de Gembloux ; ISBN (Quæ) : 978-2-7592-2708-2 ISBN CTA : 978-92-9081-620-1 ISBN (PAG) : 978-2-87016-1531 ISSN : 1778-6568. CTA, Postbus 380, 6700 AJ Wageningen, Pays-Bas, www.cta.int; Éditions Quæ, RD 10, 78026 Versailles Cedex, France, www.quae.com; Presses agronomiques de Gembloux, Passage des Déportés, 2, B-5030 Gembloux, Belgique, www.pressesagro.be; pp34-35.

[15]. Sandifolo, VS., Mahungu, NM., Mkumbira, J., Moyo, CC., Mhone, A. &Benesi, IR. 2010. Effet de la récolte des feuilles de manioc sur le rendement et la qualité des racines. Dans : Actes du 10ème symposium ISTRC-AB au Mozambique : cultures de racines et de

tubercules pour la réduction de la pauvreté grâce à la science et à la technologie pour le développement durable, (pp. 168-173), 8-12 Octobre, Maputo.

[16]. SENASEM RDC, 2019. Catalogue National Variétal des Cultures Vivrières ; Répertoire des variétés homologuées de plantes à racines, tubercules et du bananier. Secrétariat Général à l'Agriculture, Ministère de l'Agriculture, République Démocratique du Congo, édition 2019.

[17]. Station météorologique de Kisangani, indicatif 64040 : https://www.infoclimat.fr/climatologie/annee/2022/kisangani/valeurs/64040.html

[18]. Sylvestre, P. & Arraudeau, M. 1983. Le manioc, édition G.-P. Maisonneuve et Larose, 15, Rue Victor-Cousin, Paris (Ve) ; Agence de coopération culturelle et technique, 13, quai André-Citroën, Paris (XVe) ; ISBN : 2-7068-0831-4 et 92-9028-041-7 ; pp75-79.

[19]. Van Wambeke A. & Libens L., 1957. Notice explicative de la carte des sols et de la végétation du Congo Belge et de Rwanda Urundi, INEAC.