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Interrelationship among morpho-economic traits for formulation of effective selection strategy in sesame (*Sesamum indicum* L.)

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ABSTRACT

The experiment was conducted at S. D. Agricultural University, Sardarkrushinagar during kharif season of 2018 to know the character association and also for determining the cause and effect situation through the assessment of direct and indirect effects of various yield contributing traits by using 45 sesame genotypes. The estimate of correlation coefficient revealed that the values of genotypic correlation in general, were higher as compared to the corresponding phenotypic correlation. This indicated that though there was high degree of association between two variables at genotypic level, its phenotypic expression was deflated by the influence of environment. The character seed yield per plant showed significant positive correlation with number of effective branches per plant, number of capsules per plant, capsule length per plant, number of seeds per capsule and test weight both at genotypic as well as phenotypic levels revealing that selection made on the basis of these characters will assist in enhancing the seed yield. Path coefficient analysis revealed that days to flowering recorded the highest positive direct effect on seed yield followed by test weight and number of capsules per plant. Days to maturity, numbers of seeds per capsule, oil content and leaf area per plant are the other traits which showed positive direct effect on seed yield. Thus, number of capsules per plant and number of seeds per capsule and test weight may be good selection criteria for further sesame breeding programmes related to high yielding varieties.

Key words: Correlation, path analysis, seed yield, sesame

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important and perhaps the oldest and ancient oilseed crops known to man. It is cultivated extensively from tropical regions to the temperate zones in the world. It is fifth important edible oil crop in India after groundnut, rapeseed-mustard, sunflower and soybean. It is mostly grown for its seed and is an important source of premium quality oil, which is highly stable, does not develop rancidity leading to loss of flavor and vitamins and contains natural antioxidants like sesamin and sesamolin (Mirza *et al.,* 2009). Sesame seed contains 50% oil, 23% protein and 15% carbohydrate (Ranganatha *et al.,* 2012). The fatty acid composition of oil is rather attractive, due to the high level of unsaturated fatty acids (Woldesenbet *et al.,* 2015). Sesame oil consists of various fatty acids and nonfat antioxidants. Among the primary edible oils, sesame oil contains abundant fatty acids such as oleic acid (43%), linoleic acid (35%), palmitic acid (11%) and stearic acid (7%) and has the highest antioxidant content. Though sesame occupies a place of prominence among oilseeds, its production has been relatively low as compared to other oilseed crops. The major constraints identified for most of the countries including India are, instability in yield, lack of wider adaptability, drought, non synchronous maturity *etc*. As sesame production has to be maintained and even expanded, several key breeding objectives must be attained. Therefore, there is need to develop enhanced germplasm for use by the breeders in crop improvement. The knowledge of the interrelationships between yield and yield components is necessary; determination of correlation among plant characteristics is a matter of considerable importance in selection of correlated response. Correlation studies between yield and other traits of the crop will be of interest to breeders in planning the hybridization programme and evaluating the individual plants in segregating populations. But it does not give an exact position of the relative importance of direct and indirect effects of various traits on yield or any other attributes. Path coefficient analysis is useful for evaluating

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the relative contribution of each component traits both direct and indirect to the yield. Path coefficient analysis helps to specify the cause and effect and to measure their relative significance. Following correlation analysis, the path coefficient analysis would provide a true picture of genetic association among different traits (Bhatt, 1973). So, correlations in combination with the path coefficient analysis quantify the direct and indirect contributions of one characteristic upon another (Dewey and Lu 1959). By considering this, the present study was undertaken to assess the interrelationship and contribution of yield related component traits in sesame.

MATERIALS AND METHODS

The present experiment was conducted at Castor-Mustard Research Station, S.D. Agricultural University, Sardarkrushinagar, Gujarat, India during *kharif* season of 2018. The soil of the experimental field was sandy to sandy loam and free from water logged conditions. The weather during the growing season was normal and favourable for crop growth. The experimental material consisted of 45 sesame genotypes laid out in a randomized block design replicated thrice. Each genotype was accommodated in a single row of 3.0 m length with a spacing of 45 cm between rows and 15 cm between plants within the row. The experiment was surrounded by two guard rows to avoid damage and border effects. The crop was raised under recommended package of practices along with prophylactic protection measures. Observations were recorded from five randomly selected plants from each genotype on different characters *viz*., plant height (cm), number of effective branches per plant, number of capsules per plant, capsule length per plant, number of seeds per capsule, test weight (g), seed yield per plant (g), oil content (%) and leaf area per plant (cm^2). Days to flowering and days to maturity were measured on plot basis. Data from five plants of each genotype were averaged replication wise and mean data was used for statistical analysis. Correlation coefficients for yield and yield components were evaluated utilizing the formula suggested by Al-jibouri *et al.* (1958). Path coefficient analysis was carried out to understand the direct and indirect effects of the yield contributing characters as given by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Correlation Coefficients

The correlation coefficients between seed yield and its ten component characters as well as among themselves were estimated at genotypic and phenotypic levels (Table 1). The genotypic correlation was greater than phenotypic correlation in all the traits except number of seeds per capsule and oil content. This indicated that although there is strong inherent association between the various pairs of characters studied the low phenotypic correlation would result from the masking and modifying effects of environment on the association of characters at gene level. Shekhawat *et al.,* (2013) also reported that genotypic correlation coefficients were higher than the respective phenotypic correlation coefficients for all the characters.

In the present study, correlation analysis indicated that seed yield per plant exhibited highest significant positive correlation with the traits number of capsules per plant (r_g=0.7074, r_p=0.7031) followed by capsule length per plant (r_g=0.2974, r_p=0.221), number of seeds per capsule (r_g=0.4481, r_p=0.5105) and test weight (r_g=0.6897, r_p=0.6252) at both phenotypic as well as genotypic levels indicating that selection made on the basis of these characters will assist in enhancing the seed yield. Similar results were also reported by Shekhawat*et al.*(2013) and Bharathi*et al.* (2015) for number of seeds per capsule and number of capsules per plant; Shekhawat*et al.*(2013) and Saxena and Bisen(2016) for capsule length per plant; Agrawal *et al.*(2017) and Lalpantluangi and Shah (2018) for test weight. The traits plant height, days to maturity, oil content and leaf area per plant showed positive and non-significant correlation with seed yield per plant at both the levels. Such results also reported by Singh *et al.*(2018) for days to maturity and oil content and Thirumala Rao *et al.*(2013) for plant height. Seed yield per plant was found significant and negatively correlated with days to flowering at genotypic level. Such negative interrelationship between seed yield per plant and days to flowering had also been reported in sesame by Sabiel *et al.*(2015).

Table 1: Genotypic (r_g) and phenotypic (r_p) correlation coefficients among characters in genotypes of sesame

Characters		Days to flowering	Days to maturity	Plant height	Effective branches/plant	Capsules /plant	Capsule length/ plant	seeds/ capsule	Test weight	Oil content	Leaf area/plant
Seed yield/plant	r_g	-0.1734*	0.0158	0.1761*	0.3051**	0.7074**	0.2974**	0.4481**	0.6897**	0.0098	0.1319
	r_p	-0.1214	0.0128	0.1018	0.2177*	0.7031**	0.2210**	0.5105**	0.6252**	0.0221	0.1169
Days to flowering	r_g	.	0.6827**	0.8623**	0.2575**	0.0460	-0.0905	-0.0108	-0.2944**	-0.3247**	-0.1306
	r_p		0.6420**	0.6201**	0.2171*	0.0593	-0.0704	-0.0260	-0.2827**	-0.2914**	-0.1178
Days to maturity	r_g			0.7982**	0.2832**	0.1670	-0.0864	-0.0785	-0.0540	-0.3657**	-0.1626
	r_p			0.5753**	0.2761**	0.1347	-0.0571	-0.0473	-0.0577	-0.3151**	-0.1502
Plant height	r_g				0.1838*	0.1873*	-0.0467	0.0360	0.1370	-0.2856**	-0.0267
	r_p				0.1741*	0.1280	-0.0347	-0.0199	0.1020	-0.2298**	-0.0131
Effective branches/plant	r_g					0.7735**	-0.3247**	-0.2111*	-0.2514**	-0.4258**	-0.0031
	r_p					0.6192**	-0.2407**	-0.1959*	-0.2272**	-0.3781**	-0.0003
Capsules/plant	r_g						-0.0262	-0.0997	0.1503	-0.1198	0.0607
	r_p						-0.0385	-0.0484	0.1415	-0.1048	0.0502
Capsule length/ plant	r_g							0.2999**	0.4505**	0.2365**	-0.0915
	r_p					0.6192**	-0.2407**	0.1469	0.4123**	0.2297**	-0.0839
Seeds/ capsule	r_g								0.2564**	0.0318	-0.0508
	r_p						-0.0385	-0.0484	0.1840*	0.0524	-0.0322
Test weight	r_g							0.2999**		0.1059	0.2178*
	r_p							0.1469	0.4123**	0.1030	0.2138*
Oil content	r_g								0.2564**		0.1370
	r_p								0.1840*	0.0524	0.1338

*, ** *Significant at 5% and 1% levels, respectively*

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

Characters	Days to flowering	Days to maturity	Plant height	Effective branches /plant	Capsules /plant	Capsule length/ plant	Seeds/ capsule	Test weight	Oil content	Leaf area /plant	Genotypic correlation with seed yield/plant
Days to flowering	3.5315	0.7562	-3.6278	-0.2829	0.0805	0.0871	-0.0841	-0.6012	-0.0267	-0.0061	-0.1734*
Days to maturity	2.411	1.1077	-3.3582	-0.3111	0.2922	0.0831	-0.061	-0.1103	-0.0301	-0.0076	0.0158
Plant height	3.0452	0.8842	-4.2071	-0.2019	0.3278	0.0449	0.0279	0.2797	-0.0235	-0.0012	0.1761*
No. of effective branches/plant	0.9095	0.3138	-0.7734	-1.0985	1.3536	0.3125	-0.1639	-0.5133	-0.035	-0.0001	0.3051**
Number of capsules/ plant	0.1625	0.1849	-0.788	-0.8497	1.7499	0.0252	-0.0774	0.307	-0.0098	0.0028	0.7074**
Capsule length/plant	-0.3197	-0.0957	0.1965	0.3567	-0.0458	-0.9624	0.2328	0.9199	0.0194	-0.0043	0.2974**
Number of seeds/capsule	-0.3827	-0.087	-0.1514	0.2319	-0.1744	-0.2886	0.7765	0.5235	0.0026	-0.0024	0.4481**
Test weight	-1.0397	-0.0598	-0.5763	0.2761	0.2631	-0.4336	0.1991	2.042	0.0087	0.0101	0.6897**
Oil content	-1.1467	-0.4051	1.2017	0.4677	-0.2097	-0.2276	0.0247	0.2162	0.0822	0.0064	0.0098
Leaf area/plant	-0.4613	-0.1801	0.1125	0.0034	0.1063	0.088	-0.0395	0.4447	0.0113	0.0466	0.1319

*, ** *Significant at 5 % and 1% levels, respectively, Residual effect, R = 0.0441*

The character days to flowering showed highly significant positive correlation with days to maturity (r_g=0.6827, r_p=0.6420) and plant height (r_g=0.8623, r_p=0.6201) at both genotypic and phenotypic levels. This trait exhibited highly significant and negative correlations at both genotypic and phenotypic level with test weight (r_g=-0.2944, r_p=-0.2827) and oil content (r_g=-0.3247, rp=-0.2914). The days to maturity possessed positive and highly significant genotypic and phenotypic correlation with plant height (r_g=0.7982, r_p=0.5753) and number of effective branches per plant (r_g=0.2832, r_p=0.2761). It showed negative and highly significant genotypic and phenotypic association with oil content (r_g=-0.3657, r_p=-0.3151). The plant height exhibited significant and positive correlations with number of effective branches per plant at both the levels (r_g=0.1838, r_p=0.1741). Plant height showed highly significant and negative correlation at both genotypic and phenotypic level with oil content (r_g=-0.2856, r_p=-0.2298). Ramireddy kumar and Sundaram (2002) revealed the positive association of plant height with number of effective branches per plant. Number of effective branches per plant exerted highly significant and positive genotypic and phenotypic correlation with number of capsules per plant (r_g=0.7735, r_p=0.6192). It showed highly significant negative correlation with capsule length per plant (r_g=-0.3247, r_p=-0.2407), test weight (r_g=-0.2514, r_p=-0.2272) and oil content (r_g=-0.4258, r_p=-0.3781). This character showed negative and significant correlation at both genotypic and phenotypic level with number of seeds per capsule (r_g=-0.2111, r_p= -0.1959). Pawar *et al.* (2002) reported the positive association of number of branches per plant with number of capsules per plant. Number of capsules per plant exhibited non-significant and positive correlation at both the levels with test weight (r_g=0.1503, r_p=0.1415) and leaf area per plant (r_g=0.0607, r_p=0.0502). Capsule length per plant showed highly significant and positive correlation at both level with test weight (r_g=0.4505, r_p=0.4123) and oil content (r_g=0.2365, r_p=0.2297). Number of seeds per capsule exerted significant positive correlation at both genotypic (r_g=0.2564) and phenotypic level (r_p=0.1840) with test weight. The trait test weight exhibited significant and positive correlation at both level with leaf area per plant (r_g=0.2178, r_p=0.2138). The oil content showed non-significant and positive correlations at both level genotypic and phenotypic with leaf area per plant (r_g=0.1370, r_p=0.1338).

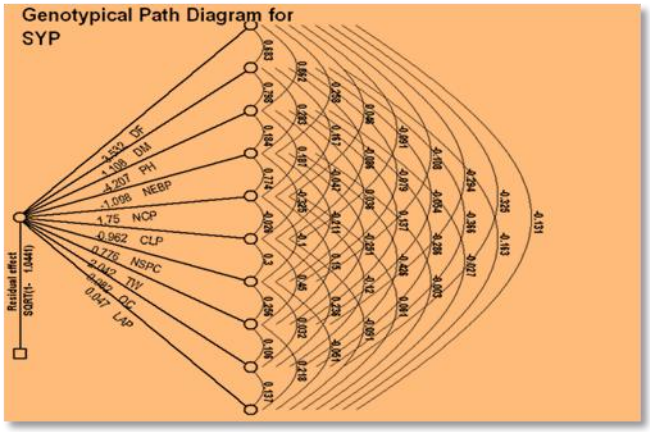

Fig. 1: Diagrammatic representation of genotypic path analysis in sesame

Where, DF = Days to flowering, DM = Days to maturity, PH = Plant height, NEBP = Number of effective branches per plant, NCP = Number of capsules per plant, CLP = Capsule length per plant, NSPC = Number of seeds per capsule, TW = Test weight, OC = Oil content, LAP = Leaf area per plant

Path coefficient analysis

When two or more variables are included in the correlation studies, it becomes difficult to determine which characters enhance the seed yield. The technique of path coefficient analysis overcomes this situation which partitions the forces of association and examines the relative contribution of direct and indirect effects of the independent variables on the dependent variables. The genotypic path coefficient analysis (Table 2 & Fig. 1) revealed that days to flowering (3.5315) followed by test weight (2.042), number of capsules per plant (1.7499), days to maturity (1.1077), number of seeds per capsule (0.7765) exhibited high and positive direct effect on seed yield per plant and was found to be the most important yield components. The oil content (0.0822) and leaf area per plant (0.0466) had negligible and positive direct effect on seed yield per plant. Days to flowering exhibited high and negative indirect effects on seed yield per plant through plant height (-3.6278) and test weight (-0.6012), while it had moderate and negative indirect effects on seed yield per plant *via*number of effective branches per plant (-0.2829). Days to maturity showed high and positive indirect effects on seed yield per plant *via* days to flowering (2.411) and moderate and positive indirect effect through number of capsules per plant (0.2922). The plant height exerted high and positive indirect effects on seed yield per plant *via* days to flowering (3.0452), days to maturity (0.8842) and number of capsules per plant (0.3278), while moderate and negative indirect effect on seed yield per plant *via* number of effective branches per plant (-0.2019). The number of effective branches per plantexhibited high and positive indirect effects on seed yield per plant through days to flowering (0.9095), days to maturity (0.3138), number of capsules per plant (1.3536) and capsule length per plant (0.3125). Number of capsules per plant contributed indirectly to seed yield per plant by giving positive and high indirect effect through test weight (0.307). Capsule length per plant had high positive indirect effects on seed yield per plant through number of effective branches per plant (0.3567) and test weight (0.9199), while moderate and positive indirect effect with number of seeds per capsule (0.2328). Number of seeds per capsule showed high and positive indirect effect towards seed yield per plant *via* test weight (0.5235).It showed moderate and positive indirect effect with number of effective branches per plant (0.2319). The trait test weight had high and negative indirect effects towards seed yield per plant *via* days to flowering (-1.0397), plant height (-0.5763) and capsule length per plant (-0.4336). It had moderate and positive indirect effects towards seed yield per plant *via* number of capsules per plant (0.2631) and number of effective branches per plant (0.2761). Oil content also contributed indirectly by giving high and positive indirect effects on seed yield per plant through plant height (1.2017) and number of effective branches per plant (0.4677). This character also contributed indirectly by giving high and negative indirect effects through days to flowering (-1.1467) and days to maturity (-0.4051). Leaf area per plant exerted positive and high indirect effect through test weight (0.4447), while negative and high indirect effect *via* days to flowering (-0.4613) toward seed yield per plant.

High and positive direct effect of number of seeds per capsule on seed yield per plant has also been reported in sesame by Bharathi *et al.* (2015); of number of capsules per plant on seed yield per plant by Bharathi *et al.* (2015); of days to flowering on seed yield per plant by Saxena and Bisen (2016); of days to maturity on seed yield per plant by Agrawal *et al.*(2017) and Lalpantluangi and Shah (2018); of test weight on seed yield per plant by Agrawal *et al.*(2017). Thus, characters *viz*., number of seeds per capsule, number of capsules per plant, days to flowering, days to maturity and test weight were considered as the major components of seed yield and direct selection for these traits might be rewarding for yield improvement in sesame.The characters plant height, number of effective branches per plant and capsule length per plant had high and negative direct effect on seed yield per plant. High and negative direct effect of plant height on seed yield per plant has also been reported in sesame by Agrawal *et al.*(2017); of number of effective branches per plant on seed yield per plant by Singh *et al.*(2018); of capsule length per plant on seed yield per plant by Patil and Lokesha (2018).

On the basis of above study it can point out that the characters *viz*., number of capsules per plant and number of seeds per capsule and 1000-seed weight have positive direct association along with significant positive correlation with seed yield. Therefore, due emphasis should be given to these characters while selection for improving seed yield in sesame.

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