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Research Article

CHARACTER ASSOCIATION AND PATH ANALYSIS STUDIES IN SESAME (*SESAMUM INDICUM* L.) ADVANCED BREEDING LINES AND VARIETIES

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Abstract: The present study was undertaken with the objective to determine the degree of association between yield and it`s component characters and their direct, indirect effects on seed yield in sesame (*Sesamum indicum* L.). 41 genotypes were evaluated for identifying their efficiency with respect to 10 quantitative characters. Character association studies revealed significant positive association of seed yield per plant with plant height, number of branches per plant, first capsule height, capsules per plant, and 1000-seed weight. This indicated the possibility of simultaneous selection of all these characters for yield improvement. A critical path analysis revealed that the number of capsules per plant, diameter of stem, capsule length, number of branches per plant and plant height directly affected the seed yield per plant. This indicated that direct selection for yield improvement via these traits would be possible.

Keywords: *Sesame, Genotypes, Traits, Character association, Path analysis*

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Introduction

Sesame (*Sesamum indium* L.) "Queen of the oil seeds" is one of the ancient and traditional oilseed crops cultivated in India, for its quality oil as well as seed. Sesame seeds are highly nutritive and contain 50 to 60 percent oil. Sesame oil is highly stable due to the presence of antioxidants such as sesamin and sesamolin. Sesame seeds are rich in protein too. They are used in the preparation of number of food products and confectioneries and are found in many salads and baked snacks. Sesame oil is mainly used as cooking oil. It is also used in salad for marinating meat and vegetables and manufacturing of paints, soaps, perfumes and insecticides [1]. Refined sesame oil is used in pharmaceuticals and cosmetic products. It is known to be used for massaging, health treatment as laxative and to promote menstruation. De-oiled cake and meal of sesame are used as livestock feed. Myanmar, India and China are the top three sesame producing countries in the world. But, the productivity of sesame in India is very low (432 kg/ha) compared to China (1382 kg/ha) and Myanmar (565 kg/ha) [2]. Hence it is imperative to develop high yielding varieties and hybrids with increased productivity to sustain the sesame cultivation. Increased sesame production will help to reduce the shortage of domestic production of edible oil in India. But in India the breeding programs in sesame are relatively limited and also the heterosis is not fully exploited so far. Before attempting heterosis breeding, it is important to assess the magnitude of variability, degree of association between yield and it`s component characters and their direct, indirect effects on seed yield present in this crop. Information about association of various yield components can be obtained through correlation analysis. Path analysis partitions the correlation into direct and indirect effects. It measures the direct and indirect effects of the independent variables through other variables on dependent variable like yield. Hence correlation in association with path analysis will provides a better idea of nature of association and their relative contribution [3].

In the light of the above scenario, the present investigation is carried out with the objective of studying the character associations and path analysis in sesame (*Sesamum indicum* L.) advanced breeding lines and varieties for yield improvement.

Material and Methods

Experimental Site

The experiment was carried out at the experimental field of Indian Institute of Oilseeds Research (IIOR), Rajendranagar, Hyderabad, during August, 2013. Geographically, the place is located at an altitude of 542 m above mean sea level, 17°19^{1} 13^{11} N latitude and 78°48^{1}52^{11} E longitudes.

Plant Materials

The experimental materials for the present study consisted of 41 sesame varieties and advanced breeding lines supplied by major sesame breeding centres in India through Indian Institute of Oilseeds Research (IIOR), Rajendranagar, Hyderabad. The details are given in [Table-1].

Experimental Design and Setting the Experiment

The experiment was laid out in a randomized block design (RBD) with two replications. Each genotype was grown in a row of 2m length with a row spacing of 30 cm and plant to plant spacing of 10-15 cm. Seeds were sown on 24th August 2013.

Land preparation and crop management

The land was ploughed by mould board plough followed by two harrowings to bring the soil to fine tilth so as to facilitate sowing.

The residues of the previous crop and weeds were removed from the experimental area. The land was levelled with the help of plank. The recommended dose of nutrients (40:20:20 kg of N: P: K per ha) was supplied in the form of urea, single super phosphate and muriate of potash. Fifty percent of nitrogen (20kg/ha) and entire quantity of phosphorus and potash were applied in the rows 5 cm away from the seed during sowing. Remaining 50 percent of nitrogen was applied 30 days after sowing as top dressing. Thinning was done 15 days after sowing leaving a single healthy seedling at a distance of about 10 cm per hill. The crop was kept weed-free and three hand weedings were carried out during the crop growth period. Proper soil moisture was maintained throughout the crop growth period through supplementary irrigations. Necessary plant protection measures were taken to control pests and diseases.

Table-1 *List of genotypes and their source of collection used in the experiment*

SN	Name of the Genotype	Source	SN	Name of the Genotype	Source
1	Paten-64	Amreli[1]	22	LT-8	Mandor[6]
2	Nesadi Selection	Amreli[1]	23	RT-125	Mandor[6]
3	Nana Bhamodra-5	Amreli[1]	24	DS-5	Dharwad[2]
4	AT-213	Amreli[1]	25	DS-1	Dharwad[2]
5	DS-10	Dharwad[2]	26	DSS-9	Dharwad[2]
6	DS-30	Dharwad[2]	27	SVPR-1	Vridhachalam[5]
7	Prachi	Dharwad[2]	28	VRI-2	Vridhachalam[5]
8	MT-10-81	Dharwad[2]	29	TMV-3	Vridhachalam[5]
9	JCS-1020	Jagtial[3]	30	Rajeswari	Jagtial[3]
10	YLM-17	Jagtial[3]	31	Swetha	Jagtial[3]
11	Madhavi	Jagtial[3]	32	Hima	Jagtial[3]
12	JL-Sel-05-3	Jalgaon[4]	33	G.Til-1	Amreli[1]
13	JLS-9707-2	Jalgaon[4]	34	G.Til-2	Amreli[1]
14	JLS-408-2	Jalgaon[4]	35	G.Til-10	Amreli[1]
15	Hawari	Jalgaon[4]	36	JLS-403-33	Jalgaon[4]
16	VS-07-023	Vridhachalam[5]	37	IsAgi-95-10	Jalgaon[4]
17	TKG-22	Vridhachalam[5]	38	JLT-408	Jalgaon[4]
18	Nirmala	Vridhachalam[5]	39	RT-346	Mandor[6]
19	TKG-87	Vridhachalam[5]	40	RT-356	Mandor[6]
20	CST-2001-1	Mandor[6]	41	RT-358	Mandor[6]
21	CST-2008-2	Mandor[6]			

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Data Collection

Data on ten morphological characters were collected for all genotypes, including plant height (cm), number of branches per plant, first capsule height (cm), capsule length (cm), capsules per plant, diameter of stem (cm), number of seeds per capsule, days to maturity, 1000-seed weight (g) and seed yield per plant (g). The Observations were recorded on five randomly chosen plants from the row in each genotype in each replication for all the above-mentioned characters except days to maturity, which was taken on per plot basis.

Statistical Analyses

Genotypic and phenotypic correlation coefficients for different characters were calculated in all possible combinations following the formula given by [4]. The direct and indirect effects both at genotypic and phenotypic level were estimated by taking seed yield per plant as dependent variable using path coefficient analysis suggested by [5] and [3].

Results and Discussion

Character association

Crop yield is a complex and highly variable character and is the result of cumulative effects of various characters. A thorough understanding of the interaction of characters among themselves had been of great use in plant breeding. Character association provides information on the nature and extent of association between pairs of metric traits and helps in selection for the improvement of the character. Phenotypic and genotypic correlation coefficients were worked out on yield and its component characters and the results are presented in [Table-2]. Genotypic correlations were higher than phenotypic correlations. This indicated that though there was a strong inherent association between characters studied, their expression was influenced by environment. Seed yield per plant, a dependent variable recorded a significant positive correlation with plant height [$r^2(g) = 0.87$, $r^2(p) = 0.50$], number of branches per plant [$r^2(g) = 0.66$, $r^2(p) = 0.36$], first capsule height [$r^2(g) = 0.74$, $r^2(p) = 0.38$], capsules per plant [$r^2(g) = 0.99$, $r^2 (p) = 0.60$], and 1000 seed weight [$r^2(g) = 0.70$, $r^2(p) = 0.23$] at both levels. Positive and non-significant correlation with no. of seeds per capsule [$r^2(g) = 0.10$, $r^2 (p) = 0.20$], negative non-significant correlation with days to maturity [$r^2(g) = -0.19$, $r^2(p) = -0,08$], negative and significant correlation at genotypic level, no significant correlation at phenotypic level with capsule length [$r^2(g) = -0.28$, $r^2(p) = -0.09$], positive significant correlation at genotypic and non-significant correlation at phenotypic level with diameter of stem [$r^2(g) = -0.33$, $r^2(p) = -0.12$]. The results obtained indicated that yield was increased whenever there was increase in plant height, branches per plant, first capsule height, capsules per plant and 1000 seed weight. Hence, these characters could be considered as criteria for selection for higher yield as these indicated significant positive associations associated with seed yield. Similar kind of associations were reported by [6], [7], [8] and [9] for number of branches per plant, capsules per plant and plant height (cm).

Path coefficient analysis

Correlation gives only the relationship between two variables, whereas path coefficient analysis allows separation of the direct effect and their indirect effects through other attributes by partitioning the correlation [5]. Hence, this analysis was undertaken in the present investigation. The phenotypic and genotypic correlations were used to determine direct effect and indirect effect of yield and its contributing characters. The results are presented in [Table-3]. Number of capsules per plant [0.95(G), 0.65(P)] had maximum direct effect on seed yield per plant, followed by diameter of stem [0.86(G), 0.13(P)], capsule length [0.52(G), 0.2146(P)], no.of branches [0.22(G), 0.0019(P)], plant height [0.11(G), 0.10(P)], no.of seeds per capsule [0.17(P)], days to maturity [0.23(G)] and 1000 seed weight [0.10(P)], which contributed direct effects to seed yield per plant. These results are in accordance with the findings [10], for capsules per plant, number of seeds per capsule and 1000-seed weight; [11] for plant height, capsule length;[12] for days to maturity. Negative direct effects were recorded for first capsule height [-0.73(G), -0.08(P)], no.of seeds per capsule [-0.56(G)], days to maturity [-0.01(P)] and 1000 seed weight [-0.09(P)] as reported by [13] for first capsule height. The genotypic and phenotypic residual effects were 0.71 and 0.72, respectively, which indicated the need for increasing the traits studied path analysis.

Application of research: In the present study, the path coefficient analysis indicated that capsules per plant had the maximum direct contribution to seed yield. Plant height and no. of branches per plant also had positive direct effect and significant correlation with the seed yield, hence these traits may be considered while selection for high yielding sesame lines.

Research Category: plant breeding and genetics

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Study area / Sample Collection: ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad, 500030

Table-2 *Genotypic and Phenotypic correlation coefficients between seed yield and its components in sesame*

Character		Plant height (cm)	Nuumber of branches	First capsule height (cm)	Capsule length (cm)	Capsules per plant	Diameter of stem (cm)	Number of seeds per capsule	Days to maturity	1000-seed weight (gm)	Seed yield per plant (g)
Plant height (cm)	G	1.00	0.56**	0.57**	-0.35**	0.74**	-0.26*	0.31**	-0.14	0.35**	0.87**
	P	1.00	0.52**	0.44**	-0.31**	0.71**	-0.13	0.25*	-0.10	0.24*	0.50**
Number of branches	G		1.00	0.62**	0.19	0.41**	-0.11	0.07	-0.12	0.80**	0.66**
	P		1.00	0.53**	0.15	0.39**	0.04	0.02	-0.10	0.42**	0.36**
First capsule height (cm)	G			1.00	0.03	0.72**	-0.05	-0.16	0.12	0.96**	0.74**
	P			1.00	0.05	0.60**	-0.01	-0.08	0.07	0.33**	0.38**
Capsule length (cm)	G				1.00	-0.47**	-0.11	-0.12	0.36**	0.41**	-0.28**
	P				1.00	-0.43**	-0.02	-0.07	0.35**	0.14	-0.09
Capsules per plant	G					1.00	0.01	0.04	-0.19	0.39**	0.99**
	P					1.00	0.00	0.05	-0.14	0.20	0.60**
Diameter of stem (cm)	G						1.00	0.21*	-0.23*	0.25*	0.33**
	P						1.00	0.01	-0.21*	0.02	0.12
Number of seeds per capsule	G							1.00	-0.07	-0.23*	0.10
	P							1.00	-0.04	-0.23*	0.20
Days to maturity	G								1.00	-0.09	-0.19
	P								1.00	-0.00	-0.08
1000-seed weight (gm)	G									1.00	0.70**
	P									1.00	0.23*
Seed yield per plant (g)	G										1.00
	P										1.00

** Significance at 5% level,** Significance at 1% level,P=Phenotypic level,G =Genotypic level*

Table-3 *Direct (bold) and indirect effects of yield and its components in sesame*

Character		Plant height (cm)	Number of branches	First capsule height (cm)	Capsule length (cm)	Capsules per plant	Diameter of stem (cm)	Number of seeds per capsule	Days to maturity	1000-seed weight (gm)	Seed yield per plant (g)
Plant height (cm)	G	0.11	0.13	-0.42	-0.18	0.71	0.23	0.18	0.03	0.03	0.81**
	P	0.10	0.00	-0.04	-0.08	0.47	-0.02	0.04	0.00	0.03	0.50**
Number of branches	G	0.63	0.23	-0.46	0.10	0.40	-0.10	-0.04	-0.03	-0.07	0.66**
	P	0.05	0.00	-0.05	0.04	0.26	0.01	0.01	0.00	0.04	0.36**
First capsule height (cm)	G	0.64	0.14	-0.73	0.02	0.69	-0.04	0.09	0.03	-0.09	0.74**
	P	0.05	0.00	-0.09	0.01	0.40	0.00	-0.02	0.00	0.03	0.38**
Capsule length (cm)	G	-0.39	0.04	-0.03	0.53	-0.46	-0.10	0.07	0.09	-0.04	-0.28**
	P	-0.03	0.00	0.00	0.24	-0.29	0.00	-0.01	-0.01	0.02	-0.09
Capsules per plant	G	0.83	0.10	-0.53	-0.25	0.95	0.01	-0.03	-0.05	-0.04	0.99**
	P	0.07	0.00	-0.05	-0.11	0.66	0.00	0.01	0.00	0.02	0.60**
Diameter of stem (cm)	G	-0.29	-0.03	0.04	-0.06	0.01	0.87	-0.12	-0.06	-0.02	0.33**
	P	-0.01	0.00	0.00	-0.01	0.00	0.14	0.00	0.00	0.00	0.12
Number of seeds per capsule	G	0.35	0.02	0.12	-0.07	0.04	0.19	-0.56	-0.02	0.02	0.10
	P	0.03	0.00	0.01	-0.02	0.04	0.00	0.17	0.00	-0.02	0.20
Days to maturity	G	-0.16	-0.03	-0.09	0.19	-0.19	-0.21	0.04	0.24	0.01	-0.19
	P	-0.01	0.00	-0.01	0.08	-0.09	-0.03	-0.01	-0.01	0.00	-0.08
1000-seed weight (gm)	G	0.40	0.18	-0.71	0.22	0.37	0.22	0.13	-0.02	-0.09	0.70**
	P	0.03	0.00	-0.03	0.04	0.13	0.00	-0.04	0.00	0.10	0.23*

*Genotypic residual effect = 0.71, Phenotypical residual effect = 0.72, P=Phenotypic level, G =Genotypic level, * Significant at 5 percent level,** Significant at 1 percent level*

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Cultivar / Variety name: Sesame (*Sesamum indicum* L.)

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