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Traits influencing yield in sesame (*Sesamum indicum*. L.) and multilocational trials of yield parameters in some desirable plant types

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Abstract

For ascertaining component (s) maximizing yield, 21 genotypes (parental cultivar and 20 macromutants) of sesame (*Sesamum indicum.* L., var - *B-67*, Family: Pedaliaceae) were analyzed based on genetic parameters *viz*. genetic variability, character association and path analysis considering seven yield related traits (plant height, number of primary branches/plant, total branches/plant, distance from base to first branching, capsules on main axis, total capsules/plant and capsule length) and yield (seed yield/seed protein content/seed fatty oil content) in rainfed *kharif* season of West Bengal plains. Total capsule per plant is predicted to be the most important selection criterion. For assessment of variation in yield attributes, 6 desirable plant types (parental cultivar and five mutants) were given multilocational trial under four different agroclimatic conditions and the results obtained are discussed and the better plant types are predicted.

Keywords: *Sesamum indicum.* L, yield related traits, multilocational trial, agroclimatic conditions.

Introduction

For efficient breeding and crop improvement it is of utmost importance in any crop plant to ascertain the contribution of each yield related trait to yield and to select component maximizing yield. Such studies will also be helpful in determining model plant type for the species. With a view to it, the present investigation is undertaken to study genetic variability, character association and path analysis (basic requirement for yield analysis) in 21 genotypes (normal and 20 mutants) of sesame, *Sesamum indicum* L. (Family: Pedaliaceae), much valued oil crop with immense therapeutic uses, considering 7 yield related traits (plant height, number of primary branches/plant, total branches/plant, distance from base to first branching, capsules on main axis, total capsules/plant and capsule length) and yield (seed/protein/oil) in rainfed *kharif* season (best season for sesame cultivation in West Bengal plains). Further, yield (seed/protein/oil) was assessed in parental cultivar and five desirable mutants of sesame (Chowdhury & Datta, 2008; Chowdhury *et al.,* 2009a, b) under multilocational trials in four different locations (districts) of West Bengal to ascertain the influence of agroclimatic conditions on yield. Apart from being an oil yielding plant species, sesame also possessed many agronomic advantages like, capacity to set seeds under high temperature, a deep tap root system that grows well by intercropping and fits well into crop rotation.

Materials and methods

The experiment was laid with 21 (parental cultivar and 20 plant type mutants - Chowdhury & Datta, 2008) genotypes (true breeding) of *Sesamum indicum* var. *B-67* at the experimental plots of Kalyani University during May to August 2008 (rainfed *kharif* season) in design described earlier (Chowdhury *et al*., 2009a, b). Data were assessed for 7 yield related traits (Table 1) and yield

Table 1. Estimate of genetic parameters in sesame

Attributes	Population mean ± S. E.	Coefficient of variability (%)	Heritability (%)	Genetic gain as % of mean	Attributes
		GCV	PCV		
Plant height (cm)	91.08 ± 4.35	38.26	38.53	98.61	78.27
Primary branches / plant	3.77 ± 0.21	41.50	43.98	89.03	80.66
Total branches/ plant	6.99 ± 0.44	50.39	51.02	97.54	102.52
Distance from base to first branching(cm)	26.69 ± 1.89	56.50	57.16	97.70	115.05
Capsule on main axis	24.30 ± 1.24	40.38	41.08	96.63	81.77
Total capsules / plant	48.00 ± 2.72	45.05	45.56	97.79	91.78
Capsule length (cm)	2.24 ± 0.04	15.54	15.98	94.61	31.14
Seed yield (gm)	5.77 ± 0.28	39.02	39.62	96.97	79.16
Seed protein content (%)	14.47 ± 0.36	19.31	19.90	94.11	38.58
Seed fatty oil content (%)	34.10 ± 0.46	10.25	10.76	90.64	20.10

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(seed/protein/oil) from randomly selected 5 plants from each replications for studying genetic variability, character association and path analysis as per method described by Burton (1952), Johnson *et al.* (1995) and Dewey and Lu (1959) respectively.

Some desirable plant types (parental cultivar; mutants-*elongated leaf, thick leaf, ovate leaf, bushy* and *unbranched stem*) were assessed for seed yield and seed protein and fatty oil (estimated as per method described earlier by Chowdhury *et al.,* 2009a, b) content (following the use of Duncan's t-test analysis, alphabets denotes degree of significance-a>b>c>d>e>f>g) in agronomically four different locations (districts) of West Bengal (Nadia-Kalyani University experimental field: Latitude 22°50' to 24°11' N, longitude 88°09' to 88°48' E; North 24 Parganas - Dattapukur farmer field: Latitude 22°11'6'' to 23°15'2'' N, longitude 88°20' to 89°5' E; Burdwan - Shamsyar farmer field: Latitude 23°15' to 23°25' N, longitude 87°45' to 87°75' E; Birbhum - Rampurhat farmer's field: Latitude 23°32'30'' to 24°35' N, Longitude 88°1'40'' to 87°5'25'' E). Chemical (carbon, hydrogen and nitrogen contents analyzed by CHN analyzer; micronutrients estimated from Atomic Absorption Spectroscopy) and physical (sand, silt and clay contents and texture) contents of soil samples from four locations were reported (Chowdhury *et al.*, 2009b) earlier (analysis done in Marine Wing, GSI, Kolkata, West Bengal). Agrometeorological (May to August) data (Nadia: temperature-31.6°C to 39.7°C max., 24.0°C to 26.8°C min., relative humidity - 92.2% to 99.2% max., 56.8% to 84.7% min., rainfall - 2.08 mm to 18.18 mm; North 24 Parganas: temperature-30.2°C to 40.2°C max., 23.6°C to 27.2°C min., relative humidity - 94.4% to 98.2% max., 51.2% to 79.4% min., rainfall - 1.62 mm to 21.4 mm; Burdwan: temperature - 28.0°C to 41.2°C max., 22.8°C to 27.6°C min., relative humidity - 92.9% to 98.8% max., 57.2% to 74.4% min., rainfall - 2.52 mm to 20.8 mm; Birbhum: temperature - 34.0°C to 44.2°C max., 25.2°C to 27.6°C min., relative humidity - 88.8% to 98.6% max., 56.4% to 75.2% min., rainfall - 1.02 mm to 10.6 mm) were obtained from Agrometeorological Department of B.C.K.V. , Mohanpur and Govt. of West Bengal, Writer's Building , Kolkata.

Results and discussion

Estimates of genetic parameters (Table 1) indicated that the magnitude of GCV (genotypic coefficient of variation) and PCV (phenotypic coefficient of variation) were low to moderate, and for all the traits PCV and GCV values were more or less similar. Heritability (broad sense) for different quantitative traits was high (89.03% to 98.61%) and it was coupled with high genetic gain (index for selection criteria) excepting for capsule length and seed protein and fatty oil contents.

Correlation studies (Table 2) showed that for all characters genotypic and phenotypic associations were in the same direction and genotypic estimates were relatively higher than the phenotypic ones indicating an inherited association between the traits. Capsule on the main axis and total capsules per plant were positively and significantly (p>0.01) correlated with seed yield and seed protein content. Seed yield per plant was also significantly (p>0.05) associated with seed protein

Table 2. Phenotypic (P) and Genotypic (G) correlation between different attributes and between different traits with seed oil content

Attributes		Plant ht. (cm)	Primary branch / plant	Total branches/ plant	Distance from base to first / branching (cm)	Capsule on Main axis	Capsule per plant	Capsule length (cm)	Seed yield (gm)	Protein content (%)	Oil content (%)
Plant height (cm)	P		**0.67**	**0.68**	**0.87**	0.32	**0.48**	0.23	0.25	0.21	-0.15
	G		**0.69**	**0.69**	**0.88**	0.32	**0.49**	0.24	0.26	0.21	-0.16
Primary branch per plant	P			**0.88**	**0.66**	0.05	**0.56**	0.12	0.15	0.05	0.16
	G			**0.92**	**0.70**	0.07	**0.59**	0.11	0.15	0.05	0.15
Total branches per plant	P				**0.66**	0.04	**0.58**	0.29	0.20	0.02	0.08
	G				**0.67**	0.04	**0.59**	0.30	0.20	0.02	0.08
Distance from base to first branching (cm)	P					0.21	**0.58**	0.02	0.17	0.39	-0.19
	G					0.20	**0.59**	0.02	0.17	0.40	-0.20
Capsule on main axis	P						**0.52**	0.35	**0.74**	**0.56**	0.04
	G						**0.59**	0.37	**0.77**	**0.59**	0.04
Total capsule per plant	P							0.10	**0.68**	**0.53**	0.30
	G							0.11	**0.68**	**0.56**	0.30
Capsule length (cm)	P								0.32	0.08	0.06
	G								0.33	0.08	0.06
Seed yield (gm)	P									0.41	0.29
	G									**0.44**	0.28
Seed Protein content (%)	P										-0.19
	G										-0.19

Significant at 5% > 0.43 Bold values are significant Significant at 1% > 0.55

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content but none of the parameters analyzed was significantly interrelated with fatty oil content. Different agroclimatic factor(s) on yield attributes of sesame. Result (Table 5) indicated that seed yield was high in

Table 3. Direct and indirect effects of yield components of sesame on yield of oil content.

Attributes		Plant height (cm)	No of primary branch /plant	Total Branches /plant	Distance from base (cm) to first branching	Capsule on the main axis	Total capsule per plant	Capsule length (cm)	Seed yield (gm)	Seed Protein content (%)	Genetic correlation with seed oil content
Plant Height (cm)	K	0.0326	0.0449	-0.2624	-0.3546	-0.0590	0.5343	0.0103	-0.0040	-0.1123	-0.162
No. of primary branch/ plant	K	0.0225	0.0651	-0.3512	-0.2795	0.0119	0.6466	0.0049	-0.0023	0.0262	0.152
Total branches / plant	K	0.0224	0.0598	-0.3826	-0.2687	-0.0075	0.6389	0.0129	-0.0030	-0.0128	0.075
Distance from base to first branching (cm)	K	0.0288	0.0453	-0.2559	-0.4016	0.0367	0.6422	-0.0008	-0.0027	-0.2154	-0.197
Capsule on main axis	K	0.0105	-0.0042	-0.0157	-0.0803	-0.1832	0.5823	0.0160	-0.0017	-0.3148	0.035
Total capsule/ plant	K	0.0160	0.0386	-0.2242	-0.2365	-0.0978	1.0904	0.0046	-0.0104	-0.2967	0.304
Capsule length (cm)	K	0.0077	0.0073	-0.1129	0.0076	-0.0671	0.1145	0.0437	-0.0051	0.0417	0.063
Seed yield (gm)	K	0.0086	0.0096	-0.0761	-0.0699	-0.1407	0.7425	0.0146	-0.0152	-0.2347	0.281
Seed protein content	K	0.0069	-0.0032	-0.0092	-0.1619	-0.1079	0.6051	-0.0034	-0.0067	-0.5345	-0.193

Residual effect (K) - 0.7174; K = Kharif

yield related traits showed positive and significant (probability level 0.05 to 0.01) relationship among themselves.

In addition to the degree of associations, path coefficient analysis takes into account the cause and effect relationship and has been performed to partition the genetic correlation into direct and indirect effects for understanding the relative importance of the component characters on yield (traits analyzed for oil yield). Results (Table 3) obtained for path analysis revealed that only total capsules per plant (1.0904) had substantial positive and direct contribution to oil yield; while, the other traits showed poor or negative contribution. Significance of total capsule per plant as important selection criteria in sesame was also suggested earlier (Mishra *et al.,* 1993; Biswas and Akbar, 1995; Singh *et al*., 1997; Sengupta and Datta, 2004). However, high residual effect (0.7174) in path analysis suggested the inclusion of other traits for better precision.

Pooled ANOVA (Table 4) performed over the districts for 3 yield parameters considering six plant types (among which parental cultivar, *thick leaf, bushy* and *unbranched stem* were better parents as evidenced from Principal Component Analysis and Hierarchial clustering using single linkage and complete linkage method of Dillon and Goldstain (1984) mentioned earlier by Chowdhury (2009) revealed that yield varied significantly among districts and plant types. Further, district x replication (seed yield) and districts x plant types (protein and oil content) also varied significantly thereby suggesting the influence of *bushy* mutant in Nadia compared to other districts; while, seed protein content was maximum in *thick leaf* in Burdwan. Seed protein content varied considerably among districts in *unbranched stem* mutant but fatty oil content was highest in the plant type. Nadia seems to give better result for the traits analyzed. Over the districts the plant types were in the following order for different traits: seed yield - *bushy > thick leaf > elongated leaf* = control = *unbranched stem > ovate leaf*; seed protein content - *thick leaf > elongated leaf > ovate leaf > unbranched stem > bushy* > control; fatty oil content - *bushy > unbranched stem > ovate leaf* = control *> elongated leaf > thick leaf*. Thus, the plant types evolved as the consequence of radiation induced mutation in sesame may be utilized directly (not withstanding the marker traits associated with the mutants - Chowdhury *et al*., 2009a,b) and/or be exploited through intercrossing (between/among) followed by selection.

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Table 4. ANOVA - Pooled over the Districts

Source	Seed yield				Seed protein				Oil			
	SS	df	MSS	F	SS	df	MSS	F	SS	df	MSS	F
District	4.08	3	1.36	3.58*	58.57	3	19.52	44.36***	517.85	3	172.33	152.50***
District X Replication	17.01	6	2.84	7.47***	2.94	6	0.49	1.11	4.42	6	0.74	0.65
District X Plant types	5.62	15	0.37	1.00	111.14	15	7.41	16.84***	125.91	15	8.39	7.42***
Error (District)	11.29	30	0.38		13.26	30	0.44		34.01	30	1.13	
Replication	0.22	2	0.11	0.92	0.38	2	0.19	1.12	1.21	2	0.60	0.34
Plant type	23.13	5	4.63	38.58***	655.46	5	131.09	771.11***	1154.56	5	230.91	129.72***
Error	1.17	10	0.12		1.71	10	0.17		17.76	10	1.78	

, ** and * = Significant at 0.05, 0.01 and 0.001 probability level respectively*

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Table 5. Seed yield and protein and oil contents in sesame plant types in four different locations of West Bengal

Plant types		Seed yield (gm)					Seed protein content (%)					Seed oil content (%)				
		North 24-Parganas	Burdwan	Birbhum	Nadia	Overall	North 24-Parganas	Burdwan	Birbhum	Nadia	Over all	North 24-Parganas	Burdwan	Birbhum	Nadia	Over all
Control	Mean	6.29	6.37	5.99	6.37	6.26d	12.00	13.90	13.13	12.83	12.97f	29.93	31.43	26.13	34.35	30.40d
	S.E.	0.23	0.18	0.20	0.16	0.19	0.23	0.17	0.34	0.19	0.23	0.18	0.69	1.30	0.81	0.74
Elongate leaf	Mean	6.31	6.07	6.53	7.25	6.54d	14.87	17.27	16.27	16.63	16.26b	29.40	31.40	26.40	33.40	30.10d
	S.E.	0.50	0.18	0.32	0.37	0.38	0.18	0.18	0.24	0.32	0.23	0.31	0.46	0.42	1.68	0.72
Thick leaf	Mean	7.97	7.77	7.47	7.83	7.76c	19.43	21.97	19.13	21.40	20.48a	26.07	26.07	22.20	27.57	25.40e
	S.E.	0.23	0.24	0.15	0.14	0.19	0.19	0.67	0.18	0.64	0.42	0.35	0.18	0.23	0.35	0.28
Ovate leaf	Mean	5.08	5.31	5.17	5.20	5.19e	14.27	16.10	15.60	15.37	15.33c	30.33	32.33	28.47	32.87	31.00cd
	S.E.	0.19	0.14	0.18	0.02	0.13	0.18	0.15	0.12	0.56	0.25	0.59	0.18	0.58	0.75	0.53
Bushy	Mean	9.28	8.55	8.62	9.49	8.99a	12.73	14.33	14.23	13.83	13.78e	30.33	33.93	29.67	35.87	32.40b
	S.E.	0.50	0.54	0.36	0.07	0.37	0.24	0.24	0.15	0.23	0.21	0.47	0.41	0.30	0.413	0.41
Unbran-ched stem	Mean	6.42	6.32	6.45	6.62	6.45d	12.20	13.23	12.80	20.13	14.59d	30.07	29.60	27.27	9.43	31.50bc
	S.E.	0.37	0.32	0.28	0.19	0.29	0.23	0.20	0.50	0.18	0.28	0.24	0.42	0.24	0.38	0.32
Total	mean	6.89	6.73	6.71	7.13	6.87	14.25	16.13	15.19	16.69	15.57	29.36	30.79	26.69	33.93	30.13
	S.E.	0.33	0.29	0.29	0.33	0.31	0.62	0.72	0.56	0.81	0.68	0.76	0.87	0.95	0.98	0.89