Plant Archives Vol. 26, Supplement 2, 2026 pp. 3074-3079 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.392

ASSESSMENT OF MUTAGENIC EFFICIENCY AND EFFECTIVENESS IN SESAME (*Sesamum indium* L.) VARIETIES AKT-64 AND N-8 UNDER GAMMA IRRADIATION

Pallavi R. Sasane[1*], Aditi R. Rajane[2], Vividha M. Sirsat[3], E.R. Vaidya[4] and S.S. Bhurghate[5]
[1]Department of Genetics and Plant Breeding, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India.
[2]P. R. Pote College of Agriculture Amravati, Maharashtra, India
[3]K. K. Wagh College of Agriculture Biotechnology Nashik, Maharashtra, India
[4]Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India.
[5]Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India.
*Corresponding author E-mail: pallavisasane94@gmail.com
(Date of Receiving : 04-05-2026; Date of Revision : 28-06-2026; Date of Acceptance : 18-07-2026)

ABSTRACT

The effectiveness of gamma radiation as a physical mutagen to create genetic variability in two genotypes of sesame (*Sesamum indicum* L.) AKT-64 and N-8 is assessed in this study, which was conducted at Deparment of agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola. In the M2 generation, chlorophyll mutation profiling is used as a diagnostic of mutagenic efficacy. The optimal mutagenesis efficiency, which balances significant mutation induction with little biological harm (lethality and sterility), is genotype dependent and reaches a maximum at 600 Gy for AKT-64 and 500 Gy for N-8, despite the highest mutation frequency occurring at 700 Gy. These ideal dosages offer a foundation for focused mutant breeding intended to enhance sesame agronomic characteristics.
Keywords **:** Sesame (*Sesamum indicum* L.), Gamma radiation, Physical Mutagen, Genetic Variability.

Introduction

Mutation breeding offers a comparatively expedited and focused methodology for the crop enhancement, as induced mutations can significantly improve yield potential, stress resilience, and various quantitative attributes of plants. Sesame (*Sesamum indicum* L.) is one of the oldest cultivated oilseed crops (Brar and Ahuja, 1979) and, serves as a crucial source of high-quality edible oil and protein. This is particularly relevant for smallholder and low-income farmers in key sesame-producing nations, including Sudan, Ethiopia, Uganda, Nigeria, Mexico, Venezuela, India, China, Pakistan, Turkey, and Myanmar (Oplinger *et al*., 1990).

Taxonomically, sesame belongs to the family *Pedaliaceae* and is predominantly a diploid species (2n = 2x = 26), although certain species occur as tetraploids or octaploids (Kobayashi, 1991). Although chlorophyll mutations are not of direct agronomic value, they serve as useful indicators for assessing the efficiency and effectiveness of mutagens, thereby assisting in determining suitable mutagen types and optimal doses for mutagenesis.

The present study utilizes physical mutagens, with a particular emphasis on gamma rays, to induce genetic variability in sesame plants. Furthermore, it seeks to assess and compare the relative efficacy of these mutagens while adhering to standardized treatment conditions

Material and Method

Dried seeds of two sesame (*Sesamum indicum* L.) varieties, AKT-64 and N-8, were exposed to gamma radiation at doses of 400, 500, 600, and 700 Gy, utilizing a ^{60}Co gamma source at the Bhabha Atomic Research Centre (BARC) in Mumbai, India. The irradiated and control seeds were planted in the field following a Randomized Block Design (RBD) with five replications. Each experimental plot consisted of three rows, each 3 meters long, with a spacing of 30 centimeters between rows and 10 centimeters between plants. All advised agronomic practices were adhered to during the crop growth period.

The M1 generation was grown to maturity and seeds were collected to grow M2 generation during Kharif 2019 season with uniform spacing and experimental design. The observations provided data on phenotypic traits and mutation expression. The treated populations were scored for chlorophyll and macro mutations according to the method described by Gustafsson (1947). Evaluation of chlorophyll mutations was done at the seedling emergence stage and continued for four weeks after germination while evaluation of macro mutants was done throughout the growing period.

Chlorophyll mutants were divided into albino (completely free of chlorophyll; white seedlings surviving only a few days), xantha (from bright to deep yellow), white streak leaf (white streaks on leaves from the edge to the midrib), chlorina (yellowish-green), viridis (light green), xantha viridis (green leaves with yellow apices). The data were analyzed to obtain the statistical parameters like mutant effectiveness, efficiency and mutation frequency.The mutation frequency was calculated using the method proposed by Gaul (1957).

$$\text{Mutation frequency based on M2 (\%)} = \frac{\text{Number of Chl. Mutant in M2}}{\text{Total population in treatment}} \times 100$$

Mutagenic efficiency and effectiveness

The efficiency and effectiveness of the mutagen in different treatments in the M2 generation were be estimated using the formula given by Konzak *et al.* (1965).

$$\text{Mutagenic efficiency} = \frac{MP}{L}$$

$$\text{Mutagenic efficiency} = \frac{MP}{S}$$

$$\text{Mutagenic effectiveness} = \frac{MP}{Gy}$$

Where,

MP = Mutants per 100 M2 plants
L = Percent lethality
S = Pollen Sterility
Gy = Dose of gamma radiation in Gray

Result and Discussion

Table 1 summarizes the frequency of chlorophyll mutations in the M_2 progeny of the sesame cultivars AKT-64 and N-8. As gamma-ray doses increased, there was a steady increase in the frequency of chlorophyll mutations per M2 plant. Chromosome abnormalities or saturation of mutational events could be the cause of the higher mutation frequency at higher dosages, which could result in the selective loss of mutant cells during subsequent growth and development (Brock, 1965).

In the M_2 generation, albino mutants within the AKT-64 genotype exhibited the highest mutation frequency (0.04%) at 700 Gy, while in N-8, the maximum frequency (0.05%) occurred at 700 Gy as well. Xantha mutants were found in both genotypes at all dosages, with a peak frequency of 0.15% in N-8 at 500 Gy. White streaks that extended from the leaf margins to the midrib were a characteristic of these mutants. AKT-64 showed white streak leaf mutants at 600 and 700 Gy, while N-8 showed the highest frequency (0.10%) at 700 Gy. Chlorina mutants, characterized by golden-yellow to light-green leaves that were lethal within 15–20 days, appeared at all irradiation levels in both genotypes. The highest frequencies were recorded at 700 Gy (0.44% in AKT-64 and 0.40% in N-8). Viridis mutants, displaying yellow-green to pale-green leaves that progressively reverted to normal green, were also present across all doses, with the greatest frequency (0.15%) at 500 Gy in N-8. Xantha-viridis mutants, possessing green leaves with yellow apices, were viable and detected only in the M_2 generation, with a maximum frequency (0.12%) at 600 Gy in AKT-64.

In general, the frequency of chlorophyll mutations increased with the increase in irradiation dose, peaking at 700 Gy with values of 0.74% in AKT-64 and 0.75% in N-8. This was followed by doses of 600 Gy (0.72% and 0.61%), 500 Gy (0.48% and 0.56%), and 400 Gy (0.33% and 0.38%) for AKT-64 and N-8, respectively. In the M_2 generation, six different types of chlorophyll mutants were observed: albino, xantha, white streak leaf, chlorina, viridis, and xantha viridis (Figure 3). The overall mutation frequency was marginally higher in N-8 (2.30%) than 2.27% in AKT-64. Among the mutants, chlorina had the highest occurrence at 0.27%, followed by xantha (0.10%), xantha viridis (0.07%), viridis (0.03%), white streak leaf (0.03%), and albino (0.02%) mutants. These results align with earlier studies by Saha and Paul (2018), Sheeba *et al.* (2003), Pradhan and Paul (2019), and Rajaramadoss *et al.* (2014) on sesame.

The efficiency of mutagenesis, assessed through lethality, showed considerable variation among the treatments, with values ranging from 1.60 at 400 Gy in genotype N-8 to 2.22 at 600 Gy in genotype AKT-64.

Regarding chlorophyll mutations, genotype AKT-64 achieved the greatest mutagenic efficiency at 600 Gy (2.22), followed by 500 Gy (2.09), 700 Gy (2.05), and 400 Gy (1.61). Conversely, genotype N-8 reached its highest mutagenic efficiency at 500 Gy (2.10), with subsequent values at 700 Gy (1.81), 600 Gy (1.66), and 400 Gy (1.60).

When assessing mutagenic efficiency through sterility, values ranged from 2.75 at 400 Gy in AKT-64 to 3.83 at 600 Gy in the same genotype, respectively. AKT-64 exhibited peak efficiency at 600 Gy with a value of 3.83, followed by 3.30 at 500 Gy, 3.29 at 700 Gy, and 2.75 at 400 Gy. In a similar pattern, genotype N-8 achieved its highest mutagenic efficiency at 500 Gy with a value of 3.48, then 3.29 at 600 Gy, and both 400 and 700 Gy recorded 3.25. The mutagenic effectiveness in the M_2 generation ranged from 0.0825 at 400 Gy in AKT-64 to 0.1200 at 600 Gy in the same genotype. The highest mutagenic effectiveness for AKT-64 was at 600 Gy (0.1200), whereas genotype N-8 reached its maximum at 500 Gy (0.1120). The lowest effectiveness for both genotypes was consistently noted at 400 Gy, with values of 0.0825 for AKT-64 and 0.0950 for N-8.

Efficiency metrics, based on lethality and sterility, indicate the ratio of beneficial mutations to harmful effects such as mortality and sterility. In contrast, effectiveness denotes the frequency of mutation induction per unit gamma radiation dose. Doses of 600 Gy for AKT-64 and 500 Gy for N-8 were found to be the most efficient and effective for maximizing chlorophyll mutation induction. These results are consistent with those of earlier studies that have identified similar dose ranges as optimal for inducing a wide variety of chlorophyll mutations in sesame (Boranayaka *et al.*, 2010; Rajaramadoss *et al.*, 2014; Kumar and Shunmugavalli, 2015).

Table 1: Spectrum and frequency of chlorophyll mutation in different doses of gamma rays in M2 generation (%) in sesame

Mutants	**AKT-64**					**N-8**				
Doses	**400Gy**	**500Gy**	**600Gy**	**700Gy**	**Average**	**400Gy**	**500Gy**	**600Gy**	**700Gy**	**Average**
Total M_2 plant population	3309	2913	2501	2298		2876	2678	2299	2013	
Albina	0.03	0.00	0.00	0.04	0.02	0.03	0.04	0.00	0.05	0.03
Xantha	0.09	0.10	0.08	0.13	0.10	0.07	0.15	0.13	0.05	0.10
White streak mutants	0.00	0.00	0.08	0.04	0.03	0.00	0.00	0.00	0.10	0.03
Chlorina	0.12	0.21	0.32	0.44	0.27	0.14	0.15	0.35	0.40	0.26
Viridis	0.03	0.10	0.12	0.04	0.07	0.10	0.15	0.09	0.05	0.10
Xantha viridis	0.06	0.07	0.12	0.04	0.07	0.03	0.07	0.04	0.10	0.06
Total chlorophyll mutation frequency	0.33	0.48	0.72	0.74	0.57	0.38	0.56	0.61	0.75	0.58
Average chlorophyll mutation frequency					0.16					0.16

Table 2: Mutagenic efficiency and effectiveness of chlorophyll mutant different doses of gamma rays in M2 and M3 generations in sesame

Genotypes	**Doses**	**Lethality % (L)**	**Pollen Sterility (%) (S)**	**Mutant per 100 plants (MP)**	**Mutagenic Efficiency (MPx100/L)**	**Mutagenic Efficiency (MPx100/S)**	**Mutagenic Effectiveness (MPx100/Gy)**
AKT-64	400Gy	20.46	11.98	0.33	1.61	2.75	0.0825
	500Gy	23.02	14.55	0.48	2.09	3.30	0.0960
	600Gy	32.50	17.78	0.72	2.22	3.83	0.1200
	700Gy	36.15	22.50	0.74	2.05	3.29	0.1057
N-8	400Gy	23.73	11.71	0.38	1.60	3.25	0.0950
	500Gy	26.61	16.07	0.56	2.10	3.48	0.1120
	600Gy	36.67	18.52	0.61	1.66	3.29	0.1017
	700Gy	41.50	23.08	0.75	1.81	3.25	0.1071

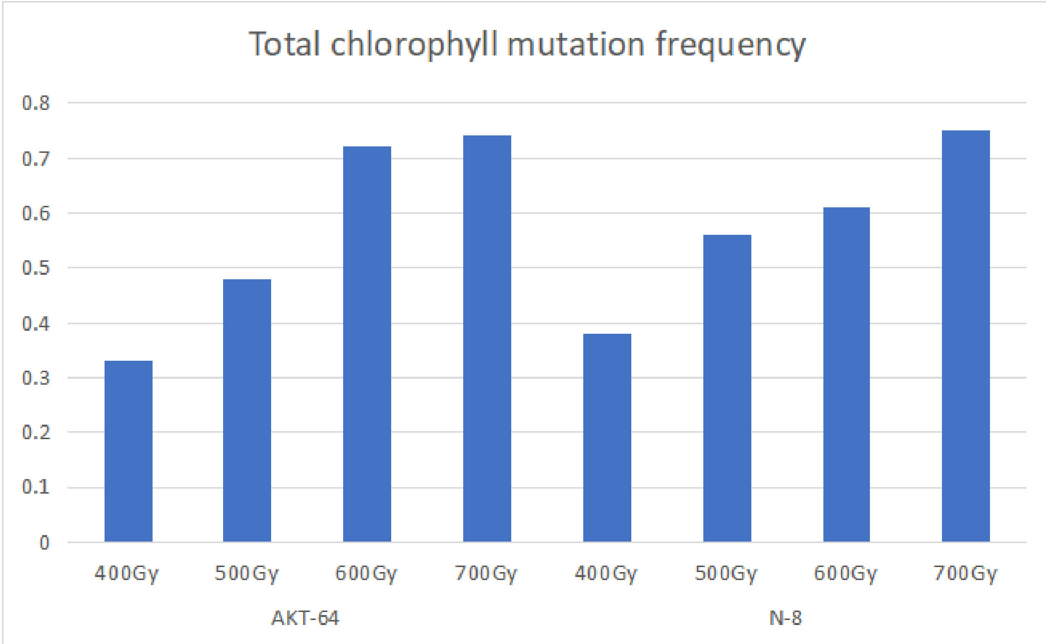


Fig. 1: Total chlorophyll mutation frequency

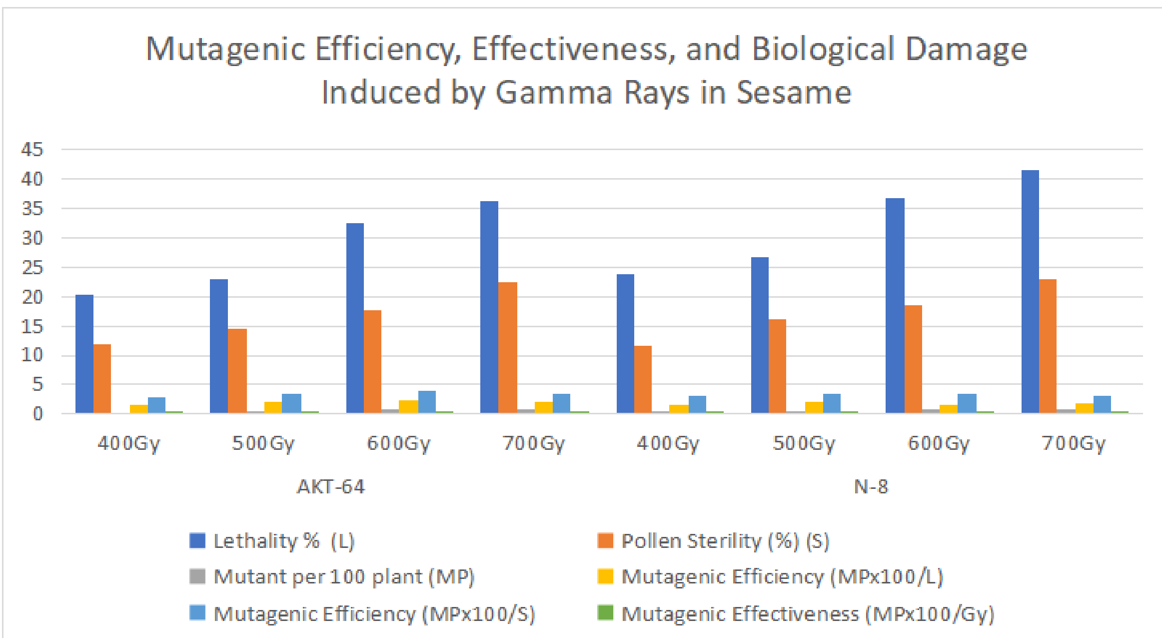


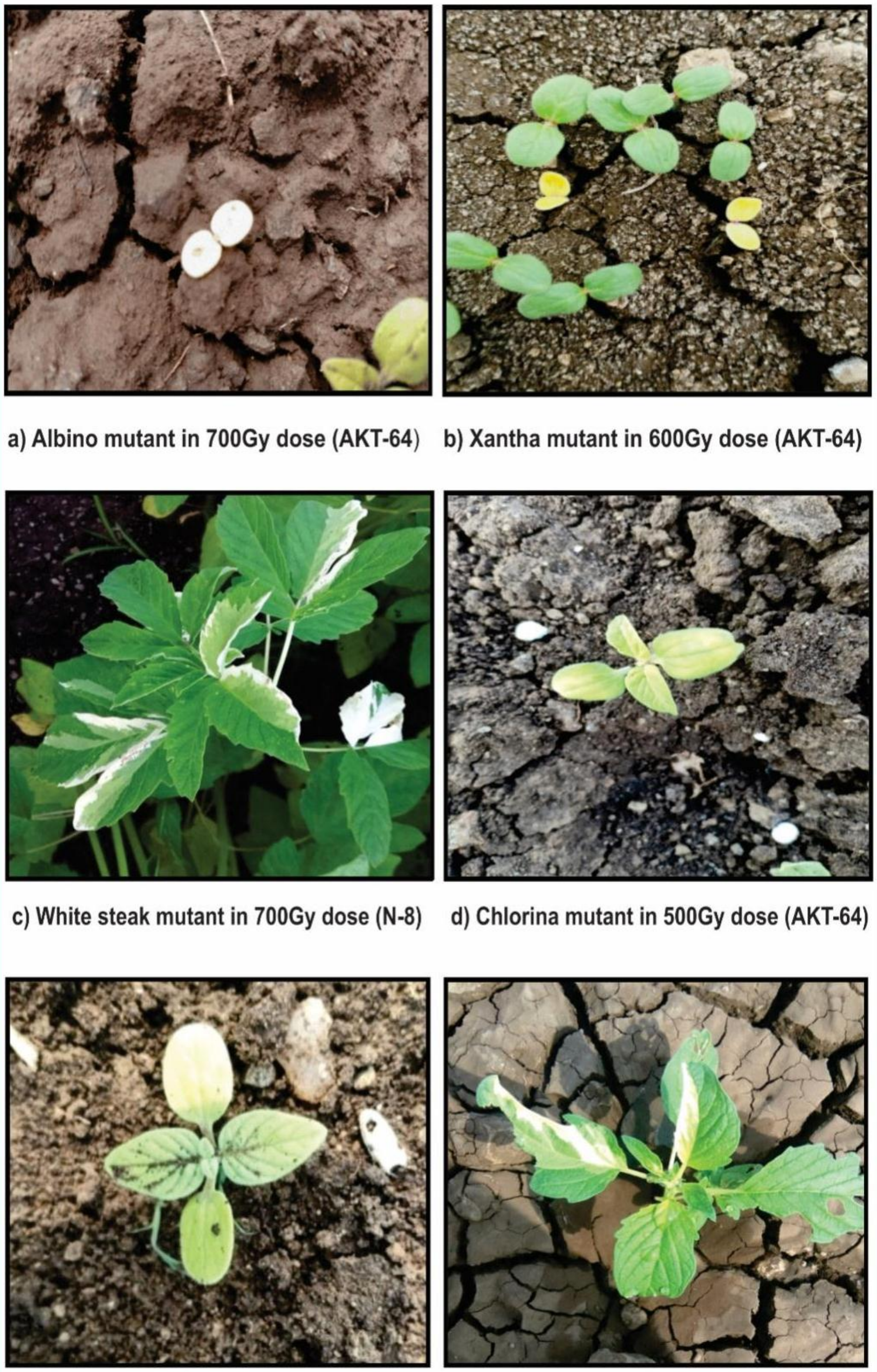
Fig. 2: Mutagenic efficiency effectiveness and biological damage induced by Gamma Rays in Sesame

Conclusion

The present study demonstrated that gamma ray irradiation is an effective mutagen for inducing genetic variability in sesame (*Sesamum indicum* L.). Six types of chlorophyll mutations, namely albino, xantha, white streak leaf, chlorina, viridis, and xantha-viridis, were identified in the M_2 generation of both AKT-64 and N-8 genotypes. The frequency of chlorophyll mutations increased with increasing doses of gamma radiation, with the highest frequencies recorded at 700 Gy for both genotypes.

Analysis of mutagenic effectiveness and efficiency revealed that the optimum irradiation dose varied among the genotypes. The 600 Gy treatment was found to be the most effective and efficient for inducing mutations in AKT-64, whereas 500 Gy was optimal for N-8. These doses provided a favorable balance between mutation induction and associated biological damage such as lethality and sterility.

The results indicate that gamma ray induced mutagenesis can be successfully utilized to create genetic variability in sesame and may serve as an important tool in crop improvement programs. The identified optimum doses can be employed in future mutation breeding efforts aimed at developing high-yielding and stress-tolerant sesame varieties.



a) Albino mutant in 700Gy dose (AKT-64)

b) Xantha mutant in 600Gy dose (AKT-64)

c) White steak mutant in 700Gy dose (N-8)

d) Chlorina mutant in 500Gy dose (AKT-64)

e) Viridis mutant in 400Gy dose (AKT-64)

f) Xantha Viridis mutant in 400Gy dose (N-8)

Plate 2 Chlorophyll mutants

References

Boranayaka, M. B., Ibrahim, S. M., Kumar, C. R. A. and Rajavel, D. S. (2010b). Induced macro-mutational spectrum and frequency in sesame (*Sesamum indicum* L.). *Indian Journal of Genetics*, ***70***, 155–164.

Brar, G. S. and Ahuja, K. L. (1979). Sesame: Its culture, genetics, breeding and biochemistry (pp. 245–313). In C. P. Malik (Ed.), *Annual review of plant sciences*. Kalyani Publishers.

Buhler, D. D. and Oplinger, E. S. (1990). Influence of tillage systems on annual weed densities and control in solid-seeded soybean (*Glycine max*). *Weed Science*, ***38***(2), 158–165.

Gaul, H. (1958). Present aspects of induced mutation in plant breeding. *Euphytica*, ***7***, 237–279.

Gustafsson, Å. (1947). A study on induced mutations in plants. In *Induced mutations in plants* (pp. 9–35). International Atomic Energy Agency.

Kobayashi, K. (1991). On generalized gamma functions occurring in diffraction theory. *Journal of the Physical Society of Japan*, ***60***(5), 1501–1512.

Kumar, R. and Shunmugavalli, N. (2015b). Mutagenic effectiveness and efficiency of induced mutations in sesame (*Sesamum indicum* L.). *Life Science Leaflets*, ***66***, 42–54.

Pradhan, M. and Paul, A. (2019a). Spectrum and frequency of chlorophyll mutation in sesame (*Sesamum indicum* L.). *The Pharma Innovation Journal*, ***8***(4), 453–455.

Rajaramadoss, B., Ganesamurthy, K., Angappan, K. and Gunasekaran, M. (2014b). Mutagenic effectiveness and efficiency of gamma rays in sesame (*Sesamum indicum* L.). *Global Journal of Molecular Sciences*, ***9***(1), 1–6.

Saha, S. and Paul, A. (2018). Effectiveness and efficiency of gamma rays on sesame genotypes. *The Bioscan*, ***13***(1), 197–201.

Sheeba, A., Ibrahim, S. M. and Yogameenakshi, P. (2003a). Induced chlorophyll mutant studies in sesame (*Sesamum indicum* L.). *Sesame and Safflower Newsletter*, ***18***, 33–38.