Evaluation of sesame (Sesamum indicum L.) genotypes for genetic variability based on different traits under rainfed conditions

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Abstract
The present study was conducted to evaluate 24 sesame genotypes under rainfed conditions to determine the magnitude of variability and to understand the heritable component of variation for 10 agro-morphological characters. Analysis of variance revealed considerable variability among all the characters studied. The phenotypic coefficient of variation (PCV) was greater than genotypic coefficient of variation (GCV) for all the characters studied, this shows the influence of the environmental effect on the characters. High genetic advance coupled with high heritability (broad sense) were observed for number of branches/plants, biological yield/plant, harvest index and seed yield/plant as these characters were controlled by additive gene effects, and selection based on these characters would be effective for future sesame crop improvement programme for rainfed agriculture.

Keywords
Sesame, PCV, GCV, heritability, genetic advance

INTRODUCTION
Rainfed agriculture is practiced on 80% of the world’s agricultural land area that generates about 70% of the world’s staple foods and India ranks first among the countries that practice rainfed agriculture under a variety of agro-climatic and rainfall conditions (Sharma et al. 2010). Rainfall amount and distribution during the growing season are considered the most serious environmental problem limiting crop production under rainfed conditions (Fahad et al., 2017). Sesame is an important Kharif oilseed crop of India, mainly grown as a rainfed crop in the arid and semi-arid tropics (Singh et al. 2009). Sesame crop is rarely irrigated although it is a drought-tolerant plant, it is sensitive to drought at germination and seedling stages (Bahrami et al. 2012). In reality, sesame is mostly grown under moisture stress with low management input by smallholders(Pham et al. 2010). Despite the economic importance for food, oil and medicine, the yield potential of sesame is not spectacular due to its cultivation in sub-marginal lands and non-availability of superior high yielding varieties due to lack of an appropriate breeding program (Pandey et al. 2015). Effective and efficient breeding programs depend on the amount of variability existing in the genetic stocks of the crop so that, it can be exploited for crop improvement by geneticist and crop breeders. Genetic variation is the inherent variation which remains unchanged by the environmental factors and this type of variation is more useful to a breeder for exploitation by selection or hybridization (Bagheri et al., 2017). Progress in any crop improvement project depends not only on the magnitude of genetic variability but also on the heritability and genetic advance under selection (Dutta et al. 2013). Heritability and genetic advance are very important selection parameters for the selection of best genotype from the base population. Heritability estimates the magnitude of variation present in a particular trait which is transmissible from the parent to the offspring which helps plant breeders for the selection of elite genotypes from diverse genetic populations (Patidar et al., 2018). Since heritability is also influenced by environment, the information on heritability alone may not help in selecting characters on the basis of their phenotype (Nahak et al., 2018). Therefore, the genetic advance is also considered important because high value of genetic advance is indicative of additive gene action which is the only genetic variance which response to the selection and it also provides information about the expected gain in a character from one cycle of selection (Dutta et al. 2013). Keeping in view of the above facts,
the present study was carried out with the objectives to assess genetic variability, heritability and genetic advance among the 10 agro-morphological characters of sesame.

MATERIALS AND METHODS
The field experiment was conducted at the Research Farm of the Dryland Agriculture Unit, Department of Agronomy, CCS Haryana Agricultural University, Hisar (Haryana) during Kharif season, under the rainfed condition with no pre and post sowing irrigation. Monthly and date wise data of rainfall during Kharif, 2016 is given in Table 1. The experimental material for the present study consists of 24 diverse genotypes of sesame (*Sesamum indicum* L.) which were procured from the Oilseed Section, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar was laid out in Randomized Block Design (RBD) with three replications. The description of genotypes is given in Table 2. Each genotype was sown in five rows of 4m length spaced at 45cm with 10cm plant to plant distance. All the recommended package of practices suggested for dryland agriculture was adopted to raise a good crop. The observations were recorded for 10 agro-morphological characters viz. days to 50% flowering, days to maturity, plant height (cm), the number of branches per plant, the number of capsules per plants, the number of seeds per capsules, 1000-seeds weight (g), biological yield per plant (g), harvest index (%) and seed yield per plant (g). The data for days to flowering (50%) and days to maturity were recorded on plot basis for while rest of the traits viz. plant height (cm), the number of branches per plant, the number of capsules per plants, the number of seeds per capsules, 1000-seeds weight (g), biological yield per plant (g), harvest index (%) and seed yield per plant (g) were on the basis of five randomly selected plants in each genotype and each replication. Analysis of variance (ANOVA) for the observations recorded on different characteristics was carried out as per the standard procedure suggested by Panse and Sukhatme (1995). PCV and GCV were computed based on the methods given by Burton and Dewane (1953). The heritability was computed based on the methods given by Falconer (1981) and the genetic advance was estimated according to the formula given by Johnson et al., (1955). The GCV and PCV estimates were taken as low, medium and high as per the classification of Singh and Chaudhary, (1977) while the heritability and genetic advance as per cent of mean estimates were taken as low, medium and high as per the classification of Johnson et al., (1955).

### Table 1. Rainfall during Kharif, 2016 at DLA Research Farm, CCS HAU, Hisar

| Month      | Date | Rainfall (mm) |
|------------|------|---------------|
| July 2016  | 3    | 53            |
| July 2016  | 4    | 13            |
| July 2016  | 15   | 14            |
| July 2016  | 16   | 34            |
| July 2016  | 19   | 11            |
| July 2016  | 28   | 25            |
| July 2016  | 29   | 39            |
| July 2016  | Total | 189          |
| August 2016| 18   | 4             |
| August 2016| 19   | 14            |
| August 2016| 25   | 7             |
| August 2016| 29   | 50            |
| August 2016| 30   | 7.8           |
| August 2016| Total | 82.8          |
| September 2016 | 25 | 7              |
| September 2016| Total | 7          |
| October 2016| 3    | 30            |
| October 2016| Total | 30           |

*Normal Rainfall

RESULTS AND DISCUSSION
Rainfall is a very crucial factor for the successful crop production under rainfedsituation because the performance of crops is directly correlated to the rainfall received during the crop season (Beyer et al. 2016). The amount of rainfall received during this crop growing season was adequate and rainfall during the months July and August were above than normal rainfall. In fact, rainfall in July month, which is the most crucial for Kharif sowing, was approximately 7 per cent more than normal rainfall. Mean sum of squares due to genotypes were highly significant for all the characters which indicated the existence of substantial genetic variation among genotypes for all the characters understudied (Table 3).
Table 2. List of 24 Genotypes taken for the study

| Sr. No. | Genotypes                  | Source                                      | Sr. No. | Genotypes                  | Source                                      |
|---------|----------------------------|---------------------------------------------|---------|----------------------------|---------------------------------------------|
| 1.      | CST 2001-9                 | CSAUAT, Kanpur (U.P.)                        | 13.     | HT 9913                    | CSH AU, Hisar (Haryana)                     |
| 2.      | RT 125                     | SKRAU, Jodhpur (Rajasthan)                 | 14.     | TKG 22                     | ZARS, Tikamgarh (M.P.)                      |
| 3.      | HT 15                      | CCS HAU, Hisar (Haryana)                   | 15.     | HT 9907                    | CCS HAU, Hisar (Haryana)                   |
| 4.      | HT 20                      | CCS HAU, Hisar (Haryana)                   | 16.     | T 78                       | CSAUAT, Kanpur (U.P.)                       |
| 5.      | OC 201                     | OUA&T, Bhubaneswar (Odisha)                 | 17.     | HT 2000                    | CCS HAU, Hisar (Haryana)                   |
| 6.      | JLS 110-12                 | Jalagaon, Maharashtra                       | 18.     | HT 45                      | CCS HAU, Hisar (Haryana)                   |
| 7.      | OC 251                     | OUA&T, Bhubaneswar (Odisha)                 | 19.     | KMR 60                     | UAS, Dharwad (Karnataka)                    |
| 8.      | HT 24                      | CCS HAU, Hisar (Haryana)                   | 20.     | HT 9316                    | CCS HAU, Hisar (Haryana)                   |
| 9.      | RT 54                      | SKRAU, Jodhpur (Rajasthan)                 | 21.     | HT 1 (LC)                  | CCS HAU, Hisar (Haryana)                   |
| 10.     | Pragati                    | CSAUAT, Kanpur (U.P.)                        | 22.     | HT 2 (LC)                  | CCS HAU, Hisar (Haryana)                   |
| 11.     | NC187                      | NAU, Navsari (Gujarat)                      | 23.     | HTC 1 (black)              | CCS HAU, Hisar (Haryana)                   |
| 12.     | Shekhar                    | CSAUAT, Kanpur (U.P.)                        | 24.     | KMR 41                     | UAS, Dharwad (Karnataka)                    |

Sumathi and Muralidharan (2010), Menzir (2012), Khairnar and Monpara (2013), Vanishree et al. (2013), Ismaila and Usman (2014), Abate et al. (2015), Lal et al. (2016), Bamrotiya et al. (2016) and Teklu et al. (2017) also reported significant differences for these characters in sesame. The presence of sufficient variability indicated that the materials of sesame under study were good enough for further study. The phenotypic coefficient of variation (PCV) was greater than the genotypic coefficient of variation (GCV) for all the characters studied, which reflected the role of the environment in the expression of the observed traits. Similar results were also reported by Revathi et al. (2012), Abate et al. (2015), Meenakumari and Ganesamurthy (2015), Bamrotiya et al. (2016), Saxena and Bisen (2016), Soury et al. (2016) and Saxena and Bisen (2017) in sesame. In the present study, high PCV & GCV estimates were observed for harvest index and seed yield per plant which showed that there was the considerable possibility of further improvement of harvest index and seed yield per plant through hybridization followed by appropriate selection. High GCV and PCV values were also reported by Sumathi and Muralidharan (2010), Gangadhara et al. (2012), Khairnar and Monpara (2013), Vanishree et al. (2013), Mahmoud and Ghareeb (2015), Saxena and Bisen (2016), Soury et al. (2016), Bamrotiya et al. (2016), Saxena and Bisen (2017) and Teklu et al. (2017) in sesame.

Table 3. Analysis of variance for various agro-morphological traits in sesame

| Sr. No. | Genotypes                  | Source                                      | Sr. No. | Genotypes                  | Source                                      |
|---------|----------------------------|---------------------------------------------|---------|----------------------------|---------------------------------------------|
| 1.      | CST 2001-9                 | CSAUAT, Kanpur (U.P.)                        | 13.     | HT 9913                    | CSH AU, Hisar (Haryana)                     |
| 2.      | RT 125                     | SKRAU, Jodhpur (Rajasthan)                 | 14.     | TKG 22                     | ZARS, Tikamgarh (M.P.)                      |
| 3.      | HT 15                      | CCS HAU, Hisar (Haryana)                   | 15.     | HT 9907                    | CCS HAU, Hisar (Haryana)                   |
| 4.      | HT 20                      | CCS HAU, Hisar (Haryana)                   | 16.     | T 78                       | CSAUAT, Kanpur (U.P.)                       |
| 5.      | OC 201                     | OUA&T, Bhubaneswar (Odisha)                 | 17.     | HT 2000                    | CCS HAU, Hisar (Haryana)                   |
| 6.      | JLS 110-12                 | Jalagaon, Maharashtra                       | 18.     | HT 45                      | CCS HAU, Hisar (Haryana)                   |
| 7.      | OC 251                     | OUA&T, Bhubaneswar (Odisha)                 | 19.     | KMR 60                     | UAS, Dharwad (Karnataka)                    |
| 8.      | HT 24                      | CCS HAU, Hisar (Haryana)                   | 20.     | HT 9316                    | CCS HAU, Hisar (Haryana)                   |
| 9.      | RT 54                      | SKRAU, Jodhpur (Rajasthan)                 | 21.     | HT 1 (LC)                  | CCS HAU, Hisar (Haryana)                   |
| 10.     | Pragati                    | CSAUAT, Kanpur (U.P.)                        | 22.     | HT 2 (LC)                  | CCS HAU, Hisar (Haryana)                   |
| 11.     | NC187                      | NAU, Navsari (Gujarat)                      | 23.     | HTC 1 (black)              | CCS HAU, Hisar (Haryana)                   |
| 12.     | Shekhar                    | CSAUAT, Kanpur (U.P.)                        | 24.     | KMR 41                     | UAS, Dharwad (Karnataka)                    |

Broad sense heritability ranged from 22.81 (Days to 50% flowering) to 77.55 (1000-seeds weight) per cent (Table 4). Heritability (broad sense) was found higher for plant height, the number of branches per plant, the number of seeds per capsule, 1000-seed weight, biological yield per plant, harvest index and seed yield per plant, which indicated that these characters were least influenced by the environmental effects and high capacity of the characters for transmission to subsequent generation. Similar results for one or more character were also reported by Sumathi and Muralidharan (2010), Jadhav and Mohrir (2012), Khairnar and Monpara (2013), Meenakumari and Ganesamurthy (2015), Soury et al. (2016), Bamrotiya et al. (2016), Saxena and Bisen (2016) and Saxena and Bisen (2017) in sesame. High genetic advance coupled with high heritability was observed for the number of branches per plant, biological yield per plant, harvest index and seed yield per plant which indicated that these traits were governed largely through additive effects of genes and improvement in these characters could be achieved through simple phenotypic selection. Similar finding was also reported by Gangadhara et al. (2012), Khairnar and Monpara (2013), Siva et al. (2013), Vanishree et al. (2013), Soury et al. (2016), Saxena and Bisen (2016), Bamrotiya et al. (2016) and Saxena and Bisen (2017) for one or more of these characters in sesame.

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Table 4. Estimates of mean performance, range, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense) and genetic advance (GA) as per cent of mean for different traits in sesame

| Traits | Mean ± SE | Range | Coefficient of variation (%) | Heritability (%) (broad sense) | Genetic advance as per cent of mean (%) |
|--------|-----------|-------|-----------------------------|--------------------------------|----------------------------------------|
|        |           |       | Genotypic (GCV)             | Phenotypic (PCV)               |                                        |
| DF     | 41.39±1.93| 36.00-45.00 | 3.10                        | 6.48                           | 22.81                                  | 3.05                                  |
| DM     | 91.07±2.02| 82.00-95.00 | 2.45                        | 3.67                           | 45.21                                  | 3.42                                  |
| PH     | 142.50±8.97| 116.10-167.00 | 9.47                        | 12.21                          | 60.14                                  | 15.13                                 |
| NBP    | 6.25±0.59  | 4.63-7.93   | 14.47                       | 18.52                          | 61.03                                  | 23.29                                 |
| NCP    | 74.98±8.46 | 56.20-92.70 | 11.44                       | 17.93                          | 40.67                                  | 15.02                                 |
| 1000-SW| 51.28±2.94| 43.53-60.23 | 9.38                        | 11.71                          | 64.12                                  | 15.47                                 |
| BYP    | 3.36±0.15  | 2.75-4.14   | 10.10                       | 11.47                          | 77.55                                  | 18.32                                 |
| HI     | 15.56±1.83 | 8.56-21.37  | 16.54                       | 18.86                          | 76.90                                  | 29.88                                 |
| SYP    | 12.54±1.63 | 8.18-17.73  | 19.61                       | 25.28                          | 60.19                                  | 31.34                                 |

DF = Days to flowering (50%), DM = Days to maturity, PH = Plant height (cm), NBP = No. of branches/plant, NCP = No. of capsules/plant, NSC = No. of seeds/capsule, 1000-SW = 1000-seeds weight (g), BYP = Biological yield/plant (g), HI = Harvest index (%), SYP = Seed yield/plant (g).

Days to maturity exhibited moderate heritability with low genetic advance may be due to non-additive gene action and moderate heritability being exhibited might be due to favorable influence of environment rather than genotypes and selection for days to maturity might not be effective. Similar observations were also made by Abate et al. (2015) and Bamrotiya et al. (2016) for days to maturity in sesame.

High heritability coupled with moderate genetic advance was observed for plant height, the number of seeds per capsule and 1000-seed weight indicating equal importance of additive and non-additive gene actions. Similar observations were reported by Sumathi and Muralidharan (2010) and Saxena and Bisen (2016) for one or more of these characters in sesame. Moderate heritability accompanied with moderate genetic advance was observed for the number of capsules per plant which indicated the role of non-additive gene action in the expression of these traits and selection might not be effective at the early stage. Similar results were reported in sesame by Meenakumari and Ganesamurthy (2015) and Soury et al. (2016).

Considering the forgoing discussion, based on the high genotypic coefficient of variation, high heritability (broad sense) along with high genetic advance which were observed here for the number of branches per plant, biological yield per plant, harvest index and seed yield per plant, indicating their usefulness in genetic amelioration in sesame. These characters can be used further in selection programme for the development of high yielding variety of sesame.

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