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STUDIES ON FREQUENCY DISTRIBUTION OF YIELD AND YIELD RELATED TRAITS IN F_2M_2 GENERATION OF SESAME (*Sesamum indicum* L.)

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ABSTRACT

The present investigation was undertaken to assess the combined effects of hybridization and mutagenesis on distribution parameters of yield and its related traits. The materials were grown in Randomized Block Design with three replications at Economic Botany-II Section of the Department of Plant Breeding and Genetics, College of Agriculture, OUAT, Bhubaneswar and observations were taken on polygenic traits. All populations appeared as fairly symmetrical, except ${}^{1}F_2{}^{1}M_2$ (0.638) and ${}^{3}F_2{}^{2}M_2$ (0.829) showing moderately positive skewness for plant height. Frequency curves showed restricted distribution in mutants for primary branches per plant than respective controls. All the populations showed moderately positive skewness except, ${}^{3}F_2$ and ${}^{3}F_2{}^{2}M_2$ with highly positive skewness (1.296) and nearly symmetrical distribution (0.106) for number of capsules per plant. All the populations showed moderate to high positive skewness for seed yield per plant. Populations ${}^{2}F_2$, ${}^{2}F_2{}^{1}M_2$, ${}^{3}F_2$ and ${}^{3}F_2{}^{2}M_2$ showed leptokurtic distribution with kurtosis estimates of 3.971, 5.088, 4.678 and 5.721 respectively for this character. In general, negative changes were observed for plant height and positive changes for number of capsules per plant and seed yield per plant in mutants compared to respective controls. These changes must have come through induced mutagenesis indicating higher effectiveness of mutagenesis on hybrids for enlarging variations.This variability might be further utilized in the potential breeding programme for yield improvement.

INTRODUCTION

Sesame (*Sesamum indicum* L.) belongs to the order tubiflorae, family Pedaliaceae, genus Sesamum, is an ancient oil yielding crop. Sesame is cultivated in an area of 13.9 lakh hectares in India with an annual production of 41.8 lakh tonnes and productivity of 291 kg/ha (Anonymous, 2019). Uttar Pradesh, Gujarat, Madhya Pradesh, Tamil Nadu, Odisha, Andhra Pradesh, West Bengal and Rajasthan are the major sesame growing states in India. In Odisha, sesame is cultivated in 0.23 lakh hectares with a production of 0.55 lakh tonnes and productivity of 237 kg/ha (MOA, 2015). The low productivity of sesame in India is due to low yield potential of the varieties coupled with poor crop management (Monpara and Gohil, 2018). Genetic variation in a crop is a pre-requisite to make the selection effective (Holme *et al*., 2019). Hybridization followed by selection in segregating generations is the main approach in breeding in self-pollinated crop like sesame, but tight linkage of polygenes controlling the characters could be an obstruction to release the useful variability. To overcome this difficulty some workers have examined the usefulness of combining hybridization and mutagenesis for generating variability for quantitative traits (Gregory, 1961). Chemical mutagen treatment of hybrids is one of the methods to increase mutation frequency. Studies on the efficacy of chemical mutagen treatment like Ethyl methanesulfonate (EMS) in hybrids for enlarging useful variability in sesame are extremely limited. Chakravarti *et al*. (2013) and Singh *et al*. (2018) reported enhanced variability in EMS treated mutants compared to control during the evaluations. It is hypothesized that mutagenic treatment might bring changes in the distribution pattern in both positive as well as in negative directions (Mishra *et al*., 2008); these positive changes could be further utilized in the selection of superior plants. The objective of present investigation intended to analyze additional induced variability if any, created by recurrent mutagenesis through distribution patterns which could be utilized further in sesame improvement.

MATERIALS AND METHODS

The basic material of the present investigation consisted of three adapted sesame varieties of Odisha *viz*., Nirmala, Prachi and Amrit. These varieties were crossed and three inter-varietal crosses (F_1s) were created, excluding the reciprocal crosses. Based on the previouly reported research ethyl methanesulfonate (EMS) with dose of 0.5 per cent for three hours/cycle was selected for mutagenic treatment of hybrids (Begum and Dasgupta, 2010, Begum and Dasgupta, 2015 and Kumari *et al*., 2016). In F_2M_2 generation materials comprising of six F_2M_2s mutant populations (three non recurrent and three recurrent), three F_2s populations and three parents. These materials were grown in a Randomized Block Design (RBD) with three replications during Kharif, 2017 at Economic Botany-II Section of the Department of Plant Breeding and Genetics, College of Agriculture, OUAT

Bhubaneswar. Designation of various treatments and controls (F_2s) is presented in Table 1. In F_2M_2 generation experimental plot consisted of eight rows of three meters each, with 30 cm x 10 cm spacing. In order to ensure stand, two to three seeds were dibbled per hill and later thinned one seedling per hill. Normal cultural practices, including fertilizer application @ 30 kg N, 60 kg P_2O_5 and 40 kg K_2O and plant protection measures were followed as needed. Observations were taken on four quantitative traits *viz*., plant height, number of primary branches per plant, number of capsules per plant and single plant yield. Single plant observation was taken for all the studied characters using a sample of 30 randomly chosen competitive plants per plot. In F_2M_2 generation, pattern of variations among mutants was examined through frequency curves using Microsoft Excel 2007 (Microsoft Corp., Redmond, WA, USA). Possible deviation of these populations from normal distribution was examined through skewness and kurtosis estimates following method as suggested by Gupta (1981).

RESULTS AND DISCUSSION

The purpose of present investigation intended to analyze additional induced variability if any, created by recurrent mutagenesis of hybrids through analysis of distribution patterns which could be utilized further in sesame improvement. The pattern of variations of yield and yield related traits in F_2M_2 generation was analyzed by frequency curves, skewness and kurtosis. Skewness describes the degree of deviation of a distribution from symmetry and kurtosis characterizes the peakedness or flatness of a distribution. In mutagen treated populations skewness and kurtosis indicates the nature of variation. Symmetrical distribution assures equal frequency of minus and plus mutations. Any deviation from normality is indicated by tests of skewness and kurtosis. Frequency curves of the F_2M_2 populations of four characters are presented in Figure1 to Figure 12, also the estimates of skewness and kurtosis are presented in Table 2.

All the F_2s and F_2M_2s populations were found to be fairly symmetrical except populations ${}^1F_2{}^1M_2$ and ${}^3F_2{}^2M_2$ with moderately positive skewness for plant height in sesame, which is also apparent from the frequency curves (Figure1 to Figure 3). Among the mutants and crosses, three populations (${}^2F_2$, ${}^2F_2{}^1M_2$ and ${}^3F_2{}^1M_2$) were platykurtic, one population (${}^3F_2{}^2M_2$) as leptokurtic and rest of the populations found as mesokurtic in nature for plant height in sesame, however, in frequency curve population ${}^1F_2{}^2M_2$ appeared as more peaked than respective control (${}^1F_2$) and corresponding one cycle EMS treated population ${}^1F_2{}^1M_2$ for plant height in sesame. All the mutant and cross populations were found to be fairly symmetrical, except populations ${}^1F_2$ and ${}^2F_2{}^2M_2$ (moderately positive skewed) for number of primary branches per plant. All the $F_2{}^2M_2$s populations appeared as leptokurtic, population $F_2{}^1M_{2s}$ as platykurtic and population F_2s with mesokurtic distribution of number of primary branches per plant. Frequency curves showed more or less restricted distribution in mutants for primary branches per plant than respective

Table1: Treatment symbol and description of various treatments and controls in F_2M_2 generation of sesame

Sl. No	Treatment symbol	Description
1.	V_1	Variety 1 (Nirmala)
2.	V_2	Variety 2 (Prachi)
3.	V_3	Variety 3 (Amrit)
4.	${}^1F_2$	F_2 generation of cross 1 (Nirmala x Prachi)
5.	${}^2F_2$	F_2 generation of cross 2 (Nirmala x Amrit)
6.	${}^3F_2$	F_2 generation of cross 3 (Prachi x Amrit)
7.	${}^1F_2{}^1M_2$	F_2M_2 generation following one cycle EMS treatment of F_1 seeds of cross 1
8.	${}^2F_2{}^1M_2$	F_2M_2 generation following one cycle EMS treatment of F_1 seeds of cross 2
9.	${}^3F_2{}^1M_2$	F_2M_2 generation following one cycle EMS treatment of F_1 seeds of cross 3
10.	${}^1F_2{}^2M_2$	F_2M_2 generation following EMS treatment (two cycles) of $F_2{}^1M_2$ seeds* of cross 1
11.	${}^2F_2{}^2M_2$	F_2M_2 generation following EMS treatment (two cycles) of $F_2{}^1M_2$ seeds* of cross 2
12.	${}^3F_2{}^2M_2$	F_2M_2 generation following EMS treatment (two cycles) of $F_2{}^1M_2$ seeds* of cross 3

(* Mark indicates seeds of $F_1{}^1M_1$ plants. The superscript of F_2 in treatment symbol is not a part of the filial generation it represents the cross number, similarly superscript of M_2 indicates the mutagen treated cycles)

Table 2: Skewness (Sk) and Kurtosis (kts) estimates for four characters in F_2M_2 generation of sesame

Treatments	Plant height		Number of primary branches per plant		Number of capsules per plant		Seed yield per plant	
	Sk	Kts	Sk	Kts	Sk	Kts	Sk	Kts
V_1	0.18	2.607	-0.182	1.721	0.469	3.084	0.561	2.718
V_2	0.199	3.272	-0.17	1.897	0.128	2.154	0.463	2.558
V_3	0.369	2.347	0.089	2.27	0.492	2.71	0.829	2.954
${}^1F_2$	0.309	2.83	0.646	3.309	0.538	3.763	0.722	3.662
${}^1F_2{}^1M_2$	0.638	2.996	-0.176	1.818	0.638	2.484	0.949	3.284
${}^1F_2{}^2M_2$	0.169	3.171	0.372	3.878	0.648	2.224	0.908	3.191
${}^2F_2$	0.006	2.301	0.691	3.383	0.831	3.308	1.086	3.971
${}^2F_2{}^1M_2$	0.255	2.141	0.482	1.856	0.638	2.743	1.342	5.088
${}^2F_2{}^2M_2$	0.015	2.65	0.683	4.917	0.708	2.294	0.843	3.397
${}^3F_2$	0.027	2.655	0.208	2.893	1.296	5.179	1.147	4.678
${}^3F_2{}^1M_2$	-0.052	2.053	0.218	2.029	0.657	2.226	0.726	2.938
${}^3F_2{}^2M_2$	0.829	5.405	0.425	4.008	0.106	2.028	1.261	5.721

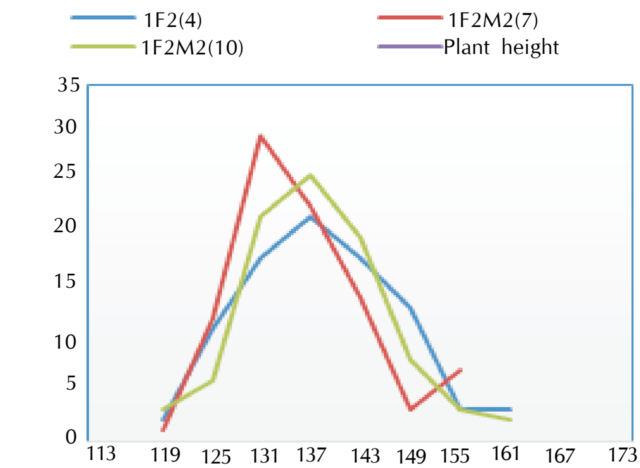

Figure 1 : Frequency curves of plant height in F_2M_2 of Nirmala x Prachi

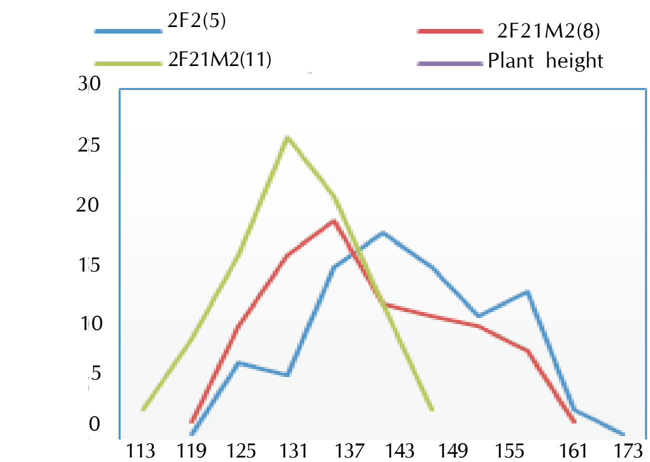

Figure 2 : Frequency curves of plant height in F_2M_2 of Nirmala x Amrit

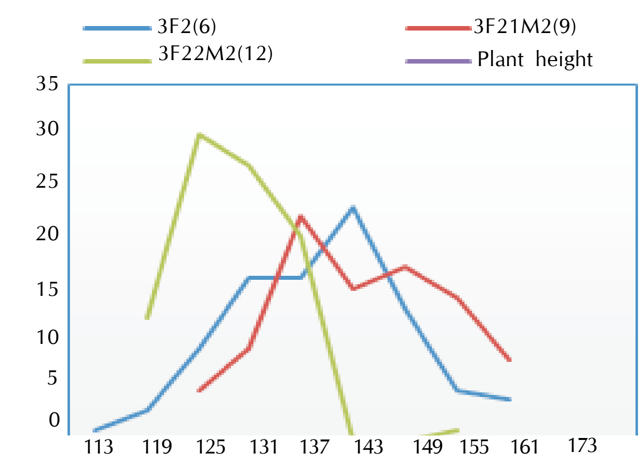

Figure 3:Frequency curves of plant height in F_2M_2 of Prachi x Amrit

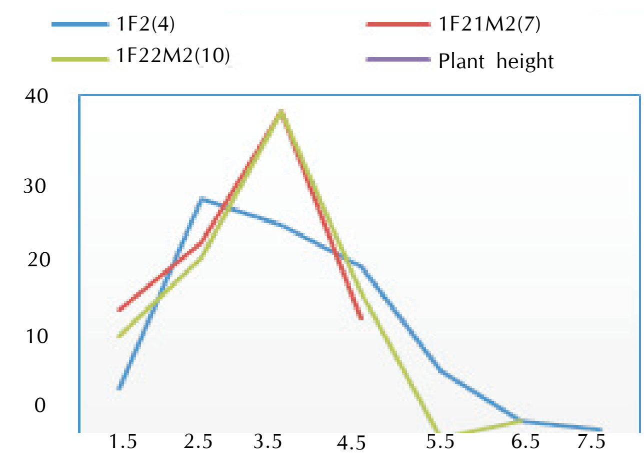

Figure 4:Frequency curves of primary branches/ plant in F_2M_2 of Nirmala x Prachi

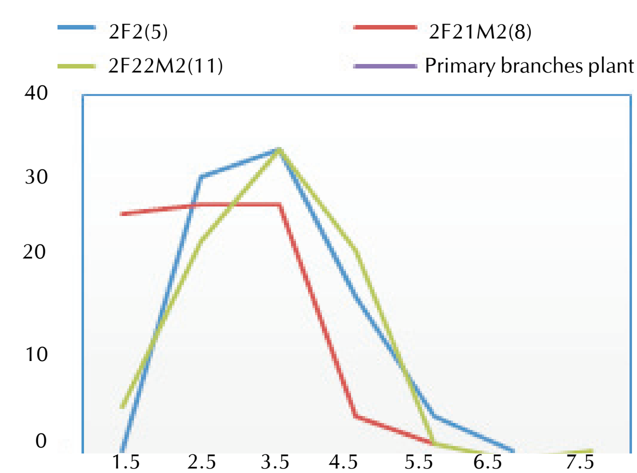

Figure 5: Frequency curves of primary branches/plant in F_2M_2 of Nirmala x Amrit

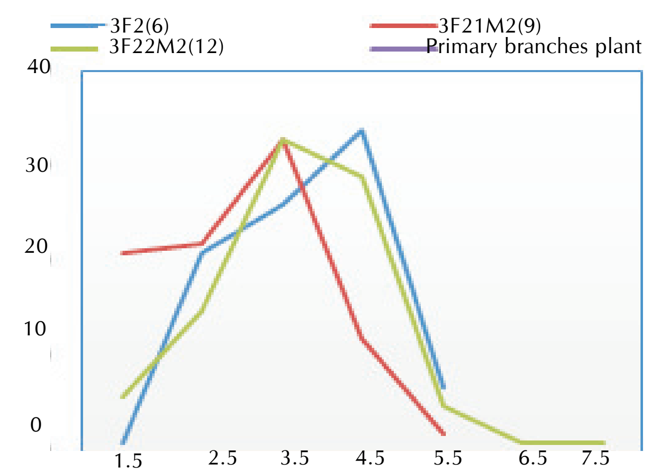

Figure 6: Frequency curves of primary branches/ plant in F_2M_2 of Prachi x Amrit

controls in sesame (Figure 4 to Figure 6).

All the crosses and mutant populations showed moderately positive skewness, except population ${}^3F_2$ (with highly positive skewness) and population ${}^3F_2{}^2M_2$ (symmetrical distribution) for number of capsules per plant, also all the mutants showed platykurtic distribution. In the frequency curve one and two cycles EMS treated populations showed more spread and flatter distributions than respective controls (Figure 7 to Figure 9). In

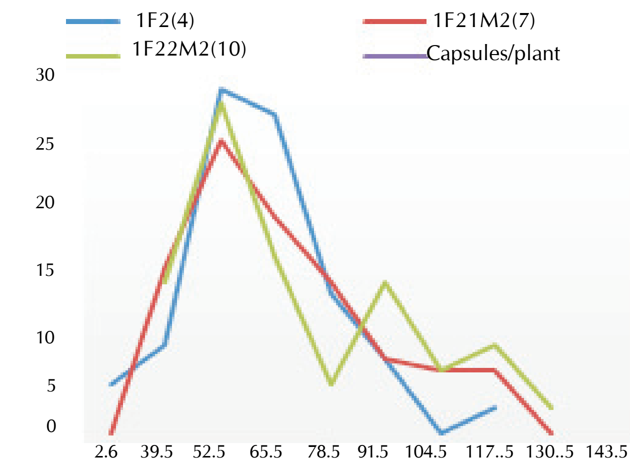

Figure 7: Frequency curves of capsules / plant in F_2M_2 of Nirmala x Prachi

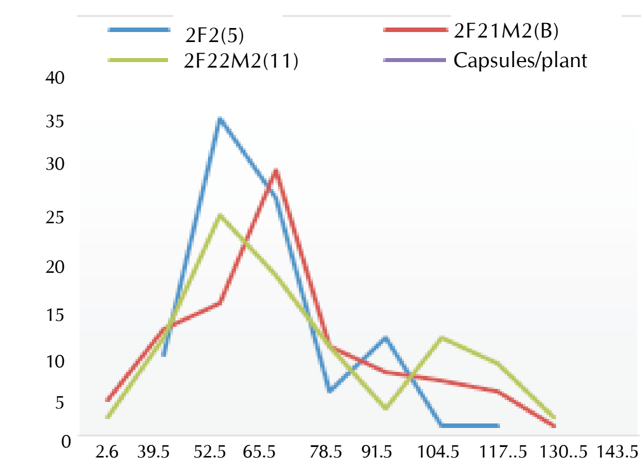

Figure 8: Frequency curves of capsules / plant in F_2M_2 of Nirmala x Amrit

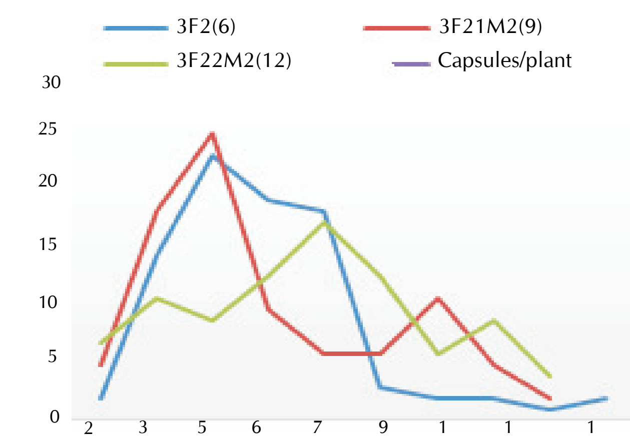

Figure 9: Frequency curves of capsules / plant in F_2M_2 of Prachi x Amrit

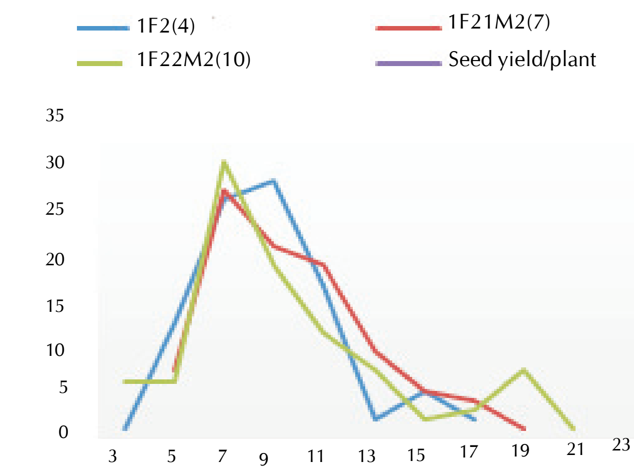

Figure 10: Frequency curves of seed yield / plant in F_2M_2 of Nirmala x Prachi

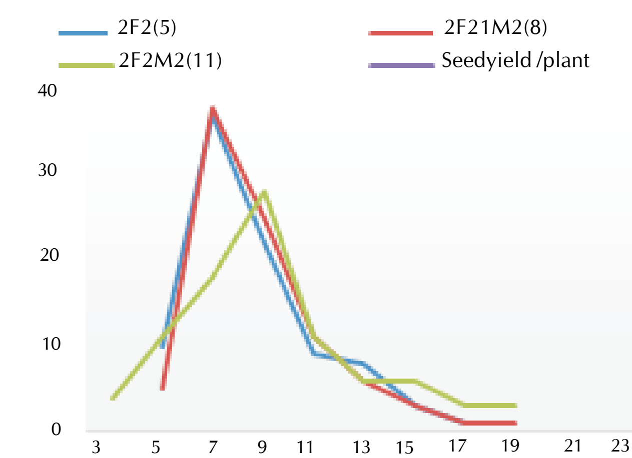

Figure 11: Frequency curves of seed yield/plant in F_2M_2 of Nirmala x Amrit

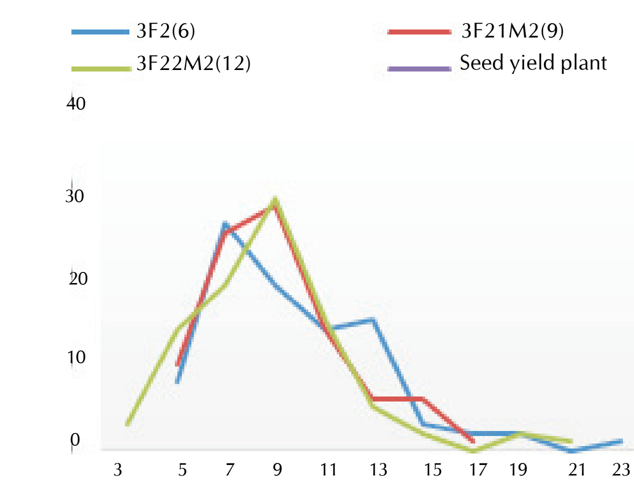

Figure 12: Frequency curves of seed yield/plant in F_2M_2 of Prachi x Amrit

general, two cycles EMS treated populations showed more spread than respective one cycle EMS treated populations for number of capsules per plant in sesame. All the crosses and mutant populations showed moderately positive skewness to highly positive skewness estimates for seed yield per plant. Populations ${}^2F_2$, ${}^2F_2{}^1M_2$, ${}^3F_2$ and ${}^3F_2{}^2M_2$ showed leptokurtic distribution. Positive skewness and leptokurtic distributions for crosses and mutant populations are also manifest from the frequency curves for seed yield per plant (Figure 10 to Figure 12). Sumathi and Muralidharan (2010) reported positive skrewness in different F_2 populations for number of primary branches, number of capsules per plant and seed yield per plant, also they noticed both leptokurtic and platykurtic distribution of the studied characters in different F_2 populations of sesame.

All the F_2M_2s populations showed difference in terms of frequency distribution, skewness and kurtosisas compared to respective control populations, however the magnitude and frequency of such variants might be more in one or the other direction in some cases or be equal in both directions. Populations having a higher intensity of expression of a trait showed negative skewness for that trait and populations having low values for the traits showed positive skewness. Moreover, populations having intermediate values for the traits, mostly did not show skewness and the distribution were often platykurtic (flatter). The positive skewness in the distribution of yield and its components in the EMS treated populations showed that positive mutations occurred with greater frequency than negative mutations. Brock (1967) observed mutagenic treatments generally increased both skewness and kurtosis by ionizing radiations. The direction of induced micro mutations is of course a function of the genetic make-up of the genotypes subjected to mutagen treatment/ irradiation treatment if Brock's hypothesis (Brock 1967) is correct. These changes in mutants for different characters might be due to the discrepancy expression of a trait induced by mutation. In general, negative skewness was observed for plant height, so to obtain dwarf plants, selection should be done from the lower end of the distribution. Traits number of capsules per plant and seed yield per plant generally observed with positive skewness indicating more proportion of individuals present in lower end of distribution but some plants were also obtained at higher end indicating favorable changes for these traits, also selection should be done at higher end for improvement of these traits. Kar *et al*. (2019) also reported enhanced variability over hybridization only during evaluations of F_1M_1 generation of sesame. The positive changes in mutants compared to respective controls, particularly for number of capsules per plant and seed yield per plant must have come through induced mutagenesis, which indicated the higher effectiveness of mutagenic treatment of hybrids to for enlarging variability over hybridization only. This enhanced variability might be further utilized in the potential breeding programme for yield improvement.

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