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EFFECT OF GAMMA RAYS ON YIELD AND YIELD ATTRIBUTES OF LARGE SEEDED CHICKPEA

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ABSTRACT

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A pot experiment was conducted at the Plant Breeding Division of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during November to February. Fresh seed of two genotypes (Binasola-2 & CPM-834) of chickpea were irradiated with ten different doses of gamma ray including a control viz. 0, 100, 200, 300, 400, 500, 600, 700, 800 and 900 Gy from ^{60}Co source. The seeds were sown in pots and yield and yield attributes were studied in M_1 generation. All the characters showed significantly different effect for the different doses. Flowering and maturity occurred earlier in treated population than the control. Due to 700 Gy dose the number of branches were recorded the highest. The number of pods/plant and seeds/pod reduced due to higher doses of gamma rays. But 300 Gy and 100 Gy caused the increase of 100 seed weight and seed yield/plant than control, respectively. Protein percentage of M_1 seeds was higher in 400 Gy treated plants.

Key words: Gamma-ray, radiation, yield and yield attributes

INTRODUCTION

Among the pulses chickpea (*Cicer arietinum* L.) is an important one. It is also known as gram, Bengal gram or Chola. It is the earliest domesticated crop in the Mediterranean and middle Eastern region (Vavilov, 1951). On the basis of cultivated area chickpea stands 19th position amongst the important crops and is grown in 34 countries of the world. In Bangladesh it is the third major pulse crop after grasspea) and lentil (Islam, 1981). Pulses cover about 546833 ha of the cultivated area of Bangladesh of which chickpea occupies 16650 ha. (BBS, 2000).

`There are two distinct types of chickpea are recognized; small seeded deshi better adapted to the East Asian region including the Indian subcontinent, and large seeded Kabuli adapted is the middle East and the Mediterranean region (Saxena and Singh, 1984). In the Indian subcontinent the crop is grown during winter on the soil conserved from the preceding monsoon season (Ali, 1986). In spite of its importance and well adaptability in the agroclimatic conditions of Bangladesh, the hectrage and per hectare productivity are decreasing gradually because the crop has received less care by researchers in comparison to other cereal grain crops. The guidelines to get maximum return from this crop can encourage the farmers to cultivate chickpea to decrease the percentage of protein scarcity chickpea give more yield of protein in kg/ha than some of the crops, even than that of our major food crop, rice (Brock and Autret, 1952).

Variability in the population creates the chance of selection for desirable improvement. Induced mutagenesis can be used to create variability as the rate of spontaneous mutation is very low. The use of induced mutation has been widely accepted by plant breeders as a tool in crop improvement. The induction of mutation in plant materials can be achieved either through physical or chemical mutagens. Many workers have attempted to exploit somaclonal variation for crop improvement through physical mutagens particularly treated by gamma radiation. The mutation breeding can play an efficient role in developing an ideal plant type having high yield potential (Sarwar *et al.*, 1986). Many workers like Gregory (1961), Kawai (1963), Krull and Frey (1961) and Frey (1964) are of the opinion that mutation breeding may be an alternative and supplement to hybridization as a source of variability. Through effective selection, varieties of better types can be developed out of the mutated population (Nayar, 1968; Srinivaschar and Malik, 1970; Balint *et al.*, 1968). The development of varieties using conventional breeding usually takes a longer time but if conventional as well as mutation breeding program can be taken simultaneously the development of new variety may take a shorter time.

Considering the above idea in mind the present investigation was, therefore, taken to study the different doses of gamma rays in creating variability in the M_1 population of two genotypes of large seeded chickpea for selecting desirable doses of gamma rays for the specific characters of plants.

MATERIALS AND METHODS

The experiment was conducted in pot condition at the Genetics and Plant Breeding Division of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh to study the different doses of gamma rays in creating variability in the M_1 population of two genotypes of large seeded chickpea for selecting desirable doses of gamma rays for the specific characters of plants. Soil was collected from BINA farm area and air-dried soil was taken in the pot. The test crop included two genotypes of chickpea (*Cicer arietinum* L.). The genotypes are Binasola-2 and CPM-834. In the experiment there were 10 treatments comprising irradiated with 0, 100, 200, 300, 400, 500, 600, 700, 800 and 900 Gy $^{60}C_0$ gamma rays. Each treatment was replicated 5 times. The treatments were laid out in Randomized Complete Block Design (RCBD) at the pot yard of BINA, Mymensingh. Data of yield and yield attributes were collected and all the data statistically analysed for each character separately. The mean data of each genotype for different characters were used for statistical analysis. Duncan's Multiple Range Test (DMRT) was performed for all the characters to test the significant differences among the means of the genotypes following Steel and Torrie (1960).

RESULTS AND DISCUSSION

Days to first flowering

Days to first flowering showed different effect with different doses of gamma ray. This character ranged from 52.12 to 57.23 days. The first flowering was seen at the 200 Gy treated plants. But statistically there were no significant difference among control, 100 Gy, 200 Gy and 300 Gy; 400 Gy, 600 Gy, 700 Gy and 800 Gy. 900 Gy treated plants are the delayed one to set flower. These findings showed that gamma-ray can change the flowering time of the plants. Many of the workers reported earlier that gamma-ray can change flowering either positive or negative direction. Mahala *el al.,* (1990) found that mutagenesis could widen variability to both positive and negative direction which resulted sufficient variability in the treated population that could be utilized for selection of early or late flowering plants.

Early flowering chickpea varieties are required to minimize the cropping period which will increase the cropping intensity. The result of the present study offers a good scope for isolation of desirable plants of chickpea with earlyness in days to flowering from the gamma ray treated population in M_1 generation for selecting in M_2 population.

Number of primary branches/plant

Number of primary branches ranged from 1.83 to 2.43. The maximum primary branches were obtained from 700 Gy treated plants. It was significantly different from all other doses except 100 Gy. 400 Gy treated plants were similar with 500, 600, 800 and 900 Gy. 100, 200 and 300 Gy treated plants did not show any difference with the control plants. The minimum primary branches were observed for 400 Gy treated plants. Similar observation was made by Malik *et al.,* (1995)

Number of secondary branches/plant

The range of secondary branches was 2.51-3.63 under different doses of gamma ray. The maximum secondary branches 3.63 (Table 1) were recorded at 700 Gy of gamma ray followed by 800 Gy. The minimum secondary branches were obtained from 200 Gy treated plant. Besides this the result showed that control, 100 Gy, 300 Gy, 500 Gy and 600 Gy showed no statistical significant difference. 800 Gy and 900 Gy; 500 Gy and 600 Gy showed no statistical significant difference. Similar result was obtained by Malik *et al.,* (1995)

Days to maturity

Days to maturity were the highest in 600 Gy treated plants (Table 1). 100 Gy treated plant showed the lowest duration for plant maturity. 400, 600, 800 and 900 Gy showed no significant difference for this character. There are a good number of similar reports of developing early maturity mutant varieties of chickpea (Shaikh *et al.,* 1982; Shamsuzzaman and Shaikh, 1991) and in rice (Hakim *et al*., 1988). The duration of maturity of all the existing varieties of chickpea in Bangladesh is long. Farmers are not much interested to grow long duration crops which interferes the other crops. Besides this, in Bangladesh chickpea is affected by hailstorm and early monsoon at mature stages which drastically reduces the yield. Here, cropping intensity can be increased only by developing early maturity varieties through induced mutation.

Plant height at maturity

The plant height was higher in the treated population than the control. Plant height ranged from 23.47 to 29.31 cm. The highest plant height 29.31cm (Table 1) was recorded in 800 Gy treated plants. 700, 800 and 900 Gy treated plants are statistically similar. 300, 400, 500 and 600 Gy was also same. Athwal *et al.* (1970) created variability in plant height in chickpea through gamma radiation, which supports this result. The result indicated that the mutagen could cause both positive and negative genetic variability in plant height. Selection than could be made for both tall and short variety.

Number of pods/plant

Number of pods/plant showed distinct significant difference among all the doses except 300 Gy and 500 Gy. The highest pod number 54.30 was obtained through 100 Gy treatment and the lowest was through 900 Gy (Table 1). The range of pods/plant was from 6.00 to 54.30. The second highest pods/plant was in control. The reduction in mean of number of pods found in most treatments may be attributed to induction of more mutation with negative effects.

Number of seeds/pod

The range for number of seeds/pod was 0.96-1.19. The highest number was for control, 100 Gy and lowest for 900 Gy (Table-1). Control, 100, 200 and 400 Gy; 400, 500 and 600 Gy; 700, 800 and 900 Gy had no statistical significant difference. With a over view from this result it can be said that the number of seeds/pod decreased with increasing of doses of gamma ray.

100 - seed weight

The range of 100-seed weight was 26.00 - 29.83 gm. The highest seed weight was obtained from 300 Gy treated plants and the lowest was in control (Table 1). 200- 800 Gy treated plants showed the statistically similar result though the values were different. Increasing of 100-seed weight through mutation in M_1 generation was reported by many workers. Dhopte *et al*., (1974) irradiated some chickpea cultivars with gamma ray and observed noticeable changes in 100-seed weight.

Table 1. Mean performances of different characters of two chickpea genotypes after irradiation

Doses	No. of secondary branches /plant (No.)	Days to maturity (No.)	Plant height at maturity (cm)	Pods/ plant (No.)	Seeds/ pod (No.)	100-seed weight (g)	Protein percentage	Seed yield/ plant (g)
0 Gy	2.82 d	107.1 cd	23.47 e	47.55 b	1.19 a	26.00 b	20.63 c	14.25 b
100 Gy	2.81 d	106.3 cd	24.62 de	54.30 a	1.19 a	27.95 ab	21.87 ab	16.80a
200 Gy	2.51 e	106.0 d	26.44 cd	37.35 c	1.19 a	28.55 a	21.63 ab	11.40 c
300 Gy	2.83 d	108.6 bc	25.23 cd	26.70 e	1.11 b	29.83 a	21.01 bc	8.55 e
400 Gy	2.71 de	111.6 a	25.98 cd	22.35 f	1.16 ab	28.46 a	21.91 a	7.50 f
500 Gy	2.78 d	108.6 c	26.05 cd	26.25 e	1.11 b	28.96 a	21.40 a-c	8.85 e
600 Gy	2.95 cd	111.9 a	26.98 bc	32.55 d	1.11 b	29.33 a	21.24 a-c	10.50 d
700 Gy	3.63 a	110.9 ab	28.36 ab	27.9 e	1.02 c	28.36 a	21.05 a-c	7.80 f
800 Gy	3.25 b	112.3 a	29.31 a	12.00 g	0.99 c	29.07 a	21.34 a-c	3.15 g
900 Gy	3.18 bc	111.7 a	28.81 a	6.00 h	0.96 c	27.90 ab	21.28 a-c	1.65 h
LSD	0.24	2.23	1.66	3.90	0.06	2.12	0.75	0.90

Protein percentage of the seed

Protein percentage ranged from 20.63 - 21.91 %. The highest percentage of protein was recorded at 400 Gy treated seed and lowest was in control. Except control and 300 Gy the other doses showed no statistical significant different with 400 Gy. Dhopte *et al*., (1974) performed an experiment by irradiating chickpea, where he also observed significant differences in protein percentage of seeds in various doses. So it can be said that there is a great possibility for improvement of protein content in chickpea genotypes by using gamma ray.

Seed yield/plant

Seed yield/plant ranged from 1.65 to 16.80gm. The highest yield was obtained through the plants treated with 100 Gy and the lowest yield was at 900 Gy. 300 and 500 Gy 400 and 700 Gy showed statistically similar result. The other doses showed significant difference. Higher seed yield mutant of chickpea was reported by a number of researchers (Dhopte *et al*., 1974; Abdulomonov and Nigmatullin, 1978; Shaikh *et al*., 1982)

Interaction between genotypes and different doses of radiation for different characters

Days to first flowering

Days to first flowering ranged from 46.01 to 63.05 days. The earliest flowering was observed when CPM-834 was irradiated with 100 Gy gamma ray, it showed no significant difference with other treatments in the same genotypes except 900 Gy and it was only similar 500 Gy of Binasole-2. When Binasola-2 was irradiated with 800 Gy, which took the longest duration for flowering and this, was statistically similar with the treatments 300 Gy to 800 Gy. For both of the genotypes flowering was observed earlier than control in the irradiated population.

Number of primary branches/plant

Number of primary branches ranged from 1.15 to 3.27. The highest primary branches were observed when Binasola-2 was irradiated with 100 Gy gamma ray, though it showed no significant statistical differences with control, 200 Gy, 300 Gy and 700 Gy in the same genotype. The lowest number of primary branches (1.15) were recorded when CPM-834 was irradiated with 200 Gy (Table 2). This showed no significant difference with control, 100, 200, 300, 400, 500, 600 and 900 Gy treatment of the same genotype. The two genotypes for all doses showed significant difference between them for number of primary branches.

Number of secondary branches/plant

The secondary branches of two genotypes differently responded to ten doses of gamma ray including a control. In general, the irradiation with 700 Gy to Binasola-2 generated the maximum secondary branches 3.82, which showed significant difference with other doses to both genotypes. At 300, 400 and 800 Gy both the genotypes showed statistically similar though for the control they showed very distinct significant difference for number of secondary branches.

Table 2. Interaction between genotypes and different doses of gamma rays for different characters

Doses	Days to first flowering (No.)		No. of primary branches/plant (No.)		No. of secondary branches/plant (No.)		Days to maturity (No.)		Plant height at maturity (cm)	
	Binasola-2	CPM-834	Binasola-2	CPM-834	Binasola-2	CPM-834	Binasola-2	CPM-834	Binasola-2	CPM-834
0 Gy	59.12 bc	48.24de	3.11 a	1.19 e	3.53 a-c	2.10 j	120.2 ab	94.00 ef	24.99 ef	21.95 g
100 Gy	61.22a-c	46.01 e	3.27 a	1.27 de	3.30 cd	2.33 h-j	120.00 ab	92.60 f	24.00 fg	25.24 ef
200 Gy	58.78 c	45.54 e	3.07 a	1.15 e	3.44 bc	1.57 k	115.4 c	96.60 e	27.14 c-e	25.75d-f
300 Gy	62.24a-c	46.55 e	3.06 a	1.26 de	2.95 d-f	2.70 e-g	117.0 bc	100.2 d	23.29 fg	27.17c-e
400 Gy	62.27a-c	47.80de	2.44 b	1.23 de	2.74 e-g	2.67 f-h	121.6 a	110.6 d	24.70 ef	27.26c-e
500 Gy	62.37a-c	48.39de	2.51 b	1.45 c-e	3.05 de	2.50 g-i	120.6 a	96.60 e	24.87 ef	27.24c-e
600 Gy	62.26a-c	47.74de	2.47 b	1.35 de	3.61 a-c	2.29 ij	121.6 a	102.2 d	27.17 c-e	26.79c-e
700 Gy	62.83 ab	48.03de	3.16 a	1.69 c	3.82 a	3.44 bc	119.4 ab	102.4 d	26.83 c-e	29.90 b
800 Gy	62.61 ab	48.97de	2.41 b	1.51 cd	3.24 cd	3.26 cd	128.1 a	102.8 d	25.07 ef	33.56 a
900 Gy	63.05 a	51.42 d	2.39 b	1.39 de	3.75 ab	2.62 f-i	120.4 ab	103.0 d	29.34 bc	28.28b-d
LSD	3.21		0.28		0.33		3.15		2.35	

Table 2. Contd.

Doses	Pods/plant (No.)		Seeds/pod (No.)		100-seed weight (gm)		Protein percentage		Seed yield/plant (gm)	
	Binasola-2	CPM-834	Binasola-2	CPM-834	Binasola-2	CPM-834	Binasola-2	CPM-834	Binasola-2	*CPM-834*
0 Gy	66.30 a	28.65 e-g	1.27 a	1.12 b-e	21.71 f	30.30 cd	19.68 f	21.58 a-e	18.75 a	9.75 e
100 Gy	61.50 b	45.15 c	1.18 a-c	1.20 ab	22.64 f	33.27 bc	21.25 a-e	22.48 a	18.00 b	18.45 a
200 Gy	50.55 c	24.00 hi	1.20 ab	1.19 a-c	22.71 f	34.39 ab	21.77 a-d	21.48 a-e	13.20 c	9.60 e
300 Gy	31.65 d-e	21.75 i	1.20 a-c	1.09 c-f	22.46 f	37.20 a	19.85 f	22.16 ab	8.10 f	9.15 e
400 Gy	23.25 i	21.30 i	1.13 b-e	1.20 ab	23.33 ef	33.58 b	21.71 a-d	22.10 ab	6.60 h	8.25 f
500 Gy	25.20 g-i	27.30 f-h	1.12 b-e	1.10 b-e	22.72 f	35.21 ab	20.74 c-f	22.05 ab	7.05 gh	10.50 d
600 Gy	34.20 d	30.90 d-f	1.07 b-g	1.15 b-d	21.72 f	36.93 a	20.56 d-f	21.92 a-c	6.45 f	13.05 c
700 Gy	31.65 d-e	24.00 hi	1.04 e-h	1.00 f-h	23.88 ef	32.83 bc	19.78 f	22.32 ab	7.65 fg	7.95 f
800 Gy	10.05 k	13.95 j	1.00 f-h	0.98 gh	23.00 ef	35.13 ab	21.13 b-e	21.56 a-e	2.40 j	4.05 i
900 Gy	5.40 l	6.60 kl	0.98 gh	0.95 h	26.20 e	29.60 d	20.46 ef	22.10 ab	1.35 k	1.80 jk
LSD	3.90		0.09		2.99		1.06		0.74	

Days to maturity

The duration for maturity ranged from 92.60 to 121.80 days. The earliest maturity was recorded when CMP-834 was irradiated with 100 Gy gamma ray. It was significantly different at all other doses for both genotypes except control in the same genetype. Binasola-2 at 800 Gy showed the longest maturity period, which showed statistically similarity with other treatments except 200 and 300 Gy. On the aspect of genotypes there were significant differences for all the same doses.

Plant height at maturity

Response of plant height at maturity was different for two genotypes when they were treated with ten doses of gamma ray including a control. Plant height ranged from 21.95 to 33.56 cm. In general, the application of 800 Gy gamma ray resulted the maximum height, which was recorded for the genotype CPM-834 and this was significantly different from all other treatments for the both genotype. It was similar to both genotypes when irradiated with 900 Gy. The shortest plant was recorded when CPM-834 was not irradiated (i.e. control). The control, 300, 700 and 800 Gy the two genotypes showed significant differences statistically but other doses they did not show any significant difference.

Number of pods/plant

Number of pods/plant of two genotypes differently responded to the doses of gamma rays. Number of pods/plant ranged from 5.40 to 66.30. The maximum pod number 66.30 was recorded in Benasola-2 when it was not irradiated and it differed significantly with all other observations (Table 2). The second highest was for the same genotype when it was treated with 100 Gy. The lowest number of pod was observed when Binasola-2 was treated with 900 Gy, which was statistically similar with same dose in CPM-834. Both the genotypes at 0 Gy was found distinctly different but at the highest dose there were no significant difference between the genotypes. At 400 Gy the two genotypes showed non significant difference and also showed in control.

Number of seeds/pod

Effect of gamma ray on two genotypes on the aspect of number of seeds/pod showed significant differences. The number of seeds/pod ranged from 0.95 to 1.27 per pod (Table 2). The highest number was recorded for Bineaola –2 in control, which was similar at 100 and 200 Gy of the same genotype and 200 Gy of CPM-834 . The lowest number was recorded for CPM-834 when treated with 900 Gy, which did not show any significant difference with 700, and 800 Gy for the both genotypes.

100 - seed weight

100 seed weight for two different genotypes responded differently to different ten doses of gamma ray including a control. It ranged from 21.71 to 37.20 gm (Table 2). The highest weight was recorded in CPM-834 when irradiated with 300 Gy and it was statistically similar with 200, 600 and 800 Gy of the same genotype. The lowest 100-seed weight was recorded in Binasola-2 when it was not irradiated (i.e. control), which was statistically similar with all other treatments except 800 and 900 Gy of the same genotype. The two genotypes differed statistically for the same treatment.

Protein percentage of seed

Protein percentage ranged from 19.68 to 22.48 %. The highest protein percentage was recorded when the genotype CPM-834 was treated with 100 Gy, this was statistically similar with all other treatments of same genotype and 100 Gy, 200 Gy, 400 Gy of Binasola-2. The minimum protein percentage was observed for Binasola-2 in control (Table 2). It was statistically similar with 300, 500, 600 and 700 Gy of Binasola-2. At higher doses the difference was more than the controls of two genotypes.

Seed yield/plant

Seed yield/plant of two genotypes responded differently to different doses of gamma ray. It ranged from 1.35 to 18.75gm. Maximum yield was obtained from Binasula-2 control (18.75 gm) shown in . It was statistically similar with 100 Gy treatment of CPM-834 (Table 2). These two plants showed significant difference with all the others. Minimum yield was recorded when Binasola-2 was irradiated with 900 Gy. It was similar with 900 Gy of CPM-834. In maximum cases significant differences were observed.

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