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Gamma rays effect on frequency and spectrum of chlorophyll mutation in chickpea (*Cicer arietinum* L.)

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Abstract
The present investigation was undertaken to study the frequency and spectrum of chlorophyll mutations of different doses of gamma rays in variety Uday. No chlorophyll mutations were observed in the control population. Highest mutation frequency of chlorophyll mutation (1.22%) was induced at 10kR presoaked dose of gamma rays treatment. The spectrum of chlorophyll mutations (albino, xantha, chlorine, viridis and striata) were observed and grouped. Except striata, remaining four kinds of mutations viz. xantha, chlorine, viridis and albino were more frequently. The overall mutation spectrum showed that xantha (0.701%) occurred with the highest frequency followed by chlorine (0.621%), albino (0.408%) and viridis (0.307%).

Keywords: Chickpea, gamma rays, chlorophyll mutations, mutation frequency

Introduction
Chickpea is the third most important pulse crop in the world (Garg *et al*., 2011) [2] but it ranks first among pulses in India. In India, chickpea is grown in the drier areas as they are best suited for its production. Chickpea performs well when grown on sandy, loam soils and having well drainage system. Based upon seed size and colour, chickpea is being classified as "kabuli type" or "macrosperma" and "desi type" or "microsperma". With the discovery of ionizing and chemical mutagens a new field of science known as "mutation breeding" was developed. The mutagenic effect is reflected in the segregation of chlorophyll mutants, these mutations were evaluated in order to determine the effectiveness and efficiency of physical mutagens in variety of chickpea. The spectrum and frequency of chlorophyll mutants is being used as primary index of effectiveness of mutagens and mutability of the genotypes towards the mutagen which in turn would be useful to generate the wide array of desirable mutants in the treated population (Gaul, 1964) [3]. The choice of mutagen holds great importance in changing the frequency and spectrum of chlorophyll mutations in a predictable manner. In the present study, the effect of gamma rays was studied on the frequency and spectrum of chlorophyll mutations in M_2 generation in chickpea.

Material and methods
Healthy, uniform and dry seeds of uday variety of chickpea (*Cicer arietinum* L.) were exposed to 60CO gamma rays each to 00 kR, 05 kR, 10 kR, 15 kR, 20 kR, 25 kR, 30 kR, 35 kR, 40 kR and wet seeds of the same were exposed to 00 kR, 05 kR, 10 kR, 15 kR, 20 kR doses of gamma rays at 2.2 kR per minute intensity at the Department of Botany, NBRI, Lucknow, making a total of 14th treatments including controls. The 100 seeds from each treatment along with control were placed in rolled towel paper in laboratory for taking observations on seed germination and seedling height. Rest of the treated seeds were sown in a randomized block design (RBD) with three replications each consisting of 100 seeds along with control for raising M_1 generation. The seeds were sown at a distance of 45cm between rows and 25cm within row, immediately after gamma rays treatment under ideal agronomic condition in the field during rabi season of 2010. The M_2 populations were screened for both frequency and spectrum of different types of chlorophyll mutations at various development stages, particularly from flowering to maturity period. The classification and characterization of various chlorophyll mutants was done according to Gustafsson (1940) [4] and Blixt (1961) [1] and the spectrum was recorded as xantha, chlorina, viridis and albina. The xantha mutants displayed a bright yellow to deep golden yellow colour. Chlorina mutants were yellowish green in colour, the viridis mutants displayed light green colour and albino shows white colour. The chlorophyll mutants like xantha, chlorine and viridis survived till maturity. But albino did not survive for many days and it proved to be lethal.

Result and discussion

Frequency and spectrum of chlorophyll mutations

Four different types of chlorophyll mutants were obtained when seedlings were 8-20 days old. The spectrum of chlorophyll mutations included: xantha, chlorina, albina and viridis. Chlorine and viridis types survived up to maturity while the other died at seedling stage. A brief description of these chlorophyll mutants is given below:-

Xantha: These mutants, predominant in the mutagenized population, were characterized by bright yellow colour of the seedlings. These seedlings survived for 10-20 days only.

Chloina: These were characterized by the presence of light green colour of the seedling. Some of them died within 20 days. However, a few vigorous surviving plants flowered but did not bear fruits.

Albina: The mutants were white, lethal, survived for upto 10-12 days.

Viridis: The mutants were characterized by reduced height and showed a dark green foliage colour. The plants were slow growing and had low seed yield.

Frequency of chlorophyll mutation

It is evident from the data (table-1) that the highest frequency of chlorophyll mutations (1.224%) was induced at 10kR wet dose of gamma rays treatment, while the lowest frequency of chlorophyll mutation (0.294%) was induced at 05kR dry dose of gamma rays treatment. The frequency of chlorophyll mutations varied from (0.303% to 1.186%) at different doses of gamma rays. On an average, the frequency of mutant was (7.98%) per 1000 M_2 plants.

Spectrum of chlorophyll mutation

The spectrum of chlorophyll mutations obtained in the present study induced different types viz. chlorina, albina, xantha and viridis. Chlorina, xantha, albina and viridis type of chlorophyll mutants were recorded by Vannirajan *et al*. (1993) [7] in blackgram and Mehraj-ud-din *et al*. (1999) [5] in mungbean during M_2 generation. In uday variety induced mutations in the order xantha(4.016%) > chlorina (2.823%) > viridis(1.464%) > albina(1.277%). Except straita, remaining four kinds of mutations viz. albina, xantha, chlorina and viridis were more frequent. The overall mutation spectrum showed that xantha(0.701%) occurred with the highest frequency, followed by chlorina(0.621%), albina(0.408%) and viridis(0.307%). Similar results were reported by Sarkar & Sharma, (1989) [6] and Mehraj-ud-dis, (1999) [5] reported that mutations of xantha type were induced more after than chlorina. Among all the mutation, viridis appeared with the lowest frequency. The relatively poor induction of this mutation has been reported earlier, Sarkar & Sharma, (1989) [6] and Mehraj-ud-dis, (1999) [5].

Table 1: Spectrum and frequency of induced chlorophyll mutations in M_2 generation of chickpea

Mutation freq & spect Treatments	No. and chlorophyll mutations										No. of M_2 plants	Mutant/ 1000 M_2 plant	Average no. of mutant/1000 M_2 plants/mutagen
	xantha		chlorina		viridis		albina		Total				
	No.	%	No.	%	No.	%	No.	%	No.	%			
05 kR(dry)	0	0	1	0.294	0	0	0	0	1	0.294	340	2.94	7.988
10 kR "	1	0.277	1	0.277	0	0	1	0.277	3	0.833	360	8.33	-
15 kR "	1	0.310	2	0.621	0	0	0	0	3	0.931	322	9.31	-
20 kR "	1	0.307	1	0.307	1	0.307	0	0	3	0.923	325	9.23	-
25 kR "	2	0.701	1	0.350	0	0	0	0	3	1.052	285	10.52	-
30 kR "	1	0.289	0	0	0	0	1	0.289	2	0.578	346	5.78	-
35 kR "	2	0.540	1	0.270	1	0.207	0	0	4	1.08	370	10.80	-
40 kR "	1	0.303	0	0	0	0	1	0.303	2	0.606	330	6.06	-
05 kR (Presoaked)	1	0.288	0	0	1	0.288	0	0	2	0.576	347	5.76	-
10 kR "	1	0.408	1	0.408	0	0	1	0.408	3	1.224	245	12.24	-
15 kR "	2	0.593	1	0.296	1	0.296	0	0	4	1.186	337	11.86	-
20 kR "	0	0	0	0	1	0.303	0	0	1	0.303	330	3.03	-
Total	13	4.016	9	2.823	5	1.464	4	1.277	31	9.586	3937	95.86	-

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 the threshold dose of a mutagen that would increase the genetic variability and number of economically useful mutants in the segregating generations.

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