Phenology and Yield Attributes of Inbred Lines of Flutedpumpkin (Telfairia occidentalis Hook) Derived from Landraces in South Eastern Nigeria

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Abstract
Inbred lines of *T. occidentalis* derived from Landraces which are collected in five states of Anambra (AN), Imo (IM), Abia (AB), Enugu (EN) and Rivers (RV) of South Eastern Agro-ecology of Nigeria were established *ex-situ* during 2012 and 2013 cropping seasons and assessed for their desirability for use as hybridization materials. Their Phenological assessment based on vegetative, flowering, and fruiting attributes indicate that all the inbreds did not differ in number of days to 50% seed emergence but Abia inbred (AB/AB) performed better than all other inbreds. Producing the longest vine most number of branches and nodes and highest internode length and leaf number plant^{-1} at 6 weeks after planting (6 WAP). The male (AB/AB) inbred also flowered earlier (10 WAP) than other inbreds while those of (AN/AN) flowered later (13 WAP). The female Anambra (AN/AN) inbreds flowered earlier (12 WAP) than other female inbreds while those of Rivers flowered last (16 WAP). The highest number of female flowers plant^{-1} (150) was obtained from Anambra (AN/AN) inbreds and their fruits also matured earlier at 13 weeks after pod set (13 WAPS), while the female Abia (AB/AB) inbreds had the lowest number of flowers and fruits which also matured last (18 WAPS). Our findings show potential for genetic enhancement of fluted pumpkin of different landraces through hybridization.
Keywords: Phenology, Inbred lines, landraces, and agro-ecology.

1. Introduction

Telfairia occidentalis (fluted pumpkin) belongs to the genius *Telfairia* Hooker, Tribe *Joliffeae*, sub-family *Cucurbitoideae* and family *Cucurbitaceae* (Jeffrey, 1980).

It is an important crop in Tropical West Africa, especially in Nigeria, Sierra Leone, Ghana and Benin Republic where it is used as food and as commercial garden vegetable (Purseglove, 1984; Irvine, 1969; Eziaba, 1982). In Nigeria, the largest diversity in plant population of this crop can be found in the South-Eastern Agroecology encompassing Imo, Anambra, Enugu, Ebonyi, Cross-River, Akwa-Ibom and Abia States of Nigeria. (Akoroda, 1990; Nwonuala, *et al*, 1999). The edible parts include the young vines or shoots, leaves, seeds and petiole which are important source of carbohydrate, protein, vitamins and minerals (Achinewhu, 1983; Asiegbu, 1987). In a survey on the pattern of consumption of leafy vegetables in Nigeria, Hart *et al.*(2005) estimated the per capita consumption as 91-130kg. This range was reported to be among the highest in Africa and fluted pumpkin was also listed among the Regionally Consumed Indigenous and Traditional Leafy Vegetables for West Africa, (Smith and Pablo, 2007). The oily seeds apart from nutritional properties also have lactating properties while the root extracts are used to kill rats, mice and fish (Schipper, 2000). Giami, *et al*, (2003) reported the economic and nutritional benefits to Nigeria of blending fluted pumpkin seed with wheat flour for bread because of its nutritional value.

The plant is dioecious having only staminate (male) flower or the pistilate (female) flower on individual plants. This makes *T. occidentalis* 100% cross-pollinate and thus characterized by high genetic variability. The landraces of cross-pollinators are heterogeneous genetically and form a relative continuum of agronomic types in the field (Heiser, *el al,* 1990). According to Thompson (1976), the agronomic problem encountered when growing *T. occidentalis* is that the plants exhibit variations in many quantitative and qualitative characters. These variations are expressed in their differences in stem length, number of leaves, length and size of pods, time of pod maturity and effective duration of vegetative growth.

The main benefit of hybridization is to eliminate this variability and to produce seeds that produce fairly uniform plants and high yields. (Kuckuch *et al*., 1991), Nwonuala, *et al*, 2007. In *Cucurbita,* demand for uniformly and selection had resulted in high homozygosity and true breeding cultivars. Inbred lines have been used to develop hybrids which were more uniform and homogenous, than open-pollinated cultivars (Paris, 1989). *Cucurbita* like *Telfairia* belongs to the same family of *Cucurbitaceae.* Very limited research has been targeted on the genetic enhancement of *T. occidentalis.* This work reports on the Phenological growth and reproductive characteristics of inbred lines derived from *Telfairia occidentalis* landraces.

2. Materials and Methods

2.1 Description of Experimental Site

The field experiment was conducted at the Federal University of Technology, Teaching and Research Farm, Owerri, Imo State, Nigeria, ($5^{0}29^{1}$N, $7^{0}02^{1}$E, 55meters asl). Owerri has a humid tropical climate. The mean annual rainfall varies from 2000 – 2500mm in bimodal distribution. The peak period of rainfall is between May and October while the dry season falls between November and February. The mean annual temperature is about 29^{o}C. Soils in the area are derived from coastal, plain sands and taxonomically classified as ultisols (Eshett and Anyahucha, 1992). Sand-sized particles dominate soil particle distribution. Owerri belongs to the lowland area of Southeastern Nigeria and lies within the tropical rainforest characterized by multiple plant species, arranged in tiers with emergent trees hovering above the vegetation. Common plant species include oil palm trees (*Elaeis guineensis*). Vegetables grown in the area apart from *Telfairia occidentalis* include *Amaranthus cruentus* and *Venonia amygdalina*. Agriculture is the major socio-economic activity in the area; land clearing is by slash and burn method while soil fertility regeneration is mainly through bush fallowing though fallow length has reduced to 1-2yrs due to population pressure.

2.2 Land Preparation

The land used for the experiment was measuring 34x52m^2 (0.18ha). it was cleared manually and then ridged. The ridges were 30 meters long and 1 in apart. Each of the ridges was a plot of 30m^2. There were total of 20 ridges and five treatments made up of 5 ridges each.

2.3 Experimental Design and Treatment

The treatment for the experiment consists of twenty fruits of different landrace of *T. occidentalis* obtained from selected home gardens within five states in South-Eastern agrocological zones of Nigeria. Four fruits were obtained from each of the states which are centers of genetic variability and named after the states. The states were Imo (IM), Abia (AB), Anambra (AN), Enugu (EN) and Rivers (RV) the fruits were characterized for length, width and circumference. These were split open and the seeds scooped, processed, counted and bulked. The seeds were then weighed and fairly uniform ones of same weights $(12 \pm 0.50g)$ were selected and used. These treatment lots were randomized in plots and replicated four times in a randomized complex block design (RCBD). The seeds were planted on the already prepared ridges at a rate of one seed per hole and at a depth of 5cm and with a spacing of 2m x 2m between and within the ridges. There were 15 seeds per plot in four (4) replications and these gave a total of sixty (60) seeds per treatment. These translated to 2,500 seeds per hectare.
Selfing among selected male and female plants from each treatment population to produce inbred was carried out in the field. In the process, immature buds of the female parents were protected from foreign pollen with pollination bags until they were matured and receptive. Receptivity was recognized by the whitish colour of the stigma. Pollen from selected male parents were then collected and shed on the receptive stigma. Male or female parents were selected on the basis of superior growth rate, early flowering and increase in leaf size. In addition the male parents were selected for fewer numbers of tendrils and flowers. Receptivity was achieved when the stigmas finally changed from white to pink and withered, receptivity had been achieved, it was then safe to remove the pollination bags.

The selfed plants were labeled accordingly and their fruits harvested at maturity as S1 (selfed) progenies. Seeds of the S1 progenies were planted out the following year in a randomized complete block design, replicated four times with the same spacing and depth of planting as in the first experiment. They were evaluated to identify promising S1 families based on Phenological observation, vegetative and reproductive yield characteristics.

2.4 Data Collection and Analysis

Data collected from the fruits include vine length, internode length, number of branches per plant, number of nodes per plant, number of leaves per plant, leaf area per plant, leaf yield, number of days to 50% flowering and end of flowering, number of female flowers per plant, percentage of male and female plants, number of days to fruit harvest, number of seeds per fruit. These data collected were subjected to analysis of variance (ANOVA), and treatment means were compared using the least significant different (LSD).

3. Results and Discussion

3.1 Growth and leaf yield characteristics of T. occidentalis inbreds.

It is desirous that vegetable production be profitable during the early stages of growth hence the growth characteristics and leaf yield within 6 weeks after planting *T. occidentalis* is important. The result of the vegetative characteristics and leaf yield of inbred *T. occidentalis* at 6 WAP is shown in Table 1. The AN/AN inbred had the longest vine (120cm) which was not different from those of AB/AB and IM/IM but was significantly $(P \geq 0.05)$ longer than those of EN/EN and RV/RV inbreds which had the shortest vine length of 87.8 and 87.0cm respectively. The internode length was also significantly different the highest of 15.8cm was from AB/AB inbreds. Similarly, the number of branches (6.3) which was produced by the AB/AB inbreds were significantly different from other inbreds except EN/EN inbreds that had 4.3 branches at 6 WAP. The lowest number of branches (2.3) was produced by RV/RV inbreds but this, did not differ significantly from IM/IM and AN/AN inbreds with 3.0 and 3.3 branches respectively.

The number of nodes and leaves per plant^{-1} at 6 WAP also followed the same trend with AB/AB inbreds being consistently the highest and RV/RV inbreds the lowest.

The leaf area per plant differed little amongst the inbreds which is an indication that gene controlling leaf area is fairly constant (fixed) in all the inbreds. The highest leaf yield of 109.5kg ha^{-1} was however obtained from AB/AB inbred which was significantly great than the yield from all other inbreds. This can simply be adduced to the much higher number of leaves per plant (50 per plant) produced by the AB/AB inbreds.

Growth characteristics and leaf yield at 6 WAP were consistently the highest within AB/AB inbreds while the RV/RV inbreds had the least.

The vigor in growth characteristics significantly recorded for the AB selfed plants may be due to the fact that only physiologically good plants were selfed. According to (Assman, 1970) this can result in favourable gene combination that hastened the physiological process for faster and better growth as manifested in the AB/AB inbreds at the early growth stage. These growth characteristics of the inbred lines grown under the same condition revealed that the AB/AB inbreds had the most desired characteristics and leaf yield compared with other inbreds therefore lends itself for use as the best material for any improvement program targeted for increased vegetable production of *T. occidentalis* in Southern Nigeria.

3.2 Flowering characteristics of T. occidentalis Inbreds

The data for of flowering and fruit yield characteristics of inbred lines of *T. occidentalis* are presented in Table 2. The number of days to 50% flowering differed amongst the male and female plants. Among the male plants, the AB/AB inbred flowered earlier (69 DAP) than other inbreds but did not differ from that of EN/EN (70 DAP). The inbred AN/AN females plants were earliest (82.3 DAP) to attain 50% flowering but was not significantly different from EN/EN, IM/IM and AB/AB inbreds. The RV/RV inbreds took the longest (109 DAP) to attain 50% flowering and differed significantly from other inbreds. The variations in time of flowering of the different inbreds allowed for easy productive crosses of superior traits of one inbred with another related or unrelated one. This has been achieved in *cucurbita* species where the demand for uniformity and selection for earliness resulted in inbred lines used to develop homogynous hybrids. (Paris 1989).The number of female flowers per plant varied. The AN/AN inbred had the highest number of fruit set per plant (150). This was followed by EN/EN inbreds while AB/AB had the lowest (64).

Percent male and female plants per treatment also differed significantly amongst the inbreds (Table 2) AB/AB and RV/RV inbreds had more males than females. IM/IM and EN/EN had more females than males. The highest percent of female plants (55%) was obtained by EN/EN inbreds and the lowest (36%) was the RV/RV inbred. Equal proportions of male and female plants (48%) were obtained with AN/AN inbreds. Plants with more females are preferred because of expected high yields of both leaf and seeds. (Opukiri *et al* 2011). Usually, high endogenous auxin level was associated with femaleness (Galun *et al.,* 1963), while high endogenous level of gibberellin favoured maleness (Atsmon *et al*., 1963; Opukiri *et al.,* 2011).

3.3 Fruiting characteristics of T. occidentalis inbreds

The inbreds took longer time to mature 13 to 18 weeks after pod set. (WAPS) being much later than the parents which matured 11-14 WAPS. Although the AB/AB and AN/AN inbreds flowered at the same time, the AN/AN inbreds matured earlier and had a shorter fruit filling period. The AN/AN inbreds could be selected for further testing for early flowering and early maturity while AB/AB inbreds maybe selected for early flowering and late maturing. Emebiri and Obisesan (1991) observed in cowpea that a plants life cycle consists of a succession of relatively distinct phases that compromise a developmental pattern which often influenced yield. They speculated that certain phases of the developmental pattern like number of days to pod maturity, duration of vegetative period and duration of pod filling are potentially important criteria for selecting higher yields. These phases are controlled by genes with both additive and non-additive effects. These reports are applicable to these observed results in *T. occidentalis* inbreds.

The number of matured fruits harvested from the inbreds also differed significantly: IM/IM inbreds had the highest number of fruits (84) while the least number (44) was by RV/RV inbred (Table 3)

The low number of matured fruits obtained by RV/RV inbreds can be attributed to the delayed fertilization of the female flowers due to delayed attainment of 50% female flowering. Also, the short anthesis of the female flower and low number of female plants can be attributed to the low number of matured fruits.

The result for fruit weight indicated that the IM/IM inbred produced the heaviest mean weight = 7.3kg per fruit^{-1} followed by AB/AB and RV/RV inbreds which weighed 6.8kg per fruit^{-1} and were no significantly heavier than the EN/EN inbred.

Table 1: Growth and vegetative yield attributes of *T. occidentalis* inbreds at 6 WAP

S1 Inbred	Vine length (cm)	Internode length (cm)	Number of Branches Plant^{-1}	Number of Nodes Plant^{-1}	No. of leaves Plant^{-1}	Leaf area Plant^{-1} (cm^2)	Leaf yield (kg)ha^{-1}
EN/EN	87.8	7.3	43	32.0	38.3	79.0	68.0
AN/AN	120.0	7.5	3.3	31.3	36.0	94.8	45.5
AB/AB	115.0	15.8	6.3	42.3	50.0	82.0	109.5
IM/IM	113.3	9.3	3.0	32.3	38.0	99.7	55.3
RV/RV	87.0	11.0	2.3	26.0	31.3	92.9	40.0
LSD 0.05	40.3	5.41	2.51	6.47	9.22	29.66	7.01

Table 2: Flowering characteristics of *T. occidentalis* Inbreds

S1 Inbred	Number of DAP to 50% Flowering		No. of Days to end of flowering		No. of Female flower Plant^{-1}	Percent (%) of reproductive Plants	
	Male	Female	Male	Female		Male	Female
EN/EN	70.0	92.0	107.3	141.7	88	36.0	55.0
AN/AN	93.7	82.3	120.0	114.3	150	48.0	48.0
AB/AB	69.0	85.7	95.3	145.3	64	60.0	40.0
IM/IM	91.0	94.0	111.3	146.7	83	47.0	53.0
RV/RV	89.7	109.0	114.7	156.0	87	61.0	36.0
LSD 0.05	13.13	16.5	40.0	24.78	13.47	1.49	1.60

Table 3: Fruiting characteristics of *T. occidentalis* Inbreds

S1 Inbred	No. of Days to fruit harvest	No. of Matured Fruits treatment^{-1}	Fruit weight (Kg) fruit^{-1}	No. of seeds. Fruits^{-1}
EN/EN	203.7	60	4.6	42
AN/AN	76.3	68	4.1	47
AB/AB	207.3	48	6.8	58
IM/IM	208.3	84	7.3	69
RV/RV	218.0	44	6.8	75
LSD 0.05	31.27	2.92	2.23	14.67

4. Conclusion

For the enhancement of vegetable and or fruit production of *T. occidentalis,* the AB/AB inbreds and IM/IM inbred families will be better materials because of the desirable performance across the various growth and reproductive characteristics assessed. These identified S1 inbreds can form the basis for selection and recombination with any other landrace or hybrids. Our findings showed the potentials for genetic enhancement of fluted pumpkin from different landraces in Southeast Nigeria, having identified desirable traits and performance in the inbreds.

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