Agronomic Performance and Organoleptic Characteristics of Local Varieties of Sweet Potato (*Ipomea batatas*) Cultivated in Mbaiki (Central African Republic)

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Authors' contributions

This work was carried out in collaboration among all authorsAll authors read and approved the final manuscript.

Original Research Article

ABSTRACT

In the Central African Republic, there are a multitude of local varieties of sweet potato. However, few studies have been carried their agro morphological and organoleptic characteristics. A Fisher random block device was set up on the three local varieties of sweet potato. The growing and production parameters were evaluated as well as the organoleptic characteristics through the food

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taste test. The parameters of growing and production were assessed by means of analysis of variance (ANOVA) with one classification criterion using the R software version 3.1.3. A Principal Component Analysis (PCA) was also performed with the growth and yield parameters in order to highlight the correlations between these different parameters. The variety 1 (V1) produced the plants with the largest diameters (1.30 cm), while the smallest diameters was observed in the variety 2 (V2) with 0.55 cm. There is a significant difference (P-value = 0.0001) between the different varieties according to the ANOVA test. According to the length of the tuber, the V2 produced the longest tuberous root than the others with an average of 28.53 cm. The smallest length is observed in the V3 with an average of 25.12 cm. There is not significant (p-value = 0.216) in relation with the length of the tuber for the cultivated varieties of the sweet potato. The eigenvalues of the two main axes extracted from the Principal Component Analysis explained 53.68% and 16.82% of the matrix growth/ yield information. Along the factor axes, apart from parameters such as tuber diameters and length which are not positively correlated, there is little variability between the other parameters which are strongly correlated.

1. INTRODUCTION

Sweet potato *(Ipomoea batatas* (L) Lam) belongs to the botanical family Convolvulaceae [1-2]. It is grown mainly in the tropics but has the ability to adapt to a wide range of climatic conditions [3].

The annual global production of sweet potato tubers is estimated at 104 million tonnes and cultivation takes place in 114 countries around the world [4-5]. Industrially, tuberous root are used for the production of starch [1], fuel, alcohol and acetic acid [6]. The sweet potato has interesting agronomic capacities such as good productivity, a more or less short production cycle, a wide climatic and soil adaptation of most varieties. Sweet potatoes have great potential for utilization in the food industry for the production of a number of commercial products especially considering the fact that their starch content is high and major assets for facing the challenge of food security in the context of climate change [7].

Sweet potato cultivars are known to be rich in dietary fiber, minerals, vitamins and antioxidants, including anthocyanins, phenolic acids, beta-carotene and tocopherol [8-13].

Few studies have been carried out on sweet potato both in some African countries [14-15] and the Central African Republic (CAR) is not an exception. In CAR, the sweet potato is cultivated in limited quantities and despite its importance in terms of contribution to improving food security, sweet potato is one of the less important crops, relegated to second place in favor of cassava [16-17]. The hypothesis of this work was that the knowledge of the agronomic performance and organoleptic characteristics are important to promote the production of Sweet potato in CAR. The objectives of this study is to determinate the agronomic performance and organoleptic characteristics of the local varieties of Sweet potato in Lobaye (CAR).

2. MATERIALS AND METHODS

2.1 Site description

The tests were carried out during from july 14 to décember 2021at Higher Institute for Rural Development (ISDR) of Mbaiki. ISDR is located in the Province of Lobaye, at 104 km from Bangui, the capital of the CAR. (Fig. 1). The type of climate is the Guinean forest with the alternation of two seasons: a rainy season (March to mid-December) and a dry season (January to February). The annual mean maximum of temperature is 30.65 ° C. The differences between the minimum and the average maximum are moderate (11.44 ° C). The average annual rainfall is in the order of 1600 mm / year and the soil has a sandy clay texture [18]. The forest area presents a very great forest diversity and a whole range of forests ranging from the dense humid forest of low altitude south of the 4th parallel to the dense dry forest north of the 4th parallel interspersed by savannas. This vegetation consists of reworked forest, secondary with *Triplochiton scleroxylon* and *Terminalia superba* [19].

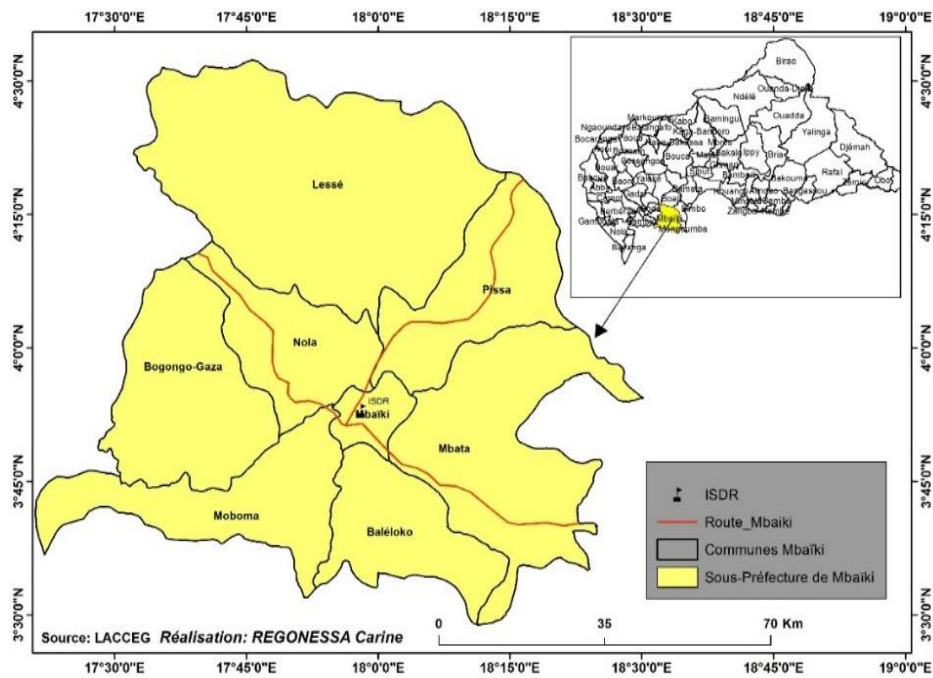ISDR has experimental plots for all types of crops for the agricultural practices for students.
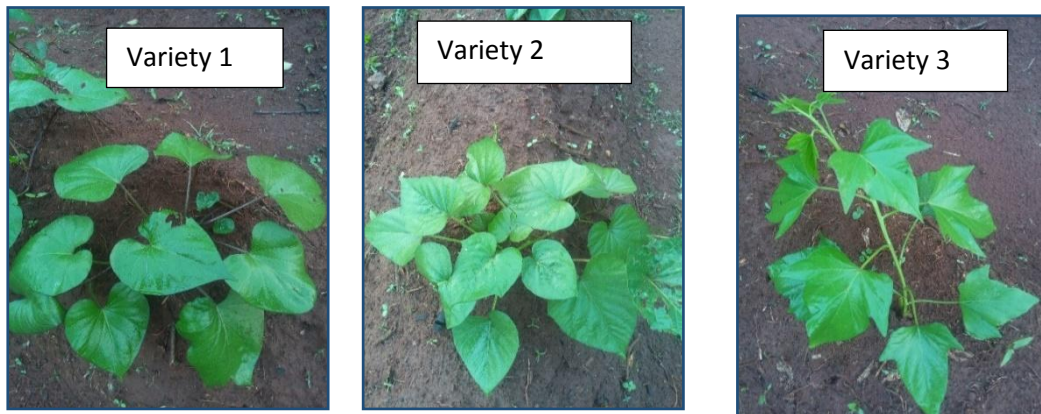
Fig. 1. location map of the study area

Fig. 2. Varieties of sweet potato used in the experiment
Source : Dan-Zi 2019

2.2 Plant Material and Experimental Design

The sweet potato samples were provided from the farmers' plot at M'baïki. These varieties are known by the local names of: Mon tanè: potato with red skin (V1); My moumè: white-skinned potato (V2 and V3).

The experiment was laid out in a randomized Fisher block design with three (3) replications [20]. Plot size was 14.5 m X 13 m. The block design consists of three (3) blocks subdivided into three (3) elementary plots (4.5 m X 2.5 m). In each of the elementary plots three (3) ridges of 2.5 m long and 0.5 m wide spaced 1 m apart were laid out. A 50 cm border was established between the plot boundary and the first ridge and the blocks were spaced 1.5 m apart. For the distribution of varieties (V1, V2, V3) on the plots (P1, P2, P3, P4, P5, P6, P7, P8, P9) within the system, a random draw was carried out.

The runners were cut with a scissor sterilized with 90% alcohol into cuttings with 3 nodes (button). The cuttings were dressed in that 2 leaves were removed and the last leaf was reduced by half. The cuttings were then disinfected with bleach. They were then buried

by covering the 2 nodes without leaves underground and only the part containing the reduced leaf is maintained on the surface. On a ridge, borders of 0.25 cm were made at each end, the spacing on the line of the cuttings is 50 cm on the line. The number of plants per ridge was 5 with a total of 135 plants for the whole set-up. The digging of the tubers at harvest was done with a machete. No amendments were applied to the crop.

2.3 Assessment of Organoleptic Characteristics

The organoleptic characteristics were evaluated after preparation of tuberous root [19]. For each variety of potato, one (1) kg of tubers was cut and placed in a container containing the same amount of water and subjected to the same cooking time. The cooked tuberous root were arranged in 3 plates according to variety. The preference rate was awarded by a jury made up of thirty (30) people including 10 men, 10 women and 10 researchers, after they had tasted each variety prepared. The following parameters were also observed: the color of the flesh after cooking (C.CC); tuberous root structure (S.T) and preference rates (T.P). A rating scale of 1-5 was used with the following score values: 5 = very good, 4 = good, 3 = fair, 2 = bad and 1 = very bad).

2.4 Collection of Agronomic Data

The measurements of the agronomic parameters started one (1) month after sowing and concerned:

- The recovery rate (T.R), estimated by making the ratio between the number of runners which presented the pre-leaves and the total number of runners in culture,
- The diameter at the collar (D.C), measured using a caliper every week,
- The length of the petiole (L.P); leaf blade length (L.L); leaf blade width (LA.L); the estimated length between knots (L.E) using a tape measure every week,
- The number of tuberous root per plant (N.T / p) is estimated by counting and the weight of ten tuberous root (P.10t) was estimated using a mechanical balance during harvest,
- The length of the tuberous root (L.T) is estimated using a tape measure during harvest,

- The tuberous root diameter (D.T) is estimated using a tape measure during harvest.
- The yield in t / ha was estimated by extrapolation of the weight of 10-foot tuberous root. Since the number of plants per hectare is known, the rule of three was used to obtain the total weight.

2.5 Statistical Analysis

The parameters of growing and production were assessed by means of analysis of variance (ANOVA) with one classification criterion using the R software version 3.1.3. The Shapiro-Wilk test was used to verify the normality of the data and the different tests were validated at the 5% threshold. A Principal Component Analysis (PCA) was also performed with the growth and yield parameters in order to highlight the correlations between these different parameters.

3. RESULTS

3.1 Growth Parameter

3.1.1 Recovery rate

The overall leaf recovery started four (4) days after sowing and lasted for three (3) weeks. The highest rate was observed in the V2 (100%) with a duration of two (2) weeks (Fig. 3). Although the V3 (97%) had a lower recovery rate compared to V1(98 %) and V2, overall all varieties showed a high recovery rate on average (97%). Statistical analyses revealed that there is not significant (P-value= 0.744) among the varieties.

3.1.2 Collar diameter

The variety 1 (V1) produced the plants with the largest diameters (1.30 cm), while the smallest diameters are observed in the variety 2 (V2) with 0.55 cm (Fig. 4). There is a significant difference (P-value = 0.0001) among the different varieties according to the analysis of variance (ANOVA).

3.1.3 Length of internodes and petiole

The different cultivated varieties have short internodes with an average of 5.50 cm (Fig. 5). The variety 1 (V1) has the largest internode (6.11 cm). There is a highly significant difference (P-value = 2e-16) in relation with the different varieties.

According the length of the petioles, they are generally short (from 5.50 to 23 cm) with an average of 11.82 cm. The V1 has longer petioles with an average length of 9.06 cm. The smallest value is observed in V3 with 6 cm (Fig. 6). There is a significant difference (P-value = 0.0001) in relation with the different varieties.

3.1.4 Leaf length and width

The Figs 7 and 8 illustrate the length and the width of the leaves from the three cultivated varieties of sweet potato. There is a significant difference (P-value length = 0.001) in relation with the length and the width of the leaves. The V1 had the greatest values for length and width (12.48 cm; 15.49 cm).

3.1.5 Tuber diameter and length

The tuber diameters of cultivated varieties are measured and there some variation (from 4.60 to 12.65 cm) with an average of 7.89 cm. The V2 has smaller tubers (7.41 cm) however the largest tubers are observed in V3 with (8.76 cm) (Fig. 9). There is a significant difference (P-value = 0.003) in relation with the different diameter of the cultivated varieties.

According to the length of the tuber, the V2 has the longer tubers than the others with an average of 28.53 cm. The smallest length is observed in the V3 with an average of 25.12 cm. There is not significant (p-value = 0.216) in relation with the length of the tuber for the cultivated varieties of the sweet potato.

3.1.6 Tuber number and yield

The V2 exhibited a greater number of tubers (4 tubers / plant) than the other varieties.There is a significant difference (P-value = 0.009) according to the statistical analysis.
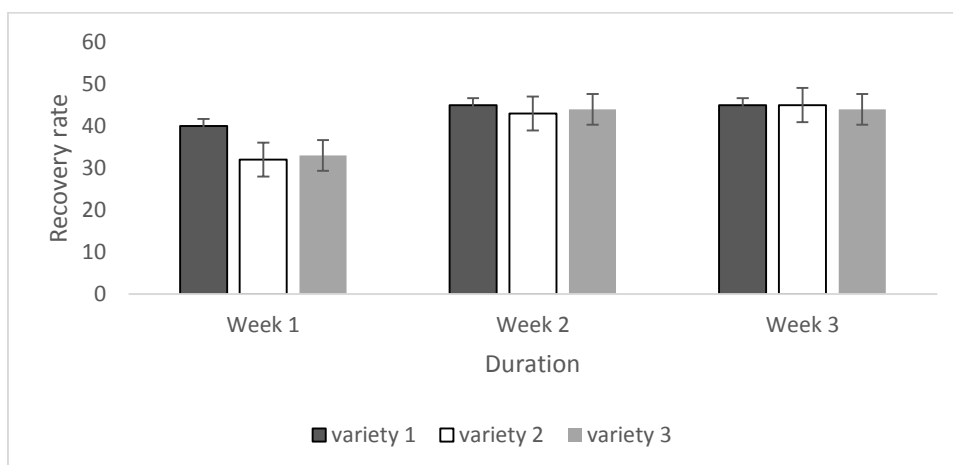

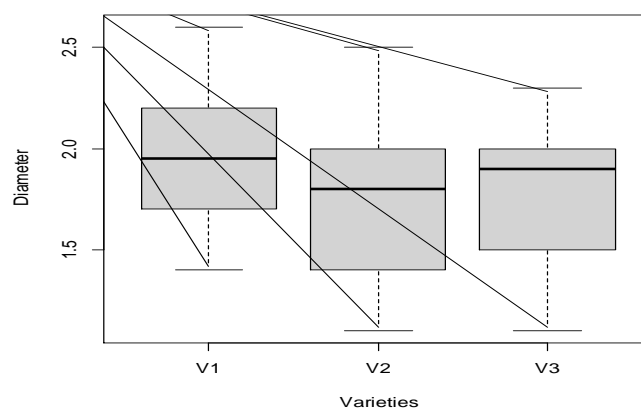**Fig. 3. Recovery rate according to the varieties**

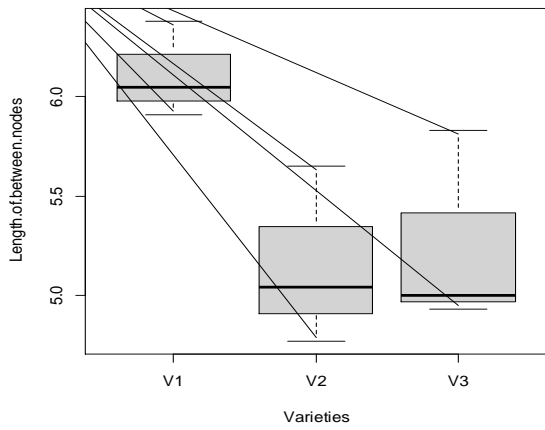**Fig. 4. Diameter of varieties according to the collar**

Fig. 5. Length of internodes according to the varieties
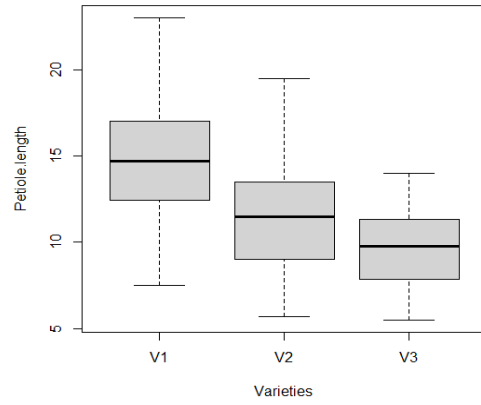

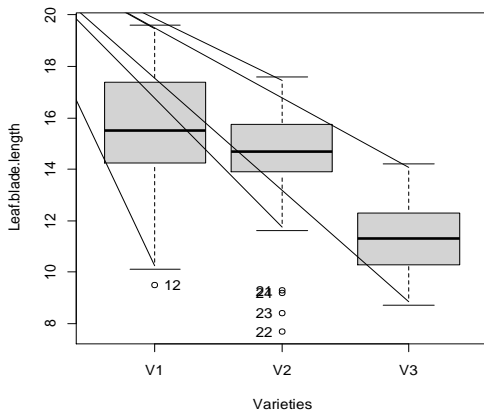**Fig. 6. Length of petiole according to the varieties**

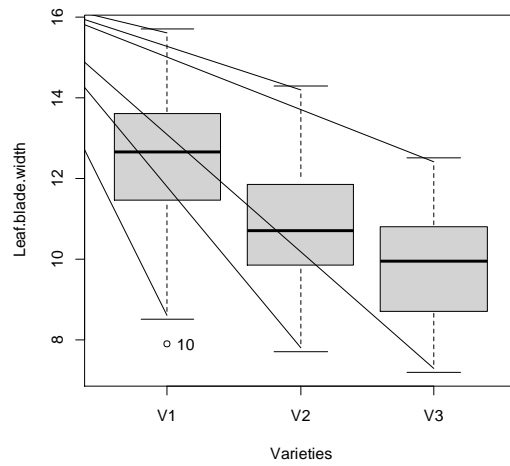**Fig. 7. Leaf blade width according to the varieties**

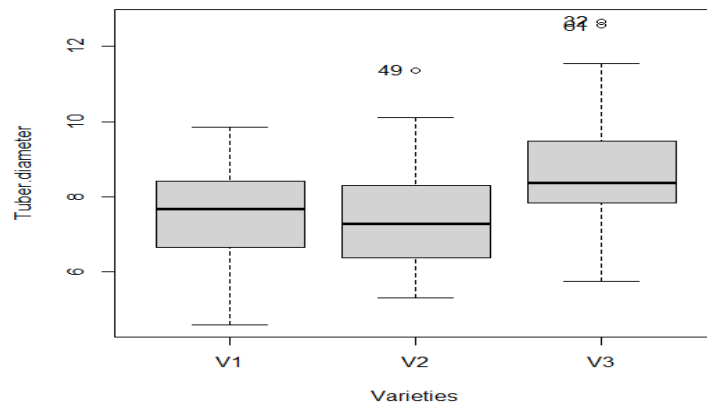**Fig. 8. Leaf blade length according to the varieties**

Fig. 9. Tuber diameter according to the varieties

The variability is observed between the weights of 10 tubers of the different varieties. The V1 has heavier tubers (4.05 kg) followed by the V2 (3.21 kg) and the V3 (3.20 kg), but the observed difference is not significant (P-value = 0.93). The V1 has a better yield (6.09 t / ha) followed by the V2 (5.009 t / ha) and the V3 (4.909 T / ha) (Fig. 10).

3.1.7 Organoleptic character

According to the organoleptic characteristics (Figs. 11 and 12), the observation of the color of the flesh of the tubers after cooking revealed that only the V2 underwent a change in the color of its flesh which went from yellowish white to yellow. There is no changing of color after cooking in the V1 and V3. However, the V1 and

V3 exhibited a crumbly structure after cooking while the V3 exhibited a fibrous structure. For the food taste test, the V1 is the most appreciated and delicious (85%), followed by the V2 (68%) and V3 (65%).

3.1.8 Correlation between growth and yield parameters

The eigenvalues of the two main axes extracted from the Principal Component Analysis explained 53.68% and 16.82% of the matrix growth/ yield information. Along the factor axes, apart from parameters such as tuber diameters and length which are not positively correlated, there is little variability between the other parameters which are strongly correlated (Fig. 13).
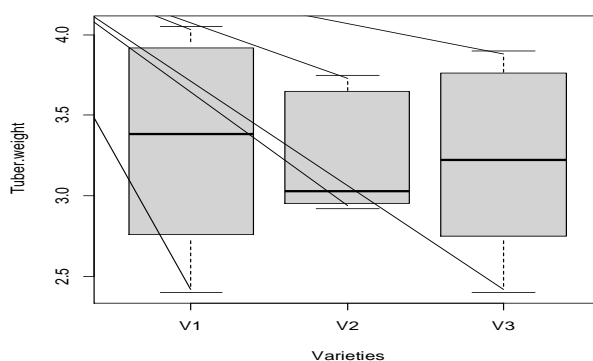

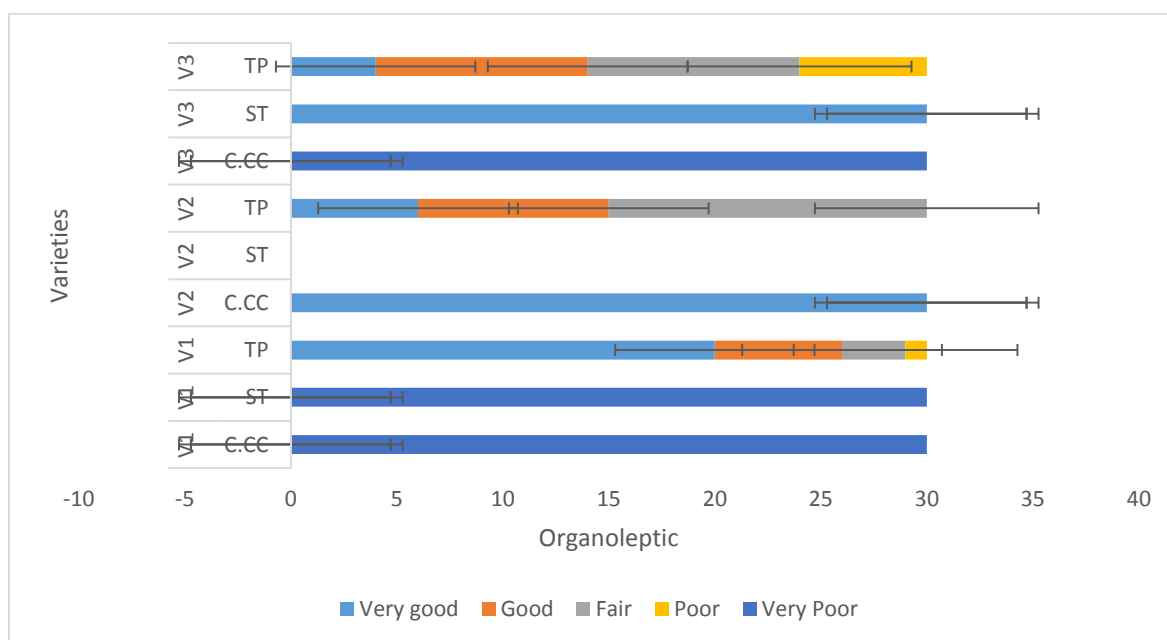
Fig. 10. Tuber weight according to the varieties

Fig. 11. Organoleptic evaluation of four sweet potato varieties

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Color of the tubers of V1

Color of the tubers of V 2

Color of the tubers of V3
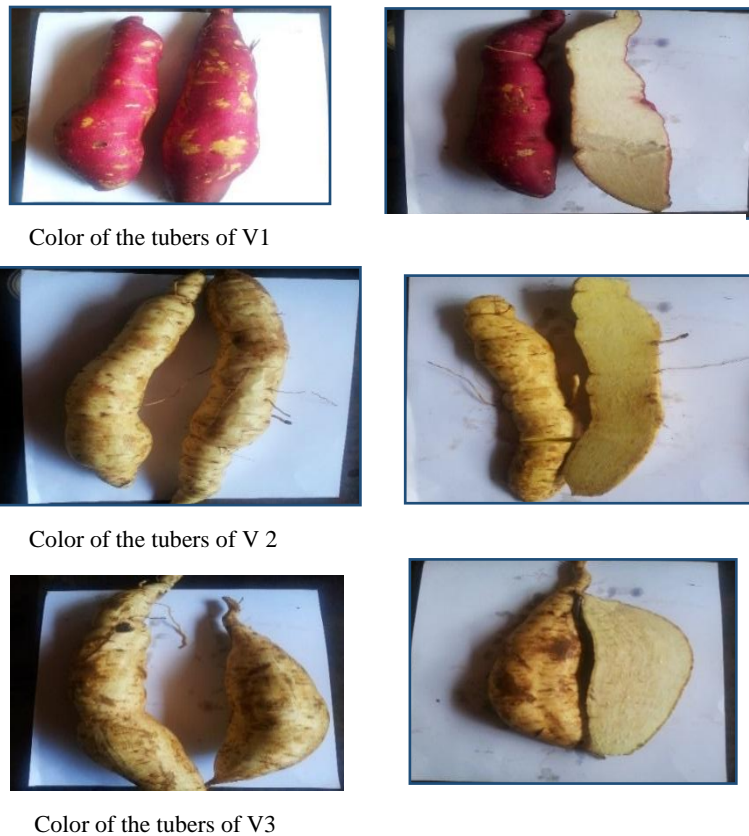
Fig. 12. Tuber color of the three varieties of sweet potato
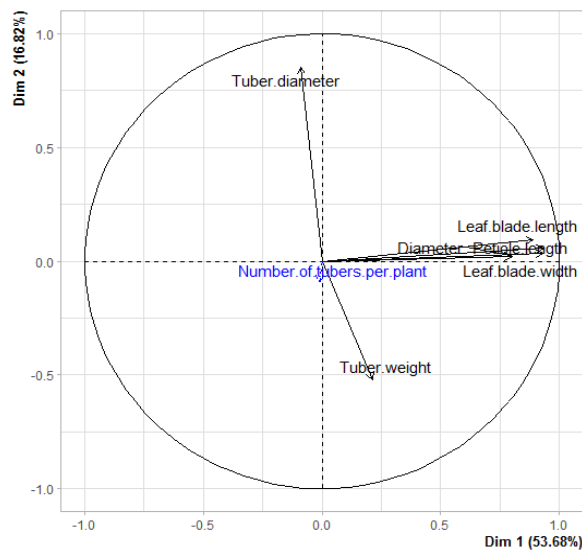

Fig. 13. PCA linking the different growth and yield parameters

4. DISCUSSION

The evaluation of growing and vegetative parameters showed that the overall leaf recovery began four (4) days after sowing and lasted for three (3) weeks. The average recovery rate overall is (97%), and the highest rate of 100% is observed in V2. The statistical analyses revealed

that there is not significant (P-value= 0.744) among the different varieties. Concerning the length of the petioles, they are generally short (from 5.50 to 23 cm) with an average of 11.82 cm. The V1 has longer petioles with an average length of 9.06 cm. The smallest value is observed in V3 with 6 cm (Fig. 6). There is a significant difference (P-value = 0.0001) in relation with the different varieties.

The sweet potato is an easy crop to establish [12]. Measurement of diameter, internodes and leaf length showed that the V1 produced larger values, while the greatest value for leaf blade width was observed in variety 2. These results demonstrate that there is variability between the different vegetative growth parameters of the three cultivated varieties. As for the shape of the leaves, they are very diverse, and cases of leaf polyphormisks are also noted. The sweet potato contains a large number of cultivated varieties. The general shape of the leaf blade may be rounded, kidney-shaped, cordated, triangular, stave, lobed, and nearly divided. The lobes differ in their depth, ranging from superficial to deep lobed, and in their number, which usually ranges from 3 [16-20].

In this case of our study the V2 has smaller tubers (7.41 cm) however the largest tubers are observed in V3 with (8.76 cm) (Fig. 9). There is a significant difference (P-value = 0.003) in relation with the different diameter of the cultivated varieties. The V2 exhibited a greater number of tubers (4 tubers / plant) than the other varieties. There is a significant difference (P-value = 0.009) according to the statistical analysis.

The variability is observed between the weights of 10 tubers of the different varieties. The V1 has heavier tuberous root (4.05 kg) followed by the V2 (3.21 kg) and the V3 (3.20 kg), but the observed difference is not significant (P-value = 0.93). The V1 has a better yield (6.09 t / ha) followed by the V2 (5.009 t / ha) and the V3 (4.909 T / ha).

The yields of fresh tuberous root in Africa are in the order of 5 to 10 tonnes per hectare for traditional cultivars according to [18]. This attests that the yields obtained within the framework of this study are in line with the average in Africa.

For the food taste test, the V1 is the most appreciated and delicious (85%), followed by the V2 (68%) and V3 (65%). Although, the outer skin of sweet potato is usually discarded before consumption in many parts of the world and reports had shown that the skin contain a number of additional nutrient and phytochemicals [20-22]. In our study, there is no changing of color after cooking in the V1 and V2. However, the V1 and V2 exhibited a crumbly structure after cooking while the V3 exhibited a fibrous structure. In the world, the sweet potato can be used in various ways; boiled, steamed, baked, fried and also have the potential to be processed into various products. In the developing world, they are most commonly consumed following boiling, steaming, roasting or drying. Sweet potatoes in sub-Saharan Africa are cultivated on subsistence rather than commercial scale due to lack of appropriate technologies for their utilization in food product development [23-26].

While the tuberous root is consumed as a staple food, other roles are reported and as well other parts of the crop have been found to be important. Other than being combined with lime juice to make dye for clothes, sweet potatoes have also been used as fodder for animals and as green vegetables. The skin colors of sweet potatoes range from white, cream, yellow, orange, pink, red to purple. Flesh colors may be white or various shade of cream, yellow, orange or even purple. [27-31].

5. CONCLUSION

The results show that they are distinguished by various aspects which may be linked to the morphology, the coloring of certain organs, the length of the cultivation cycle, the yield, and the aspects of their flesh after cooking and their taste. The V1 showed better performance in terms of vegetative growth and yield. Although the V2 produced a better recovery rate (100%) with a shorter cycle (3.5 months). The V2 exhibited a greater number of tuberous root (4 tuberous root / plant) than the other varieties. The best yield was observed in variety V1 (6.09 t / ha) followed by variety V2 (5.009 t / ha) and variety V3 with 4.909 t / ha. The results on the agro morphological and yield parameters from the sweet potato can be used as comprehensive database of the local sweet potato in CAR for further research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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