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

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Abstract
An experiment was conducted with twenty one genotypes to study the variability, character association and path analysis in sesame (*Sesamum indicum* L.). Genotypes varied significantly for all the morpho-physiological characters. The mean values shifted bidirectionaly significantly as compared to better check, thus provide scope of selection. A close proximity between PCV and GCV indicated strong base of genetic component in expression of all the characters under study. High heritability coupled with high genetic advance for characters plant height, productive capsules per plant 1000 seed weight, harvest index and seed yield per plant suggested the preponderance of additive gene effect in expression of these characters, seed yield per plant had positive association with harvest index, productive capsules per plant, number of seeds per capsules, number of branches per plant, productive branches per plant, biological yield and 1000 seed weight at genotypic and phenotypic level. Path coefficient analysis indicated maximum direct effect of number of branches per plant, biological yield and harvest index on seed yield indicating the importance of these traits in determining seed yield.

Keywords: Sesame, genetic variability, path analysis

Introduction
Sesame (*Sesamum indicum* L., Pedaliaceae) is a diploid (2n=26) dicotyledonous and one of the oldest oilseed crop which grown widely in tropical and sub tropical area for its edible oil, proteins, vitamins and amino acids. Sesame is a broad leafed plant with mostly indeterminate inflorescence (Tashiro *et al*., 1991) [38]. Though there are dehiscent and non-dehiscent types, but most sesame seed is produced with dehiscent types. When the capsules on dehiscent cultivars mature, they split from top to down wards over about two thirds of their length and shed their seeds, if not timely harvested, causing yield losses.

Sesame is a self pollinated crop with an average cross pollination to the extent of 4 to 5 per cent. Sesame is a high value food crop which is an important source of edible oil and is also used as a spice (in bakeries). The seed oil containing high proportion of natural antioxidants such as *sesamolin*, *sesamin* and *sesamol* which give excellent stability (Brar and Ahuja, 1979; Hatam and Abbasi, 1994; Uzun *et al.*, 2002) [9, 19, 42] and 19-25% protein (Ashakumary *et al*., 1999) [3] and oil content ranging from about 45 to 53%. Genetic and environmental factors influence the oil content and fatty acid compositions of sesame (Carlsson *et al.*, 2008) and also the indeterminate cultivars accumulated more oil than determinate ones (Uzun *et al.*, 2002) [42]. The principal unsaturated fatty acids are oleic and linoleic with about 40% of each and 14% saturated fatty acids. The seeds are very rich in iron, magnesium, copper, calcium and vitamin B_1 (thiamine) and E (tocopherol). It contains lignin, including unique content of *sesamin* which are phytoestrogen with antioxidant and anticarcinogenic properties. The variations in climate and edaphic conditions, affect sesame yields and performance, Muhamman and Gungula (2008) [27]. The major constraints identified in growing sesame in most countries are instability in yield, lack of wider adaptability, drought, non-synchronous maturity, poor stand establishment, lack of response to fertilizer application, profuse branching, lack of seed retention, low harvest index and susceptibility to insect pests and pathogens.

In Bihar, the sesame is grown in about 2754 ha. with an annual production of 2390 Mt and productivity of 868 kg/ha (Directorate of economics and statistics), mainly grown in *Kharif* season as rainfed crop and also in summer where irrigation facilities are available .Sesame is the most neglected oil seed crop grown on marginal lands under poor management resulting in very low yield. Further, the poor yield is due to the non-availability of cultivars to suit the diverse agro-climatic conditions. Hence, development of improved high yielding cultivars adapted to local conditions has become need of the hour.

Better understanding of the genetic makeup of the characters, the extent of variability, selection parameters, *i.e.* heritability and genetic advance and indirect selection parameters *i.e.* association existing between and amongst these attributes and seed yield as well as quantum of their direct and indirect contribution towards expression of seed yield helps in deciding a suitable and successful breeding programme.

Keeping in view the above facts, the present investigation was taken up with a view to assess the quantum of variation and to elucidate the relative importance and association between seed yield and yield components so that systematic breeding efforts may be initiated to evolve high yielding cultivar.

Materials and Method

The experiment was carried out in Randomized Block Design, with three replications during *kharif*, 2017 at Research Farm of Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar. Data on eleven parameters *viz*. days to 50 per cent flowering, plant height, number of branches per plant, days to maturity, productive branches per plant, productive capsules per plant, number of seeds per capsule, 1000 seed weight, biological yield (dry matter per plant), harvest index and seed yield per plant were recorded on six randomly selected plant. Geographically, University Farm is situated between 25.98^0 N latitude and 85.67^{0}E longitudes at 51.8m above mean sea level. The recommended doses of compost @ 600 kg/ha was applied before ploughing the field and fertilizer @ 40:20:20 kg (N: P: K) per ha was applied. N was applied in two split doses, first at the time of field preparation and second before flowering. Intercultural operations like manual weeding were done in the field twice, *i.e.*, once at two weeks after sowing and second at 35 days after sowing. The data were recorded on eleven quantitative traits by randomly selecting six competitive plants per replication, leaving the first two border rows from all the four sides, in order to avoid the sampling error. Data of six plants were averaged replication wise and the mean data was used for statistical analysis for 11 characters.

The statistical analysis of replicated data on individual character was carried out on the mean values over three replications. The analysis of variance (ANOVA) was worked out to test the differences among genotypes by F-test. It was carried out according to the procedure of Randomized Complete Block Design for each character as per methodology advocated by Panse and Sukhatme (1967) [28]. ANOVA helps in partitioning the total variance into three component *viz*., replication, treatment and error. Whereas heritability in broad sense and genetic advance following Jonson *et al*. (1955) [22] path analysis was done following Deway and Lu (1959) [13].

Results and Discussion

In the present investigation, twenty one sesame genotypes were studied to assess their performance in terms of traits implicated to yield. The analysis of variance revealed significant differences among the genotypes for each character, indicating the presence of considerable variability among the genotypes for the characters studied (table-1&2). Thus, it is implied that there was reasonably sufficient variability in material used for the study, which provides ample scope for selecting superior genotypes by the plant breeder for further improvement Previous studies from Ethiopia, Gidey *et al.* (2012) [18] also reported high variability for various traits in sesame, for several characters

The mean performance of genotypes along with check is presented in Table-3. According to the mean performance, a wide range of variation was found for most of characters amongst genotypes. The mean values shifted bidirectionaly significantly as compared to better check, thus provided scope of selection. The variability exploited in breeding programme was derived from the naturally occurring variants and wild relative of main crop species as well as from strains and genetic stocks artificially developed by human efforts. Through this study an attempt was made to assess the extent of genetic variability in twenty one sesame genotypes for eleven traits in the field condition. The cultivar Krishna was used as check.

The genotypic and phenotypic coefficient of variation, heritability and genetic advance as per cent of mean were estimated for eleven genotypes and presented in Table –4.The phenotypic variances were found higher than the corresponding genotypic variances (Abate and Mekbib, 2015) [1] for all the morpho-physiological traits under study. This may be due to the non-genetic factor which played an important role in the manifestation of these characters. Wide ranges of variation (phenotypic & genotypic) were observed in the experimental material for all the traits under study. Genotypic coefficient of variation (GCV) along with heritable estimates would provide a better picture of the amount of genetic advance to be expected by phenotypic selection (Burton, 1952) [10]. It is suggested that genetic gain should be considered in conjunction with heritability estimates (Johnson *et al*., 1955) [22]. The estimate of genotypic and phenotypic coefficient of variation were found to be higher for the traits *viz*. seed yield per plant, harvest index, productive capsule per plant, number of branches per plant, productive branches per plant, plant height and biological yield per plant. It revealed the presence of large amount of variation in the genotypes under study for these traits. Similar results were also observed by Gidey *et al.* (2012) [18] and Vanishree *et al.* (2013) [43] for these characters. The estimates of genotypic and phenotypic coefficient of variation were found to be moderate for the characters *viz*. no of seed per capsule and 1000 seed weight. It indicates that there is scope for improvement of these characters. Bharathi *et al.* (2014) [7], Kiruthika *et al.* (2017) [24] reported the moderate genotypic and phenotypic coefficient of variation for various characters.

The heritability in broad sense and genetic advance as percent of mean was work out for all the characters and their performance adjudged on the basis given Robinson *et al.* (1949) [31] for heritability and Jonshon *et al.* (1955) [22] for genetic advance as per cent of mean. The heritability estimates were found to be high for all the traits. A perusal of genetic advance as per cent of mean revealed that, the characters such as plant height (cm) number of branches per plant, productive branches per plant, productive capsule per plant, number of seeds per capsule, 1000 seed weight, biological yield per plant, harvest index and seed yield per plant expressed high genetic advance as per cent of mean.

The heritability coupled with genetic advance as per cent of mean were found to be high for all the traits studied expect for characters days to 50 per cent flowering and days to maturity which reveled the roll of additive gene action in heritance of these traits. Hence, these traits could be effectively improved by simple and direct selection. The similar findings were observed by Gangadhara *et al.* (2012) [17] and Vanishree *et al.*

(2013) [43] for plant height; Hika *et al.* (2015) [20], Abhijatha *et al.* (2017) [2] for number of branches per plant; Iqbal *et al*. (2016) [21], Abhijatha *et al*. (2017) [2] and Begum *et al*. (2017) [5] for number of capsule per plant.

High heritability coupled with moderate genetic advance as per cent of mean was observed for days to 50 per cent flowering (13.24) and days to maturity (16.04). Hence, there is good scope of improvement for these traits through simple selection. Chandramohan (2014) [7] and Abate and Mekbib (2015) [1] also noticed high heritability coupled with moderate genetic advance as per cent of mean for this character.

Correlations between yield and its contributing traits at phenotypic and genotypic level were estimated and presented in table-5 and 6. In this study, the genotypic correlation coefficient was in general higher than corresponding phenotypic correlation coefficients revealed that the observed relationship among various characters were due to genetic cause. She khawat *et al*. (2013) [34] and Kalaiyarasi *et al*. (2019) also reported higher genotypic correlation coefficient than the respective phenotypic correlation coefficients for yield and its component characters. In the present investigation number of branches per plant, productive branches per plant, productive capsules per plant, number of seeds per capsule, 1000 seed weight, biological yield and harvest index exhibited highly significant and positive association with seed yield at both phenotypic and genotypic level indicating the importance of these characters for yield improvement. Similar results were observed by Bhuyan and Sharma (2004) [8] for number of branches per plant and number of capsules per plant, Elangovan (2001) [14] and Sankar and Kumar (2003) [32] for number of seeds per capsule and 1000 seed weight, Pawar *et al*. (2002) [30] for biological yield and harvest index. On contrary, reported negative significant association between seed yield and days to maturity and non significant and negative association with days to 50 per cent flowering. Similar results were observed by Yirga Belay Kindeya (2017) [23], Abate and Mekbib (2015) [1], Mahalaxmi *et al.* (2018) [26], for days to maturity and for days to 50 per cent flowering. The results obtained were indicated that seed yield was increased whenever there was increase in characters that were positive and significantly associated with seed yield. These characters can be considered as criteria for selection for higher yield as these were mutually and directly associated with seed yield.

Correlation studies indicated that harvest index, productive capsules per plant, number of seeds per capsule, number of branches per plant, productive branches per plant, biological yield, 1000 seed weight and plant height showed significant positive association with seed yield per plant as well as among themselves at phenotypic and genotypic level, hence selection for any one at these characters would bring in simultaneous improvement of other character and also finally improvement in seed yield.

Path coefficient analysis revealed that considerable positive direct effect on seed yield was exerted by Days to 50 per cent flowering were observed negative moderate direct effect on seed yield. However, it exhibited indirect negative effect on seed yield *via* plant height, number of branches per plant, number of seeds per capsule, biological yield and harvest index. Whereas, it showed positive indirect effect through days to maturity, productive branches per plant, productive capsules per plant and 1000 seed weight. Since this trait showing high correlation and direct effect on seed yield per plant, one can improve the seed yield per plant by making selection for this character during yield improvement programme. Similar results were found by Shekhawat *et al*. (2013) [34] and Bharathi *et al*. (2015) [6]. Low and positive direct effect of plant height was observed on seed yield whereas, positive and indirect effect on seed yield observed *via* days to 50 per cent flowering, number of branches per plant, biological yield and harvest index but negative indirect effect was reported *via* Days to maturity, productive branches per plant, productive capsules per plant and 1000 seed weight. This results was in agreement with Shekhawat *et al*. (2013) [34], and Abate and Mekbib (2015) [1] for positive direct effect of plant height on seed yield, for positive indirect effect of number of branches per plant Vanishree *et al*. (2013) [43], Abate and Mekbib (2015) [1], Fazal *et al*. (2015) [15]. Number of branches exhibited very high and positive direct effect on seed yield whereas, positive indirect effect on seed yield of number of branches observed *via* days to 50 per cent flowering, plant height, number of seeds per capsule, biological yield and harvest index, negative and indirect effect was observed *via* productive branches per plant followed by days to maturity, productive capsules per plant and 1000 seed weight. Bharathi *et al*. (2015) [6] and Fazal *et al.* (2015) [15] for seed yield, Gidey *et al.* (2012) [18], Kumar *et al*. (2012) [25] and Abate and Mekbib (2015) [1] were also observed similar results. Days to maturity had moderate positive direct effect on seed yield. Whereas, it showed positive indirect effect *via* productive branches per plant, productive capsules per plant and 1000 seed weight. However, it exhibited negative indirect effect through days to 50 per cent flowering, plant height, number of branches per plant, number of seeds per capsule, biological yield and harvest index. Similar results were reported by Sudhakar *et al*. (2007) [36], Thirumalarao *et al.* (2013) [39] and Abate and Mekbib (2015) [1]. Direct effect of productive branches per plant was found to be high negative direct effect on seed yield. Whereas, it showed positive indirect effect on seed yield per plant *via* days to 50 per cent flowering, plant height, number of branches per plant number of seeds per capsule, biological yield and harvest index but through days to maturity, productive capsule per plant and 1000 seed weight had negative direct effect on seed yield. Similar results were found by Kumar *et al*. (2012) [25] and Sivaprasad and Yadavalli (2012) [35] for number of branches per plant, Suvarna *et al*. (2008) [37] for 1000 seed weight, Thiyagu *et al*. (2007) [40], and Azeez and Morakinyo (2011) [4] had also found similar result.

Productive capsules per plant had found negative and negligible direct effect on seed yield and through days to maturity, productive branches per plant, 1000 seed weight; it exhibited negative indirect effect on seed yield. Whereas, *via* days to 50 per cent flowering, plant height, number of branches per plant, number of seeds per capsule, biological yield and harvest index, it showed positive indirect effect on seed yield. This result was accordance with the findings of Bharathi *et al*. (2015) [6].

The direct effect of number of seed per capsule was reported low positive on seed yield, whereas *via* number of branches per plant, it showed very high positive indirect effect on seed yield followed by harvest index, biological yield, plant height and days to 50 per cent flowering, whereas through productive branches per plant it reported high negative indirect effect on seed yield followed by days to maturity, productive capsules per plant and 1000 seed weight. Similar results were found by Bharathi *et al*. (2015) [6] and Fazal *et al*. (2015) [15].

1000 seed weight had negligible negative direct effect on seed yield. Whereas, *via* days to maturity and productive capsules per plant, through days to 50 per cent flowering, plant height, number of branches per plant, number of seeds per capsule, biological yield and harvest index, it exhibited positive indirect effect on seed yield. Similar results were found by Abate and Mekbib (2015) [1] for number of seeds per capsule.

Biological yield (dry matter per plant) showed positive and high direct effect on seed yield. However, *via* harvest index, days to 50 per cent flowering, number of branches per plant, plant height and number of seeds per capsule, it exhibited positive indirect effect on seed yield. Negative and negligible indirect effect of biological yield was observed *via* days to maturity, productive branches per plant, productive capsules per plant and 1000 seed weight.

Harvest index exhibited high positive direct effect on seed yield, whereas through another traits *viz.* days to 50 per cent flowering, plant height, number of branches per plant, number of seeds per capsule and biological yield it exhibited positive indirect effect on seed yield. However, *via* days to maturity, productive capsules per plant and 1000 seed weight, it showed negative indirect effect on seed yield. Similar result was reported by Sharma and Mandal (2001) [35] Abate and Mekbib (2015) [1]. The direct effect of traits *viz.*, plant height, number of branches per plant, days to maturity, number of seeds per capsule, biological yield and harvest index had positive direct effect on seed yield whereas days to 50 per cent flowering, productive branches per plant, productive capsules per plant and 1000 seed weight had negative direct effect on seed yield.

Path analysis revealed that high positive direct effect was exhibited by number of branches per plant, biological yield and harvest index. Hence, selection based on these characters would be more effective for yield improvement.

Table 1: Analysis of variance for eleven characters in sesame

Sl. No.	Characters	Mean sum of squares		
		Replication	Treatments	Error
1	Days to 50% flowering	4.333	49.171**	1.383
2	Plant height (cm)	62.613	3384.3401**	111.703
3	Number of branches/plant	0.084	3.735**	0.359
4	Days to maturity	1.063	150.744**	2.747
5	Productive branches/plant	0.057	3.073**	0.283
6	Productive capsule/plant	3.111	1223.344**	22.078
7	Number of seed/capsule	25.444	195.7159**	24.361
8	1000 seed weight (g)	0.0705	0.515**	0.033
9	Biological yield (Dry matter/plant in g)	4.855	27.680**	2.766
10	Harvest index (%)	5.586	213.112**	10.963
11	Seed yield/plant(g)	0.025	7.227**	0.126

P=5%*, P=1%** (P= Probability)

Table 2: Mean, range and coefficient of variance (CV) for eleven characters in sesame

Sl. No.	Characters	Mean ± S.E	Range		CV
			Min	Max	
1	Days to 50% Flowering	59.57 ± 0.68	48.00	65.67	1.97
2	Plant Height (cm)	131.01 ± 6.10	69.73	185.50	8.06
3	Number of Branches/plant	3.83 ± 0.35	1.97	6.00	15.65
4	Days to Maturity	87.78 ± 0.96	75.00	100.00	1.8
5	Productive Branches/ Plant	3.48 ± 0.31	1.83	5.67	15.27
6	Productive Capsules/ Plant	46.11 ± 2.71	15.33	82.33	10.19
7	Number of Seeds /Capsule	54.31 ± 2.85	38.00	67.33	9.08
8	1000 Seed Weight (g)	2.45 ± 0.10	2.01	3.65	7.35
9	Biological Yield (dry Matter/ Plant g)	15.72 ± 0.96	10.27	20.33	10.58
10	Harvest Index (%)	18.60 ± 1.91	7.61	35.89	17.80
11	Seed Yield/ Plant (g)	2.96 ± 0.21	0.98	6.46	12.02

Table 3: Mean performance of twenty one genotypes of sesame for eleven characters

Character	Days to 50% Flowering	Plant Height (cm)	Number of Branches/ Plant	Days to Maturity	Productive Branches/ Plant	Productive Capsules/ Plant	Number of Seeds /Capsule	1000 Seed Weight (g)	Biological Yield (dry Matter/ Plant gm)	Harvest Index (%)	Seed Yield/ Plant (g)
NIC-16073	61.33	144.27*	2.17	86.33	1.83	31.00	48.67	2.51	17.73	10.10	1.77
S-0175	56.33	141.30*	1.97	81.33	1.97	24.67	39.00	2.20	16.74	10.02	1.67
NIC-13586	64.00	185.50	5.67	88.33	5.00	61.33	57.67	2.36	20.33	14.96	3.01
NIC-8225	59.00	153.00*	5.00	84.00	4.67	56.67	56.67	2.18	15.80	19.53	3.06
ES-58	65.00	160.50	4.00	90.00	3.83	51.67	64.00	2.50	10.27	30.38	3.04
IC-204533	63.33	158.00*	6.00	88.33	5.67*	80.00	63.00	2.26	19.66	22.07	4.35
Lolgida Local	57.00	156.33*	4.57	82.00	4.17	66.00	59.67	2.60	13.54	8.74	1.18
IC-54035	61.67	108.07*	4.77	88.33	3.50	51.33	59.67	2.01	14.29	34.09*	4.78
S-0527	57.33	107.60*	3.67	82.33	3.50	29.33	61.67	2.27	18.82	20.86	3.91
IC-81563	58.67	132.93*	3.90	84.67	3.50	82.33	56.33	2.28	17.11	27.60	4.71

Jubong Sesame	57.33	131.07*	3.83	82.33	3.83	48.00	54.00	2.05	16.73	17.99	2.99
SI-1865-1-B	61.33	129.90*	3.00	86.33	2.67	32.00	38.00	2.58	14.10	12.53	1.75
S-0062-A	65.67	125.27*	3.00	98.00	3.00	30.33	53.00	2.22	10.39	13.71	1.38
IS-346	61.33	117.00*	3.03	100.00	3.00	47.00	49.33	2.47	12.76	13.93	1.75
NIC-17274-C	59.00	102.60*	3.43	99.00	3.33	26.33	60.67	2.23	15.53	12.81	1.97
847-1-C	63.33	72.50*	2.57	99.33	2.17	15.33	44.67	2.19	13.03	7.61	0.98
IS-425-C	59.00	69.73*	3.47	93.00	3.17	19.33	49.00	2.50	16.03	20.82	3.32
SI-2670	61.33	88.17*	2.73	93.33	2.17	29.33	46.33	2.19	11.50	10.94	1.26
RT-54	48.00*	107.00*	4.00	75.00*	3.83	49.67	51.33	2.92	17.38	18.12	3.14
Pragati	56.00	184.33	4.20	81.33	3.67	60.00	67.33	3.40	18.16	35.89*	6.46*
Krishna	55.00	176.17	5.40	80.00	4.67	76.67	60.67	3.65	20.17	27.90	5.62
Mean	59.57	131.01	3.83	87.78	3.48	46.11	54.32	2.46	15.72	18.60	2.96
C.D. 5%	1.94	17.44	0.99	2.73	0.88	7.75	8.14	0.30	2.74	5.46	0.59

* Superior to Krishna

Table 4: Genetic parameters of eleven characters in sesame

Sl. No.	Characters	σ^2_g	σ^2_p	GCV	PCV	h^2 (Broad sense) %	Genetic advance as % of mean
1	Days to 50% Flowering	15.93	17.31	6.70	6.98	92	13.24
2	Plant Height (cm)	1090.88	1202.58	25.21	26.47	91	49.46
3	Number of Branches/plant	1.13	1.48	27.72	31.83	76	49.73
4	Days to Maturity	49.33	52.08	8.00	8.22	95	16.04
5	Productive Branches/ Plant	0.93	1.21	27.69	31.62	77	47.94
6	Productive Capsules/ Plant	400.42	422.50	43.40	44.58	95	87.03
7	Number of Seeds /Capsule	57.12	81.41	13.91	16.62	70	24.00
8	1000 Seed Weight (g)	0.16	0.19	16.32	17.90	83	30.66
9	Biological Yield (dry Matter/ Plant g)	8.30	11.07	18.33	21.17	75	32.71
10	Harvest Index (%)	67.38	78.35	44.14	47.59	86	84.32
11	Seed Yield/ Plant (g)	2.37	2.49	52.02	53.39	95	104.41

σ^2g- Genotypic variance, σ^2p= Phenotypic variance, GCV= Genotypic coefficient of variance, PCV= Phenotypic coefficient of variance, h^2bs= Heritability in broad sense, GAM= Genetic advance as % of mean

Table 5: Genetic correlation coefficient for eleven characters in sesame

Character	Days to 50% Flowering	Plant Height (cm)	Number of Branches/ Plant	Days to Maturity	Productive Branches/ Plant	Productive Capsules/ Plant	Number of Seeds /Capsule	1000 Seed Weight (g)	Biological Yield (dry Matter/ Plant gm)	Harvest Index (%)
Plant Height (cm)	-0.02									
Number of branches/ Plant	-0.06	0.58								
Days to Maturity	0.73	-0.49	-0.35							
Productive Branches/ Plant	-0.09	0.60	0.98	-0.34						
Productive Capsules/ Plant	-0.16	0.71	0.85	-0.47	0.83					
Number of Seeds /Capsule	-0.05	0.51	0.78	-0.21	0.77	0.65				
1000 Seed Weight (g)	-0.52	0.47	0.25	-0.46	0.23	0.37	0.28			
Biological Yield (dry Matter/ Plant gm)	-0.48	0.44	0.48	-0.61	0.49	0.43	0.32	0.40		
Harvest Index (%)	-0.11	0.35	0.60	-0.32	0.50	0.56	0.74	0.38	0.31	
Seed Yield/ Plant (g)	-0.31	0.43	0.67	-0.48	0.58	0.63	0.71	0.52	0.63	0.92

Table 6: Phenotypic correlation coefficient for eleven characters in sesame

Character	Days to 50% Flowering	Plant Height (cm)	Number of Branches/ Plant	Days to Maturity	Productive Branches/ Plant	Productive Capsules/ Plant	Number of Seeds /Capsule	1000 Seed Weight (g)	Biological Yield (dry Matter/ Plant gm)	Harvest Index (%)
Plant Height (cm)	0.02									
Number of Branches/ Plant	-0.03	0.48*								
Days to Maturity	0.70**	-0.45*	-0.28							
Productive Branches/ Plant	-0.07	0.50*	0.94**	-0.29						
Productive Capsules/ Plant	-0.14	0.67**	0.69**	-0.43*	0.69**					
Number of Seeds /Capsule	0.01	0.42	0.62**	-0.13	0.61**	0.53**				
1000 Seed Weight (g)	-0.44*	0.41	0.23	-0.38	0.19	0.32	0.25			
Biological Yield (dry Matter/ Plant gm)	-0.37	0.36	0.45*	-0.51*	0.43*	0.37	0.22	0.26		
Harvest Index (%)	-0.13	0.30	0.41	-0.31	0.36	0.50*	0.57**	0.35	0.13	
Seed Yield/ Plant (g)	-0.30	0.38	0.54**	-0.47*	0.49*	0.60**	0.57**	0.46*	0.53**	0.89**

*and ** = $P < 0.05$, $P < 0.01$, respectively

Table 7: Genotypic path coefficient analysis of eleven characters on seed yield in sesame

Character	Days to 50% Flowering	Plant Height (cm)	Number of Branches/ plant	Days to Maturity	Productive Branches/ Plant	Productive Capsules/ Plant	Number of Seeds /Capsule	1000 Seed Weight (g)	Biological Yield (dry Matter/ Plant gm)	Harvest Index (%)
Days to 50% Flowering	-0.2793	0.0046	0.0175	-0.2034	0.0258	0.0438	0.0144	0.1452	0.1348	0.0315
Plant Height (cm)	-0.0025	0.1501	0.0870	-0.0738	0.0894	0.1060	0.0759	0.0703	0.0662	0.0526
Number of Branches/Plant	-0.0820	0.7579	1.3073	-0.4590	1.2853	1.1150	1.0141	0.3292	0.6326	0.7824
Days to Maturity	0.1798	-0.1214	-0.0867	0.2469	-0.0833	-0.1151	-0.0514	-0.1125	-0.1510	-0.0798
Productive Branches/Plant	0.1173	-0.7555	-1.2479	0.4280	-1.2693	-1.0481	-0.9823	-0.2963	-0.6178	-0.6353
Productive Capsules/Plant	0.0047	-0.0210	-0.0254	0.0139	-0.0246	-0.0298	-0.0195	-0.0111	-0.0129	-0.0166
Number of Seeds/Capsule	-0.0055	0.0542	0.0832	-0.0223	0.0830	0.0701	0.1073	0.0299	0.0339	0.0789
1000 Seed Weight (g)	0.0047	-0.0042	-0.0023	0.0041	-0.0021	-0.0034	-0.0025	-0.0090	-0.0036	-0.0034
Biological Yield (dry Matter/Plant gm)	-0.1757	0.1604	0.1762	-0.2226	0.1772	0.1574	0.1152	0.1457	0.3640	0.1113
Harvest Index (%)	-0.0673	0.2095	0.3577	-0.1932	0.2991	0.3322	0.4398	0.2246	0.1827	0.5976
Seed Yield/ Plant (g)	-0.3059	0.4348	0.6666	-0.4815	0.5805	0.6281	0.7109	0.5160	0.6290	0.9194

Residual effect=0.0468, R square=0.9978

Table 8: Phenotypic path coefficient analysis of eleven characters on seed yield in sesame

Character	Days to 50% Flowering	Plant Height (cm)	Number of Branches/ Plant	Days to Maturity	Productive Branches/ Plant	Productive Capsules/ Plant	Number of Seeds /Capsule	1000 Seed Weight (g)	Biological Yield (dry Matter/ Plant gm)	Harvest Index (%)
Days to 50% Flowering	0.0027	0.0001	-0.0001	0.0019	-0.0002	-0.0004	0.0000	-0.0012	-0.0010	-0.0004
Plant Height (cm)	-0.0020	-0.0891	-0.0431	0.0398	-0.0443	-0.0600	-0.0377	-0.0370	-0.0317	-0.0264
Number of Branches/ Plant	0.0019	-0.0293	-0.0606	0.0170	-0.0568	-0.0421	-0.0376	-0.0136	-0.0273	-0.0249
Days to Maturity	0.0174	-0.0111	-0.0070	0.0249	-0.0073	-0.0107	-0.0033	-0.0096	-0.0128	-0.0077
Productive Branches/ Plant	-0.0028	0.0213	0.0402	-0.0125	0.0429	0.0296	0.0262	0.0080	0.0184	0.0154
Productive Capsules/ Plant	-0.0132	0.0636	0.0656	-0.0404	0.0650	0.0945	0.0505	0.0305	0.0349	0.0473
Number of Seeds /Capsule	0.0000	0.0027	0.0040	-0.0009	0.0040	0.0035	0.0065	0.0016	0.0014	0.0037
1000 Seed Weight (g)	-0.0425	0.0405	0.0220	-0.0375	0.0181	0.0315	0.0241	0.0978	0.0257	0.0339
Biological Yield (dry Matter/ Plant gm)	-0.1565	0.1493	0.1886	-0.2145	0.1796	0.1548	0.0928	0.1103	0.4194	0.0532
Harvest Index (%)	-0.1036	0.2361	0.3276	-0.2461	0.2854	0.3986	0.4528	0.2759	0.1010	0.7960
Seed Yield/ Plant (g)	-0.2985	0.3841	0.5372	-0.4683	0.4865	0.5992	0.5743	0.4627	0.5280	0.8901

Residual effect=0.1512 R square=0.9771

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