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Morphological Characterization of Sesame Germplasm in Semi-arid Condition of Delhi

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Abstract: The base line for sesame improvement is to evaluate that diversity among trait of importance. Total 696 germplasm of sesame conserved in gene bank of ICAR-NBPGR were evaluated for morphological traits under augmented block design during kharif season of 2017-18 at ICAR-NBPGR Experimental Farm, Issapur and New Delhi. Analysis of variance revealed significant difference among genotypes for all the ten characters studied. IC500816 found promising for early flowering (26 days) while very late flowering observed in IC208657 (75 days). Higher yield per plant recorded in IC501018 (47.00 gm) and while maximum tallness recorded in IC204843 (226 cm). Highest no. of capsule per plant found in IC023271 (195.00) and maximum no. of locules per capsule identified in IC132182 (20). Violet- purple corolla and blackish seed observed in IC208662 genotype. Phenotypic coefficient of variation (PCV) found higher than genotypic coefficient of variation (GCV) for most of the characters studied indicates the role of environmental variance in the total variance. High heritability was recorded for plant height and capsule per plant.

Key words: Sesame, germplasm, variability, yield, plant height.

Sesame (*Sesamum indium*) commonly known as Til, is a most ancient oilseed crop being grown by human being. It is believed that it has cultivated and domesticated on the Indian subcontinent during Harappan and Anatolian eras over 4,000 year ago (Bedigian and Mesen, 2003). Presence of sesamol, a unique anti-oxidant and more poly-unsaturated fatty acid such as oleic acid (43%), linoleic acid (35%), palmitic acid (11%) and stearic acid (7%), protein (18-25%), carbohydrate (13.5%), and minerals (Bedigian *et al.*, 1986) made it to superior oilseed crop as "queen of oilseed". Sesame ranks fifth for important edible oil crop in India after groundnut, rapeseed-mustard, sunflower and soybean. India holds top position in the world in sesame-acreage (24%) and contribution in export (40%) (FAO Statistics Division, 2012). Productivity of sesame in India is low nearly 335 kg ha^{-1} compared to Egypt 1211 kg ha^{-1} (FAO, 2002). Improvement in productivity will definitely boost the crop expansion in non-traditional areas of India and other ancillary industries. One of the simple approaches to improve production of this crop is to boost up productivity through utilization of existing genetic resource. A large germplasm resource is always favored in plant breeding program as many desirable traits may obviously remain in the population which may exploit breeding program. The National Bureau of Plant Genetic Resources (NBPGR), New Delhi, maintains about 6,000 accessions of sesame, including the world collection. Sesame being a crop that originated from India, phenotypic and genetic variability assessment in the germplasm has not been studied completely. Wide diversity in morphological and yield-contributing characters has been reported by Bisht *et al.* (1999). Traditional sesame landraces as well as related wild species *(S. mulyanum, S. malabaricum* and *S. radiatum*) are an important source of donor genes in particular of phyllody disease resistance. Hence, characterizations of sesame germplasm collected from different places and abroad are essential for use of existing genetic variability for sesame improvement. However, the development of improved plant cultivars is restricted mainly due to narrow genetic pool, which results into limited possibility to restructure this crop. The knowledge of genetic variability in germplasm will certainly help in selection and breeding of high yielding, good quality cultivars that will proportionally increase productivity. It is

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Table 1. Mean Performance of yield and yield related traits of 696 sesame genotypes

Parameters	Qualitative characters							
	Early plant Vigour	Yield / plant (gm)	Total yield (gm)	Seed per capsule	Days to 50% flowering	Capsules per plant	Seed per capsule	Plant height (cm)
Minimum	0	0	0	10	26	14	10	72
Maximum	3	47	198	96	80	195	96	226
Mean	2.40325	11.08326	45.74382	46.32593	4.550898	78.22895	52.35832	151.884
SD	0.742729	7.467017	30.54821	8.856949	1.576281	28.23605	8.645101	24.81199
CV (%)	30.90519	67.37203	66.78106	19.11877	34.6367	36.09412	16.51142	16.33615

assumed that characterization of higher no. of accessions will enable in identification of germplasm with one or more desired traits and by combining large scale phenotyping. Keeping the above points in view, this study was carried out for assessing variation among 696 sesame accessions for morphological traits. This will help in further to develop a core-set and trait/ traits specific reference sets or genotypes with higher breeding values, which will be useful in the introgression in to cultivars having improved genetic and agronomic backgrounds through strategic breeding programs.

Materials and Methods

Total 696 sesame germplasm collected from diverse eco-geographical regions of India and abroad were characterized under Augmented Block Design (ABD) with national check (HT 11 and RT 46) having planted in 10 cm spacing between plants and 45 cm between rows at experimental station, NBPGR, New Delhi during 2017-18. The station is situated at an elevation of 190.7 m above sea level, at approximately 28.24°N latitude and 76.50°E longitudes. The soil of the station varies from sandy loam to loamy sand with a pH of around 8.0. N: P: K fertilizers were applied at the rate 50:25:25 kg ha^{-1}, half of N and full of P and K applied as basal and rest N as top dressing after 30 days of germination. The ground water of experimental field was highly saline having an EC of over 8 m mhos cm^{-1} therefore canal water was mixed for irrigation. Two irrigations were undertaken to crop i.e. first at 15 days after germination and second at the time of capsule bearing stage. Apart from irrigation around 400 mm annual precipitation was received during the year 2017-18.

Morphology of all sesame accession was characterized for 10 agronomic traits on 05 randomly selected plants per accession based on NBPGR descriptor. The traits measured were plant vigour, plant height, days to first flowering, days to 50% flowering, days to first capsule, number of capsules per plant, number of seeds per capsule, yield per plant, locules per capsule, seed color etc. The differences in the means of each agronomic trait between accession were compared using ANOVA (analysis of variance), while mean values were used for analysis of variance using Zenstat software. The coefficient of variation was calculated as per Burton (1952). Heritability in broad sense and genetic advice were calculated as per Johnson *et al.* (1955).

Result and Discussion

All genotype from accession no IC500835 to IC501145 belong to *Sesamum indicum* species found erect type with simple or branched stem, campanulate and whitish to pink corolla, mostly with white seeded. While Sesamum *radiatum* (IC210433) recorded very late in flower emergence more than 50 days from sowing. The entire leaves of this species found small compare to *S. indicum* and sessile with nectary long capsule and blackish seeds. *Sesamum marlothi* (IC208683) did not reach up to capsule bearing stage while *Sesamum mulayanum* (IC208671 to IC208677) performed at par of *Sesamum indicum* in respect of flowering behavior.

Morphological characterization of Sesame germplasm

It is clear from Table 1 that wide variation exist in 696 sesame germplasm for seed per capsule (15-96), yield per plant (1-47 gm), capsules per plant (14-195), plant height (72-226 cm), 50% flowering days from sowing (26-80) and locules per capsule (4-20). Based on the mean performances, IC500816 recorded earliest in 50% flowering, 26 days after sowing (Table 2) and it could be used in breeding programmes as early flowering reported as desirable trait for

Table 2. Promising accession of Sesame

Characters	Range		Promising germplasm	Value check
	Min	Max		
Seed per capsule (No.)	10.00	96.00	IC041945 (96.00)	HT 11 (57.50)
Yield per plant (gm)	1.00	47.00	IC501018 (47.00), IC501027 (41.50), IC501052 (39.00), IC501010 (37.50), IC132465 (35.50), IC132599 (35.00), IC501058 (35.00), IC501099 (33.00), IC501109 (32.00), IC132096 (31.00) PL (30.33)	HT 11 (17.79)
Capsules per plant (No.)	14.00	195.00	IC023271 (195.00), IC017476-1 (178.00), IC016244 (173.00), IC500930 (169.00), IC016239 (165.00), IC023309 (157.00), IC131634 (156.00), IC204849 (156.00), IC042999 (156.00), IC132465 (153.00), IC500847 (153.00), IC204843 (147.00),	HT 11 (78.17)
Plant height (cm)	72.00	226.00	IC204843 (226.00), IC204523 (210.00), IC132386 (210.00), IC204549 (205.00), IC500955 (205.00), IC043170 (205.00), IC131546 (205.00), IC017477 (204.00),	RT 46 (152.17)
50% Flowering (Days)	26	80	IC132293(28), IC132295(27), IC132489(26)	RT 46 (35)
Locules/Pod (No.)	4	20	IC132182(20) IC26304(6) IC500956(06)	HT 11 (4)

early maturity. The present study revealed that the genotype IC023271 had highest number of capsules per plant (195) followed by IC017476 (178), indicating that it can be used in breeding programs for increasing number of capsules per plant. Germplasm accession IC204843 had higher mean value for plant height (226 cm) which can again useful for improving yield as higher height of stem proportionally associated with more capsules per plant. IC585583 observed as monostem genotype (without branching) with profuse cluster bearing of capsules which highly suitable trait for development mechanically harvesting ideotype. IC132182 highest (20) locule bearer per capsule (Table 2) while variability for locule number per capsule was observed in few genotypes at intra-plant level viz., IC204522 exhibited six and eight locules per capsule; EC334991 exhibited 10 and 12 locules per capsule. Variability in number of locules per capsule at intra-plant level reflects the significant role of genotypic plasticity on phenotypic diversity with assessment of genetic variability being the first step in its utilization in any crop improvement programme (Bedigian *et al.*, 1986).

Genetic variability, phenotypic and genotypic co-efficient of variation

It is indicated by Table 3 that high heritability observed for the characters like seed yield per plant (0.23) and plant height (0.29) while capsule per plant have low heritability (0.12). This indicates that selection for such characters could contribute desirable results for selecting sesame genotypes with high heritability (Kalaiyarasi *et al.*, 2019). Relative comparison of heritability estimates along with genetic advance as percent of mean would give an idea about the nature of gene action governing a particular character, improving the effectiveness selection which is estimated based upon the heritability, genetic variability and selection intensity. The variation of different traits under this study revealed that the phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the characters studied indicating the role of environmental variance in the total variance (Table 3). The traits yield per plant (18.67) followed by capsule per plant(13.89) and seed per capsules(9.86) showed high PCV estimates. High coefficient

Table 3. Estimates of variability, heritability and genetic advance in Sesame

Character	Minimum	Maximum	Mean	GCV (%)	PCV (%)	Heritability (H^2)	Genetic advance	GA as % of mean
Seed/capsule (No.)	10	96	52.23	0.16	9.86	0.15	1.71	3.18
Yield per plant (gm)	1	47	10.92	4.29	18.67	0.23	0.63	3.78
Capsules per plant (No.)	14	195	78.11	0.20	13.89	0.12	2.49	3.45
Plant height (cm)	72	226	152.47	0.17	7.75	0.29	6.90	4.82

of variation for yield per plant has also been reported (Sumathi and Murlidharan, 2010; Sudhakar *et al.*, 2007). Hence, these characters can be relied upon and simple selection can be practiced for further improvement. High genetic advance as percentage of mean was observed in plant height (6.90) followed by capsule per plant (2.49). Genetic advance as per cent of mean (GA) is more reliable index for understanding the effectiveness of selection in improving the traits because the estimates are derived by involvement of heritability, phenotypic standard deviation and intensity of selection. Thus, genetic advance along with heritability provides clear picture regarding the effectiveness of selection for improving the plant characters (Noor *et al.*, 2004; Gidey *et al*., 2013). Low genetic advance was observed in case of seed per capsule (1.71) (Table 3). High heritability (0.29) coupled with high genetic advance (6.90) was observed for plant height (Table 3) which shows lesser influence of environment in expression of these characters and these characters are controlled by additive gene effect, hence, amenable for simple selection (Thirumala Rao *et al.*, 2013). Low heritability and low genetic advance is noted for seed per capsule where exercising of selection would impart no advantage (Table 3).

Sesame genotypes showed considerable amount of morphological variability and heritability for plant height, number of capsule per plant, yield per plant and locules per capsule. Hence, further selection and hybridization among promising genotype can improve quality and productivity of sesame.

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