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RESEARCH ARTICLE

GENETIC VARIANCE AND PERFORMANCE OF SESAME MUTANTS FOR YIELD CONTRIBUTING CHARACTERS

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ABSTRACT

In Bangladesh average sesame production is lower than other sesame producing country of the world, Therefore an experiment was conducted using five sesame M_5 mutants along with the mother variety to observe their performances regarding seed yield and other yield attributes. Analysis of variance showed highly significant variations among the mutants and check for most of the characters. The mutant SM-07 required the shortest maturity period and produced the tallest plant and highest number of capsules plant^{-1} in each location and combined over locations, where as SM-01 and the mother variety Binatil-1 required the longest maturity period. Results over different locations also showed that the three mutants SM-06, SM-04 and SM-07 produced significantly higher seed yield (1477, 1449 and 1438 kg ha^{-1}, respectively) which was 7.3, 5.2 and 4.4% higher than the mother variety Binatil-1 with seed yield of 1377 kg ha^{-1}. This suggests that mutation techniques can be fruitfully applied to develop variety with higher seed yield and other improved agronomic traits of sesame.

KEYWORDS

Sesame, genetic component, yield and yield component, mutant

1. INTRODUCTION

Sesamu indicum L. (Family Pedaliaceae) commonly known as sesame is an important oilseed crop. It is referred as 'queen of oilseeds' due to its regard by the users and owing to its oil quality [1]. It is one of the most ancient crops in the world known to mankind, with archeological evidences dating back to 2250 and 1750 BC at Harappa in the Indus valley [2]. Ironically, it is considered as an 'orphan crop' due to meager research efforts attributed to the fact that it is not a mandate crop for any international crop research institute [3]. Sesame is mainly a crop of warmer areas including Asia and Africa, In Bangladesh the total production is 2970 metric tons [4,5]. Average productivity of sesame has lowered ranging from 144 to 234 kg ha^{-1} compared to past 20 years which has led to a gap in the demand and the supply [6]. It is an excellent rotation crop of cotton, maize, groundnut, wheat, and sorghum. It reduces nematode populations that attack cotton and groundnut [7]. Its deep and extensive root system makes it an excellent soil builder. It also improves soil texture, retains moisture and reduces soil erosion. The left over composted sesame leaves also help in moisture retention of the soil making favorable conditions for planting the next crop. Considering the importance of sesame, development of higher yielding sesame variety is persistent demand.

For any plant breeding programme, creation of genetic variation followed by selection plays an important role in developing improved crop varieties. Therefore, genetic variations in useful traits are prerequisites for any crop improvement programme. Like other breeding proramme in sesame creation of variability transpires to be primary step to get desirable types. Mutation breeding has long been known as a potential technique to unlock additional genetic variability for supplementing conventional crop breeding methodology. Mutagenesis offers a unique scope for creating variation, as it may alter even those genes that are common to all the varieties of a species. Induced mutation has been extensively and successfully used for the improvement of many crops including oilseed crop like sesame. Henceforth an attempt was made to select desirable sesame mutant line with high yield potential.

2. MATERIALS AND METHOD

Seeds of sesame variety Binatil-1 were irradiated with 500, 600, 700 and 800 Gy doses of gamma rays using Co^{60} gamma cell to create genetic variations. Irradiated seeds then sown to grow M_1 generation at BINA, Mymensingh in 2011 for selecting desirable mutants in subsequent generations. Selection was made in each of M_2, M_3 and M_4 generation based on desired agronomic traits. From M_4 populations, five homozygous and true breed mutants namely SM-01, SM-04, SM-05, SM-06 and SM-07 were selected for further evaluation. These five true breeding mutants along with the mother variety Binatil-1 and check variety Binatil-2 were evaluated at three sesame growing areas of Bangladesh during 2017 following randomized complete block design with three replicates. Seeds were sown within first week of March 2017 maintaining unit plot size of 20m^2 (5.0m × 4.0m) with a line spacing of 25cm and 6-8cm for plant to plant within rows. Recommended production packages like weeding, thinning and application of fertilizers, irrigation, pesticide etc. were done uniformly to ensure normal growth and development of the plants in each plot as and when necessitated.

Data were taken on different morphological traits and yield attributes like plant height, number of branches plant^{-1}, number of capsules plant^{-1} and number of seedscapsule^{-1} from 10 randomly selected representative plants from each plot at maturity. List of all the traits under study and their description of measurement have been presented in Table 1. The collected data were analyzed statistically according to the design followed using the analysis of variance (ANOVA) technique following Gomez & Gomez (1984). The mean values were compared by DMRT at 5% level of significance. Standard heterosis for each character was expressed as per cent increase or decrease of mutant over the standard variety (SV). Using formula suggested by a group researchers [8]. The t' test was applied to determine significant difference of mutant means from respective standard parent values using formulae as reported in a study by a group researchers [9]. The mean square of genotypic and phenotypic variances were estimated according to a study [10].

Table 1: List of seven different traits and their description of measurement

Serial No.	Traits	Methods of measurement
1	Days to maturity	The number of days from sowing to 70% siliquae turned into brownis color
2	Plant height (cm)	The height from the base to the tip of the plant
3	Branches plant^{-1} (no.)	Total number of primary branches plant-1
4	capsule plant^{-1} (no.)	Total number of capsule with seeds in a plant
5	Seeds siliqua^{-1} (no.)	Total number of seeds in a capsule
6	Seed yield (kg/ha)	Weighting the seeds produced in a plot and then converted into kg ha^{-1}

3. RESULTS AND DISCUSSION

In M_5 generation, the analysis of variance for different quantitative characters revealed that mean squares were highly significant for all the traits indicating the existence of high genetic variability among the mutants for yield and yield components (data was not presented here). In other words, mutation induced substantial genetic variability among the lines. Significant variations for different quantitative characters have also been reported in sesame earlier by Begum and Dasgupta 2015 and in other oilseed crops that's findings confirmed the present observation [11-13].

Table 2: Estimation of genetic component of variation for yield and yield contributing

	VG	VP	PCV	GCV	h^{2}b	GA (%)	GA
Plant height	135.2	216.5	11.48	9.07	62.43	14.74	18.0
Days to maturity	13.09	20.94	5.95	4.18	62.51	6.81	5.89
Branches plant^{-1}	5.56	8.89	185.1	146.45	60.54	2.38	3.98
Capsule plant^{-1}	345.68	553.09	34.94	27.56	78.78	56.20	37.78
Seeds Capsule^{-1}	49.54	62.33	10.60	9.48	79.48	19.11	12.85
Capsule length	1.78	2.84	56.93	45.07	62.67	73.52	2.17
Seed yield	6881.6	11010.6	7.35	5.81	61.5	69.5	9.4

Here, V_G = Genotypic component of variance, GCV = Genotypic coefficient of variance, V_P = Phenotypic component of variance, PCV = Phenotypic coefficient of variance, h^{2}b = Broad sense heritability and GA = Genetic advance

The component of variant along with coefficient of variability and genetic parameter of some yield component of the studied genotype are present at Table-1. Seed yield showed the higher genotypic and phenotypic variability followed by capsule plant^{-1}. Capsule length showed minimum difference considering genotypic and phenotypic components of variance followed by branch plant^{-1}. The narrow differences between genotypic and phenotypic components of variance indicate those major portions of this phenotypic variance are genetic in nature. In this study capsule length showed higher broad sense heritability followed by capsule plant^{-1}. The lowest broad sense heritability was found in case of branch plant^{-1}. Higher genetic advanced was found in case of capsule length followed by seed yield. The lowest genetic advance was found in case of branch plant^{-1} followed by capsule length. Higher broad sense heritability along with high genetic advance is usually more helpful in predicting the resultant effect for selection of the best individual than heritability only. Here higher heritability with higher genetic advance was found for the characters seed capsules^{-1}, capsule plant^{-1} plant height and days to maturity. So this type of characters needs to be consider for sesame improvement.

Mean values of three individual locations for understand the performances of the studied genotype have been consider and presented in Table 2. Maturity period is the most important and frequently observed character which can be modified in oilseed using induced mutation. Significant differences were observed for days to maturity in different locations. At Magura, except SM-07 other mutants matured earlier then mother variety Binatil-1. Both Ishurdi and Magura, SM-07 required the shortest period of 85 and 84 days respectively to mature. At Ishurdi mutant SM-01 and check Binatil-2 took the highest maturity period of 89 days. Like other two location at Chapainawabganj, mutant SM-07 also required the shortest maturity period of 83 days having non-significant difference with other mutants while Binatil-1, Binatil-2 and mutant SM-01 required the longest duration 87 days. It is observed that, most of the mutants matured earlier than the mother variety. This result revealed that through induced mutation maturity period can be reduced. Induction of early maturity in the mutants of oilseed has been reported in some study on sesame which confirm the present result [14,15].

Plant height differed significantly when comparing the mean of locations. At Magura, mutant SM-07 produced the highest plant height (136cm) closely followed by SM-06 (134cm) while SM-05 produced the shortest plant of 116cm. At Ishurdi, SM-07 also produced the tallest plant (122cm) which was closely followed by mother variety Binatil-1(119cm) and mutants SM-04 and SM-05. Statistically non-significant plant height was obtained from SM-01 and SM-06 whereas SM-06 produced the shortest plant of 115cm. similar result was also obtained at Chapainawabganj. Sesame demonstrates indeterminate growth habit, which causes non-synchronous maturity and very high plant height; these prevent mechanized harvesting. Shorter plant height is therefore an essential part of adaptation in modern agricultural systems with combine harvesting. Reducing plant height also improves lodging resistance, which is another problem in sesame cultivation. However, low plant height seems to be a disadvantage with respect to higher seed yield, because plants of greater height tend to bear more capsules and thus yield more seed. Development of shorter mutants in oilseed *Brassica* has been reported in studies [16,17]. These results also conform that using induced mutation plant stature can be altered in oil seed crops.

The number of branches is one of the important selection criteria in sesame improvement programs because a higher number of branches enable bearing more capsules per plant and result in higher seed yield [18]. In this study, all the mutant except SM-07 are uniculam type.

Table 3: Mean performance of sesame mutant lines along with check varieties for different quantitative characters

Mutants/ Check	Plant height (cm)	Branches plant^{-1} (no.)	Capsule plant^{-1} (no.)	Seeds capsule^{-1} (no.)	Capsule length	Seed yield (kg ha^{-1})	Days to maturity
Magura							
SM-01	132a	1c	71c	75bc	2.67b	1386b	88a
SM-06	134a	1c	78b	79b	2.71b	1431a	86b
SM-07	136a	3.2a	87a	77bc	2.91c	1433a	84c
SM-04	133a	1c	78b	73d	2.61d	1456a	85bc
Binatil-1	124b	1c	63d	99a	4.53a	1366b	88a
SM-05	116b	1c	61d	78ab	2.90a	1395b	86b
Binatil-2	122b	2.7b	64b	77bc	2.54b	1400ab	88a
Ishurdi							
SM-01	116c	1c	53c	54c	3.45a	1417c	89a
SM-06	115c	1c	51c	58c	2.43c	1500a	87b
SM-07	122a	2.73b	75a	62bc	2.79c	1433bc	85b
SM-04	119b	1c	65b	62bc	2.50bc	1492a	86b
Binatil-1	119b	1c	52c	75a	3.93a	1408c	89a
SM-05	119b	1c	65b	63bc	2.45b	1417c	87b
Binatil-2	116c	3.73a	65b	71b	3.09a	1458b	89a
Chapainawabganj							
SM-01	125ab	1b	57d	72c	2.55b	1417d	87a
SM-06	134a	1b	73b	82b	2.65b	1500a	85ab
SM-07	136a	3.4a	85a	78bc	2.97b	1450c	83c
SM-04	131a	1b	77ab	76bc	2.67b	1458b	84bc
Binatil-1	119b	1b	59d	96a	4.43a	1358e	87a
SM-05	116b	1b	64c	79bc	3.07ab	1375e	85ab
Binatil-2	120b	3.2a	69b	78bc	2.55b	1408de	87a

Note: Same letter(s) in a column for individual location/combined means/location means do not differ significantly at 5% level of significance.

At Magura, SM-07 produced the highest number of capsules plant^{-1} (87) closely followed by mutants SM-06 and SM-04 (74) and mother variety produced the lowest number (63) which was statistically similar with mutant SM-05 (61). Like Magura, both of Ishurdi and Chapainawabganj, SM-07 produced the highest number capsules plant^{-1} (75 and 85 respectively). In oilseed *Brassica*, as a consequence of mutagenesis reported higher siliqua number in developed mutants over their mothers [19-21]. Significant differences were also observed for capsule length in different locations. On an average, mother variety Binatil-1 produced the highest capsule length which was significantly different with all other mutants but at Ishurdi, mutant SM-06 produced statistically similar capsule length that was 3.45cm whereas in Binatil-1 it was 3.93cm. A group researchers also find this type of result in his research work on sesame [22].

Like other character number of seeds capsule^{-1} differ significantly both in individual locations and combined over locations. At Magur, maximum number of seeds capsule^{-1} was obtained from mother variety Binatil-1(99) followed by mutant SM-05 (78) while mutant SM-04 produce minimum seeds capsules^{-1}. At Ishurdi, maximum number of seeds capsules^{-1} was obtained from mother variety Binatil-1(75) followed by check variety Binatil-2 (71) while mutant SM-01 produce minimum seeds capsules^{-1} (54) number. Similarly, at Chapainawabganj, Binatil-1 produced maximum seeds capsule^{-1} (96) followed by SM-06 (82) and mutant SM-01 produced lowest seeds capsules^{-1} that was 72 number. Baydar stated that capsule production is one of most important traits defining the ideal type of sesame plant; it has also been identified [18,23]. Although produced the highest number of capsules, the seed yield of this genotypes was lower than the others or control because sesame's indeterminate character can cause non-mature capsule production at harvest time.

The mutants SM-07 produced the highest seed yield of 1456 kg ha^{-1} followed by SM-04 (1433 kg ha^{-1}) and SM-06 (1431 kg ha^{-1}) which was statistically similar to each other. Mother variety Binatil-1 produced the lowest yield of 1366kg ha^{-1} which was statistically identical with two other mutants SM-01 and SM-04, on the other hand check variety Binatil-2 produced seed yield of 1400 kg ha^{-1} having statistically significant different from all other mutants and mother check variety at Magtura. At Ishurdi mutants were also performed higher seed yields, the mutant SM-07 produced the higher seed yield of 1500kg ha^{-1} closely followed by the mutant SM-04 which produced 1492kg ha^{-1} of seed yield, like this at Chapainawabganj mutant SM-07 produced the higher seed yield of 1500kg ha^{-1} closely followed by mother variety Binatil-1 which produced 1458kg ha^{-1} of seed yield. Positive shift in mean values due to the enhancing effect of gamma-rays was also reported earlier by many research workers likes in sesame and rapeseed [21, 24].

Table 4: Standard heterosis for different yield contributing component of sesame mutant

Mutants/ Check	Plant height (cm)	Days to maturity	Branches plant^{-1} (no.)	Capsules plant^{-1} (no.)	Seeds Capsules $^{-1}$ (no.)	Capsules length	Seed yield (kg ha^{-1})
SM-01	1.70*	-	-50**	-9.09**	-10.66**	-6.25**	-1.12**
SM-06	4.20*	-2.27**	-50**	-1.50**	-2.66**	-4.77**	-3.80**
SM-07	10.08*	-4.5**	55.5*	24.24*	10.24*	6.25*	1.80*
SM-04	4.20*	-3.4**	-50**	10.24*	6.60*	-4.77**	1.14*
SM-05	-5.04**	-2.27**	-40**	-4.54**	-2.40**	2.94*	-1.80**

*indicates significant at 5% level
** indicates significant at 1% level

Compared with Check variety Binatil-2 at seed yield was decreased 1.12% in SM-01, 3.80% in SM-06 and 1.18% in SM-05. At the mutant SM-07 it increased 1.8% and 1.14% in SM-04 over check variety Binatil-2. In plant breeding, generation of genotypes having improved yield contributing characters is the main objective for achieving higher yield [25]. In oilseed, the most important yield attributes responsible for the increased seed yield are the capsule number and seed number in capsule. Seed yield is a complex quantitative character governed by a large number of genes and is greatly affected by environmental fluctuations [26, 27]. In seed yield and its attributes and other morphological traits variations were observed among the locations which are due to the variations in environments among the locations.

4. CONCLUSION

It was observed that among the mutants and mother variety three mutants SM-04, SM-06 and SM-07 performed better for seed yield and yield contributing characters which can be selected for further trials to be registered as varieties. Moreover, this study suggests that for Sesame improvement breeding program researcher need to consider the characters like seed capsules^{-1}, capsule plant^{-1} plant height and days. It also concludes that gamma rays irradiation can be fruitfully applied to induce mutants in *Sesame* with higher seed yield and other improved agronomic traits.

REFERENCE

[1] Bedigian, D., Harlan, J.R. 1986. Evidence for cultivation of sesame in the ancient world. Economic Botany, 40 (2), 137–154.

[2] Najeeb, U., Mirza, M.Y., Jilani, G., Mubashir, A.K., Zhou, W.J. 2012. Sesame. In: Gupta SK (ed), Technological innovations in major world oil crops, vol 1. Springer, New York, pp 131–145.

[3] Bhat, K.V., Babrekar, P.P., Lakhanpaul, S. 1999. Study of genetic diversity in Indian and exotic sesame (Sesamum indicum L.) germplasm using random amplified polymorphic DNA (RAPD) markers. Euphytica, 110, 21–33.

[4] Ashri, A. 1988. Sesame breeding-objectives and approaches. In: Oil crops-sunflower, linseed and sesame. In: Proceedings of 4th oil crop network workshop, Njoro.

[5] BBS. 2016. Statistical Pocket Book of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Government of People's Republic of Bangladesh. pp:117.

[6] Raikwar, R.S., Srivastva, P. 2013. Productivity enhancement of sesame (Sesamumindicum L.) through improved production technologies. African Journal of Agricultural Research, 8 (47), 6073–6078.

[7] Elbadri, G.A., Yassin, A.M. 2010. Sesame's protective role in crop nematode control. In Bedigian D(ed) Sesame: the genus Sesamum, CRC Press, Boca Raton, pp 211–217.

[8] Virmani, S.S., Viraktamath, B.C., Casal, C.L., Toledo, R.S., Lopez, M.T., Manalo, J.O. 1997. Hybrid Rice Breeding Manual, International Rice Research Institute, Philippines.

[9] Wynne, J.C., Emmer, D.A., Rice, P.W. 1970. Combining ability estimates in Arachis hypogaea L. II. Field perfomramne of F_1 hybrids. Crop Science, 10, 713– 715.

[10] Johnson, H.W., Robinson, H., Comstock, R.F. 1955. Estimates of genetic and environmental variability in soybean. Agronomy Journal, 47, 314 – 318.

[11] Ali, N., Javidfar, F., Attary, A.A. 2002. Genetic variability, correlation and path analysis of yield and its components in winter rapeseed (Brassica napus L.). Pakistan Journal of Botany, 34 (2), 145–150.

[12] Hasan, M., Seyis, F., Badani, A.G., Pons-Kühnemann, J., Friedt, W., Lühs, W., Snowdon, R.J. 2006. Analysis of genetic diversity in the Brassica napus L. gene pool using SSR markers. Genetic Resources and Crop Evolution, 53, 793–802.

[13] Mahmud, F., Rasul, M.G., Rahim, M.A. 2008. Genetic diversity analysis in some advanced lines of Brassica napus. Science Asia, 34, 432–434.

[14] Shah, S.A., Rahman, K. 2009. Yield and growth response of rapeseed (Brassica napus L.) mutants to different seeding rates and sowing dates. Pakistan Journal of Botany, 41 (6), 2711–2716.

[15] Begum, T., Dasgupta. 2014. Induced genetic variability, heritability and genetic advance in sesame (SesamumindicumL.). SABRAO Journal of Breeding and Genetics, 46, 21-33.

[16] Shah, S.A., Ali, I., Rahman, S. 1990. Induction and selection of superior genetic variables of oilseed rape, Brassica napus L. The Nucleus, 7, 37–40.

[17] Malek, M.A., Begum, H.A., Begum, M., Sattar, M.A., Ismail, M.R., Rafii, M.Y. 2012a. Development of two high yielding mutant varieties of mustard (Brassica juncea (L.) Czern.) through gamma rays irradiation. Australian Journal of Crop Science, 6 (5), 922–927.

[18] Baydar, H. 2005. Breeding for the improvement of the ideal plant type of sesame. Plant Breeding, 124, 263-267.

[19] Javed, M.A., Siddiqui, M.A., Khan, M.K.R., Khatri, A., Khan, I.A., Dehar, N.A., Khanzada, M.H., Khan, R. 2003. Development of high yielding mutants of Brassica campestris L. cv. Toria selection through gamma rays irradiation. Asian Journal of Plant Sciences, 2 (2), 192–195.

[20] Khatri, A., Khan, I.A., Siddiqui, M.A., Raza, S., Nizamani, G.S. 2005. Evaluation of high yielding mutants of Brassica juncea cv. S-9 developed through gamma rays and EMS. Pakistan Journal of Botany, 37 (2), 279–284.

[21] Malek, M.A., Ismail, M.R., Monshi, F.I., Mondal, M.M.A., Alam, M.N. 2012b. Selection of promising rapeseed mutants through multi-location trials. Bangladesh Journal of Botany, 41 (1), 111–114.

[22] Sarwar, G., Haq, M.A., Chaudhry, M.B., Rabbani, I. 2007. Evaluation of early and high yielding mutants of sesame (Sesamumindicum L.) for different genetic parameters. Journal of Agricultural Research, 45, 125-133.

[23] Osman H.E. 1989. Heterosis and path coefficient analysis in sesame. Acta agronomic Hungarica, 38, 105-112.

[24] Begum, T., Dasgupta. 2015. Amelioration of Seed Yield, Oil Content and Oil Quality Through Induced Mutagenesis in Sesame (SesamumIndicumL.) Bangladesh Journal of Botany, 44 (1), 15-22.

[25] Ahmad, M., Khan, M.A., Zafar, M., Sultana, S. 2010. Environment friendly renewable energy from sesame biodiesel energy sources. Energy Sources Part A, 32, 189–196.

[26] Gomez, K.A., Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. John Wiley and Sons, USA.

[27] Morris, J.B. 2002. Food, industrial, nutraceutical and pharmaceutical uses of sesame genetic resources. In: Janick J, Whipkey A (eds) Trends in new crops and new uses. ASHS Press, Alexandria, pp 153–156.

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