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Use of induced mutation for the resistance against Dry root rot in chickpea (*Cicer arietinum* L.) in M1 generation

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Abstract
Chickpea (*Cicer arietinum* L.) is an important cool-season food legume grown extensively by the poor farmers throughout the Indian subcontinent. In India chickpea is being grown in 8.32 million hectare with production of 9.8 million tones and 925 - kg/ha productivity (Project coordinators report, 2014-16). The Dry root rot (DRR) of chickpea caused by necrotropic fungus *Rhizoctonia bataticola.* During the past few decades, modern techniques such as mutation breeding by radiation and chemical mutagens and genetic engineering methodology have been tried to develop resistant cultivars of many crop plants. The utilization of mutation breeding is a simple, less cost full and time saving method. Present investigation entitled "Radiation induced mutation for resistance against *Rhizoctonia bataticola* in chickpea (*Cicer arietinum* Linn.)" was aimed at identification of suitable mutant or a combination of mutants influencing resistance to dry root rot in chickpea. The experimental material was consisted of the population of three selected cultivars of chickpea (JG 63, JG 74, and JG 130) grown in randomized complete block design in the Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, Jabalpur (M.P) under AICRP on chickpea project during *Rabi* 2014-16. Dry seeds (10-12% moisture content) of these varieties were irradiated with different doses of gamma rays (150Gy, 200Gy and 400 GY). Another set of presoaked seeds in distilled water (12hrs.) were treated with ethyl methane sulphonate at different concentration (0.3, 0.4 and 0.5%) prepared for 6 hrs. A portion of seeds irradiated at 150 and 200 GY gamma- ray doses were also treated with 0.3% and 0.4% EMS independently for 6 hrs. present findings revealed that JG 63, JG 74, JG 130 showed significant reaction for mutagenic treatments *i.e*, 200Gy, 400Gy, 0.3% EMS, 0.4% EMS, 150Gy+0.3% EMS, 200Gy+0.3% EMS. Among 11 treatments, 7 have shown effect on biological traits of experimental genotypes *i.e*. change in seedling height, decrease in germination percentage and decrease in plant height as compared to control.

Keywords: *Rhizoctonia bataticola*, gamma- ray, EMS, *Cicer arietinum* L.

Introduction
Chickpea is a cool season pulse crop and is grown in several countries worldwide as a food source. Chickpea is the third most important food legume crop and India is the largest producer contributing to 65% of world's chickpea production. The improvement of chickpea using conventional breeding approaches has been hampered due to lack of sufficient genetic variability. Mutagenesis is a common and efficient tool to create new desirable genetic variability in chickpea [1]. The use of ionizing radiation such as, x-rays, gamma rays, and neutrons and chemical mutagens for inducing variation is well established. Induced mutation have been used to improve major crop which are seed propagated. Mutation can be linked to changes in DNA sequences for some plant traits and to establish molecular maps in structural and functional genomics of crop plants. These in turn would lead to a rapid enhancement of crop yields and quality [2].

Material and Methods
The experiment was carried out under AICRP- Chickpea, at seed breeding farm, Adhartal, JNKVV, Jabalpur (M.P.) during rabi 2014-16. Temperature extremes vary between minimum temperature of 2°C in December and January months to maximum temperature of 45°C in May and June months. The average annual rainfall mostly received between mid - June to first week of October with occasional showers in limited quantum during the winter months, ranges between 1000-1500 mm. The relative humidity remains minimum 20 to 35% during summer and medium 40 to 60% during winter season, while it attains maximum values of 80 to 95% during rainy season. Chickpea seeds of JG 130, JG 63, and JG 74 entries/ varieties were collected from healthy plants at maturity stage of the crop from AICRP on chickpea located at seed breeding farm J.N.K.V.V., Jabalpur. Gamma irradiation has been performed (Nuclear Research Laboratory IARI, New Delhi) in gamma chamber by exposing the seeds to the

gamma rays from ^{60}Co source was filled and handpicked uniform sized seeds with moisture content of 10-12% were chosen for irradiation. A sample of 120 seeds pre treatment will be packed in butter paper cover and placed in 100 curie ^{60}Co gamma cells the treatments will be given for various duration depending on the doses required (150Gray, 200Gray and 400 Gray) with the dose rate of say 54.05 rads/sec. Set of presoaked seeds of selected genotypes in distilled water (12 hrs.) were treated with ethyl methane sulphonate at different concentration by using magnetic stirrer (0.3,0.4 and 0.5%) for 6 hrs. with constant intermitted shaking in shaker and after that washed under running tap water. A portion of seeds irradiated at 150 and 200 GY gamma- ray doses were also treated with 0.3 and 0.4 EMS independently for 6 hrs with constant intermitted shaking in shaker and after that washed under running tap water. A total of 11-treatment combinations (including control) were evaluated separately for each variety planted in Randomized Block Design with three replication following biological parameters of observation during Rabi season 2014-15 at Seed Breeding farm, JNKVV Jabalpur.

Result

Effect of the mutagenic treatments on seed germination and some morphological parameters in M1 generation.

Effect of the mutagenic treatments on seed germination % on chickpea varieties

The mean seed germination percentage was reported to be 59.1% at 150 GY. The germination (%) was also reduced by using chemical mutagens. The germination (%) was noted to be 50.7% at 0.2% EMS treatments respectively. Whereas, the mean seed germination percentage in combination of Gamma irradiation and EMS at treatment was reported as 49.5% at 150 GY+0.2% EMS respectively as compared to control (69.2%) of genotype (JG 63) and genotype (JG 74) showed the mean seed germination percentage was reported to be 54.3% at 150 GY. Similarly, the germination (%) was also reduced by using chemical mutagens. The germination (%) was noted to be 46.3% at 0.2% EMS. Whereas, the mean seed germination percentage in combination of Gamma irradiation and EMS at treatment was reported as 47.6% at 150 GY+0.2 EMS respectively as compared to control (62.0%) as well as genotype (JG 130) showed the mean seed germination percentage was reported to be 51.3% at 150 GY. Similarly, the germination (%) was also reduced by using chemical mutagens. The germination (%) was noted to be 45.5% at 0.2% EMS. Whereas, the mean seed germination percentage in combination of Gamma irradiation and EMS at treatment was reported as 45.7% at 150 GY+0.2% EMS respectively as compared to control (60.2%) (Table 1)

Plant height

The mean plant height of JG 63 was noted 52 cm at 150 GY, 50.3 cm in 0.2% EMS and 49.3 cm in combination treatment 150 GY+0.2% EMS respectively, among the all treatments as compared to control (54.3 cm) and in genotype JG 74 it was 34.6 cm at 400 GY, 47.7 cm in 0.2% EMS and 47.6 cm in combination treatment 200 GY+0.2% EMS respectively, among the all treatments as compared to control (53.0 cm). Similarly in JG 130 the mean plant height was noted 39.6 cm at 150 GY, 45.6 cm in 0.2% EMS and 44.6 cm in combination treatment 150VGY+0.2% EMS respectively, among the all treatments as compared to control (50.6 cm).(Table 2).

Number of pods per plant

The maximum number of pods per plant of JG 63 was noted 58.3 at 150 GY, followed by 39.3 at 200 GY and 43.3 at 400 GY. Minimum number of pods per plant was also decreased using chemical mutagens, the lowest pods per plant in EMS treatment was noted at 0.3% EMS (25.6), whereas in combination treatment lowest mean pods per plant was reported to be 34.0 at 200 GY+0.2% EMS as compared to control (64.6) and in JG 74 showed 55.3 at 150 GY, followed by 33.3 at 200 GY and 35.3 at 400 GY. Minimum number of pods per plant was also decreased using chemical mutagens, the lowest pods per plant in EMS treatment was noted at 0.3% EMS (24.3), whereas in combination treatment lowest mean pods per plant was reported to be 30.6 at 200 GY+0.2% EMS as compared to control (60.6). Similarly JG 130 showed 26.0 at 150 GY, followed by 17.0 at 200 GY and 20.0 at 400 GY. Minimum number of pods per plant was also decreased using chemical mutagens, the highest pods per plant in EMS treatment was noted at 0.3% EMS (18.6), whereas in combination treatment lowest mean pods per plant was reported to be 25.6 at 200 GY+0.2% EMS as compared to control (39.3). (Table 3).

Number of seeds per plant

The mean number of seeds per plant (%) in genotype JG 63 was noted to be 34.3 at 150 GY, 24.0 at 200Gy and 27.3 at 400 GY respectively. Similarly in chemical mutagenic treatments the mean seeds per plant (%) were noted to be 33.6 at 0.2% EMS, 25.3 at 0.3% EMS and 32.6 at 0.4%EMS respectively. In the combination treatment highest numbers of mean seeds per plant (%) among all the mutagenic treatments were found at 200 GY +0.2% EMS (21.6) as compared to control (46.3) and genotype JG 74 showed the mean seeds per plant (%) was 30.3% at 150 GY, 22.0 at 200 GY and 25.6 at 400 GY respectively. Similarly in chemical mutagenic treatments the mean seeds per plant (%) were noted to be 32.0 at 0.2% EMS, 23.6 at 0.3% EMS and 28.0 at 0.4%EMS respectively. In the combination treatment highest numbers of mean seeds per plant (%) among all the mutagenic treatments were found at 200 GY +0.2% EMS (20.0) as compared to control (44.3). A well as the genotype JG 130 showed the mean seeds per plant (%) was noted 23.4 at 150 GY, 20.0 at 200 GY and 21.6 at 400 GY respectively. Similarly in chemical mutagenic treatments the mean seeds per plant (%) were noted to be 30.3 at 0.2% EMS, 19.6 at 0.3% EMS and 23.7 at 0.4%EMS respectively. In the combination treatment highest numbers of mean seeds per plant (%) among all the mutagenic treatments were found at 200 GY +0.2% EMS (18.3) as compared to control (37.3). (Table 4).

Seed yield per plant

The mean seed yield per plant (g) in genotype JG 63 was noted to be 5.73 g at 150 GY, 4.0 g at 200 GY and 4.9 g at 400 GY. Similarly in chemical mutagenic treatments the highest percentage of mean seed yield per plant was 5.4 g at 0.2%EMS, whereas in combination treatments (150 GY+0.2% EMS) the highest percentage of mean seed yield per plant was noted to be 5.0 g respectively compared to control (7.0 g) and in genotype JG 74 the mean seed yield per plant (g) was recorded to be 4.0 g at 150 GY, 3.1 g at 200 GY and 3.8 g at 400 GY. Similarly in chemical mutagenic treatments the highest percentage of mean seed yield per plant was 4.9 g at 0.2% EMS, whereas in combination treatments (150 GY+0.2% EMS) the highest percentage of mean seed yield per plant was noted to be 4.2 g respectively compared to control (5.9 g). As well as genotype JG 130 showed the mean seed yield per plant (g) was 4.2 g at 150 GY, 3.1 g at 200 GY

and 3.8 g at 400 GY. Similarly in chemical mutagenic treatments the highest percentage of mean seed yield per plant was 4.6 g at 0.2% EMS, whereas in combination treatments (150 GY+0.2% EMS) the highest percentage of mean seed yield per plant was noted to be 4.00 g respectively compared to control (5.5 g). (Table 5).

Seedling height

Mean seedling height (cm) after 15 days of sowing in genotype JG 63 was reported to be 13.9 cm at 150 GY, 7.0 cm at 200 GY and 12.6 cm at 400 GY respectively. Similarly in chemical mutagenic treatments the seedling height was 11.9 cm at 0.2% EMS, 9.8 cm at 0.3% EMS and 10.7 cm at 0.4% EMS respectively. Whereas in combination treatments the mean seedling height was noted to be 13.1 cm at 150 GY+0.2% EMS, 10.0 cm at 200 GY+0.2% EMS, 10.2 cm at 150 GY +0.3% EMS and 12.3 cm at 200 GY+ 0.3%EMS respectively, as compared to control (18.0 cm) and in genotype JG 74 it showed Mean seedling height (cm) after 15 days of sowing was reported to be 11.6 cm at 150 GY, 5.9 cm at 200 GY and 10.9 cm at 400 GY respectively. Similarly in chemical mutagenic treatments the seedling height was 10.4 cm at 0.2% EMS, 8.6 cm at 0.3% EMS and 9.2 cm at 0.4% EMS respectively. Whereas in combination treatments the mean seedling height was noted to be 11.3 cm at 150 GY+0.2% EMS, 9.2 cm at 200 GY+0.2% EMS, 9.4 cm at 150 GY+0.3% EMS and 11.0 cm at 200 GY+ 0.3% EMS respectively, as compared to control (16.3 cm). As well as the genotype JG 130 showed mean seedling height (cm) after 15 days of sowing was recorded to be 10.9 cm at 150 GY, 4.9 cm at 200 GY and 9.7 cm at 400 GY respectively. Similarly in chemical mutagenic treatments the seedling height was 9.8 cm at 0.2% EMS, 7.9 cm at 0.3% EMS and 8.8 cm at 0.4% EMS respectively. Whereas in combination treatments the mean seedling height was noted to be 10.7 cm at 150 GY+0.2% EMS, 8.9 cm at 200 GY+0.2% EMS, 9.0 cm at 150 GY+0.3% EMS and 10.4 cm at 200 GY+ 0.3% EMS respectively, as compared to control (15.7 cm) (Table 6).

100 Seed weight

The mean 100 seed weight (g) in genotype JG 63 was reported to be 16.0 g at 150 GY, 14.2 g at 200 GY and 15.0 g at 400 GY, respectively. Whereas, in chemical mutagenic treatments it was recorded to be 15.1 g at 0.2% EMS, 14.4 g at 0.3% EMS and 15.0 g at 0.4% EMS also in combination treatments the mean 100 seed weight percentage was noted to be 17.0 g at 150 GY+0.2% EMS, 13.2 g at 200 GY +0.2% EMS, 13.4 g at 150 GY +0.3% EMS and 15.6 g at 200 GY + 0.3% EMS respectively, as compared to control. (21.0 g) and genotype JG 74 showed the mean 100 seed weight (g) was noted to be 13.9 g at 150 GY, 12.70 g at 200 GY and 13.8 g at 400 GY, respectively. Whereas, in chemical mutagenic treatments it was recorded to be 14.2 g at 0.2% EMS, 13.2 g at 0.3% EMS and 14.1 g at 0.4% EMS also in combination treatments the mean 100 seed weight percentage was noted to be 16.2 g at 150 GY +0.2% EMS, 12.2 g at 200 GY +0.2% EMS, 12.9 g at 150 GY +0.3% EMS and 13.7 g at 200 GY + 0.3% EMS respectively, as compared to control (17.4 g). As well as genotype JG 130 showed the mean 100 seed weight (g) was recorded to be 14.1 g at 150 GY, 13.2 g at 200 GY and 13.8 g at 400 GY, respectively. Whereas, in chemical mutagenic treatments it was recorded to be 14.1 g at 0.2% EMS, 13.5 g at 0.3% EMS and 13.9 g at 0.4% EMS also in combination treatments the mean 100 seed weight percentage was noted to be 15.8 g at 150 GY +0.2% EMS, 14.9 g at 200 GY +0.2% EMS, 15.3 g at 150 GY +0.3% EMS and 15.6 g at 200 GY + 0.3%EMS respectively, as compared to control. (18.9 g). (Table 7).

Lethality

The highest lethality percentage in genotype JG 63 was recorded in combination treatments, which was 55.3 % at 150 GY +0.2% EMS, whereas in physical mutagenic treatment the maximum lethality was recorded to be 50.0% in 150 GY and in chemical mutagenic treatments the maximum lethality percentage was recorded to be 47.0% at 0.2% EMS as compared to control (24.3%) and in genotype JG 74 the highest lethality percentage was noted in combination treatments, which was 73.3% at 150 GY +0.2% EMS, whereas in physical mutagenic treatment the maximum lethality was recorded to be 66.0 % in 150 GY and in chemical mutagenic treatments the maximum lethality percentage was recorded to be 57.3 % at 0.2% EMS as compared to control (31.6%). As well as in genotype JG 130 showed the highest lethality percentage was noted in combination treatments, which was 81.0% at 150 GY +0.2% EMS, whereas in physical mutagenic treatment the maximum lethality was recorded to be 70.6% in 150 GY and in chemical mutagenic treatments the maximum lethality percentage was recorded to be 68.3% at 0.2% EMS as compared to control (38.6%) (Table 8).

Growth habit

Growth habit is an important criteria for characterization of plants. The plants were counted in all the 11 treatments for their growth habit. In the present study maximum number of plants in genotype JG 63 was grouped into prostate type (7) at 200 GY, followed by spreading (12) at 200 GY +0.3% EMS, and erect (7) at 0.2 % EMS type as compared to control (13) spreading and in genotype JG 74 the maximum number of plants are grouped into prostate type (7) at 400 GY, followed by semi erect (14) at 200 GY and spreading (3) at 0.3% EMS as compared to control (14) semi erect type. Similarly in genotype JG 130 the maximum number of plants were grouped into prostate type (6) at 200 GY, followed by semi erect (13), spreading (4) at 0.4% EMS and erect (4) type at 400 GY as compared to control (13) semi erect type. (Table 9).

Table 1: Effect of mutagenic treatments on seed germination percentage in M1 generation

		Variety *			
Treatment	**Dose**	**JG 63**	**JG 74**	**JG30**	**Mean**
Gamma irradiation	150 GY	73.6(59.1)	66.0 (54.3)	61.0 (51.3)	66.8 (54.9)
	200 GY	56.3 (48.6)	41.6 (40.1)	38.0 (37.0)	53.8 (47.2)
	400 GY	63.0 (52.5)	50.0 (44.9)	48.6 (44.2)	45.3 (42.2)
Ethyl methane sulphonate	EMS 0.2%	60.0 (50.7)	52.3 (46.3)	51.0 (45.5)	54.4 (47.5)
	EMS 0.3%	46.0 (42.6)	42.3 (40.5)	39.3 (38.8)	46.5 (43.0)
	EMS 0.4%	56.3 (48.6)	44.0 (41.3)	43.0 (40.6)	42.5 (40.6)
Gamma irradiation+ Ethyl methane sulphonate	150 GY + 0.2% EMS	58.0 (49.5)	54.6 (47.6)	51.3 (45.7)	54.6 (47.6)

	200 GY + 0.2% EMS	35.4 (33.6)	33.7 (31.0)	32.5 (29.0)	45.7 (42.5)
	150 GY + 0.3% EMS	44.6 (41.9)	40.0 (39.2)	39.0 (38.6)	41.2 (39.9)
	200 GY + 0.3% EMS	49.3 (44.6)	46.0 (42.6)	42.0 (40.3)	33.9 (31.2)
Untreated	Control	87.3 (69.2)	78.0 (62.0)	75.3 (60.2)	80.2 (63.8)
Mean		56.7 (49.1)	49.6 (44.8)	47.0 (43.3)	51.1 (45.7)
		Sem±		CD (5%)	
Varieties		0.65(0.40)		1.85(1.12)	
Treatments		1.25(0.76)		3.54(2.14)	
Interaction		2.17(1.31)		6.12(3.70)	

Figures in parenthesis are * Angular arc sine transformation

Table 2: Effect of mutagenic treatments on plant height (cm) in M1 generation

		Variety			
Treatment	**Dose**	**JG 63**	**JG 74**	**JG 130**	**Mean**
Gamma irradiation	150 GY	52.0	34.6	39.6	41.6
	200 GY	39.0	31.3	34.0	35.0
	400 GY	43.6	33.3	34.8	37.4
Ethyl methane sulphonate	EMS 0.2%	50.3	47.7	45.6	43.8
	EMS 0.3%	45.0	44.0	42.5	46.8
	EMS 0.4%	48.3	46.6	42.6	46.8
Gamma irradiation+ Ethyl methane sulphonate	150 GY + 0.2% EMS	49.3	47.6	44.6	45.2
	200 GY+ 0.2% EMS	43.0	42.1	35.3	47.0
	150 GY + 0.3% EMS	45.3	43.2	37.1	41.8
	200 GY + 0.3% EMS	47.3	43.7	44.0	40.1
Untreated	Control	54.3	53.0	50.6	52.6
Mean		47.0	42.5	41.0	43.5
		Sem±		CD (5%)	
Varieties		0.57		1.62	
Treatments		1.10		3.10	
Interaction		1.90		5.37	

Table 3: Effect of mutagenic treatments on number of pods per plant in M1 generation

		Variety			
Treatment	**Dose**	**JG 63**	**JG 74**	**JG 130**	**Mean**
Gamma irradiation	150 GY	58.3	55.3	26.0	46.5
	200 GY	39.3	33.3	17.0	32.8
	400 GY	43.3	35.3	20.0	29.8
Ethyl methane sulphonate	EMS 0.2%	43.0	34.3	31.0	22.8
	EMS 0.3%	25.6	24.3	18.6	35.0
	EMS 0.4%	32.6	27.3	27.6	30.3
Gamma irradiation+ Ethyl methane sulphonate	150 GY + 0.2% EMS	49.0	44.6	33.0	41.2
	200 GY + 0.2% EMS	34.0	30.6	25.6	39.2
	150 GY + 0.3% EMS	38.0	34.6	30.0	35.2
	200 GY + 0.3% EMS	44.6	40.3	32.6	30.1
Untreated	Control	64.6	60.6	39.3	54.8
Mean		42.9	38.2	27.3	36.2
		Sem±		CD (5%)	
Varieties		1.14		3.23	
Treatments		2.19		6.18	
Interaction		3.79		10.70	

Table 4: Effect of mutagenic treatments on number of seeds per plant in M1 generation

		Variety			
Treatment	**Dose**	**JG 63**	**JG 74**	**JG 130**	**Mean**
Gamma irradiation	150 GY	34.3	30.3	23.4	28.7
	200 GY	24.0	22.0	20.0	24.3
	400 GY	27.3	25.6	21.6	22.5
Ethyl methane sulphonate	EMS 0.2%	33.6	32.0	30.3	32.0
	EMS 0.3%	25.3	23.6	19.6	22.8
	EMS 0.4%	32.6	28.0	23.7	28.1
Gamma irradiation+ Ethyl methane sulphonate	150 GY + 0.2% EMS	36.0	34.0	32.6	20.0
	200 GY + 0.2% EMS	21.6	20.0	18.3	31.9
	150 GY + 0.3% EMS	25.3	24.0	19.2	22.8
	200 GY + 0.3% EMS	35.4	33.6	26.7	34.2
Untreated	Control	46.3	44.3	37.3	42.6
Mean		31.1	28.8	24.6	28.2
		Sem±		CD (5%)	
Varieties		0.75		2.11	

Treatments		1.43	4.04
Interaction		2.48	7.03

Table 5: Effect of mutagenic treatments on seed yield (g) per plant in M1 generation

		Variety			
Treatment	**Dose**	**JG 63**	**JG 74**	**JG 130**	**Mean**
Gamma irradiation	150 GY	5.7	4.0	4.2	3.9
	200 GY	4.0	3.1	3.1	4.6
	400 GY	4.9	3.8	3.8	3.6
Ethyl methane sulphonate	EMS 0.2%	5.4	4.9	4.6	5.0
	EMS 0.3%	4.8	3.9	3.7	4.1
	EMS 0.4%	5.1	4.2	3.9	4.4
Gamma irradiation+ Ethyl methane sulphonate	150 GY + 0.2% EMS	5.0	4.2	4.0	4.2
	200 GY + 0.2% EMS	4.7	3.8	3.4	4.0
	150 GY + 0.3% EMS	4.4	3.6	3.5	3.9
	200 GY + 0.3% EMS	4.4	4.1	3.6	4.1
Untreated	Control	7.0	5.9	5.5	6.1
Mean		5.0	4.1	3.9	4.4
		Sem±		CD (5%)	
Varieties		0.10		0.27	
Treatments		0.19		0.52	
Interaction		0.32		0.98	

Table 6: Effect of mutagenic treatments on seedling height (cm) per plant in M1 generation

		Variety			
Treatment	**Dose**	**JG 63**	**JG 74**	**JG 130**	**Mean**
Gamma irradiation	150 GY	13.9	11.6	10.9	12.1
	200 GY	7.0	5.9	4.9	11.1
	400 GY	12.6	10.9	9.7	5.9
Ethyl methane sulphonate	EMS 0.2%	11.9	10.4	9.8	9.6
	EMS 0.3%	9.8	8.6	7.9	10.7
	EMS 0.4%	10.7	9.2	8.8	8.8
Gamma irradiation+ Ethyl methane sulphonate	150 GY + 0.2% EMS	13.1	11.3	10.7	11.7
	200 GY + 0.2% EMS	10.0	9.2	8.9	11.2
	150 GY + 0.3% EMS	10.2	9.4	9.0	9.5
	200 GY + 0.3% EMS	12.3	11.0	10.4	9.4
Untreated	Control	18.0	16.3	15.7	16.7
Mean		11.8	10.3	9.7	10.6
		Sem±		CD (5%)	
Varieties		0.19		0.52	
Treatments		0.36		1.00	
Interaction		0.62		1.73	

Table 7: Effect of mutagenic treatments on 100 seed weight (g) per plant in M1 generation

		Variety			
Treatment	**Dose**	**JG 63**	**JG 74**	**JG 130**	**Mean**
Gamma irradiation	150 GY	16.0	13.9	14.1	14.0
	200 GY	14.2	12.7	13.2	14.7
	400 GY	15.0	13.8	13.8	13.5
Ethyl methane sulphonate	EMS 0.2%	15.1	14.2	14.1	13.7
	EMS 0.3%	14.4	13.2	13.5	14.3
	EMS 0.4%	15.0	14.1	13.9	14.4
Gamma irradiation+ Ethyl methane sulphonate	150 GY + 0.2% EMS	17.0	16.2	15.8	16.3
	200 GY + 0.2% EMS	13.2	12.2	14.9	13.6
	150 GY + 0.3% EMS	13.4	12.9	15.3	13.9
	200 GY + 0.3% EMS	15.6	13.7	15.6	14.7
Untreated	Control	21.0	17.4	18.9	19.1
Mean		15.4	14.0	14.8	14.8
		Sem±		CD (5%)	
Varieties		0.17		0.47	
Treatments		0.32		0.90	
Interaction		0.55		1.56	

Table 8: Effect of mutagenic treatments on Lethality (%) in M1 generation

		Variety			
Treatment	**Dose**	**JG 63**	**JG 74**	**JG 130**	**Mean**
Gamma irradiation	150 GY	50.0	66.0	70.6	57.1
	200 GY	46.3	55.3	59.0	57.0
	400 GY	48.6	60.3	69.3	60.3
Ethyl methane sulphonate	EMS 0.2%	47.0	57.3	68.3	57.5
	EMS 0.3%	41.0	49.6	60.6	52.1
	EMS 0.4%	44.3	51.3	67.0	53.3
Gamma irradiation+ Ethyl methane sulphonate	150 GY + 0.2% EMS	55.3	73.3	81.0	57.8
	200 GY + 0.2% EMS	51.0	56.6	66.0	66.0
	150 GY + 0.3% EMS	52.3	67.3	75.0	69.4
	200 GY + 0.3% EMS	54.0	67.6	78.0	66.8
Untreated	Control	24.3	31.6	38.6	31.5
Mean		46.7	57.8	66.9	57.2
		Sem±		CD (5%)	
Varieties		0.73		2.06	
Treatments		1.40		3.95	
Interaction		2.42		6.84	

Table 9: Growth habit on different plants of JG 63, JG 74 and JG 130 chickpea varieties after mutagenic treatments in M1 generation

Variety	**JG 63**				**JG 74**				**JG 130**			
Dose	S	S E	E	P	S	S E	E	P	S	S E	E	P
150 GY	6	-	4	5	-	10	-	5	-	10	-	5
200 GY	8	-	-	7	1	14	-	-		12	-	3
400 GY	8	-	2	5	-	8	-	7	-	8	5	2
0.2% EMS	7	-	7	1	1	12	-	2	-	13	-	2
0.3% EMS	9	-	-	6	3	9	-	3	1	10		4
0.4% EMS	5	-	6	4	-	11	-	4	4	8	3	-
150 GY +0.2% EMS	5	-	5	5	-	13	-	2	3	9	2	1
200 GY +0.2% EMS	11	-	1	4	2	10	-	3	-	13	-	2
150 GY +0.3% EMS	5	-	6	4	1	9	-	5	-	10	-	5
200 GY +0.3% EMS	12	-	1	2	1	10	-	4	2	7	-	6
Control	13	-	-	2	1	14	-	-	1	13	-	1

S-spreading, SE- Semi erect, E- erect and P- prostate

References

1. Micke A. Genetic improvement of grain legumes using induced mutations. An overview. In Improvement of grain legume production using induced mutations. IAEA, Vienna 2004; (1):50-51.
2. Maluszynski M, Van Zanten, Asir A, Brunner H, Ahloowalia B, Zapata FJ *et al*. Mutation techniques in plant breeding. Proc. induced mutations and molecular techniques for crop improvement. Fao/iaea, austria, vienna, 2005, 489-504.
3. Haq MA, Singh K, Abidin Z, Ahmad MS. Mutation studies in chickpea (*Cicer arietinum* L.) Pak. J Agri. Sci., 2003; 29(4).
4. Khan S, Wani MR, Bhat M, Kouser P. Induced chlorophyll mutations in chickpea *(Cicer arietinum* L.) Iinternational journal of agriculture and biology, 2005. 1560–8530/2005/07–5–764–767
5. Omar M, singh KB. Development of early mutants with resistance to ascochyta blight or leaf miner. International Chickpea and Pigeonpea Newsletter 1995, 2006; (2):10-11.
6. Shah T, Mirza J, Haq MA, Babar MA. Induced genetic variability in chickpea (*Cicer arientinum* L.) and comparative mutagenic effectiveness and efficiency of physical and chemical mutagens. pak. J. Bot. 2008; 40(2):605-613.
7. Kharakwal MC. Induced mutations in chickpea (*Cicer arietinum* L.) VI.Significance of Induced altered correlations, Indian J. Genet. 2003; 63(3):219-224.
8. Aijaz A Wani. Mutagenic Effectiveness and efficiency of Gamma Rays, Ethyl Methane sulphonate and their combination treatment in chickpea (*Cicer arietinum* L.) Asian Journal of Plant Sciences. 2009; 8(4):318-321.
9. Bashir S, Wani A, Nawchoo I. Studies on mutagenic effectiveness and efficiency in Fenugreek (*Trigonella foenum-graecum* L.) African Journal of Biotechnology. 2013; 12(18):2437-2440.