FULafia Journal of Science & Technology
ISSN (print) 2449-0954 \ ISSN (online) 2636-4972
https://lafiascijournals.org.ng/index.php/fjst
Sponsored By TERTIARY EDUCATION TRUST FUND
Manuscript => Received: Dec., 2025; Accepted: Feb., 2026; Published: March, 2026 https://doi.org/10.62050/fjst2026.v10n1.687

DETERMINATION OF TRAITS ASSOCIATION AND CONTRIBUTION AMONG AGRONOMIC AND SEED OIL TRAITS OF SESAME (*Sesamum indicum* L.) GENOTYPES EVALUATED IN LAFIA METROPOLIS, NASARAWA STATE, NIGERIA

Yusuf Mohammed Ibrahim*, Ogah Godwin Omane, Kana Hauwa Ahmad, Hanah Eyo Nsemoh, Okposhi Isah Ibrahim, Zainab Alhassan and Jibril Lawal Imam
Department of Plant Science and Biotechnology, Federal University of Lafia, Nasarawa State, Nigeria
*Corresponding email: ibrahimyusuf1113@gmail.com

ABSTRACT
Sesame is an important oilseed crop in tropical and subtropical regions; however, its productivity in Nigeria remains low due to the limited availability of improved, high-yielding varieties. The lack of comprehensive information on genetic variability for both agronomic and quality traits hinders effective selection and breeding strategies. Therefore, this study evaluated genetic variability and trait association among agronomic and seed oil-related traits in sesame genotypes to identify selection criteria for yield and quality improvement. Twenty sesame genotypes were evaluated in Lafia LGA of Nasarawa, Nigeria using a randomized complete block design (RCBD) with three replications. Data were collected on agronomic traits, including plant height, number of capsules, number of seeds per capsule and dry seeds weight, as well as seed quality traits such as moisture content, ash content, crude proteins and percentage fat. Analysis of variance revealed significant differences among genotypes for most traits. Principal component (PC1) explained 40% of the variation followed by principal component (PC2) explained 15% of the variation. Dry seed weight contributes indirectly through PC3 (33%) while percentage moisture content through PC4 contributes 12%. Traits such as number of capsules, plant height, and 1000 seed weight contributed significantly to PC1, making them ideal for yield-based selection. Number of capsules per plant, a key yield determinant, showed a positive correlation with crude protein (r=0.36) and fat content (r=0.29). This paper provided useful genotypes which would be serving parents. These parental genotypes could be used in sesame breeding program to develop desirable varieties in Nigeria.

Keywords: Determination, Traits, Agronomic, Seed, Oil sesame, Genotypes,

INTRODUCTION
Sesame (*Sesamum indicum* L) is believed to be one of the most ancient crops cultivated by humans. It is regarded as the "Queen of oilseeds" because of its excellent quality of edible oil (Biswas *et al.*, 2018). It was first recorded as a crop in Babylon and Assyria over 4000 years ago. The seeds of the crop are used both as condiment and oil source. The Babylonians made wine and cakes with sesame seeds, whereas sesame oil was used for cooking, medicinal, and cosmetic purposes. The Chinese believed that sesame seeds could promote health and longevity. It is widely cultivated across Asia and Africa. In recent years, the production of sesame seeds in African countries has increased, and Tanzania has replaced India as the leading producer of sesame seeds. Sesame has been cultivated for centuries, particularly in Asia and Africa, for its high content of edible oil and protein (Johnson *et al*., 1979). AP, MP, West Bengal and Rajasthan are the leading sesame producer in India and major sesame producing districts in West Bengal are Midnapur, Hooghly, Nadia, Jalpaiguri and 24 Parganas. Sesame is highly suitable crop for south 24 Parganas (soil pH 7.4 and EC 0.16 to 4.01 ds m-1).

Currently, sesame is grown in 26 states in Nigeria the states are: Adamawa, Bauchi, Benue, Borno, Gombe, Jigawa, Kaduna, Kano, Katsina, Kebbi, Kogi, Nasarawa, and Niger. Plateau. Sokoto. Taraba, Yobe, and Abuja. Jigawa has the highest area of production in the country followed by Benue State. In the Tiv and Idoma tribes of Benue State, Nigeria, two species of sesame, namely *S indicum* and *S. rudiatum* are cultivated mainly for their seeds and leaves (Obiajunwa *et al.*, 2005).Sesame seed contains 50 % oil, 23 % protein and 15 % carbohydrate along with a high amount of calcium, phosphorous and oxalic acid (Abhijatha *et al.*, 2017). Sesame is a self-pollinated crop with an average cross pollination to the extent of 4 to 5 per cent. Sesame is a high value food crop which is an important source of edible oil and is also used as a spice (in bakeries).

Sesame oil is very stable due to the presence of powerful antioxidants viz., sesamin, sesamolin and sesamol which confer resistance to the oxidative deterioration (Pathak *et al.*, 2014).Among all the edible oils, the antioxidant content is reported to be highest in sesame oil (Cheung *et al.*, 2007).The crop is high tolerant to drought, grows well in most of the well-drained soils and various agro-climatic regions as well as adapted to different rotations. It can set seed and yield well under fairy high temperature and can grow in stored soil moisture without rainfall and irrigation.

However, continuous flooding or severe drought adversely affects the crop resulting in low yield (Mensah *et al.*, 2009).

Sesame oil contains several fatty acids such as oleic acid (43%), linoleic acid (35%), palmitic acid (11%) and stearic acid (7%). It is an annual oilseed crop of the pedaliaceae family in the tropics and warm sub tropics, where it is usually grown in small patches (Agrawal *et al.*, 2018). Its stability due to antioxidant i.e. sesomin and sesamolin leads its industrial application in the developing countries for improving the shelf life of canned products. Sesame seed has higher oil content (around 50%) than most of the known oilseeds although its production is far less than the major oilseeds such as soybean or rapeseed due to labor-intensive harvesting of the seeds. Sesame oil is generally regarded as high-priced and high-quality oil. It is one of the most stable edible oils despite its high degree of un-saturation.

Sesame is extensively cultivated in tropical to temperate regions in the world. Even though the crop originated in Africa, India is considered to be the major center of genetic diversity (Maiti *et al.*, 2012).Variability in salt tolerance of sesame and genetic regulation of salinity tolerance of genotypes is well documented (Ramirej *et al.*, 2005). Sesame is a diploid (2n=26) dicotyledonous and one of the oldest oilseed crops which grown widely in tropical and sub-tropical area for its edible oil, proteins, vitamins and amino acids. Salinity and drought have considerable adverse impacts on productivity of agricultural plants. The production of sesame oil not only depends upon the metabolic state of the source tissues, but also may be integrated with the stress factors (Sangwan *et al.*, 2001).

MATERIALS AND METHODS

The field experiment was conducted during the 2023 rainy season at the Botanical Garden of the Department of Plant Science and Biotechnology, Federal University of Lafia, Nasarawa State, Nigeria, is located at approximately 8.49^{o}N latitude and 8.52^{o}E longitude within Southern Guinea Savannaagro-ecological zone. Twenty sesame accessions were obtained from the National Cereal Research Institute (NCRI), Badeggi, Niger State, and Nigeria. The genotypes were evaluated using a Randomized Complete Block Design (RCBD) with three replications. Each plot measured three rows of 1 m in length with intra and inter-row spacing of 15 x 30 cm (Ullah *et al.*, 2012). Data on agronomic traits were collected at appropriate growth stages of sesame. Five randomly selected plant were used for individual plant measurements. Data were collected on plant height (cm), number of capsules per plant, number of seeds per capsule, dry seed weight (g), and 1000 seed weight (g). For seed quality analysis, standard procedures as outlined by FISS/FMARD were followed to determine moisture, ash, crude protein, crude fat, crude fiber, and carbohydrate content.

Statistical analysis was conducted using R software (version 3.3.0). Analysis of variance (ANOVA) was carried out on the data to assess the genetic variation using a general linear model (GLM) procedure for RCBD (Table 1).

Form of analysis of variance for one environment

Sources of variation	DF	MS	EMS
Replication	$r-1$	MS_3	
Genotype	$g-1$	MS_2	$\sigma_e^2 + r\sigma_g^2$
Error	$(r-1)(g-1)$	MS_1	σ_e^2

Principal Component Analysis

Contribution of each trait to the total variability was determined through principal component analysis (PCA) based on a correlation matrix of all variables, and principal component with Eigen-value >1.0 was selected. To assess extent of relatedness among the sesame genotypes, a cluster analysis using Ward's minimum variance method by genotypes was conducted to generate a dendogram using PROC CLUSTER.

RESULTS AND DISCUSSION

In the present investigation, twenty sesame genotypes were studied to assess their variability in terms of agronomic and seeds oil traits. The analysis of variance revealed highly significant ($p<0.01$) variation among the 20 genotypes for key traits such as plant height, number of capsules per plant, fat content, ash content, crude protein, fiber, and carbohydrate (Table 2). This suggests that sufficient genetic variability exists within the genotypes, which provides the basis for effective selection and improvement. Such variability provides opportunities for breeders to identify and select superior genotypes for both yield seed quality traits. These findings align with the report of Gidey *et al.* (2012), who also observed considerable genetic variation in sesame for multiple morphological traits, supporting the potential for effective selection. The significant genetic variations observed in the present study suggest that the population contains genotypes with diverse genetic background, which is valuable for broadening the genetic base through hybridization. Furthermore, this is in agreement with Johnson *et al.* (1955) and Burton *et al.* (1953), who stated that significant differences among genotypes for quantitative traits indicate the presence of exploitable genetic variance. According to Iqbal *et al.* (2016) and Begum *et al.* (2017), the presence of significant difference among genotypes for these traits has been successfully used in selecting high-yielding and high-quality sesame lines.

Table 2: Analysis of variance for Agronomic and Seed oil traits of sesame, evaluated in Lafia in 2023

Characters	Sources of variance		
	Replication	Genotype	Error
PH	108.78	715.21**	91.53
NC	19.99	152.50**	24.89
NSPC	31.91	84.86*	59.65
DSWT	0.01	0.01	0.01
TSWT	3.63	0.84	0.80
PMC	0.04	5.03	0.02
PAC	0.03	1.07**	0.02
PCP	0.04	0.89**	0.02
PFAT	0.01	12.91**	0.02
PCF	0.04	9.15**	0.02
PCHD	0.01	10.27**	0.01

PHT- Plant height, NC- numbers of capsule, NSPC- numbers of seed per capsule, DSWT- dry seed weight, TSWT- 1000 seed weight, PMC- Percentage moisture content, PAC- Percentage ash content, PCP- Percentage crude protein, PFAT- Percentage fat, PCF- Percentage crude fiber, PCHD- Percentage carbohydrate

From Table 3, PCA identified five principal components (PCs) with eigen values >1, explaining 80 % of total variability. The first principal component (PC1), which accounted for the highest proportion of variation (40 %), was primarily influenced by plant height (-0.33), number of capsules (-0.32), number of seeds per capsule (-0.25), crude protein (-0.23), and 1000 seed weight (-0.23). This suggests that PC1 largely reflects yield-related traits and seed weight, which are major contributors to the total genetic variation. Similar findings were reported by Singh *et al.* (2010) and Kumar *et al.* (2016), who noted that traits associated with yield, such as capsule number and plant height, often dominate the first component in sesame PCA. The negative signs of eigenvectors are relative and do not imply lesser importance; rather, they reflect the direction of correlation within the principal axis (Jolliffe *et al.*, 2002).

Table 3: Eigenvectors for the principal of the traits associated with agronomic and seed oil traits.

Parameters	PC axis[1]				
	PC1	PC2	PC3	PC4	PC5
Standard Deviation	2.81	1.71	1.53	1.23	1.19
Explained proportion of variation (%)	40	15	12	8	7
Cumulative proportion of variation (%)	40	54	66	73	80
Traits (eigenvectors)					
Plant height	-0.33	0.08	-0.18	-	-0.06
Number of capsules	-0.32	0.02	-0.12	0.13	0.13
Number of seeds per capsules	-0.25	-0.13	0.02	0.18	-0.20
Dry seeds weight	-0.17	-0.39	0.33	-0.07	0.03
1000 seeds weight	-0.23	-0.38	0.22	-0.03	0.02
Percentage moisture content	0.08	-0.03	-0.12	0.61	-0.07
Percentage ash content	0.11	-0.41	-0.34	-0.17	0.05
Percentage crude proteins	-0.23	0.17	0.41	0.02	-0.05
Percentage fat	-0.16	0.35	0.33	-0.01	-0.13
Percentage crude fiber	0.03	-0.32	-0.10	0.14	0.01
Percentage carbohydrate	-0.15	0.11	-0.01	-0.50	-0.16

[1]PC = principal component; PC1, PC2, PC3, PC4 and PC5 = 1st, the 2nd, the 3rd, the 4th and the 5th PC, respectively

Table 4: Correlation coefficient between agronomic and seed oil traits of sesame

Trait	PCP	PFAT	PCHD	PCF	PAC	PMC
PHT	0.37**	0.29*	0.39**	0.87**	-0.19	-0.09
NC	0.36**	0.29*	0.22	0.03	-0.23	-0.13
TSWT	0.22	0.03	0.07	0.08	0.06	-0.09
DSWT	0.24	0.02	0.05	0.07	0.05	-0.09
NSPC	0.29*	0.15	0.04	0.04	-0.07	0.00

PHT- Plant height, NC- numbers of capsules, NSPC- numbers of seed per capsules, DSWT- dry seed TSWT- 1000 seed weight, PMC- Percentage moisture content, PAC- Percentage ash content, PCP- Percentage crude protein, PFAT- Percentage fat, PCF- Percentage crude fiber, PCHD- Percentage carbohydrate

In Table 4, PC2, which explained an additional 15 % of the variation (cumulative 54 %) was associated with fat content (0.35) and crude protein (0.17), but negatively influenced by ash content (-0.41) and 1000 seed weight (-0.38). This axis contrasts seed quality traits (fat and protein) against structural or mineral traits (ash content), indicating a divergence in genotype performance for these contrasting attributes. Ashri *et al.* (1998) and Abdi *et al.* (2010) highlighted the importance of such contrasts in identifying trait-specific genetic divergence, especially in crops with dual goals of yield and nutritional quality.

PC3 added another 12 % (cumulative 66 %) to the variability and was largely influenced by crude protein (0.41), fat content (0.33), and dry seed weight (0.33). This component clearly emphasizes the nutritional quality profile of sesame seeds, suggesting its relevance in selecting genotypes with superior oil and protein content. Such traits have been highlighted in quality-focused breeding programs as essential for improving sesame seed utility in food and industrial applications (Ali *et al.*, 2007; Sanni *et al.*, 2008). PC4 and PC5 explained smaller proportions of the total variation (8 and 7 %, respectively), with PC4 being heavily influenced by moisture content (0.61) and carbohydrate (-0.50). PC5 had weaker and more distributed contributions, reflecting lesser importance in selection. These components, although contributing minor variation, may still be useful for identifying specific genotypes with unique seed storage or moisture-resistance characteristics, especially for breeding under stress-prone environments.

Plant height (PHT) showed positive and highly significant correlations with percentage crude protein (r = 0.37**), percentage fat (r = 0.29*), percentage carbohydrate (r = 0.39**), and percentage crude fiber (r = 0.87**). These strong positive relationships indicate that taller plants tend to accumulate higher levels of oil and nutritional components in their seeds. This may be attributed to greater vegetative growth and photosynthetic efficiency in taller plants, which enhances assimilate production and translocation toward protein, oil, and carbohydrate synthesis during seed development. Similar positive associations between plant height and oil or quality traits have been reported in sesame and other oilseed crops (Sharma *et al*., 2014; Bedigian, 2011).

Plant height, however, showed negative but non-significant correlations with percentage ash content (r =

−0.19) and percentage moisture content (r = −0.09). This suggests that taller plants tend to produce seeds with lower moisture content, a desirable attribute for oil stability, storage, and processing. Reduced moisture content in seeds has been associated with improved oil quality and shelf life (Weiss, 2000).

Number of capsules per plant (NC) exhibited positive and significant correlations with percentage crude protein (r = 0.36**) and percentage fat (r = 0.29*), indicating that genotypes with more capsules tend to produce seeds with higher protein and oil contents. This suggests effective assimilate partitioning toward reproductive structures in plants with higher capsule numbers. These findings agree with earlier reports that capsule-bearing capacity contributes to improved seed quality in sesame (Alege & Mustapha, 2020).

However, NC showed negative correlations with percentage ash content (r = −0.23) and percentage moisture content (r = −0.13), indicating a slight dilution effect on mineral accumulation and moisture as capsule number increases. This suggests a possible trade-off between capsule number and some quality traits due to competition for assimilates among developing capsules, as reported by Alhassan *et al*. (2018).

Thousand seed weight (TSWT) showed weak and non-significant correlations with all seed oil traits, including crude protein (r = 0.22), fat (r = 0.03), carbohydrate (r = 0.07), crude fiber (r = 0.08), and ash content (r = 0.06). This indicates that seed size has minimal influence on oil and nutritional composition in sesame. The negative correlation with moisture content (r = −0.09) suggests that larger seeds tend to have lower moisture levels, which is beneficial for storage and oil extraction. Similar observations of independence between seed size and oil content have been reported by Johnson *et al*. (1979).

Dry seed weight (DSWT) showed positive but non-significant correlations with crude protein (r = 0.24), carbohydrate (r = 0.05), crude fiber (r = 0.07), and ash content (r = 0.05), while its correlation with percentage fat was very low (r = 0.02). These results indicate that increased seed yield does not necessarily translate into increased oil content. The negative correlation between dry seed weight and moisture content (r = −0.09) suggests that high-yielding genotypes tend to produce drier seeds, which enhances post-harvest quality. This agrees with reports that yield and oil concentration are often governed by different genetic mechanisms (Mahmoud & Ahmed, 2016).

Number of seeds per capsule (NSPC) exhibited a positive and significant correlation with percentage crude protein (r = 0.29*), indicating that increased seed number per capsule enhances protein accumulation. However, its association with percentage fat was weak (r = 0.15), suggesting minimal influence on oil accumulation. NSPC showed very weak correlations with carbohydrate (r = 0.04) and crude fiber (r = 0.04), and a negligible association with moisture content (r = 0.00). The weak negative correlation with ash content (r = −0.07) suggests a slight dilution of mineral content as seed number increases. These findings indicate that seed number per capsule can be improved without adversely affecting oil quality, as also reported by Sharma *et al*. (2014).

CONCLUSION

The study revealed considerable genetic variability existed among the genotypes under study and hence, there is ample scope for the selection of promising lines that could be used as parents in further crossing programmes. The positive correlations between agronomic traits like number of capsules, seeds per capsule, and seed weight with seed oil traits (especially fat and protein content) suggest the possibility of simultaneous selection for high yield and nutritional quality in sesame. Notably, number of capsules emerges as a particularly valuable trait due to its strong association with both yield and seed oil content. Traits such as number of capsules, plant height, and 1000 seed weight contributed significantly to PC1, making them ideal for yield-based selection. Fat and crude protein played significant roles in PC2 and PC3, indicating potential for quality-based improvement. Dry seed weight contributes indirectly through PC3 (12 %) while percentage moisture content through PC4 contributes 8 %.

Acknowledgment: The authors express profound gratitude to the late Professor Usman Alhassan, for his exceptional guidance, unwavering support, and invaluable mentorship throughout the course of this research. His profound expertise, constructive criticism, and constant encouragement were instrumental in shaping the quality and direction of the research work. May his soul rest in perfect peace.

REFERENCES

Abhijatha, A., Arya, K., Madhukar, K. and Srinivas, G. (2017). Evaluation of sesame (*Sesamum indicum* L.) genotypes under shaded uplands of the southern region. *International Journal of Current Microbiology and Applied Sciences*, 6(7), 332–339.

Abdi, H. and Williams, L. J. (2010). Principal component analysis. Wiley Interdisciplinary Reviews: *Computational Statistics*, 2(4), 433–459. https://doi.org/10.1002/wics.101/

Agrawal, M. M., Singh, S., Macwan, S., Sasidharan, N. and Wawge, M. N. (2018). Genetic variability studies in sesame (*Sesamum indicum* L.). *Agriculture and Environment*, 3(2), 80–86.

Alege, G. O. and Mustapha, O. T. (2020). Correlation and path coefficient analysis of yield and its components in sesame (*Sesamum indicum* L.). *African Journal of Agricultural Research*, 15(4), 512–519.

Alhassan, U., Anaso, A. B. and Ibrahim, A. (2018). Genetic variability, heritability and correlation analysis of yield and yield-related traits in sesame (*Sesamum indicum* L.). *Journal of Plant Breeding and Crop Science*, 10(8), 214–221.

Begum, T., Iqbal, A. and Dasgupta, T. (2017). Genetic variability and divergence among genotypes of sesame (*Sesamum indicum* L.). *Bangladesh Journal of Botany*, 46(3), 955–962.

Biswas, S., Natta, S., Ray, D. P., Mondal, P. and Saha, U. (2018). Til (*Sesamum indicum* L.) - An Underexploited but Promising Oilseed with Multifarious Applications: A Review. *Raw Materials Research and Development Council (RMRDC).* Survey Report of Ten Selected Agro Raw Materials in Nigeria Beniseed (Maiden Edition), 108p.

Burton, G. W. and DeVane, E. H. (1953). Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agronomy Journal*, 45(10), 478–481.

Cheung, S. C., Szeto, Y. T. and Benzie, I. F. F. (2007). Antioxidant protection of edible oils. Plant Foods for Human Nutrition, 62(1), 39–42.

Falconer, D. S. (1989). *Introduction to Quantitative Genetics* (3rd ed.). Longman. New York, NY, USA, 3rd edition.

Gidey, Y., Kebede, S. and Gashawbeza, G. T. (2012). Extent and pattern of genetic diversity for morpho-agronomic traits in Ethiopian sesame landraces (*Sesamum indicum* L.). *Asian Journal of Agricultural Research*, 6, 118–128.

Iqbal, A., Akhtar, R., Begum, T. and Dasgupta, T. (2016). Genetic estimates and diversity study in sesame (*Sesamum indicum* L.). *Journal of Agriculture and Veterinary Sci.*, 9, 2319–2372.

Johnson, H. W., Robinson, H. F. and Comstock, R. E. (1955). Estimates of genetic and environmental variability in soybeans. *Agronomy Journal*, 47, 314–318.

Johnson, L. A., Suleiman, T. M. and Lusas, E. W. (1979). Sesame protein: A review and prospectus. *Journal of the American Oil Chemists' Society,* 56, 463–468.

Jolliffe, I. T. (2002). Principal component analysis (2nd ed.). Springer. https://doi.org/10.1007/b98835

Mahmoud, M. W. and Ahmed, A. A. (2016). Relationship between agronomic traits and seed oil quality in sesame (*Sesamum indicum* L.). *Int. J. of Agricultural Sci. and Res.*, 6(3), 245–252.

Maiti, R., Satya, P., Rajkumar, D. and Ramaswamy, A. (2012). Crop plant anatomy (pp. 141–146). CABI.

Mensah, J. K., Obadoni, B. O., Eruotor, P. G. and Onome-Irieguna, F. (2009). Simulated flooding and drought effects on germination, growth and yield parameters of sesame (*Sesamum indicum* L.). *African J. of Biotech.*, 8(6), 1249–1253.

Obiajunwa, E. I., Adebiyi, F. M. and Omode, P. E. (2005). Determination of essential minerals, trace elements and fatty acid composition of sesame seeds. *Turkish Journal of Agriculture and Forestry*, 26(5), 269–274.

Pathak, N., Rai, A. K., Kumari, R. and Bhat, K. V. (2014). Value addition in sesame: A perspective on bioactive components for enhancing utility and profitability. *Pharmacognosy Reviews*, 8, 147–155.

Ramirez, R., Gutierrez, R. V. and Lizaso, J. I. (2005). Salt tolerance of sesame genotypes at germination, vegetative and maturity stages. *Communications in Soil Science and Plant Analysis*, 36(17), 2405–2419.

Sangwan, N. S., Farooqi, A. H. A., Shabih, F. and Sangwan, R. S. (2001). Regulation of essential oil production in plants. Plant Growth Regulation, 34, 3–21.

Sharma, R., Pathak, N. and Singh, R. (2014). Correlation and path analysis for yield and quality traits in sesame (*Sesamum indicum* L.). *Indian J. of Agricultural Res.*, 48(4), 291–295.

Ullah, R., Ayub, G., Ahmad, N. and Hassan, G. (2012). Genetic variability and heritability studies in sesame (*Sesamum indicum* L.). *Pakistan Journal of Agriculture Research*, 25(3), 189-193.

Weiss, E. A. (2000). *Oilseed Crops*. 2nd ed. Oxford (UK): Blackwell Science Ltd., 660p.