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Effect of gamma rays on quantitative traits of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] In m1 generation

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Abstract
Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] variety "Pusa Naubahar" was exposed to varying doses of gamma rays to study their effect on various characters like plant height, number of leaves per plant, days taken to fifty per cent flower, pod length, number of pods per cluster, number of cluster per plant, days to maturity, number of seeds per pod, hundred seed weight and yield per plant. In M_1 generation the results revealed that there was more reduction at higher doses compared to lower doses for all the characters. The results were obtained in the present study clearly indicate that different doses of gamma rays can be effectively utilized to create variability for various quantitative traits of the crop.

Keywords: Gamma rays, cluster bean, M1 generation, quantitative traits

Introduction
Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] [2n=14], is rather less exploited leguminous vegetable crop belonging to the family Fabaceae. It is known to be drought hardy, deep rooted annual legume. It is an important and potential vegetable cum industrial crop grown for its tender pods for vegetable purpose and for endospermic gum which ranges between 30-35 per cent. Tender pods are nutritionally rich in energy (16 Kcal), moisture (81 g), protein (3.2 g), fat (1.4 g), carbohydrate (10.8 g), Vitamin A (65.3 IU), Vitamin C (49 mg), phosphorus (57 mg), calcium (130 mg) and iron (4.5 mg) for every 100 g of edible portion (Kumar and Singh, 2002) [10].
Mutations are theoretically changes which occur in DNA sequence and result in changes in the genetic code. A gene mutation or point mutation is the group of all heritable changes which occur within the limits of a single gene. The majority of gene mutations show recessive inheritance but dominant gene mutations occur at a very low frequency (Micke, 1999) [15].
In general, mutation breeding has been playing a key role in self-pollinated crop with limited variability. In this context, it is to be noted that many workers have observed, in Castor (Ankineedu *et al.,* 1968) [1], in Wheat (Swaminathan, 1969) [26], in sesame (Sharma, 1993) [25], in cowpea (Dhanavel *et al.,* 2008), in black gram (Thilagavathi and Mullainathan, 2009) [27] and in soybean (Padmavathi *et al.,* 1992 and Pavadai *et al.,* 2010) [19, 20] developed plants variability by mutation on breeding. Gamma irradiation is one of the main physical mutagens for mutation studies in plants. Mutagens have been effective to decrease the mitotic index (Savaskan and Toker, 1991) [24]. Gamma irradiations as a mutagen can induce useful as well as harmful mutation in plants (Gupta, 1996; Micke and Donini, 1993) [6, 16]. Charbaji and Nabulsi (1999) [4] reported that gamma irradiation has been widely applied in medicine and biology in terms of biological effects induced by a counter intuitive switch-over from low doses of stimulation to high-doses of inhibition. Previous studies have shown that relative low-doses ionizing irradiation on plants and photosynthetic microorganisms are manifested as accelerated cell proliferation, germination rate, cell growth, enzyme activity, stress resistance and crop yields (Chakravarty and Sen 2001) [3]. Gamma irradiation has provided number of useful mutants and still shows an elevated potential for improving vegetative plants (Predieri, 2001). The present study was undertaken to know the effect of gamma rays on quantitative characters of cluster bean in M_1 generation and results are discussed.

Materials and Methods
The dry and dormant seeds of the cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] variety

"Pusa Naubahar" were treated with gamma irradiation were used in the present study. 500 well filled healthy seeds were packed in moist germination paper and selected for each treatment in the gamma chamber at 80, 100, 120 and 140 kR doses of gamma rays in ^{60}CO gamma source (irradiation source capacity to release 3000 Ci delivery 7200 r/min). The gamma irradiation was carried out at Baba Atomic Research Centre (BARC), Mumbai, India. After the completion of the treatment the treated seeds were line sowned in the field along with their respective control to rise the M_1 generation. All the treatments including the controls were raised adopting a spacing of 45 cm in between rows and 25 cm in between plants. All the recommended cultural measures namely, irrigation, weeding and plant protection methods were carried out during the growth period of the crop. The present study was undertaken to know the nature of induced genetic variability in variety Pusa Naubahar were subjected to physical mutagenic treatments for M_1 generations. The mutagenic seeds were grown in the field and the following characters *viz.,* plant height, number of leaves per plant, days taken to fifty per cent flower, pod length, number of pods per cluster, number of cluster per plant, days to maturity, number of seeds per pod, hundred seed weight and yield per plant.

Results and Discussions

The effect of gamma rays on quantitative characters were studied in various doses (80, 100, 120 and 140 KR) like plant height, number of leaves per plant, days taken to fifty per cent flower, pod length, number of pods per cluster, number of cluster per plant, days to maturity, number of seeds per pod, hundred seed weight and yield per plant. All the mutagenic treatments showed a gradual reduction of mean performance than the control with increasing doses/concentrations (Table 1). The variability of quantitative characters influencing yield was much greater in mutagenic progenies than in control (Prasad, 1976 and Gregory, 1995) [21, 5]. The ability of these mutagens to enter the cell of living organisms to interact with the DNA produces the general toxic effects associated with their mutagenic properties. Thus, their effects are mainly due to the direct interaction between the mutagen and the DNA molecules (Mensah *et al.,* 2007) [14]. Mutagens can cause physiological damages mainly manifested as growth retardation and death is generally not restricted in M_1 generation (Mak *et al.,* 1986) [13]. This is in agreement with present investigation which showed inhibitory growth and yield performance in M_1 generation with the effect of gamma rays.

In M_1 generation quantitative characters were decreased but days to 50 per cent flowering, and days to maturity were increased in treated plants, which were ranged from 30.5 to 37 and 75 to 88 days, respectively in control. The maximum duration for all these characters was observed at 140 kR (73.78 and137.06 days). Whereas, the minimum duration was recorded at 80 kR (50.10 and 129.5 days) treatment derived M_1 progenies (Table 1). Similar results have been recorded by Maheshwari *et al.* (2003) [12]; Khan and Wani (2005) [8] and (Sasi *et al.,* 2005).

In general, all the mutagenic treatments caused a reduction in the plant height compared with control. The plant height was ranged from 38 cm to 66 cm in control. In treated plants, the maximum plant height was observed at 80 kR of gamma rays (50.16 cm). The minimum plant height was recorded at 140 kR of gamma rays (16.84 cm). The reduced morphological variations may be due to physiological and some other disturbances at genetic level like chromosomal damage disturbed chromosomal coiling, failure or restricted pairing *etc*. Similar results were reported by (Rai and Das, 1978) [23]; (Koteswara Rao *et al.,* 1983) [9]; (Odeigah *et al.,* 1998) [18] and (Naik and Murthy, 2009) [17]. A general reduction in number of leaves per plant was observed in all the mutagenic treatments than in the control. The number of leaves was ranged between 35 to 42 numbers in control. In treated plants, the maximum number of leaves was observed at 80 kR of gamma rays (31.32) whereas, minimum number of leaves was observed at 140 kR of gamma rays (10.50) (Table 1). The pod length ranged between 3 to 7.5 cm in control. The maximum values were observed at 80 kR of gamma rays (7.47cm). While, the minimum was observed at 140 kR of gamma rays (3.34cm).

A general reduction in number of cluster per plant, seeds per pod, 100 seed weight and pod yield per plant was observed in all the mutagenic treatments. The numbers of pods were ranged from 9 to 10.9 in control. In treated plants, the maximum number of pods was observed at 80 kR of gamma rays (9.34), while the minimum number of pods was observed at 140 kR of gamma rays (3.85). Reduction in pod number may be due to a probable inhibiting action of enzymes, changes in the enzymes activity and the toxicity of the mutagen. These attributes of physiological and biochemical disturbances in the development of plants as already reported by Larik (1975) [11].

The numbers of clusters were ranged from 9.5 to 16.5 in control. In treated plants, the maximum number of cluster was observed at 80 kR of gamma rays (8.64), while the minimum number of cluster was observed at 140 kR of gamma rays (2.96). The number of seeds per pod, 100 seed weight and pod yield were ranged between 6 to 8, 3.6 to 4.9g and 152.5 to 175.5g, respectively in control. In treated plants, the maximum values were observed at 80 kR of gamma rays (6.89, 3.78g and 126.34g), While, the minimum of them was observed at 140 kR of gamma rays (2.23, 1.76g and 57.31g), respectively. The present results were observed in different crops by (Varshney and Siddiqui 1997, Banu *et al*. 2005) [28, 2] observed reduced yield in combined treatments with gamma rays and EMS in *Solanum melongena* L. Similar remarkable loss in yield has been experienced by chemical mutagens in soybean (Pavadai *et al.,*, 2010) [20] and bread wheat (Varshney and Siddiqui, 1997 and Karthika and Lakshmi, 2006) [28, 7].

Table 1: Effect of gamma rays on quantitative traits of cluster bean in M_1 generation.

Treatment (Dose kR)	PH (cm)	NLPP	DFF	PL (cm)	NPPC	NCPP	NDM	NSPP	HSW (g)	PYPP (g)
Control	56.00	38.70	33.02	8.82	9.79	9.52	82.95	7.28	4.10	161.02
80	50.16	31.32	50.10	7.47	9.34	8.64	129.49	6.89	3.78	126.34
100	47.69	27.52	57.90	6.56	7.40	8.09	133.19	5.80	3.22	96.44
120	36.10	16.71	67.71	5.49	3.91	3.29	134.96	2.41	2.14	61.81
140	16.84	10.50	73.78	3.34	3.85	2.96	137.06	2.23	1.76	57.31

PH-Plant height (cm), NLPP-Number of leaves per plant, DFF-Days to first flower, PL-Pod length (cm), NPPC-Number of pods per cluster, NCPP-Number of cluster per plant, NDM-Number of days to maturity, NSPP-Number of seeds per pod, HSW-100 seed weight, PYPP-Pod yield per plant.

Conclusions

All the quantitative traits were proportionately decreased with increased in dose or concentration of gamma rays in cluster bean. Gamma ray was decrease quantitative characters have been attributed to the physiological disturbance or chromosomal damage caused to the cells of the plants. Mutations in plants are powerful tools, not only for clarifying physiological mechanisms in plants but also for developing new plant varieties in practical breeding programs. Mutation breeding offers the possibilities of recovering some of the lost but useful variability in cluster bean, especially improved yield and disease/pest resistance. Mutation techniques have contributed significantly to plant improvement worldwide, and have made an outstanding impact on the productivity and economic value of some crops.

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