Genetic Variability, Heritability and Genetic Advance in Sesame (Sesamum indicum L) Genotypes

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A B S T R A C T

Sesamum (Sesamum indicum L) is the most cultivated oil crop in India. It has great diversity across the Indian biota. The existing variability would be utilized for the commercial purpose of sesame. The purpose of the study is to evaluate the morphological characterization and variability available in the sesame genotypes available in Tamil Nadu. Fifteen sesame genotypes were grown during Rabi Summer 2018 at Agricultural College and Research Institute, Kudumiyanmalai (TNAU) for the estimation of genotypic and phenotypic coefficient of variation along with heritability and genetic advance. Eight biometrical and morphological traits were recorded for fifteen genotypes. High PCV and GCV are recorded for the traits viz., number of branches per plant, seed yield per plant and total number of capsules per plant. High heritability and genetic advance was observed for the characters number of branches per plant, number of capsules per plant, seed yield per plant, plant height, plot yield, 1000 seed weight and number of seeds per capsules. The traits with high heritability and high genetic advance as percent of mean are governed by the additive gene action where simple selection is effective for breeding programmes.

Keywords
Sesame genotypes, GCV, PCV, Heritability, Genetic advance

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Introduction

Sesamum (Sesamum indicum. L) is the ancient oil seed crop widely cultivated in Asia and Africa. The cultivated species of sesame, Sesamum indicum. L is proved to be domesticated in India around 5000B.C based on the archeological evidence of charred sesame found in Harappa civilization (Ali Al-Somain et al., 2017; Bedigian, 2003). The wild relatives and probable progenitor of sesame would be Sesamum malabaricum, rooted its origin in India, are the appropriate reason for the varying diversity found in India, despite the fact that the majority of the wild species of the genus Sesamum are native to sub-Saharan Africa. Sesamum, the favored oil crop, has much utility because of the edible
seed and quality oil content used in various Indian cuisines for its flavorsome. Sesamum seed contains 20% proteins high amounts of (83% - 90%) unsaturated fatty acids, mainly linoleic acid (37% - 47%), oleic acid (35% - 43%), palmitic (9% - 11%) and stearic acid (5% - 10%) with trace amount of linolenic acid, and also high oil content (46% - 50%), 20% proteins, carbohydrates (Pal, Khanum, and Bawa, 2010). Apart from these, a group of special health benefitting compounds called lignans (sesamin, sesamolin, sesaminol and sesamolinol), tocopherol, phytosterols, phytates and some other micronutrients are also present (Bedigian, 2003; Brar and Ahuja, 1980; Fukuda et al., 1985; Pathak et al., 2014). Sesame is said to be a drought tolerant crop because of its long tap root system which makes it a promising oil crop for tropical and subtropical. Though India ranks first in acreage and production in sesame, the low productivity has always made sesame to be a marginal crop (NMOOP, 2015).

Low yield level is due to lack of wider adaptability, non-synchronous maturity, non-availability of superior high yielding varieties with built in resistance to biotic and abiotic stresses and presence of pre and post fertilization barriers (Rao et al., 2002). Lack of sufficient researches unlike cereals is also a reason for under development of this crop. India being rich in the genetic variability of genus, Sesamum, exploiting of variability would come hand in hand in the improvement of genetics background of the crop. Enriching the details of the genetic diversity available in the genus Sesamum of Indian origin greatly helps in the selection of parent base material for hybridization and development of high yielding varieties suitable to various geographical situations. The present study aimed in analyzing of genotypic and phenotypic variability, heritability and genetic advance of biometrical morphological characters of fifteen sesame genotypes which could provide a wide magnitude of genetic parameters for selection in sesame breeding programme.

Materials and Methods

In this present study, fifteen genotypes were selected including 11 advance sesame culture of Tamilnadu Agricultural University and one local variety and three checks varieties (Table 1). The experiment was conducted in Agricultural College and Research Institute (Tamil Nadu Agricultural University), Kudumiyanmalai, Pudukkottai District of Tamil Nadu during Rabi Summer 2018. The genotypes were sown in Randomized Block Design (RBD) with 2 replications in 4 rows of length 5 meter and breadth of 0.3 meter covering an area of 6m² for a genotype. The plants are grown with inter-row spacing of 30 cm and inter plant spacing with 30 cm (30 cm x 30 cm). All the recommended Agronomic practices like thinning, weeding were practiced for raising the healthy plants. Five plants were randomly selected and biometrical observations were recorded on eight quantitative characters viz., days to fifty per cent flowering, plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, thousand seed weight (gm), seed yield per plant (g) and plot yield (g). Observations on each characters contributed to the genetic diversity of the sesame genotypes were calculated using mean, variability (PCV and GCV), heritability and genetic advance.

Statistical analysis

Phenotypic and genotypic variances were estimated according to the formula given by Lush (1940), PCV and GCV were computed based on the methods given by Burton (1952). The coefficients of variation were categorized as proposed by Sivasubramanian and
Madhava Menon (1973). The heritability was computed based on the methods given by Lush (1949). Genetic advance and genetic advance as percentage of mean were estimated according to the formula given by Johnson et al., (1955). Statistical analysis was done by using INDOSTAT software.

**Results and Discussion**

**Mean performance of sesame genotypes based on morphological characters**

Based on the mean performances, the genotype COS 14017 (W) which showed early flowering and it could be used in breeding programmes as early flowering was desirable for the benefits that come along with it such as early duration, escape from undesirable characters. In the present study, the genotype COS 14017 (W) was identified as early flowering and early maturing type than the other varieties studied (Table 2). The present study revealed that the genotype COS 14001 had higher mean value for plant height and COS 13015 has higher number of branches per plant, indicating that it could be used in breeding programmes for increasing plant height and number of primary branches per plant. The genotype COS 14001 exhibited high means value for number of capsules per plant followed by COS 14026(W) respectively (Table 2). High mean value for capsule length was recorded in COS14017 (DW) and COS 13015 highest number of seeds per capsule. TMV 7 showed high mean value for 1000 seed weight, recorded high mean value for seed yield per plant followed by the genotypes TMV 7 (Table 2). These genotypes can be used as donors in plant breeding programmes. The genotypes COS14017 and COS14018 were found to be the monopodial sesame genotype along with the seed characters. High yield was found to be recorded in COS13006 followed by COS 13015. The genotype COS 13015 was recorded for high yielding variety with maximum recorded for number of seeds per capsule ranging upto 84 seeds per capsules and these capsules are 4 and 6 loculed (Table 2). These sesame genotypes can advanced as high yielding varieties in plant breeding programmes.

**Genetic variability, phenotypic and genotypic co-efficient of variation**

In the present study, all the quantitative characters that were studied viz., days to fifty per cent flowering, plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, thousand seed weight, seed yield per plant and plot yield shows significance difference for all the genotypes under study which indicates that there are sufficient genetic variation exist among the genotypes which could eligible for further breeding programmes. The variation analysis of different quantitative traits under study showed that the Phenotypic Coefficient of Variation (PCV) is higher than the Genotypic Coefficient of Variation (GCV) among the genotypes with the minimum environmental interference exhibiting greater performance (Table 3). The traits number of branches per plant (Gidey et al., 2013; Saha et al., 2012; Sudhakar et al., 2007) followed by seed yield per plant (Sudhakar et al., 2007; Sumathi and Muralidharan, 2011) and total number of capsules per plant (Parameshwarappa, et al., 2009; Singh, et al.,2018) showed higher PCV and GCV estimates. It indicated that there was greater diversity for these traits in sesame. Hence, direct selection based on these traits would be effective for the improvement of this crop. The PCV and GCV are medium for plant height, number of seeds per capsule, thousand seed weight and plot yield. Days to maturity had low PCV and GCV estimates indicating low scope of selection for improvement. The estimates of heritability help the plant breeder in selection of elite genotypes from diverse
populations. In the present study, high heritability was observed for the characters number of capsules per plant, seed yield per plant, plot yield, plant height, number of seeds per capsule, Total number of branches per plant and thousand seed weight (Dash et al., 2018; Mahalakshmi K. Patil et al., 2017). This indicates that selection for these characters would give the best results for selecting sesame genotypes with these traits with high heritability. Days to 50% flowering has medium heritability. 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 (Allard, 1960). High genetic advance as percentage of mean was observed in number of branches, number of capsules per plant, seed yield per plant, Total number of branches per plant and thousand seed weight (Bharathi, et al., 2014; Gidey et al., 2013), plant height, plot yield, 1000 seed weight and number of seeds per capsules. Low genetic advance as percentage of mean was observed in case of Days to 50% flowering. High heritability coupled with high genetic advance was observed for the characters number of branches, number of capsules per plant, seed yield per plant, plant height, plot yield, 1000 seed weight and number of seeds per capsules (Thirumala Rao et al., 2013). This showed that these characters were controlled by additive gene action and revealed better scope for improvement of these characters through direct selection. Low heritability and low genetic advance is noted for days to 50% flowering where excising of selection would impart no advantage.

**Table 1** List of genotypes studied under the experiment

| Sl. No. | Genotypes      |
|---------|----------------|
| 1.      | COS13006       |
| 2.      | COS13015       |
| 3.      | COS14001       |
| 4.      | COS14017(W)    |
| 5.      | COS14017(DW)   |
| 6.      | COS14018       |
| 7.      | COS14025       |
| 8.      | COS14026       |
| 9.      | COS14026(W)    |
| 10.     | COS16007       |
| 11.     | COS16009       |
| 12.     | GT10           |
| 13.     | TMV 7          |
| 14.     | SVPR 1         |
| 15.     | NAYAKARPATTI LOCAL W – white; DW – dull white |
### Table 2: Mean Performance of yield and yield related traits of fifteen sesame genotypes

| Genotype          | Days to fifty percent flowering | Plant height (cm) | Total No. of branches per plant | Total No. of capsules per plant | Thousand seed weight (g) | Seed yield per plant (g) | Plot yield (g) |
|-------------------|--------------------------------|-------------------|---------------------------------|--------------------------------|-------------------------|------------------------|-----------------|
| COS13006          | 41.0                           | 133.30            | 3.7                             | 173.50                         | 73.0                    | 3.165                  | 19.65           | 640.5           |
| COS13015          | 34.0                           | 123.00            | 6.1                             | 240.10                         | 82.0                    | 3.435                  | 19.30           | 594.5           |
| COS14001          | 36.0                           | 148.00            | 5.1                             | 240.20                         | 62.4                    | 3.500                  | 16.70           | 510.0           |
| COS14017(W)       | 32.0                           | 122.80            | 1.0                             | 158.50                         | 73.0                    | 2.955                  | 20.30           | 530.0           |
| COS14017(DW)      | 33.0                           | 122.00            | 4.5                             | 150.50                         | 73.4                    | 2.940                  | 20.85           | 550.0           |
| COS14018          | 33.0                           | 136.30            | 1.0                             | 171.00                         | 68.2                    | 3.365                  | 20.55           | 598.0           |
| COS14025          | 37.0                           | 137.00            | 4.0                             | 200.25                         | 62.4                    | 3.510                  | 19.45           | 594.0           |
| COS14026          | 34.0                           | 106.55            | 1.7                             | 161.10                         | 70.9                    | 2.785                  | 15.15           | 422.0           |
| COS14026(W)       | 33.0                           | 97.80             | 1.8                             | 108.30                         | 72.0                    | 3.115                  | 13.80           | 527.0           |
| COS16007          | 36.0                           | 92.00             | 4.1                             | 186.00                         | 60.4                    | 3.225                  | 13.60           | 560.0           |
| COS16009          | 41.0                           | 132.80            | 4.6                             | 227.60                         | 65.4                    | 2.680                  | 12.75           | 545.0           |
| GT10              | 36.0                           | 87.20             | 3.8                             | 202.50                         | 68.2                    | 2.615                  | 10.10           | 420.0           |
| TMV 7             | 36.0                           | 120.80            | 5.0                             | 135.80                         | 50.4                    | 3.840                  | 11.60           | 540.0           |
| SVPR 1            | 34.0                           | 104.70            | 4.5                             | 122.60                         | 66.8                    | 2.600                  | 10.95           | 535.0           |
| NAYAKARPATTI LOCAL| 35.0                           | 105.00            | 6.0                             | 116.45                         | 76.4                    | 2.415                  | 9.10            | 410.0           |
**Table.3 Estimation of Variability, heritability and Genetic Advance**

| Characters                        | mean  | Range     | PCV (%) | GCV (%) | Heritability ($h^2$) | Heritability (%) | GA(%) of Mean (%) |
|----------------------------------|-------|-----------|---------|---------|----------------------|------------------|-------------------|
| Days to 50 % flowering           | 35.40 | 32-41     | 8.779   | 6.226   | 0.503                | 50.3             | 9.10              |
| Plant height                     | 117.95| 87.2-148  | 15.535  | 15.302  | 0.970                | 97.0             | 31.10             |
| Total No. of branches per plant  | 3.79  | 1-6.1     | 45.605  | 42.461  | 0.867                | 86.7             | 81.43             |
| Total No of capsules per plant   | 172.96| 108.3 - 240.2 | 24.945 | 24.840  | 0.992                | 99.2             | 51.00             |
| No. of seeds per capsule         | 68.33 | 50.4 - 82 | 11.338  | 10.882  | 0.921                | 92.1             | 21.51             |
| 1000 seed weight                | 3.08  | 2.415 - 3.84 | 14.146 | 12.414  | 0.770                | 77.0             | 22.44             |
| Seed yield per plant            | 15.59 | 9.1 - 20.85 | 26.950 | 26.822  | 0.990                | 99.0             | 55.00             |
| Plot yield                      | 531.73| 410 - 640.5 | 12.907 | 12.775  | 0.980                | 98.0             | 26.05             |
High heritability coupled with high genetic advance was observed for the characters seed yield per plant, number of seeds per capsule, number of capsules per plant, number of branches per plant, plant height. This showed that these characters were controlled by additive gene action and revealed better scope for improvement of these characters through direct selection.

References

Ali Al-Somain, B. H., Migdadi, H. M., Al-Faifi, S. A., Alghamdi, S. S., Muharram, A. A., Mohammed, N. A., and Refay, Y. A. 2017. Assessment of genetic diversity of sesame accessions collected from different ecological regions using sequence-related amplified polymorphism markers. 3 Biotech, 7(1), 82. doi:10.1007/s13205-017-0680-2

Bedigian, D., 2003. Evolution of sesame revisited: domestication, diversity and prospects. Genetic resources and crop evolution, 50(7), 779-787.

Bharathi, D., Rao, T., Mohan, C., Bhadru, D., and Venkanna, V., 2014. Genetic variability studies in sesame (Sesamum indicum L.). International Journal of Applied Biology and Pharmaceutical Technology, 5(4), 31-33.

Brar, G., and Ahuja, K., 1980. Sesame: its culture, genetics, breeding and biochemistry. Annual reviews of plant sciences.

Burton, G. W. 1952. Quantitative Inheritance in grasses. Proc. Sixth Inter. Grassland Cong., 1: 277-283

Dash, M., Haibru, G., Kabi, M., Pradhan, B., Lenka, D., and Tripathy, S. K., 2018. Morphology-Based Genetic Diversity Analysis of Sesame Germplasm for Yield and Capsule Characters. International Journal of Current Microbiology and Applied Sciences, 7(09), 1817-1826. doi:10.20546/ijcmas.2018.709.221

Fukuda, Y., Osawa, T., Namiki, M., and Ozaki, T., 1985. Studies on antioxidative substances in sesame seed. Agricultural and Biological Chemistry, 49(2), 301-306.

Gidey, Y. T., Kebede, S. A., and Gashawbeza, G. T., 2013. Assessment of genetic variability, genetic advance, correlation and path analysis for morphological traits in sesame genotypes. International Journal of Plant Breeding and Genetics, 7(1), 21-34.

Johnson, H. W., H. F. Robinson and Comstock, R. E., 1955. Estimation of genetic and environmental variability in soybean. Agron. J., 47: 314-318.

Lush. J. L. 1940. Intra - sire correlation and regression of offspring on dams as a method of estimating heritability of characters. Proc. Amer. Soc. Animal Production 33: 293-301.

Lush. J.L. 1949. Heritability Of Quantitative Characters In Farm Animals. Proc. VII. Int. Congo Genet. Suppl. Heriditas, 36: 356-375.

Mahalakshmi K. Patil., Lokesha, R., and Diwan, J. R., 2017. Genetic Divergence of Advanced Mutant Breeding Lines, In Sesame (Sesamum indicum L.) Assessed Through D2 Statistics. International Journal of Current Microbiology and Applied Sciences, 6(9), 3133-3139. doi:10.20546/ijcmas.2017.609.387.

NMOOP, 2015. National Mission On Oilseeds and Oilpalm statistics. https://nmoop.gov.in/Statistics.aspx

Pal, A., Khanum, F., and Bawa, A., 2010. Nutritional, Medicinal and Industrial Uses of Sesame (Sesamum indicum L.) Seeds - An Overview (Vol. 75).

Parameshwarappa, S., Palakshappa, M., Salimath, P., and Parameshwarappa, K., 1982.
2009. Evaluation and characterization of germplasm accessions of sesame (Sesamum indicum L.). Karnataka Journal of Agricultural Sciences, 22(5), 1084-1086.

Pathak, N., Rai, A. K., Kumari, R., Thapa, A., and Bhat, K. V., 2014. Sesame Crop: An Underexploited Oilseed Holds Tremendous Potential for Enhanced Food Value. Agricultural Sciences, 05(06), 519-529. doi:10.4236/as.2014.56054

Rao, K., Kishor, P., and Vaidyanath, K., 2002. Biotechnology of sesame- an oil seed crop. Plant Cell Biotechnol Mol Biol, 3, 101-110.

Saha, S., Begum, T., and Dasgupta, T., 2012. Analysis of genotypic diversity in sesame based on morphological and agronomic traits. Paper presented at the Proceedings of the Conference on International Research on Food Security, Natural resource management and rural development, September 2012, Georg - August Universität Göttingen and University of Kassel - Witzenhausen, Germany.

Singh, A., Bisen, R., and Tiwari, A., 2018. Genetic Variability and Character Association in Sesame (Sesamum indicum L.) Genotypes. International Journal of Current Microbiology and Applied Sciences, 7(11), 2407-2415. doi:10.20546/ijcmas.2018.711.274.

Sivasubramanian, S and Madhava Menon, P. 1973. Genotypic and phenotypic variability in rice. Madras Agri. Journal., 60: 1093-1096.

Sudhakar, N., Srdevi, O., and Salimath, P., 2007. Variability and character association analysis in sesame, Sesamum indicum L. Journal of Oilseeds Research, 24(1), 56. 

Sumathi, P., and Muralidharan, V., 2011. Analysis of genetic variability, association and path analysis in the hybrids of sesame (Sesamum indicum L). Tropical Agricultural Research and Extension, 13(3).

Thirumala Rao, V., Bharathi, D., Chandra Mohan, Y., Venkanna, V., and Bhadru, D., 2013. Genetic variability and association analysis in sesame (Sesamum indicum L.) Crop Research (0970-4884) (Vol. 46 Issue 1-3). p122

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