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PLANT TYPE MUTATION IN SESAME (*SESAMUM INDICUM* L.) : A REVIEW

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Abstract

A review article on *Sesamum indicum* L. (Pedaliaceae), an important oil seed crop of commerce is constructed considering the aspects of plant type macromutation and inheritance of traits. The objective of the work is to provide insight to the future researchers associated to the field of oil seed crop improvement for identification and selection of heritable phenotypic traits close to the plant ideotype been looked for in the species.

Key words : *Sesamum indicum*, Macromutation, Inheritance, Oil seed.

Introduction

Sesame (*Sesamum indicum* L., family: Pedaliaceae) is referred to as "Queen of Oil Seed" (Bedigian and Harlan, 1986). The plant species is commercially significant for its oil yielding property containing a very high percentage (about 85%) of unsaturated fatty acids (Bhunia *et al.*, 2016). Major fatty acids present in oil are oleic acid (37.0%-50.0%) followed by linoleic acid (37.0% -47.0%), palmitic acid (7.0%-9.0%) and stearic acid (4.0%-5.0%). The oil contains two major constituents that are not found in other fixed oils, namely sesamin (0.5%-1.0%) and sesamolin (0.3%-0.5%). On hydrolysis, the latter yields sesamol - a powerful antioxidant which gives excellent stability to oil (Pathak *et al.*, 2018). After oil extraction, the remaining meal containing 35% - 50% protein is rich in tryptophan and methionine (Nascimento *et al.*, 2012). Apart from oil, sesame seeds are extensively used for therapeutic purposes and they are considered emollient, diuretic, lactagogue and a nourishing tonic. Seeds of sesame are also helpful for the remedy of piles, cough and ulcer besides having several ethnobotanical uses (Chopra *et al.*, 1958).

In our country edible oil crisis is a recurring event causing considerable loss of foreign exchange every year for its import. This can be minimized by using sesame oil as a substitute of mustard and other edible oil. Thus, sustainable production of sesame and sesame oil needs to be stepped up by raising superior plant type exploring the existing better ones and it can be achieved quickly through induced mutagenesis as the species is predominantly self-pollinated and offers little scope for improvement through conventional breeding techniques.

The present article encompasses a review on "plant type" mutation (easily identified due to its phenotype) on *S. indicum* with an objective to provide resources for future researchers looking to improve the oil seed crop for proper utilization in human welfare.

Induced mutagenesis

The plant type mutations recorded in the species along with inheritance of traits are presented in the tabulated format for better understanding.

Conclusion

Considering the plant ideotype, it seems that the most significant plant type mutants in sesame are: a) non-shattering - as there is huge loss during harvest due to non-synchronous maturity, b) branching from base - as such type of mutant wilhance pod number and subsequently yield, c) enhancement in capsule number in the main axis - tri- and quadri-carpellary fruits per axil, d) unbranched type may be preferred due to enhancement of plantation per unit area, e) bushy phenotype - can enhance yield per plant, f) early flowering/early maturity - is always a breeders' choice, g) resistance to pest - *Antigastra catalaunalis* as it induces loss of yield, h) lodging resistance, among others. Till date non-shattering

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Plant type mutants (macromutation)

S.No.	Type	Description	Reference
1.	*White flower* and *small seeded*	High oil content	Rai and Jacob (1956)
2.	*Small seeded* (SSM_2) in *T –10* Variety	X-irradiation, with higher oil content 55.48% than the parent var. 47.82%	Nayar (1961)
3.	*White flower small seeds*, increased number of fruits with heavier seeds with increase oil content	X-ray and fast neutron (^{35}S and ^{32}P) – mutants showed recessive inheritance. The mutants showed meiotic abnormalities.	Kobayashi (1965) Ankinudu *et al.* (1968)
4.	*Indehiscent capsule* and *early maturing* traits		Kobayashi (1973)
5.	Male sterility	Seeds treated with FW450, 1% mateic hydrazide and 0.5% dalapon	Chauhan and Singh (1971)
6.	*Male sterility* affecting pollen fertility and anther dehiscence	Induced by 2,2 dichloropropionic acid and trichlorobenzoic acid	Mazzani *et al.* (1971)
7.	*Chlorophyll* mutant in X_3 Generation	Reduced vigor and fertility	Nayar (1969)
8.	*Non-branching* and *non-lodging* mutants	The mutants were tall, radiation induced	Nayar and George (1969)
9.	*Petalloid* mutant	True breeding in which the stamimal filament were petalloid forming and inner corolla tube within the normal one	Sawant and Dhagat (1970)
10.	Male sterility	Due to lower content of histone, DNA and total protein than male fertile plant-induced by gametocide treatment	Chauhan and Kinoshita (1979)
11.	Male sterility	Induced by periodic acid; abnormal tapetal behavior in pollen abortion. The mutant plant were with lesser amount of insoluble polysaccharides than male fertile plants	Chauhan and Rathore (1980)
12.	Male sterility	Shriveled anthers containing no pollen at anthesis, monogenic recessive to male fertility	Rangaswamy and Rathinam (1982)
13.	High yielding mutants *TMV-5* and *15103*	Seeds treated with gamma-rays and colchicine – higher seed yield (3 to 30 %) and oil (5% to 13%) content than parent varieties.	Kamala and Sasikala (1985)
14.	Male sterility	EMS and gamma irradiation induced; segregation – 1:1 for pollen fertility/ sterility.	Ganesan (1995)
15.	Mutation affecting plant height, branching pattern, leaf morphology plant color and texture, floral parts and maturity	Seeds treated with EMS – the plants were screened at M_2	Jeya Mary and Jayabalan (1995)
16.	*Semi-dwarf–suwan–128*	Induced by sodium azide treatment; lodging resistance with good yield potential when planted in high density	Kang *et al.* (1996)
17.	Mutations affecting leaf characters and sterile plant in M_2 and F_2 M_2 Population	Gamma irradiation to seeds	Govindarasu and Ramamoorthi (1998)
18.	Cytoplasmic–genetic male sterility	Abnormal behavior of PMCs of post meiosis affects the coordination between microspore and tapetum	Kavitha and Ramalingam (1999)
19.	*Multicapsule per leaf axil, semi-shattering capsule, early maturity*	M_2 and M_3, Gamma irradiation to seeds	Sorour *et al.* (1999)
20.	*Late flowering and seed-coat color – reddish brown*	Induced by EMS treatment late flowering plant type was protein rich; while, seed-coat color	Sengupta and Datta (2004a)

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S.No.	Type	Description	Reference
		mutant was reported to be used as genetic marker	
21.	Viridis, thick leaf, broad leaf, diffused branching early flowering, white flower white flower non-shattering capsule and bold seeded	Different treatments of EMS, dES, NH_2OH and HNO_2; mutants were monogenic recessive to normal trait(s) excepting *viridis*, which showed digenic mode of inheritance	Sengupta and Datta (2004b)
22.	Narrow leaf	Seed treated with HNO_2 and H_2O_2 – mutants had higher number of capsules per plant and on the main axis, smaller distance from base to first branching, higher soluble sugar content in seeds and higher flower fertility	Sengupta and Datta (2005)
23.	Oil rich mutant plants-*lax branching and small flower*	X-ray and gamma rays induced, mutant fruits were monogenic recessive to normal; both plant types showed enhancement in total branches per plant, capsule on main axis and capsule length than normal plants	Chowdhury *et al.* (2009)
24.	*(i) broad leaf* (ii) thick leaf (iii) diffused branching (iv) white flower (v) globular fruit (vi) non shattering capsule (vii) viridis *(viii) dark reddish brown seed coat*	Reciprocal crossing show-monogenic (3:1) recessive Do Do Do Do Do monogenic (3:1) recessive	Sengupta and Datta (2004b)
25.	*Narrow leaf* mutant	Reciprocal data reveals that narrow leaf trait is recessive to narrow and controlled by a single gene pair	Sengupta and Datta (2005)
26.	Determinate plant type Altered phyllotaxy multicapsules per axil multilocules	Gamma irradiations and EMS at different doses of treatments	Boranayaka *et al.* (2010)
27.	Coarse leaf Ovate leaf Elongated petiole I Thick stem White flower Pigmented flower Bushy Unbranched Globular fruit Dwarf Early flowering Narrow leaf Broad leaf I and II, Triaxillary fruit, Quadraxillary fruit, Tripetiolar node Multilocular fruit Branching from base	Monogenic (3:1) recessive Do do do do do do do do do do do 9:7 do do do 15:1 All the mutants are raised following treatments with EMS, gamma irradiations and nanoparticles (Cu-, CdS-, CuO- and ZnO-NPs) exposures at different doses.	Das *et al.* (2017)

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S.No.	Type	Description	Reference
		Most of the mutants show pleiotropic gene action as no segregants are found in subsequent population.	
28.	Early maturing Determinate growth Monostem	Gamma irradiation exposures to cultivars namely tilottama and rama	Saha and Paul (2017)

Inheritance of mutant traits

S. No.	Trait(s)	Nature of inheritance	Reference
1.	Black vs white color seed-coat	3 genes involved in inheritance	Teshima (1930)
2.	Prostrate habit over erect one pod/leaf axil over more than one pod/ axil	Monogenic dominance digenic dominance	Pal (1934)
3.	Alternate phyllotaxy of leaves over opposite	Monogenic dominance	Mohammad and Gupta (1941)
4.	(i) green color stem over yellow (ii) one flower per leaf axil over multiflower (iii) normal leaf over wrinkle	Monogenic dominance	Langham (1945) Sikka and Gupta (1947)
5.	(i) normal vs mottled character of leaves (ii) normal vs indehiscent condition of capsule	Simple recessive inheritance	Langham (1946)
6.	Flower color	4 different sets of dominant factors are involved	Langham (1946)
7.	(i) Star flowered condition (ii) Fused filament vs separate filaments	Recessive duplicate genes recessive	Langham (1947)
8.	Fertility vs sterility in '*Bijapur White*' variety	Monogenic dominant	Kumar and Rao (1945)
9.	(i) Purple vs white flower (ii) Dark brown vs dirty white seed type (iii) Cross between black and dirty white	Controlled by one pair of genes Segregating progeny – 9 black : 3 gray : 4 dirty white seed types	Sikka and Gupta (1947)
10.	(i) Rough testa with low oil content (ii) Plant height (iii) Capsule length	A dominant gene heritance 3 to 10 pairs of genes involved 2 to 5 pairs	Culp (1959) Culp (1960)
11.	Deep venation	Pair of recessive gene	Costa and Carvalho (1961)
12.	Resistance to *Pseudomonas sesami*	Controlled by recessive genes like b,c,d the gene complex and f and a dominant gene A	Ribers *et al.* (1964)
13.	Bi-carpellate condition and quadrifide stigma	Show pleiotrophic inheritance	Yadav (1968)
14.	Female sterility	One or more recessive genes	Dabral (1968)
15.	Bi-carpellatum over quadricarpellatum fasciation found to occur with quadricarpllatum	One or more recessive genes monogenic dominance	Demir (1969)
16.	Brown-seeded vs white seed Black seeds vs white seeds Brown seeds×black seed	Dihybrid segregation Dihybrid segregation Monohybrid segregation AABB-Black; AAbb – Brown; aabb-White – genotypes assigned	Khidir and Ali (1971)
17.	Wrinkle leaves, flower and fruit appendages, low pod set and dehiscence of pods	Individually controlled by a single recessive gene. The gene controlling pod dehiscence has shown pleiotrophic effects	Reddy *et al.* (1972)

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S. No.	Trait(s)	Nature of inheritance	Reference
18.	Oil content	Governed by one pair of major genes with modifiers and the heritability vale of which was 48.26%	Selim and El-Ahmar (1976)
19.	Percentage of oleic and linoleic acid	By single recessive gene or a group of genes with major effects showing a transgressive segregation	Brar and Ahuja (1979)
20.	Indehiscent capsule	Monogenic recessive	Delgado *et al.* (1994)
21.	Hairness trait	Inherited as a simple dominant gene with no cytoplasmic or maternal effects	Tan (1998)
22.	Seed coat color: tilottama – black, savitri – yellowish white and roma – brown	Intervarietal natural crossings reveal intermediate dominance at F_1	Das *et al.* 2018
23.	Seed coat color	Brown seed coat is dominant over white seed coat	Laurentin and Benítez (2014)

mutant in sesame is reported (Saha and Paul, 2017) but yet to be commercialized as variety/cultivar which is highly essential for the species productivity.

An unabridged repository of references is provided in relation to plant type mutation and inheritance of traits in sesame with an objective for improvement of the crop. Sesame improvement may include increase in raw product and/or value added product(s) specifically targeting unsaturated fatty acid and dietary lignan content. The current review may be helpful for researchers working in sesame considering induced mutagenesis as the tool for improvement.

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