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Genetic variability studies and path coefficient analysis in parents and F_1 families of sesame [*Sesamum indicum* L.]

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Abstract

Fifty one genotypes (36 crosses + 12 lines + 3 testers) of sesame were evaluated for seed yield and its components for different variability parameters and path coefficient analysis. Analysis of variance revealed significant differences among the genotypes for all the characters. The magnitude of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was larger for number of internodes per plant, height to first capsule, number of branches per plant, number of capsules per plant, number of capsules per leaf axils and seed yield per plant. Genetic advance as percent of mean for seed yield per plant, number of internodes per plant, height to first capsule, number of branches per plant, number of capsules per plant and number of capsules per leaf axils were higher in sesame genotypes. Path coefficient analysis of fourteen yield contributing characters clearly indicated that number of capsules per plant showed the highest positive direct effect on seed yield followed by number of seeds per capsule, 1000-seed weight, plant height and length of capsule which indicated positive direct effects in descending order and other characters days to maturity, height to first capsule, number of branches per plant, width of capsule and oil content contributed indirectly towards seed yield in sesame.

Keywords: Variability, path coefficient analysis, yield attributes, sesame

Introduction

Sesame (*Sesamum indicum* L.) is one of the most ancient and important oilseed crop grown next to groundnut and mustard in India. The oilseed crops play important role in agriculture and industrial economy of our country. It is called "Queen of Oilseeds" for its high quality and stability of oil which is due to the presence of saturated and unsaturated fatty acids in balanced form and antioxidants in the oil imparts stability. In India, sesame is cultivated on an area of 18.09 lakh ha with production of 8.17 lakh tones and productivity 451 kg/ha (Anonymous 2021) [3]. However, the productivity is low in India as compared to other countries which need to be improved.

Various components of seed yield very often exhibit varying degree of associations with seed yield as well as among themselves. Analysis of correlation coefficients between characters contributing directly or indirectly towards seed yield is a matter of considerable importance in exercising the selection programme. A study of correlation alone is not enough to provide an exact picture of relative importance of direct and indirect influences of each of the component traits on seed yield. In this context, path coefficient analysis is an important tool for the plant breeders in partitioning the total correlation coefficients into direct and indirect effects of independent variables on dependent variable *i.e.* seed yield per plant. Estimates of various genetic parameters for seed yield and yield components are essential for an efficient breeding program. Therefore, the present study was carried out to estimate different variability parameters *viz.*, genotypic and phenotypic variance, GCV, PCV, heritability and genetic advance for yield and yield components and genotypic correlation of different characters with seed yield and path coefficient analysis in 51 genotypes of sesame (*Sesamum indicum* L.).

Materials and Methods

The present study on sesame was conducted at Department of Genetics and Plant Breeding, Junagadh Agricultural University, Junagadh, Gujarat. Twelve diverse lines *viz.*, IC-205314, IC-43063, IC-81564, IC-204983, AT-164, AT-238, AT-115, Borda-1, Patan-64, TNAU-12, Keriya-2, NIC-75 and three testers *viz.,* G. Til-3, G. Til-4 and G.Til-10 were used as parental lines. The selected twelve lines and three testers were crossed in a line x tester design during summer 2012 to produce 36 hybrids.

The resulting 36 hybrids along with 15 parents were evaluated during kharif-2012 in a Randomized Block Design with three replications. Each plot was constructed with a row length of 3m and adopted a spacing of 45 x 15cm. All need based agronomic practices were followed during the crop growth period to raise a good crop. Observations were recorded on randomly selected five plants in each entry for 15 quantitative traits and the mean values were used for statistical analysis. Genotypic and phenotypic correlation between yield and its component traits were worked out as per the method suggested by Johnson *et al*. (1955) [10] and Al-jibouri *et al*. (1958) [2]. The significance of correlation coefficient was tested by referring to the standard table given by Fisher and Yates (1938) [7]. Path coefficient analysis was carried out as suggested by Dewey and Lu (1959) [6]. The path coefficient analysis was carried out according to the method suggested by Dewey and Lu (1959) [6].

Results and Discussion

The analysis of variance revealed that mean sum of square due to genotypes was significant for all the fifteen characters studied (Table 1). This indicated that considerable amount of variability was present in the genotypes for all the characters. Hence, there is a scope for inclusion of promising genotypes in breeding program for improvement of yield and its component characters in sesame. Results of investigation revealed that all fifteen characters are individually significant. Similar results for the above traits were also observed by Sumathi and Muralidharan (2010) [19], Spandana *et al*. (2012) [17] & Yirgalem *et al*. (2013) [22], Vivek *et al*. (2022) [21] worked on sesame crop.

Coefficient of variation truly provides a relative measure of variance among the different traits. 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 indicating the role of environmental variance in the total variance (Table 2). PCV ranged from 5.395 (oil content) to 41.784 percent (number of capsules per leaf axil), while GCV varied from 2.892 (oil content) to 41.231 percent (number of capsules per leaf axil). Higher magnitude of both PCV and GCV was recorded for number of capsules per leaf axil (41.784%), and (41.231%) followed by number of capsules per plant (36.507%) and (36.089), number of branches per plant (30.105%) and (29.177%) and seed yield per plant (30.066%) and (28.914%). Similar findings were reported by Sumahi and Muralidharan (2010) [19], Siva *et al*. (2013) [16], Tripathi *et al*. (2013) [20], Kiruthika *et al*. (2017) [11], Vivek *et al*. (2022) [21] and Singh *et al*. (2022) [15] in sesame.

The heritability in broad sense and genetic advance as percent of mean was work out for all the characters and their performance was adjudged on the basis given by Robinson *et al*. (1949) [13] for heritability and Johnson *et al*. (1955) [10] for genetic advance as percent of mean. The heritability estimates were found to be high for all the traits except number of seeds per capsule (66.6%) and oil content (28.7%) (Table 2). High heritability was observed for number of capsules per plant (97.7%) followed by number of capsules per leaf axil (97.4%), 1000-seed weight (97.3%), length of capsule (94.2%), number of branches per plant (93.9%), height to first capsule (93.0%) and seed yield per plant (92.5%). A perusal of genetic advance as percent of mean revealed that the characters such as number of capsules per leaf axil (83.81), number of capsules per plant (73.493), number of branches per plant (58.252), seed yield per plant (57.28) and height to first capsule (50.355) expressed high genetic advance as percent of mean.

The heritability coupled with high genetic advance as percent of mean were found for number of capsules per leaf axil, number of capsules per plant, number of branches per plant and seed yield per plant which revealed the roll of additive gene action in the inheritance of these traits. Hence, these traits could be effectively improved by simple and direct selection. The similar findings were observed by Hika *et al*. (2015) [8], Iqbal *et al*. (2016) [9], Abhijatha *et al*. (2017) [1] and Begum *et al*. (2017) [4]. High heritability coupled with moderate genetic advance as percent of mean was observed for height to first capsule, number of internodes per plant and plant height. Hence, there is good scope of improvement for these traits through simple selection. Vivek Kumar *et al*. (2022) [21] and Singh *et al.* (2022) [15] also noticed high heritability coupled with moderate genetic advance as percent of mean for this character.

Path analysis can provide an effective means of partitioning the correlation coefficient in to direct and indirect coefficient of fourteen independent characters on seed yield. The results of path coefficient analysis of direct and indirect effects of different characters on seed yield are presented in Table 3. The genotypic path coefficient analysis revealed that number of capsules per plant, number of seeds per capsule, 1000-seed weight, plant height and length of capsule exhibited high and positive direct effects on seed yield per plant. These characters turned out to be the major components of seed yield. The maximum and positive direct effects of such traits were also reported by Pawar *et al*. (2002) [12], Sankar and Kumar (2003) [14], Bhuyan and Sharma (2004) [5] and Singh *et al*. (2022) [15]. The genotypic path coefficient analysis revealed that days to 50% flowering, number of internodes per plant, number of capsules per leaf axil and protein content exhibited moderate and positive direct effects on seed yield per plant. These characters turned out to be the minor components of seed yield. The results of moderate and positive direct effects of such traits were also reported by Vivek Kumar *et al*. (2022) [21] and Singh *et al*. (2022) [15].

The negative direct effect of low magnitude of days to maturity, height to first capsule, number of branches per plant, width of capsule and oil content was nullified by high and positive indirect effects of days to 50% flowering. Similarly, the negative direct effect of low magnitude of days to maturity, height to first capsule, number of branches per plant was nullified by positive and significant correlation with seed yield per plant. The residual effect was of low magnitude suggesting that the majority of the yield attributes have been included in the path analysis.

Considering the correlation and path coefficient analysis for seed yield per plant and its component traits, an ideal plant type in sesame would be one with more number of capsules per plant, more number of seeds per capsule, number of branches per plant and lowest days to maturity. Therefore, more emphasis should be given to these components while making selection for higher seed yield in sesame.

Table 1: Analysis of variance for fifteen quantitative characters of sesame

Sr. No.	Character	Mean Sum of Square		
		Replication (df=2)	Genotype (df=50)	Error (100)
1	Days to 50% flowering	1.026144	52.873203**	3.566144
2	Days to maturity	2.019608	60.715294**	4.419608
3	Plant height	11.326732	793.396983**	28.496332
4	Height to first capsule	1.466928	352.815195**	8.598128
5	Number of branches per plant	0.094902	2.932957**	0.061835
6	Number of internodes per plant	0.161830	64.630912**	2.304763
7	Length of capsule	0.003738	0.251792**	0.005066
8	Width of capsule	0.000949	0.014300**	0.000599
9	Number of capsules per plant	13.361830	1512.038599**	11.648230
10	Number of capsules per leaf axil	0.008105	0.907650**	0.008105
11	Number of seeds per capsule	0.113137	105.650227**	15.102871
12	1000-seed weight	0.005510	0.510303**	0.004691
13	Seed Yield per plant	1.096841	66.569788**	1.756121
14	Oil content	2.300412	10.411048**	4.711443
15	Protein content	0.261684	15.298081**	0.914054

** Significant at 1 percent level

Table 2: Genetic variability parameters for fifteen quantitative traits of sesame genotypes

Sr. No.	Characters	σ_e^2	σ_g^2	σ_p^2	ECV (%)	GCV (%)	PCV (%)	h^2 (broad sense) (%)	Genetic advance	Genetic advance as % of mean
1	D50F	3.566	16.436	20.002	4.282	9.192	10.14	82.2	7.57	17.165
2	DM	4.42	18.765	23.185	2.361	4.865	5.408	80.9	8.028	9.016
3	PH	28.496	254.967	283.463	6.114	18.287	19.282	89.9	31.196	35.728
4	HFC	8.598	114.739	123.337	6.938	25.344	26.276	93.0	21.283	50.355
5	NBPP	0.062	0.957	1.019	7.416	29.177	30.105	93.9	1.953	58.252
6	NIPP	2.305	20.775	23.08	8.24	24.738	26.074	90.0	8.908	48.35
7	LC	0.005	0.082	0.087	2.546	10.257	10.568	94.2	0.573	20.507
8	WC	0.001	0.005	0.005	2.904	8.017	8.527	88.4	0.131	15.528
9	NCPP	11.648	500.13	511.778	5.508	36.089	36.507	97.7	45.542	73.493
10	NCPLA	0.008	0.300	0.308	6.778	41.231	41.784	97.4	1.113	83.81
11	NSPC	15.103	30.182	45.285	7.088	10.02	12.274	66.6	9.239	16.852
12	GW	0.005	0.169	0.173	2.105	12.615	12.79	97.3	0.834	25.633
13	SYPP	1.756	21.605	23.361	8.243	28.914	30.066	92.5	9.208	57.28
14	OC	4.711	1.900	6.611	4.555	2.892	5.395	28.7	1.522	3.194
15	PC	0.914	4.795	5.709	4.806	11.007	12.01	84.0	4.134	20.78

(D50F= Days to 50% flowering, DM= Days to maturity, PH= Plant height, HFC= Height to first capsule, NBPP= Number of branches per plant, NIPP= Number of internodes per plant, LC= Length of capsule, WC= Width of capsule, NCPP= Number of capsules per plant, NCPLA= Number of capsules per leaf axil, NSPC= Number of seeds per capsule, GW=1000-Seed Weight, SYPP= Seed yield per plant, OC=Oil Content and PC= Protein Content)

Table 2: Genotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on seed yield of sesame

Characters	D50F	DM	PH	HFC	NBPP	NIPP	LC	WC	NCPP	NCPLA	NSPC	GW	OC	PC	Genotypic correlation with seed yield
D50F	0.0606	0.0304	0.02	0.0189	0.017	0.0171	-0.0004	0.0042	0.0146	0.0069	-0.002	-0.0209	0.0093	-0.0039	0.1409
DM	-0.0545	-0.1088	-0.0748	-0.0798	-0.0533	-0.0689	0.0212	0.0151	-0.0671	0.0358	-0.0258	0.0292	0.0294	-0.0076	0.5677**
PH	0.0729	0.1516	0.2205	0.2037	0.1189	0.1875	0.0153	0.0008	0.1699	-0.0824	0.0692	-0.0512	-0.0675	-0.0109	0.8164**
HFC	-0.0151	-0.0355	-0.0447	-0.0484	-0.0276	-0.0407	-0.0003	0.0046	-0.0394	0.0199	-0.0125	0.0119	0.0175	0.0018	0.8169**
NBPP	-0.005	-0.0087	-0.0096	-0.0101	-0.0178	-0.0094	0.0038	0.0067	-0.0125	0.0058	0.0024	0.0059	0.0074	-0.0006	0.5594**
NIPP	0.0114	0.0255	0.0342	0.0338	0.0212	0.0403	-0.0008	-0.0021	0.0279	-0.0105	0.0089	-0.0109	-0.0185	-0.0004	0.7142**
LC	-0.0008	-0.0242	0.0086	0.0008	-0.0267	-0.0025	0.1241	0.0665	-0.0282	0.0072	0.0677	0.0388	0.0743	-0.0158	0.0733
WC	-0.0107	0.0214	-0.0006	0.0146	0.0579	0.0082	-0.0829	-0.1548	0.0453	-0.0402	-0.0251	-0.054	-0.0691	-0.0092	-0.1824*
NCPP	0.195	0.5004	0.6251	0.6608	0.5683	0.561	-0.1845	-0.2372	0.8113	-0.3202	0.015	-0.271	-0.2207	-0.0158	0.8473**
NCPLA	0.0042	-0.0122	-0.0139	-0.0153	-0.0121	-0.0096	0.0022	0.0096	-0.0147	0.0371	-0.0087	0.0006	0.0205	-0.0007	-0.451**
NSPC	-0.0095	0.0681	0.09	0.0744	-0.0384	0.0636	0.1567	0.0466	0.0053	-0.0669	0.2871	0.03	0.0459	-0.0789	0.3651**
GW	-0.089	-0.0694	-0.06	-0.0636	-0.0863	-0.07	0.0808	0.0901	-0.0863	0.0042	0.027	0.2583	0.0887	0.094	-0.0298
OC	-0.0129	0.0228	0.0258	0.0305	0.035	0.0388	-0.0505	-0.0376	0.0229	-0.0465	-0.0135	-0.029	-0.0843	-0.0242	-0.1418
PC	-0.0057	0.0062	-0.0044	-0.0033	0.0032	-0.001	-0.0113	0.0053	-0.0017	-0.0016	-0.0244	0.0323	0.0254	0.0888	0.0166

*, ** Significant at 5% and 1% levels, respectively, Residual effect R= 0.2747

(D50F= Days to 50% flowering, DM= Days to maturity, PH= Plant height, HFC= Height to first capsule, NBPP= Number of branches per plant, NIPP= Number of internodes per plant, LC= Length of capsule, WC= Width of capsule, NCPP= Number of capsules per plant, NCPLA= Number of capsules per leaf axil, NSPC= Number of seeds per capsule, GW=1000-Seed Weight, OC=Oil Content and PC= Protein Content)

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