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**Research Paper**

# Agronomic performance of 27 local cassava cultivars (*Manihot esculenta* Crantz) characterized in the Bengamisa region, Tshopo Province, Democratic Republic of Congo

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***Abstract***
*Cassava is an important source of food and income for rural communities in the Democratic Republic of Congo. On small family farms, farmers have a large number of cultivars that have not been exploited by research. The aim of this study was to evaluate the agronomic performance of 27 local cassava cultivars undergoing characterization in the Bengamisa region. The aim was to identify which cultivars would offer useful agronomic performance for the crop improvement program and for farmers.In this context, an experiment was conducted in the concession of the Bengamisa Higher Institute of Agronomic Studies in the Bengamisa region, Banalia Territory, Tshopo Province in the Democratic Republic of Congo from 2022 to 2023 and lasted 12 months.A randomized complete block design with 27 treatments (cultivars) repeated four times was set up.Plant height at harvest, number of tubers per plant and weight per plant were studied after 12 months of planting.The following results were obtained. Cultivars with useful agronomic performance were highlighted for use in the crop improvement program and for farmers; these cultivars were grouped into three categories: lowest, medium and highest; least productive, medium and most productive and Plant height is not necessarily related to the number of tubers and their weight.The tallest cultivar was not necessarily the most productive, with a few exceptions, and the lowest cultivar can also be more productive.*

***Key words: cassava, cultivar, performance, tubers***

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## I. Introduction

In most African countries, agriculture is undoubtedly the most important sector for the economy of non-oil exporting countries (Mkpado, 2013).Roots and tubers, notably cassava, sweet potatoes, yams and potatoes, are among the most important primary crops (Lawrence et al., 2006).

They have long been the main source of food and nutrition for many of the world's poorest and most undernourished populations. They are generally valued for their stable yields in conditions where other crops are likely to fail (Lawrence et al., 2006).

Among these, cassava is attracting a great deal of attention and has seen its importance grow in both industrial and family farming.Today, it has evolved towards monoculture, high-yielding genotypes and greater use of irrigation and agrochemicals. It's a crop that also lends itself to intensification.But this intensification is fraught with major risks, including the resurgence of pests and diseases and soil depletion (FAO, 2013).

Worldwide, the five biggest producers (FAO estimates for 2008 based on root production volumes alone) are Nigeria (44.5 million tonnes), Brazil (26.7 MT), Thailand (25.1 MT), Indonesia (21.5 MT) and the

DRC (15 MT) (FAOSTAT, 2011).In Africa, Nigeria is followed by the DRC, Ghana (11.3 MT), Angola (10 MT) and Tanzania (6.6 MT), and cassava is used exclusively for human consumption (FAOSTAT, 2009).

Africa accounts for 50% of the world's cassava production, and although cassava occupies larger areas, yields remain low and unevenly distributed.Average yields are highest in Nigeria (11 t/ha), 21 t/ha in Thailand, 18 t/ha in Indonesia and 14 t/ha in Brazil (FAOSTAT, 2009).

Despite this high level of production, the cultivation system remains traditional, relying for the most part on cultivars with low production potential (less than 15 t/ha), and sensitive in the medium term to meeting the ever-increasing food demand of a growing world population.Enhancing the value of local cassava cultivars for food is one such strategy for preserving agro-diversity and, by the same token, adapting farming systems to climate change (Marjolaine, 2015).

In tomorrow's world, with more frequent droughts and where farmers will have to exploit increasingly less fertile soils, the use of local cassava cultivars that are resilient to climate change; tolerant or resistant to adverse conditions is necessary.These local cultivars exist within the diversity of cassava grown today in rural areas (Abbott, 2005).

In the Bengamisa region, cassava, along with rice*(Oriza sativa* L.), plantain*(Musa* spp.), maize*(Zea mays* L.), sweet potato*(Ipomoea batatas* L.), taro*(Colocasia esculenta*), and macabo*(Xanthosoma sagittifolia* (L. ) *Schott*) the seven staple food crops that contribute to food security, these agronomic and ecological characteristics of cassava, as well as its potential for transformation into numerous food and non-food derivatives, give it a special importance in the lives of farmers or baloni, sowers, who come into contact with it on a daily basis and take care of it in the family fields (Bolakonga, 2017).

Both national and international cassava research programs aim to make available to growers new selected or improved varieties capable of expressing superior agronomic and technological traits to local cultivars and pre-existing improved varieties.The main selection criteria include yield and resistance to diseases (mosaic, bacterial blight) and pests (mites, mealy bugs).

In the various production basins of the Bengamisa region, farmers use several local cassava cultivars in their fields to ensure good yields. The use of several cultivars with very different cycles does not meet the needs of the population.

The study consisted in setting up 27 local cassava cultivars in Bengamisa, in 2023, collected from different production basins in the Bengamisa region, with the aim of characterizing them. The aim of this work was to evaluate the agronomic performance of 27 local cassava cultivars undergoing characterization in the Bengamisa region.

## II. Materials and methods

### Study site

The study took place in the concession of the Institut Supérieur d'Etudes Agronomiques de Bengamisa in Bengamisa region, Banalia Territory, Tshopo Province, Democratic Republic of Congo, and lasted 12 months.The site's GPS coordinates are 00°58'50.2" N latitude North and 25° 14 ' 15 .9"E longitude East. Our site has an average altitude of 437 m.

The site's climate is of the Af type of Koppen's classification, a hot, humid climate with an aridity index of 47. Average monthly insolation ranges from 30% to 55%.The region experiences regular high rainfall, with a short two-month dry season between mid-December and mid-February. Average annual rainfall varies between 1,600 mm and 1,700 mm.The site's soils are heavy clay, but also include sandy-clay, sandy-sandy, sandy-clay and soils with humus-bearing horizons. The pH ranges from 4.5 to 5.5.The vegetation is dominated by primitive *Gilbertiodendron dewevrei* forests, heterogeneous primitive forests with local *Cynometra* dominance, secondary forests, fallow and forest recurrence, riparian and swamp forests (Van Wambeke, 1958).
The dominant vegetation on the site was composed of *Chromoleana odorata, Panicum maximum*, *Purera javanica, Mimosa* sp., *Andropogon goyanus ; imperata* sp and *Loudetia arundinacea.*

### Materials

The plant material used consisted of 27 local cassava cultivars collected from ten production basins in the Bengamisa region. These local cassava cultivars were referenced by vernacular names and codes.

### Methodology

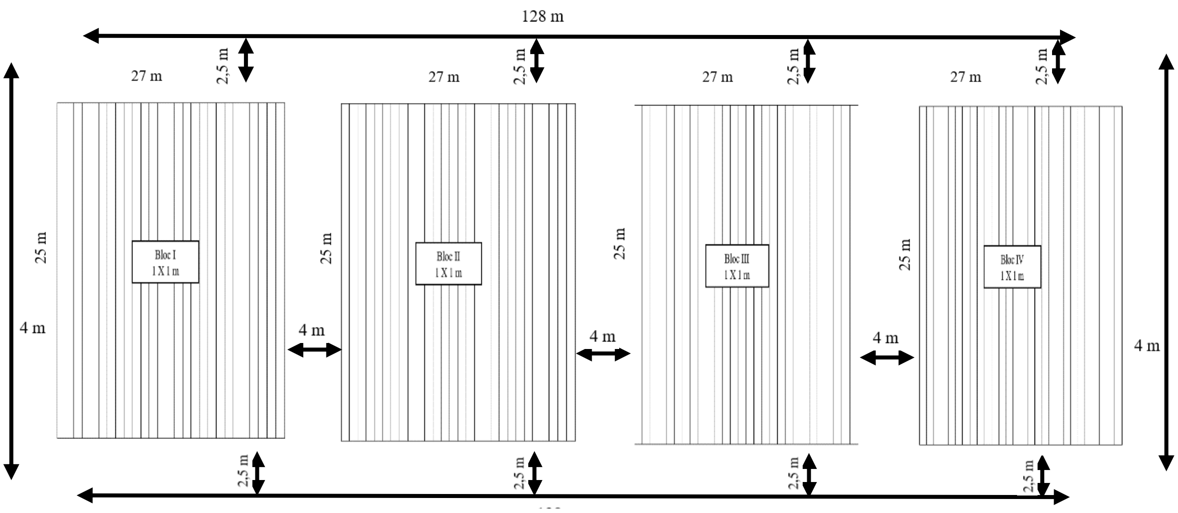
#### Survey and collection of local cassava cultivars

Considering the data on the subdivision of production basins in the Bengamisa region presented in Table 7.1 (Prodat, 2015), we scoured the entire region to cover all basins and the various cultivars were collected. Collection operations were based on farmers' declarations. In the farmers' fields, we took cuttings corresponding to local cassava cultivars with phenotypic differences. Fifty cuttings of around 100 cm were taken for the local cultivars identified, then bevelled using a disinfected machete.

They were then collected, packed in coded plastic bags and labelled. Accessions were assigned two-digit numbers, the first indicating the collection production basin and the last designating the order in which collection was carried out.Collection fields were located at least 1 km from main roads. Each collection was followed by an interview with the farmer who provided the samples.This interview consisted in collecting the local names of the cultivars.

**Experimental design and growing conditions**

The experimental design adopted was that of randomized complete blocks with 27 treatments and four replications.The treatments were local cassava cultivars, the distance between blocks was 4 m, the elementary plot measured 25 m long by 1 m (one line represented one plot) wide, i.e. an area of 25 m² with a total of 25 plants per plot.Plots were represented by lines of 25 randomized plants; total area: 3840 m²; area of each block: 675 m² (25 m x 27m); distance between blocks: 4 m; aisles: 2.5 m; spacing: 1 x 1 m Each elementary plot was labelled (block and cultivar name).




**Legend**: total area: 3840 m²; block area: 675 m² (25 m x 27 m); distance between **blocks**: 4 m; aisles: 2.5 m; spacing: 1 x 1 m

**Figure 2.2.** Experimental set-up of our trial
Figure 1. Experimental setup for our test

The cultivation work consisted of clearing, burning, skidding, ploughing and staking, while the cultural care consisted of sarclo-buttages.

The cuttings used in our experiment were those of local cassava cultivars collected in the ten production basins of the Bengamisa region; the middle parts were selected from 6-month-old plants. These cuttings were conditioned in such a way as not to crush the nodes, which can pose a problem for recovery. Planting consisted of placing two cuttings with 4 nodes and a length of 20 cm in each horizontal position, spaced 1x1m apart.

**Data collection**

Observations were made on each plantation line; at 13 months, 5 plants were taken at random from each plot, the sampling being carried out in such a way as not to disturb the other plants. After harvest, the weight of tuberized roots per plant, the number of tuberized roots per plant and the plant height at harvest were obtained by weighing, manual counting and measuring.Weights, measurements and numbers were carried out for each local cassava cultivar and for each block.Simple random probability sampling was used.

**Parameters studied**

Root weight (using a precision balance) and number of tuberized roots (by post-harvest counting) per plant and plant height at harvest (using a metric tape) were the parameters studied.

**Statistical analysis**

A single-factor analysis of variance was performed using GrapPad Prism5 (Graph Pad Software**,** San Diego, California, USA) to compare cultivars at the 5% significance level.

## III.Results and Discussion

**Results**

**Average plant height at harvest**

Figure 2 shows the average plant height for each cultivar at harvest.

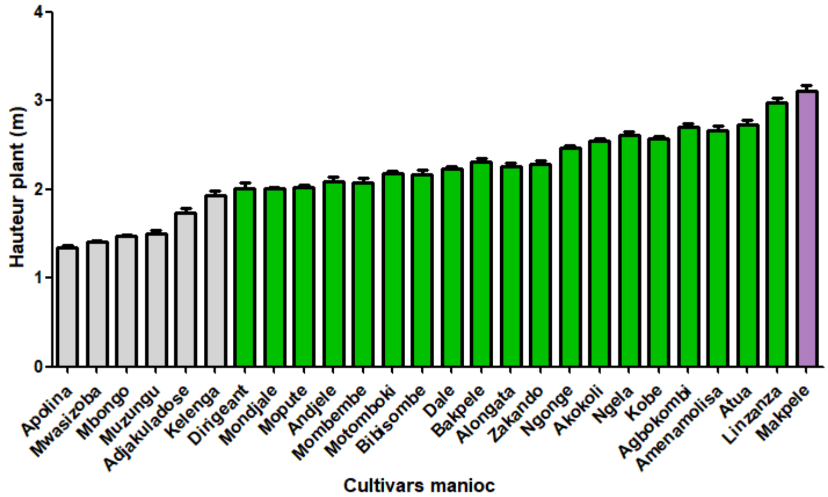



Figure 2: Average plant height at harvest (m)

This figure shows that 6 cultivars had an average height of less than 2 m, varying between 1.4 ± 0.02 and 1.9 ± 0.1 m; the majority of cultivars, i.e. 18, had an average height greater than 2, but less than 3 m (2.01 ± 0.1 and 2.97 ± 0.05 m) and only one cultivar exceeded the 3 m mark with an average height of 3.12 ± 0.07 m. The differences thus observed were confirmed by analysis of variance between the three categories (P=0.0001), and Bonferroni's post hoc test showed significant (P=0.01), highly significant (P=0.001) and highly significant (P=0.0001) differences between cultivars in the same and different categories.

**3.2.Average number of tuberous roots per plant**

The average number of tuberous roots per cassava cultivar is shown in figure 3.

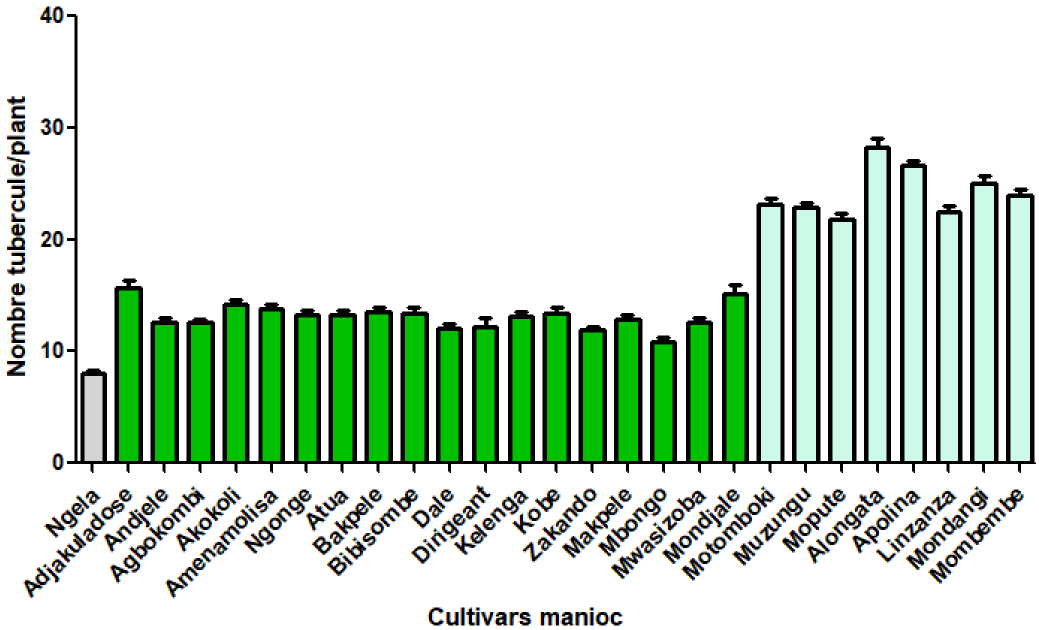



**Figure 3:** Average number of tuberous roots per plant

This figure shows that the cultivars are again divided into three groups, this time with the first group having only one cultivar with an average of 8.1 ± 0.3 tuberous roots; the second group contains the majority of cultivars producing more than 15 tuberous roots per plant, with averages ranging from 10. 9 ± 0.5 and 15.7 ± 0.6 tuberous roots and the third group of 8 cultivars had an average production of more than 20 and less than 30 tuberous roots per plant (23.2 ± 0.6 and 28.3 ± 0.7 tuberous roots). Analysis of variance showed highly significant differences between cultivars (P=0.0001).Bonferroni's post hoc test also showed significant (P=0.01), highly significant (P=0.001) and highly significant (P=0.0001) differences between the three cultivar groups and between cultivars within the same group.

**Average tuberous root weight per plant**

The figure below shows the average tuberous root weight for each cultivar after characterization.

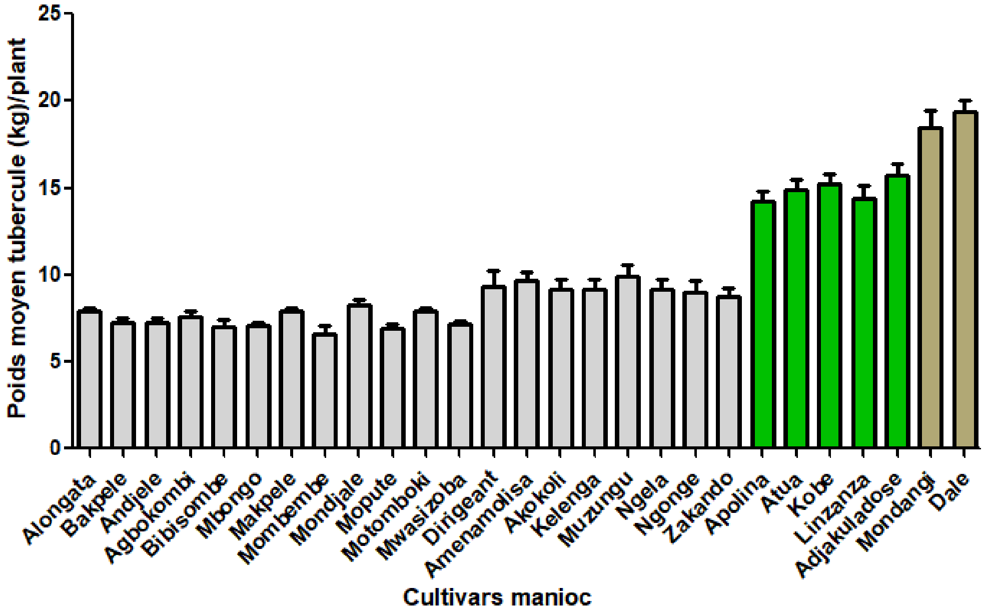



Figure 4.Average tuberous root weight per plant (kg)

Figure 4 classifies the 27 cultivars into 3 categories: the first consists of 20 local cassava cultivars with an average production per plant of just over 7 kg, but less than 10 kg, ranging from 7.1 ± 0.2 to 9.8 ± 0. 7 kg; the second category is made up of 5 cultivars producing just over 10 kg of tuberous roots with averages between 14.2 ± 0.6 and 15.7 ± 0.6 kg and the third is made up of 2 cultivars with an average production of over 15 kg (18.5 ± 0.9 and 19.4 ± 0.6 kg) and less than 20 kg. Analysis of variance showed highly significant differences between the different categories (P=0.0001) and Bonferroni's post hoc test showed significant (P=0.01) and highly significant (P=0.001) differences (P=0.0001) between cultivars in the same and different categories.

## IV. Discussion

Characterization of local cultivars in the production basins of the Bengamisa region resulted in three cultivar categories for all parameters studied (plant height at harvest, number of tubers and tuber weight per plant). Height yielded 6 cultivars less than 2 m tall, with the majority of cultivars over 2 m and under 3 m tall, and only one cultivar over 3 m tall.These results are close to those of Gmakouba et al. (2018), who also found three accession groups, but for these authors, the reduced height was 112.74 cm, the intermediate height was 130.89 cm and the large height was 145.08 cm, lower than the height of our small cultivars had a height that oscillated between 140 and 190 cm.

Djaha1 et al. (2017) also found three groups, the first group, made up of small-sized accessions (≤ 168.91 cm), group 2 made up of large-sized accessions (≥ 250.50 cm) and group 3, made up of intermediate individuals, results close to ours.

The number of tubers also gave three categories, with only one cultivar producing less than 10 tubers per plant, the majority of cultivars giving a number of tubers between just over 10 and over 15tubers; finally, 8 cultivars considered more productive (23 to 28 tubers). Cultivars from the Bengamisa production basin are more productive than those used by Gmakouba et al. (2018), whose most productive cultivars had only 7.5 roots per plant.

Crop yield is one of the main objectives of cassava breeders. In terms of tuber weight, the majority of cultivars produced tubers with an average weight of less than 10 kg per plant, 5 cultivars produced 14 to over 15 kg of tubers per plant and two cultivars produced between 18 and 19 kg per plant.

The results also showed that plant height is not necessarily linked to the number of tubers and their weight, which partly corroborates the results of Gmakouba et al. (2018) who found that it was the small-sized accessions that had a high number of tubers per plant.Mapkele, the tallest cultivar, produced fewer than 10 tubers and less than 10 kg per plant; same trend for Amanamolisa, Atua, Kobe, Dale, but the cultivar Linzanza was an exception to this rule because, being among the tallest cultivars, it produced more tubers that also had a high weight. Conversely, a number of lower cultivars produced more tubers with a higher weight per plant (Apolina, Mozungu, Mbongo). This shows that a cultivar's productivity is more a genetic trait, but one that can be enhanced by environmental factors.

## V. Conclusion

The aim of this study was to evaluate the agronomic performance of 27 local cassava cultivars undergoing characterization in the Bengamisa region. The aim was to identify which cultivars would offer the best agronomic performance for the crop improvement program and for farmers. A randomized complete block design with 27 treatments (cultivars) repeated four times. Plant height at harvest, number of tubers per plant and weight per plant were studied after 12 months of planting.

The following results were obtained:

– Cultivars with useful agronomic performances have been highlighted and can be used in the crop improvement program and for farmers;

– For all parameters, these cultivars were grouped into three categories: lowest, medium and highest; lowest, medium and highest productivity;

– Plant height is not necessarily linked to tuber number and weight. The tallest cultivar is not necessarily the most productive, with a few exceptions, and the lowest cultivar can also be more productive.

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