
RESEARCH ARTICLE

Varietal evaluation of potato (*Solanum tuberosum* L.) genotypes for growth and yield traits in Mambilla Plateau, Taraba State, Nigeria

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Abstract

The study was conducted at Nguroje, Mambilla Plateau to evaluate twelve potato genotypes for their growth, yield and internal characteristics during the two growing seasons of 2021/2022. The experiment was carried out using randomized complete block design with three replications. The results of the combined analysis of variance revealed highly significant differences ($p \leq 0.01$) among the genotypes for all the characters studied except for percentage marketable tuber size. The mean performance showed that Caruso performed better than the other varieties in leaf width, percentage marketable tuber size, weight of tubers per plant, weight of tubers per plot, and total tuber yield per hectare, closely followed by Superior variety with percentage marketable size, weight of tuber per plant, weight of tubers per plot, and total tuber yield per hectare respectively. Bertita exhibited highest values in number of tubers per plant, number of tubers per plot and starch content. Higher yielding potentials exerted by Caruso, Superior and Bertita varieties indicates a good adaptation to the prevailing environmental conditions and hence recommended for the study area.

Keywords: Potato, genotype, tuber yield, traits

Introduction

Potato (*Solanum tuberosum* L.) is among the oldest crop cultivated for food and one of the most profitable crop following rice and maize for the farmer (Reddy *et al.*, 2018). The crop is considered as the third most important food crop after rice and wheat, and plays significant role in food and nutritional security worldwide (Hajam *et al.*, 2018). Potato is considered a vegetable with the highest antioxidant potentials and rich in carbohydrates, proteins, vitamins, minerals and dietary fiber. The nutrient rich potato can improve food security and health, especially among women and children, thus reducing mortality rate caused by malnutrition (Kumari *et al.*, 2018). Potato is a good source of vitamin B1, B2 and B6, minerals such as iron, potassium, phosphorus, and magnesium, and it contains folate, pantothenic acid and riboflavin (Devaux *et al.*, 2020), hence, it contributes to combat micronutrient deficiency, referred to as hidden hunger, which is a major public issue affecting an estimated two billion people globally (Bailey *et al.*, 2015).

Interestingly, Singh *et al.*, (2020) stated that the protein content in potato is of higher quality, higher than other major roots and tubers, major cereals and moreover, higher than proteins of animal origin like milk and beef. Sanginga (2015) highlighted that potato productivity in terms of energy produced is the highest of all major arable crops, almost double that of rice and wheat. Potato tubers are known to combat prostate cancer and breast cancer due to their higher antioxidant content (Kumari *et al.*, 2018). Nigeria ranked 41th in the world production and 7th in Africa with estimated output of 1,216,400 mmt on 322,523 harvestable area and yield of 37,715 tons per hectare (FAO, 2023). Favorable environmental conditions in the highlands of Jos, Plateau State, Mambilla Plateau, Taraba State, Obudu, Cross River State and Biu, in Borno State have favored potato production in Nigeria. In spite of the importance role played by potato in the Mambilla Plateau in terms of ensuring food security and income generation, production is still under small farm holdings, reliant on landraces and poor varieties as seeds with low yield and susceptible to biotic and abiotic stress. However, lack of research to select well adapted and high yielding potato varieties necessitated the study. Therefore, this research was undertaken to test the performance of potato genotypes for growth, yield and internal quality traits in the area.

Materials and methods

The study was conducted at the Mambilla Plateau (Nguroje) during the 2021 and 2022 cropping season at the farmers' field. The Mambilla Plateau is located at latitude 7°20'N and longitude 11°43'E, with an average elevation of 1,524 m above sea level. The area enjoys low temperatures ranging between 12 to 25°C in most parts of the year, and it receives over 1,850 mm of rainfall annually.

The genotypes comprised of twelve potato cultivars, six of the potato varieties were sourced from the National Root Crop Research Institute (NRCRI), substation Vom, Plateau State, five of the varieties were obtained from the Mambilla Plateau, and one of the variety was collected from farmer in the potato producing area in Bokkos Local Government Area of Plateau State, as showed in Table 1. The experiment was laid out in a Randomized Complete Block Design with three replications. The genotypes were sown at the spacing of 70 x 30 cm at the depth of 5-10 cm. All other management practice was carried out as recommended. Data were collected on percentage emergence (%), days to first flower, plant height (cm), number of branches per plant, leaf length (cm), leaf width (cm), number of leaves per plant, number of tubers per plant, percentage marketable tuber size, weight of tubers per plant (g), number of tubers per plot, weight of tubers per plot (kg), total tuber yield per hectare (ton/ha), tuber dry matter content (%), specific gravity (g), and the starch content (%). Data collected were subjected to statistical tool using SAS for windows version 9.4 (2012), SAS institute Inc. Cary, North Carolina, USA.

Results and discussion

The mean squares of the combined analysis of variance for the 16 characters revealed highly significant differences ($p \leq 0.01$) among the genotypes for all the characters tested except percentage marketable tubers size that showed non-significant indicating the presence of considerable genetic variability. The results are in conformity with those reported by Rohit *et al.*, (2022) and Tessema *et al.*, (2022) in potato. The combined analysis for two years on growth performance of the potato are presented in Table 3.

Table 1: Genotypes used and area of collection

Sr. No.	Genotypes	Areas of collection
1	Superior	Nguroje, Mambilla, Taraba State
2	Bawon doya	Bokkos, Jos, Plateau State
3	Red Irish	Nguroje, Mambilla, Taraba State
4	Yellow Cece	Nguroje, Mambilla, Taraba State
5	Yellow leaf Nicola	NRCRI, Vom, Plateau State
6	Cameroun variety	Nguroje, Mambilla, Taraba State
7	Green leaf Nicola	NRCRI, Vom, Plateau State
8	Marabel	NRCRI, Vom, Plateau State
9	Bertita	NRCRI, Vom, Plateau State
10	Madam	Nguroje, Mambilla, Taraba State
11	Caruso	NRCRI, Vom, Plateau , State
12	Lady Christly	NRCRI, Vom, Plateau , State

Table 2: Mean squares values for characters measured for combined years

Df	1	2	11	11	45
Percentage emergence	1.70	8.41	178.93**	45.41*	20.44
Days to first flower	1946.21**	0.93	334.86**	0.00	2.62
Plant height	896.72**	12.58	199.25**	8.03	11.45
Number of branches/plant	1.37*	0.20	3.61**	0.56*	0.21
Leaf length	0.57	0.42	3.43**	0.13	0.34
Leaf width	0.07	0.20	3.18**	0.07	0.16
Number of leaves/plant	4880.87	162.70	33354.32**	1915.19	2313.32
Number of tubers /plant	2.12	1.09	16.22**	0.37	2.22
% marketable tubers size	124.85	4.44	76.06	71.56	45.71
Weight of tubers /plant	0.028*	0.004	0.183**	0.003	0.006
Number of tubers /plot	4.61	1374.61	6472.61**	169.92	654.69
Weight of tubers /plot	85.91**	97.06**	311.23**	1.26	5.80
Tuber yield /hectare	36.06**	101.55**	202.53**	5.92	5.21
Tuber dry matter content	3.84	0.24	28.99**	2.36	2.17
Specific gravity	0.003	0.013	0.050**	0.003	0.007
Starch content	1.54	5.16	227.37**	19.81**	5.77

The results revealed that Red Irish, Yellow leaf Nicola and Caruso recorded highest plant percentage emergence (97.9%), which statistically differs from Madam (90.0%), Cameroun variety (83.3%) and Marabel (83.3%) respectively. Similar trend of results was reported in potato by Hajam *et al.*, (2018) and Rohit *et al.*, (2022).

Days to first flower was statistically significant ($p \leq 0.01$) among the varieties, nevertheless, Red Irish flowered late (70.8), while Bawon doya (45.5) flowered earlier than the other genotypes. Carrie *et al.*, (2014) reported that early flowering in potato may indicates the beginning of tuberization at an early stage. In line with the present study, Abebe *et al.*, (2013), observed similar results in potato. The Tallest plant was recorded for Superior (46.3cm), which significantly differed from other varieties except Cameroun variety (42.4cm), however, the shortest plant was noted for Marabel (24.9cm). The findings are consonance with the findings of Tessema *et al.*, (2022), and Rohit *et al.*, (2022) in potato. In this study, Marabel exhibited the maximum number of branches per plant (6.0), which statistically differed from other, but minimum number of branches was obtained by Madam (3.4). This variation could be attributed to differences in genetic potentials among the genotypes. The results are consistent with previous studies by Abebe *et al.*, (2013). Significant variation was observed among the varieties tested in this current study with respect to leaf length, accordingly, the longest leaf was observed for Bawon doya (4.9cm), which statistically differed from the other genotypes, besides, the shortest leaf value was showed by Yellow Cece (2.1cm). For, leaf width, Marabel and Caruso reported the widest leaf with mean of 4.1cm.

Whereas, the least or narrowest leaf was noted for Superior (2.1cm). For longest and widest leaf, these findings are conformity with observations made by Abebe *et al.*, (2013).

Statistical variations among the genotypes for number of leaves per plant was observed, Bawon doya showed the highest number of leaves per plant (478.3), while the least number of leaves per plant was obtained by Madam (204.0). Similar observations were seen in Rohit *et al.*, (2022). Number of stems is related to number of branches and leaves, thus contributing to photosynthetic activity (Tufan and Ozturk, 2024). Hence an increase in the uptake of solar radiation can ensure higher photosynthesis and encourage the synthesis and accumulation of carbohydrate positively affecting the final tuber yield (White *et al.*, 2007). In the same vein, the combined performance for the yield characters are presented in Table 4. Number of tubers per plant showed significant variation among the genotypes used for this study. The maximum number of tubers per plant was observed for Bertita (15.3) which was statistically similar to Red Irish (14.3), but also differed from other varieties. The minimum number of tubers per plant was obtained for Superior (9.1). Mihovilorich *et al.*, (2009) stated that potential number of tubers that a plant can successfully produce varies with genotypes. Variation for number of tubers per plant were previously reported by Abdeta *et al.*, (2023), and Tufan and Ozturk (2024). Statistically significant variation existed among the genotypes for percentage marketable tuber size, Caruso variety had the highest percentage marketable tuber size (78.5 %) and significantly differed from other varieties.

Table 3: Means Performance of the characters studied for combined years

Genotypes	Plant emergence	Days to 50% flowering	Plant height	Branches per plant	Leaf length	Leaf width	Leaves per plant
Superior	96.5a	47.4f	46.3a	3.7e	3.0bcde	2.1c	363.8b
Bawon doya	96.3a	45.5g	38.1bcd	4.5c	4.9a	3.7a	478.3a
Red Irish	97.9a	70.8a	35.0d	4.4cd	3.1bc	2.7b	234.2de
Yellow Cece	94.6ab	53.8d	40.4bc	3.9cde	2.1f	2.5bc	266.8cde
Yellow leaf Nicola	97.9a	57.7c	37.4cd	4.4cd	2.5cdef	2.8b	278.8cd
Cameroun variety	83.3c	56.8c	42.4ab	3.8de	3.0bcde	2.9b	250.2cde
Green leaf Nicola	97.5a	54.2d	37.6cd	5.1b	2.6cdef	3.8a	226.7de
Marabel	83.3c	58.5c	24.9f	6.0a	2.3ef	4.1a	291.0cd
Bertita	97.5a	51.3e	35.9cd	5.2b	3.2bc	3.7a	303.5c
Madam	90.0b	67.3b	29.3e	3.4e	2.4def	2.2c	204.0e
Caruso	97.9a	48.7f	38.5bcd	5.6ab	3.4b	4.1a	254.7cde
Lady Christly	95.8a	54.8d	30.2e	4.5cd	2.8bcdef	3.8a	226.5de

Here means with the same letter are not significantly different at 5% level of probability using DMRT

Table 4: Means Performance of the characters studied for combined years

Genotypes	Tubers per plant	Percent marketable size	Tubers weight per plant	Tubers per plot	Tubers weight per plot	Tuber yield per hectare
Superior	9.1d	74.2ab	1.2a	428.5f	46.6a	39.8a
Bawon doya	11.7b	70.5ab	0.79cd	460.3e	29.2f	23.8fg
Red Irish	14.3a	72.2ab	0.70def	523.7abc	31.1ef	25.1ef
Yellow Cece	12.3b	65.2b	0.64f	495.2cd	25.8g	21.2g
Yellow leaf Nicola	12.1b	68.3b	0.78cde	535.2ab	38.5cd	30.4c
Cameroun variety	9.7cd	69.3b	0.78cde	483.6de	32.7e	27.3de
Green leaf Nicola	12.3b	72.0ab	0.91b	523.4abc	40.5bc	32.6bc
Marabel	11.5bc	70.8ab	0.94b	494.5cd	43.1b	35.1b
Bertita	15.3a	68.0b	0.94b	553.5a	38.8cd	30.4c
Madam	11.7b	67.2b	0.69ef	505.4bcd	28.7fg	27.4de
Caruso	10.9bcd	78.5a	1.2a	521.6.abc	48.6a	40.2a
Lady Christly	12.3b	70.0ab	0.87bc	515.2bcd	36.2d	29.8cd

This was followed by Superior (74.2 %), while on the other hand, the lowest percentage marketable tuber size was obtained by Yellow Cece (65.2 %). Statistical analysis for weight of tubers per plant indicated significant variation among the genotypes, Superior and Caruso recorded maximum weight values (1.2 kg), while the lowest weight of tubers per plant was recorded by Yellow Cece (0.64 kg). These findings are in accordance to that of Hajam *et al.*, (2018). Abdeta *et al.*, (2023) asserted that variation in tuber weight among

potato varieties may be attributed to the inherent genetic variation on tuber bulking potential. For, number of tubers per plot Bertita outperformed the other genotypes (553.5), followed by Yellow leaf Nicola (535.2), whereas Superior observed the least number of tubers per plot (428.5). The heaviest tubers per plot was obtained for Caruso (48.6 kg), and Superior (46.6 kg), which was statistically not significant from each other, nevertheless differs from the other varieties.

While, the least yielding variety was recorded by Yellow Cece (25.8 kg). Similar results were seen in Hajam *et al.*, (2018). Expertly, tuber yield per hectare was highest for Caruso (40.2 tons), and Superior (39.8 tons), which significantly out yielded the other varieties. The lowest tuber yield per hectare was observed for Yellow Cece (21.1 tons). High yielding potentials exhibited by potato varieties have been reported previously by numerous researchers on different potato genotypes in different production environment. Tessema *et al.*, (2022), and Abdeta *et al.*, (2023) reported variation in tuber yield among the potato genotypes tested. The combined data for quality characters used for the study are presented in Table 5. Accordingly, Red Irish produced significant higher tuber dry matter content than all other varieties tested in this study with a mean of 23.6, at the same time, Caruso (16.4) had the lowest tuber dry matter. Similar results were reported by Rohit *et al.*, (2022), and Tessema *et al.*, (2022). Incidentally, Yellow Cece (1.22) recorded significantly higher specific gravity than the other varieties, followed by Yellow leaf Nicola (1.16), whereas the lowest specific gravity was produced for Green leaf Nicola (0.88). Similar results can be seen in

Rohit *et al.*, (2022). The varieties tested for this study showed significant differences in their starch content production potentials. Bertita (30.6 %) observed the highest starch content, nonetheless, the least starch content was recorded by Cameroun variety (10.9 %). These findings are conformity with previous works of Tessema *et al.*, (2022). Potato starch content as reported by Kumari *et al.*, (2018) varies according to cultivars, geographical area and climate; and it ranged between 11-45 % of the tuber fresh weight.

Hence, in conclusion the present investigation revealed the significant differences existed among the potato genotypes studied. These variations among the potato cultivars might be attributed more to different effect of genetic variation and less environmental factors. Accordingly, the higher percentage marketable tuber size, weight of tubers per plant, weight of tubers per plot and total tuber yield per hectare was exhibited by Caruso, while Bertita performed best in number of tubers per plant, number of tubers per plot and starch content, indicates a good adaptation of the cultivars to the prevailing environmental conditions of the area.

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