Differential Expressivity Influence of 2,4-D Auxin on Growth, Yield and Sex Expression in Fluted Pumpkin *(Telfairia Occidentalis F. Hook)*

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ABSTRACT

Experiments was conducted in 2023 academic session to evaluate the role and influence of 2-4-D, a plant growth hormone on sex expression, growth and yield of three ecotypes of Telfaria occidentalis obtained from calabar, Ikom and Ogoja. Two concentrations of 2-4-D at 0 (control), 50 and 100 ml/kg soil were used for the study. The seeds from the different ecotypes obtained from three different locations in each of the aforementioned states and established in Calabar. The seeds were planted out in plastic bags containing 1 kg of soil each. The experiment was a two factor experiment laid out in a completely randomized design and replicated thrice. Factor 1 was the three localities with three levels of Calabar, Ikom and Ogoja while factor 2 was the two concentrations of 2-4-D 50 and 100ml/kg soil including the control of 0ml/kg soil. This gave a treatment combination of 9 and a total experimental unit of 27. Data for morphological attributes were taken at two weeks interval while sex expression and other yield attributes were obtained at maturity. Generated data from the study were subjected to statistical analysis using the analysis of variance (ANOVA) procedures. Combined treatment means with significant differences were further separated using the Fischer's least significant difference (LSD) test at 5 % probability level. The results shows that females flowers were more expressed in number upto 193 than male flowers numbering only 37 with treated with 100 ml/kg soil 2-4-D. The results of morphological attributes shows that vine length varied from 99.60 to 168 cm, number of leaves per plant ranged from 8.00 to 16.33, leaf area varied from 20.90cm^2 to 92.92 cm^2, internode length per plant ranged from 6.00 to 9.70 while leaf length per plant ranged between 5.27 to12.45 while Leaf width varied between 3.49 to7.41 cm.

Significant ($p<0.05$) differences were also detected to exist among three of the evaluated yield attributes. Number of seeds per pod ranged between 59.70 to 95.30 among the ecoitypes. Days to pod maturity varied from 113 to 121 days among the ecotypes while fresh pod weight ranges from 213.70 g to 456.70 with an average of 335.20 g. Hence, plant growth regulators such as 2-4-D can be effectively used to increase the expression of sex related traits in *Telfaria occidentalis.*

KEYWORDS: Chemical auxins, 2,4-D, male and female flowers, Telfaria occidentalis, growth and yield,

INTRODUCTION

1.1 Background of study

Auxin is a plant hormone produced in the stem tip that promotes cell elongation. Auxin moves to the darker side of the plant, causing the cells there to grow larger than corresponding cells on the lighter side of the plant. This produces a curving of the plant stem tip toward the light, a plant movement known as phototropism. Auxin also plays a role in maintaining apical dominance. Most plant shave lateral (sometimes called auxiliary) buds located at nodes (where leaves attach to the stem). 2,4-Dichlorophenoxyacetic acid (usually called 2,4-D) is an organic compound with the chemical formula $C_8H_6C_{l2}O_3$. It is a systemic herbicide which selectively kills most broad leaf weeds by causing uncontrolled growth in them, but most grasses such as cereals, lawn turf, and grass land relatively unaffected. *Telfairia occidentalis* a tropical plant, belonging to the family Cucurbitaceae, is an important leaf and seed vegetable and a local medicinal plant. It is naturally found in the humid part of West African countries like Nigeria, Cameroon and the Republic of Benin. It is well known for its high nutritional, medicinal and economic potentials and widely cultivated in the Eastern part of Nigeria. The plant is dioecious, however, monoecious one shave also been observed. The female plant is preferred by farmers to the male plant because it produces seeds for later planting (Akoroda,1990).

Telfairia occidentalis has many economic values. The leave sand stems are succulent and tasty. This makes it the most popular vegetable to millions of people, ranking as one of the three most widely eaten vegetable at homes and in restaurants across Nigeria. The seeds are nutritious, widely consumed in Nigeria and are processed into seasonings, high-protein cake, marmalade, infant weaning foods, flour bread supplement and different local fermented foods. They are also a good source of edible oil. However, immature seeds are preferred to mature ones when eaten cooked or roasted because antinutrient characteristics increase with maturity (Abiose, 1999). Moreover this species has been reported to have several medicinal and health benefits. In rats fed on *Telfairia occidental is* supplemented diet, a significant increase in weight and reduced oxidative brain damage was reported (Iweala and Obidoa, 2009; Kayode *et al.*, 2010).

It has been established that the plant is useful in the treatment or management to fanemia (Ajayi *et al.*, 2000) and diabetes (Eseyin *et al.*, 2007). The seeds, believed to have lactation promoting properties are in high demand by nursing mothers (Schippers, 2000). The roots have high alkaloid content and their extracts are therefore used for

controlling pest and rodents (Akubue *et al.,* 1980; Ajibesin *et al.,* 2002). The ability of the plant to combat certain diseases may be due to its antioxidant and antimicrobial properties and its minerals (especially iron), vitamins (especially vitamins A and C) and high protein contents (Kayode *et al.*,2009; Kayod and Kayode,2010)

Despite the dietary and health benefits of vegetables, the production of fluted pumpkin in Nigeria is still at subsistence level and the average yield very low. Moreover, it has virtually no commercial importance at that moment. As such, little or no research has been done on the effect of different level of auxin on growth and sex expression in fluted pumpkin. Hence, the need for this research on effect of different level of auxin (2,4-D) on growth

MATERIALS AND METHODS

2.1 Plant materials

The materials used for this research work include the followings, seed of three collection [phenotypes) of fluted pumpkin, represented as S1, S2. S3 was obtained from Calabar, while S2 was obtained from Ogoja and S3 from Ikom.

2.2 Study area

This experiment was conducted at the research garden behind the Department of Genetics and Biotechnology, University of Calabar, Calabar Nigeria.

2.3 Collection of samples

Seeds were carefully removed from matured pods purchased from Watt market in Calabar, Cross River State. Auxin application was done two time, at the beginning of flowering (when buds appeared) and one week later the concentration of 2,4-D applied was observed.

2.4 Land preparation and planting

A plot of land measuring about 20 x 10 meters was used for the study. The land was fertilized and manure added to improve its fertility before planting took place. Seeds were sown per stand at a spacing of 1m x 1m (between and within rows). Normal cultural practices (weeding, watering, etc.) was performed until maximum germination was achieved.

2.5 Layout of experiment

A complete randomized design (CRD) was used for the study.

2.6 Experimental Design and layout

Factor A	**Factor B**	**Rep I**	**Rep II**	**Rep III**
Calabar	0 ml/kg soil (B_1)	A_1 B_1	A_1B_3	A_1B_3
A_1	50 ml/kg soil (B_2)	A_1B_2	A_1B_2	A_3 b_3
	100 ml/kg soil (B_3)	A_1B_3	A_3B_3	A_1B_2
	0 ml/kg soil (B_1)	A_2B_2	A_1B_1	A_2B_2
Ogoja	50 ml/kg soil (B_2)	A_2B_2	A_1B_2	A_3B_3
A_2	100 ml/kg soil (B_3)	A_2B_2	A_1B_2	A_3B_2
Ikom	0 ml/kg soil (B_1)	A_3B_1	A_2B_2	A_2B_1
	50 ml/kg soil (B_2)	A_3B_2	A_3B_1	A_3B_1
A_3	100 ml/kg soil (B_3)	A_3B_3	A_3B_2	A_1B_1

2.7 Data collection and statistical analysis

Data generated was subjected to analysis of variance (ANOVA). Significant differences were determined using least significant differences test (LSD) at 5% level of probability.

2.8 Determination of soil physical and chemical properties

Soil samples from the experimental location behind biological science building were sampled using a soil auger to depth of 0-40 cm. The soil samples were bulked differently, air dried, crushed, sieved to pass through 2 mm mesh and analyzed for physico-chemical properties using standard laboratory procedures in the soil science laboratory as follows;

(a) Soil particle size distribution for percent silt, clay and sand using hydrometer method of Bouyoucos.

(b) Soil pH at 1:2.5 soil liquid ratio in water and KCl using electrode pH meter.

(c) Organic carbon was determined using Walkey and Black method of 1934.

(d) Total nitrogen was determined using Jackson procedures of 1965.

(e) Exchangeable Acidity was determined using the Mclean procedures of 1965.

(f) Exchangeable Bases Mg, K and Na were determined using Flame Photometry while Ca was determined by the Atomic Absorption Spectrophotometry.

(g) Available phosphorus was determined using the Bray and Kurtz procedures of 1945.

(h) Effective cation exchange capacity (ECEC) was obtained by summation.

Table1. Physico-chemical properties of the soil used in the Experiment.

S/N	Soil properties	Values
1.	pH (H20)	5.3
2.	Organic C (%)	6.12
3.	Total N (%)	0.08
4.	Available P (mg/kg-1)	6.15
5.	Exch. Bases (cmol kg-1)	0.79
6.	Ca	0.42
7.	Mg	0.13
8.	K	0.16
9.	Na	0.08
10.	Exchangeable acidity	0.25
11.	CEC (cmol kg-1)	0.12
12.	Base saturation (%)	68.0
13.	%Sand	65.0
14.	%Silt	23.2
15.	%Clay	145
16.	Textural class	Sand loam

RESULTS

3.1. Influence of plant growth auxin (2-4-D) on the number of male and female flowers sex expression in *Telfaria occidentalis*

Table 2 presents the results of sex expression of male and female flowers in three ecotypes of *Telfaria occidentalis* treated with different concentrations of 2-4-D auxin plant growth regulator. The results as presented above shows that the applications of the treatment at the various concentrations favours the production and development of more female flowers than the male flowers. The results further shows that increasing concentrations of auxin had a proportional effect on sex expression in *Telfaria occidentalis*. Application of 100 ml of 2-4-D auxin per kg of soil planted with Calabar ecotype produced the highest number of 135.00 female flowers while the least number of 24.00 female flowers were expressed on the control plot were 0 ml of 2-4-D per kg of soil. The highest number of 36.00 male flowers were expressed when 100 ml of 2-4-D Auxin was applied to *Telfaria occidentalis* ecotype sourced from Ikom while the least sex expression of only19.00 male flowers were obtained in the control plot planted with Ikom Telfaria ecotype (Table 2)..

Table 2: Influence of 2-4-D Auxin on sex expression in *Telfaria occidentalis*

Factor A	Factor B	Male	Female
Calabar	0ml/kg soil (B_1)	24.00	78.00
A_1	50 ml/kg soil (B_2)	27.00	120.00
	100 ml/kg soil (B_3)	33.00	135.00
Ogoja	0 ml/kg soil (B_1)	21.00	65.00
	50 ml/kg soil (B_2)	25.00	75.00
A_2	100 ml/kg soil (B_3)	29.00	102.00
Ikom	0ml/kg soil (B_1)	19.00	24.00
	50 ml/kg soil (B_2)	23.00	80.00
A_3	100ml/kg soil (B_3)	36.00	108.00

3.1.2 Growth Characteristics of Telfaria occidentalis ecotypes as influenced by 2-4-D auxin applications

Table 2 shows the results of growth characteristics of three ecotypes of *Telfaria occidentalis* treated with three different concentrations 2-4-D auxin. The results shows that significant ($p<0.05$) differences were detected in all the parameters evaluated for both *Telfaria occidentalis* ecotypes, the different concentration of 2-4-D plant growth regulators and their interactions (Table 2). The results revealed that vine length differed ($p<0.05$) significantly with average vine length of 133.80 cm across ecotypes. The vine length ranged from 99.60 cm in Ikom ecotype treated with 50 ml/kg soil of 2-4-D to 168 cm in Ogoja ecotype cultivated in the control plot without 2-4-D auxin. The results also shows that average number of leaves per plant was 12.16 across all ecotypes. The number of leaves per plant differed ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The number of leaves per plant varied ($p<0.05$) significantly between 8.00 in Ikom ecotype treated with 50 ml/kg soil 2-4-D to 16.33 leaves in Ogoja ecotype planted in the control plot.

The result also shows that average internode length per plant was 7.85 cm across all ecotypes. The internode length differed ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The internode length differed ($p<0.05$) significantly and ranged from 6.00 cm in Ikom ecotype raised in the control plot to 9.70 cm internode length in Ogoja ecotype treated with 50 ml/kg soil. The result further shows that average leaf length per plant was 8.55 cm^2 across all ecotypes. The leaf length per plant differed ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The leaf length per plant varied ($p<0.05$) significantly from 5.27 cm in Ikom ecotype treated with 100 ml/kg soil 2-4-D to 12.45 cm long in Ogoja ecotype planted in the control plot. Table 3 results further shows that average leaf width per plant was 3.49 cm across all ecotypes. The leaf width per plant differed ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The leaf width per plant varied ($p<0.05$) significantly from 4.98 cm in Ikom ecotype treated with 50 ml/kg soil 2-4-D to 7.41 cm wide in Ogoja ecotype planted in the control plot. Finally the results in Table 3 also shows that average leaf area per plant was 56.97 cm^2 across all ecotypes. The leaf area per plant differed ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The leaf area per plant varied ($p<0.05$) significantly from 20.90 cm^2 in Ikom ecotype treated with 100 ml/kg soil 2-4-D to 92.92 cm^2 in Ogoja ecotype planted in the control plot.

Table 3: Growth performance of *Telfaria occidentalis* as influenced by 2-4-D auxin plant growth regulators

Treatment Combination	Vine length (cm)	No of leaves/ plant	Internode length (cm)	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)
A1B1	164.40 a±2.40	12.00 b±1.33	8.00 b±2.33	9.90 b±1.00	5.40 b±0.40	53.56 b±16.40
A1B2	157.20 b±2.05	8.70 c±0.57	6.90 a±1.23	7.80 d±0.57	4.40 d±1.00	36.72 c±3.98
A1B3	157.01 b±2.04	9.00 c± 1.00	7.80 a±1.65	7.70 c±0.57	5.10 c±0.57	38.77 b±2.40
A2B1	168.00 a±1.87	16.33a± 0.33	9.70 a±0.76	12.45 a±0.88	4.13 a±0.88	92.92 a±0.57
A2B2	103.50 b±0.89	10.70 c±3.48	8.60 a±2.11	10.20 b±2.10	3.22 b±2.42	52.84 b±1.00
A2B3	123.50 c±3.11	12.00 b±0.87	9.60 a±1.45	7.90 c±0.54	50.30 c±1.67	97.37 c±12.85
A3B1	115.30 d±1.87	9.30 c±1.55	6.30 a± 1.88	6.40 d±1.00	4.41 e±0.61	25.62 d±6.98
A3B2	99.60 e±2.34	8.00 c±2.54	6.00c±2.11	7.67 b±0.34	3.98 e±1.00	26.29 d±13.64
A3B3	103.00 e±1.53	9.70c±0.57	9.30 a±1.77	5.27 e±0.67	3.45 d±2.30	20.90 d±8.78
LSD (0.05)	10.44	1.08	0/91	1.34	4.45	96.88

4.1.3 Yield Attributes of *Telfaria occidentalis* ecotypes as influenced by 2-4-D auxin applications

Table 4 shows the results of yield attributes of three ecotypes of *Telfaria occidentalis* treated with three different concentrations 2-4-D auxin. The results shows that significant ($p<0.05$) differences were detected in three of the six parameters evaluated for both *Telfaria occidentalis* ecotypes, the different concentration of 2-4-D plant growth regulators and their interactions (Table 4). The results revealed that days to 50% flowering did not differ ($p<0.05$) significantly with average days to 50% flowering of 56.70 across ecotypes. The days to 50% flowering ranged from 53.70 in Calabar ecotype in the control plot with 0 ml/kg soil of 2-4-D to 59.70 in Ikom ecotype treated with 100 ml/kg soil of 2-4-D auxin. The result also shows that average number of seeds per pod was 77.50 across all ecotypes. The number of seeds per pod differed ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The number of seeds per pod varied ($p<0.05$) significantly between 59.70 in Ogoja ecotype planted in the control plots to 95.30 in Ogoja ecotype treated with 50 ml/kg soil 2-4-D. The result further show that average days to maturity per plant is 117 days across all ecotypes. The days to maturity differed ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The days to maturity differed ($p<0.05$) significantly and ranged from 113 days in Ogoja ecotype raised in the control plot to 121 days in Calabar ecotype treated with 50 ml/kg soil of 2-4-D. The result further shows that average number of pods per plant was 2.00 across all ecotypes. The number of pods per plant did not differ ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The number of pods per plant varied ($p<0.05$) significantly from 1.00 pod in Ogoja ecotype treated with 100 ml/kg soil 2-4-D to 3.00 pods per plant in Ikom ecotype treated with 100 ml/kg soil 2-4-D. Table 3 results further shows that average weight of 10 seeds per plant was 165.17 g across all ecotypes. The weight of 10 seeds per plant did not differ ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The weight of 10 seeds per plant varied ($p<0.05$) significantly from 161.65 g in Ikom ecotype treated with 100 ml/kg soil 2-4-D to 168.70 g in Ogoja ecotype treated with 50 ml/kg soil 2-4-D plant growth regulator. Finally the result in Table 4 shows that average fresh pod per plant was 335.20 g across all ecotypes. The weight of fresh pod per plant differed ($p<0.05$) significantly among the evaluated ecotypes and 2-4-D concentrations used. The fresh pod weight per plant varied ($p<0.05$) significantly from 213.70 g in Ikom ecotype planted in the control plot to 456.70 g in Ogoja ecotype treated with 100 ml/kg soil of 2-4-D auxin.

Table 4: Yield performance of *Telfaria occidentalis* as influenced by 2-4-D Auxin plant growth regulators

Treatment combination	Days to 50% Flowering	No. of seeds per pod	Days to Maturity	No. of pods per plant	10 seed Weight(g)	Fresh pod weight (g)
A1B1	53.70	61.70e ±1.57	120.30a ±1.00	3.00	162.70	265.61e ±2.02
A1B2	55.30	80.00b ± 0.03	121.30a ±1.00	2.67	164.30	298.54d ±2.02
A1B3	55.30	53.30f ± 0.34	120.00a ±0.34	3.00	163.50	387.99b ±2.02
A2B1	55.30	59.70f ±3.33	113.70d ±0.57	2.00	167.60	270.80d ±2.02
A2B2	56.00	95.30a ±0.67	114.30c ±1.86	2.33	168.70	333.60c ±2.02
A2B3	56.00	89.00a ±1.00	115.30c ± 1.33	1.00	165.60	456.70a ±2.02
A3B1	59.70	79.70d ±0.57	120.70a ±2.67	3.00	163.70	213.70f ±2.02
A3B2	59.00	79.60d ±0.57	118.00b ±1.09	2.00	166.10	258.70e ±2.02
A3B3	59.70	64.00e ±1.00	117.00b ± 1.23	3.00	161.65	273.70d ±2.02
LSD (0.05)	**NS**	**4.44**	**5.06**	**NS**	**NS**	**36.21**

Discussion

Despite its interesting features and many potential uses, fluted pumpkin has remained a regional treasure, largely unknown outside West Africa. The morphology and potential uses of fluted pumpkin are discussed in relation to the economic importance as a tropical crop (FAO, 2008).

It value lies in the seed's high content of protein (>25%) and extractable oil (55-60%) (Ajayi*et al.,* 2004). Also, the young, succulent vegetables are succulent with vigorous yield when grown. Asiegbu (2004) reported female plant to produce more vigorous plant than the male. Native farmers harvest the males for leaves and allow the females to produce fruits for edible seeds and for future planting. This reports is in line with the findings of the present study.

Furthermore vegetables are of interest economically from several points of view; they are a good source of opportunities for sale, also they are among the most profitable agricultural products (Schippers, 2008). Another economic and nutritional advantages of *Telfairia* plant is its clears agronomic superiority over many plant protein sources. For instance, leaf harvesting begins one month after leaf emergence and this continues at 3-4weeks intervals depending on the irrigation facilities. Between 4-6 harvests or more can be expected (Asiegbu, 2004). This reports is in line with the findings of the present study.

The importance of fluted pumpkin crop in rural household economy cannot be overemphasized. Therefore drought poses one of the most important environmental constraints to plant survival and productivity and hence food security in the tropics (Speranza *et al.*, 2007). The crop is rare in Uganda and absent in East Africa. It has been suggested that is originated in South East Nigeria and was distributed by the Igbo. It is equally possible that fluted pumpkin was originally wild throughout its current range but that wild plant has been harvested to local extinction and is now replaced by cultivated forms (Chweya and Ezzaguirre, 1999). There are so many nutritional value and health benefits of *Telfairia occidentalis*. Moreover leaves and seeds to *Telfairia occidentalis* can be used to lower diabetes and heart disease risks. The Nigerian Society of Endocrinology and Metabolism (NSEM) and the Diabetes Association of Nigeria (DAN) recommended traditional foods such as fluted pumpkins to beat diabetes and heart disease including hypertension. This reports is in line with the findings of the present study.

Fluted pumpkin leaves, like all dark green leafy vegetables, are rich in dietary properties such as calcium, iron, potassium and some levels of folic acid and manganese. The leaves equally contain high levels of vitamins A and K and also vitamins C, B2, and E. The leaves have great antioxidant capacities to help in restoring damaged cells and skins.

The leaves can protect the heart and liver from toxins and painkillers like paracetamol. It reduces the risk of heart diseases because it contains lots of natural anti-inflammatories. As if these are not enough, it also contains lots of phytonutrients which are thought to reduce the risks of breast and stomach cancers. This reports is in line with the findings of the present study.

Previous researches and studies have also indicated that "fluted pumpkin processes anti-inflammatory (painkiller), antibacterial, erythropietic (erythropoieses is the process by which red blood cells – erythrocytes are produced) and anticholestroltemic (presents the buildup of

cholesterol and antidiabetic (treat diabetes mellitus by lowering glucose levels in the blood) activities. *Telfairia occidentalis* is solely propagated by seeds (Akoroda, 1988) in most pans of southern Nigeria. It is grown close to trees, fence, walls, or special platforms on which the shoots are allowed to climb freely. However, in some places such as Rivers State, the plant is grown on beds and special moulds as thus yam beds (Offiong *et al*.. 2010). They are grown on well drained fertile soil with large amount of organic matter (FAO, 2005).

CONCLUSION

The present study had shown the all the increased concentrations of plant growth regulators will enhanced the expression of more female plants than male plants in *Telfaria occidentalis*. The growth and yield performance of *Telfaria occidentalis* was also found to increased with increasing concentration of auxin 2-4 –D as a plant growth regulator. Concentration of 2-4-D at 100 ml/kg soil was found to enhanced the highest number of female sex flowers development compared to lower concentration of 50 ml/kg soil and the control at 0 ml/kg soil. The growth attributes such as vine length, number of leaves per plant, branches per plant and leaf area were enhanced with increasing concentration of 2-4-D in the soil for all the phenotypes evaluated from calabar, ogoja and Ikom..

The yield attributes such as days to flower initiation, number of pods per plant, number of seeds per pod, pod weights were enhanced with increasing concentration of 2-4-D in the soil for all the phenotypes evaluated from calabar, ogoja and Ikom..

5.3 RECOMMENDATION

Based on the result and findings from the present study, it could be recommended that increasing the concentrations of the plant growth regulator 2 – 4-D auxin is essential for increased sex expression for females plants, increased growth and yield performance in *Telfaria occidentalis*. Therefore higher concentration of the growth regulator is essential for increased productivity of the leafy vegetable as well as ensuring food security for our nation.

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