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ORIGINAL RESEARCH ARTICLE

Examination of the diversity in pumpkin (*Cucurbita maxima* L.) growth accessions in south-eastern Nigeria

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ABSTRACT

The aim of the study was to compare the growth rates of various pumpkin (*Cucurbita maxima* L.) accessions. Pumpkins from Aku I, Aku II, Awka, Ifite-Ogwari Nsukka I, and Nsukka II were the various accessions. A field study was conducted at the Ifite-Ogwari Campus of Nnamdi Azikiwe University in Anambra State. The experiment was laid out using a completely randomized design (CRD) with three replications. As experimental sample units, two (2) of the middlemost plants in each polybag were cut off and tagged. Analysis of Variance (ANOVA) was used to analyze data on vegetative growth factors at a 5% probability level and the treatment means were divided using the least significant difference (LSD 0.05). The result of the experiment revealed that all of the pumpkin accessions performed similarly in terms of the amount of time it took for them to emerge after sowing, their percentage of emergence, and their overall vegetative growth. None of the accessions were statistically different with respect to their emergence and growth parameters. However, the growth parameter evaluations were dominated, on average, by pumpkin accession from Nsukka (I and II) pumpkins. In addition, the Aku II pumpkin had the shortest days-to-emergence (3.33 days) and the greatest mean percentage of emergence (100%). Conversely, Aku I pumpkin consistently performed the lowest when it came to the factors that were looked at. For a comprehensive characterization of *C. maxima*, additional research at the molecular and genomic levels is advised including a greater number of accessions.

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INTRODUCTION

Cucurbita maxima L. (pumpkin) is a significant vegetable crop in the Cucurbitaceae family. a family that includes watermelon, muskmelon, eggplant, cucumber, and egusi melon, among other relatives. The crop grows in a variety of agro-ecological zones, is rich in nutrients, and adapts well to local conditions (Ahmed & Khan, 2019; Oluoch, 2012; Ogbonna, 2013; Sandra *et al*., 2016). They are known as the largest family of vegetable crops and are often referred to as cucurbits or the gourd family. They are herbaceous annuals or perennials with a store root and mostly damp vines (Fapohunda *et al*., 2018; Malley, 2008; Rahman *et al*., 2008). *Cucurbita maxima* belongs to the sub-family Cucurbitoideae, which is primarily made up of food plants, especially vegetables, that include all the necessary components for optimal human health (Fapohunda *et al*., 2018; Malley, 2008; Ogbonna, 2013). Pumpkins are annual, monoecious, short-lived perennial plants that climb or crawl throughout the day. Their stems can reach lengths of over 10 meters. The structure, development, and color of the male and female flowers differentiate them from one another. The male and female flowers are seen to be shorter (3–5 cm) and to be more elongated (6–12 cm), with both flowers ranging in color from yellow to pale orange. Water availability, precipitation, irrigation, and regional feeding practices all affect their dispersion (Hosen *et al*., 2021). Even when the crop was domesticated, natural selection remained a major factor in its evolution. Fruit size, color, form, leaf texture, maturity duration, tolerance to low soil fertility, and resilience to pests and diseases have all been subject to artificial selection pressure (Aruah *et al*., 2010). There are notable variations in the composition of different cultivars of pumpkin seed oil that are produced from different sources or cultivars of pumpkin (Amin *et al*., 2019). The relationships between *Cucurbita* subspecies have been examined using a broad range of molecular marker techniques. Unfortunately, these linkages remain unresolved, possibly because most research has concentrated on commercial and improved cultivars, typically including just a small number of landraces from Mexico, where primitive landraces are still produced (Castellanos-Morales *et al*., 2019). Farmers won't be able to determine which cultivars are the highest producing and the best to cultivate commercially to meet the quality standards for various value-adding opportunities, thus, the need to examine the diversity in pumpkin growth accessions in Southeastern Nigeria.

MATERIALS AND METHODS

Experimental site

The experiment was carried out in Anambra State at the Ifite-Ogwari Campus of Nnamdi Azikiwe University. The study region is situated at latitude 6.6020°N and longitude 6.9504°E in Southeast Nigeria. It has an average annual rainfall of 1828 mm and a minimum and highest average temperature of 25.3°C during the planting period. The seeds of the several accessions of pumpkin were obtained from different places in Southeastern Nigeria where they are residents, namely Nsukka and Aku (two each), and Awka and Ifite-Ogwari (one each).

Treatments

Six pumpkin (*Cucurbita maxima*) accessions were used for the treatments, which are given below:

A Nsukka I
B Nsukka II
C Aku I
D Aku II
E Ifite-ogwari
F Awka

Layout and design of the experiment

Three replications of the experiment were conducted using Completely Randomized Design (CRD).

Field operation

A total of eighteen (18) polybags were made and placed next to each replication after being filled with thirty kg of topsoil. Each polybag's soil was amended with the dry weight of chicken droppings at a rate of 10 t/ha prior to planting. Three seeds per polybag, one seed per hole, and a seed depth of 2.5 cm were used to sow the pumpkin accessions.

Cultural practices

Before planting, a uniform application of 10 t/ha of poultry manure was made and well mixed into the soil. Knock insecticide was used to manage insect infestations. Hand picking was used for routine weeding every two weeks.

Data collection

Information on the following agronomic metrics was gathered from two plants in each polybag: Agronomic Characteristics: Measurements and records were made for the following agronomic parameters. Days-to-emergence after planting (DAP), percentage of emergence, the number of branches, vine length at 4 weeks after planting and continuing every 2 weeks from the base to the growing tip of the main vine, leaf length and leaf width.

Analysis of data

Data was statistically examined using the GENSTAT Statistical Software Package, 2013 and the guidelines for completely randomized design (CRD). The least probability level significant difference (LSD) at 5% was used to separate the means.

RESULTS AND DISCUSSION

Pumpkin accessions' impact on emergence metrics

The impact of several pumpkin accessions on emergence metrics, such as days to emergence and percentage of emergence, is displayed in Table 1. Regarding the mean performances of the different pumpkin accessions in terms of days to emergence and percentage of emergence, there were no significant differences ($p>0.05$) found. Regarding their average percentage emergence and days to emergence, several pumpkin accessions recorded varying results. As can be seen, Aku I pumpkin had the lowest mean percentage of emergence (55.59%), whereas Aku II pumpkin recorded the highest mean percentage of emergence (100%). The emergence percentages for Awka, Nsukka I, and Nsukka II pumpkins were 88.89%, respectively. However, it was found that Aku I pumpkin appeared significantly later, with a mean day-to-emergence value of 4.22 days, whereas Aku II pumpkin emerged earlier, with a mean value of 33.33 days. The average time for Awka and Ifite-Ogwari pumpkins to emerge was 4.11 days. According to the experiment's findings, all of the pumpkin accessions examined performed similarly in terms of the amount of time it took for them to emerge after sowing, their percentage of emergence, and their overall vegetative growth. None of the accessions were found to be statistically significantly different with respect to these growth parameters. Aku II emerged earlier than Aku I, and it was observed that Aku II had the highest mean percentage emergence (100%) compared to Aku I, which emerged least.

Table 1. Effect of pumpkin accessions on emergence parameters.

Pumpkin Accessions	Days to Emergence	Percentage Emergence
Aku I	4.22	55.59
Aku II	3.33	100.00
Awka	4.11	88.89
Ifite-Ogwari	4.11	66.67
Nsukka I	3.89	88.89
Nsukka II	3.77	88.89
LSD (0.05)	NS	NS

Table 2. At 4- and 6-weeks post-planting, the vine length parameter as impacted by pumpkin accessions (WAP).

Pumpkin Accessions	Vine Length 4WAP	Vine Length 6WAP
Aku I	33.77	53.58
Aku II	35.58	60.00
Awka	38.50	58.73
Ifite-Ogwari	36.13	57.08
Nsukka I	43.35	69.95
Nsukka II	51.53	68.15
LSD(0.05)	NS	NS

Table 3. Impact of pumpkin accessions on branch count at 4 and 6 weeks post-planting (WAP).

Pumpkin Accessions	Number of Branches 4WAP	Number of Branches 6WAP
Aku I	1.67	4.50
Aku II	2.00	5.33
Awka	2.00	4.67
Ifite-Ogwari	2.00	4.50
Nsukka I	2.17	4.83
Nsukka II	2.33	5.50
LSD (0.05)	NS	NS

Table 4. Pumpkin accessions' leaf counts at 2, 4, and 6 weeks following planting (WAP).

Pumpkin Accessions	Number of Leaves 2WAP	Number of Leaves 4WAP	Number of Leaves 6WAP
Aku I	3.17	5.17	12.00
Aku II	3.67	4.83	15.33
Awka	3.50	5.50	15.00
Ifite-Ogwari	3.57	5.00	13.83
Nsukka I	4.00	5.67	15.83
Nsukka II	3.83	5.50	16.50
LSD (0.05)	NS	NS	NS

This could be interpreted as a direct correlation between the amount of time it takes to emerge and the percentage of emergence, as also noted by Mavi *et al.* (2010). They found that the mean days to emergence in *Cucurbita species* was significantly correlated with the percentage of emergence, and that the days to emergence increased in proportion to the percentage of emergence. Since slower emergence has been linked to lower emergence, Matthews and Hosseini (2006) also discovered a strong relationship between emergence and mean emergence time in soil.

Impact of pumpkin accessions at 4- and 6-weeks post-planting on the vine length parameter

Table 2, displays the impact of pumpkin accessions on the vine length parameter at 4 and 6 WAP. According to the findings, after both the fourth and sixth weeks of assessment, the mean vine length of the different pumpkin accessions was found to be statistically equivalent (p>0.05). The largest vine length (51.53 cm) was recorded by Nsukka II pumpkin at 4 WAP, as can be seen in the table below. However, this tendency was not constant, since Nsukka I pumpkin had the longest vine length (69.95 cm) at 6 WAP. The Aku I pumpkin did, however, consistently record the shortest vine length (33.77 cm and 53.58 cm, respectively, at 4 and 6 WAP). Aku I pumpkin had the shortest vine length during the assessment periods, while Nsukka II and Nsukka I pumpkins reported the longest mean vine length (51.53 cm and 69.95 cm, respectively) at 4 and 6 WAP. According to Chukwudi & Agbo's (2017) research, the genetic differences among the 18 accessions of pumpkin sourced from different locations were evident in the measured vegetative growth parameters, including vine length. This could be attributed to the higher genetic tendency of the Nsukka pumpkin accessions to grow longer vines and that of the Aku I pumpkin to produce shorter vines.

Pumpkin accessions' impact on branch count four and six weeks after planting (WAP)

The impact of pumpkin accessions on the number of branches at 4 and 6 WAP is displayed in Table 3. Regarding their number of branches at 4 and 6 WAP, the various pumpkin accessions are statistically equal (p>0.05), according to the result. The Nsukka II pumpkin recorded the highest mean number of branches (2.33 and 5.5) after 4 and 6 weeks after planting, respectively, indicating a consistent trend in the mean highest and lowest rates of branching of the pumpkin accessions. Additionally, the Aku I pumpkin had the lowest mean number of branches (1.67 and 4.50) at the 4- and 6-week mark, respectively, following planting. Pumpkins from Aku II, Awka, and Ifite-Ogwari all recorded a mean number of branches of two at 4 weeks after planting. During the assessment period, Nsukka II pumpkin had the highest mean number of branches, while Aku I pumpkin had the lowest mean number of branches. One significant morphological characteristic that affects overall output is the number of branches per plant (Adeduntan, 2015). Given that the Nsukka pumpkin produced the longest vine, it's possible that it also mimicked the same branching rate performance. These findings corroborate those of Ansar *et al.* (2014) experiment, which examined several genotypes of brassica and discovered that, in favorable circumstances, an increase in plant height leads to an increase in branching.

Impact of different pumpkin accessions on leaf count at 2, 4, and 6 weeks post-planting

The impact of pumpkin accessions on the quantity of leaves at WAP 2, 4, and 6 is displayed in Table 4. According to the results, there is no statistically significant difference (p>0.05) between the various pumpkin accessions in terms of how many leaves they have at WAPs 2, 4, and 6. Nsukka I pumpkin had the highest mean number of leaves (4.00 and 5.67 at two and four weeks after planting, respectively); however, this changed at six weeks after planting, when Nsukka II pumpkin had the highest mean number of leaves (16.50). Comparably, Aku I pumpkin had the lowest mean number of leaves (3.17 and 12.00, respectively) at 2 and 6 weeks after planting; this only changed at 4 weeks, when Aku II pumpkin reported the lowest number of leaves (4.83). Aku I and II pumpkins were found to have produced the lowest mean values of number of leaves during the examination period, whereas Nsukka I and II pumpkins produced the highest average number of leaves. This was a follow-up study of Nsukka pumpkins, which had the longest and most progressive vines and branches, as observed in Adeduntan (2015) work. The number of leaves showed a progressive increase in leaf number across the various vine lengths with a commensurate increase in vine length.

Impact of pumpkin accessions at 2, 4, and 6 weeks post-planting on the length and width of the leaves.

The impact of pumpkin accessions on leaf length and width at 2, 4, and 6 weeks after planting (WAP) is displayed in Table 5. Regarding the mean performances of the several pumpkin accessions in terms of leaf length and width, there were no significant differences (p>0.05) found. The pumpkin with the highest mean leaf length and width (3.13 cm and 3.77 cm, respectively) at 2 WAP Nsukka I is shown in the table below. Aku II pumpkin had the highest mean leaf length and width at 6 WAP, measuring 10.36 cm and 12.51 cm, respectively, while Awka pumpkin had the highest mean leaf length and width at 4 WAP, measuring 5.31 cm and 6.52 cm. The Aku I pumpkin had the lowest leaf mean length and width at 2 and 4 WAP, respectively, measuring 2.53 and 2.87 cm and 4.51 and 5.58 cm, respectively. The Ifite-Ogwari pumpkin only showed the lowest mean leaf length and width at 6 WAP (9.00 cm and 11.27 cm). The longest and broadest leaf was generated by Nsukka I pumpkin at 2 WAP (3.13 cm and 3.77 cm), followed by Awka pumpkin at 4 WAP (5.31 cm and 6.52 cm), and Aku II pumpkin at 6 WAP (10.36 cm and 12.51 cm, respectively) as the longest and broadest leaf. The leaves at WAP 2 and 4 are the narrowest and shortest, respectively. This could directly affect crop productivity in the long run by influencing plant photosynthesis and carbohydrate metabolisms (Darshani *et al*., 2021). During the vegetative stage, a high photosynthates deposit in the leaves for increased leaf development and multiplication was shown by the increase in leaf breadth and length as well as the number of vines and leaves per plant (Chukwudi & Agbo, 2017). The assessed vegetative parameters clearly showed the genetic differences between the six pumpkin accessions that were derived from various sites. Since the accessions were preserved as landraces from the point of collection, their genetic variations may account for some of the variance among them (Chukwudi & Agbo, 2017). This is consistent with Adeduntan's (2015) research, since the genetic influence on the phenotypes produced by the pumpkin accessions sourced from the various local administrations varied significantly. On the other hand, accessions with notable yield-related characteristics may provide valuable parental material for pumpkin breeding, trait development, and improvement. According to Chukwudi & Agbo (2017), genetic variety is necessary to take advantage of heterosis and create composite varieties that would adapt to various market and climatic requirements.

Conclusion

Conclusively, the growth performance of the measures tested clearly showed the genetic differences between the accessions from different places. According to this study, characteristics that can be used to differentiate *Cucurbita maxima* include vine length, number of branches, number of leaves per plant, and length and width of leaves. The findings showed that there was no discernible contribution of the evaluated growth parameters to pumpkin diversity. On average, nonetheless, the evaluations of the growth parameters were dominated by the pumpkin accession from Nsukka. This knowledge is essential for the preservation of various genetic resources and the start of an improvement program for *Cucurbita maxima* in Nigeria and other agro-ecological zones that are comparable. For a comprehensive characterization of *Cucurbita maxima*, additional research at the molecular and genomic levels is advised including a greater number of accessions.

Authors contribution

Conceptualization, O. A. Umeh, C. Q. Ani. J. I. Ulasi, I. S. Umeh and E.R. Keyagha; Methodology, O. A. Umeh, C. Q. Ani, and I. S. Umeh; Software, O. A. Umeh; Validation, O. A. Umeh, C. Q. Ani, J. I. Ulasi , I. S. Umeh and E.R. Keyagha; Formal analysis, O. A. Umeh, and I. S. Umeh; Resources, C. Q. Ani and I. S. Umeh; Data curation, C. Q. Ani, Writing—original draft preparation, O. A. Umeh and C. Q. Ani; Writing—review and editing, O. A. Umeh, C. Q. Ani, J. I. Ulasi , and I. S. Umeh; Visualization, C. Q. Ani; Supervision, O. A. Umeh; Project administration, O. A. Umeh; Funding acquisition, O. A. Umeh, C. Q. Ani. All authors have read and agreed to the published version of the manuscript.

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Data availability: The data that support the findings of this study are available on request from the corresponding author.

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