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GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS IN SESAME (*SESAMUM INDICUM* L.)

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Abstract

A study was conducted in 30 genotypes of sesame to analyze the genetic variability, correlation and path coefficient analysis of yield and yield attributing characters. The experiment was carried out at Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India during March to May, 2016. Analysis of varianc indicated the existence of significant genotypic differences among the genotypes. Considering genetic parameters high GCV and PCV was observed for number of branches per plant. High heritability coupled with high genetic advance as percent of mean was observed for plant height at maturity, number of branches per plant, number of capsules per plant, length of the capsule, number of seeds per capsule, 1000 seed weight and seed yield per plant indicating the influence of additive and non-additive gene action, as such simple selection would likely to be effective for improvement of these traits. Seed yield per plant showed positive association with number of capsules per plant, number of seeds per capsule, number of branches per plant and 1000 seed weight. Path analysis revealed that the traits plant height at maturity, number of capsules per plant and number seeds per capsule were directly influencing the seed yield per plant.

Key words: Sesame, correlation, path coefficient, heritability and genetic advance.

Introduction

Sesame (*Sesamum indicum* L.) is one of the important indigenous oilseed crops. Its oil content varies between 46 and 56 percent. It is mostly grown for its seed and is an important source of premium quality oil, which is highly stable, does not develop rancidity leading to loss of flavor and vitamins and contains natural antioxidants like sesamin and sesamolin (Mirza *et al.,* 2009). By virtue of its good quality oil it fetched the name "Queen of oilseeds". The fatty acid composition is rather attractive, due to the high level of unsaturated fatty acids (Woldesenbet *et al.,* 2015). Sesame oil consists of various fatty acids and nonfat antioxidants. Among the primary edible oils, sesame oil contains abundant fatty acids such as oleic acid (43 percent), linoleic acid (35 percent), palmitic acid (11 percent) and stearic acid (7 percent) and has the highest antioxidant content (Cheung *et al.,* 2007; Bedigian *et al.,* 1985). India is the second largest producer of sesame in the world with an annual production of 6.36 lakh tonnes and crop is cultivated in an area of around 18.6 lakh ha (FAOSTAT 2013). Variation in climatic and edaphic conditions affects sesame yield, the major constraints identified in growing sesame are instability in yield, lack of wider adaptability and non synchronous maturity etc. Therefore, there is a need to exploit the existing genetic variability in sesame for developing high yielding varieties that can be adjusting and productive under changing environment.

Yield is a complex character and its expression depends upon the influence of yield attributing characters. So, proper evaluation of the extent of genetic variation available for the yield attributes will be of immense help to breeders. Besides this, for understanding the mode of inheritance of the yield components, the correlation among them and the association between each component and yield is necessary for intelligent choice of breeding procedures for evolving high yielding varieties (Robinson *et al.,* 1951and Johnson *et al*., 1955)

The success of plant breeding depends on the

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availability of genetic variation, knowledge about desired traits and efficient selection strategies that makes it possible to exploit existing genetic resources. The pool of genetic variation within an inter-mating population is the basis for selection as well as for plant improvement.

Path coefficient analysis measures the direct and indirect contribution of independent variables on dependent variables and thus helps breeder in determining the yield conponents and understanding cause of association between two variables. The information obtained by path coefficient analysis helps in indirect selection for genetic improvement of yield because direct selection is not effective for low heritable trait like yield. Thus, the estimation of heritability and genetic advance is essential for a breeder which helps in understanding the magnitude, nature and interaction of genotype and environmental variation of the traits.

The present investigation was conducted to study the phenotypic and genotypic variability among the genotypes and to estimate genetic advance, correlation coefficient among the characters and direct and indirect effect of component characters on yield of sesame.

Materials and Methods

The study was conducted at Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India during March to May, 2016. A total of 30 sesame genotypes of diverse origin were taken for the present study. These genotypes were obtained from Regional Research station, Virudhachalam. The details of the survived materials are presented in table 1. The 30 genotypes were raised in Randomized Block Design (RBD) with three replications. Each genotype was sown in a plot with a spacing of 30 × 15 cm. Care was taken to maintain single plant per hill. Recommended agronomic practices and need based plant protection measures were undertaken. Observations were recorded on five randomly selected plants per replication. The following characters were observed and recorded. Days to first flowering (days), Days to 50 percent flowering (days), Plant height at maturity (cm), Number of branches per plant, Number of capsules per plant, Length of the capsule (cm), Number of seeds per capsule, 1000 seed weight (g) and Seed yield per plant (g). Data from five plants of each genotype were averaged replication wise and mean data was used for statistical analysis. Mean, range and coefficient of variation were also estimated. Genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) were estimated according to Burton (1952); heritability in broad sense (h^2bs) was estimated according to Burton and Devane (1953); genetic advance (GA) and genetic advance as percent of mean (GAPM) were calculated by Johnson *et al*., (1955), correlation coefficient analysis by Robinson *et al*., (1951) and path coefficient analysis was accessed by Dewey and Lu, (1959).

Table 1: List of 30 sesame genotypes.

S. No	Genotypes	Seed coat colour	S. No	Genotypes	Seed coat colour
1.	NIC -2939	Black	16.	IS-73-1	White
2.	SI-506-B	Brown	17.	SI-437	Brown
3.	RJS-175	Brown	18.	IS-167	Brown
4.	IS-80-A	White	19.	NIC-16106	White
5.	IS-562-6	Light Brown	20.	GRT-8376	Brown
6.	JLT-1	Brown	21.	GRT-8359	Brown
7.	IS-153-A	Light Brown	22.	NIC-3032	White
8.	IS-191-B	Light Brown	23.	GSK-24	Light Brown
9.	IS-8480-A	Brown	24.	NIC-16198	Brown
10.	IS-423-C	Light Brown	25.	NIC-17263	Black
11.	NIC-8317	Brown	26.	SI-1025-B	White
12.	IS-39-A	White	27.	OCT-15	Black
13.	IS-178-A	Brown	28.	IS-350	Brown
14.	SI-1248	Light Brown	29.	RJS-61	White
15.	SI-1578	Brown	30.	GRT-8357	Brown

Results and Discussion

The numerical data collected on quantitative characters were statistically analyzed and the analysis of variance (Table 2) showed highly significant differences among the genotypes under study for all the nine traits *viz.,* days to first flowering, days to 50 percent flowering, plant height at maturity (cm), number of branches per plant, number of capsules per plant, length of the capsule (cm), number of seeds per capsule, 1000 seed weight (g) and seed yield per plant (g) indicating the presence of considerable genetic variability among the experimental material under study. The difference between GCV and PCV were high for length of the capsule, 1000 seed weight followed by seed yield per plant indicating the influence of environment. PCV was slightly higher than GCV for all the characters revealing the presence of environmental influence on the expression of these characters under study (Table 3). This finding indicates that selection may be effective based on these characters and their phenotypic expression would be a good indication of genetic potential. Similar observations were reported by Gidey *et al*., (2012),

Table 2: Analysis of variance for nine yield and yield attributing characters in sesame.

S. No.	Sources	Df	Days to first flowering (days)	Days to 50 percent flowering (days)	Plant height at maturity (cm)	Number of branches per plant	Number of capsules per plant	Length of the capsules (cm)	Number of seeds per capsule	1000 seed weight	Seed yeild per plant
1	Replication	2	4.85	7.05	7.85	2.71	1.77	1.26	0.59	3.39	0.16
2	Genotype	29	19.29**	24.37**	263.84**	3.47**	81.90**	0.25**	40.22**	0.70**	1.25**
3	Error	58	0.64	0.89	0.81	0.05	0.94	0.04	0.90	0.10	0.16

** Significance at 1 percent level, * Significance at 5 percent level.

Bharathi *et al*., (2014), Chandra Mohan, (2014), Mahmoud *et al*., (2015) and Hika *et al*., (2015). The result of phenotypic coefficient of variation revealed that the number of branches per plant (47.78), seed yield per plant (21.00) and plant height at maturity (20.02) had high PCV (Vanishree *et al*., 2013). Moderate PCV and GCV was observed in number of capsules per plant, 1000 seed weight, length of the capsule and number of seeds per capsule. Similar findings were recorded by Gangadhara *et al*., (2012), Vanishree *et al*., (2013), Bharathi *et al*., (2014) and Abate and Mekbib, (2015). Low GCV and PCV was observed for days to first flowering and days to 50 percent flowering. This is in consonance with the findings of Bharathi *et al*., (2014) and Hika *et al.,* (2015).

High heritability and genetic advance as percent of mean was observed for plant height at maturity, number of branches per plant, number of capsules per plant, length of the capsule, number of seeds per plant, 1000 seed weight and seed yield per plant. These characters were controlled by additive gene effects and phenotypic selection for these characters would likely be effective than other characters measured (Sumathi and Muralidharan, 2009). This also goes in support with the findings of Gangadhara *et al*., (2012), Narayanan and Murugan, (2013), Vanishree *et al*., (2013) and Bharathi *et al.,* (2014). The broad sense heritability was highest for the characters plant height at maturity (99.08 percent), number of capsules per plant (96.62 percent), number of branches per plant (95.72 percent), days to first flowering (90.65 percent), 50 percent flowering (89.80 percent), seed yield per plant (70.01 percent), number of seeds per capsule (68.65 percent), 1000 seed weight (67.65 percent) and length of the capsule (66.72 percent). The estimate of genetic advance as percent of mean was found to be comparatively high for the characters like number of branches per plant (94.22 percent), plant height at maturity (40.86 percent), number of capsules per plant (37.26 percent), seed yield per plant (30.32 percent), 1000 seed yield (27.88 percent), length of the capsule (23.38 percent) and number of seeds per capsule (21.13 percent). (Table 3).

In the present study, correlation analysis indicated that seed yield exhibited positive non-significant correlation with plant height at maturity (Thirumala Rao *et al.,* 2013), number of branches per plant (Bharathi *et al.,* 2015), number of capsules per plant and number of seeds per capsule (Gidey *et al.,* 2012) and 1000 seed weight (Ismaila and Usman, 2014) at both genotypic and phenotypic levels. High positive and significant correlation was observed between plant height at maturity and number of branches per plant (0.534/0.520) (Fazal *et al.,* 2015), length of the capsule (0.460/0.382) (Vanishree *et al*., 2013). Length of the capsule had positive significant association with 1000 seed weight (0.357/0.409) both at

Table 3: Grand mean, variation, heritability and genetic advance for yield and yield contributing characters in 30 sesame genotypes.

Genetic parameters	Grand mean	Phenotypic variance (Vph)	Genotypic variance (Vg)	PCV (Percent)	GCV (Percent)	Heritability (in board) sense	Genetic advance as percent of mean
Days to first flowering	38.20	6.85	6.21	6.86	6.53	90.65	12.80
Days to 50 per cent flowering	40.99	8.71	7.82	7.20	6.82	89.8	13.32
Plant height at maturity	46.99	88.49	87.68	20.02	19.93	99.08	40.86
Number of branches per plant	2.28	1.19	1.14	47.78	46.75	95.72	94.22
Number of capsules per plant	28.21	27.93	26.99	18.72	18.40	96.62	37.26
Length of the capsule	1.94	0.11	0.07	17.01	13.90	66.72	23.38
Number of seeds per capsule	34.15	14.01	13.11	10.96	10.60	68.65	21.13
1000 seed weight	2.74	0.3	0.2	20.00	16.46	67.65	27.88
Seed yield per plant	3.43	0.52	0.36	21.00	17.58	70.01	30.32

Table 4: Genotypic and phenotypic correlation co-efficient (r) for yield and yield attributing characters in sesame.

Genotypic and Phenotypic Correlation		Days to first flowering	Days to 50 percent flowering	Plant height at maturity	Number of branches per plant	Number of capsules per plant	Length of the capsule	Number of seeds per capsule	1000 seed weight	Seed yield per plant
Days to first flowering	G	1.000	0.180	-0.247	-0.247	-0.037	0.132	-0.009	0.041	-0.049
	P	1.000	0.153	-0.233	-0.217	-0.032	0.062	-0.004	0.026	-0.038
Days to 50 per cent flowering	G		1.000	-0.308	-0.096	0.047	-0.121	0.051	-0.222	-0.159
	P		1.000	-0.284	-0.090	0.039	-0.121	0.041	-0.201	-0.143
Plant height at maturity	G			1.000	0.534**	-0.305	0.460**	-0.120	0.117	0.032
	P			1.000	0.520**	-0.295	0.382*	0.116	0.091	0.026
Number of branches per plant	G				1.000	0.028	0.105	-0.095	0.055	0.063
	P				1.000	0.030	0.070	-0.083	0.020	0.045
Number of capsules per plant	G					1.000	-0.171	-0.008	0.061	0.184
	P					1.000	-0.124	-0.016	0.049	0.153
Length of the capsule	G						1.000	0.078	0.357*	-0.116
	P						1.000	0.072	0.409*	-0.002
Number of seeds per capsule	G							1.000	0.148	0.139
	P							1.000	0.115	0.106
1000 seed weight	G								1.000	0.013
	P								1.000	0.045
Seed yield per plant	G									1.000
	P									1.000

** Significance at 1 percent level, * Significance at 5 percent level, G - Genotypic correlation co-efficient, P - Phenotypic correlation co-efficient

genotypic and phenotypic level (Vanishree *et al*., 2013).

Days to first flowering was negatively associated with plant height at maturity (Abate and Mekbib, 2015), number of branches per plant (Gangadhara *et al.,* 2012), number of capsules per plant (Abate and Mekbib, 2015) and number of seeds per capsule (Vanishree *et al.,* 2013).

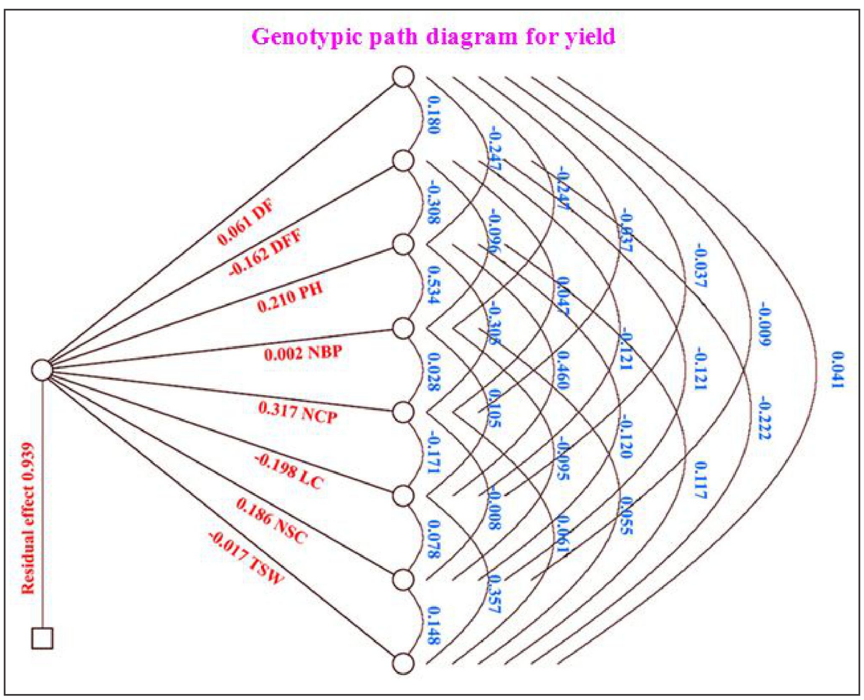

Fig. 1: Diagram of factors influencing yield at genotypic level.

Negative association may occur due to the competition of two developing structures of the plant for limited resources like nutrient and water supply (Adams, 1967). (Table 4).

Path analysis partitions correlation coefficient into direct and indirect effect which probes the cause and effect relationship (Fig 1). High positive direct effect on seed yield per plant was registered by number of capsules per plant (0.317) (Abate and Mekbib, 2015) whereas moderate positive direct effect on seed yield was registered by plant height at maturity (0.210) (Abate and Mekbib, 2015) and low positive direct effect on seed yield was registered by number of seeds per capsule (0.186) (Bharathi *et al*., 2015). In addition days to 50 percent flowering had negligible positive indirect effect on number of capsules per plant (0.010), length of the capsule (0.024) (Abate and Mekbib, 2015) and number of seeds per capsule (0.010) (Gangadhara *et al.,* 2012). Plant height at maturity had negligible positive indirect effect on 50 percent flowering (0.050) and seed yield per plant (0.032) (Abate and Mekbib, 2015).

Table 5: Path-coefficient analysis for various characters in sesame.

Effect of character	Days to first flowering (DF)	Days to 50 percent flowering (DFF)	Plant height at maturity (PH)	Number of branches per plant (NBP)	Number of capsules per plant (NCP)	Length of the capsule (LC)	Number of seeds per capsule (NSC)	1000 seed weight (TSW)	Seed yield per plant
Days to first flowering	**0.061**	-0.029	-0.044	-0.006	-0.008	-0.026	-0.002	-0.006	-0.049
Days to 50 per cent flowering	0.011	**-0.162**	-0.055	-0.002	0.010	0.024	0.010	0.004	-0.159
Plant height at maturity	-0.015	0.050	**0.210**	0.001	-0.066	-0.091	-0.023	-0.002	0.032
Number of branches per plant	-0.015	0.016	0.096	**0.002**	0.006	-0.21	-0.018	-0.001	0.063
Number of capsules per plant	-0.002	-0.011	-0.055	0.001	**0.317**	0.034	-0.001	-0.001	0.184
Length of the capsule	0.008	0.020	0.083	0.001	-0.037	**-0.198**	0.015	-0.006	-0.116
Number of seeds per capsule	-0.001	-0.008	-0.022	-0.002	-0.002	-0.015	**0.186**	-0.002	0.139
1000 seed weight	0.003	0.036	0.021	0.001	0.013	-0.071	0.028	**-0.017**	0.013

Residual effect 0.939 Bold values - Direct effect Unbold values - Indirect effect

Likewise number of branches per plant registered negligible positive indirect effect on seed yield per plant (0.063) (Fazal *et al*., 2015). The trait length of the capsule recorded negligible positive indirect effect on seed yield through plant height at maturity (0.083), days to 50 percent flowering (0.020) and number of seeds per capsule (0.015) (Shekhawat *et al*., 2013). And the trait 1000 seed weight had negligible positive indirect effect on seed yield through 50 percent flowering (0.036), plant height at maturity (0.021), number of capsules per plant (0.013) (Abate and Mekbib, 2015) and number of seeds per capsule (0.028) (Fazal *et al.,* 2015). (Table 5).

Conclusion

High heritability coupled with high genetic advance as percent of mean was observed for plant height at maturity, number of branches per plant, number of capsules per plant, length of the capsule, number of seeds per plant, 1000 seed weight and seed yield per plant indicate that these characters were controlled by additive gene action. Since the genetic advance as percent of mean is also high, the expected progress under selection could be obtained in the early generation itself. The correlation study indicated that seed yield had positive association with plant height at maturity, number of branches per plant, number of capsules per plant, number of seeds per capsule and 1000 seed weight at both genotypic and phenotypic levels. This apparently indicates that increased number of branches per plant, number of capsules per plant and number of seeds per capsules and 1000 seed weight shall increase seed yield directly, hence while making selection for seed yield emphasis to these characters may be given.

The cause and effect of relationship indicated maximum direct effect on seed yield per plant was through number of capsules per plant, number of seeds per capsule and plant height at maturity. This suggests that these characters deserve greater weightage while formulating selection indices in sesame.

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