Frequency spectrum and segregating pattern of chlorophyll mutations in sesame (*Sesamum indicum* L.)

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Abstract

Sesame (*Sesamum indicum* L.) variety Rama and Tillotoma were exposed to different doses viz. 250, 300, 350, 400 and 450 Gy of gamma rays from Bhava Atomic Research Centre (BARC) and grown (along with control) during pre-kharif 2015 and 2016 as M₁ and M₂ generation, respectively, at University experimental farm Visva-Bharati. The spectrum of chlorophyll mutation observed in M₂ generation was found to be quite narrow as only three kinds namely albina, chlorina and xantha occurred in different treatments. Highest mutation frequency of chlorophyll mutations (1.38%) was induced at 350Gy for both variety Rama and Tillotoma, however, chlorina types was more frequent (0.93%) other than two types. All the three types of chlorophyll mutations segregated in the ratio of 15 normal: 1 mutant (*P*<1.0 in most of the cases) suggesting that inheritance of chlorophyll mutation is governed by double recessive genes.

Keywords: Gamma irradiation, chlorophyll mutation, segregation, sesame, frequency and spectrum

1. Introduction

Sesame (*Sesamum indicum* L.; 2n= 26) is one of the most ancient oil seed crop belonging to the family pedaliaceae and is known for high protein content having high nutritional value similar to that of soybean [3]. It is regarded as “Queen of oilseed” as it is contains highest oil and protein among the oil crops, though, the productivity of sesame is alarmingly poor in India comparing to other oil yielding crops. To improve the seed yield combination the desirable yield component is a pre requisite which can be exploited through selection from the segregating population [1, 2, 8]. Induced mutation by radiation or chemicals is an effective technique to provide variation in plant structure and function from which breeders can select plants having useful traits. The chlorophyll mutation rate is conveniently being used as a preliminary index of the efficiencies of mutagens and mutability of the variety that could help realize the spectrum of desirable mutations in treated population [4]. Frequency of chlorophyll mutation serves as a good index to determine the different doses of mutagens. Further induced chlorophyll variations serves as diagnostic markers for viable mutation in irradiated population. In the present study, the spectrum and frequency of chlorophyll mutation against different dose of gamma rays along with their segregating pattern in M₂ generation was studied.

2. Materials and Methods

2.1 Location of experiments

The study was carried out at Agriculture Farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan (23°29’ N latitude and 87°42’ E longitudes and at an altitude of 58.9 m above the mean sea level under sub-humid, sub-tropical, lateritic belt of West Bengal) in pre-kharif season of 2015 and 2016.

2.2 Plant materials and their basic characteristics

Two selected popular sesame genotypes from West Bengal, India had following characteristics:

2.2.1 The genotype “Rama”: brown, rough, glossy seeds (1000 seed weight ~ 3.5gm), medium in size and maturity (92-100 days);
2.2.2 The genotype “Tillotoma”: black, rough, dull seeds (1000 seed weight ~ 3.1gm), medium in sizes and maturity (100-110 days).

2.3 Gamma irradiation
10,000 dry, uniform and healthy seeds of these two genotypes of sesame were irradiated using 60Co (Cobalt 60) gamma source (Gamma Chamber 900) with different doses (250, 300, 350, 400, 450 Gy) of gamma rays at the Bhabha Atomic Research Centre (BARC), Trombay, India.

2.4 Experimental layout
Irradiated seeds (M₀) along with the controls (un-irradiated) were sown in the field (treatment and variety wise) in a Split Plot Design with three replications in twelve rows plot of 5m length keeping plant to plant a row to row distance of 10 and 30 cm., respectively during pre-kharif season 2015. Four to five capsules of each M₁ plants against all the treatments were collected separately to rise the M₂ progenies during next pre-kharif season 2016, for attempting desirable selection.

2.5 Observations taken
Observations were taken on various types of chlorophyll mutants to study the mutagenic effect of different doses in M₂ generation. Chlorophyll mutants were identified tagged and counted just after germination. The process continued for a few days until the completion of germination. At the same time, normal looking plant population was also counted and recorded dose wise in each variety to estimate the chlorophyll frequency.

2.6 Statistical analysis
Frequency of chlorophyll mutations were estimated following the modified classification of Blixt [1] and their segregation pattern were studied through chi-square (χ²) test outlined by Panse and Sukhatme [2]. All statistical analyses were carried out by SPSS 20.0 and Microsoft’s Excel 2007.

3. Results and Discussion
Different types of chlorophyll mutations, their frequencies, spectrum and segregating pattern in different gamma rays treated in M₂ populations of Rama and Tillotoma are presented in Table 1, Fig. 1 (a, b, c). It is evident from the data that differential response of genotypes i.e. marked varietal differences were present in terms of induction of chlorophyll mutations at different doses of gamma rays. Three types of chlorophyll mutant such as albina, chlorina, xantha were recorded in different frequencies with highest mutation frequency of chlorophyll mutations (1.38%) was induced at 350Gy for both variety Rama and Tillotoma. In this investigation, chlorina type chlorophyll mutations were highest (0.93%) at 350Gy in the variety Rama; however, albino type chlorophyll mutations were highest (0.54%) at 250Gy in the variety Tillotoma. Thus, most of the mutations showed independent response to different doses of the gamma rays as they occur at random.

Table 1: Frequency, spectrum and segregating pattern of chlorophyll mutations in M₂ generation in sesame.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Dose (Gy)</th>
<th>Total no. of M₂ progenies studied</th>
<th>Total no. of progenies segregating</th>
<th>Total no. of M₂ seedlings studied</th>
<th>No. of mutant seedling</th>
<th>Mutation frequency (MJ %)</th>
<th>Spectrum and frequency of chlorophyll mutation</th>
<th>Chi-square (χ²) value (1:15)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Albina</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Chlorina</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Xantha</td>
<td></td>
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<tr>
<td>Control</td>
<td>10</td>
<td>0</td>
<td>626</td>
<td></td>
<td>138</td>
<td>0.97</td>
<td>38 (0.27)</td>
<td>0.47*</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>192</td>
<td>42</td>
<td>14299</td>
<td>138</td>
<td>0.97</td>
<td>38 (0.27)</td>
<td>0.02*</td>
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<tr>
<td></td>
<td>300</td>
<td>176</td>
<td>59</td>
<td>10926</td>
<td>139</td>
<td>1.27</td>
<td>34 (0.31)</td>
<td>0.61*</td>
</tr>
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<td></td>
<td>350</td>
<td>154</td>
<td>85</td>
<td>8697</td>
<td>120</td>
<td>1.38</td>
<td>19 (0.22)</td>
<td>0.33*</td>
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<tr>
<td></td>
<td>400</td>
<td>142</td>
<td>50</td>
<td>8226</td>
<td>100</td>
<td>1.22</td>
<td>32 (0.39)</td>
<td>0.32*</td>
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<tr>
<td></td>
<td>450</td>
<td>96</td>
<td>39</td>
<td>5518</td>
<td>59</td>
<td>1.07</td>
<td>42 (0.76)</td>
<td>0.52*</td>
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<tr>
<td></td>
<td>500</td>
<td>154</td>
<td>69</td>
<td>12425</td>
<td>152</td>
<td>1.22</td>
<td>35 (0.28)</td>
<td>0.12*</td>
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<td></td>
<td>550</td>
<td>150</td>
<td>61</td>
<td>8383</td>
<td>116</td>
<td>1.38</td>
<td>40 (0.48)</td>
<td>0.48*</td>
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<td>600</td>
<td>128</td>
<td>52</td>
<td>8057</td>
<td>105</td>
<td>1.30</td>
<td>35 (0.44)</td>
<td>0.55*</td>
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<td>650</td>
<td>64</td>
<td>40</td>
<td>7958</td>
<td>74</td>
<td>0.93</td>
<td>29 (0.36)</td>
<td>0.75*</td>
</tr>
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</table>

Figures in parentheses are the percentage values; Alphabetical superscripts indicating * = albina, † = chlorina, ‡ = xantha.
All the three types of chlorophyll mutations segregated in the ratio of 15 normal: 1 mutant (P<1.0 in most of the cases) (Table 1) suggesting that inheritance of chlorophyll mutation is governed by double recessive genes. Chlorophyll mutation rate is a critical parameter to determine the effectiveness and efficiency of treatment of different mutagens. Several scientists [2, 6, 8] has described and classified several chlorophyll mutations (albina, chlorina, xantha) in sesame and other crops. According to Swaminathan [9], chlorophyll development seems to be controlled by many genes located on several chromosomes which could be adjacent to centromere and proximal segments of the chromosome.

4. Conclusion
It is, therefore, concluded that although the chlorophyll mutations do not have any economic value due to their lethal nature, such a study could be useful in identifying number of economically useful mutants in the segregating generations as well as helpful in the selection of new elite recombinants.

5. References