

Evaluation of Some Sweetpotato (*Ipomoea batatas* [L.] Lam) Varieties in Mozambique

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ABSTRACT

In Mozambique, sweetpotato plays a significant role in rural areas, where the farmers use it to feed their families and as an income. In this study, we aimed to investigate the performance of different sweetpotato varieties in Niassa, Mozambique. The trial was set up in Malulu, Sanga district, located 60 km away from Lichinga, capital of Niassa, Mozambique. In Sanga, the rainy and hot season occurs from December to March, and the dry and cold season is from May to October. In this trial, the treatments correspond to sweetpotato varieties. We used the randomized block design with 12 sweetpotato varieties and 3 replications. The evaluated traits were as follows: weevil damage, roots commercial yield, roots non-commercial yield, total yield, and vine yield. Regarding statistical analysis, the results per trait were submitted to the Bartlett test of homogeneity of variances and Shapiro-Wilk normality test, and then the analysis of variance and means comparison using the Scott-Knott test when necessary was performed. All the statistical analysis was conducted at 5% on the R programming language. For commercial and total yield, the varieties Local, Sumaia, Olga, and Alisha presented the best results. Esther and Irene were the varieties most attacked by weevils.

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1. INTRODUCTION

In Mozambique, agriculture is the main population's economic activity, several crops are grown in the rural areas, with special attention to maize, cassava, rice, beans, and sweetpotato (*Ipomoea batatas* [L.] Lam). Farmers from rural areas prefer growing sweetpotato because it is a rustic, easy to maintain, and drought-tolerant crop with a relatively low production cost, minimum investments, and high returns per unit area [1]. Sweetpotato is among the world's most important, versatile, and under-exploited food crops, with over 90 million tons in annual production, contributed mostly by Asian and African countries [2]. This crop is positioned as the sixth most major food crop in the world and the fifth most essential food crop on a fresh weight basis in developing countries after rice, wheat, maize, and cassava [3]. In Mozambique, sweet potato is mainly grown in Zambézia province, with a production of about 146.476 tons, followed by Tete, with a total production of 85.955 tons [4].

Sweetpotato is grown in numerous tropical and sub-tropical countries for the consumption of its edible leaves, vines, and roots with huge special nutritional and health-promoting properties for human diet and animal feed, such as carotenoids, flavonoids, anthocyanins, minerals, carbohydrates, phenolic acids, and fibers [5], [6]. Sweetpotato is not only grown for food and fodder purposes but is also processed into indispensable raw materials for the production of starch, alcohol, and natural pigments [6], [7]. Several different health benefits, such as antioxidant, cardioprotective, anti-inflammatory, anti-cancer, anti-diabetic, antimicrobial, and anti-obesity. In addition, consumption of the sweetpotato varieties containing beta carotene contributes to a reduction in vitamin A deficiency, especially among children under five and pregnant women [8].

The color of sweetpotato skin ranges from white, cream, yellow, orange, pink, and red to purple, while flesh colors may be white or various shades of cream, yellow, orange, or even purple [9], [10]. In Mozambique, over the past years,

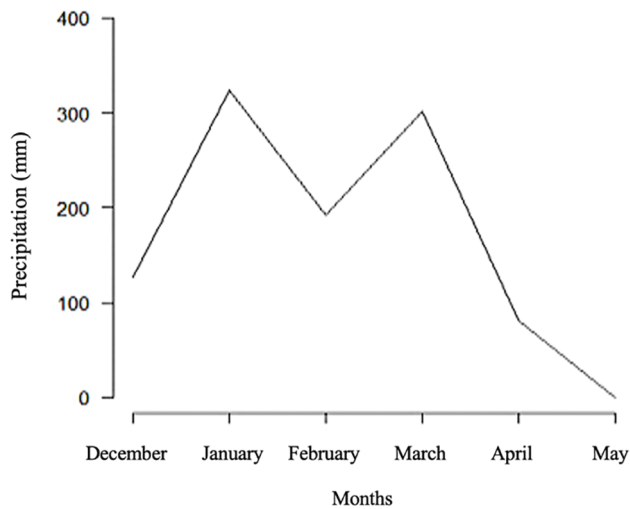


Fig. 1. Average monthly precipitation during the trial period.

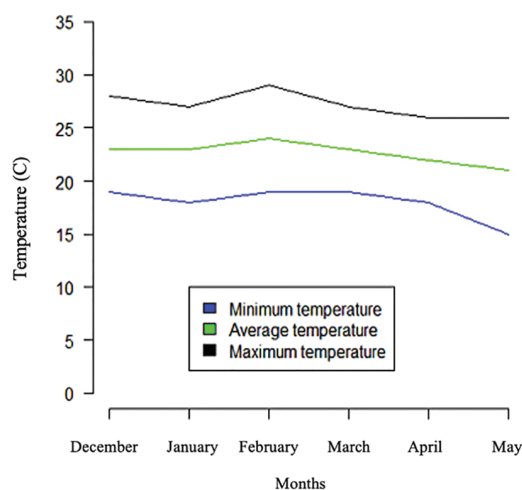


Fig. 2. Temperature during the trial period.

a lot of research related to sweetpotato breeding has been conducted. The aim of the sweetpotato breeding program in Mozambique is to release varieties that are drought tolerant, have high root yield, have high dry matter content, have high nutritional content, and are more resistant to pests.

The purpose of the current study was to investigate the performance of different sweetpotato varieties released jointly by the International Potato Center and the Institute of Agronomic Research of Mozambique from a breeding program under the agro-ecological conditions of Niassa province.

2. MATERIALS AND METHODS

2.1. Site Characterization

The trial was set up in Malulu, Sanga district, located 60 km away from Lichinga, capital of Niassa, Mozambique. In Sanga, the rainy and hot season occurs from December to March, and the dry and cold season is from May to October. The average annual precipitation is between 1000 to 1200 mm; Sanga's soils are mostly clayey, red, deep, and well-drained, associated with humid and subhumid climates [11]. Figs. 1 and 2 show the average

monthly precipitation and temperature during the trial period.

Soil tillage and harrowing were performed in the beginning of October 2022. Soil fertilization was not performed in order to mimic local farmers' production conditions.

Sweetpotato planting was performed in the second half of October. Sweetpotato planting material (sweetpotato vines) was cut in pieces of 30 cm length and planted on top of ridges with a planting spacing of 90 cm between ridges and 30 cm between plants within the same ridge. Irrigation was only performed for three weeks in the beginning of the trial to guarantee adequate plant establishment. Afterwards, the plants were maintained under rainfed system until harvest period. Figs. 1 and 2 show the average monthly precipitation and temperature during the trial period.

2.2. Treatments

In this trial, the treatments were sweetpotato varieties whose characteristics are summarised in Table 1. We used the randomized block design with 12 sweetpotato varieties and 3 replications. Each variety was planted in plots with 5 lines (ridges), each line with a 4.5 m length.

2.3. Measured Traits

2.3.1. Weevil Damage

Weevil damage was determined through scoring using a scoring mechanism/system developed by CIP (2019). The scores range from 9 to 1, where 9 to 8 severe damage (>60% of the roots are affected); 7 to 6 severe (30%–60% of the roots are affected); 5 to 4 moderate (10%–30% of the roots are affected); 3 to 2 weak (few roots affected) and 1 no roots affected [14].

2.3.2. Roots Commercial Yield

Commercial root yield was determined by selecting and weighing roots with over 100 g weight, free from any kind of damage. This trait was computed in tons/hectare.

2.3.3. Roots Non-Commercial Yield

Non-commercial root yield was determined by weighing roots below 100 g weight, and those affected by pest and disease damage. This weight was computed in tons/hectare.

2.3.4. Total Yield

To compute the total root yield, we summed the commercial and non-commercial roots yield, computed in tons/hectare.

2.3.5. Vine Yield

We also computed the vine yield, the vine yield corresponds to the weight of the plants shoots, computed in tons/hectare.

2.4. Statistical Analysis

The results per each measured trait were submitted to the Bartlett test of homogeneity of variances and Shapiro-Wilk normality test, and then the analysis of variance and means comparison using the Scott-Knott test when

TABLE I: MORPHOLOGICAL FEATURES OF THE SWEETPOTATO VARIETIES

Varieties	Type of plant	Predominant color in the branches	Color of the mature leaves	Predominant shell color	Main pulp color
Irene	Semi-erect (75–150 cm)	Totally purple	Green	Red	Light orange
Sumaia	Semi-erect	Green	Green with young purplish leaves	Cream	Deep orange
Delvia	Semi-erect	Green	Green	Purple	Orange with yellow
Gloria	Prostrate	Unknown	Unknown	Unknown	Orange/yellow
Esther	Semi-erect	Light green	Light green	Purple	Intermediate orange
Alisha	Scattered	Green	Green	Intermediate orange	Orange pulp
Caelan	Scattered (151–250 cm)	Green	Green	Red	Purple-white pigmentation
Ken	Semi-erect (75–150 cm)	Green	Green	Red	Intermediate orange
Palmira	Semi-erect (75–150 cm)	Green	Green	Orange	Intense Orange
Olga	Scattered (151–250 cm)	Moderately dark purple	Green with purple edges	Orange chestnut	Strong purple pigmentation
Super-Margarete	Semi-erect (75–150 cm)	Totally purple and dark	Green with purple veins on the top page	Red	Strong purple pigmentation
Local	Unknown	Green	Green	Cream	White/cream pulp

Note: Source: [12], [13].

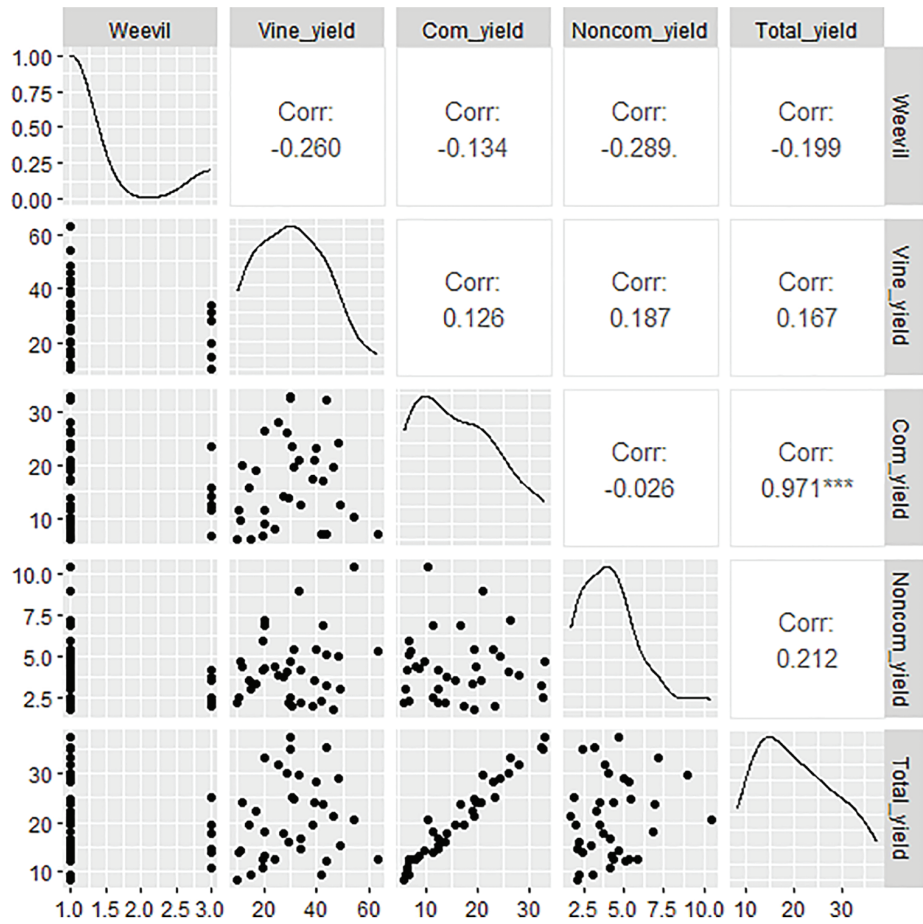


Fig. 3. Correlations among the traits.

necessary was performed. The advantage of the Scott-Knott test is that it doesn't allow the same treatment to belong to two or more different groups at the same time, reducing the ambiguity in the treatment comparison. All the statistical analysis was conducted at 5% in the R programming language [15].

3. RESULTS AND DISCUSSION

Correlations among the measured traits are presented in Fig. 3. A significant and high correlation was only observed between commercial roots yield and total roots yield.

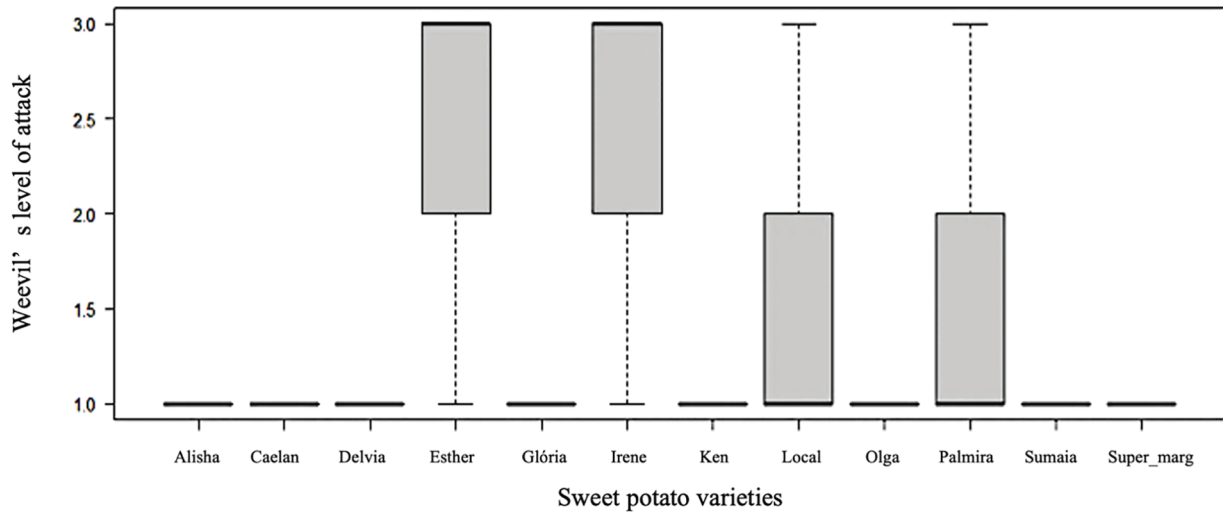


Fig. 4. Weevil's level of attack.

TABLE II: COMMERCIAL, NON-COMMERCIAL, AND TOTAL YIELD

Varieties	Vine yield	Non-commercial yield	Commercial yield	Total yield
Irene	20.78 c	4.70 ^{WD}	13.77 b	18.47 b
Sumaia	37.64 b	3.67	29.24 a	32.92 a
Delvia	28.22 c	2.48	16.74 b	19.23 b
Gloria	33.20 b	4.96	16.42 b	21.39 b
Esther	24.48 c	4.47	15.13 b	19.61 b
Alisha	22.03 c	4.05	24.59 a	28.64 a
Caelan	49.39 a	4.22	6.95 c	11.17 c
Ken	45.53 a	5.85	11.80 b	17.66 b
Palmira	10.47 c	3.10	9.00 c	12.10 c
Olga	37.57 b	5.25	19.08 a	24.34 a
Super-Margarete	19.68 c	4.43	6.96 c	11.39 c
Local	36.40 b	3.86	26.81 a	30.67 a

Note: Means followed by the same letter are not significantly different by the Scott-Knott test at 5%, WD stands for the absence of significant differences by the Fisher test at 5%.

For the weevils attack, the results are presented in the boxplot in Fig. 4. Esther and Irene were the varieties most attacked, followed by the varieties Local and Palmira; for the other varieties, the levels of attack were similar, being classified in a level 1 of attack, i.e., no roots affected.

Different results were observed by [16] in a study about 9 sweet potato varieties in Mozambique, where the varieties Alisha and Super-Margarete had a weevils level of attack of 4 on a scale from 1 to 9. This study was conducted in a rainy season (Fig. 1), weevils attack is more abundant and cause more damage in the dry season than in the rainy season, as in the dry season, the soil forms some cracks which facilitate the roots attack by the weevils [17]. It's important to highlight that weevil control is important for market-oriented producers to enhance the percentage of marketable roots [18].

Results about commercial, non-commercial, and total yield are presented in Table II. Regarding commercial yield, the highest yields were observed for the varieties.

Sumaia, Local, Alisha, and Olga, and no significant differences were observed for these varieties; however, numerically, Sumaia presented the highest yield (29.24 tons/hectare). The lowest yields were observed in the varieties Super-Margarete, Caelan, and Palmira.

No significant differences were found for non-commercial yield, but it's important to highlight that the highest value was observed in the variety Ken and the lowest in the variety Delvia. As for the total yield trait, Sumaia variety presented the highest value (32.92 tons/hectare), no significant differences were observed among Sumaia, Alisha, Olga, and Local varieties. Lowest values for total yield were observed for the varieties Super-Margarete and Caelan and Palmira. Total yield followed the same trend as the commercial yield of both traits, which are positively correlated (Fig. 3). Similar results were observed by [16] in a study about a proposal to release 9 sweetpotato varieties, where Alisha variety reached 25.28 tons/hectare of total yield in Chókwe. In a study conducted in Lichinga, in 2022, Irene variety surpassed (23.07 tons/hectare) Esther variety (5.79 tons/hectare) [19]. However, variety Esther in the previous study presented a much lower total yield (5.79 tons/hectare) when compared to its yield in the current study (19.6 tons/hectare); these differences may be explained by differences in the soil properties and climate conditions as our study was conducted in Sanga district.

In the current study, the varieties Sumaia, Delvia, Glória, Alisha, Olga, and Local surpassed 15.57 tons/hectare for commercial yield.

It's important to note that different authors use different criteria to distinguish commercial roots from non-commercial roots. According to Filgueira [20], the sweetpotato is considered commercial when it presents roots with average mass ranging from 200 g to 400 g, this a classification different from the one used in our study.

The differences in commercial root yield could be attributed to the genetic variations among the sweetpotato varieties in partitioning photosynthesis [21]. In our study, we did not conduct soil analysis to gain information on the soil's nutritional condition; according to Pedrosa *et al.* [22], the total productivity of roots is dependent on the genotype, soil and climate conditions, and cycle duration.

For vine yield, no significant differences were observed between Caelan and Ken varieties being the varieties with the highest values were observed by the Caelan and Ken varieties. The lowest values were observed for Palmira variety (10.47 tons/hectare). However, Palmira presented a vine yield of 50.47 tons/hectare in a study in Chókwe [12].

4. CONCLUSION

For farmers with similar agroecological conditions as that of Sanga district, in Niassa, the varieties Olga, Sumaia, Alisha are the recommended improved sweetpotato varieties.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

REFERENCES

- [1] Wolmann FS, Guerra D, Souza EL, Bohrer REG, Bisognin RP, Lanzaova ME *et al.* Productivity of three sweet potato cultivars: bRS Amélia, BRS Cuia and BRS Rubissol. *Acta Agronômica*. 2021;70:298–303. doi: 10.15446/acag.v70n3.79261.
- [2] FAOSTAT. Statistics division of food and agriculture Organization of the United Nations. 2020. Available from: <http://www.fao.org/faostat/en/#data>.
- [3] CIP. Institutional brochure. 2019. Available from: <https://cipotato.org/>.
- [4] MADER. Ministério da Agricultura e Desenvolvimento Rural. *Inquérito Agrário Integrado 2020*. Maputo: MADER; 2020.
- [5] Sun Y, Pan Z, Yang C, Jia Z, Guo X. Comparative assessment of phenolic profiles, cellular antioxidant and antiproliferative activities in ten varieties of sweet potato (*Ipomoea batatas*) storage roots. *Molecules*. 2019;24(24):1–13. doi: 10.3390/molecules24244476.
- [6] Yan M, Nie H, Wang Y, Wang X, Jarret R, Zhao J *et al.* Exploring and exploiting genetics and genomics for sweetpotato improvement: status and perspectives. *Plant Commun*. 2020;3(5):1–25. doi: 10.1016/j.xplc.2022.100332.
- [7] Katayama K, Kobayashi A, Sakai T, Kuranouchi T, Kai Y. Recent progress in sweet potato breeding and cultivars for diverse applications in Japan. *Breed Sci*. 2017;67:3–14. doi: 10.1270/jsbbs.16129.
- [8] Alam MK. A comprehensive review of sweet potato (*Ipomoea batatas* [L.] Lam): revisiting the associated health benefits. *Trends Food Sci & Technol*. 2021;115:512–29. doi: 10.1016/j.tifs.2021.07.001.
- [9] Alam MK, Rana ZH, Islam SN. Comparison of the proximate composition, total carotenoids and total polyphenol content of nine orange-fleshed sweet potato varieties grown in Bangladesh. *Foods*. 2016;5(3):1–10. doi: 10.3390/foods5030064.
- [10] Alam MK, Sams S, Khan MS, Azmir J, Ahsan M, Akhtaruz-zaman M, *et al.* Profiling of minerals, water soluble vitamins and carotenoid in selected unconventional leafy and non-leafy vegetables of Bangladesh. *Nat Prod Res*. 2020;36(8):2182–5. doi: 10.1080/14786419.2020.1849198.
- [11] MAE. Ministério de Administração Estatal. *Prefil do Distrito de Sanga*. Moçambique: Maputo; 2005.
- [12] Ricardo J, Andrade M, Naico A, Makunde G, Menomussanga J, Alvaro A. *Proposta para libertação de três variedades de batata doce de polpa alaranjada MUSG15099-2 (Ken), MUSG15023-8 (Bertran) e MUSG012081-3 (Palmira)*. Maputo: IIAM; 2020.
- [13] Tumwegamire SK, Mtunda RO, Mwanga MI, Andrade J, Low GN, Sisemakula SM. *Catalogue of orange-fleshed sweetpotato varieties for Sub saharan Africa*. 2nd edition. Lima, Peru: International Potato Center (CIP); 2014.
- [14] Gruneberg WJ, Espinosa J, Mwanga ROM, Andrade M, Dapaah H. *Procedures for the evaluations and analysis of sweetpotato trials*. Maputo: CIP; 2010.
- [15] R Core Team. *R: A labguage and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing; 2023. Available from: <https://www.R-project.org/>.
- [16] Ricardo J, Mutolo A, Andrade MI, Makunde G, Naico A, Alvaro A. *Proposta para libertação de 9 variedades de batata doce de duplo proposito em Moçambique*. Moçambique: CIP, IIAM; 2016.
- [17] Andrade MI, Low J, Naico A, Ricardo J, Sandramo A, Zano F. *O cultivo da batata-doce em Moçambique: Aspectos Sobre a Produção da Batata Doce*. Maputo: CIP; 2007.
- [18] Vugta Dv, Franke AC. Exploring the yield gap of orange-fleshed sweet potato varieties on smallholder farmers' fields in Malawi. *Field Crops Res*. 2018;221:245–56. doi: 10.1016/j.fcr.2017.11.028.
- [19] Tarua DCJ, Moisés LC, Damba GP, Serrote CML, Mussalama AZ. Desempenho de genótipos de batata-doce no planalto de Lichinga, Moçambique. *Agropecuária Catarinense*. 2022;35(1):29–31. doi: 10.52945/rac.v35i1.1120.
- [20] Filgueira FAR. *Novo Manual de Olericultura: Agrotecnologia moderna na Produção e Comercialização de hortaliças New Vegetable Farming Manual: Modern Agrotechnology in the Production and Marketing of Vegetables*. 3rd edition. UFV; 2008.
- [21] Nedunchezhiyan M, Byju G, Naskar SK. Sweet potato (*Ipomoea batatas* L.) as an intercrop in a coconut plantation: growth, yield and quality. *J Root Crops*. 2007;33(1):26–9.
- [22] Pedrosa CE, Andrade JVC, Pinto NAVD, Figueiredo JA, Ribeiro KG, Azevedo AM, *et al.* Seleção de clones de batata-doce com potencial de utilização na alimentação animal. *Hortic Bras*. 2010;28:1974–80.