Indian Journal of Science and Technology Vol.2 No. 7 (July 2009) ISSN: 0974- 6846

Radiation-induced two oil rich mutants in sesame (*Sesamum indicum* L.)

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Abstract Radiation (X-ray and gamma rays) induced two productive oil rich 'plant type' mutants of sesame (*Sesamum indicum* L., var - *B-67*, family: Pedaliaceae) namely *lax branching* (angle of divergence 30.50˚ to 32.35˚ of primary branches in relation to main axis; control: 19.60˚ - 22.75˚) and *small flower* (length: mutant – 2.83 cm ± 0.14, control – 4.0 cm ± 0.01, breadth: mutant 1.53 ± 0.03, control – 1.83cm ± 0.03) were cytogenetically (meiosis more or less alike to control, 2n= 26; mutant traits were monogenic recessive to normal) and qualitatively assessed (seed yield and fatty oil contents were significantly higher in the mutants than parental cultivar but protein contents were lower; yield related traits namely total branches per plant, capsule on main axis and capsule length and plant height enhanced in *small flower* and *lax branching* mutants respectively than control) at M_4 (rain fed *kharif* season). *Lax branching* and control plant types were given in multilocational trial (four districts - North 24 Parganas, Burdwan, Birbhum and Nadia of West Bengal) to assess seed yield and seed oil and protein contents, and the results obtained were discussed.

Keywords : Sesame, macromutants, oil rich, seed yield, protein content, multilocational trial.

Introduction

As a part of research initiated on radiation induced mutagenesis in sesame (*Sesamum indicum* L.; family: Pedaliaceae- an oil yielding plant of commerce and with immense therapeutic uses) for creating genetic variation and to screen desirable 'plant type' mutation for direct selection and /or efficient breeding , twenty macromutants were identified at M_2 (Chowdhury & Datta, 2008) and this communication describes two oil rich (seed fatty oil content) mutants (*Lax branching:* gamma rays: 50 Gy- 4.68%, 100 Gy- 0.74%, 300 Gy- 0.32%; X-rays: 100 Gy- 0.17%, 0.32% and *small flower*: 200 Gy- 0.20%). The mutants were also with higher seed yield than the parental cultivar.

Materials and methods

Lax branching and *small flower* mutants are spotted at M_2 and were cytogenetically assessed and evaluated for their quantitative traits at M_4 in relation to parental cultivar (*S. indicum* var. *B-67*). Morphology, meiosis (as per Chowdhury *et al.* 2009), crossed (control as stigma parent X *lax branching* mutants as pollen parent, F_1 plants raised and selfed to grow F_2 plants; F_2 segregation analyzed following χ^2-test) and M_3 (selfed M_2 seeds of *lax branching* and *small flower* mutants segregated at M_3 and χ^2-test applied to study the segregation patterns) progenies and M_4 traits (true breeding M_4 plant types grown in RBD with 3 replication at kharif season and a maximum of 15 plants were analyzed for 10 parameters listed in Table 1 for each category; plot size: 3.0m x 1.5 m, spacing 30 cm between rows and 10 cm between plants) were studied. Seed protein and fatty oil contents extracted and estimated as described by Chowdhury (2009). Test of significance (t-test analysis) was computed to ascertain variations between plant types for different traits.

Lax branching mutant in relation to parental cultivar was evaluated (at kharif season) for seed yield and seed protein and fatty oil contents in four locations (districts) of West Bengal (Nadia: 9.91 p.c.- sand, 2.89 p.c-silt, 87.20 p.c-clay, nitrogen – 0.76%, carbon- 3.25% and hydrogen- 0.56%; North 24 Parganas: 8.29 p.c- sand, 2.71 p.c- silt, 89.01 p.c-clay, 0.40%-nitrogen, 0.83%-carbon and 0.25% hydrogen; Burdwan: 37.91 p.c-sand, 0.80 p.c-silt, 61.29 p.c-clay, 0.86%-Nitrogen, 1.78%-carbon and 0.63%- hydrogen; Birbhum: 57.14 p.c-sand, 1.11 p.c- silt, 41.75 p.c-clay, 0.86%-nitrogen, 0.16%-carbon and 0.18%- hydrogen; carbon, hydrogen and nitrogen contents were analyzed by CHN analyzer). Major chemical contents in soil samples estimated by Atomic Absorption Spectroscopy are as follows: Na_2O – 0.901, 0.972, 0.436 and 0.391; K_2O – 2.397, 2.451, 1.611 and 1.028; Al_2O_3 – 10.438,10.217, 9.160 and 2.589; Fe_2O_3 – 5.656,4.252, 4.787 and 3.958; CaO – 1.175, 0.806, 0.955 and 0.254; MgO – 1.419, 1.208, 0.663 and 0.202 per cent in Nadia, North 24 Parganas, Burdwan and Birbhum respectively. Amounts (ppm) of trace elements (Cu, Zn, Ni, Co, Mn, Cd, Cr, V and Mo) were predominant in Nadia soil. Analysis of soil samples was done in Central Chemical Laboratory, Marine Wing of Geological Survey of India, Kolkata. Mean values (estimated over the districts) for 3 parameters were compared between control and mutant following the use of Duncun's t test analysis (alphabets denotes the degree of significance a> b> c> d> e> f> g).

Results and discussion

Lax branching (lax natured, angle of divergence of primary branches in relation to main axis at maturity was30.50˚ to 32.35˚ as compared to 19.60˚ - 22.75˚ in control) and *small flower* (length: mutant – 2.83 cm ± 0.14, control – 4.0 cm ± 0.01, t = 2.94 at 18 df, $p< 0.05$; breadth: mutant 1.53 ± 0.03, control – 1.83cm ± 0.03, t = 2.46, 18 df, $p< 0.05$) mutants showed monogenic recessive inheritance (*lax branching* : F_2 segregation – mutant 27,

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Table 1. Quantitative traits in control and mutants at M_4

Attributes	Plant types		
	Control	*Lax branching*	*Small flower*
Plant height	113.4±1.3	121.6*±3.4	105.4*±3.9
Primary branches/ plant	5.9±0.3	5.1±0.1	5.1±0.6
Total branches/ plant	9.1±0.1	9.1±0.2	11.6*±0.3
Distance from base to first branching (cm)	25.5±2.7	29.6±0.5	22.2±0.1
Capsule on main axis	22.2±1.2	22.5±0.7	31.2***±0.8
Total capsules per plant	62.7±1.5	57.3±2.1	68.3±2.3
Capsule length (cm)	2.2±0.02	2.3±0.01	3.0**±0.2
Seed yield (gm)	6.6±0.03	8.5**±0.5	7.2**±0.2
Seed protein content (%)	12.8±0.2	10.7*±0.8	11.8±0.4
Seed fatty oil content (%)	34.4±0.8	41.5***±0.6	38.6*±0.3

*, ** and *** = Significant at 0.05, 0.01 and 0.001 probability level respectively.; t- values estimated at 28 df

normal- 88, total 115, χ^2= 0.143 for 3: 1 at 1 df, p> 0.70; M_3 segregation – mutant 11, normal 12, total 23, χ^2= 0.043 for 1:1 at 1df, p> 0.80; *small flower* : M_3 segregation – mutant 02, normal 07, total 09, χ^2=0.037 for 3:1 at 1df, p> 0.90) *small flower* mutant had poor germination frequency (M_4- 33.30%, control: 86.70%).

Meiosis (2n = 26) was more or less alike (control: 12.93 II + 0.14 I –mean/cell at MI, 71 cells scored; 100.0% cells at AI with 13/13 separation, 44 PMCs studied; *lax branching* mutant: 13II, mean/cell at MI, 21 meiocytes scored; 100.0% cells at AI with 13/13 separation, 35 cells observed; *small flower*

: 12.89 II + 0.22 I, mean/cell at MI, 27 cells scored; 100.0% cells at AI with 13/13 separation, 25 PMCs studied) in the plant types. Predominant chromosomal association recorded was 13II formation (control – 92.96%, *lax branching* – 100.0%; *small flower* – 88.89%). Meiotic chromosomes in the plant types tended to form groups in 57.74, 52.38 and 59.26 per cent meiocytes of control (7 to 10 groups; maximum of 8 group class – 28.17%), *lax branching* (only 8 group class) and *small flower* (7 to 9, 8 group class frequent – 40.74) plant types respectively.

Analysis of agronomical parameters indicated (Table 1) that *lax branching* and *small flower* were promising mutants as they possessed higher seed yield and enhanced fatty oil content than the parental cultivar but protein content was lower in the mutants. Control and *lax branching* mutant under multilocational trial (pooled mean assessed) demonstrated similar responses (Table 2), thereby suggesting stability of the traits under the influence of different soil conditions. Seed yield and fatty oil traits responded best in Nadia soil; while, seed protein content in Burdwan. Yield related traits (Table 1) namely total branches per plant, capsule on main axis and capsule length, and plant height increased in *small flower* and *lax branching* mutants respectively than control thereby offering scope of direct selection of the mutants (*lax branching* – though detrimental for increasing plant population per unit area but high yield is compensating) as well as their utilization in efficient breeding and crop improvement not withstanding the exploitation of marker traits.

Acknowledgement

This research is grant aided by UGC.

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Table 2. Analysis of agronomic characters in sesame

Plant types	*Seed yield (gm)*					*Seed protein content (%)*					*Seed fatty oil content*				
	North 24-Parganas	*Burdwan*	*Birbhum*	*Nadia*	*Over all*	*North 24-Parganas*	*Burdwan*	*Birbhum*	*Nadia*	*Over all*	*North 24-Parganas*	*Burdwan*	*Birbhum*	*Nadia*	*Over all*
Control	*6.29± 0.23*	*6.37± 0.18*	*5.90± 0.20*	*6.37± 0.16*	*6.26d ±0.19*	*12.00 ±0.23*	*13.90 ±0.17*	*13.13 ±0.34*	*12.83 ±0.19*	*12.97f ±0.23*	*29.93 ±0.18*	*31.43 ±0.69*	*26.13 ±1.30*	*34.35 ±0.81*	*30.40cd ±0.74*
Lax branching	*7.69± 0.92*	*7.79± 1.02*	*8.07± 1.03*	*9.21± 0.03*	*8.19b ±0.75*	*10.27 ±0.26*	*11.47 ±0.18*	*11.00 ±0.12*	*10.70 ±0.78*	*10.86g ±0.33*	*38.07 ±0.24*	*39.53 ±0.41*	*36.80 ±0.35*	*41.50 ±0.61*	*38.90a ±0.40*