African Journal of General Agriculture
Vol. 3, No. 2, December 31, 2007
Printed in Nigeria

AJGA 2007037/3204

Gene frequency of polyembryonic traits governed by dominant and recessive autosomal alleles in fluted pumpkin (*Telfairia occidentalis* Hook F.)

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(Received May 23, 2007)

ABSTRACT: The gene frequency of multiple embryos in fluted pumpkin was examined. The results revealed clear evidence of existence of polyembryonic traits in the crop, irrespective of the shape of the pods that enclose the seeds. The frequencies of the S allele (polyembryony) and s allele (monoembryony) were 0.6 and 0.4 respectively. The derived zygotic frequencies were 0.36 for the homozygous dominant (SS); 0.48 for the heterozygous (Ss) and 0.16 for the homozygous recessive (ss). These summed up to 0.84 for the multiple embryonic traits and 0.16 for the single embryos.

Key Words: Homozygous, heterozygous, monoembryony, polyembryony, zygotic frequency

Introduction

Fluted pumpkin (*Telfairia occidentalis* Hook. F) is a native of West Africa, mainly cultivated along the West African Coast. In Nigeria, the plant is grown widely in the forest zone for its parts comprising the young vines, leaves, petioles and seeds (Okigbo, 1977; Taylor *et al*., 1983). It is a creeping vegetative shrub that spread low across the ground with large lobed leaves and long twisting tendrils (Horsfall and Spiff, 2005). The leaf is a good source of human diet (Onyenuga, 1986)

Multiple seedlings do sprout from one seed occasionally (Esiaba, 1982), a phenomenon referred to as polyembryony. In most cases, some of the embryos particularly those emerging around the main shoot remain rudimentary and degenerate with time. In some cases, the multiple seedlings, especially among those emerging from the embryonic axis, there is development of two, three or four shoots (as in the case of twin, triplet or quadruplet) seedlings from a seed.

Polyembrony has become a very powerful tool in genetics, plant breeding and in vitro culture. It serves as a good source of haploids and polyploids. For instance, in the flax, *Linum asitatissinum,* haploids are produced from polyembryonic lines and are used to achieve homozygosity in certain varieties (Rowland and Weerasena, 1986). In view of the acute paucity of data on the gene frequency of fluted pumpkin, this study was therefore conducted to determine the frequency of polyembryony based on different shapes of pod of *Telfairia occidentalis.*

Materials and Methods

Three fluted pumpkin accessions namely; $T_0$0-1, T_0 Rt-1 and T_0 Ro-1 (i.e. oblong, rotund and round respectively) were collected from the Nsukka Agricultural Zone of Enugu State, Nigeria. Seeds extracted from the pods of these accessions were grown in decaying softwood sawdust put in nursery boxes. These were watered daily.

Ten days after planting, the germinating seeds were removed from the decaying softwood sawdust and their cotyledons were carefully examined with a hand lens for the number of emerging embryos. Seeds with single embryos were separated from those with multiple embryos. Four hundred and ten seeds were examined from the three accessions and the frequency distribution of the embryo types was biometrically analyzed.

Result and Discussion

The distribution of polyembryony and monoembryony in the three accessions (T_0 0-1, T_o Rt-1 and T_o Ro-1) are represented in Tables 1 and 2. Fig. 1 – 4 show evidence of the existence of polyembryony in all the accessions irrespective of shape.

Table 1**:** Distribution of genotype groups, gene frequencies of S and s and population probability in 3 accessions of *Telfairia occidentalis*.

Genotype	Number	Incidence (%)	Genes	Gene Frequency	Population	Probability
SS Ss ss	154 203 53	37.5 49.5 13.0	S S, s s	0.6 0.4	p^2 $2pq$ q^2	0.36 0.48 0.16
Total	410	100		1.0		1.0

Table 2: Frequency of polyembryonic and monoembryonic traits in *T. Occidentalis* based on different fruit shapes.

ACCESSION	SEEDLING TYPE				TOTAL
	SINGLE		MULTI		
	Number	Percentage (%)	Number	Percentage (%)	
To O -1 (Oblong)	28	25.23	82	73.87	111
To Rt-1 (Rotund)	7	5.93	111	94.07	118
To Ro-1 (Round)	18	9.94	164	90.61	181
Total	53		357		410
Mean %	12.93		87.07		

The result showed population probabilities of 0.36, 0.48 and 0.16 for the SS (p^2), Ss $(2pq)$ and ss (q^2) genotypes, respectively. This agrees with the earlier report in cotton (Webber, 1940; Webber and Batchelor, (1943). The authors reported that polyembryonic traits are heritable and occur at high frequencies.

Taking p and q as the gene frequencies of the multiple and single embryonic traits, respectively, and assuming the population to be in equilibrium, the estimate of the frequency of the allele can be obtained from the frequency of the recessive genotype (q^2).

p = Frequency of S allele
q = Frequency of s allele in the gene pool. The possible chance contribution of the two gametes is illustrated as shown below:

♀ \ ♂	p	q
p (S)	p^2 SS	pq Ss
q (s)	pq Ss	q^2 ss

In order to account for all the gametes in the gene pool, $p+q=1$ or 100%.
Thus the expected zygotic frequencies are as follows:

$$(p+q)^2 = p^2 + 2pq + q^2 = 1.0$$

Where $p^2 = SS$, $2pq = Ss$ and $q^2 = ss$

Where p^2 = the fraction of the next generation expected to be homozygous dominant (SS), $2pq$ = the fraction of the next generation expected to be heterozygous (Ss) and q^2 = the fraction of the next generation expected to be recessive. A dominant phenotype may have either of the genotypes, SS or Ss and distinguishing the number that is homozygous or heterozygous in the population by visual means is rather rigorous. The only phenotype where the genotype is known for certain is the recessive (ss).

$$\text{Single} \rightarrow 53 \rightarrow \text{ss}$$

$$\text{Multiple} \rightarrow 375 \rightarrow \text{SS}$$

$$p^2(SS) + 2pq(Ss) + q^2(ss) = 1.0$$

Assuming the population is in equilibrium we can take the square root of the percentage of the population which is of the recessive genotype as our estimator for the frequency of the recessive allele (Stansfield, 1969).

$$q = \sqrt{q^2} = \sqrt{\frac{53}{410}} = 0.36 = 0.4$$

$p+q=1$, then the frequency of $S = 0.6$

$$p^2SS + 2pqSs + q^2ss = 1.0$$

$$(0.6)^2 + 2(0.6)(0.4) + (0.4)^2 = 1.0$$

$$0.36 + 0.48 + 0.16 = 1.0$$

The genotype fractions add to unity to account for all the progeny population. This preliminary investigation suggests an initial population of *T. occidentalis* that is in equilibrium with respect to the distribution of the embryonic types. It is expected that the population will remain in equilibrium as long as the Hardy-Weinberg conditions are maintained. This is subject to further investigations in the years ahead.

ACKNOWLEDGEMENT: The authors thank the Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka, where both the laboratory and field works were carried out.

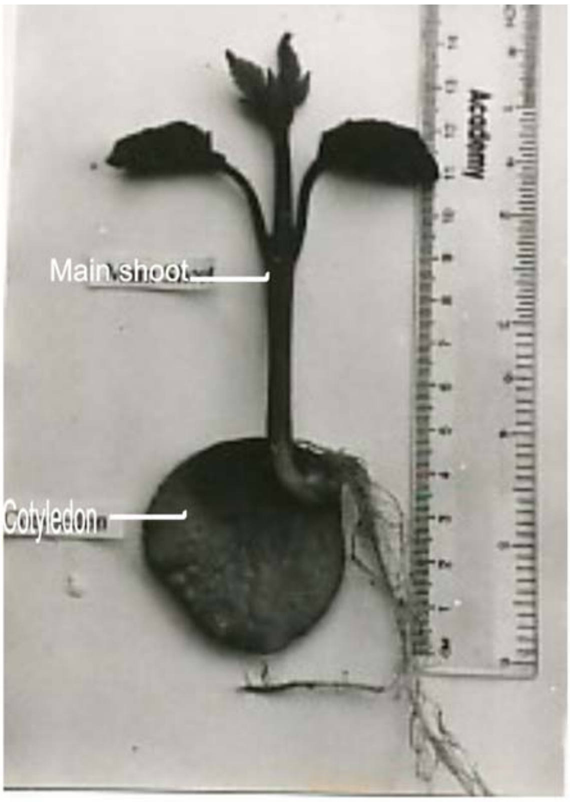

Fig. 1 Single (Monoembryony)

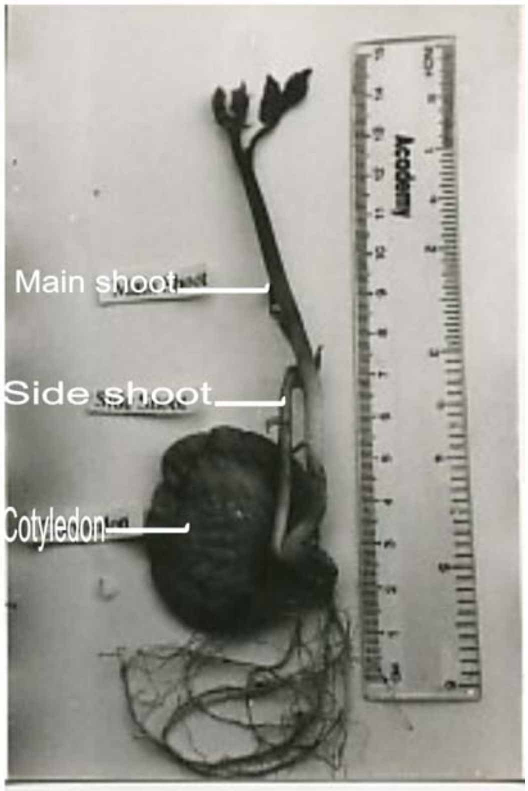

Fig. 2 Twin+

Fig 3 Triple

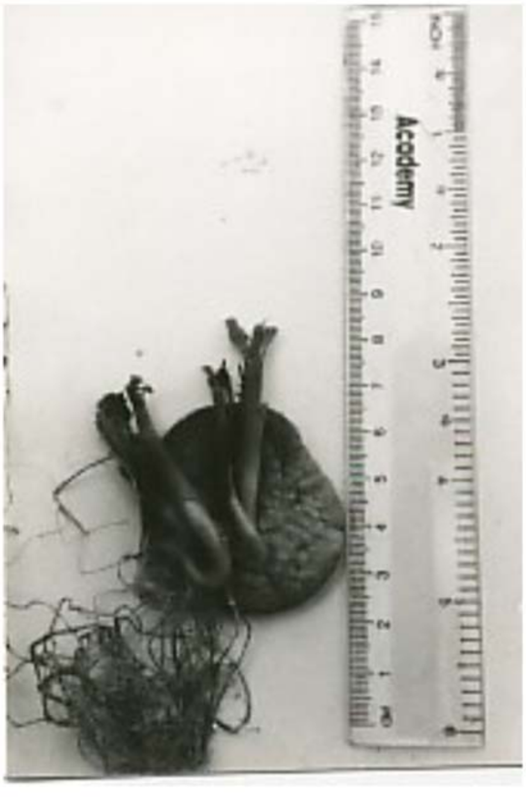

Fig . 4 Quadruple

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