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Morphological characterization of sesame (*Sesamum indicum* L.) germplasm accessions with DUS descriptors

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Abstract
The aim of the present study was to characterize 457 germplasm accessions of sesame (*Sesamum indicum* L.) based on the DUS morphological descriptors. The experiment was conducted in augmented Design without replications at AICRP on Sesame and Niger, MARS, UAS, Dharwad during Summer 2017. On the basis of DUS descriptors, sesame accessions were characterized for eighteen morphological traits**.** Maximum amount of variation was observed for most of the traits studied. On the basis of frequency distribution, majority of sesame accessions were found to possess determinate plant growth type (56.9%), erect plant growth habit (49.5%), sparse stem hairiness (61.9%), basal branching pattern (53.6%), weak leaf hairiness (42.2%), entire basal leaf margin (43.3%), no lobe incision of basal leaf (38.9%), one flower per leaf axil (58.6%), sparse corolla hairiness (45.3%), white exterior corolla colour (40.0%) and white interior corolla colour (43.5%), four locules per capsule (96.9%), narrow oblong bicarpellate capsule shape (44.0%), monocapsular capsule arrangement (90.6%), weak capsule hairiness (53.4%), brown/tan colour of dry capsule (61.9%), long capsule beak (30.9%) and beige seed coat colour (22.1%). Present study revealed the distinctness in characteristics among sesame accessions.

Keywords: DUS characterization, sesame, accessions, morphological variation

Introduction
Sesamum (*Sesamum indicum* L.) is the oldest oilseed known and used by human being. It is grown as a rainfed crop in the tropics and warm subtropics, where it is usually grown in small plots. Sesamum is described as the "Queen of oilseeds" because it contains high oil (38-54%), protein (18-25%), calcium, phosphorous, oxalic acid and excellent qualities of seed oil and meal (Prasad, 2002)[7]. Sesamum seed oil has long shelf life due to the presence of lignans (Sesamin, Sesaminol, Sesamolinol), which have remarkable antioxidant function, resisting the oxidation.

In India, it is grown in 1722.67 thousand hectares area with production of 816.81 thousand tonnes and productivity of 474 kg/ha during 2020-21. It is an important *Kharif* crop mainly cultivated in Madhya Pradesh, Rajasthan, Uttar Pradesh, West Bengal, Gujarat, Andhra Pradesh, Tamilnadu, Karnataka and Maharashtra. India produces a large variety of sesame seeds varying in colour from white to red, brown and black. In Karnataka sesame is cultivated in an area of 22.00 thousand hectares and annual production of 20.26 thousand tonnes with a productivity of 921 kg/ha.

With the introduction of Indian legislation on "Protection of Plant Varieties and Farmers Rights (PPV&FR)", the release of new crop varieties is possible if it is distinct from other varieties, uniform in their characteristics and generally stable over the years. DUS test is considered to be the foundation of plant variety protection and also to identify a new variety from reference collection (Kwon *et al.*, 2005) [4]. Thus, there is a need to search for rapid and reliable methods of varietal identification and genetic purity testing of seed. Identification of varieties based on morphological characteristics of seed, seedling and plant is the most widely used method. According to International Union for Protection of New Plant Varieties (UPOV), any new characteristic used in varietal characterization should be clearly defined, accepted and should have standard method of observation, least or not affected by environment, accessible to breeders, associated with reasonable costs and efforts. For identification of varieties/genotypes through morphological characters the plant and seed characters need to be studied and thoroughly documented. Such characterization studies are lacking in Sesamum.

Therefore, the present study was undertaken to characterize the germplasm accessions of sesame using DUS descriptors.

Materials and Methods

Four hundred and fifty seven accessions of Sesame procured from PC unit, Jabalpur along with three check varieties *viz.*, GT-10, TKG-22 as national check and DS-5 as local check were evaluated in unreplicated augmented block design at All India Co-ordinated Research Project on Sesame and Network on Niger, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka during *Summer* 2017. Each genotype was sown in a row of 4 m length with spacing of 30 × 15 cm. All the recommended crop production practices were followed to raise healthy crop. The basal dose of 25:25:25 NPK Kg/ha was applied at the time of sowing and remaining 25 kg of nitrogen was applied 30 days after sowing as top dressing. Protective irrigations were provided whenever necessary. Necessary plant protection measures were taken to control pest and disease.

DUS characterization was done as per the guidelines developed by IPGRI Rome, Italy and NBPGR New Delhi, India. Observations were recorded on eighteen essential morphological traits *viz*., plant growth type, plant growth habit, stem hairiness, branching pattern, leaf hairiness, basal leaf margin, lobe incision of basal leaf, number of flowers per leaf axil, corolla hairiness, exterior corolla colour and interior corolla colour, number of locules per capsule, bicarpellate capsule shape, capsule arrangement, capsule hairiness, colour of dry capsule (Sun dried), type of capsule beak and seed coat colour. Frequency distribution for each qualitative trait was analyzed.

Results and Discussion

The result of characterization for each qualitative trait is presented in the Table 1. Results revealed wide range of variation among the four hundred and fifty seven germplasm accessions for almost all the qualitative traits studied.

Plant characters

For plant growth type, the accessions were classified into determinate and indeterminate. Majority of accessions were of determinate type (260 accessions). Similar results reported by Palakshappa *et al.* (2020) [6]. In case of plant growth habit higher frequency of erect type (226 accessions) was observed.

Stem characters

Hairiness is the important character for providing high seed yield and natural defense mechanism for some biotic and abiotic factors. Therefore, this character could be considered as a part of ideal plant type. Among the 457 accessions, 100 genotypes showed dense stem hairiness, 283 genotypes had sparse hairiness and 74 genotypes lacked hairiness. In the present study, basal and top branching patterns were observed in 245 and 93 genotypes respectively. Previous studies have indicated that the inheritance of branching habit was determined by one single dominant gene (Sarita *et al.*, 2013) [8]. However, the genetic basis of them has remained elusive.

Leaf characters

The genotypes varied among themselves for leaf hairiness. Among 457 accessions, 33 accessions showed glabrous leaf hairiness, 193 accessions had sparse hairiness, 147 accessions had medium hairiness and 84 genotypes were categorized under the category of profuse stem hairiness. According to Liang (2006) [5] as reported in poaceae family bristles or pubescence containing silica can significantly enhance insect pest resistance in plants with consequent yield increases. Most of accessions exhibited entire type (198 accessions) followed by dentate type basal leaf margin (189 accessions) and serrate leaf margin (70 accessions). Suhasini (2006) [9]. and Palakshappa *et al*. (2020) [6] observed the similar results in sesame. On the basis of lobe incision of basal leaf, majority of accessions (178 accessions) lacked lobe incision while only 39 accessions had strong lobe incision.

Inflorescence characters

For the trait number of flowers per leaf axil, 189 accessions had more than one flower per leaf axil and remaining 268 accessions showed one flower per leaf axil. Based on the variation in the Corolla hairiness, the accessions were grouped into three categories namely absent (70 accessions), sparse (207 accessions) and dense (180 accessions). The corolla colour of the flower is one of the important characters for characterization. Regarding exterior and interior corolla colour, the accessions varied among themselves but majority of accessions exhibited white colour (192 and 199 accessions respectively) followed by pink colour (97 and 88 accessions respectively). This observation in sesame is in accordance with Suhasini (2006)[9], Bhagwat Singh *et al.* (2017) [2] and Palakshappa *et al*. (2020) [6]. The genes determine the colour of the petal by developing or blocking of anthocyanin pigmentation.

Capsule characters

Based on locule number per capsule, 443 accessions were categorized under four locular, 10 accessions were of six locules and four accessions were of eight locules. Among the 457 accessions, 201 accessions showed narrow oblong capsules while 160 accessions were of square shaped capsules, 84 accessions were of broad oblong capsules and 12 accessions had tapered capsules. On the basis of capsule hairiness accessions were categorized as glabrous (87 accessions), weak (244 accessions), medium (115 accessions) and strong (11 accessions). For the trait capsules arrangement, majority (414 accessions) showed monocapsular arrangement. Among 457 accessions, 283 accessions had brown/tan coloured capsules, 151 accessions showed Straw/yellow capsules and 23 accessions had green capsules. For type of capsule beak, the accessions were classified as short (144 accessions), long (121 accessions), curved (96 accessions) and cleft (96 accessions). Bhagwat Singh *et al.* (2017) [2] and Palakshappa *et al*. (2020) [6] observed similar results for capsule characters in sesame.

Seed characters

In case of seed coat colour, accessions were grouped as biege seeded (101 accessions), dark brown (92 accessions), light brown (73 accessions), medium brown (66 accessions), cream (56 accessions), dull black (36 accessions), dark black (31 accessions), white (one accession) and tan seed coat colour (one accessions). In present study wide range of variation was observed for seed coat colour against the reported white, brown and black. All earlier researchers in sesame outlined seed coat colour to be under digenic control with several confusing segregants beyond plausible explanation [Baydar and Turgut (2000) [1], and Falusi (2007) [3]]. Zhang *et al.*

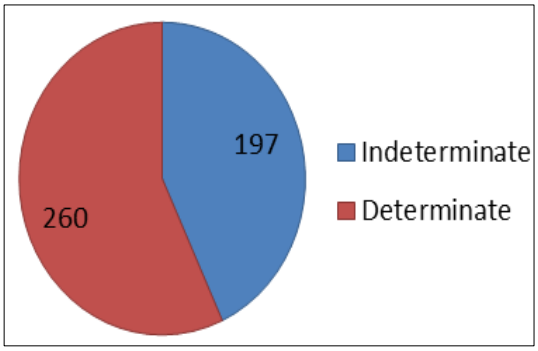
(2013) [10] using a high-density linkage map analyzed the genetic segregation and quantitative trait loci (QTL) for sesame seed coat colour and showed that two major genes with additive dominant-epistatic effects along with polygenes were responsible for controlling the seed coat colour trait. The highest polymorphism was observed for seed coat colour ranging from white to black through all intermediate colours.

Frequency distribution for 18 morphological traits is graphically represented in fig 1a, 1b and 1b. Majority of sesame accessions were found to possess determinate plant growth type (56.9%), erect plant growth habit (49.5%), sparse stem hairiness (61.9%), basal branching pattern (53.6%), weak leaf hairiness (42.2%), entire basal leaf margin (43.3%), no lobe incision of basal leaf (38.9%), one flower per leaf axil (58.6%), sparse corolla hairiness (45.3%), white exterior corolla colour (40.0%) and white interior corolla colour (43.5%), four locules per capsule (96.9%), narrow oblong bicarpellate capsule shape (44.0%), monocapsular capsule arrangement (90.6%), weak capsule hairiness (53.4%), brown/tan colour of dry capsule (61.9%), long capsule beak (30.9%) and beige seed coat colour (22.1%). Present study revealed the distinctness among the sesame accessions for morphological characteristics studied and morphological variations exist in these lines due to variation in genetic makeup. This is highly useful study for genotype identification.

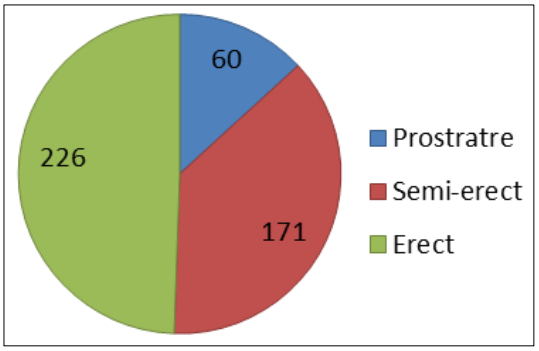
Table 1: Morphological characterization of 457 sesame germplasm accessions

Sl. No.	Descriptor	Sub descriptor	Score	Frequency observed	Frequency in %
Plant characters					
1	Plant growth type	Indeterminate	1	197	43.1
		Determinate	2	260	56.9
2	Plant growth habit	Prostate	1	60	13.1
		Semi-erect	2	171	37.4
		Erect	3	226	49.5
Stem characters					
3	Stem hairiness	Absent	1	74	16.2
		Sparse	3	283	61.9
		Dense	5	100	21.9
4	Branching pattern	Non branching	0	119	26.0
		Basal branching	1	245	53.6
		Top branching	2	93	20.4
		Other	3	0	0.0
Leaf characters					
5	Leaf hairiness	Glabrous	0	33	7.2
		Weak/sparse	3	193	42.2
		Medium	5	147	32.2
		Strong/ Profuse	7	84	18.4
6	Basal Leaf margin	Entire	1	198	43.3
		Serrate	2	189	41.4
		Dentate	3	70	15.3
7	Lobe incision of basal leaf	Absent	0	178	38.9
		Weak	3	146	31.9
		Medium	5	94	20.6
		Strong (3 or more lobes)	7	39	8.5
Inflorescence characters					
8	No. of flowers per leaf axil	One	1	268	58.6
		More than one	2	189	41.4
9	Corolla hairiness	Absent	1	70	15.3
		Sparse	3	207	45.3
		Dense	5	180	39.4
10	Exterior corolla colour	White	1	192	42.0
		White with pink shading	2	70	15.3
		White with deep pink shading	3	22	4.8
		Pink	4	97	21.2
		Light violet	5	15	3.3
		Dark violet	6	29	6.3
		Purple	7	32	7.0
		Red	8	0	0.0
		Light maroon	9	0	0.0
		Other	99	0	0.0
11	Interior corolla colour	White	1	199	43.5
		White with pink shading	2	75	16.4
		White with deep pink shading	3	46	10.1
		Pink	4	88	19.3
		Light violet	5	16	3.5
		Dark violet	6	26	5.7
		Purple	7	7	1.5
		Red	8	0	0.0
		Light maroon	9	0	0.0

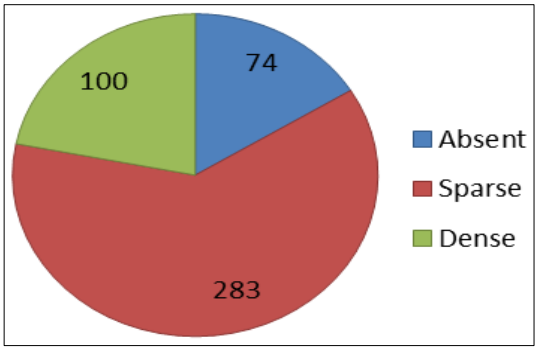
		Other	99	0	0.0
Capsule characters					
12	No. of locules per capsule	Four	1	443	96.9
		Six	2	10	2.2
		Eight	3	4	0.9
		Mixed	4	0	0.0
13	Bicarpellate capsule shape	Tapered at apex	1	12	2.6
		Narrow oblong	2	201	44.0
		Broad oblong	3	84	18.4
		Square	4	160	35.0
14	Capsule arrangement	Monocapsular	1	414	90.6
		Multicapsular	2	43	9.4
15	Capsule hairiness	Glabrous (hair absent)	0	87	19.0
		Weak/sparse	3	244	53.4
		Medium	5	115	25.2
		Strong/profuse	7	11	2.4
16	Colour of dry Capsule (Sun dried)	Green	1	23	5.0
		Straw/yellow	2	151	33.0
		Brown/tan	3	283	61.9
		Purple	4	0	0.0
17	Type of capsule beak	Short	1	124	27.1
		Long	2	141	30.9
		Curved	3	96	21.0
		Cleft	4	96	21.0
		Other	99	0	0.0
Seed characters					
18	Seed coat colour	White	1	1	0.2
		Cream	2	56	12.3
		Beige	3	101	22.1
		Light brown	4	92	20.1
		Medium brown	5	66	14.4
		Dark brown	6	73	16.0
		Brick red	7	0	0.0
		Tan	8	1	0.2
		Olive	9	0	0.0
		Grey	10	0	0.0
		Dull black	11	36	7.9
		Bright black	12	31	6.8
		Other	99	0	0.0



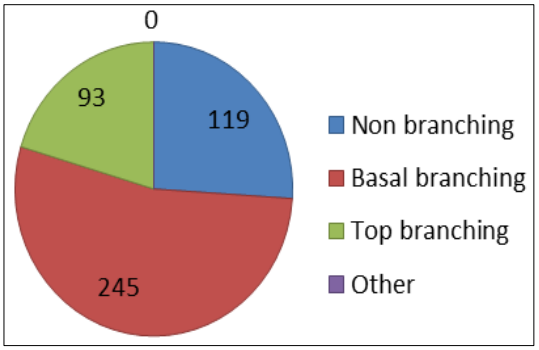
Plant growth type



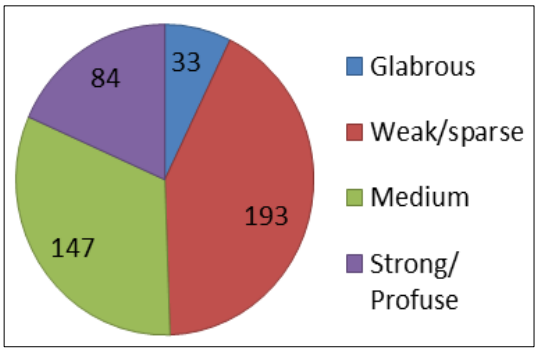
Plant growth habit



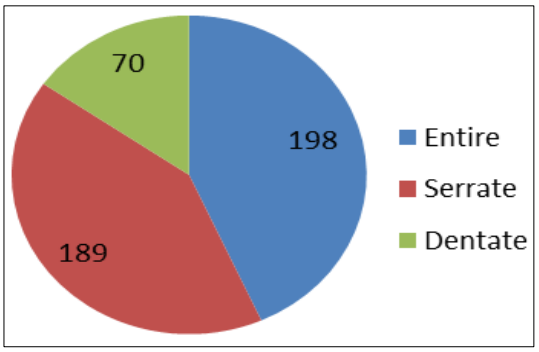
Stem hairiness



Branching pattern

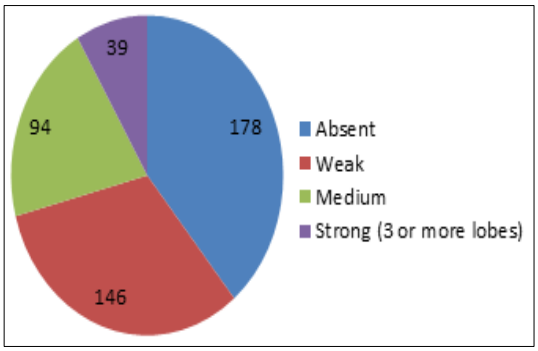


Leaf hairiness

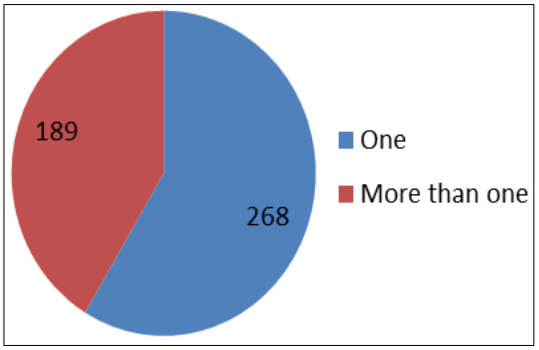


Basal Leaf margin

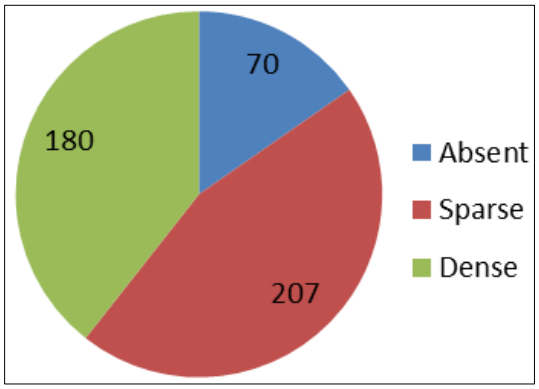
Fig 1a: Frequency distribution of different morphological traits in Sesame



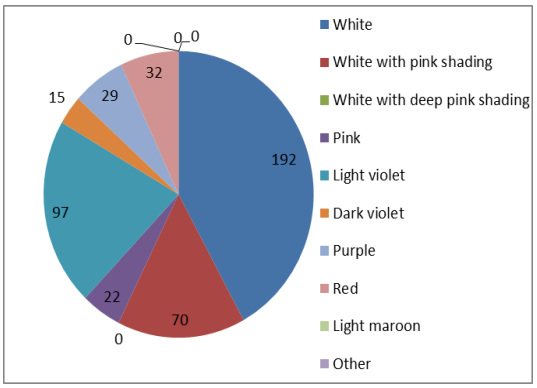
Lobe incision of basal leaf



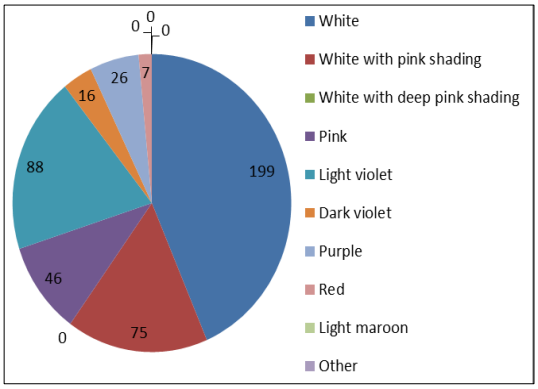
No. of flowers per leaf axil



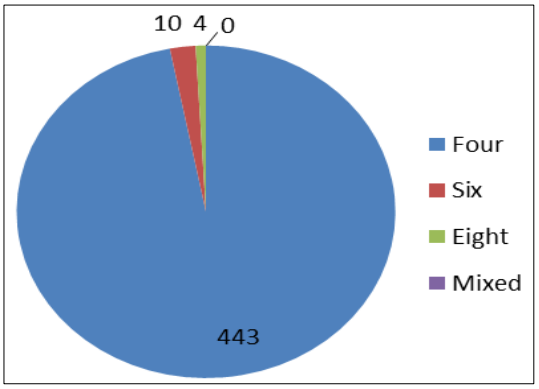
Corolla hairiness



Exterior corolla colour

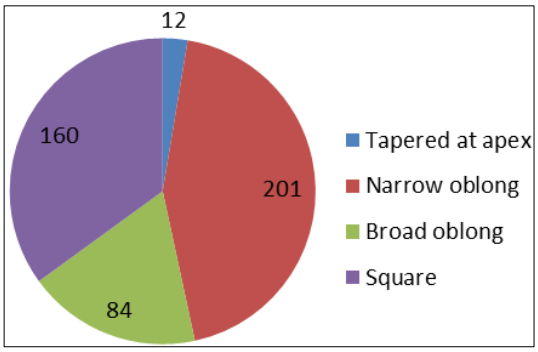


Interior corolla colour

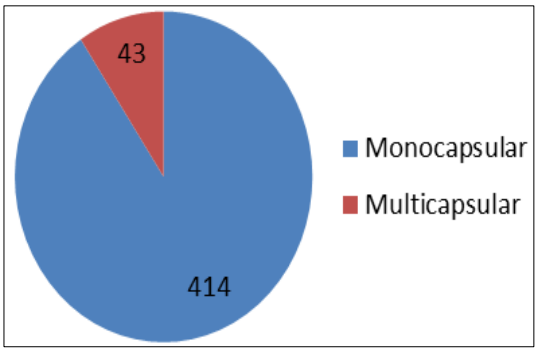


No. of locules per capsule

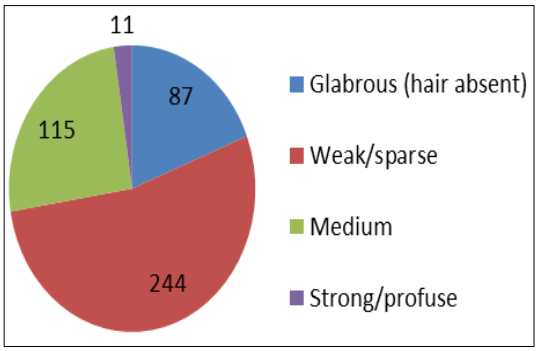
Fig 1b: Frequency distribution of different morphological traits in Sesame



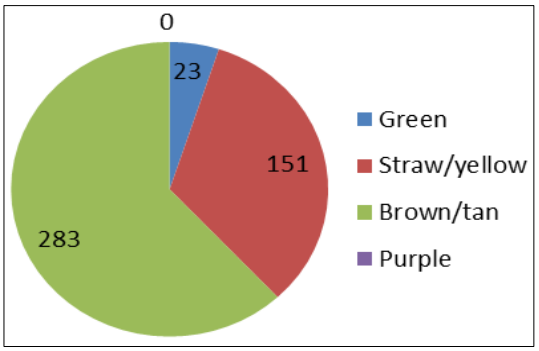
Bicarpellate capsule shape



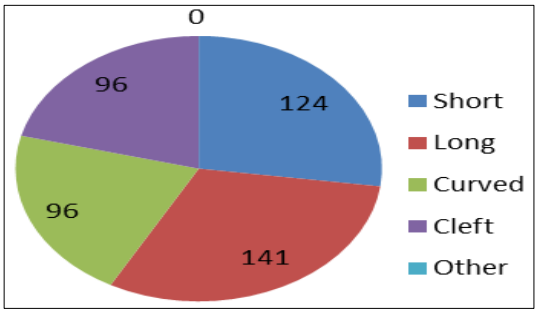
Capsule arrangement



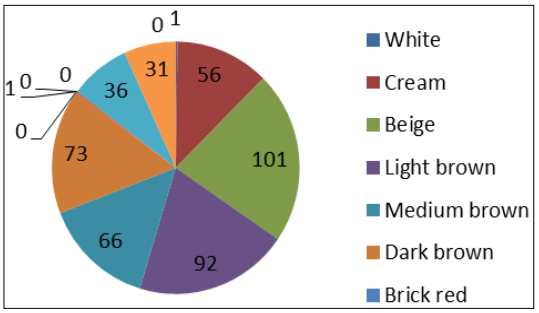
Capsule hairiness



Colour of dry Capsule

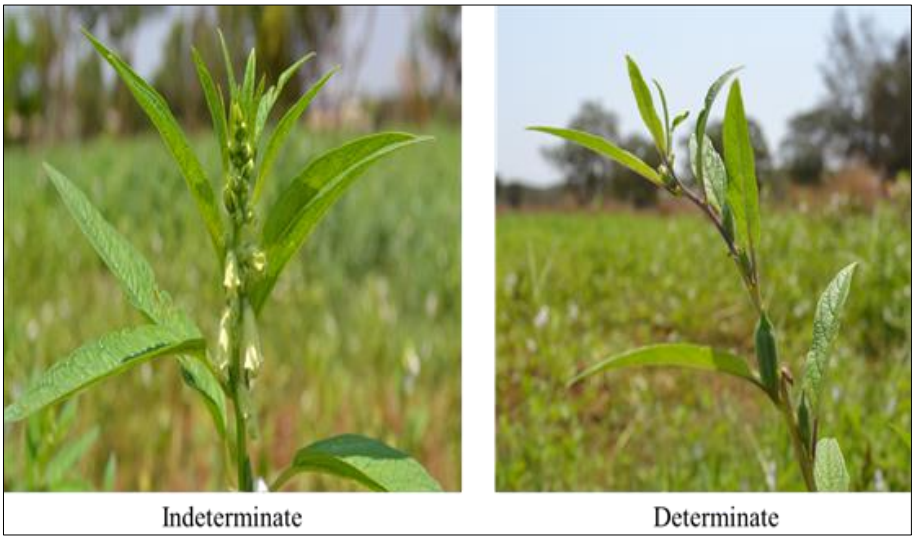


Type of capsule beak

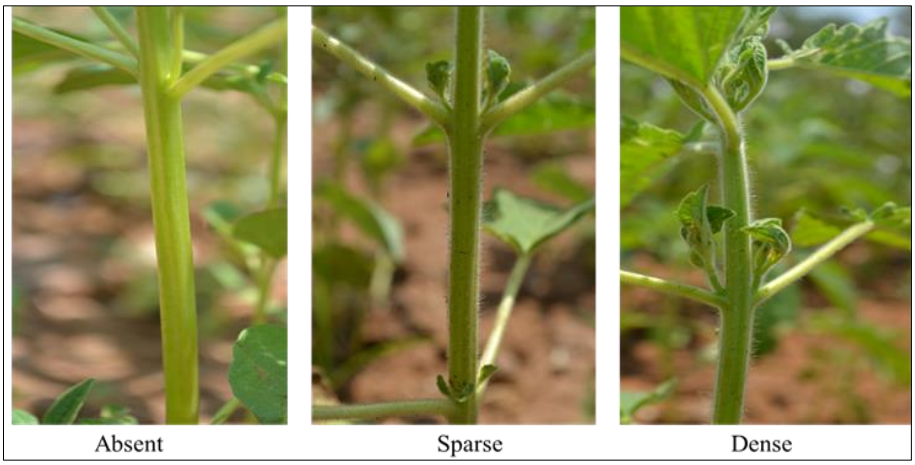


Seed coat colour

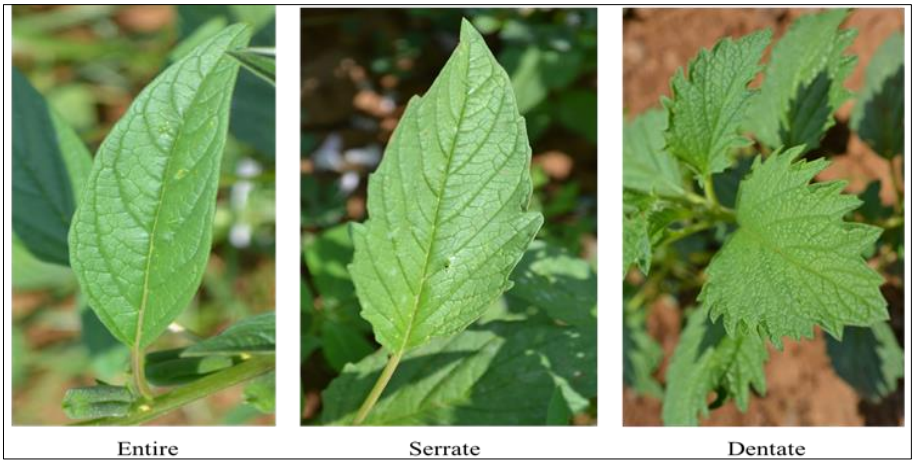
Fig 1c: Frequency distribution of different morphological traits in Sesame



Plant growth type



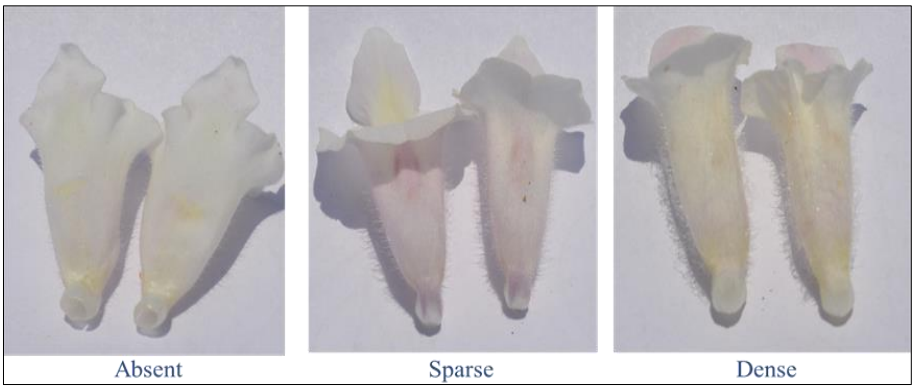
Stem Hairiness



Basal Leaf margin

Fig 2a: Variability observed for different morphological traits in Sesame

Number of flowers per leaf axil



Corolla hairiness

Number of locules per capsule

Fig 2b: Variability observed for different morphological traits in Sesame

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