

STUDY THE SPECTRUM OF INDUCED CHLOROPHYLL AND MORPHOLOGICAL MUTANTS IN MUNGBEAN (*VIGNA RADIATA* L. WILCZEK)

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Abstract: To induce mutagenesis, mung bean variety GM - 4 was irradiated with different dose of physical (Gamma rays) mutagen to induce mutagenesis. The chlorophyll mutants were studied in M₂ and M₃ generations and spectrum of chlorophyll mutation were worked out. There were five types of chlorophyll mutation was observed, i.e. albina, xantha, chlorine, viridis and complex types. While analysing the result, it was observed that the mutation frequency increased with increase in the dose of mutagen. The different types of morphological mutants were also induced. Of the different types of macro-mutations induced in the present investigation, the chlorophyll deficient mutations are of hardly any economic importance but the tall, dwarf, male sterile and brown pod colour mutants are agronomically important.

Keywords: Chlorophyll mutants, Mungbean, Mutation

INTRODUCTION

Biological effects of the mutagens require the understanding of the mechanism of action and nature of induced genetic damages. The enhancement of mutation frequency in the desired direction could be obtained after treating the material with suitable combinations of mutagens. Chlorophyll mutants can be used as markers in genetics, physiological and biochemical research for the assessment of gene action of mutagenic factors in induced mutation experiments. Effectiveness of mutagens and mutability of the genotypes towards the mutagen is the spectrum and frequency of chlorophyll mutants that appears in the study which in turn would be valuable to create the wide range of desired mutants in the treated population (Gaul, 1964). The present investigation was therefore undertaken to study the effects of gamma rays on growth and development of seedlings and their standardization for maximizing and widening the frequency and spectrum of mutations in mungbean cv. GM - 4. Because of their easy identification, chlorophyll mutations form a reliable index in the evaluation of mutagenic effects and estimation of mutational events (Goyal *et al.*, 2019). Due to their lethal nature, the chlorophyll mutation does not have any economic value, such a study could be useful in identifying the threshold dose of a mutagen that would increase the genetic variability.

MATERIALS AND METHODS

The uniform, healthy and dry seeds (moisture 9%) of mungbean variety GM - 4 was obtained from Department of Seed Technology, S. D. Agricultural University, Sardarkrushinagar, Gujarat. The seeds were treated with four different doses of Gamma rays (400, 500, 600 and 700 Gy) at B. A. R. C, Trombay, Mumbai during summer 2019. The treated seeds along with control were sown after treatment. The M₁ generation was harvested on single plant basis. All the plants from each treatment were selfed for advancing to the next generation. The progeny of each individual M₁ plant formed an M₂ progeny. Total 958 (All the survived) plants were harvested (530, 274, 100 and 46 plants for 400Gy, 500Gy, 600Gy and 700Gy respectively). The spectrum of chlorophyll mutants was studied in both M₂ and M₃ field conditions and the mutants were classified with modifications. The data of chlorophyll mutants were collected and recorded at the time of maturing and expressed in percentage of control.

RESULTS AND DISCUSSION

Chlorophyll mutant

Macro mutants are generally used to evaluate the genetic effects of various mutagens. For the evaluation of gene action of mutagenic factors to induce mutation, Chlorophyll mutants are employed as markers. The spectrum of chlorophyll mutants was

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studied in both M₂ and M₃ generation and the mutants were classified with modifications (Plate 1) as:

1. Chlorina: Leaves yellow in colour and did not survive beyond the seedling stages.
2. Xantha: Yellow to yellowish white leaves, carotenoids present but chlorophyll absent.
3. Viridis: Uniform light yellow green colour of leaves, viable plant.
4. Albina: White or creamy leaves. The seedlings died 10-15 days after germination
5. Complex types: The other types of chlorophyll mutations not conferring to the above specified types were categorized into complex types viz. Albina green, Maculata, Xantha green etc.

The frequency of chlorophyll mutants was 0.0192% and 0.0041% in M₂ and M₃ generation respectively (Table 1 and Table 2). It ranged from 0.0046% (400 Gy) to 0.1612% (700 Gy) in M₂ generation (Table 1) and 0% to 0.0297% in M₃ generation (Table 2). No chlorophyll mutants were scored for 500 Gy and 700 Gy in M₃. The outcomes further showed that the higher doses of mutagens induced high frequency of chlorophyll mutations. Similar increase in chlorophyll mutant frequency with increase in doses was also observed in mungbean.

The appearance of chlorophyll deficient mutant might be due to change in a set of genes which remains in recessive form in M₁ generation and expressed in M₂ generation and onwards (Swain *et al.*, 2019). Thus, chlorophyll development seemed to be controlled by many genes located on several chromosomes which could be adjacent to centromere and proximal segments of the chromosome. Mutations in these chlorophyll genes might induce chlorophyll mutations.

Morphological mutant

Any mutational event may bring large or small changes in the phenotype. In treated population a wide spectrum of viable mutants *i.e.* tall, dwarf, spreading, bushy, leaflet variation, dark green and light green leaves, vain type growth and pod colour variation were isolated from the M₂ and M₃ generation in field condition.

Higher doses of mutagens showed higher mutagenic frequency. Significant types of morphological mutants were observed for the variety GM-4. The frequency range was from 0.0139% (400 Gy) to 0.2419% (700 Gy) in M₂ generation (Table 1) whereas 0.0177% (400 Gy) to 0.4605% (700 Gy) in M₃ generation (Table 2) with a mean frequency of 0.0385% and 0.0563% for M₂ and M₃ generation respectively. Tall and dwarf mutants were also recorded. The tall mutant was of the height 197 cm and the dwarf mutants was of 34.75 cm. Spreading and bushy types of plants were also observed for various doses of mutagens. Among different types of morphological mutants, the most frequent types were leaf colour variations indicating high mutability of the gene for this trait. This results were in accordance with the findings of Hemnani (2017) in mungbean.

The possibility cause of these macro-mutations may be chromosomal aberrations, small deficiencies or duplications and most probably gene mutation. Several workers have reported that these viable mutations were monogenic and recessive in nature and controlled by one or more recessive gene(s).

Mutation frequency

The efficacy of any mutagen in plant breeding not only depends on its effectiveness but also upon its efficiency. The frequency of mutants induced by mutagenic treatment is an index of the effectiveness of mutagen. Konzak *et al.* (1965) observed that mutagenic efficiency offers the best available measure to evaluate different mutagenic treatments.

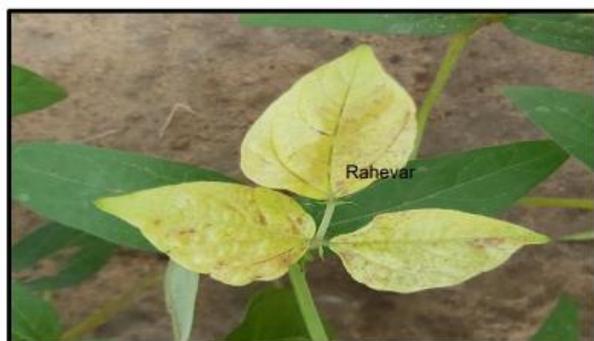
Table 1. Frequency of chlorophyll and morphological mutants in M₂ generation

Mutagen	Gamma rays (Gy)				
	400	500	600	700	Total
Doses					
No. of M ₂ plants	21520	10960	2640	1240	36360
Chlorophyll mutants					
Chlorina			1		1
Xantha	1	1			2
Viridis				1	1
Albina					0
Complex types			2	1	3
Total	1	1	3	2	7
M ₂ population basis Mutation Frequency %	0.0046	0.0091	0.1136	0.1612	0.0192
Morphological mutants					
Tall	1		1		2
Dwarf		1	1	1	3
Spreading	1				1
Bushy		1			1
Vain type		1			1
Leaflet variation			1	2	3

Dark/light green leaves	1		1		2
Brown pod colour			1		1
Total	3	3	5	3	14
M ₂ population basis Mutation Frequency %	0.0139	0.0273	0.1893	0.2419	0.0385

Table 2. Frequency of chlorophyll and morphological mutants in M₃ generation

Mutagen	Gamma rays (Gy)					
	Doses	400	500	600	700	Total
No. of M ₃ plants		28120	14920	3360	1520	47920
Chlorophyll mutants						
Chlorina				1		1
Xantha	1					1
Total	1	0	1	0	2	
M ₂ progeny/M ₃ Population basis Mutation Frequency %	0.0035	0	0.0297	0	0.0041	
Morphological mutants						
Tall			2		2	
Dwarf		4			4	
Leaflet variation				3	3	
Dark/light green leaves	5		3	2	10	
Male sterile			2	2	4	
Brown pod colour			4		4	
Total	5	4	11	7	27	
M ₂ progeny/M ₃ Population basis Mutation Frequency %	0.0177	0.0268	0.3273	0.4605	0.0563	



Chlorina



Xantha



Viridis



Albina

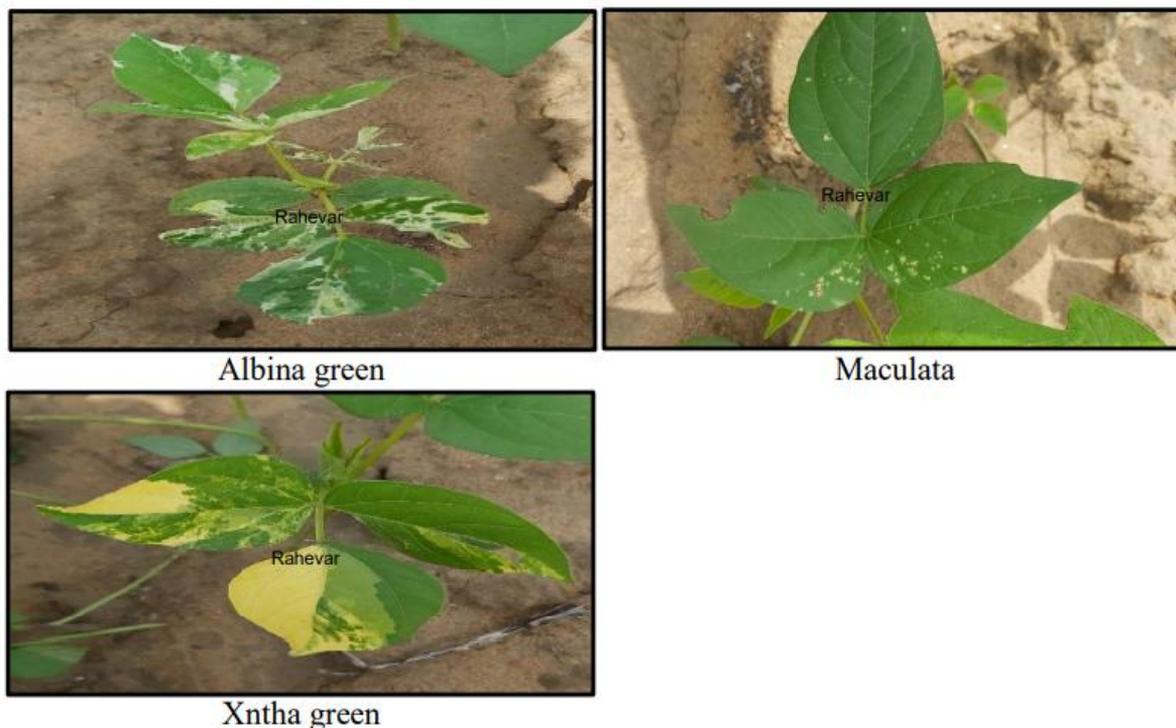


Plate 1: Spectrum of chlorophyll mutants

CONCLUSION

Of the different types of macro-mutations induced in the present investigation, the chlorophyll deficient mutations are of hardly any economic importance but the tall, dwarf, male sterile and brown pod colour mutants are agronomically important. Principal occurrence of chlorophyll mutations suggests that genes for xanthophylls are generally available for mutagenic action. Occurrence of chlorina mutants can be due to different causes such as impaired chlorophyll biosynthesis, further degradation of chlorophyll and bleaching due to deficiency of carotenoids. Thus, the morphological mutants induced in the present study include agronomically desirable features which might be utilized in future breeding programme.

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