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Assessment of genetic variability, character association and path coefficient in sesame (*Sesamum indicum* L.)

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Abstract
To analyze the genetic variability, correlation and path coefficient analysis of yield and yield attributing characters were studied in 21 genotypes of sesame. The experiment was carried out at Agricultural Research Station (S.K.N. Agricultural University, Jobner-Jaipur), Navgaon (Alwar) during kharif 2019. Analysis of variance revealed that the existence of significant genotypic differences among the genotypes for days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of capsules per plant, capsule bearing length, seeds per pod, 1000-seed weight, harvest index and seed yield per plant. Higher estimates of GCV and PCV were recorded for seed yield per plant, number of capsules per plant and number of primary branches per plant. High heritability coupled with high genetic advance as percent of mean was observed for seed yield per plant, 1000-seed weight, number of seeds per pod, number of capsules per plant and number of primary branches per plant plant indicating the influence of additive gene action, as such simple selection would likely to be effective for improvement of these traits. Seed yield per plant showed positive significant association with capsules bearing length, number of seeds per pod and harvest index, while it had negative significant association with days to flowering and days to maturity at both genotypic and phenotypic levels. Path analysis revealed that the characters capsules bearing length, plant height, days to 50% flowering and 1000-seed weight were directly and indirectly influencing the seed yield per plant were important characters to be considered for realizing the improvement in seed yield in sesame owe to their positive contribution.

Keywords: Genetic variability, correlation, heritability and sesame

Introduction
Sesame (*Sesamum indicum* L.) commonly known as '*til*' is an ancient indigenous oil crop of India. It is cultivated in Asia and Africa for its high nutritional, cosmetic and cooking characteristics of oil. It is a rich nutritious of carbohydrates (15%) and protein and in addition to excellent source of quality oil (50%) providing good health care as biomedicine. However, the productivity of this crop is a prime need. Sesame oil has highest antioxidant content and contains several fatty acids such as oleic acid (43 %), linoleic acid (35%), palmitic acid (11%) and stearic acid (7%). The variations in climatic and edaphic conditions, affect sesame yields and performance. The major constraints for growing sesame are instability in yield, lack of wider adaptability, drought, non-synchronous maturity and susceptibility to insect pests and pathogens (Muhamman and Gungula, 2008) [13].

Gujarat, Rajasthan, Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Orissa, Tamil Nadu, West Bengal and Karnataka are the major sesame growing states of the country. Pali, Nagaur, Jodhpur, Jalore, Bhilwara, Sirohi, Ajmer and Alwar are important districts cultivating sesame in Rajasthan state. In Rajasthan, sesame occupies 242.23 thousand ha, and production 84.29 thousand tones with productivity 348 kg/ha (Vital Statistics, 2018-19) [23].

The logical way to start any breeding programme, is to assess the extent of variability in the base population under study. Information on the magnitude of variability and extent, to which desirable characters are heritable, is important for planning breeding programme and ascertaining the scope of its improvement. It is essential to study variability in respect of quantitative characters with reference to genetic parameters such as genotypic and phenotypic variances, heritability (broad sense) and genetic advance.

Correlation estimates between yield and other characters are useful in selecting desired plant types in designing an effective breeding programme. Correlation studies enable breeders to know the strength of the relationship between various characters as well as the direction of changes expected during selection because more often seed yield is a complex trait and do not get improved with simple selection. Path coefficients analysis is an important tool for partitioning the correlation coefficient into direct and indirect effect of variables on dependent variable. A knowledge of the association of various component characters and their direct and indirect effects of on grain yield would be of immense help to the breeders. Hence, this study was conducted to study the genetic variability, correlation mechanism and cause effect relation in twenty one genotypes of sesame.

Materials and Methods

In the present study twenty one genotypes were sown in randomized complete block design (RBD) with three replications at Agricultural Research Station, Navgaon (Alwar) during kharif 2019. The Agriculture Research Station, Navgaon-Alwar is situated at extreme North East Corner between $76^0$7'-$28^0$2' N latitude. The average rainfall of the zone is 500 mm. The crop was grown under normal crop season. The soil of experimental field was sandy loam in texture, low in organic carbon, low in available nitrogen, medium in phosphorus and potassium. Each genotype was raised in 4 m length with spacing of 30 x 10 cm. All standard agronomic packages of practices were adopted to raise a healthy crop. Observations were recorded on five random plants in each replication for the characters viz., plant height (cm), number of primary branches per plant, number of capsules per plant, capsules bearing length (cm), number of seeds per capsule, 1000-seed weight (g), harvest index (%) and seed yield per plant (g) and the trait days to 50 % flowering and days to maturity was recorded on plot basis. The mean values were used for analysis of variance. The coefficient of variation was calculated as per Burton (1952) [4]. Heritability in broad sense and genetic advance were calculated as per Johnson *et al.,* (1955) [11]. Genotypic correlation between yield and its component traits and among themselves was worked out as per the method suggested by Johnson *et al.* (1955) [13]. The significance of genotypic correlation coefficient was tested by referring to the standard table given by Snedecor and Cochran (1967) [18]. Path coefficient analysis was carried out as suggested by Dewey and Lu (1959).

Results and Discussion

In the present study, the analysis of variance showed significant differences among the genotypes for ten characters studied indicating existence of high degree of variability in the material of sesame. Examination of the components of variance revealed that the estimates of phenotypic coefficient of variation (PCV) were higher than the corresponding genotypic coefficient of variation (GCV) for all the traits indicating the role of environmental variance in the total variance (Table 1).

Table 1: Estimates of genetic parameters of variation for 10 characters of sesame

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of capsules per plant	Capsules bearing length (cm)	Seeds per pod	1000-seed weight	Harvest index (%)	Seed yield per plant (g)
Mean	52.68	88.33	96.37	3.97	38.22	38.03	46.32	2.81	21.96	3.03
Range	49.0-56.33	84.0-92.33	82.67-114.33	2.27-4.86	24-50.58	23.87-46.58	33.33-62.5	2.11-3.33	16.34-27.05	2.32-4.59
Genotypic variance	3.65	3.62	49.42	0.35	36.17	21.44	38.11	0.13	6.46	0.28
Phenotypic variance	6.58	5.88	128.93	0.51	54.61	35.43	55.62	0.19	12.74	0.39
Genotypic coefficient of variance	3.63	2.16	7.30	14.98	15.74	12.17	13.33	13.03	11.58	17.60
Phenotypic coefficient of variance	4.87	2.75	11.78	17.90	19.34	15.65	16.10	15.33	16.26	20.52
Heritability (%)	55.50	61.60	38.33	70.03	66.23	60.50	68.51	72.26	50.72	73.61
Genetic advance	2.93	3.08	8.97	1.03	10.08	7.42	10.53	0.64	3.73	0.94
GA as % of mean	5.57	3.48	9.30	25.83	26.38	19.50	22.73	22.82	16.99	31.11

The highest PCV and GCV were recorded seed yield per plant followed by number of capsules per plant, number of primary branches per plant indicating presence of ample variation for these traits in the present material. High coefficient of variation for seed yield per plant (Sumathi and Murlidharan, 2010 [21], Parameshwarappa *et al.*, 2009 and Sudhakar *et al.*, 2007) [21, 15, 20], number of capsules per plant (Patil and Lokesha, 2018) [16] and branches per plant (Gidey *et al.*, 2013, Saha *et al.*, 2012 and Solanki and Gupta, 2003) [8, 17, 19] has also been reported. Hence, these characters can be relied upon and simple selection can be practiced for further improvement. Heritability in broad sense estimates were high for seed yield per plant, 1000-seed weight, number of primary branches per plant, seeds per pod, number of capsules per plant, days to maturity and capsules bearing length. Burton and Devane (1953) [3] has suggested that genotypic coefficient of variation together with heritability estimates gives best option expected for selection. 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.

High heritability coupled with high genetic advance shows that a progress can be made through selection as it suggests the presence of additive gene effects. In the present study, high estimates of heritability and genetic advance were obtained seed yield per plant, 1000-seed weight, number of primary branches per plant, seeds per pod and number of capsules per plant. Thus, selection for these traits is likely to accumulate more additive genes leading to further improvement of their performance and these traits may be used as selection criteria in sesame breeding program. Similar results have also been reported by Umamaheswari *et al.* (2019) [22] and Bharathi *et al.*, (2014) [2] in sesame crop.

In the present study, Seed yield per plant had significant and positive association with number of seeds per pod, harvest index and capsules bearing length at both genotypic and phenotypic levels (Table 2). Thus yield improvement in sesame can be achieved through the selection of plant type via yield contributing traits like number of seeds per plant,

capsules bearing height and harvest index. Similar results also reported for capsules bearing height (Navaneetha *et al.*, 2019) [14], number of seeds per pod (Ibrahim and Khidir, 2012) [10], Khairnar and Monopara, 2013 [12] and Fazal *et al.*, 2015) [6].

Table 2: Phenotypic and genotypic correlation coefficients between different characters of sesame

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of capsules per plant	Capsules bearing length (cm)	Seeds per pod	1000-seed weight	Harvest index (%)	Seed yield per plant (g)
Days to 50% flowering	G	1.000	0.609**	0.220	0.256*	-0.339**	-0.740**	-0.614**	-0.417**	-0.381**	-0.532**
	P	1.000	0.464**	-0.005	0.095	-0.189	-0.445**	-0.386**	-0.366**	-0.236	-0.376**
Days to maturity	G		1.000	0.110	0.529**	0.073	-0.427**	-0.596**	0.182	-0.101	-0.636**
	P		1.000	0.108	0.423**	0.014	-0.287*	-0.428**	0.092	-0.102	-0.504**
Plant height (cm)	G			1.000	0.176	-0.331**	-0.339**	0.014	-0.298*	0.187	0.019
	P			1.000	0.080	-0.173	-0.174	0.011	-0.127	0.049	0.018
Number of primary branches per plant	G				1.000	0.384**	-0.128	-0.265*	0.198	0.100	0.231
	P				1.000	0.279*	-0.089	-0.255*	0.103	-0.063	0.218
Number of capsules per plant	G					1.000	0.300*	0.097	0.331**	0.162	-0.081
	P						0.295*	0.089	0.276*	0.099	-0.080
Capsules bearing length (c	G						1.000	0.829**	0.324**	0.407**	0.459**
	P							0.588**	0.229	0.155	0.333**
Number of seeds per pod	G							1.000	0.081	0.118	0.583**
	P								0.073	0.114	0.358**
100- Seed weight (g)	G								1.000	0.296*	0.234
	P								1.000	0.159	0.142
Harvest index (%)	G									1.000	0.799**
	P									1.000	0.503**
Seed yield per plant (g)	G										1.000
	P										1.000

The days to 50% flowering and days to maturity showed negative and significant contribution to seed yield per plant at both genotypic and phenotypic levels. Days to maturity and early flowering in sesame provides early capsule developing. In our study, these characters had negative effect on seed yield and similar negative relation was obtained by Gnanasekaran *et al.* (2008) [9]. Days to flowering has significant and positive correlation with days to maturity while it had significant and negative correlation with capsule bearing length, seeds per capsules and 1000-seed weight at both genotypic and phenotypic levels. Days to maturity showed significant negative correlation with capsules bearing length and seeds per pod at both genotypic and phenotypic levels.

Yield being a complex entity, is influenced by several components and selection based primarily on correlation. Without considering cause and effect relationship can be misleading. So, the genotypic correlation coefficients were partitioned into direct and indirect effects through path coefficient analysis (Table 3) to get a clear picture under this complex situation. High positive direct effect on seed yield per plant was registered by number of capsules bearing length followed by plant height, days to maturity and 1000-seed weight, while the highest negative direct effect was exerted by number of seeds per pod, days to maturity, harvest index, days to maturity and number of primary branches per plant. Seed yield per plant had negative direct effect with harvest index and number of seeds per pod but it had positive correlation due to indirect effect of capsules bearing length, days to maturity, plant height and 1000-seed weight. This is in agreement with Abate and Mekbib (2015) [1] and Gangadhara *et al.* (2012) [7].

The residual effect estimated was 8.48 indicating that the traits under study are not sufficient to account for variability and there might be a few more pertinent characters other than those studied in the present investigation. Thus, the material studied is of diverse nature and information emanated would help in designing the selection methodology which further be used in the breeding programme. Therefore considering these traits as selection, emphasis should be given to these particular characters will be advantageous in bringing improvement in sesame genotypes.

Table 3: Genotypic path coefficients of various characters on seed yield per plant

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of capsules per plant	Capsules bearing length (cm)	Seeds per pod	1000-seed weight	Harvest index (%)	Correlation coefficient with seed yield per plant (g)
Days to 50% flowering	12.186	-9.541	4.489	-0.579	-0.009	-33.027	23.259	-3.311	6.000	-0.532**
Days to maturity	7.422	-15.664	2.244	-1.196	0.002	-19.052	22.580	1.441	1.586	-0.636**
Plant height (cm)	2.677	-1.720	20.433	-0.398	-0.008	-15.110	-0.537	-2.364	-2.954	0.019
Number of primary branches per plant	3.118	-8.280	3.594	-2.262	0.010	-5.698	9.091	1.569	-1.573	-0.431**
Number of capsules per plant	-4.133	-1.141	-6.756	-0.869	0.026	13.373	-0.661	2.626	-2.546	-0.081
Capsules bearing length (c	-9.019	6.687	-6.919	0.289	0.008	44.626	-31.381	2.574	-6.406	0.459**
Number of seeds per pod	-7.485	9.340	0.290	0.543	0.000	36.983	-37.867	0.643	-1.864	0.583**
100- Seed weight (g)	-5.082	-2.844	-6.083	-0.447	0.008	14.468	-3.068	7.940	-4.660	0.234
Harvest index (%)	-4.641	1.576	3.831	-0.226	0.004	18.143	-4.481	2.348	-15.756	0.799**

*, ** Significant at 5 % and 1 % level of significance, respectively
Residual effect Genotypic = 8.48

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