Genetic Variability for Yield and Yield Components in Sesame (*Sesamum indicum* L.)

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Abstract: ***The experiments were conducted at the research fields of the National Cereals Research Institute located at Badeggi, Mokwa and Yandev under rain fed conditions in 2013 planting season to estimate combined ANOVA, phenotypic and genotypic coefficients of variation, heritability in broad sense, genetic advance as percentage of the mean, correlations and principal components analysis for yield and yield attributes in thirteen sesame genotypes. Randomized complete block designs with three replications were used in each location. Combined analysis of variance showed significant differences among genotypes (G), locations (L), and genotype by locations interaction (GxL) for days to 50% flowering, height at flowering, number of capsules per plant, capsule length, 1000-grain weight and grain yield. High heritability coupled with high genetic gain were exhibited for number of capsules per plant, number of branches per plant, and yield per hectare indicate the additive nature of inheritance. Significant positive correlations between yield per hectare and other yield attributes were exhibited except for days to 50% flowering (r = -0.3160**) and height at flowering (r = -0.5250**). The first three PCs gave Eigen-values > 1.0 and cumulative variation accounted for 73.86%. PC1, PC2 and PC3 accounted for 33.15%, 27.02% and 13.69% respectively. The variation in PC1 was mainly associated with height at maturity, capsule length and weight of seed per capsules. PC2 was associated with yield per hectare, number of capsule per plant and number of branches per plant. Thus, the presence of variation could serve as basis for selection criteria for yield improvement in sesame.***

Keywords: Sesame genotypes, genotype by location, yield attributes, correlation coefficient and principal components analysis

1. Introduction

Sesame (*Sesamum indicum* L.) also commonly known as Beniseed in Nigeria is an important oil seed crop that has been referred to as the 'Queen of oilseeds' by the virtue of its high quality oil. It is an ancient oil crop that has being cultivated in tropical and sub-tropical regions of Africa, Asia and Latin America. In Nigeria, sesame crop is cultivated mainly for its seeds that contain approximately 50% oil and 25% protein [4]. It has been regarded as a crop of insignificant importance compared to other oil seed crops like groundnut and soybeans probably due to its lower yield in Nigeria. Sesame seed is high in calcium, phosphorous, iron and are well supplied with essential vitamins such as thiamin, riboflavin and niacin. The whole seed is used on top buns and snack foods, fried and eaten with sugar, unfried or ground and used in making soup. The leaves are used for vegetable soup [8].

The determination of genetic variability and its partitioning into various components is essential for understanding the genetic nature of yield and its components. Yield is a complex quantitative character controlled by many genes interacting with the environment and is the product of many factors called yield components. Selection of parents based on yield alone is often misleading. Hence, the knowledge about relationship between yield and its contributing characters is needed for an efficient selection strategy for the plant breeders to evolve an economic variety. The information about phenotypic and genotypic interactions of various economic traits is the immense importance to a plant breeder for the selection and breeding of different genotypes with increasing yield potential [2]. The progress in breeding for yield and its contributing characters of any crop is polygenically controlled, environmentally influenced and determined by the magnitude and nature of their genetic variability [16], [5]. It is very difficult to judge whether observed variability is highly heritable or not. Moreover, knowledge of heritability is essential for selection based improvement, as it indicates the extent of transmissibility of a character into future generations [12]. The genetic coefficient of variation together with heritability estimate would give the best picture of the amount of advance to be expected from selection. The amount of genetic advance under selection depends mainly on the amount of genetic variability. [7] reported that for yield improvement in sesame, efforts should be concentrated mainly on improvement of yield morphological traits like number of capsules and 1000-seed weight. Keeping in view on significance of varietal improvement in sesame, the objective of the study is to determine the genetic variability for yield and yield components in sesame.

2. Methodology

Thirteen sesame genotypes were evaluated under rain fed conditions in 2013 planting at the research fields of the National Cereals Research Institute at Badeggi, Mokwa and Yandev station. Field were plough, harrowed and row marked out into 13 plots each measuring 3 m x 5 m in a randomized complete block design (RCBD) with three replications in each location. Sowing of sesame seeds were done by hand-drilling after mixing with soil from the field site to ensure even distribution of the seeds within the plot. Each genotype was sowed in a seven-row of 0.5 m inter row spacing, five plants were tagged in the middle rows and data were collected from the five middle rows avoid to border effect. Recommended crop management practices were followed to raise the crop at all sites. Plots were kept weed, pest and disease free until harvest. Morphological and agronomical characters were recorded for each plot following to Descriptors of Sesame [6]. Data were recorded on days to 50% flowering, height at flowering (cm), number of branches per plant, number of capsule per plant, height at maturity (cm), capsule length (cm), weight of seeds per capsule (g), 1000-seed weight (g), seed yield per hectare (kg/ha) and capsule dehiscence. Data were analyzed using PBTools, version 1.3 [11] statistical package.

3. Results and Discussion

Mean square from combined analysis of variance showed significant differences among genotypes (G), locations (L), and genotype by locations interaction (GxL) for days to 50% flowering, height at flowering, number of capsules per plant, capsule length, 1000-grain weight and grain yield (Table 1). This indicates the presence of sufficient genetic variability for grain yield and its attributes among the genotypes which selection can be based. This result was inconformity with the results reported by [9], [6], [1], and [10]. Coefficient of variation truly provides a relative measure of variance among the different traits. Estimates of genetic parameters (Table 2) indicated that GCV (genotypic coefficient of variation) was found to be highest for number of capsules per plant followed by number of branches per plant and yield per hectare. Similar trend were observed for phenotypic coefficient of variation (PCV). Close relationship between GCV and PCV was found in all the characters and PCV values were slightly greater than GCV, revealing very little influence of environment for their expression. Heritability plays a vital role in deciding the suitability and strategy for selection of a particular character. The traits under study exhibited high broad sense heritability (70.49% to 97.60%), and it was coupled with high genetic gain (index for selection criteria) for number of capsules per plant (78.94%), followed by number of branches per plant (65.65%), and yield per hectare (53.51%) while other traits exhibited moderate to low genetic gain. Heritable variation is useful for permanent genetic improvement [13]. [14] reported that high values of genetic advance are indicative of additive gene action whereas low values are indicative of non-additive gene action.

Correlation coefficients of yield and yield attributes were shown in Table 3. Yield per hectare showed highly significant positive correlation with number of branches per plant (r = 0.4599**), number of capsule per plant (r = 0.4606**), height at maturity (r = 0.4573**), capsule length (r = 0.2229**), weight of seed per capsules (r = 0.3349**) and 1000-grain weight (r = 0.3501**). This result is in conformity with the findings of [15]. Yield per hectare also revealed significant negative correlation with days to 50% flowering (r = -0.3160**) and height at flowering (r = -0.5250**). These attributes are highly related to days to maturity thus early flowering in sesame provides early capsule developing.

Principal components analysis of the genotypes across the three locations revealed that the first three PCs (PC1 to PC3) gave Eigen-values > 1.0 and cumulative variation accounted for 73.86% (Table 4). PC1 accounting for 33.15% of the total variation, while PC2 responsible for 27.02% and PC3 contributing 13.69%. The variation in PC1 was mainly associated with height at maturity, capsule length and weight of seed per capsules. PC2 variation was associated with yield per hectare, number of capsule per plant and number of branches per plant, in PC3 the contributing attributes were days to 50% flowering and 1000-grain weight. This indicates a high degree of variation for these characters among the first three PCs.

The knowledge of genetic variability and correlation analysis revealed sufficient genetic variability for yield and yield components among the sesame genotypes studied. However, yield per hectare exhibited significant positive correlation with number of branches per plant, number of capsules per plant, height at maturity, capsule length and weight of seed per capsules, thus high heritability were also recorded for these characters which could be relied upon for selection. Selection of these genotypes on the basis of these yield attributes could certainly lead to genetic improvement in sesame especially for grain yield

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Table 1: Combined Analysis of Variance (ANOVA) for grain yield and its attributing characters in sesame evaluated at three different locations in Nigeria

Source of Variation	*Df*	*Days to 50% flowering*	*Height at flowering (cm)*	*No. of branches/ plant*	*No. of capsules/ plant*	*Height at maturity (cm)*	*Capsule length (cm)*	*Weight of seed /capsules(g)*	*1000 grain weight(g)*	*Yield/hectare (kg/ha)*	*Capsules dehiscence*
location (L)	2	265.10**	7562.56**	5.15**	2572.83**	17563.59**	0.09**	0.30	3.66**	2325257.99**	0.21
Rep within Site	6	1.97**	80.31	0.18	13.91	407.65*	0.01	0.19**	0.02	1128.97	0.21
Genotype (G)	12	45.35**	599.26**	6.55**	1097.19**	2589.67**	0.86**	0.30**	1.22**	269157.07**	0.88*
Location x Gen (LxG)	24	2.05**	176.83**	0.27	156.63**	139.07	0.03**	0.01	0.09*	32569.14**	0.18
Pooled Error	72	0.66	66.37	0.36	7.41	177.33	0.01	0.02	0.05	994.61	0.23
Total	116										

Table 2: Range, General mean, Standard error (SE±), Genotypic (GCV) and Phenotypic (PCV) Coefficient of variation for different agronomic traits in Sesame

Traits	*Range*	*Mean ± SE*	*GCV (%)*	*PCV (%)*	*h² (%)*	*GA as % means*
Days to 50% flowering	35.59 to 42.28	38.69 ± 0.49	5.67	5.80	95.49	1.41
Height at flowering	38.73 to 61.45	53.54 ± 4.80	12.80	15.24	70.49	22.13
No of branches/plant	1.92 to 4.88	2.564 ± 0.34	32.56	33.26	95.81	65.65
No of capsules/plant	19.05 to 54.86	24.7 ± 1.61	41.39	44.70	85.72	78.94
Height at maturity	63.48 to 126.33	112.8 ± 7.97	14.63	15.04	94.53	29.31
Capsule length	1.66 to 2.85	2.581 ± 0.07	21.48	21.75	97.02	23.92
Weight of seed/capsules	0.42 to 1.15	0.84 ± 0.10	11.79	11.97	97.60	43.72
1000 grain weight	1.98 to 3.22	2.863 ± 0.13	12.37	12.86	92.47	24.49
yield/hectare	385.91 to 902.07	585.2 ± 18.44	27.71	29.55	87.90	53.51
Capsules dehiscence	2.12 to 2.87	2.496 ± 0.28	11.21	12.24	79.97	20.66

h² = broad sense heritability
GA=genetic advance

Table 3: Correlation coefficients between grain yield and its attributing characters in Sesame evaluated at three different locations in Nigeria

Traits	Days to 50% flowering	Height at flowering	Number of branches/ plant	Number of capsules/ plant	Height at maturity	Capsule length	Weight of seed/capsules	1000 grain weight	Capsules dehiscence	Yield/ hectare
Days to 50% flowering	1.0000									
Height at flowering	0.2219*	1.0000								
No of branches/plant	-0.3351**	-0.4333**	1.0000							
No of capsules/plant	-0.3370**	-0.5230**	0.7656**	1.0000						
Height at maturity	0.1618	-0.1156	-0.1833*	-0.1314	1.0000					
Capsule length	0.0366	0.1745	-0.4447**	-0.5181**	0.5761**	1.0000				
Weight of seed/capsules	0.0027	-0.0385	-0.2198*	-0.1940*	0.4550**	0.5819**	1.0000			
1000 grain weight	-0.3789**	0.0268	-0.2282**	-0.2129*	0.4946**	0.6202**	0.4744**	1.0000		
Capsules dehiscence	-0.0411	0.0200	0.0670	0.1351	-0.1549	-0.3943*	-0.2015**	-0.1334	1.0000	
yield/hectare	-0.3160**	-0.5250**	0.4599**	0.4606**	0.4573**	0.2229**	0.3349**	0.3501	-0.1698	1.0000

Table 4: Results of Principal Components Analysis for grain yields and its attributing characters for the first three axes in thirteen sesame genotypes over three locations

	PC1	**PC2**	**PC3**
Eigen values	4.97	4.05	2.05
Total Variation (%)	33.15	27.02	13.69
Cumulative variation (%)	33.15	60.17	73.86
Characters	**Eigenvectors**		
Days to 50% flowering	0.0996	-0.2891	0.4548
Height at flowering	0.0227	-0.3353	-0.1868

No of branches/plant	-0.1914	0.3562	0.1644
No of capsules/plant	-0.1878	0.3633	0.2054
Height at maturity	0.3737	0.0878	0.1934
Capsule length	0.3702	-0.0347	-0.2380
Weight of seed/capsules	0.3321	0.0731	-0.1708
1000 grain weight	0.2799	0.1139	-0.3502
Capsules dehiscence	-0.1623	-0.0288	0.0592
yield/hectare	0.1645	0.4334	0.0686