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Research Article

Assessment of genetic variability, correlation and path analysis in sesame (*Sesamum indicum* L.)

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Abstract
A total of 33 sesame genotypes including three checks were grown in Randomized Block Design in three replications for evaluation of yield and yield attributing traits. Data was recorded for different yield attributing traits from all the genotypes *viz*., days to 50 % flowering, number of productive branches, plant height, height of 1st capsule bearing node, number of capsules per plant, number of seeds per capsule, capsule length, inter-node length, days to maturity, 1000-grain weight, per cent of oil and yield. 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 seed yield, number of productive branch and inter-node length. Genetic advance as per cent of mean for seed yield, numbers of productive branches, height of 1st node from ground and internode length were higher in sesame genotypes. Correlation exhibited significant and high positive for number of productive branches, number of capsules per plant, number of seeds per capsule and days to maturity with seed yield. Path analysis indicated that the traits such as number of productive branches, number of capsules per plant, days to maturity, number of seeds per capsule had high positive direct effect on seed yield. These traits are to be given due importance in the selection process of sesame breeding programme.

Keywords: PCV, GCV, Sesame, Genetic Advance, Correlation, Path analysis

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an ancient oilseed crop belonging to family Pedaliaceae with diploid (2n = 26) chromosome. The genus Sesamum contains more than 30 species of which *Sesamum indicum* is the most cultivated species (Nayar and Mehra, 1970). It is economically very important crop as it contains high oil of about 40-60% and good quality of 20-40% protein. 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.

Yield is a complex trait, and it is very much affected by the environmental factors. For improvement in a particular trait of sesame crop, genetic variability present in the crop needs to be exploited. Variability may be naturally present, or breeder may create it through several means. Analysis of variance, PCV, GCV, heritability, genetic advance and correlation coefficient is helpful parameters to understand the relationship of yield with other characters. The genotypic and phenotypic correlation coefficients are divided into direct and indirect effects through path coefficient analysis which play very important role to

increase yield. Path coefficient analysis is helpful to the breeder in identification of the direct influence of variables.

MATERIALS AND METHODS

The investigation was carried out at the research farm of Bihar Agricultural University, Sabour, Bhagalpur, Bihar in 2019-20 (summer season). Sabour is geographically situated between 25'' 15'40'' N latitude to 87°2'42'' E longitude at 46 m above mean sea level. The experiment was laid in Randomized Block Design with 33 genotypes including three checks GT-10 and TKG-22 varieties were used as national check, while JTS-8 was the zonal check. Plot area was 3.6 m^2 with plant-to-plant distance of 10 cm and row to row distance of 30 cm. Data of twelve traits has been recorded, it was recorded on five randomly selected plants in each genotype in all three replications. List of genotypes included in the study is presented in **Table 1**.

Genotypic and phenotypic correlation between yield and its component traits were worked out as per the method suggested by Johnson *et al.* (1955) and Al - jibouri *et al.* (1958). The significance of correlation coefficient was tested by referring to the standard table given by Fisher and Yates (1938). Path coefficient analysis was carried out as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The mean sum of square due to genotypes was significant for all the characters studied (**Table 2**). This revealed 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 yield and its component characters. Results of investigation revealed that all twelve characters are individually significant. Similar results for the studied traits were also observed by Parameshwarappa *et al.* (2009), Sumathi and Muralidharan (2010), Spandana *et al.* (2012) & Yirgalem *et al*. (2013) worked on sesame crop.

The estimates of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) for all the twelve characters studied are presented in **Table 3**. PCV ranged from 6.81(days to maturity) to 32.31 per cent (seed yield), while GCV varied from 5.9 (days to maturity) to 31.36 percent (seed yield).These results were in accordance with the similar findings were exhibited by Parameshwarappa *et al*. (2009), Sumahi and Muralidharan (2010), Siva *et al*. (2013), Tripathi *et al*. (2013), Higher magnitude of both PCV and GCV was recorded for seed yield (32.31%), and (31.36%) and number of productive branches per plant (25.97%), moderate estimates were recorded for height of 1st capsule bearing node (17.19%), inter node length (14.01%), number of capsules per plant (13.11%) and days to maturity Bharathi *et al*. (2014) and Singh *et al.* (2018) in sesame.

A perusal of data (**Table 3**) it is evident that the heritability (broad sense) estimated for the twelve quantitative characters, ranged from 42.97 (capsule length) to 94.25 per cent (seed yield). High heritability was observed for the traits *viz.,* seed yield (94.25%), number of productive branches per plant (94.02%), days to 50% flowering (93.80%) and inter node length (85.34%). The characters

Table 1. List of Sesame genotypes used in the study

S. No.	Genotype	Source	S. No.	Genotype	Source
1	JLS-120	ORS, Jalgaon, Maharashtra	18	RAMA	IAS, Kolkata
2	AT-255	ARS, Amreli	19	AT-324	ARS, Amreli, Gujarat
3	TKG-523	AICRP, Tikamgarh, MP	20	SHT-01	RARS, Assam
4	TKG-525	AICRP, Tikamgarh, MP	21	KALIKA	OUAT, Bhubaneshwar
5	AT-337	ARS, Amreli, Gujarat	22	OSM-170	OUAT, Bhubaneshwar
6	AT-331	ARS, Amreli, Gujarat	23	Suprava	IAS, Kolkata
7	TKG-15-01	AICRP, Tikamgarh, MP	24	CUHY-57	IAS, Kolkata
8	DS-17-28	UAS, Dharwad	25	JCS2696	AICRP, Jagtial, Telangan
9	JCS-DT-26	AICRP, Jagtial, Telangana	26	BRT-04	Collection from Purnea
10	AT-336	ARS, Amreli, Gujarat	27	BRT-06	Jharkhand
11	TKG-518	AICRP, Tikamgarh, MP	28	BRT-08	SImla, Himachal Pradesh
12	JLS-408-2	ORS, Jalgain, Maharastra	29	BRT-09	Dhaka
13	JLS-708	PC unit, Jabalpur, Madhya Pradesh	30	BRT-10	Supaul, Bihar
14	EC-370840	PC unit, Jabalpur, Madhya Pradesh	31	GT-10 (NC)	ARS, Amreli, Gujarat
15	PC-14-1	PC unit, Jabalpur, Madhya Pradesh	32	TKG-22 (NC)	AICRP, Tikamgarh, MP
16	AT-287	ARS, Amreli, Gujarat	33	JTS-8 (ZC)	AICRP, Tikamgarh, MP
17	OSM-22	OUAT, Bhubaneshwar			

Table 2. Analysis of variance of twelve quantitative characters of sesame

S. No.	Characters	Mean sum of square		
		Replication (df=2)	Genotype (df=32)	Error (df=64)
1	Days to 50% flowering	0.848485	56.801**	1.223485
2	Number of productive branches	0.208182	4.144**	0.085994
3	Plant height	31.084510	202.900**	41.485634
4	Height of 1st capsule bearing node	0.671312	68.039**	12.322870
5	Number of capsules per plant	33.093040	532.096**	46.373445
6	Number of seeds per capsule	6.447020	84.863**	11.938978
7	Capsule length	0.117577	0.222402**	0.068222
8	Inter node length	0.021168	1.0639**	0.057618
9	Days to maturity	22.97980	88.385101**	8.708965
10	1000- seed weight	0.069543	0.190243**	0.023881
11	Oil content	0.450840	57.8919**	5.573269
12	Seed yield	7662.3100	265751.14**	5300.408253

** Significant at 1 per cent level

Table 3. Genetic variability parameters of twelve quantitative traits of sesame genotype

S. No.	Characters	σ_e^2	σ_g^2	σ_p^2	ECV (%)	GCV (%)	PCV (%)	h^2 (broad sense) (%)	Genetic advance	Genetic advance as % mean
1.	Days to 50% flowering	1.22	18.53	19.75	3.08	11.98	12.37	93.80	8.59	23.89
2.	Number of productive branches	0.09	1.35	1.44	6.55	25.97	26.78	94.02	2.32	51.87
3.	Plant height	41.49	53.81	95.29	6.42	7.307	9.73	56.46	11.35	11.31
4.	Height of 1st capsule bearing node	12.32	18.57	30.89	14.01	17.19	22.18	60.11	6.88	27.46
5.	Number of capsule/plants	46.37	161.91	208.28	7.02	13.11	14.87	77.74	23.11	23.81
6.	Number of seeds per capsule	11.94	24.31	36.25	6.45	9.20	11.24	67.06	8.32	15.53
7.	Capsule length	0.0682	0.0514	0.1196	9.50	8.25	12.58	42.97	0.3061	11.14
8.	Inter node length	0.0576	0.3355	0.8534	5.81	14.01	15.17	85.34	1.10	26.66
9.	Days to maturity	8.71	26.56	35.27	3.38	5.91	6.81	75.31	9.21	10.56
10.	1000-seed weight	0.0239	0.0555	0.0793	4.79	7.30	8.73	69.90	0.4056	12.57
11.	Oil content	5.57	17.44	23.013	5.54	9.81	11.26	75.78	7.49	17.58
12	Seed yield	5300.41	86816.91	92117.32	7.75	31.37	32.31	94.25	589.26	62.73

*viz.,*yield kg/ha, number of productive branches, days to 50 % flowering, inter node length, number of capsules per plant and height of 1st capsule bearing node showed high heritability coupled with high genetic advance as percent mean. High estimates of heritability for days to maturity was reported by Haibru *et al.* (2018) and high heritability for percentage of oil reported by Bindu *et al.* (2014). Panse and Sukhatme (1985) reported that characters showing high heritability were governed predominantly by additive gene action and could be improved through individual plant selection.

High genetic advance as per cent of mean was observed for seed yield (62.73%) and number of productive branches (51.87%). High heritability coupled with high genetic advance as per cent of mean for number of productive branches, plant height, number of capsules per plant, oil content and seed yield also reported by Bindu *et al*. (2014). These results are in accordance with the results of Ismaila and Usman (2014), Prithviraj and Parameshwarappa (2017) and Haibru *et al.* (2018) in sesame. The results for these characters indicated that heritability is most likely due to additive gene effects

and selection may be effective. This type of characters could be improved by mass selection and other breeding methods based on progeny testing.

In the present study, correlation coefficient analysis measures the reciprocal relationship between twelve different quantitative traits to estimate the component trait on which selection may be emphasized for yield improvement. The phenotypic and genotypic correlation coefficients are shown in **Tables 4 & 5**, respectively. In most of the situations, the measures of genotypic correlation coefficients were higher than the respective phenotypic correlation.

Seed yield exhibited positive and significant correlation with the number of productive branches, number of capsules per plant, number of seeds per capsule and days to maturity. Gangadhara *et al.* (2012) & Abhijatha *et al.* (2017) were also reported same results in sesame. Goudappagoudra *et al*. (2011), Fazal *et al.* (2015) and Patil and Lokesha (2018) also reported significant positive correlation of seed yield with number of productive branches, number of capsules per plant and number of seeds per plant. It also showed negatively significant correlation with height of 1st capsule bearing node with this results in accordance Ismaila and Usman (2014) in sesame. The highly significant and positive correlation

Table 4. Phenotypic correlation of twelve quantitative parameters of sesame genotypes

	NPB	PH	HFCBN	NCPP	NSPC	CL	IL	DM	GW	OC	Y
D50F	0.0718	0.0531	0.2145 *	0.0592	0.1279	0.0221	0.3983 **	0.5857 **	-0.0672	-0.1369	-0.1152
NPB		0.0604	-0.3139 **	0.5276 **	0.5908 **	0.1372	0.0607	0.3726 **	0.0603	-0.1270	0.7648**
PH			0.3708 **	0.0425	-0.0031	0.2545 *	0.1495	0.1166	0.3960 **	0.4588 **	-0.0049
HFCBN				-0.3021 **	-0.1089	-0.0219	0.2031 *	0.0573	0.1374	0.2058 *	-0.3463**
NCPP					0.3089 **	0.1428	-0.0283	0.1895	-0.0522	-0.2830 **	0.6166**
NSPC						0.0106	-0.2282 *	0.2279 *	0.0544	-0.2105 *	0.5837**
CL							0.2527 *	0.0846	0.2165 *	0.2934 **	0.1004
IL								0.3704 **	0.0364	0.2910 **	-0.0631
DM									0.1577	-0.0029	0.3171**
GW										0.5694 **	0.0078
OC											-0.1353

** Significant at 1 per cent level ; * Significant at 5 per cent level

D50F = Days to 50% flowering, NPB = Number of productive branches, PH = Plant height, HFCBN = Height of 1st capsule bearing node, NCPP = Number of capsules per plant, NSPC = Number of seeds per capsules, CL= Capsule length, IL = Inter node length, DM = Days to maturity, GW = 1000- seed weight, OC = Oil content, Y = Seed yield

Table 5. Genotypic Correlation coefficient of twelve quantitative characters of sesame genotypes

	NPB	PH	HFCBN	NCPP	NSPC	CL	IL	DM	GW	OC	Y
D50F	0.0673	0.0444	0.2591	0.0761	0.1454	0.0616	0.4262	0.6763	-0.1104	-0.1709	-0.1273
NPB		-0.0026	-0.4371	0.5464	0.6939	0.1660	0.0685	0.4317	0.0070	-0.2050	0.7993
PH			0.5918	-0.1053	-0.2218	0.2940	0.2710	0.1434	0.3724	0.4175	-0.0921
HFCBN				-0.4408	-0.2370	-0.0826	0.2506	0.0514	0.1757	0.2607	-0.4867
NCPP					0.3285	0.1088	-0.0033	0.1926	-0.2158	-0.4913	0.6925
NSPC						-0.2216	-0.2499	0.3829	-0.1883	-0.5836	0.6578
CL							0.4717	0.1274	0.1156	0.1499	0.0873
IL								0.4441	0.1354	0.4376	-0.0789
DM									0.1886	-0.0065	0.3483
GW										0.5085	-0.0638
OC											-0.2383

D50F = Days to 50% flowering, NPB = Number of productive branches, PH = Plant height, HFCBN = Height of 1st capsule bearing node, NCPP = Number of capsules per plant, NSPC = Number of seeds per capsules, CL= Capsule length, IL = Inter node length, DM = Days to maturity, GW = 1000- Seed weight, OC = Oil content, Y = Seed yield

showed by number of productive branches with number of capsules per plant, number of seeds per capsule and days to maturity. The results were in accordance with the finding of Shekhawat *et al.* (2013), Kindeya (2017) and Ismaila & Usman (2017) for number of capsules per plant and Kumhar *et al*. (2008) for number of seeds per capsule. Number of capsules/plants showed positively high significant correlation with number of seeds per capsule indicated that number of capsules per plant will accommodate a greater number of seeds per capsule leading to ultimate increase in seed yield. These results agreed with the findings of Gangadhara *et al.* (2012), Bharathi *et al.* (2015) and Fazal *et al.* (2015) in sesame.

The direct and indirect effect of different traits on yield is depicted in **Tables 6 & 7**. Path analysis revealed the number of productive branches had high positive direct effect on seed yield. However, it exhibited high indirect effect on seed yield via height of 1st capsule bearing node, number capsules per plant, number of seeds per capsule, inter node length and days to maturity. Similar results were found by Gangadhara *et al.* (2012), Kumhar *et al.* (2008), Bharathi *et al.* (2015), Fazal *et al.* (2015) and Abate and Mekbib (2015) in sesame. Number of capsules per plant was reported positive direct effect on seed yield, whereas it exhibited high indirect effect on seed yield *via* number of productive branches, height of 1st capsule bearing node, number of seeds per capsule, days to maturity and 1000-seed weight. Subashini (2003) and Navaneetha *et al.* (2019) had also found similar results in sesame crop. Days to maturity (0.2861) had positive direct effect on seed yield, whereas it exhibited high positive indirect effect on seed yield *via* number of productive branches, number of capsules per plant, number of seeds per capsule and inter node length. Parameshwarappa *et al.* (2009), Sudhakar *et al.* (2007), Chandra Mohan (2014), Gangadhara *et al.* (2012), Shekhawat *et al.* (2013), Bharathi *et al*. (2015) and Abate and Mekbib (2015) were reported similar results in sesame Number of seeds per capsule had high positive direct effect on seed yield However, it had high positive indirect effect on seed yield *via* number of productive branches, plant height, height of 1st capsule bearing node, number of capsules per plant and days to maturity. Similar results were found by Vanishree *et al.* (2011), Ibrahim and Khidir (2012), Shekhawat *et al.* (2013), Bharathi *et al.* (2015) and Fazal *et al.* (2015) in sesame.

The estimation of high heritability value coupled with high genetic advance as percent mean was recorded for the characters seed yield, number of productive branches, days to 50 % flowering, inter node length, number of capsules per plant and height of 1st capsule bearing node. These characters would be more effective for desired genetic improvement. Correlation analysis indicated that the characters *viz.,* number of productive branches, number of capsules per plant, number of seeds per capsule and days to maturity are inter correlated among themselves. Therefore, these traits are to be given priority during selection for improvement of yield. Path analysis revealed that the trait number of productive branches had very high direct effect on yield followed

Table 6. Direct (diagonal) and indirect effects of different characters attributing to grain yield in sesame at phenotypic level

	D50F	NPB	PH	HFCBN	NCPP	NSPC	CL	IL	DM	GW	OC
D50F	**-0.35**	-0.0251	-0.0186	-0.0751	-0.0207	-0.0448	-0.0077	-0.1394	-0.205	0.0235	0.0479
NPB	0.0259	**0.3603**	0.0218	-0.1131	0.1901	0.2129	0.0494	0.0219	0.1343	0.0217	-0.0457
PH	-0.0021	-0.0024	**-0.0404**	-0.015	-0.0017	0.0001	-0.0103	-0.006	-0.0047	-0.016	-0.0185
HFCBN	-0.0086	0.0126	-0.0149	**-0.0403**	0.0122	0.0044	0.0009	-0.0082	-0.0023	-0.0055	-0.0083
NCPP	0.0192	0.1708	0.0138	-0.0978	**0.3237**	0.1	0.0462	-0.0091	0.0613	-0.0169	-0.0916
NSPC	0.0355	0.1642	-0.0009	-0.0303	0.0858	**0.2779**	0.0029	-0.0634	0.0633	0.0151	-0.0585
CL	-0.0003	-0.002	-0.0037	0.0003	-0.0021	-0.0002	**-0.0144**	-0.0036	-0.0012	-0.0031	-0.0042
IL	0.0046	0.0007	0.0017	0.0023	-0.0003	-0.0026	0.0029	**0.0116**	0.0043	0.0004	0.0034
DM	0.1676	0.1066	0.0334	0.0164	0.0542	0.0652	0.0242	0.106	**0.2861**	0.0451	-0.0008
GW	0.008	-0.0071	-0.0469	-0.0163	0.0062	-0.0064	-0.0256	-0.0043	-0.0187	**-0.1184**	-0.0674
OC	-0.0149	-0.0138	0.0498	0.0223	-0.0307	-0.0228	0.0318	0.0316	-0.0003	0.0618	**0.1086**
Correlation co-efficient for seed Yield	-0.1152	0.7648**	-0.0049	-0.3463**	0.6166**	0.5837**	0.1004	-0.0631	0.3171**	0.0078	-0.1353

RESIDUAL EFFECT = 0.4850

D50F = Days to 50 per cent flowering, NPB = Number of productive branches, PH = Plant height, HFCBN = Height of 1st capsule bearing node, NCPP = Number of capsules per plant, NSPC = Number of seeds/capsules, CL= Capsule length, IL = Inter node length, DM = Days to maturity, GW = 1000- seed weight, OC = Oil content, Y = Seed yield

Table 7. Direct (diagonal) and indirect effects of different characters attributing to grain yield in sesame at genotypic level

	D50F	NPB	PH	HFCBN	NCPP	NSPC	CL	IL	DM	GW	OC	Y
D50F	**-0.2742**	-0.0185	-0.0122	-0.071	-0.0209	-0.0399	-0.0169	-0.1169	-0.1854	0.0303	0.0469	**-0.1273**
NPB	-0.0095	**-0.1413**	0.0004	0.0617	-0.0772	-0.098	-0.0234	-0.0097	-0.061	-0.001	0.029	**0.7993**
PH	-0.0075	0.0004	**-0.1678**	-0.0993	0.0177	0.0372	-0.0493	-0.0455	-0.0241	-0.0625	-0.0701	**-0.0921**
HFCBN	0.0198	-0.0333	0.0451	**0.0763**	-0.0336	-0.0181	-0.0063	0.0191	0.0039	0.0134	0.0199	**-0.4867**
NCPP	0.0608	0.4363	-0.0841	-0.352	**0.7985**	0.2623	0.0869	-0.0026	0.1538	-0.1723	-0.3923	**0.6925**
NSPC	0.1195	0.57	-0.1822	-0.1947	0.2698	**0.8215**	-0.1821	-0.2053	0.3146	-0.1547	-0.4794	**0.6578**
CL	0.0174	0.0469	0.083	-0.0233	0.0307	-0.0626	**0.2824**	0.1332	0.036	0.0326	0.0423	0.1159
IL	-0.1236	-0.0199	-0.0786	-0.0727	0.001	0.0725	-0.1368	**-0.29**	-0.1288	-0.0393	-0.1269	**-0.0789**
DM	0.185	0.1181	0.0392	0.0141	0.0527	0.1048	0.0348	0.1215	**0.2736**	0.0516	-0.0018	**0.3483**
GW	0.0171	-0.0011	-0.0577	-0.0272	0.0335	0.0292	-0.0179	-0.021	-0.0292	**-0.155**	-0.0788	**-0.0638**
OC	-0.1321	-0.1584	0.3227	0.2015	-0.3797	-0.4511	0.1159	0.3382	-0.005	0.393	**0.7729**	**-0.2383**

RESIDUAL EFFECT = 0.1947

D50F = Days to 50 per cent flowering, NPB = Number of productive branches, PH = Plant height, HFCBN = Height of 1st capsule bearing node, NCPP = Number of capsules /plants, NSPC = Number of seeds/capsules, CL= Capsule length, IL = Inter node length, DM = Days to maturity, GW =1000- Seed weight, OC = Oil content, Y = Seed yield

by number of capsules per plant, days to maturity and number of seeds per capsule. As far as indirect effects are considered, the trait number of productive branches had high indirect positive effect on seed yield followed by number of capsules per plant, number of seeds per capsule and days to maturity. The study revealed that the traits number of productive branches, number of capsules per plant and number of seeds per capsule to be given more importance during selection programme for seed yield improvement in sesame.

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