Journal of
Current Opinion in Crop Science
Journal homepage: www.jcocs.com; ISSN(O):2583-0392

RESEARCH ARTICLE

Genetic variability and character association among sesame (*Sesamum indicum* L.) varieties in the forest-savanna transition zone of Edo state, Nigeria

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Article history:

Received: August 25, 2025
Accepted: September 27, 2025
Published: September 30, 2025

Citation:

Akhigbe, E., & Adavbiele, V. J. (2025). Genetic variability and character association among sesame (Sesamum indicum L.) varieties in the forest-savanna transition zone of Edo state, Nigeria. *Journal of Current Opinion in Crop Science*, *6*(3), 234-242. https://doi.org/10.62773/jcocs.v6i3.355

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ABSTRACT

A study on genetic variability and character associations in sesame (*Sesamum indicum*) was conducted at the Teaching and Research Farm, Ambrose Alli University, Ekpoma. The experiment used a Randomized Complete Block Design (RCBD) with four replicates. Data were analyzed using Analysis of Variance (ANOVA) and genetic models, with means compared by Least Significant Difference (LSD). Among the sesame varieties, NCRIBEN 01M exhibited the highest plant height at 2, 4, 6, and 8 weeks after planting (WAP), while E8 showed superior performance in number of leaves, leaf area, stem girth, and number of branches. High heritability values were recorded for plant height, number of leaves (95.24% and 95.17%), and leaf area (95.01%), suggesting strong genetic control. Additionally, stem girth and number of branches showed high heritability at all stages of growth. Days to 50% flowering and maturity also had high heritability (90.97%) and genetic gain (23.97). However, low heritability values were observed for plant height at 6 and 8 weeks, indicating non-additive gene effects. Positive correlations were found between the number of pods per plant and seed yield, as well as between number of seeds per pod and pod length and weight. Improving one positively correlated trait can lead to improvements in others. The varieties E8 and NCRIBEN 01M, which exhibited high yield potential, are recommended for farmers in this region.

Keywords: Genetic Variability; Sesame; Heritability; Seed Yield.

INTRODUCTION

Genetic variability forms the foundation of crop improvement, providing the raw material for selection and breeding. In sesame (*Sesamum indicum* L.), variability among genotypes is expressed through differences in morphological and agronomic traits such as plant height, number of branches, number of capsules per plant, capsule length, seed weight, and overall seed yield (Dossa et al., 2017; Gedifew et al., 2023). Understanding the extent of this variability enables plant breeders to identify superior genotypes with desirable traits that can be exploited for yield enhancement, adaptability, and stress tolerance (Dossa et al., 2017). Recent studies have confirmed the presence of substantial genetic variability in sesame populations: for instance, Gedifew et al. (2023) found high heritability and significant variation among 64 genotypes for traits like capsule number per plant and branches per plant. Similarly, Tadesse et al. (2024) reported >20% phenotypic and genotypic variation for seed yield, number of pods per plant and branches per plant in Ethiopian germplasm.

Beyond variability, association analysis among component characters is crucial for determining which traits contribute directly or indirectly to seed yield. Yield in sesame is a polygenic trait influenced by multiple characters, making direct selection for yield alone inefficient. By studying correlations among yield-related traits, breeders can identify the most influential characters, such as capsules per plant, seed size, or plant height, and prioritise them during selection. For example, Wang et al. (2024) found that the number of productive branches, the number of capsules per plant, the number of seeds per capsule, and days to maturity had high positive direct effects on seed yield. In a larger association-mapping study, Li et al. (2023) (in Genetic Resources and Crop Evolution) showed that capsule number per plant ($r = 0.67$) had the strongest positive correlation with seed yield among nine yield-related traits across 369 accessions.

In recent years, research has highlighted wide genetic diversity in sesame across Africa and Asia, yet most breeding programmes still rely on uncharacterised landraces. Molecular studies and large-scale phenotypic evaluations have confirmed significant variability within and between populations, supporting the need for comprehensive phenotypic evaluations (Dossa et al., 2017). In Nigeria, sesame is widely grown across northern and central states, but systematic evaluation of varieties in southern ecological zones remains limited. Given that genotype × environment interaction strongly influences trait expression, assessing variability and trait associations in the forest–savanna transition zone is critical for identifying locally adapted and high-yielding varieties. A recent study in Nigeria by Durodola et al. (2024) found significant morpho-agronomic variation among 15 sesame accessions in Nigeria, underlining the opportunity and necessity for more localized evaluation.

Studying the genetic variability and association of component characters in sesame varieties cultivated in Edo State will provide baseline information necessary for breeding programmes targeting southern Nigeria. Such studies not only help in selecting high-performing genotypes but also contribute to the conservation of genetic resources for future improvement. Ultimately, the identification of traits most strongly associated with yield will facilitate the development of improved sesame varieties that can thrive in diverse agro-ecological conditions, thereby enhancing productivity, farmer income, and the competitiveness of Nigerian sesame in global markets (FAO, 2023). This study aims to assess the genetic variability among selected sesame (*Sesamum indicum* L.) varieties (NCRIBEN 05E, E8, YANDEV 55, NCRIBEN 01M, and NCRIBEN 02M) and to identify the traits and genotypes contributing to superior yield performance for potential use in sesame improvement programmes.

MATERIALS AND METHODS

Experiment Location

The field work was carried out in the Teaching and Research Farm, Faculty of Agriculture, Ambrose Alli University, Emaudo Annex, Ekpoma. Ekpoma is located in a forest – savanna transition zone of Edo State between Latitude $6^0 45'$ North and Longitude $6^0 08'$ East with a mean air temperature of 29^0C, relative humidity of 70%, sunshine of about 5-7 hours/day and mean annual rainfall of about 1200-1500 mm (Ighalo and Remison, 2010).

Materials used

Five varieties (NCRIBEN 05E, E8, YANDEV 55, NCRIBEN 01M and NCRIBEN 02M) of sesame from National Cereals Research Institute, Badeggi, Niger state, were used.

Experimental design

The experiment was a Randomized Complete Block Design (RCBD) with four replicates, The experimental site was cleared using cutlass and the debris packed away. The plots were demarcated into 20 plots, measuring 2m by 2m each and an alley of 1m between plots. Total land space used was 11m by 14m.The five varieties were sown on flat ground. Each contained 24plant stands/plot with a spacing of 45cm by 30cm given a total of 480plant stands in the entire experimental field.

Data Collection

Vegetative characters

Data were collected on several growth and yield attributes including number of leaves per plant, plant height, leaf length, leaf breadth, stem girth, number of branches per plant, number of capsules per plant, weight of capsule per plant, number of seeds per capsule, 1000-seed weight, capsule length, and seed yield per hectare. The number of leaves per plant was determined by visually counting the leaves from five randomly selected plants per plot, and the mean value was recorded. Plant height (cm) was measured from the ground level to the tip of the plant using a measuring tape. Leaf length and leaf breadth were each obtained from five randomly selected plants per plot with the aid of a tape calibrated in centimeters. Stem girth was measured around the stem of five randomly selected plants at right angles to the stem axis using a measuring tape, and the average value was calculated. The number of branches per plant was recorded by visually counting the total number of branches on five randomly selected plants per plot and taking the mean.

Yield and yield component

For yield and yield components, the number of capsules per plant was determined by counting the total capsules from three plants per plot and recording the average. The weight of capsules per plant was obtained using a sensitive electronic weighing scale, taking measurements from five plants per plot and averaging the results. Days to 50% flowering were recorded as the number of days from the date of sowing to the time when half of the plant population had flowered in each of the twenty plots, while days to 50% maturity represented the duration from transplanting to the date when 50% of the population reached maturity. Capsule length (cm) was measured from five randomly selected plants per plot using a calibrated measuring tape. The 1000-seed weight was determined by weighing 1000 seeds on a precision balance, and the seed yield per hectare was calculated from the total seed yield obtained per experimental plot and converted to yield per hectare using standard procedures.

Data analysis

Plant growth and yield data collected were analysed using analysis of variance (ANOVA) at 5% level of probability and the means separated using the Least Significant Difference (LSD), when F – ratio prove significant.

Genetic Analysis

The genetic analysis was based on the agronomic and yield related to genotypic and phenotypic expressions. The mean square at treatment levels were taken as the phenotypic variation and the mean square at error levels were subtracted from their corresponding phenotypic variance to give the genotypic variance parameters and calculated as described by Allard (1999) as follows:

a. ***Heritability (Ho):*** Heritability in the broad sense was calculated using the Formula:

$$Ho = \frac{\delta_g^2}{\delta_{ph}^2} \times 100$$

Where; $\delta_g^2 = genotypic\ variance$, $\delta_{ph}^2 = phenotypic\ variance$

b. ***Genotypic Advance:*** This was calculated using the formula:

$$\mathbf{GA} = \frac{\delta_g^2}{\delta_{ph}^2} \times k$$

where; δ_g^2=genotypic variance

δ_{ph}^2= square root of phenotypic variance

K= 2.06 (10% selective index)

Genetic Gain (GG): This was calculated in terms of Genetic Advance (GA) expressed as a percentage of the population mean as follows:

$GG = \frac{GA}{\bar{X}} \times 100$ Where $\bar{X}$ = Population mean, GA=Genetic Adavance

RESULTS AND DISCUSSION

The plant height of NCRIBEN 01M at 2 Weeks after planting (WAP) was significantly greater than that of E8, NCRIBEN 05M, NCRIBEN 02M, and YANDEV 55. By 4 WAP, NCRIBEN 01M and E8 showed no significant difference in height, though both remained significantly taller than the other varieties. At 6 and 8 WAP, E8's height was statistically similar to most varieties except for YANDEV 55 (Table 1). These differences likely reflect underlying genotypic variation and environmental influences on growth dynamics (Wang et al., 2023). Similarly, the number of leaves per plant differed significantly across genotypes from 2 through 8 WAP. E8 and NCRIBEN 01M were consistently distinct from the other varieties, while NCRIBEN 02M, NCRIBEN 05M, and YANDEV 55 did not differ significantly among themselves (Table 2). Since leaf number contributes directly to photosynthetic surface area and assimilate accumulation, genotypic differences in leaf production may influence yield potential (Bhattacharya et al., 2024).

Total leaf area per plant also varied significantly among varieties. NCRIBEN 01M differed from the others at early stages; later, E8 and NCRIBEN 02M showed no difference between them but both surpassed the other genotypes in leaf area at 2, 6, and 8 WAP (Table 3). Given that leaf area determines light interception and carbon capture, these differences are expected to impact yield outcomes (Bhattacharya et al., 2024). In terms of stem girth, E8 differed significantly from all except NCRIBEN 01M at 6 WAP. For number of branches per plant, significant differences occurred at all measurement times (Table 4). NCRIBEN 02M was particularly distinct at 4 WAP, but by 6–8 WAP, NCRIBEN 02M, NCRIBEN 01M, and E8 converged in branch number (Table 5). Variation in branching architecture is known to be under genetic control and to influence resource allocation for reproductive development (Li et al., 2023).

Table 1. Plant height (cm) of sesame at 2, 4, 6 and 8 WAP

Variety	Weeks after planting (WAP)			
	2	4	6	8
YANDEV 55	10.44[c]	28.50[b]	71.45[b]	105.60[b]
E 8	17.18[b]	47.90[a]	76.9[ab]	131.30[a]
NCRIBEN 05E	14.95[b]	33.58[b]	84.35[ab]	127.00[a]
NCRIBEN 01M	21.92[a]	49.45[a]	87.00[a]	127.70[a]
NCRIBEN 02M	15.0[8b]	32.43[b]	71.25[b]	119.50[ab]
LSD(P<0.05)	2.80	6.51	13.18	20.09

Values with the same alphabet in the same column are insignificantly different using LSD (P<0.05). LSD: Least Significant Difference

Table 2. Number of leaves/plants of sesame at 2, 4, 6 and 8 WAP

Variety	WAP			
	2	4	6	8
YANDEV 55	8.20[b]	25.15[b]	75.55[b]	129.80[b]
E 8	18.70[a]	43.55[a]	126.05[a]	185.00[a]
NCRIBEN 05E	9.00[b]	28.70[b]	79.80[b]	135.40[b]
NCRIBEN 01M	17.15[a]	44.95[a]	120.70[a]	179.20[a]
NCRIBEN 02M	8.06[b]	26.40[b]	85.20[b]	139.80[b]
LSD(P<0.05)	2.14	6.21	18.12	19.37

Values with the same alphabet in the same column are insignificantly different using LSD (P<0.05). LSD: Least Significant Difference

Table 3. Leaf area/plant (cm^2) of sesame at 2, 4, 6 and 8 WAP

Variety	WAP			
	2	4	6	8
YANDEV 55	118.78[b]	1748.59[c]	6783.08[b]	11430.15[b]
E 8	190.27[b]	2492.44[ab]	10040.28[a]	20467.16[a]

NCRIBEN 05E	134.79^{b}	1910.59^{bc}	5616.98^{b}	13012.25^{b}
NCRIBEN 01M	362.32^{a}	3002.74^{a}	10425.68^{a}	18077.09^{a}
NCRIBEN 02M	132.22^{b}	1744.88^{c}	5888.03^{b}	10557.54^{b}
LSD(P<0.05)	5.71	19.03	26.30	24.64

Values with the same alphabet in the same column are insignificantly different using LSD (P<0.05). LSD: Least Significant Difference.

Table 4. Stem girth(cm) of sesame at 2, 4, 6 and 8 WAP

Variety	WAP			
	2	4	6	8
YANDEV 55	0.30^{b}	1.06^{b}	1.50^{bc}	1.84^{bc}
E 8	0.57^{a}	1.54^{a}	1.84^{a}	2.58^{a}
NCRIBEN 05E	0.33^{b}	0.98^{b}	1.38^{c}	1.74^{c}
NCRIBEN 01M	0.37^{b}	0.84^{b}	1.65^{ab}	2.156^{b}
NCRIBEN 02M	0.34^{b}	1.05^{b}	1.39^{c}	1.84^{bc}
LSD(P<0.05)	0.12	0.40	0.23	0.36

Values with the same letter(s) in the same columns are not significantly different at 5% level of probability; LSD: Least significant difference

Table 5. Number of branches/plants of sesame at 4, 6 and 8 WAP

Variety	WAP		
	4	6	8
YANDEV 55	4.55^{b}	6.38^{bc}	9.65^{b}
E 8	5.15^{b}	11.40^{a}	16.90^{ab}
NCRIBEN 05E	5.30^{b}	5.75^{c}	11.15^{b}
NCRIBEN 01M	5.83^{b}	10.25^{ab}	17.00^{ab}
NCRIBEN 02M	8.75^{a}	13.65^{a}	20.50^{a}
LSD(P<0.05)	2.16	4.13	8.46

Values with same letter(s) in the same columns are not significantly different at 5% level of probability; LSD: Least significant difference

Table 6. Days to 50% flowering and maturity, and yield and yield components of sesame

Variety	Days to 50% Flowering	Days 50% Maturity	Number of pods /plants	Number of seeds /pods	Pod length (cm)	Weight of 1000 Seeds (g)	Pod weight (kg/ha)	Seed weight (kg/ha)
YANDEV 55	51.0^{bc}	74.0^{ab}	85.55^{ab}	69.0^{c}	3.42^{b}	6.75^{b}	611.20^{b}	474.40^{bc}
E 8	48.0^{c}	68.50^{c}	116.17^{a}	126.50^{a}	5.89^{a}	13.75^{a}	963.80^{a}	708.80^{a}
NCRIBEN 05E	57.75^{a}	78.50^{a}	77.55b	81.75^{c}	3.51^{b}	5.0^{b}	711.20^{b}	458.80^{bc}

NCRIBEN 01M	58.50^{a}	75.25^{ab}	92.35^{ab}	73.00^{c}	5.15^{ab}	8.0^{b}	758.80^{b}	333.80^{c}
NCRIBEN 02M	53.00^{b}	70.75^{bc}	105.30^{ab}	110.25^{b}	5.41^{ab}	11.75^{a}	698.80^{b}	552.50^{ab}
LSD(P<0.05)	4.13	5.2	30.1	15.86	2.14	3.07	204.70	180.60

Values with the same letter(s) in the same columns are not significantly different at 5% level of probability; LSD: Least significant difference

Table 7. Association of component characters of sesame

	Plant height (cm)	No. of leaves per plant	Leaves area (cm^2)	Stem girth (cm)	No. of branches	Days to 50% flowering	Days to 50% maturity	No. of pods/ plant	No. of seeds/ pod	Pod length (cm)	1000 seed weight (g)	Pod weight (kg/ha)	Seed weight (kg/ha)
Plant height(cm)		0.283	0.282	0.318	-0.003	0.183	0.175	-0.169	0.245	0.042	0.153	0.182	0.107
No. of leaves			0.688	0.652	0.239	-0.043	-0.297	0.271	0.378	0.504*	0.398	0.495*	0.140
Leaves area (cm^2)				0.682	0.119	-0.045	-0.183	0.379	0.229	0.290	0.258	0.667	0.201
Stem girth (cm)					-0.020	-0.301	-0.273	0.376	0.511*	0.324	0.530*	0.566	0.456*
N0. Of branches						-0.266	-0.640	0.419	0.330	0.653	0.511*	0.302	0.178
50% flowering							0.758	-0.305	-0.499*	-0.377	-0.477*	-0.181	-0.590
50% maturity								-0.449*	-0.537*	-0.651	-0.678	-0.268	-0.452*
Number of pods/plant									0.426	0.244	0.587	0.756	0.449*
Number of seeds/pod										0.450*	0.791	0.466*	0.606
Pod length (cm)											0.563	0.102	0.142
Weight of 1000 seeds (g)												0.468*	0.512*
Pod weight (kg/ha)													0.578

*: significant at 5% level of probability

Table 8. Genetic analysis of vegetative and yield characters of some varieties of sesame

Character	Weeks after planting	PCV	GCV	H_o (%)	GA	GG
Plant height	2	69.375	66.072	95.24	1.96	12.32
	4	369.34	351.49	95.17	1.96	5.11
	6	210.82	137.59	65.26	1.34	1.71
	8	420.6	250.5	59.56	1.23	1.01
Number of leaves	2	110.109	108.181	98.25	2.02	16.53
	4	374.96	358.73	95.67	1.97	5.84
	6	2299.7	2161.4	93.99	1.94	1.99

	8	2729.2	2571.1	94.21	1.94	1.26
Leaves area	2	275.31	261.58	95.01	1.96	12.76
	4	1073.5	920.9	85.78	1.77	2.74
	6	2271	1979.5	87.16	1.8	2.26
	8	3181.9	2926.5	91.97	1.89	1.98
Stem girth	2	0.046705	0.4036	86.41	1.78	468.42
	4	0.28208	0.21408	75.89	1.56	142.73
	6	0.14995	0.12704	84.72	1.75	112.9
	8	0.47187	0.41741	88.46	1.82	89.7
Number of branches	4	10.872	8.907	81.93	1.69	28.55
	6	45.222	38.026	84.09	1.73	18.25
	8	81.3	51.17	62.94	1.3	8.67
Days to 50% flowering		79.700	72.5	90.97	1.87	23.49
Days to 50% maturity		60.83	49.44	81.28	1.67	22.28
Number of pod		954.6	572.8	60	1.24	21.3
Number of seed		2518.3	2412.3	95.8	1.97	22.14
Pod length		5.17	3.24	62.68	1.29	27.62
1000 seeds		52.175	48.2	92.38	1.9	21
Pod weight		69138	51490	74.47	1.53	20.2
Seed yield		76172	62437	81.97	1.69	20.33

PCV: Phenotypic coefficient of variation; GCV: Genotypic coefficient of variation; H_o: Heritability; GA: Genetic advance; GG: Genetic gain

The genotypes also varied significantly in days to 50% flowering and days to 50% maturity. Generally, earlier flowering genotypes matured earlier and tended to yield more seeds. Generally, earlier flowering genotypes matured earlier and tended to yield more seeds. This result aligns with studies showing that shorter growth duration can enhance partitioning efficiency and yield under certain environments (Gedifew et al., 2023). Yield-component traits including number of capsules per plant, seeds per capsule, capsule length, 1000-seed weight, capsule weight, and seed yield showed significant variation (Table 6). For example, E8 and NCRIBEN 02M did not differ in 1000-seed weight but both differed from the other genotypes. These results reflect genotypic differences in sink strength, reproductive efficiency, and seed-filling ability (Wang et al., 2023).

High estimates of broad-sense heritability and genetic gain were recorded for many traits: early-stage plant height, leaf number, leaf area, stem girth, branching, flowering and maturity dates, seeds per capsule, 1000-seed weight, and seed yield (Table 7 & 8). This pattern suggests that additive genetic effects are substantial and that selection for these traits is promising (Sanni et al., 2025). For instance, in sesame breeding, Sanni et al. (2025) observed realized genetic advancement under selection for yield and related traits.

Correlation and path-coefficient analyses revealed positive and significant relationships between leaf number, capsule length, capsule weight, stem girth, 1000-seed weight, and seed yield. These associations imply that improving one trait may lead to concurrent gains in others. For example, enhancing 1000-seed weight was closely tied to increased capsule length and weight, which in turn positively correlated with yield (Wang et al., 2023). Overall, the observed genotypic differences, favorable trait correlations, and high heritability offer a solid basis for selection-oriented breeding of improved sesame varieties under the tested conditions.

CONCLUSION

The study revealed significant variation among the vegetative and yield traits of the evaluated sesame (*Sesamum indicum* L.) varieties, confirming the presence of exploitable genetic diversity. Variety E8 exhibited superior performance for most agronomic traits, including plant height, number of leaves per plant, leaf area, stem girth, pod length, number of pods per plant, number of seeds per pod, 1000-seed weight, and overall seed yield, indicating its potential for high productivity. Positive and significant correlations were observed between number of leaves per plant, number of pods per plant, 1000-seed weight, and seed yield, suggesting that improvement in one of these traits could lead to simultaneous enhancement in others. High heritability and genetic gain estimates recorded for days to 50 % flowering, days to 50 % maturity, pod length, 1000-seed weight, number of seeds per pod, number of pods per plant, pod weight, and seed yield indicate a predominance of additive gene effects, implying that these characters are amenable to genetic improvement through selection. Conversely, traits with low heritability and genetic gain are likely influenced by non-additive gene action and are less reliable for selection. Based on these findings, sesame was shown to perform well under the agro-ecological conditions of the study area, and varieties E8 and NCRIBEN 01M with superior growth and yield attributes are recommended for farmers in the forest–savanna transition zone. Furthermore, moderate rainfall conditions are preferable for optimum sesame productivity, as excessive rainfall was found to delay flowering and extend vegetative growth, thereby reducing yield potential.

ACKNOWLEDGEMENTS

Not applicable

AUTHORS CONTRIBUTIONS

All the authors contributed equally to this work. All authors read and approved the final manuscript.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

ETHICAL APPROVAL

Not applicable.

FUNDING

Funding not involved in this study.

AVAILABILITY OF DATA AND MATERIALS

All datasets analyzed and described during the present study are available from the corresponding author upon reasonable request.

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