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Genetic Variability, Heritability and Genetic Advance in Oleaginous Gourd *Lagenaria siceraria* (Molina) Standl

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Abstract | **Original Research Article**

The present investigation was carried out to estimate phenotypic and genotypic coefficients of variation, heritability and genetic advance as percent of mean in F_2 generation for seeds yield of *Lagenaria siceraria* and its components in three crosses NI283 x NI215, NI354 x NI215 and NI106 x NI215. For each family, involving six diverses parents on two locations, Abidjan and Manfla. The experimental layout was a randomized completed block design with three replications. The phenotypic coefficients of variation are higher than those of genotypic coefficients of variation in Abidjan and Manfla. That indicated the influence of environment in the expression of all characters. For fruit weight and number of seeds, average values recorded for genotypic and phenotypic coefficients of variation are all high in crosses made in two localities. High heritability with high genetic advance as percent of mean observed in majority of crosses indicates high degree of additive genes effect implies less control by environment on these traits. For 100-seed weigh high to moderate range of heritability in conjunction with high genetic advance as percent of mean was observed for this trait which indicates the preponderance of additive gene action governing the inheritance of this character and offers the best possibility of improvement through simple selection procedure. For seeds yield or seed weight, the values of the phenotypic and genotypic coefficients of variation are moderate and low respectively in the two localities. Moderate heritability estimate coupled with moderate genetic advance as percentage mean indicated the role of non additive genetic variance in their expression. A significant difference was recorded for all traits, indicating the presence of high degree of variability in the genotypes studied that suggesting the possibility of improving yield through selection for these traits.

Keywords: *Lagenaria siceraria*, Phenotypic, Genotypic, Coefficient of variation, Heritability, Genetic advance.

INTRODUCTION

Oleaginous gourd, *Lagenaria siceraria* (Molina) Standley, is a member of Cucurbitaceae family. It is a prostrate-growing, herbaceous and monoecious plant easily distinguished by its white flowers (Muralidharan *et al.*, 2017). *L. siceraria* is believed to be of African and Asian origin (Morimoto *et al.*, 2005). This specie is well adapted to various cropping systems, characterised by minimal inputs (Taffouo *et al.*, 2008). Juvenile shoots and fruits of *L. siceraria* are sliced and cooked as vegetables throughout South Africa (Xaba and Croeser 2011; Sithole *et al.*, 2015). In Côte d'Ivoire, Oleaginous gourd is mainly cultivated for seed consumption. Mature seeds are roasted and crushed to a paste used to thicken stews, while seed oil extract is an ideal alternative for vegetable oil (Chimonyo and Modi 2013, Loukou *et al.*, 2012). *L. siceraria* shows great variability on yield components: seed number, fruit weight and 100-seeds weight and seed weight (Yao *et al.*, 2015; Yao *et al.*, 2019). These plants are cultivated at small scale by women for their oleaginous seeds that are a great importance in the sociocultural live of several peoples (Zoro Bi *et al.*, 2003). Its cultivation permits achievement of food security for family unit and represents a potential source of additional income for rural women, who are the main producers in West Africa (Zoro Bi *et al.*, 2003). Increased production and use of these cucurbits can result in food security and diversify small farmer's income (Chweya & Eyzaguirre, 1999; Williams & Haq, 2002). Growing of these cucurbits represents a potential source of additional income at the same time it covers the immediate food needs of the family unit. But despite this, it is known that Cucurbit

have long been absent from the major programs of research and development (Williams & Haq, 2002). Despite several studies conducted on cucurbit edible seed (Achigan *et al*., 2008; Koffi *et al*., 2009) their production are weak. Of particular importance to plant breeders is the proportion of the observed variability which is heritable. This determines above all the breeding methods to be used and the intensity of evaluation required to bring about rapid changes in the respective traits (Dudley & and Moll, 1969). Information on predicted genetic gain from selection is also useful in formulating effective breeding or selection strategies (Anbessa *et al*., 2006). The study of variability and heritability is of primary importance for an efficient breeding program as its selection. And progress from selection for a particular character depends, in part, on the magnitude of heritability estimates (Nya & Eka, 2007). Very little genetic knowledge is available on the hereditary behaviour of the yield components of *L. siceraria*. Heritability of metric characters has been identified as a genetic relationship between the parents and the offspring. The heritable variations could be divided into additive and non-additive components. These genetics components has been widely used to asses the degree to which a character is transmitted from one parent to the offspring. Genetic information on heritability could as well indicate the possibility and the extent to which improvement in a character is possible (Adeniji & Olawale, 2007). The information on variability and heritability of characters is essential for identifying characters amenable to genetic improvement through selection (Vidya *et al*., 2002). The genotypic variance includes non-additive components which are not transmitted to the next generation. Hence high heritability coupled with high genetic advance was reported to be more useful in practicing selection in a population (Johnson *et al*., 1955). The present experiment was carried out to know the nature and extent of genetic variability, heritability and genetic advance of yield components of oleaginous gourd *L. siceraria*.

MATERIALS AND METHODS

Plant Material

In the experiment, we used three families developed from three crosses of *Lagenaria siceraria* inbred cultivars or lines to estimates the heritability of fruit weight, seed weight, 100-seed weight and seed number. Each of the three high yielding cultivars NI283, NI354 and NI106 was crossed with the low yielding cultivar NI215. The table 1 present the charateristics of parental genotypes used in this study. In this way three families were developed; 'NI283 x NI215' (C1), 'NI354 x NI215'(C2) and 'NI106 x NI215'(C3).

Table 1: Agronomic characteristics of parental genotypes of oleaginous gourd *L. siceraria*

Seed yield components	Genotypes			
	NI106	NI283	NI354	NI215
Fruit weight (g)	1548 ± 360	2000±70	1900±200	380±110
Number of seed	275.83±36.28	303.25±7.42	303.33±86.68	83.96±34.85
100-seed weight (g)	18.18±2.96	20.82±3.49	20.8±1.8	8.80±1.61
Seed yield (g)	37.62±10.75	66.18±4.36	58.76±9.85	9.75±4.91

For each family, involving six diverse parents which were grown in completely randomized block design with some replications. Planting was done according to a completely randomized block design with three replications. Each plot was 96 x 30 m. The holes at depth of 3 cm and they were arranged in rows at spacing of 3m between and within rows. Two or three seeds of each generation were planted per hole, with intra row spacing of 3 m. The plots were hoe weeded regularly to prevent any interaction between plant materials and weed load. Disease and pest control was carried out using a carbamate-based insecticide applied when necessary. The field was harvested when more than 90% of the fruit were ripe. Most of the plants had only one fruit.

Experimental locations

The first experimental site was located in Abidjan at University of Nangui Abrogoua, between 5°17'N-5°31' and longitudes 3°45'W - 4°22'W. The second experimental was conducted in the village of Manfla, located in centre (latitudes 7°00N – 7°26N and longitudes 6°00W- 6°30W) during 400 km north Abidjan.

Data Analysis

We tested the F_2 data for homogeneity of variances using Bartlett's method (Ostle & Malone, 1988; Steel *et al*., 1997). Because the variances were heterogeneous, we analyzed the data by family and location. The data recorded were statistically analyzed for genotypic coefficient of variation and phenotypic coefficient of variation according to Burton and Devane (1953). Heritability in broad sense was estimated as per the formular suggested by Allard (1960) and Genetic advance was estimated as per the formula proposed by Lush (1940) and Johnson *et al*., (1955). The statistical analysis was performed using the Statistica statistical package (1984-2005).

RESULTS AND DISCUSSION

The result of the multivariate analysis of variance showed that fruit weight, number of seeds, 100-seed weight and seed weight differed significantly between the families studied in the crosses made at the study sites ($P<0.001$). The distributions of F_2 generation of traits are presented by location and family in figures 1 in the form of box plots.

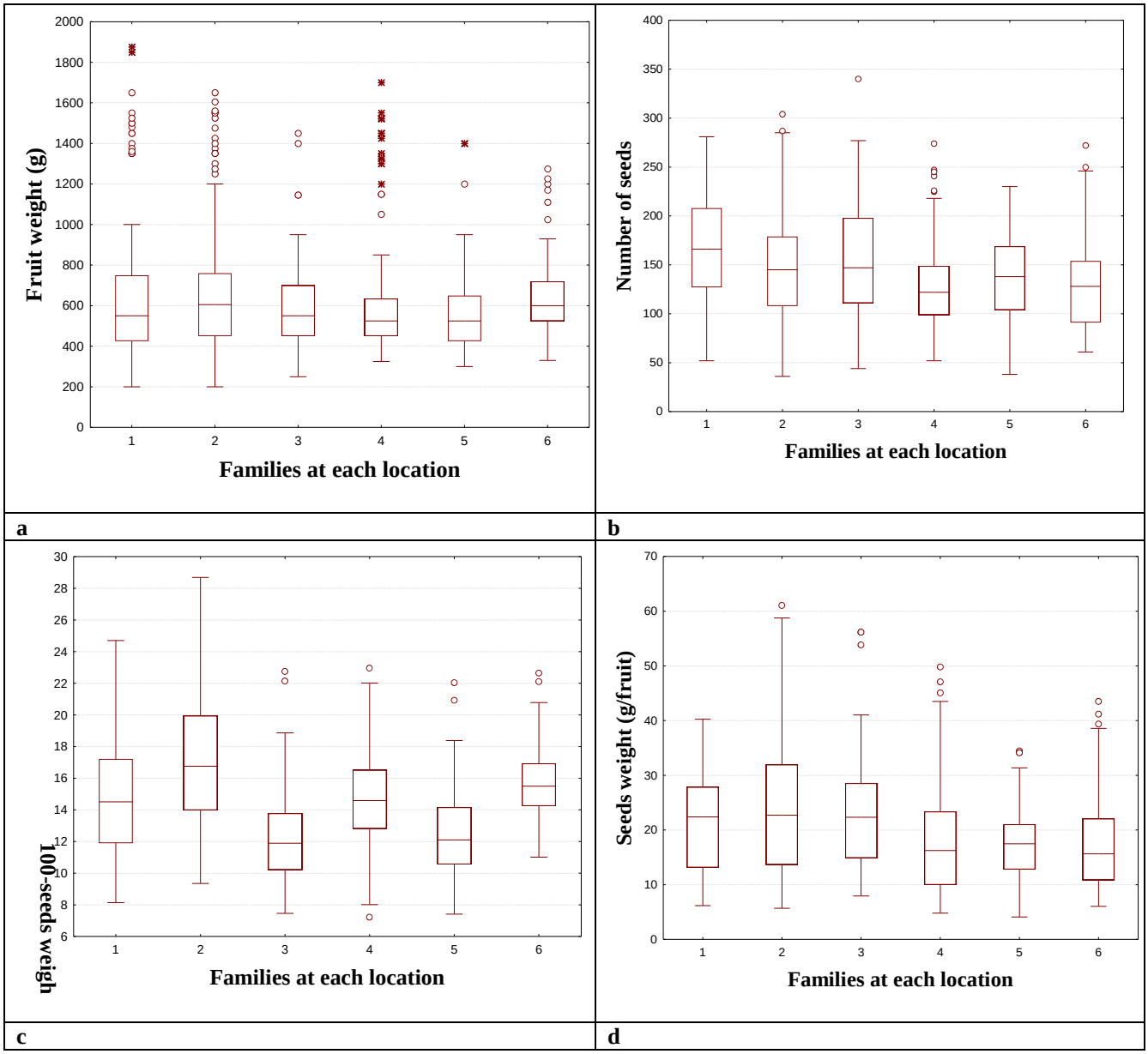

Figure 1: Box plots showing the distribution of F2 data for the three families at two locations for fruit weight, number of seed, 100-seed weight and seed yield. 1, 2 = NI283 x NI215 at Abidjan and Manfla; 3, 4 = NI354 x NI215 at Abidjan and Manfla; 5, 6 = NI106 x NI215 Abidjan and Manfla, respectively.

In the crosses made for each of the yield components, we observe phenotypic variance higher than genotypic variance. Similarly, the values of the phenotypic coefficient of variation are higher than those of the genotypic coefficient of variation in Abidjan and Manfla. That indicated the influence of environment in the expression of all characters in this study. Wide différence between phenotypic and genotypic coefficient of variation indicated their sensitiveness to environmental fluctuations whereas narrow difference showed less environmental interference on expression of these traits. Thus, for fruit weight and number of seeds, the average values recorded for the genotypic and phenotypic coefficients of variation are all high in the crosses made at the two localities. The results for variances, phenotypic and genotypic coefficients of variation, heritabilities and genetic advance of percentage of the mean in the two localities are summarized in Table 2.

Table 2: Estimates of variability parameters for seed yield and its components in oleaginous gourd of *Lagenaria siceraria*

Cross/Characters	σ² (P)	σ² (G)	CVP	CVG	H^2	GA	GAM
Fruit weight (Abidjan)							
C1	80734.140	65966.330	43.069	38.932	0.820	444.846	67.429
C2	70483.600	52348.210	45.112	38.877	0.740	399.240	67.839
C3	57383.050	43490.040	42.977	37.414	0.760	296.081	53.119
Mean	69533.600	53934.860	43.719	38.408	0.770	380.056	62.796
Manfla							
C1	60202.260	46158.250	35.731	31.287	0.770	333.593	48.579
C2	45234.150	30463.600	33.322	27.346	0.670	179.632	28.144
C3	44271.360	28511.580	33.485	26.872	0.640	260.064	41.388
Mean	49902.590	35044.480	34.179	28.502	0.690	257.763	39.370
Overall mean	59718.090	44489.670	38.949	33.455	0.730	318.909	51.083
100-seed weight (Abidjan)							
C1	8.870	4.440	20.233	14.315	0.500	2.822	19.173
C2	7.040	4.100	21.607	16.489	0.580	3.006	24.480
C3	8.770	5.930	23.806	19.575	0.680	4.026	32.366
Mean	8.230	4.820	21.882	16.793	0.590	3.285	25.340
Manfla							
C1	12.240	8.680	20.388	17.169	0.710	4.757	27.719
C2	12.320	8.010	24.157	19.478	0.650	3.977	27.370
C3	11.250	7.880	21.323	17.846	0.700	3.040	19.327
Mean	11.940	8.190	21.956	18.164	0.690	3.925	24.805
Overall mean	10.080	6.500	21.919	17.479	0.640	3.605	25.073
Number of seed (Abidjan)							
C1	5090.940	3273.470	43.112	34.571	0.640	86.720	52.399
C2	5539.190	4165.140	47.672	41.339	0.750	111.921	71.689
C3	4834.240	3317.530	50.201	41.587	0.690	74.479	53.776
Mean	5154.790	3585.380	46.995	39.165	0.690	91.040	59.288
Manfla							
C1	2654.270	1468.440	35.693	26.549	0.550	44.575	30.882
C2	3201.650	2320.250	43.965	37.427	0.720	57.115	44.378
C3	3054.490	2185.960	42.658	36.087	0.720	58.064	44.816
Mean	2970.140	1991.550	40.772	33.354	0.660	53.251	40.025
Overall mean	4062.460	2788.460	43.884	36.260	0.680	72.146	49.657
Seed yield (Abidjan)							
C1	75.440	50.230	11.513	9.395	0.670	11.630	15.416
C2	54.650	28.840	13.527	9.827	0.530	7.005	12.818
C3	68.250	36.550	12.105	8.858	0.540	7.999	11.720
Mean	66.110	38.540	12.382	9.360	0.580	8.878	13.318
Manfla							
C1	60.440	33.340	12.863	9.553	0.550	7.687	12.719
C2	55.650	28.030	13.405	9.514	0.500	7.376	13.255
C3	70.250	38.730	11.931	8.859	0.550	7.942	11.306
Mean	62.110	33.370	12.733	9.309	0.540	7.669	12.427
Overall mean	64.110	35.950	12.557	9.334	0.560	8.273	12.872

σ² (P) : Phenotypic variance **; σ² (G) :**Genotypic variance **; CVP :**Phenotypic coefficient of variation **; CVG :**Genotypic coefficient of variation, H^2 **:**Heritability **; GA :** Genetic advance **; GAM :** Genetic advance as percent of mean ;C1 :NI283 x NI215; C2 : NI276 x NI215; C3 :NI354 x NI215

For fruit weight in Abidjan, values ranged from 42.97 in cross C3 to 45.12% in cross C2 for phenotypic coefficients of variation, with an average of 43.72%, and from 37.41 in cross C3 to 38.93 in cross C1 for genotypic coefficients of variation, with an average of 38.40%. In the Manfla locality, phenotypic variation coefficients ranged from 33.32 in cross C2 to 35.73% in cross C1, with an average of 34.18%, and genotypic variation coefficients from 26.87 to 31.29%, with an average of 28.50%. For the number of seeds, high values for the phenotypic and genotypic coefficients of variation were recorded in Abidjan and Manfla. Phenotypic variations in these locations ranged from 43.11 to 50.20%, with an average of 46.99%, and from 35.69 to 43.96%, with an

average of 40.77%. Similarly, genotypic variations in these localities range from 34.57 to 41.58% with an average of 39.16% and from 26.55 to 37.43% with an average of 33.35% respectively. High phenotypic and genotypic coefficient of variation, recorded for fruit weight and seeds numbers indicating that high magnitude of variability was present in the germplasm for these characters. Thus indicating scope for improvement of these characters of through simple selection. High heritability accompanied with high genetic advance as percent of mean observed in majority of the crosses indicates high degree of additive gene effect implies less control by environment on the trait. Similar results were reported by Ram *et al.,* (2006), Kumar *et al.,* (2013), Chandramouli *et al.,* (2021) on *lagenaria siceraria*, Harshitha *et al.,* (2021) in ridge Gourd [*Luffa acutangula* (L.) Roxb. The coefficient of phenotypic variation values observed for 100-seed weight are slightly elevated in both localities for the different crosses. They range from 20.23 to 23.81% in Abidjan, with an average of 21.88%, and from 20.39 to 24.16% in Manfla, with an average of 21.92%. While the genotypic coefficient of variation values for this trait are moderate. In Abidjan, they range from 14.31 to 19.57%, with an average of 16.79%, and in Manfla from 17.17 to 19.48%, with an average of 18.16%. High to moderate range of heritability in conjunction with high genetic advance as percent of mean was observed for this trait which indicates the preponderance of additive gene action governing the inheritance of this character and offers the best possibility of improvement through simple selection procedure. These results are in accordance with the conclusions of Kumar *et al*., (2018), Gohil *et al.,* (2006), in soybean; Aybegün and Adem (2017) in chickpea. For yield or seed weight, the values of the phenotypic and genotypic coefficients of variation are moderate and low respectively in the two localities. In Abidjan, values for the phenotypic coefficient of variation ranged from 11.51 to 13.52%, with an average of 12.38%, while values for the genotypic coefficient of variation were between 8.85 and 9.39%, with an average of 9.36%. Also at Manfla, phenotypic coefficient of variation values range from 11.93 to 13.40% with an average of 12.73%, and genotypic coefficient of variation values are between 8.85 and 9.55% with an average value of 9.30%. Moderate heritability estimate coupled with moderate genetic advance as percentage mean indicated the role of non additive genetic variance in their expression.

CONCLUSION

Analysis of variance revealed a significant difference for all genotypes. A significant difference was recorded for all traits, indicating the presence of a high degree of variability in the genotypes studied. Phenotypic and genotypic coefficient of variation were high for fruit weight, seeds number and 100-seed weight in all crosses, suggesting the possibility of yield improving through selection for these traits.

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