World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

Agronomic evaluation sweet potato (*Ipomoea batatas* (L) Lam.) genotypes in two agro-ecological zones of Côte d'Ivoire

Jean Hugues Martial Kouassi [1, 2, *], Mambé Auguste-Dénise Boyé [1], Konan Evrard Brice Dibi [2], Brice Sidoine Essis [2], Amani Michel Kouakou [2], Boni N'zué [2] and Wanyou Darius Litché [1]

[1] *Laboratory for Improving Agricultural Production (APA), UFR Agroforestry, University Jean Lorougnon Guédé, BP 150 Daloa, Côte d'Ivoire.*
[2] *National Agricultural Research Center (CNRA), 01 BP 633 Bouake, Côte d'Ivoire.*

World Journal of Advanced Research and Reviews, 2023, 17(02), 208–218

Publication history: Received on 19 December 2022; revised on 02 February 2023; accepted on 04 February 2023

Article DOI: https://doi.org/10.30574/wjarr.2023.17.2.0194

Abstract

The sweetpotato is the seventh most important crop in the world after wheat, rice, maize, potato, barley and cassava. It is produced annually in all regions of Côte d'Ivoire. Sweetpotato plays a role in food security and income generation for rural populations. However, the crop is facing the challenges of climate change leading to a decline in yields of local cultivars. This phenomenon leads to unproductive soils and the abandonment of many crops, including sweetpotato. To address this problem, 15 sweetpotato genotypes from the CNRA and from farmers were evaluated in two agro-ecological zones on the basis of agronomic parameters. Descriptive analysis of the data showed a variation in the agronomic performance of the genotypes from one zone to another. Thus, in Kounontonvogo, yields varied from 3.81 to 30.41 t/ha. The genotypes Irene, CIP-199062-1, TIB-440060 and Fatoni 2 had the best agronomic performance. On the other hand, at CNRA Station, the cultivar Sanfo figui 1 showed a better yield. While at Attrokro, the Irene genotype had the highest yield with lower susceptibility to weevils. Local genotypes such as Aleda ouffouet, Sanfo figui 1 and Sanfo figui 2 had the highest DM content.

Keywords: Agronomic performance; Yield; Multi-environment trials; Sweet potato

1 Introduction

Sweetpotato (*Ipomoea batatas* (L) Lam.), a dicotyledonous species belonging to the Convolvulaceae family, is cultivated for its edible tuberous roots but also for its leaves consumed as a green vegetable (1). It is adapted to a wide range of agro-climatic conditions and its cultivation is very low-input (2). Indeed, sweetpotato is easy to grow and has a short production cycle. Sweetpotato is produced annually in all regions of Côte d'Ivoire (3) and plays a role in food security and income generation for rural populations. The annual production sweetpotato in 2017, about 54,100 tons (4) composed mainly of white and yellow fleshed varieties, was carried out in the north and center of the country in villages around the cities of Bouaké and Korhogo. It is commonly consumed as boiled, French fries (5) mashed and foutou (6). Although sweetpotato is easy to grow, productivity is relatively low because enormous difficulties including scarcity of rainfall, declining quality and health of planting material, declining soil fertility, post-harvest conservation problems, lack of high-yielding varieties and pests and diseases pressure. The lack of varieties adapted to the different agro-climatic zones also hinders the expansion of the crop. To address these constraints, breeders have collected and introduced new provitamin A-rich sweetpotato genotypes that are resistant to biotic and abiotic stresses and have high-yield potential (7). However, these varieties have not yet been evaluated under the climatic conditions in Côte d'Ivoire. Apart from quality parameters, farmers have a great interest in high-yielding varieties that adapt to their environmental conditions. Before any dissemination of new varieties to farmers, any varietal selection program must evaluate these

* Corresponding author: Jean Hugues Martial KOUASSI; Email: jhmkouassi@gmail.com

introductions to assess their performance under the prevailing environmental conditions of the target regions. The objective of this study was to evaluate the agronomic performance of sweetpotato varieties in two agro-climatic zones of Côte d'Ivoire.

2 Material and methods

2.1 Study site and plant material

2.1.1 Study site

The tests were conducted on an experimental plot at the CNRA's Foods crops Research Station in Bouaké and in the villages of Attrokro (Bouaké district) and Kounontonvogo (Korhogo district) respectively. The CNRA experimental station (7°46'N, 5°06'W) and Attrokro (07° 35' N, 04° 48' W) are located in central Côte d'Ivoire. Relative humidity, which fluctuates between 70% and 80% in rainy periods, can drop to 55% in January (8). The temperature varies between 25°C and 38°C, with annual rainfall ranging from 1000 mm to 1700 mm. The climate of the Bouaké district is humid tropical with four seasons, including a long dry season (November to February), a long rainy season (March to June), a short dry season (July to August) and a short rainy season (September to October). These periods have become less marked in recent years (9). Kounontonvogo (09°53'N, -05°54'W) is located in the north of Côte d'Ivoire in the district of Korhogo. The district of Korhogo has a dry tropical regime of the Sudan-Sahelian type characterized by a dry season from November to April and a rainy season from May to October. Annual rainfall varies from 1,100 to 1,600 mm with temperatures ranging from 24° to 33°C (10).

2.1.2 Plant material

The plant material consisted of cuttings from 15 sweetpotato genotypes from the collection of the National Center for Agronomic Research -CNRA- (Irene, TIB-440060, CIP-199062-1, BF59×CIP4, Covington, Fatoni 2, Aleda manda, CIP 2, Kabode, Bela bela) and farmers (Aleda ouffouet, Sanfo figui 1, Chinois wosso, Sanfo figui 2, Gotchan).

Table 1 List and characteristics of the selected genotypes

Genotypes	ID	Origin	Fresh color
		Introduced clones	
Covington	IC-1	United States (US)	Dark-orange
TIB-440060	IC-2	INERA-Burkina Faso	Orange-pale
CIP-199062-1	IC-3	INERA-Burkina Faso	Dark-orange
BF59×CIP4	IC-4	Burkina-Faso	Orange
Irene	IC-5	CIP-Mozambique	Orange
Kabode	IC-6	Uganda	Dark-orange
CIP 2	IC-7	CIP-Mozambique	White
Bela bela	IC-8	CIP-Mozambique	Orange
		Landraces	
Aleda manda	LR1	CNRA- Côte d'Ivoire	Yellow-pale
Fatoni 2	LR2	CNRA- Côte d'Ivoire	Yellow-pale
Aleda ouffouet	LR3	Côte d'Ivoire	White
Chinois wosso	LR4	Côte d'Ivoire	Dark-yellow
Gotchan	LR5	Côte d'Ivoire	Dark-yellow
Sanfo figui 1	LR6	Côte d'Ivoire	White
Sanfo figui 2	LR7	Côte d'Ivoire	White

* IC: Introduced Clone; LR: Landrace; INERA: Institute of Environment and Agriculture Research; CIP: International Potato Center; CNRA: National Center for Agronomic Research

2.2 Methods

2.1.3 Setting up trials and crop setting up

The agronomic evaluation was carried out according to an experimental block design with three replications (blocks). These were plots with ten treatments composed of genotypes introduced by the CNRA and a local control proposed by the farmers. In Kounontonvogo and on the CNRA experimental plot, fields of about 1650 m^2 (55 m x 30 m) were constructed. The plot was divided into three blocks, each 2.5 m apart. In each block, the elementary plots occupied five 6 m long ridges (30 m^2), with spacing's of 1 m between the ridges and 0.30 m between the plants on the ridge. The elementary plots were spaced 2 m apart and each accommodated 20 plants/ ridge or 100 plants/elementary plot. A total of 300 cuttings/genotype were required for the establishment of each trial. In Attrokro, planting was done on mounds. A field of about 1500 m2 (50 m x 30 m) was created. In each block, each of the varieties occupied a 6×4 m (24 m^2) plot on which 5 rows of 7 mounds were made (35 mounds in total), with a spacing of 1 m / 1 m. Each mound contained 3 cuttings planted near the top in an equidistant triangle. In total, 105 cuttings were planted per elementary plot. The cuttings were planted on mounds or ridges with about 2-3 nodes buried in the soil. A total of 315 cuttings/genotypes were needed for the trial. Two manual weeding's were carried out throughout the trial at 21 and 90 DAP.

2.1.4 Data collection

Agronomic performance

Data collection was carried out per plot. Fresh tuberous roots were harvested 120 days after planting with a hoe. The weight and number of roots per plant for each variety in each plot were determined. Tuberous roots were considered unmarketable if they were too small (diameter < 10 cm). The incidence of weevils and nematodes was also determined after counting the attacked tuberous roots. Fresh root yield was determined by combining the roots harvested from each plot. The recorded weight per unit plot was extrapolated to tons per hectare (t/ha). The weight of total fresh biomass was measured in kilograms, which was used to calculate the harvest index. These data were collected using methods described by Crop Ontology (11) and Grüneberg, et al. (12).

2.3 Statistical analysis

Agronomic and nutritional parameters were subjected to a one-factor analysis of variance (ANOVA). In case of significant difference, least significant difference (LSD) test was performed to determine the differences between the means and to classify them into homogeneous groups. Another two-factor analysis of variance is performed to study the effect of variety and locality on agronomic traits. These analyses were performed with a significance level of 5%. These analyses were performed using Statistica 7.1 and R-studio software.

3 Results

3.1 Agronomic evaluation of sweetpotato genotypes tested on station and on-farm

3.1.1 Agronomic evaluation of sweetpotato genotypes tested in Attrokro

There were significant differences ($p < 0.05$) among varieties for all the agronomic parameters measured, except for the number of tuberous roots per plant whose values oscillated between 1 and 3 (Table 2). The average root weight per plant varied from 0.22 to 0.56 kg/plant. The highest average weight was obtained with Sanfo figui 2 (0.56 kg) and the lowest with BF59×CIP4. For the harvest index, it fluctuated from 0.49 to 0.85%. Covington recorded the highest index (0.85%) followed by the Sanfo figui 2 (0.71%) and Gotchan (0.67%), while the lowest indices were obtained by the Aleda ouffouet, Fatoni 2, BF59×CIP4 and Irene with 0.47%, 0.49%, 0.51% and 0.52% respectively. The yield of marketable roots varied from 0.37 to 10.0 t/ha. The highest value was obtained for the Sanfo figui 2 (10.09 t/ha) followed by Aleda manda (7.64 t/ha) and Irene (7.59 t/ha) and the lowest for the genotypes Covington (0.37 t/ha), BF59×CIP4 (1.88 t/ha) and CIP-199062-1 (2.42 t/ha). As for the yield of tuberous roots, it fluctuated from 15.83 to 1.59 t/ha. The lowest yield was recorded for Covington with 1.59 t/ha and the highest for Irene with 15.83 t/ha. The other genotypes varied from 5.12 to 13.79 t/ha. The DM varied from 25.34 to 33.27%. The highest DM was observed in Aleda ouffouet (33.27%) followed by Sanfo figui 2 (32.47%) and Gotchan (31.64%) and the lowest in Covington and CIP-199062- 1 with 25.73 and 25.75%. In addition, a significant difference ($p = 0.000$) was also observed for weevil attacks and the results varied from 14.81 to 64.11%. Irene (14.81%), TIB-440060 (16%), Aleda ouffouet (17%) presented fewer tuberous roots attacked by weevils. They were followed by the Sanfo figui 2 (18.33%) and CIP-199062-1 (18.66%). Aleda manda (64.11%) and Fatoni 2 (52.33%) presented the greatest number of tuberous roots attacked.

3.1.2 Agronomic evaluation of sweetpotato genotypes tested in station CNRA

The analysis of variance revealed that apart from the incidence of weevils (p = 0.143), a significant difference was observed between genotypes for all the other parameters measured ($p < 0.001$). However, it should be noted that Aleda manda and Fatoni 2 were heavily attacked, although the level of incidence was not statistically different from the other genotypes (Table 3). Thus the number of tuberous roots per plant oscillated between 1.59 and 3.51. The genotypes Bela bela (1.59) and Irene (1.83) obtained the lowest results while the variety Aleda manda obtained the highest (3.51). Concerning the yield in tuberous roots, the results varied from 0.87 to 10.74 t/ha. The highest yield was obtained with Sanfo figui 1 (10.74 t/ha) followed by the BF59×CIP4 variety (8.42 t/ha). As for the Bela bela variety, it recorded the lowest yield (0.87 t/ha) followed by Irene (2.83 t/ha) and Aleda manda (4.59 t/ha). In addition, the Sanfo figui 1 variety (5.27 t/ha) also had the highest marketable root yield. It is followed by far by the BF59×CIP4 and CIP-199062-1 genotypes with 2.50 and 2.53 t/ha. For DM, the results ranged from 22.50 to 32.75. The highest DM was obtained in the Sanfo figui 1 variety (32.75%) and the lowest in Covington (22.50%).

3.1.3 Agronomic evaluation of sweetpotato genotypes tested in Kounontonvogo

There is a significant difference ($p < 0.05$) between the genotypes for all the agronomic parameters measured except for the percentage of marketable roots (p = 0.331) whose values oscillated from 14.7 to 37.31 (Table 4). Thus the number of tuberous roots per plant varied from 1.92 to 5.63, the weight of tuberous roots per plant from 0.22 to 0.92, the yield from 3.81 to 30.41, the index of yield from 0.23 to 0.67, marketable root yield from 1.73 to 19.37, DM from 21.10 to 32.13 and weevil incidence from 0.72 to 8.42. The Fatoni 2 variety obtained the highest number of roots per plant (5.63), the highest weight of roots per plant (0.92 kg), the highest yield (30.41 t/ha) and the highest marketable root yield (19.37 t/ha). It followed by the genotypes CIP-199062-1, Irene and TIB-440060 (Table 4). At the level of the harvest index, it is the variety TIB-440060 (0.71%) which recorded the highest index followed by the genotypes CIP-199062-1 (0.67%) and BF59×CIP4 (0.62%). In addition, the lowest index was obtained by the Bela bela variety (0.23%). In addition, the Sanfo figui 1 (32.13%) and Kabode (31.68%) genotypes obtained the highest DM while the BF59×CIP4 (21.10%) and Covington (23.98%) genotypes recorded the lowest rates. Regarding the incidence of weevils, the tuberous roots of the BF59×CIP4 (0.72%) and Fatoni2 (0.84%) genotypes were less attacked compared to the Kabode (8.12%) and Covington (8.46%) genotypes).

3.2 Effect of locality on agronomic parameters

The highest number of tuberous roots per plant was recorded in the locality of Kounontonvogo (4.11) as for CNRA station and Attrokro, they recorded respectively 2.52 and 2.64. The highest weight of tuberous roots per plant was obtained in the locality of Kounontonvogo (0.67 kg/plant) followed by the locality of Attrokro with 0.40 kg/plant. The lowest weight was observed in CNRA station with 0.20 kg/plant. The highest yield was obtained in the locality of Kounontonvogo (19.92 t/ha) followed by Attrokro (10.31 t/ha) while the lowest yield was recorded in CNRA station (6.53 t/ha). Harvest indices varied from 0.56 to 0.67. CNRA station recorded the highest index while Kounontonvogo (0.56) and Attrokro (0.60) the lowest indices. The locality of Kounontonvogo obtained the highest rates (29.53%) and yield of marketable roots (12.43 t/ha). It is followed by far by Attrokro with 18.14% of marketable roots and a yield of 5.14 t/ha of marketable roots. The locality of CNRA station recorded the lowest rate (10.85%) and yield (1.83 t/ha). Weevil attacks had a higher incidence in the localities of CNRA station (32.72%) and Attrokro (31.57%) compared to the locality of Kounontonvogo which recorded a low incidence of weevils (3.54%). A significant difference ($p < 0.05$) was observed for all these parameters (Table 5).

Table 2 Mean values of quantitative variables for the agronomic parameters of the genotypes studied in Attrokro

Genotypes	Number tuberous roots/plant	Weight tuberous roots/plant (Kg/plant)	Yield (t/ha)	Harvest index (%)	Percentage marketable roots (%)	Marketable roots yield (t/ha)	Dry matter content (%)	Weevil incidence (%)
Sanfo figui 2	1.88 ± 0.1[a]	0.56 ± 0.09[a]	13.79 ± 2.2[a]	0.71 ± 0.17[ab]	26.00 ± 15.56[a]	10.09 ± 1.42[a]	32.47 ± 1.91[ab]	18.33 ± 11.71[c]
Fatoni 2	2.15 ± 0.4[a]	0.47 ± 0.17[abcd]	12.31 ± 4.6[a]	0.49 ± 0.08[c]	22.04 ± 11.03[a]	6.38 ± 4.09[b]	27.63 ± 2.44[bc]	52.33 ± 6.42[ab]
TIB-440060	2.43 ± 0.4[a]	0.35 ± 0.06[bcde]	11.79 ± 2.5[a]	0.59 ± 0.05[bc]	16.65 ± 0.93[a]	4.77 ± 1.2b[c]	27.76 ± 1.68[bc]	16.0 ± 3[c]
Covington	2.5 ± 1.0[a]	0.29 ± 0.17[de]	1.59 ± 0.39[c]	0.85 ± 0.05[a]	12.62 ± 9.63[a]	0.37 ± 0.18[d]	25.73 ± 1.72[c]	49.33 ± 14.97[b]
CIP-199062-1	2.7 1± 0.9[a]	0.31 ± 0.19[cde]	6.96 ± 4.25[b]	0.59 ± 0.07[bc]	12.30 ± 3.5[a]	2.42 ± 1.99[c]	25.75 ± 2.13[c]	18.66 ± 8.08[c]
Gotchan	2.74 ± 0.8[a]	0.46 ± 0.06[abcd]	6.59 ± 2.36[b]	0.64 ± 0.05[bc]	22.68 ± 14.07[a]	3.24 ± 1.62[c]	31.64 ± 2.99[ab]	23.66 ± 9.01[c]
Aleda ouffouet	2.93 ± 0.5[a]	0.42 ± 0.05[abcd]	13.62 ± 0.49[a]	0.47 ± 0.05[c]	17.35 ± 4.56[a]	6.40 ± 0.51[b]	33.27 ± 7.56[a]	17.0 ± 8[c]
BF59×CIP4	3.06 ± 0.4[a]	0.22 ± 0.03[e]	5.12 ± 1.34[bc]	0.51 ± 0.14[c]	12.18 ± 8.92[a]	1.88 ± 1.27[c]	25.34 ± 0.38[c]	19.0 ± 4[c]
Irene	3.07 ± 0.4[a]	0.49 ± 0.06[abc]	15.83 ± 2.73[a]	0.52 ± 0.06[c]	21.94 ± 5.53[a]	7.59 ± 1.89[ab]	29.67 ± 1.91[abc]	14.81 ± 1.28[c]
Aleda manda	3.31 ± 0.1[a]	0.53 ± 0.04[ab]	13.79 ± 1.57[a]	0.54 ± 0.11[bc]	21.40 ± 6.57[a]	7.64 ± 0.92[ab]	28.15 ± 1.97[ab]	64.11 ± 8.33[a]
Mean	2.68	0.41	10.27	0.59	18.52	5.08	28.74	29.32
p	0.206	0.019	0.000	0.008	0.052	0.000	0.03	0.000

The values presented as mean ± standard deviation, Means followed by the same letters indicate no differences at $P < 0.05$; P = Approximate Probability of Tests

Table 3 Mean values of quantitative variables for the agronomic parameters of the genotypes studied in Station

Genotypes	Number of tuberous roots/plant	Weight of tuberous roots/plant (Kg/plant)	Yield (t/ha)	Harvest index (%)	Percentage of marketable roots (%)	Marketable roots yield (t/ha)	Dry matter content (%)	Weevil incidence (%)
Bela bela	1.59 ± 0.36[d]	0.09 ± 0.05[c]	0.87 ± 0.22[e]	0.79 ± 0.08[a]	2.02 ± 3.49[b]	0.03 ± 0.06[b]	28.0 ± 1.0[bc]	40.20 ± 35.22[a]
Fatoni 2	2.44 ± 0.36[bc]	0.15 ± 0.02[bc]	4.81 ± 2.12[bcd]	0.68 ± 0.01[b]	5.34 ± 1.49[b]	0.94 ± 0.28[b]	27.66 ± 1.65[bc]	51.94 ± 26.77[a]
TIB-440060	2.46 ± 0.30[bc]	0.18 ± 0.01[bc]	7.22 ± 0.27[abc]	0.67 ± 0.02[b]	10.71 ± 9.96[b]	1.66 ± 0.96[b]	24.56 ± 3.21[cde]	19.40 ± 5.77[a]
Covington	2.68 ± 0.39[b]	0.18 ± 0.03[bc]	6.11 ± 0.48[bcd]	0.66 ± 0.00[b]	4.50 ± 6.22[b]	0.92 ± 0.89[b]	22.50 ± 2.29[e]	42.24 ± 21.63[a]
CIP-199062-1	2.50 ± 0.70[bc]	0.20 ± 0.09[bc]	7.53 ± 3.67[abc]	0.68 ± 0.01[b]	10.34 ± 10.8[b]	2.53 ± 2.44[ab]	25.0 ± 2.64[cde]	17.54 ± 9.87[a]

Sanfo figui 1	2.18 ± 0.30^{bcd}	0.39 ± 0.13^{a}	10.74 ± 3.05^{a}	0.68 ± 0.0^{b}	38.40 ± 15.43^{a}	5.27 ± 3.61^{a}	32.75 ± 3.11^{a}	40.59 ± 19.17^{a}
Chinois wosso	2.27 ± 0.29^{bcd}	0.18 ± 0.08^{bc}	4.96 ± 2.61^{bcd}	0.67 ± 0.02^{b}	4.17 ± 3.18^{b}	0.70 ± 0.59^{b}	29.35 ± 2.49^{ab}	31.31 ± 6.57^{a}
BF59×CIP4	2.56 ± 0.63^{bc}	0.20 ± 0.07^{bc}	8.42 ± 3.36^{ab}	0.68 ± 0.01^{b}	10.04 ± 8.76^{b}	2.50 ± 2.67^{ab}	23.63 ± 1.09^{de}	20.48 ± 4.98^{a}
Irene	1.83 ± 0.07^{cd}	0.09 ± 0.03^{c}	2.83 ± 0.67^{de}	0.68 ± 0.0^{b}	5.80 ± 4.69^{b}	0.51 ± 0.22^{b}	26.66 ± 1.52^{bcd}	17.50 ± 1.02^{a}
Aleda manda	3.51 ± 0.64^{a}	0.22 ± 0.08^{b}	4.59 ± 0.37^{cd}	0.66 ± 0.01^{b}	1.68 ± 2.33^{b}	0.33 ± 0.36^{b}	26.66 ± 2.08^{bcd}	52.06 ± 18.10^{a}
Mean	2.40	0.19	5.81	0.69	9.30	1.54	26.68	33.33
p	0.004	0.005	0.001	0.002	0.000	0.037	0.000	0.143

The values presented as mean ± standard deviation, Means followed by the same letters indicate no significant differences at P < 0.05; P = Approximate Probability of Tests

Table 4 Mean values of quantitative variables for the agronomic parameters of the genotypes studied in Kounontonvogo

Genotypes	**Number of tuberous roots/plant**	**Weight of tuberous roots/plant (Kg/plant)**	**Yield (t/ha)**	**Harvest index (%)**	**Percentage of marketable roots (%)**	**Marketable roots yield (t/ha)**	**Dry matter content (%)**	**Weevil incidence (%)**
Sanfo figui 1	2.77 ± 1.53^{cd}	0.59 ± 0.05^{bc}	8.61 ± 5.97^{de}	0.48 ± 0.12^{c}	36.68 ± 12.49^{a}	5.69 ± 3.91^{b}	32.13 ± 2.19^{a}	3.33 ± 5.77^{a}
Fatoni 2	5.63 ± 1.91^{a}	0.92 ± 0.24^{a}	30.41 ± 8.87^{a}	0.53 ± 0.0^{bc}	24.47 ± 5.22^{a}	19.37 ± 5.07^{a}	26.68 ± 1.40^{bc}	0.84 ± 0.29^{a}
TIB-440060	3.78 ± 0.77^{bc}	0.7 ± 0.29^{ab}	23.95 ± 10.43^{a}	0.71 ± 0.03^{a}	30.0 ± 14.88^{a}	15.69 ± 10.59^{a}	27.07 ± 2.61^{bc}	2.96 ± 2.00^{a}
Covington	4.56 ± 0.7^{ab}	0.53 ± 0.19^{bcd}	7.98 ± 2.82^{de}	0.48 ± 0.06^{c}	25.35 ± 10.94^{a}	4.86 ± 3.18^{b}	23.98 ± 1.36^{cd}	8.46 ± 3.13^{b}
CIP-199062-1	4.73 ± 0.71^{ab}	0.75 ± 0.27^{ab}	26.80 ± 9.32^{a}	0.67 ± 0.05^{a}	28.69 ± 12.32^{a}	16.04 ± 8.48^{a}	27.60 ± 3.19^{bc}	1.03 ± 0.71^{a}
Bela bela	2.45 ± 0.45^{cd}	0.30 ± 0.06^{cd}	9.09 ± 2.77^{cde}	0.23 ± 0.07^{d}	22.02 ± 14.56^{a}	4.44 ± 2.68^{b}	26.69 ± 1.18^{bc}	2.59 ± 4.12^{a}
CIP 2	1.92 ± 0.41^{d}	0.22 ± 0.04^{d}	3.81 ± 0.78^{e}	0.23 ± 0.08^{d}	14.7 ± 3.33^{a}	1.73 ± 0.52^{b}	24.35 ± 4.02^{cd}	3.19 ± 1.93^{a}
BF59*CIP4	4.38 ± 0.43^{ab}	0.61 ± 0.13^{abc}	19.93 ± 4.27^{abc}	0.62 ± 0.04^{ab}	26.31 ± 4.54^{a}	11.18 ± 3.32^{ab}	21.10 ± 1.62^{d}	0.72 ± 0.55^{a}
Irene	4.55 ± 0.64^{ab}	0.72 ± 0.16^{ab}	26.73 ± 7.10^{a}	0.52 ± 0.06^{bc}	27.37 ± 7.05^{a}	15.90 ± 6.47^{a}	28.7 ± 2.33^{ab}	2.86 ± 1.34^{a}
Kabode	2.46 ± 0.27^{cd}	0.55 ± 0.2^{bc}	14.93 ± 5.3^{bcd}	0.50 ± 0.05^{c}	37.31 ± 10.23^{a}	10.76 ± 4.57^{a}	31.68 ± 1.21^{a}	8.12 ± 2.62^{b}
Mean	3.72	0.59	17.2	0.50	27.3	10.56	27.00	3.41
p	0.000	0.007	0.000	0.000	0.331	0.010	0.000	0.021

The values presented as mean ± standard deviation, Means followed by the same letters indicate no significant differences at P < 0.05; P = Approximate Probability of Tests

Table 5 Effect of locality on agronomic parameters

Locality	Number of tuberous roots/plant	Weight of tuberous roots/plant (Kg/plant)	Yield (t/ha)	Harvest index (%)	Percentage of marketable roots (%)	Marketable roots yield (t/ha)	Weevil incidence (%)
Attrokro	2.64 ± 0.68b	0.40 ± 0.15b	10.31 ± 5.44b	0.60 ± 0.15b	18.14 ± 8.99c	5.14 ± 3.6b	31.57 ± 20.4b
CNRA station	2.52 ± 0.60b	0.20 ± 0.10c	6.53 ± 3.01c	0.67 ± 0.01a	10.85 ± 13.22b	1.83 ± 2.20c	32.72 ± 19.92b
Kounontonvogo	4.11 ± 1.32a	0.67 ± 0.21a	19.92 ± 10.17a	0.56 ± 0.10b	29.53 ± 9.81a	12.43 ± 7.23a	3.54 ± 3.7a
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000

The values presented as mean ± standard deviation, Means followed by the same letters indicate no significant differences at P < 0.05; P = Approximate Probability of Tests

Table 6 Effect of genotypes on agronomic parameters

Genotypes	Number tuberous roots/plant	Weight tuberous roots/plant (Kg/plant)	Yield (t/ha)	Harvest index (%)	Percentage marketable roots (%)	Marketable roots yield (t/ha)	Weevil incidence (%)
Irene	3.15 ± 1.24^{a}	0.43 ± 0.28^{a}	15.13 ± 11.04^{ab}	0.578 ± 0.09^{bc}	18.37 ± 10.95^{b}	8.00 ± 7.47^{a}	11.72 ± 6.83^{a}
Covington	3.25 ± 1.19^{a}	0.33 ± 0.20^{a}	5.22 ± 3.19^{c}	0.66 ± 0.18^{a}	14.16 ± 12.06^{b}	2.05 ± 2.69^{b}	33.34 ± 23.09^{b}
TIB-440060	2.89 ± 0.81^{ab}	0.41 ± 0.27^{a}	14.32 ± 9.21^{ab}	0.659 ± 0.06^{a}	19.14 ± 12.41^{b}	7.37 ± 8.32^{a}	12.78 ± 8.25^{a}
Sanfo figui 1	2.27 ± 0.87^{b}	0.51 ± 0.13^{a}	11.48 ± 4.54^{ab}	0.629 ± 0.15^{abc}	33.70 ± 13.89^{a}	7.02 ± 3.59^{a}	20.75 ± 19.95^{a}
CIP-199062-1	3.31 ± 1.26^{a}	0.42 ± 0.30^{a}	13.76 ± 11.19^{ab}	0.65 ± 0.06^{ab}	17.11 ± 12.09^{b}	7.00 ± 8.15^{a}	12.41 ± 10.67^{a}
BF59×CIP4	3.33 ± 0.93^{a}	0.35 ± 0.21^{a}	11.16 ± 7.28^{ab}	0.61 ± 0.10^{abc}	16.18 ± 10.14^{b}	5.18 ± 5.02^{ab}	13.40 ± 10.05^{a}
Aleda manda	3.09 ± 0.60^{a}	0.43 ± 0.19^{a}	11.10 ± 5.66^{ab}	0.570 ± 0.09^{c}	20.13 ± 16.65^{b}	6.24 ± 5.19^{a}	41.43 ± 27.43^{b}
Fatoni 2	3.41 ± 1.94^{a}	0.51 ± 0.36^{a}	15.84 ± 12.49^{ab}	0.574 ± 0.09^{c}	17.28 ± 10.91^{b}	8.90 ± 8.92^{a}	35.04 ± 29.10^{b}
p	0.046	0.100	0.000	0.039	0.002	0.026	0.000

The values presented as mean ± standard deviation, Means followed by the same letters indicate no significant differences at P < 0.05; P = Approximate Probability of Tests

3.2 Effect of genotype on agronomic parameters

The number of tuberous roots per plant varied from 2.27 to 3.41. Fatoni 2, BF59*CIP4, CIP-199062-1, Covington, Irene and Aleda manda genotypes obtained the highest numbers (Table 6). A significant difference ($p = 0.046$) was observed between the genotypes. The average root weight per plant varied from 0.33 to 0.51. No significant difference ($p > 0.05$) was observed for mean weight. As for the yields of tuberous roots and marketable roots, the results obtained showed a significant difference ($p < 0.05$). The highest yields were obtained by the genotypes Fatoni 2 (15.84 t/ha), Irene (15.13 t/ha) and the lowest by Covington (5.22 t/ha). Moreover, at harvest, the Aleda manda, Fatoni 2 and Covington genotypes presented the tuberous roots most attacked by weevils. While the weakest attacks were recorded with the Irene genotypes, CIP-199062-1, TIB-440060 (Table 6). A significant difference ($p = 0.000$) was noted for this parameter between the genotypes.

3.3 Locality*variety interaction on agronomic parameters

The highest yields of tuberous roots (30.42 t/ha) and marketable roots (19.38 t/ha) were obtained with the Fatoni 2 variety in Kounontonvogo while the lowest were recorded with the Covington genotypes in Attrokro and Irene in CNRA station (Table 7). A significant difference was noted for these two parameters with respectively a probability of 0.000 and 0.005. For the number of tuberous roots per plant, Irene (1.83) and Sanfo figui 1 (1.88) obtained the lowest numbers respectively in CNRA station and Attrokro. As for yield, the highest number of roots (5.63) was recorded by Fatoni 2 at Kounontonvogo. The genotypes*localities interaction had a significant effect ($p = 0.001$) on this parameter. The BF59*CIP4, Fatoni 2 and CIP-199062-1 genotypes were less attacked by weevils at Kounontonvogo. While the most attacked were the Aleda manda and Fatoni 2 genotypes in Attrokro and CNRA station. Regarding the harvest index, the results varied from 0.49 to 0.85. The highest index was recorded at Attrokro with Covington, while the lowest was obtained at Kounontonvogo with Sanfo figui1 (Table 7). The results showed a significant effect for weevil incidence ($p = 0.003$) and harvest index ($p = 0.000$).

Table 7 Effect of genotype*locality interaction on agronomic parameters

Locality	Genotypes	Number tuberous roots/plant	Yield (t/ha)	Harvest index (%)	Percentage marketable roots (%)	Marketable roots yield (t/ha)	Weevil incidence (%)
	Irene	3.08^{efgh}	15.83^{cd}	0.53^{cde}	21.95^{bcdef}	7.59^{cd}	14.81^{abc}
	Covington	2.50^{fghi}	1.59^{i}	0.85^{a}	12.63^{defg}	0.37^{e}	49.33^{cd}
	TIB-440060	2.43^{fghi}	11.80^{defg}	0.59^{bcde}	16.66^{defg}	4.78^{cde}	16.00^{abc}
	Sanfo figui 1	1.88^{hi}	15.09^{cde}	0.71^{b}	26.01^{abcd}	10.09^{bc}	18.33^{bc}
Attrokro	CIP-199062-1	2.72^{efghi}	6.96^{fghi}	0.59^{bcde}	12.31^{defg}	2.43^{de}	18.67^{bc}
	BF59*CIP4	3.06^{efghi}	5.13^{ghi}	0.51^{de}	12.18^{defg}	1.89^{de}	19.00^{bc}
	Aleda manda	3.32^{defgh}	13.80^{cdef}	0.54^{cde}	21.41^{cdef}	7.65^{cd}	64.12^{d}
	Fatoni 2	2.16^{ghi}	12.31^{cdefg}	0.50^{de}	22.04^{bcdef}	6.39^{cde}	52.33^{cd}
	Irene	1.83^{i}	2.83^{i}	0.69^{b}	5.81^{g}	0.52^{e}	17.51^{abc}
	Covington	2.69^{efghi}	6.11^{ghi}	0.66^{bc}	4.51^{g}	0.93^{e}	42.25^{c}
	TIB-440060	2.46^{fghi}	7.22^{fghi}	0.67^{b}	10.71^{efg}	1.67^{de}	19.41^{bc}
	Sanfo figui 1	2.18^{ghi}	10.74^{defgh}	0.69^{b}	38.41^{a}	5.28^{cde}	40.59^{c}
CNRA station	CIP-199062-1	2.50^{fghi}	7.54^{efghi}	0.69^{b}	10.35^{efg}	2.54^{de}	17.54^{abc}
	BF59*CIP4	2.56^{fghi}	8.43^{defghi}	0.69^{b}	10.05^{fg}	2.50^{de}	20.48^{c}
	Aleda manda	3.52^{cdef}	4.59^{hi}	0.66^{bc}	1.69^{g}	0.33^{e}	52.07^{cd}
	Fatoni 2	2.44^{fghi}	4.81^{ghi}	0.69^{b}	5.34^{g}	0.94^{e}	51.95^{cd}
	Irene	4.55^{abc}	26.74^{ab}	0.52^{de}	27.37^{abcd}	15.90^{ab}	2.86^{ab}

	Covington	4.57[abc]	7.99[efghi]	0.48[e]	25.35[abcde]	4.86[cde]	8.47[bc]
	TIB-440060	3.78[bcde]	23.96[ab]	0.71[b]	30.07[abc]	15.69[ab]	2.96[abc]
Kounont	Sanfo figui 1	2.77[fghi]	8.61[defghi]	0.49[e]	36.69[ab]	5.69[cde]	3.33[abc]
onvogo	CIP-199062-1	4.74[ab]	26.81[ab]	0.67[b]	28.70[abc]	16.04[ab]	1.04[a]
	BF59*CIP4	4.39[bcd]	19.93[bc]	0.63[bcd]	26.32[abcd]	11.18[c]	0.73[a]
	Aleda manda	2.46[fghi]	14.93[cde]	0.51[de]	37.31[a]	10.76[bc]	8.12[abc]
	Fatoni 2	5.63[a]	30.42[a]	0.54[cde]	24.47[abcdef]	19.38[a]	0.85[a]
	p	0.001	0.000	0.000	0.021	0.005	0.003

Means followed by the same letters indicate no significant differences at $P < 0.05$; P = Approximate Probability of Tests

4 Discussion

The results of the evaluated parameters revealed significant differences between genotypes, localities and locality x variety interaction with respect to yield and its components. The number of tuberous roots varied from 1.28 to 5.63 roots per plant. Marketable root yield varied from 0.37 t/ha to 19.38 t/ha, while root weight varied from 0.10 to 0.92 kg per plant. The harvest index varied from 43 to 85% and the average yield of fresh roots from 30.42 t/ha to 1.59 t/ha. The average root yield in Kounontonvogo was higher than in the localities of Attrokro and CNRA station and the respective yields of 6.53 t/ha and 10.31 t/ha. The variation between genotypes for the number of marketable roots, fresh root yield and harvest index could be explained by environmental factors. Vanaja & Babu (13) and Yadeta et al. (14) reported that if the variability of most sweetpotato yield components is attributable to environmental factors. Indeed, during the growing season, the rainfall conditions were more favorable in Kounontonvogo than in the localities of CNRA station and Attrokro. The locality of Kounontonvogo benefited from an adequate amount of rain (1157.2 mm) during cultivation, which was not the case in CNRA station and Attrokro. CNRA station, plants benefited from an average rainfall of 651.2 mm of rain while Attrokro recorded 633.1 mm of rain. These low rainfalls recorded in CNRA station and Attrokro, would have led to the reduction of the canopy of the genotypes during their growth, consequently causing the reduction of the growth parameters. To this end, Motsa et al. (15) reported that water stress reduced stem development, internode diameter, leaf growth and therefore plant leaf area with consequent reduction in vegetative growth of sweetpotato. Thus, reduction in plant cover can limit photosynthetic activity with subsequent effects on root yield according to Lewthwaite & Triggs (16). In addition, the work of Mbusa et al. (17) found that water deficit increased the percentage of non-marketable roots (small roots) at the expense of marketable ones (large roots). Our results are in agreement with those obtained by Adebola et al. (18) and Kouassi & Dibi (1) who found in similar studies in South Africa and Côte d'Ivoire respectively that sweetpotato genotypes responded differently to environmental conditions. In addition, the date of planting could have an effect on the development and growth of the plants. Indeed, the plantations of Kounontonvogo are carried out in June 2018, while those of CNRA station and Attrokro were set up in August 2019 and July 2020. The plants of the different localities would not all have benefited same periods of growth. It has been reported that yield and its components can be determined by the length of the growing period (19). These observations were also supported by Tairo et al. (20) and Mbusa et al. (17) who observed in different agro-ecological zones in Tanzania and Kenya respectively, a significant difference in root number, root weight, root weight per plant and DM content of sweetpotato. In the present study, in addition to genotypic variability, there were variations due to localities and seasons that may have significantly influenced yield and its components. It would therefore be wise to set the planting at the ideal growing period to optimize tuberous root yields.

5 Conclusion

The behavior of the genotypes varied from one zone to another for the yield, the number of marketable and non-marketable roots. However, overall, the Irene, Fatoni 2 and TIB-440060 genotypes presented the best agronomic performance. In addition, the genotypes Irene, TIB-440060 and CIP-199062-1 were resistant to weevil attacks while local genotypes such as Aleda ouffouet, Sanfo figui1 and Sanfo figui2 obtained the highest DM content. Evaluation of sweetpotato accessions could be used to identify and select accessions with high root yield and resistance for incorporation into breeding programs.

Compliance with ethical standards

Acknowledgments

The authors are grateful to National Agricultural Research Center (CNRA), Bouaké, Côte d'Ivoire, University Jean Lorougnon Guédé (UJLoG), Daloa, Côte d'Ivoire and the grant opportunity INV-008567 (formerly OPP1178942): Breeding RTB Products for End User Preferences (RTBfoods), to the French Agricultural Research Center for International Development (CIRAD), Montpellier, France, by the Bill & Melinda Gates Foundation (BMGF): *https://rtbfoods.cirad.fr.*

Disclosure of conflict of interest

The authors declare that they have no conflict of interest regarding the publication of this article.

References

[1] Kouassi DEO, Dibi KEB. Agronomic Characterization of 88 Accessions of the Sweet Potato (Ipomoea batatas (L.) Lam.) Collection of Côte d'Ivoire. International Journal of Sciences. 2020; 9(11):1-12.

[2] Alemu MD, Aragaw A. Genetic variability of Sweet Potato on yield and yield related traits at werer Agricultural Research Center, Ethiopia. Electronic journal of plant breeding. 2016; 7(2): 362-370.

[3] Dibi KEB, Kouassi JHM, N'goran KE, Essis BS, N'zue B, Kouakou AM. Effect of Different Rates of Mineral Fertilizer on the Yield of Two Varieties of Sweet Potato [Ipomoea batatas (L) Lam] in Bouaké, Central Côte d'Ivoire. European Scientific Journal. 2019; 15(33): 135-146.

[4] Faostat. Food and Agriculture Organization Corporate Statistical Database [Internet]. 2022 [cited 2 mars 2022]: https://www.fao.org/faostat/fr/#data/QCL

[5] Dibi KEB, Essis BS, N'zué B, Kouakou AM, Zohouri GP, Assouan AB. Participatory selection of orange-fleshed sweetpotato varieties in north and north-east Côte d'Ivoire. Open Agriculture. 2017; 2(1): 83-90.

[6] Kouassi JHM, Ahou Yah Koua G, Evrad Konan Dibi B, Amani Kouakou M, Bomoh Ebah Djedji C, Brice Essis S. Consumer Preferences for Boiled and Fried Sweet Potato in Central and Northern Côte d'Ivoire, West Africa. Journal of Advances in Biology & Biotechnology. 2021; 24(8): 33-46.

[7] Mwanga ROM, Andrade MI, Carey EE, Low JW, Yencho GC, Grüneberg WJ. Sweetpotato (Ipomoea batatas L.). In: Genetic Improvement of Tropical Crops. Cham: Springer International Publishing; 2017. p. 181-218.

[8] Kouassi DEO, N'Zué B, Bonny BS, Dibi KEB, Essis BS, Koné T. Diversity and relationships among morphological characters in the sweetpotato collection of Cote D'Ivoire. African Crop Science Journal. 2019; 27(3): 375-394.

[9] Brou YT, Akindès F, Bigot S. Climate variability in Côte d'Ivoire : Social perceptions and agricultural responses. Cahiers Agricultures. 2005; 14(6): 533-540.

[10] Boko-Koiadia AN, Cissé G, Koné B, Séri D. Climate variability and change in the environment at Korhogo in Côte d'Ivoire : Myth or reality? European Scientific Journal. 2016; 12(5): 158-176.

[11] Crop Ontology. Crop Ontology Curation Tool [Internet]. 2020 [cited 23 sept 2020]: https://www.cropontology.org/ontology/CO_331/Sweet%20Potato

[12] Grüneberg, WJ, Eyzaguirre R, Diaz F, De Boeck bert, Espinoza J, Mwanga ROM. Procedures for the evaluation of sweetpotato trials. Lima (Peru): International Potato Center; 2019 [cited 2 July 2020]. 77 p. https://hdl.handle.net/10568/105875

[13] Vanaja T, Babu LC. Variability in grain quality attributes of high yielding rice varieties (Oryza sativa L.) of diverse origin. Journal of Tropical Agriculture. 2007; 44: 61-3.

[14] Yadeta B, Belew D, Gebreselassie W, Marame F. Variability, heritability and genetic advance in hot pepper (Capsicum annuum L.) genotypes in West Shoa Ethiopia. American-Eurasian Journal of Agricultural & Environmental Sciences. 2011; 10: 587-592.

[15] Motsa NM, Modi AT, Mabhaudhi T. Sweet potato (Ipomoea batatas L.) as a drought tolerant and food security crop. S Afr J Sci. 2015; 111(11-12): 1-8.

[16] Lewthwaite SL, Triggs CM. Sweetpotato cultivar response to prolonged drought. Agronomy New Zealand. 2012; 42: 1-10.

[17] Mbusa H, Ngugi K, Olubayo F, Kivuva B, Muthomi J, Nzuve F. Agronomic Performance of Kenyan Orange Fleshed Sweet Potato Varieties. JPS. 6 June 2018; 7(2):11.

[18] Adebola PO, Shegro A, Laurie SM, Zulu LN, Pillay M. Genotype x environment interaction and yield stability estimate of some sweet potato [Ipomoea batatas (L.) Lam] breeding lines in South Africa. J Plant Breed Crop Sci. 30 sept 2013; 5(9):182-6.

[19] Lebot V. Tropical Root and Tuber Crops: Cassava, Sweet Potato, Yams and Aroids. CABI; 2009. 435 p.

[20] Tairo F, Mneney E, Kullaya A. Morphological and agronomical characterization of Sweet potato [Ipomoea batatas (L.) Lam.] germplasm collection from Tanzania. Afr J Plant Sci. 2008; 2(8):77-85.