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INDUCED POLYGENIC VARIATION STUDY IN SESAME (*SESAMUM INDICUM L.)* AND ITS IMPLICATION IN SELECTION

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ABSTRACT

In this study, ninety four single plants selected from M_2 generation were evaluated during summer 2006 in M_3 generation. Single plant data pertaining to different morphological traits viz. plant height, number of branches, capsule per plant, capsule length, capsule breadth, seeds per capsule and seed yield were recorded and analyzed for genetic parameters, correlation coefficients and path coefficient. Number of branches and capsule per plant showed highly significant and positive correlation with seed yield. Capsule length exhibited maximum direct positive effect (0.8791) followed by capsule/plant (0.755) and plant height. Except capsule length other two attributes showing positive direct effects also exhibited highly significant and positive genotypic correlation which indicated that these characters may be selected directly for the improvement of seed yield. Highest heritability in broad sense was estimated in case of capsule length (74.5%) followed by plant height (63%), capsule breadth (60.8%) number of branches (51.9%) and seed per capsule (50.3%). Seed yield indicated the highest value of genetic advance (41.72%) followed by number of branches (34.32%), capsule length 17.84%) and capsule breadth (17.77%). High heritability in case of capsule length, number of branches, capsule length and capsule breadth combined with corresponding higher values of genetic advance indicated that these characters are controlled by additive type of genes and may be selected directly for seed yield improvement. From these results, it may be concluded that for making selection directly in this type of population, the main emphasis should be placed on plant height, number of capsule and to some extent number of branches. Secondarily to a minor extent capsule length may be considered alongwith seed yield and other yield components.

Keywords: Induced polygenic variation, *Sesamum indicum L,* selection.

INTRODUCTION

Pakistan is facing an acute shortage of edible oil and an amount of Pak Rupees 59,187/- million is being spent on its import. The country is producing only 30% of its requirement while 70% is being met through import (anonymous, 2005).

Sesame is an important edible oil seed crop containing about 50 – 58% oil and 25% protein Sesame oil and foods fried in sesame oil have a long shelf life because the oil contains two very powerful antioxidant called sesamole and sesamin together with tocopherols. In addition to this it has tremendous food, industrial and medicinal value (Yosida and Tagaki, 1997; Morris, 2002). The use of sesame oil reduces the blood pressure due to the presence of polyunsaturated fatty acid (PUFAS), the good kind of fat that cuts cholesterol. The seed of sesame contain a protein with eight amino acids and vitamin of B complex which are important for cell oxygenation and thus have a favorable influence on the liver cells. So sesame seeds are recommended specially to those who suffer from some type of liver disorder.

Sesame is an import substitute/export item of Pakistan, earning an amount of 19.3 million dollars (Anonymous, 2005) and is cultivated on an area of 82.0 thousand hectare with an annual production of 35.1 thousand tons having an average seed yield of 42.8 $kgha^{-1}$ (Anonymous, 2006) which is very low as compared to 1267 and 1063 $kgha^{-1}$ of world's leading countries, like Hondrus and Egypt respectively (Anonymous, 2000). Presently two cultivars viz. TS3 and Til 89 are available for cultivation which are simply the collection from locally available germplasm from the farmer's field (Khan and Din, 1999). The major constraints to low yield are poor yielding varieties susceptible to various biotic and abiotic stresses alongwith improper management practices. Breeding for crop improvement, genetic variability is a prerequisite. Induced mutation has proved to be an efficient and supplemented tool for creation of genetic variability. Furthermore, the induced mutation is also helpful in breaking of unwanted/negative linkages present among different qualitative and quantitative attributes (Ashri, 1994; Kang *et al*., 1994; Rajput and Sarwar, 1994; Rehman and Das, 1994).

Keeping in view these facts mutation breeding work on sesame improvement was initiated for creation of genetic variability and selection of desirable mutants in the succeeding generations. Genetic parameters such as genotypic and phenotypic correlations, path analysis,

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Table 1. Genotypic correlation between different traits in M_3 generation of sesame 2006.

Variables	Plant Height(cm)	No. of Branches	Capsule/ plant	Capsule Length(cm)	Capsule Breadth (cm)	Seed/ Capsule
Plant Height (cm)						
No. of Branches	.6379*					
Capsule/ plant	.4275**	.6449**				
Capsule Length(cm)	-.5970**	-.7317**	-.3715**			
Capsule Breadth(cm)	.0770	-.3677**	.0782	.4781**		
Seed/ Capsule	-.5177**	-.6740**	-.4289**	.8259**	.2011	
Seed Yield (g)	.3166**	.6600**	.6900**	-.4050**	-.4137**	-.4400**

Table 2. Phenotypic correlation between different traits in M_3 generation of sesame 2006.

Variables	Plant Height (cm)	No. of Branches	Capsule/ plant	Capsule Length (cm)	Capsule Breadth (cm)	Seed/ Capsule
Plant Height(cm)						
No. of Branches	-.3530**					
Capsule/ plant	.1979	.4555**				
Capsule Length(cm)	-.53553**	-.4189**	-.0321			
Capsule Breadth(cm)	.0860	-.1563	.1015	.4129**		
Seed/ Capsule	-.2234*	-.3196**	-.0496	.6578**	.2524*	
Seed Yield (g)	.2395*	.4926**	.4988**	-.1120	-.0908**	-.1241

heritability and genetic advances are helpful in identifying the characters which are important for selection directly or indirectly.

Furthermore, it also tells us that to what extent weightage should be given to certain trait and on which characters the selection should be based for a particular population and environment. Heritability and genetic advance combination tells about the nature and type of genes whether they are of additive or non additive. Keeping in view all these facts, genetic parameters were worked out in induced population of sesame and based on this genetic information, selection criteria was formulated for further improvement.

MATERIALS AND METHODS

Sesame seed of four different genotypes viz. TS3, Til 89, Gp 11504, Gp 117 04 were got irradiated with gamma rays ranging from 100 – 800 Grey and M_1 generation was grown during Kharif 2004. The M_2 was raised during Kharif 2005 and single plant selection based on visual field observation regarding high bearing and disease resistance in respect of phyllody and virus were selected. Ninety four single plants selected from M_2 generation were grown as plant progeny rows of 3 M length, keeping row to row and plant to plant distance of 45 and 15 cm respectively and studied during Kharif 2006 in M_3 generation in three repeats in RCBD. Single plant data pertaining to different morphological traits viz. plant height, no. of branches, capsule per plant, capsule length, capsule breadth, seed per capsule and seed yield were recorded. The data thus collected were then subjected to analysis of variance (Steel and Torrie, 1980). The genetic parameters, genotypic/ phenotypic correlations and path coefficient were estimated following the procedures as described by Singh and chaudhry (1985).

RESULTS AND DISCUSSION

Plant height showed positive and highly significant genotypic correlation with number of branches, capsules per plant and seed yield (Table 1). Negative and highly significant correlation of plant height was observed in the capsule length and seeds/capsule. Number of branches showed highly significant and positive correlation with capsule per plant and seed yield. Capsules per plant showed positive and highly significant correlation with seed yield and highly significant but negative with capsule length and seed/capsule. Capsule length exhibited positive and highly significant correlation with capsule breadth and seed per capsule, while negative and highly significant with seed yield. Capsule breadth and seed/capsule showed negative and highly significant correlation with seed yield

Table 3. Direct (in parenthises) and indirect effect of different traits in M_3 generation of sesame.

Variables	Plant Height (cm)	No. of Branches	Capsule/ plant	Capsule Length (cm)	Capsule Breadth (cm)	Seed/ Capsule	Genotypic correlation (rg) with Seed Yield (rg)
Plant Height (cm)	(.3602)	-.0616	.3228	-.5248	-.0651	.2851	.3166**
No. of Branches	.2304	(-.0963)	.4870	-.6432	.3109	.3712	.6600**
Capsule/plant	.1540	-.0621	(.7551)	-.3266	-.0661	.2362	.6905**
Capsule Length (cm)	-.2150	.0705	-.2805	(.8791)	-.4042	-.4248	-.4050**
Capsule Breadth (cm)	.0278	.0354	-.0591	.4202	(-.8454)	-.1108	-.4137**
Seed/Capsule	-.1865	.0649	-.3238	.7260	-.1700	(-.5507)	-.4401**

Table 4. Genetic parameters of different traits in M_3 generation of sesame 2006.

Variables	Mean	G.VAR.	G.COV. (%)	P.VAR.	P.COV. (%)	h^2 (%)	GA (% of Mean)
Plant Height (cm)	174.10	239.558	8.784	380.007	11.064	63.00	12.41
No. of Branches	607	3.285	26.662	6.382	37.004	51.90	34.32
Capsule/plant	103.22	239.108	14.949	1770.812	40.682	13.50	9.68
Capsule Length (cm)	2.69	0.100	11.731	0.134	13.587	74.50	17.84
Capsule Breadth (cm)	0.63	0.007	12.665	0.011	16.425	60.80	17.77
Seed/Capsule	70.80	35.346	8.405	70.389	11.840	50.30	10.48
Seed Yield (g)	11.58	26.961	37.846	70.289	61.107	38.40	41.72

G. VAR.= Genotypic variance, G. COV. = Genotypic coefficient of variation
P.VAR. = Phenotypic variance, P. COV. = Phenotypic Coefficient of variation
h^2 = heritability in broad sense, GA = Genetic advance

In the case of phenotypic correlation (Table 2), plant height showed positive and significant correlation with number of branches and seed yield. Number of branches showed highly significant and positive correlation with capsule per plant and seed yield. Capsule per plant showed positive and highly significant correlation with seed yield. Capsule length exhibited positive and highly significant correlation with capsule breadth and seed per capsule. Capsule breadth showed significant and positive correlation with seed per capsule.

Capsule length exhibited maximum direct positive effect (0.8791) followed by capsule/plant (0.755) and plant height (Table 3). Except capsule length other two attributes showing positive direct effects, also accompanied highly significant and positive genotypic correlation which indicated that these characters may be selected directly for the improvement of seed yield. Capsule length showed highest positive indirect effects (0.726) via seed per capsule followed by capsule per plant via number of branches (0.487) and capsule length via capsule breadth (0.4202).

Genotypic coefficient of variation (Table 4) was highest (37.846%) in case of seed yield followed by number of branches (26.662%) and capsule per plant (14.949%). Phenotypic coefficient of variation (Table 4) was also highest in case of seed yield per plant (61.107%) but followed by capsules per plant (40.682%) and number of branches per plant (37.004%).

Highest heritability in broad sense (Table 4) was estimated in case of capsule length (74.5%) followed by plant height (63%), capsule breadth (60.8%), number of branches (51.9%) and seed per capsule (50.3%). The highest value of genetic advance as percent of mean was computed in seed yield per plant (41.72%) followed by number of branches (34.32%), capsule length 17.84%) and capsule breadth (17.77%). High heritability in case of capsule length, number of branches, capsule length and capsule breadth combined with corresponding higher values of genetic advance indicated that these characters are controlled by additive type of genes and may be selected directly for seed yield improvement (Johnson *et al*., 1955; Panse, 1957; Sarwar *et al*., 2004).

Morphological data of elite selected mutants (Table 5) based on high bearing and seed yield indicated that maximum plant height (200 cm) was noted in mutant NS4/3 as compared to check variety TS3 (192.7 cm). Other high yielding mutants had less plant height than TS3. The minimum plant height (147 cm) was observed in mutant NS288/1 followed by mutant NS202/3 (164 cm). Branches per plant were highest in case of NS 14/3 (15) followed by NS 146/1 (13) and NS 60/1 (12). As compared to this, TS3 had 7 branches per plant. Almost all the selected high yielding mutants had more number of capsules per plant than the overall mean (103.22) and check variety TS3 (131.3). Maximum capsule per plant were noted in NS 4/3 (257) followed by NS 321/1 (228) and NS 14/3 (222). The capsule length was highest in

Table 5. Morphological attribures of sessame mutants in M_3 generation 2006.

S. No.	Genotype	Plant height (cm)	Branche / plant	Capsule/ plant	Capsule length (cm)	Capsule breadth (cm)	Seed/ capsule	Seed yield/ plant (g)	Phyllody Reaction (%)
1.	NS 4/3	200	11	257	2.9	0.9	68	33	0
2.	NS 14/3	185	15	222	3.0	0.8	72	49	0
3.	Ns 32/2	150	10	201	2.6	.06	68	43	0
4.	NS 44/1	190	8	190	2.6	0.5	72	30	0
5.	NS 60/1	187	12	214	2.4	0.6	48	53	0
6.	NS 120/1	130	11	184	2.6	0.6	72	39	0
7.	NS 146/1	184	13	150	2.7	0.6	80	33	0
8.	NS 146/2	179	10	183	2.7	0.6	76	35	0
9.	NS 202/3	164	3	102	3.8	0.8	88	22	0
10.	NS 288/1	147	4	126	3.9	0.8	96	24	0
11.	NS 311/1	185	9	200	2.5	0.6	76	33	0
12.	NS 321/1	180	8	228	2.5	0.6	72	50	0
13.	TS3 (Check)	192.7	7	131.3	2.56	0.76	64	18.6	0
	Mean	174.10	6.7	103.22	2.69	0.63	70.80	13.58	1.07
	CV(%)	11.06	37.00	40.68	13.58	16.24	11.84	61.107	-

case of mutant NS 288/1 (3.9 cm) and NS 202/3 (3.8 cm). These two mutants had also the highest number of seeds per capsule i.e. 96 and 88 respectively. The highest seed yield (53 g) was estimated in mutant NS 60/1 followed by NS 321/1 (50 g) and NS 14/3 (49 g). As compared to this over all mean seed yield per plant was 13.58 g and that of check variety TS3 18.6 g/plant.

Plant height, number of branches and capsule per plant showed highly significant and positive correlation with seed yield, hence following these results more stress should be given to these traits while selecting sesame genotypes for seed yield improvement. Except number of branches, plant height and capsule per plant also showed positive direct effects alongwith positive and significant genotypic correlation with seed yield which indicated that seed yield can be exploited directly by selection genotypes based on these attributes. In case of branches per plant where correlation coefficient was positive, but the direct effect was negative, the indirect effects seem to be cause of correlation. In such situation, the indirect casual factors are to be considered simultaneously. Highest positive direct effect was noted in case of capsule length but the correlation was negative. Under these circumstances, a restricted simultaneous selection model is to be followed, *i.e*. restrictions are to be imposed to multiply the undesirable indirect effects in order to make use of the direct effect (Singh and Kakar, 1977).

Govindarsu and Ramamoorthi (1998) observed strong correlation of seed yield with number of branches and capsule number in irradiated and non irradiated segregating population of sesame. These attributes had also high direct effects in both types of populations, revealing that they had significant effects on determining seed yield.

In another study Govindarsu *et al*. (1998), observed consistently high strong positive genotypic correlation and high positive direct effect of branches per plant and capsule number with seed yield in M_3, F_3 and F_2M_2 generations. The other component characters fluctuated in their relationship with seed yield. They suggested that in determining seed yield, branch number and capsule number are the most important traits; hence selection for these traits would ensure the improvement of seed yield in sesame. Studying 60 diverse types of sesame, Nimbalkar *et al*. (1999) estimated highly significant and positive correlation of seed yield with number of capsule, plant height, 1000 seed weight and number of branches.

Backiyarani *et al*. (1999) found positive correlation of seed yield with capsule number, 1000 seed weight and plant height and negative with percentage of seed oil in F_2 and F_3 populations of sesame. In both the generations, path coefficient analysis revealed the importance of number of branches as selection criteria for seed yield improvement. Intermating in the F_2 or a later generation was suggested for improvement of yield and oil content simultaneously.

Gandhara (2005) observed high heritability and high genetic advance in case of plant height, capsule number and 100 seed weight in 72 genotypes of sesame but combination of high heritability and low genetic advance in case of branches per plant and seed yield. He has explained that in the first case, simply selection at this stage may be benefited and workable for seed yield improvement, but for the 2nd case to select superior lines, recurrent selection would be effective in the succeeding generations. High heritability indicates that the character is controlled by such type of genes which are less influenced by environmental factors and vice versa. It was further reported that in case of high heritability combined with a low genetic advance, the character is mainly under the control of non additive type of genes (epistasis, dominance or their interaction). Saravanan *et al.* (2003) evaluating sesame lines also emphasized that if a character is influenced less by the environment and controlled by additive type of genes, selection can be made directly for the improvement of this particular character at an early stage, and if the character is controlled by non additive type of genes, then the selection for this trait should be postponed and performed safely in the advanced/ succeeding generations.

From the results of foregoing study, it may be summarized and concluded that through nuclear techniques, first the variability can be created in seed yield and its components and secondly positive variability may be exploited through continuous selection based on certain scientific knowledge. For making selection directly in this type of population, the main emphasis should be placed on plant height, number of capsule and to some extent number of branches. Secondarily to a minor extent capsule length may be considered alongwith seed yield and other yield components.

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