Plant Archives Vol. 25, No. 2, 2025 pp. 602-608 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.2.081

MORPHOLOGICAL CHARACTERIZATION AND HIERARCHICAL CLUSTER ANALYSIS OF SESAME (*SESAMUM INDICUM* L.) GENOTYPES USING DUS DESCRIPTORS

Ganesh Phatate, Akash Barela*, Shrishti Srivastava, Shama Parveen, Sudheer Kumar Pathak and Pramod Kumar Yadav

Department of Genetics and Plant Breeding, ITM University, Gwalior - 474 001 (M.P.), India.

*Corresponding author E-mail : akashbarelagpb@gmail.com

(Date of Receiving-16-06-2025; Date of Acceptance-25-08-2025)

ABSTRACT

Sesame (*Sesamum indicum* L.), also known as til, benniseed is an erect annual herb is regarded as the "Queen of oilseed crops" because of its great nutritional benefits while maintaining high oil content (40 to 63%). Distinctness, Uniformity, and Stability (DUS) characterization of 26 sesame genotypes including two check varieties were carried out at Crop Research Centre-1, ITM University, Sithouli, Gwalior, during *kharif*-2024. DUS descriptor was used to characterize sixteen morphological characters of sesame accessions. Frequency distribution showed that the majority of sesame accessions had top branching pattern (73.08%), deeply lobed leaf structure (76.92%), weak leaf serration of margin (76.92%), four locules per capsule (96.15%), sparse capsule hairiness (84.62%), one capsule per leaf axil (100%), alternate capsule arrangement (92.3%), medium capsule length (96.15%) and white seed coat colour (65.38%). A distance matrix heatmap showed that seed coat colour had the lowest morphological correlation with other traits, that includes branching pattern with leaf lobes (0.16), capsule arrangement with locule per capsule (0.16) and capsules per leaf axil (0.32), capsules per leaf axil with locule per capsule (0.24), petal colour with capsule hairiness (0.25), leaf serration of margin with capsule arrangement (0.34) showed high morphological correlation between themselves. The hierarchical cluster analysis performed to identify divergence among genotypes with 16 morphological traits resulted in the formation of two major groups. The first sub-group included 13 genotypes and second sub-group contains 10 genotypes. There are minor clusters one of them includes two genotypes, Rupa and SG-24-15. The other one is a solitary group having a single genotype, Govinda.

Key words : DUS characterization, Frequency distribution, Distance matrix heatmap, Hierarchical cluster analysis.

Introduction

Sesame (*Sesamum indicum* L.), one of the oldest oilseed crops, is an annual with a chromosomal number of 2n = 2X = 26, reported by Nayar and Mehra (1970). Sesame, a member of the family Pedaliaceae and order Tubiflorae as stated by Dossa *et al.* (2017); Jaiswal and Bisen (2021) sometimes referred to as til, simsim, benniseed and gingelly also regarded as the "Queen of oilseed crops" because of its great nutritional benefits and high oil content (40 to 63%). Sesame is an annual herb with hairy leaves and height range of 60 to 150 cm. The corolla is a tube and the flower blooms in late summer and early autumn (Wei *et al*., 2022). A top oilseed crop, sesame is planted all over the world alongside rapeseed, mustard, and groundnut. It thrives in regions between 500 and 800 meters above MSL and can reach up to 1250 MSL on well-drained, moderately fertile soils.

According to DA & FW, In India, cultivation spans 1,531.35 thousand hectares, yielding 847.11 thousand tonnes, with a productivity of 553 kg/ha for the 2023-24 period. It is an important *Kharif* crop majorly cultivated in West Bengal, Gujarat, Madhya Pradesh, Uttar Pradesh, Rajasthan and cultivated on some extent in Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra. India

cultivates a wide variety of sesame seeds, exhibiting colours ranging from white to gray, brown and black, reported by Zhang *et al.* (2013). In Madhya Pradesh sesame is cultivated across an area of 236 thousand hectares, with annual production of 122.48 thousand tonnes and productivity of 519 kg/ha. As for Gwalior district, sesame has been cultivated in 4.72 thousand hectares producing 2.2 thousand tonnes having productivity of 466 kg/ha, as reported by DA & FW.

To make farmers and seed growers assured that they are being given quality seed material, Government of India has introduced Protection of Plant Varieties and Farmers Rights (PPV&FR), according to this act new crop varieties will be released only if they follow four principles: novelty, distinctiveness, uniformity, stability reported by Vanishree *et al.* (2022). According to Vanishree *et al.* (2022); Kwon *et al.* (2005); Palakshappa *et al.* (2020), DUS test along with identifying novelty is considered to be the foundation of plant variety protection and also to identify a novel variety from reference collection. So, the purpose of this study was to characterize germplasm of sesame using DUS descriptors. Genetic variation among genotypes reflects differences in gene frequency.

Materials and Methods

A field experiment was conducted during the *kharif*-2024 to characterize morphological traits of sesame genotypes at Crop Research Centre-1, Department of Genetics and Plant Breeding, School of Agriculture, ITM University, Sithouli, Gwalior (M.P.). Crop Research Center-1 is located at 26.14º latitude and longitude of 78.19º, at northern part of Madhya Pradesh, having elevation of 197 meters above MSL, as mentioned in reports of Government of Madhya Pradesh Gwalior district climate. The soil of experimental site is sandy loam, red and light shallow soil with pH 5.5 and with an annual rainfall of 800-1000mm. Total 24 accessions of sesame were procured from Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur and the germplasm were evaluated by using randomized block design with three replications and two check varieties: Rupa (national check) and Govinda (local check). The experimental land was ploughed two times and then leveled. Each genotype was planted in a plot length of 4m and 2.4m width with row to row and plant to plant distance of 30 × 10cm. Supplementary irrigations were given for adequate supply of moisture.

As per the UPOV (International Union for the Protection of New Varieties of Plants) guidelines, the study on morphological characteristics of sesame was based on DUS characterization. Observations were recorded on sixteen essential morphological traits viz., plant main stem height, branching, branching pattern, stem hairiness, leaf lobes, leaf size, leaf serration of margin, locules per capsule, capsule hairiness, capsule shape, capsules per leaf axil, capsule arrangement, capsule length, flower colour, petal hairiness and seed coat colour. Frequency distribution for each trait was analysed.

Results and Discussion

Result of DUS aided morphological characterization is mentioned in the given below Table 1. Result showed wide range of variation along the characters, among 26 accessions of *Sesamum indicum.*

Plant characters

Main stem height is classified as short, medium and tall. Although there were 10 accessions (38.46%) showing medium height, majority of accessions, *i.e.* 16 (61.54%), showed short height of main stem.

Stem characters

Branching pattern is one of the most important components of the plant structure, which plays an important role in yield and cultivation practices of many crops, including sesame discovered by Bayder (2005); Teichmann and Muhr (2015). The variation in branching pattern can be easily detected in sesame varieties and germplasm accessions. In the present study, basal and top branching patterns were observed in 07 (26.92%) and 19 (73.08%) genotypes, respectively. Similar branching pattern were observed by Sala *et al.* (2023). Different sesame accessions can have a substantial impact on branching, with some exhibiting higher branching tendencies than others. In this study 06 accessions (23.07%) showed no branching, 11 accessions (42.31%) showed few branches (1 to 2 branches), 07 accessions (26.92%) showed medium branches (2-4) and 02 accessions (7.69%) showed profuse branching (More than 4).

Weiss (1983) suggested that hairiness is a beneficial character of sesame and can be observed on many parts of plant such as stem, leaf, corolla and capsules. Dense hairiness character contributes in defence mechanism against insect pests and diseases in sesame, given by Yol and Uzun (2011). Among the 26 accessions, 04 accessions (15.38%) showed dense stem hairiness, 13 accessions (50%) had sparse hairiness and in 09 genotypes (34.62%) hairiness was absent. Similar results were concluded from the study by Sala *et al.* (2023) and Gangishetti and Bisen (2021). Percentage proportion of character depicted in the Fig. 2.

Table 1 : Distribution of twenty-six genotypes based on sixteen DUS characters of sesame.

S. no.	Descriptor	Sub descriptor	Score	Frequency observed	Frequency in %
1	Main stem height	Short Medium Tall	3 5 7	16 10 00	61.54 38.46 00
2	Branching (Fig.2)	Absent Few Medium Profuse	1 3 5 7	06 11 07 02	23.07 42.31 26.92 7.69
3	Branching pattern (Fig. 2)	Basal Top	1 2	07 19	26.92 73.08
4	Stem hairiness (Fig. 2)	Absent Sparse Dense	1 3 5	09 13 04	34.62 50 15.38
5	Leaf size	Small Medium Large	3 5 7	12 14 00	46.15 53.85 00
6	Leaf serration of margin	Weak Strong	3 5	20 06	76.92 23.08
7	Leaf lobes	Slightly lobed Deeply lobed	1 2	06 20	23.08 76.92
8	Petal colour (Fig. 2)	White Light purple Dark purple	1 2 3	15 09 02	57.69 34.62 7.69
9	Petal hairiness	Absent Sparse Dense	1 3 5	00 14 12	00 53.85 46.15
10	Capsule length	Short Medium Long	3 5 7	00 25 01	00 96.15 3.85
11	Capsule shape (Fig. 2)	Tapered Narrow oblong Broad oblong Square	1 2 3 4	00 10 16 00	00 38.46 61.54 00
12	Capsule hairiness	Absent Sparse Dense	1 3 5	00 22 04	00 84.62 15.38
13	Capsules per leaf axil	One More than one	19	2600	10000
14	Capsule arrangement	Alternate Opposite Cluster	123 2 3	24 01 01	92.30 3.85 3.85
15	Locules per capsule	Four Six Eight	3 5 7	25 00 01	96.15 00 3.85
16	Seed coat colour (Fig. 2)	White Grey Light brown Dark brown Black	1 2 3 4 5	17 00 01 02 06	65.38 00 3.85 7.69 23.08

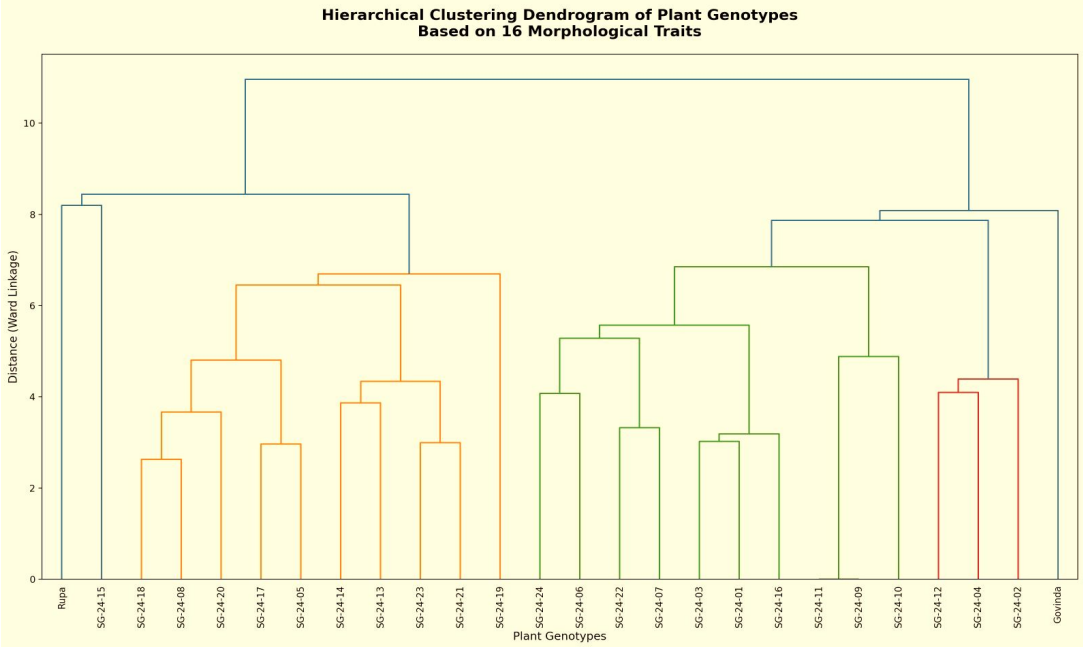

Fig. 1 : Dendrogram showing relationship among sesame genotypes based on different morphological traits.

Leaf characters

Mesera and Mitiku (2015) explored that sesame leaves exhibit significant variability as lower leaves are often broader and may be trilobed, while the upper leaves tend to be narrower and more lanceolate. Leaf size ranges from small, medium to large. Based on readings, 12 accessions (46.15%) observed to have small leaf size and remaining 14 (53.85%) have medium leaf. Leaf size can also be influenced by factors like cultivar and environmental conditions.

Sesame leaves can be either simple or compound. Lower leaves are often lobed, while upper leaves are typically entire. They are divided into slightly lobed and deeply lobed leaves. Characterisation of leaf lobes revealed that 6 accessions (23.08%) observed to have slightly lobed and 20 accessions (76.92%) have deeply lobed structures on lower leaves (Fig. 5).

Sesame leaf serration, is a significant morphological trait used for characterization and identification of sesame genotypes. While serration on sesame leaf margin can be weak or strong. About 20 accessions (76.92%) showed weak leaf serration and remaining 6 accessions (23.08%) showed strong leaf serration. A study conducted by Bhoot *et al.* (2019) concluded similar results (Fig. 5).

Flower characteristics

Sesame has zygomorphic flowers with pendulous tubular corolla that is 3 to 4 mm long. It commonly has petals of white, pink or purple shades, as seen in the study by Andrade *et al.* (2014). For the petal colour most of the accessions *i.e.* 15 accessions (57.69%) were observed to have white petal colour and 09 accessions (34.62%) have light purple petal colour and at last, dark purple petal colouration showed by 02 accessions (7.69%) (Fig. 6). The petal colour is determined through inhibition of anthocyanin pigmentation, as reported by Zhao *et al.* (2025).

In sesame plants, petal hairiness refers to the presence and density of hairs on the corolla of the flower. Hairiness can be classified as absent, sparse or dense. Among all accessions, 14 (53.85%) observed to be densely haired whereas, 12 (46.15 %) possessed sparse hairiness (Fig. 2) shown in Fig. 4 (C) and (D).

Capsule characteristics

Sesame plants produce capsules as their fruit. Capsules exhibit different shapes like tapered, narrow oblong, broad oblong, square. Based on variation in capsule shape, 16 accessions (61.54%) classified as broad oblong and 10 accessions (38.46%) as narrow oblong (Fig. 2).

Capsule length is a crucial character which directly influences yield. Capsule length is categorised in three different groups *i.e.* short, medium and long. Characterization shows that capsule length of 25 accessions (96.15%) differentiated as medium. Meanwhile, 01 accession (3.85%) shows long capsule length. In sesame plants, capsule hairiness is controlled by a single dominant gene, meaning plants with hairiness will express the trait. In capsule hairiness, 22 accessions (84.62%) showed sparse hairiness while, 04 accessions (15.38%) showed dense hairiness. This trait is linked to both seed yield and a natural defence mechanism against

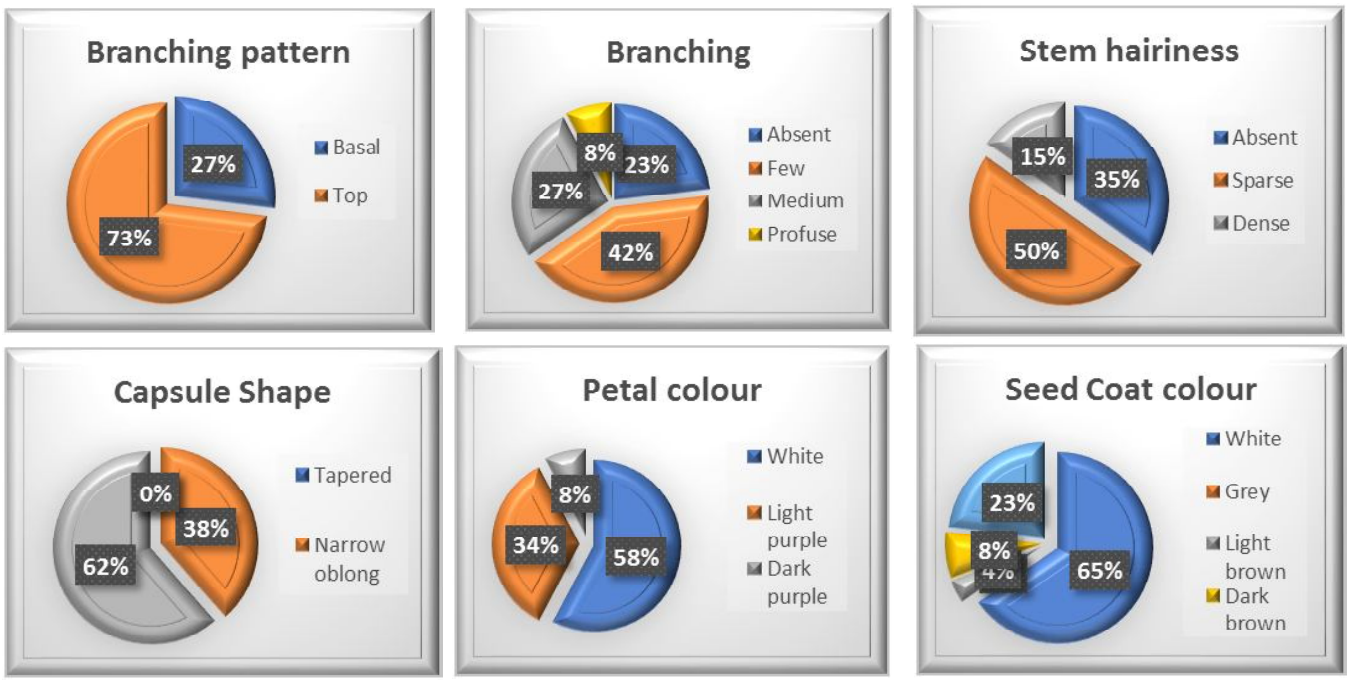

Fig. 2 : Frequency distribution pie chart for different morphological traits.

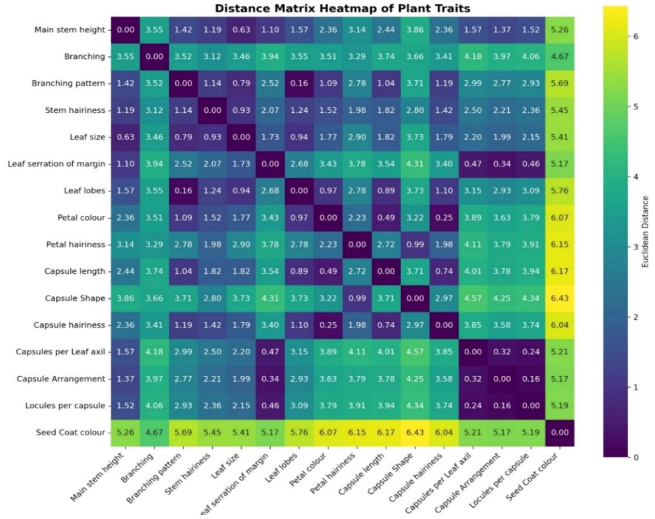

Fig. 3 : Distance matrix heatmap analysis of Sesame.

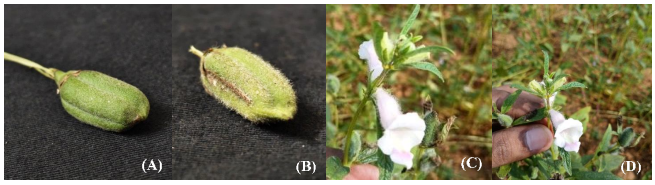

Fig. 4 : Variation in capsule and petal hairiness. **(A)** Sparse capsule hairiness **(B)** dense capsule hairiness **(C)** dense petal hairiness **(D)** sparse petal hairiness.

pests and diseases (Fig. 4).

In sesame plants, the number of capsules per leaf axil is a heritable trait, and it can range from one to three. Generally, sesame plants are known for having one capsules per leaf axil, but very few varieties exhibit multiple capsules per axil. In number of capsules per leaf axil, all accessions *i.e.* 26 accessions (100%) show one capsules per leaf axil and none showed differential observations. In sesame, capsule arrangement refers to how capsules are positioned on the plant. There are three types of capsule arrangement, they are alternate, opposite and cluster. Characterization shows that 24 accessions (92.30%) observed to be having alternate arrangement, 01 accession (3.85%) observed to have opposite arrangement of capsules and 01 accession (3.85%) showed cluster arrangement of capsule.

Sesame capsules typically have four locules. While some accessions may have six or eight locules, four is the most common and preferred in breeding due to the higher fertility of seeds produced within the locules. For this trait, 25 accessions (96.15%) showed four locules per capsule and only 01 accession (3.85%) showed eight locules per capsule. Similar findings based on capsule morphological characters were observed in study conducted by Singh *et al.* (2017).

Seed characteristics

Sesame seeds exhibit a range of seed coat colours, including white, black and various shades of brown and yellow, which are determined by the accumulation of pigments like chlorophyll, carotenoids and phenolic compounds. Wide range of variation is seen in seed coat colour trait (Fig. 7) as 17 accessions (65.38%) observed to have white seed coat colour, while 01 (3.85%), 02 (7.69%), 06 (23.08%) accessions were of light brown, dark brown and black seed coat colour respectively (Fig. 2). Similar results were observed in study by Singh *et al.*

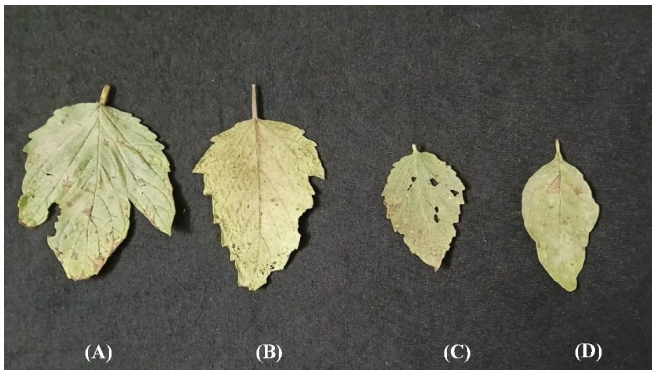

Fig. 5 : Variation in Leaf lobes and leaf serration. **(A)** Deeply lobed leaf **(B)** Strong leaf serration **(C)** Weak leaf serration **(D)** Entire leaf.

Fig. 6 : Variation in petal colour. **(A)** White petal colour **(B)** Light purple petal colour **(C)** Dark purple petal colour.

(2017).

Hierarchical Cluster analysis of Dendrogram

Cluster analysis shows 16 morphological traits of 26 Sesame genotypes structured into two major groups. Major cluster is subdivided into two groups with 14 and 12 genotypes, respectively. First sub-group was further divided into two parts. Major cluster contained 13 genotypes, namely SG-24-24, SG-24-06, SG-24-22, SG-24-07, SG-24-03, SG-24-01, SG-24-16, SG-24-11, SG-24-09, SG-24-10, SG-24-12, SG-24-04, SG-24-02. In the major cluster all 13 genotypes exhibit similarity in some traits, medium capsule length, one capsule per leaf axil, four locules per capsule, white seed coat colour and minor cluster remain solitary. Likewise, second sub-group was further sub-divided into two parts and major part include10 genotypes that are SG-24-18, SG-24-08, SG-24-20, SG-24-17, SG-24-05, SG-24-14, SG-24-13, SG-24-23, SG-24-21 and SG-24-19. Second sub-group consist of some traits that shows similarity in appearance, top branching pattern, medium capsule length, sparse capsule hairiness, one capsule per leaf axil, alternate capsule arrangement, four locules per capsule. While a minor cluster, had two genotypes Rupa and SG-24-15 (Fig. 1).

Distance matrix heatmap analysis

A distance matrix heatmap is a graphical representation of a matrix showing the correlation between different traits. Lowest Euclidean values

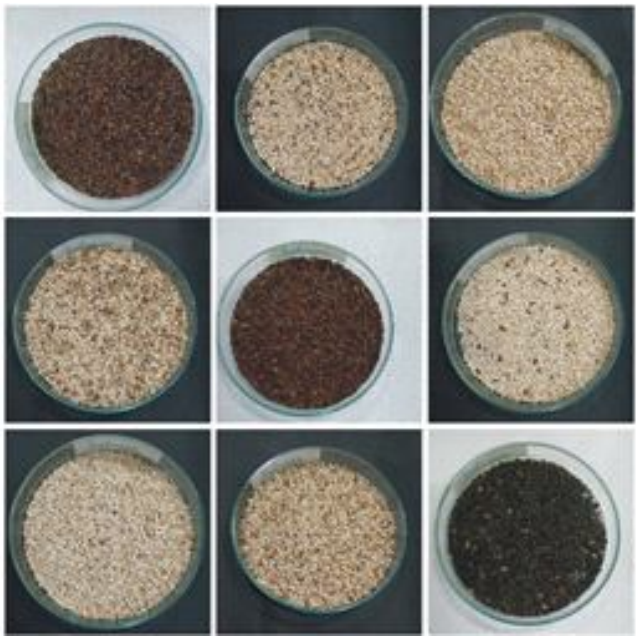

Fig. 7 : Variation in seed coat colour.

conclude highest morphological correlation which is represented by darker colour and vice versa (Fig. 3). Seed coat colour shows lowest morphological correlation with most of the morphological traits, as it has large Euclidean distance with all the other traits. The high Euclidean distance values were observed in capsule shape (6.43), capsule length (6.17), petal hairiness (6.15), petal colour (6.07) and capsule hairiness (6.04). As Euclidean distance shows lower value, it represents more morphological correlation between those traits. Capsules per leaf axil has low morphological correlation with capsule shape (4.57), branching (4.18), petal hairiness (4.11). Capsules per leaf axil show highest morphological correlation with locules per capsule (0.24), capsule arrangement (0.32) and leaf serration of margin (0.47). Some traits show high morphological correlation between themselves, they are branching pattern with leaf lobes (0.16), capsule arrangement with locule per capsule (0.16) and capsules per leaf axil (0.32), capsules per leaf axil with locule per capsule (0.24), petal colour with capsule hairiness (0.25), leaf serration of margin with capsule arrangement (0.34).

Conclusion

Queen of Oilseed (Jaiswal and Bisen, 2021) *i.e.* sesame is one of the oldest annual crops. Morphological description of sesame using DUS description guidelines helps in identifying variability among accessions and selection of genotypes based on specific required trait. Among sixteen morphological trait most varying trait is seed coat colour and lowest varying trait is capsules per leaf axil. Cluster analysis of 26 sesame genotypes reveals

the traits which are similar and grouped it into two categories (*i.e.*, Baydar, 2005; Sala *et al*., 2023). Heat map helps in depicting how different characters respond to varying conditions and helps in interpretation of influence of one trait on other. Distance matrix heatmap shows high Euclidean distance values for capsule shape, capsule length, petal hairiness, petal colour and capsule hairiness Therefore, in 26 sesame genotypes there was considerable level of variability. Genetic variability among genotypes plays significant role in adapting to new environment, to develop new varieties and forms the basis of selection.

Acknowledgement

The authors would like to convey their appreciation to guide and the members of research committee for providing the material needed for research and helping throughout the experiment.

References

Andrade, P.B.D., Freitas B.M., Rocha E.E.D.M., Lima J.A.D. and Rufino L.L. (2014). Biologia floral e exigências de polinização do gergelim (*Sesamum indicum* L.). *Acta Scientiarum. Animal Sciences*, **36**, 93-99. https://doi.org/10.4025/actascianimsci.v36i1.21838

Baydar, Hasan (2005). Breeding for the improvement of the ideal plant type of sesame. *Plant Breeding*, **124(3)**, 263-267. https://doi.org/10.1111/j.1439-0523.2005.01080.x

Bhoot, H.V., Sharma L.K., Kulkarni G.U., Ravat U. and Rathva S. (2019). Characterization of sesame genotypes through morphological characters. *J. Pharmacog. Phytochem.*, **8(3)**, 3132-3138.

DA&FW (2024). Department of Agriculture & Farmers Welfare. *Sesamum 2023-24*. Retrieved from: https://upag.gov.in/dashboard/apy-insights-cropwise-tab

Dossa, K., Diouf D., Wang L., Wei X., Zhang Y., Niang M. and Cisse N. (2017). The emerging oilseed crop *Sesamum indicum* enters the "Omics" era. *Front. Plant Sci.*, **8**, 1154. https://doi.org/10.3389/fpls.2017.01154

Gangishetti, R. and Bisen R. (2021). Morphological characterization of sesame (*Sesamum indicum* L.). *Biolog. Forum–An Int. J.*, **13(4)**, 758-764.

Government of Madhya Pradesh Gwalior district Climate https://gwalior.nic.in/en/climate/#:~:text=It%20is%20at%20an%20average,usually%20continues%20till%20mid%2DSeptember.

International Union for the Protection of New Varieties of Plants (UPOV) Retrieved from: https://www.upov.int/#:~:text=The%20International%20Union%20for%20the,of%20New%20Varieties%20of%20Plants.

Jaiswal, A. and Bisen R. (2021). Estimation of Correlation and Path Analysis between Seed Yield and Various Quantitative Traits in Black Sesame (*Sesamum indicum* L.). *Int. J. Curr. Microbiol. Appl. Sci.*, **10(01)**, 893-901. https://doi.org/10.20546/ijcmas.2021.1001.107

Kwon, Y.S., Lee J.M., Yi G.B., Yi S.I., Kim K.M., Soh E.H. and Kim B.D. (2005). Use of SSR markers to complement tests of distinctiveness, uniformity and stability (DUS) of pepper (*Capsicum annuum* L.) varieties. *Molecules and Cells*, **19(3)**, 428-435. https://doi.org/10.1016/S1016-8478(23)13189-X

Mesera, T. and Mitiku M. (2015). Performance evaluation of sesame (*Sesamum indicum* L.) varieties in lowland area of South Omo zone, SNNPR, Ethiopia. *Int. J. Agric. Sci.*, **7(2)**, 434-439.

Nayar, N.M. and Mehra K.L. (1970). Sesame: Its uses, botany, cytogenetics and origin. *Economic Botany*, 20-31.

Palakshappa, M.G., Banu H., Parmeshwarappa S.G., Bisen R., Nagappa H. and Holeyannavar P. (2020). DUS testing of sesame (*Sesamum indicum* L.) accessions using morphological descriptors and evaluation for foliar diseases of sesame. *Int J Curr Microbiol App Sci.*, **9(1)**, 1837-1852. https://doi.org/10.20546/ijcmas.2020.901.206

Sala, M., Divyadarshini V.B., Sridevi R., Cholan J.R.R., Yaseen S.M. and Harish N. (2023). Morphological characterization of Sesame (*Sesamum indicum* L.) Genotypes with DUS. *Int. J. Plant Soil Sci.*, **35(18)**, 1044-1051. https://doi.org/10.9734/ijpss/2023/v35i183369

Singh, B., Bisen R. and Tiwari A. (2017). DUS testing of sesame (*Sesamum indicum* L.) varieties using morphological descriptors. *Bull Environ Pharmacol Life Sci.*, **6(1)**, 05-12.

Teichmann, T. and Muhr M. (2015). Shaping plant architecture. *Front. Plant Sci.*, **6**, 233. https://doi.org/10.3389/fpls.2015.00233

Vanishree, S.G., Parmeshwarappa H., Banu H., Palakshappa M.G. and Holeyannavar P. (2022). Morphological characterization of sesame (*Sesamum indicum* L.) germplasm accessions with DUS descriptors. *Pharma Innovation*, **11(12)**, 938-945.

Wei, P., Zhao F., Wang Z., Wang Q., Chai X., Hou G. and Meng Q. (2022). Sesame (*Sesamum indicum* L.): A comprehensive review of nutritional value, phytochemical composition, health benefits, development of food and industrial applications. *Nutrients*, **14(19)**, 4079. https://doi.org/10.3390/nu14194079

Weiss, E.A. (1983). Oilseed crops, x+ 660 pp. *London and New York*.

Yol, E. and Uzun B. (2011). Inheritance of number of capsules per leaf axil and hairiness on stem, leaf and capsule of sesame (*Sesamum indicum* L.). *Aust. J. Crop Sci.*, **5(1)**, 78-81.

Zhang, H., Miao H., Wei L., Li C., Zhao R. and Wang C. (2013). Genetic analysis and QTL mapping of seed coat color in sesame (*Sesamum indicum* L.). *PloS One*, **8(5)**, e63898. https://doi.org/10.1371/journal.pone.0063898.t001

Zhao, F., Cui C., Wei W., Du Z., Wu K., Jiang X. and Zhang H. (2025). The candidate gene SibHLHA regulates anthocyanin-driven purple pigmentation in *Sesamum indicum* flowers. *Theoret. Appl. Gen.*, **138(2)**, 40.