

Induced mutagenesis in cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.]

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Abstract

A mutagenesis programme was carried out using two mutagens viz. gamma rays (25, 50, 100 and 150 kR) and EMS (0.1, 0.2, 0.3 and 0.4 per cent) on two varieties of cluster bean namely Pusa Navbahar and GC 1. Observations for germination per cent and radicle length were recorded in M_1 generation and for different quantitative characters in M_2 generation. Gamma rays beyond 100 kR was found to be detrimental to plant. Gamma rays treatment was more efficient in inducing variability as compared to EMS. Cultivar GC 1 was more sensitive to mutation than Pusa Navbahar.

Key words: Gamma rays, EMS, cluster bean, induced mutation

Introduction

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] is an important legume crop cultivated in Indo-Pakistan subcontinent. It is a dry land crop of the tropics and can tolerate high daily temperature. It has spherical shaped endosperm containing significant amount of galactomannan gum, which form viscous gel in cold water. 90 per cent of guar produced is used for production of guar gum and the rest used for culinary purpose and cattle feeding. The prime strategy in mutation based breeding has been to upgrade the well adapted plant varieties by altering one or two major traits, which limit their productivity or enhance their quality value. However in the available germplasm, there do not exist much of variability. Therefore, in the present study an attempt was made to create genetic variability through the treatment of seeds with gamma rays and EMS.

Material and methods

Two morphologically distinct cultivars of cluster bean viz. Pusa Navbahar (non branching type) and Gujarat cluster bean 1 (GC 1, branching type) were used for mutation with gamma rays and EMS. The seeds were exposed to 25 and 50 kR gamma rays at Bhabha Atomic Research Centre, Trombay, Mumbai. Another lot of seeds were treated with four concentrations of EMS i.e. 0.1, 0.2, 0.3 and 0.4 per cent of EMS. The seeds were soaked for 2 hours in normal water and then

treated with different EMS concentrations for 3 hours before sowing. Observations were recorded for germination per cent and radicle length in M_1 generation under laboratory conditions in 3 replications and were analyzed in CRD. This M_1 generation was advanced to M_2 generation by harvesting the seeds of each treatment separately and bulking equal number of seeds from each plant in each treatment. Rest of the observations viz. inflorescence length, plant height internode length, days to maturity, protein per cent and gum per cent were recorded in M_2 generation with three replications. All the treatments except 100 kR and 150 kR were advanced from M_1 to M_2 generation due to non availability of sufficient amount of seeds in M_1 generation for both the varieties. Protein per cent was estimated through Kjeldhal method and gum per cent was estimated by hydrolyzing the seeds in autoclave in water at 15 psi pressure for 4 hours. Then the colour was developed by phenol and conc. H_2SO_4 . The intensity of colour was measured at 485 nm wavelength and compared with standard. The data was subjected to statistical analysis and the variance components were estimated by using models suggested by Johnson *et al.* (1).

Results and discussion

The results indicated the effectiveness of the physical and chemical mutagens to induce heritable variations in the morphological characters like leaf drooping

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(Plate 1) and leaf thickening (Plate 2).

Germination per cent

Both the varieties showed different effects for gamma rays irradiation. Pusa Navbahar showed increase in germination per cent whereas, GC 1 showed decrease in germination per cent with increase in doses of gamma rays. The results were contrary to the observations of Milkov (2) but were in confirmation with Singh and Verma (3). However, EMS reduced germination in both the varieties with increased concentration from 0.1 to 0.4 per cent.

Radicle length

There was reduction in radicle length of cluster bean cultivar GC 1 with increase in dose and concentration of both the mutagens viz. gamma rays and EMS. However, cultivar Pusa Navbahar showed reduction in radicle length with increased dose of gamma rays. There was decrease in radicle length initially with increase in EMS concentration from 0.1 (5.3 cm) to 0.2 (2.47 cm) per cent, the radicle length reached a peak of 4.79 cm at 0.3 % EMS only to fall again at 0.4 % EMS (3.79 cm).

Inflorescence length

50 kR gamma rays significantly increased inflorescence length in GC 1, whereas, gamma rays did not any effect on cultivar Pusa Navbahar. In EMS treatments, no variation was observed for either of the cultivar. However, many morphological variations were observed like comb shaped inflorescence (Plate 3) and sterility of entire plant (Plate 4).

Plant height

Both the varieties did not show any variability due to gamma rays irradiation. This was in confirmation with Amrita *et al.* (4). However, EMS at 0.2 per cent was found to be effective in reducing plant height in cluster bean cultivar GC 1 and was not in confirmation with Nanda *et al.* (5) in *V. sesquipedalis*. But none of the concentrations of EMS were found to induce variability for plant height in cluster bean cultivar Pusa Navbahar.

Internode length

No variability was developed due to both the mutagens in either of the varieties.

Table 1. Effect of gamma rays and EMS on germination (%) and radicle length in Cluster bean varieties Pusa Navbahar and GC 1 in M_1 generation.

Mutagens	Pusa Navbahar		GC 1	
	Germination %	Radicle length	Germination %	Radicle length
25 kR gamma rays	34.67	4.0	80.67	5.4
50 kR gamma rays	40.00	3.1	84.00	4.6
100 kR gamma rays	56.00	2.2	76.67	2.6
150 kR gamma rays	60.67	1.5	74.00	2.0
0.1 % EMS	92.00	5.3	62.67	4.3
0.2 % EMS	90.67	2.5	50.67	3.7
0.3 % EMS	71.33	4.8	39.33	0.7
0.4% EMS	6.00	3.8	22.00	0.5
Control	92.67	5.6	94.00	5.8
C.D. _{0.05}	11.53	0.9	13.85	1.8
C.V. %	11.12	30.0	12.44	29.1



Plate 1: leaf curl and drooping due to 0.3 % EMS

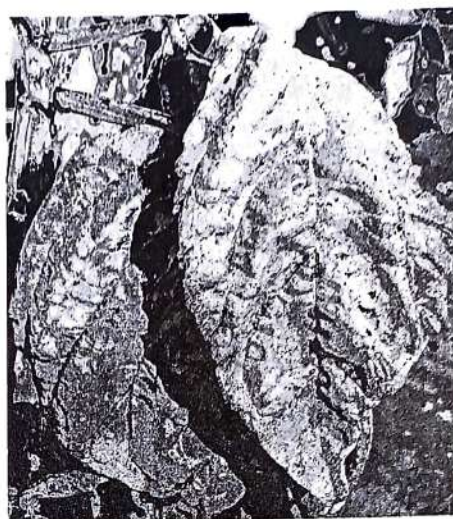


Plate 2: leaf thickening due to 25 kR and 50 kR gamma radiation



Plate 3: sterility in GC 1 plant due to mutation

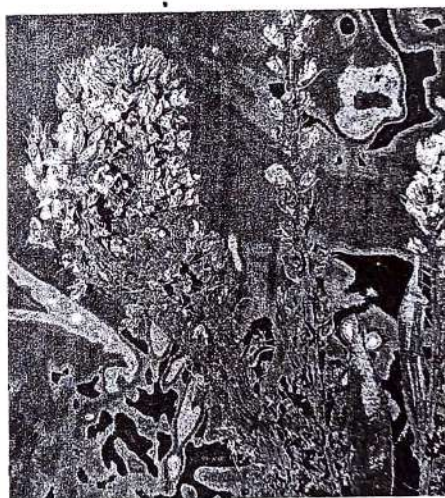


Plate 4: comb shaped inflorescence due to 50 kR treated plants

Days to maturity

Both the mutagens were unable to develop variability in Pusa Navbahar. However, gamma rays increased days to maturity in GC 1, an observation which was in contradiction with Singh and Agarwal (6). However, EMS treatment resulted in early maturity in GC 1 which is in agreement with Singh and Agarwal (6). It was also observed that EMS and gamma rays had contrasting effect in GC 1.

Protein per cent

Increase in protein per cent was observed in Pusa Navbahar at both the doses of gamma rays (25 kR and 50 kR). However, GC 1 showed significant increase in protein per cent at 25 kR gamma rays which was in

confirmation with Chaudhary *et al.* (7). On the contrary, EMS failed to develop variability for protein percent in both the varieties.

Gum per cent

EMS at 0.1 per cent was able to significantly increase gum per cent (34.5) in GC 1 only. The result confirms the finding by Chaudhary *et al.* (7) and Singh and Agarwal (6). However, rest of treatments were found to be ineffective.

The variability parameters for various characters were estimated and the data presented in Table 3. The results revealed that for gum per cent genotypic and phenotypic variances differed considerably, indicating

Table 2. Mean performance of various morphological characters in cluster bean in M_2 generation under mutagenesis.

Variety	Characters	Gamma rays (kR)				EMS (%)				Control	C.D. _{0.05}	C.V. %
		25	50	0.1	0.2	0.3	0.4					
Pusa Navbahar	Inflorescence length	6.6 (2.0 – 21.0)	6.2 (1.0 – 20.6)	6.0 (1.5 – 14.0)	6.0 (1.0 – 14.0)	5.3 (1.0 – 11.5)	6.7 (1.0 – 19.0)	6.2 (1.5 – 11.8)	NS	14.18		
	Plant height	71.9 (27 – 118)	73.4 (30 – 118)	70.3 (45 – 98)	69.9 (29 – 185)	68.8 (37 – 128)	75.7 (42 – 126)	72.4 (48 – 105)	NS	10.58		
	Internode length	3.1 (1.0 – 7.0)	3.2 (1.0 – 6.5)	3.3 (1.3 – 5.5)	3.2 (1.0 – 6.5)	3.2 (1.5 – 5.7)	3.3 (1.0 – 7.0)	3.5 (1.5 – 6.2)	NS	7.96		
	Days to maturity	130.4 (105 – 154)	129.9 (105 – 153)	131.9 (108 – 147)	132.3 (105 – 169)	129 (106 – 154)	135 (108 – 162)	127.4 (120 – 136)	NS	4.23		
	Gum per cent	43.2	40.0	32.4	31.4	37.9	35.5	33.4	3.44	5.33		
	Protein per cent	45.46	32.50	20.86	28.81	32.96	28.15	26.42	NS	29.73		
GC 1	Inflorescence length	3.6 (1.0 – 12.0)	4.7 (1.5 – 12.0)	3.2 (1.2 – 10.0)	3.2 (1.2 – 5.5)	2.9 (1.0 – 8.0)	2.9 (1.0 – 8.6)	3.6 (1.0 – 8.0)	NS	13.22		
	Plant height	87.1 (58 – 130)	92.5 (60 – 140)	82.3 (57 – 121)	70.8 (17 – 120)	79.1 (59 – 121)	84.2 (45 – 164)	86.1 (57 – 112)	10.39	7.02		
	Internode length	2.4 (1.0 – 5.0)	2.9 (1.0 – 7.5)	2.7 (1.2 – 4.1)	2.6 (1.5 – 4.5)	2.6 (1.0 – 5.1)	2.7 (1.0 – 6.0)	2.8 (1.3 – 5.3)	NS	7.16		
	Days to maturity	144.5 (110 – 164)	143.5 (113 – 165)	128.3 (105 – 152)	123.8 (108 – 151)	124.7 (102 – 169)	123.7 (105 – 144)	134.7 (121 – 145)	5.65	2.41		
	Gum per cent	41.2	30.9	33.5	29.1	33.1	33.3	33.5	3.8	6.36		
	Protein per cent	23.62	27.72	34.49	26.82	29.76	27.45	25.36	4.86	9.79		

Figure parenthesis indicate range

Table 3. Estimation of variability parameters in M₂ generation of cluster bean cv. Pusa Navbahar and GC 1

Characters	Pusa Navbahar					GC 1				
	Genotypic variance	Phenotypic variance	Heritability broad sense	Genetic advance	Genotypic variance	Phenotypic variance	Heritability broad sense	Genetic advance		
Germination per cent	876.49	921.68	95.1	98.4	526.16	591.35	89.0	68.7		
Radicle length (cm)	1.96	2.24	87.2	74.2	4.81	5.53	87.0	106.2		
Inflorescence length (cm)	*	-	-	-	0.30	0.51	59.3	25.3		
Plant height (cm)	-	-	-	-	35.61	69.69	51.1	10.6		
Internode length (cm)	-	-	-	-	0.02	0.06	35.2	6.5		
Days to maturity	-	-	-	-	79.97	90.06	88.8	13.2		
Gum per cent	17.45	21.19	82.4	21.6	12.67	17.22	73.6	18.8		
Protein per cent	30.75	114.26	26.9	19.3	9.69	17.14	56.6	17.3		

* Estimation of variance were negative

high influence of environment in the expression of the character. Character protein per cent was less influenced by external factors in its expression. Germination per cent had very high genetic advance and heritability. This indicated that the character is controlled by additive gene and can be improved through selection. However, most of the characters exhibited low genetic advance indicating their non-fixability.

Characters, viz. days to maturity, protein per cent and inflorescence length are less influenced by external factors. Very high heritability was observed for days to maturity (88.8 %). Inflorescence length (59.3 %) and plant height (51.1 %) both showed moderately high heritability. Most of the characters showed low and very low genetic advance except for character radicle length.

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