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ORIGINAL ARTICLE

Gamma ray induced chlorophyll mutations in *Cyamopsis tetragonoloba* (L.)Taub.

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ABSTRACT

Dry seeds of *Cyamopsis tetragonoloba* (L.)Taub.var. Golden Early-36 and Harit Rani were exposed to 5kR, 10kR and 15kR of gamma rays produced from Co^{36} source. Three hundred fifty seeds from each treatment were grown at the experimental farm of Botanical garden of Dr.Babasaheb Ambedkar Marathwada University, Aurangabad. Plant wise and treatment wise capsules were harvested. In the progeny, phenotypically typical plants with regard to chlorophyll development were marked and their frequency recorded. The M3 generation along with respective normal were studied to analyse the mutagenic activity of gamma ray on cluster bean.

Keywords:

Cyamopsis tetragonoloba (L.)Taub., gamma rays, Co^{36}.

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Introduction

Cluster bean is also called as guar. The word "GUAR" represents a derivation from the Sanskrit word "GAUAAHAR" which means cow fodder or fodder of live stock. Basically cluster bean is a drought hardy, deep rooted annual legume. The crop is mainly grown in the dry habitats of Rajasthan, Haryana, Gujarat and Punjab. In addition to its major cultivation in India, the crop is also grown as a cash crop, although to limited extent in other parts of the world like Australia, Brazil and South Africa. The crop is known for its exceptionally high adaptation towards poor and erratic rains, multiuse in cropping system, in industrial use in many ways besides other social and dietary uses. These qualities have made it most the favoured crop of marginal farmers in arid areas.

Vegetables act as a good source of nutrients. To enhance variability in such crops the tool of mutation breeding is accepted by various plant breeders. To increase the productivity of vegetables various mutation breeding programs are carried out in brinjal (Datar and Ahstaputre 1984), chilli (Gupta and Yadav 1984), pea (Cemalettin et al., 2004), rye (Savaskan and Toker, 1991) and capsicum (Alcantara et al., 1996). Different vegetables contribute towards the fibre and protein production besides getting the induced genetic variability for disease /pest/insect resistance.

Material and methods:

The seed material of two varieties of cluster bean (*Cyamopsis tetragonoloba* (L.) Taub.) namely, Golden Early 36 and Harit Rani obtained from Golden Seeds Pvt. Ltd, Bangalore, Karnataka and Navalakha Seeds Pvt. Ltd, Pune have been used in the present study. Seeds were treated with physical mutagen, Gamma rays in the present investigation.

Gamma rays:

Electromagnetic ionizing radiations were applied from a Co^{60} 1000 curie source of gamma irradiation unit installed at the Department of

Biophysics, Government Institute of Science, Aurangabad.

Chlorophyll deficient sectors in M1 generation:

Plants with chlorophyll deficient sectors in leaves were recorded. The chlorophyll chimeras of different types in leaves of all mutagenic treatments were scored. The frequency of plants carrying chlorophyll deficient sectors was noted in the field.

Studies in M2 and M3 generations:-

Chlorophyll mutations:-

The chlorophyll mutations were scored in field on plant to a row basis in M2 generation, when the seedlings were 7-10days old. The different types of chlorophyll mutations scored were: *xantha, chlorina* and *viridis* in different treatments.

The above spectrum of chlorophyll mutants was classified according to the terminology of Gustafsson (1940) and Blixt (1961). The frequency of chlorophyll mutants was calculated according to Gaul (1957) i.e. number of mutants / 100 M2 seedlings and the spectrum was recorded as follows

Xantha- yellow to whitish yellow in colour,
Chlorina-yellow green in colour,
Viridis – light green or yellow green in colour.

Results:

Chlorophyll mutants: - (Tables- 1, Plate-1)

The M2 generation was raised from the seed progenies of M1 plants on plant to a row basis. The chlorophyll mutants were scored at the seedling stage. They were of three different types such as *xantha, chlorina* and *viridis*.

Xantha mutants displayed a bright yellow colour. In some mutants the colour was little lighter. The *viability* of this mutant was very less (2-3 days).

Chlorina mutants showed yellowish green colour. A few of them changed to normal green type. The *viridis* mutants showed dull light green colour. This colour gradually changed to normal green colour during subsequent growth phases of the plant.

Only some of the chlorophyll mutants such as *chlorina* and *viridis* could be found growing well till maturity. The response of two varieties towards the different mutagens was differential. The frequency values for chlorophyll mutants showed an increasing trend with the gradual rise in mutagenic concentration/dose in majority of the treatments.

In M1 generation, highest frequency of chlorophyll deficient sectors was observed at 15kR dose of gamma ray in both GE-36 and Harit Rani, 3.52 and 3.07 respectively (Table 1 and 2). In M2 generation frequency of chlorophyll mutants were observed in increasing order of dose of gamma rays. Highest frequency of chlorophyll mutants was observed in 15kR in both the varieties (2.61 and 3.33, table 3 and 4). In M2 generation distinct chlorophyll mutants were screened with very small life span. In GE-36 Xantha mutant was found only at higher dose of gamma ray (Table 5 and 6, plate 2). While *chlorina* and *viridis* though are expressed but as the dose increases it decreases. In HR variety the relative percentage of chlorophyll mutants (*xantha, chlorina and viridis*) show variability in expression *Xantha* and *Viridis* mutants are higher at higher doses. While *Chlorina* mutant show vice versa effect on chlorophyll mutants.

Discussion

Among the several ionizing radiations, gamma rays comprise the most widely used mutagen for mutation induction in crop plants. These are electromagnetic radiations of very short wavelength similar to X rays and thus very penetrating. Their energy may be absorbed by atoms in the tissue through which they pass, causing ejection of electrons resulting in ionization and consequent changes in chemical activity. Kinetic energy in ejected electrons produces further ionization (Ehrenberg et al., 1961).

Deshpande (1980) reported yellow tipped mutant and Bianu and Marki (1970) using gamma irradiation and certain alkylating agents reported *albino, xantha* and *viridis* types of mutants while Beard (1971) induced light-green, yellow- green, yellow-virescent, yellow, albino-virescent and albina mutants through recurrent X irradiation.

The use of gamma rays to create variability in sugarcane has led to some progress in sugar cane mutation breeding (Srivastava et al., 1986 and 1991). Factors such as

inhibition of auxin synthesis (Gordan, 1954), production of diffusible growth retarding substances (Mackey ,1951), change in specific activity of enzymes (Endo ,1967) and inhibition of DNA synthesis (Gaul,1970) have all been reported to affect reduced growth in irradiated plants or seeds.

Gamma rays as a mutagen can induce useful as well as harmful mutation in plants, (Gupta, 1996 and Micke and Donini, 1993).

Basha and Rao, (1988) reported mutagenic effects of gamma rays and sodium azide in cluster bean varieties Pusa Navabahar and FS 277, and found the higher level of each treatment to be more efficient in inducing chlorophyll mutations in each variety. Vig (1969) reported quicker germination, increased rate of root growth but poor survival at maturity in irradiated populations of two varieties of cluster bean. He further noted several chlorophyll deficient mutants except *albino* in M_2 generation.

The chlorophyll deficient sectors were of different types such as yellow (*xantha*), light green (*viridis*) and yellow green (*chlorina*). Such sectors were located at the margins of leaves or spread in lamina producing beautiful chimeric appearances. They were noticeable after gamma ray treatment. As the dose of mutagen increased frequency of chlorophyll deficient sectors were found to increase.

Summary:

Acknowledgement:

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Tables

Table 1: Effect of mutagens on frequency of plants carrying chlorophyll deficient sectors in M_1 generation of *Cyamopsis tetragonoloba* (L.)Taub.variety GE-36 and HR.

Treatment	Concentration (%) / Dose	Number of plants observed		Number of plants with chlorophyll deficient sectors		Frequency of chlorophyll deficient sectors	
Control	--	296	315	-	-	-	-
Gamma rays	5kR	309	297	07	04	2.26	1.34
	10kR	300	256	09	06	3.00	2.34
	15kR	284	293	10	09	3.52	3.07

Table 2: Effect of mutagens on frequency of carrying chlorophyll mutants in M_2 generation of *Cyamopsis tetragonoloba* (L.)Taub.variety GE-36 and HR.

Treatment	Concentration (%) / Dose	Number of plants observed		Number of plants with chlorophyll deficient sectors		Frequency of Chlorophyll deficient sectors	
Control	--	296	300	--	--	--	--
Gamma rays	5kR	300	309	05	05	1.66	1.61
	10kR	316	260	07	07	2.21	2.69
	15kR	306	270	08	09	2.61	3.33

Table 3: Effect of mutagens on the spectrum of chlorophyll mutants in M_2 generation of *Cyamopsis tetragonoloba* (L.)Taub.variety GE-36 and HR.

Treat-ment	Concent-ration (%) /Dose	Number of plants observed		Relative percentage of chlorophyll mutants					
				Xantha		*Chlorina*		*Viridis*	
Control	--	300	315	--	--	--	--	--	--
Gamma rays	5 kR	300	309	-	-	42	58	58	42
	10kR	316	260	-	3	48	48.5	52	48.5
	15kR	306	270	29	8	29	36	42	56

Plate 1:

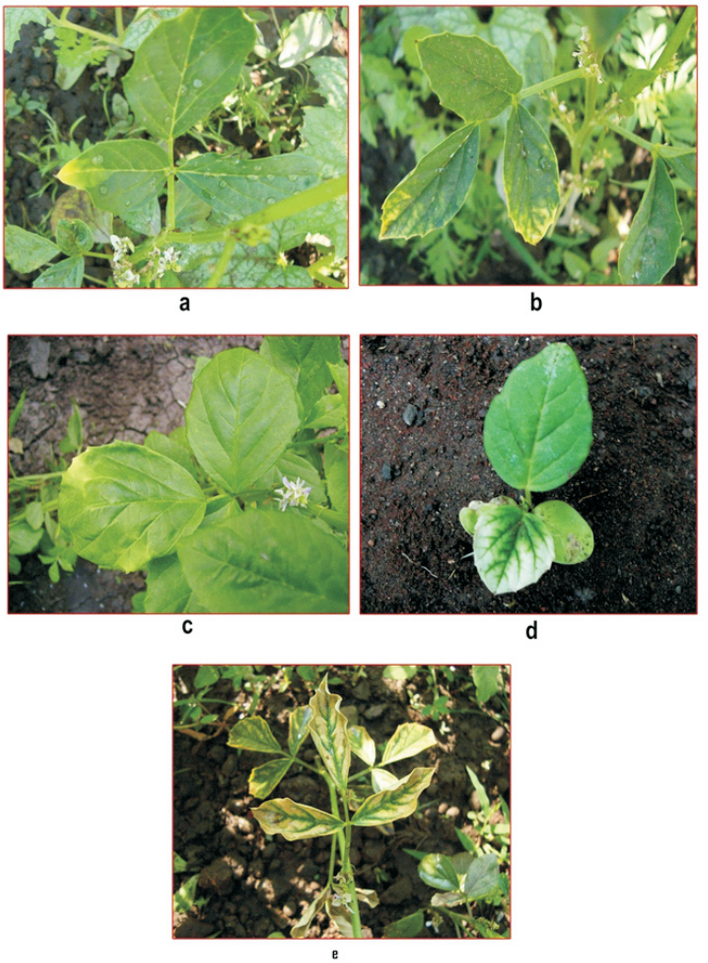

Plate 1:-
Chlorophyll deficient sectors in M1 generation.

a)Chlorophyll deficient sector (*xantha*) at the apex of leaf lamina in variety GE-36.
b)Chlorophyll deficient sector (*xantha*) at the apex of leaf lamina in variety HR.
c)Leaf lamina showing chlorophyll deficient sector (*viridis*) in variety GE-36.
d)Chlorophyll deficient sector (*viridis*) in variety HR.
e)Chlorophyll deficient sector (*chlorina*) affecting venation of leaf lamina in variety HR.

Plate 2:-
Chlorophyll mutants in M2 generation.

a)*Xantha* in variety GE-36.
b)*Xantha* in variety HR.
c)*Chlorina* in variety GE-36.
d)*Chlorina* in variety HR.
e)*Viridis* in variety GE-36 and
f)*Viridis* in variety HR.

Plate-2