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Original Research Article

Studies on Genetic Variability for Yield and Yield Contributing Traits through Induced Mutation in Desi Cotton (*Gossypium arboreum* L.)

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A B S T R A C T

Mutations were induced in two desi cotton varieties viz.PA255 and PA 402 and hybrid PA 402 x PA 255 using EMS and gamma rays as mutagens. Selection studies were conducted to improve the yield and to generate genetic variability in different quantitative traits viz., number of bolls per plant, boll weight and seed yield per plant. Mean values in traits increase significantly over the controls and genetic parameters were recorded higher for the mutants isolated in M_1, F_1M_1 and M_2, F_2M_2 generation. In general wide range of variability was created as compared to control. The range in general increased towards positive side in all the populations with both the mutagens. The observed changes in both the generations revealed that the magnitude of variability increase from M_1, F_1M_1 to M_2, F_2M_2 generation. The magnitude of CV in the treated populations as generally higher than the control for most of the traits in both the generations for both the varieties. Both mutagens were quite effective in inducing genetic variability in Cotton. High values of heritability and genetic advance for the mutants indicate that further improvement could be made in next generations.

Keywords

Gamma rays, EMS, genetic variability and yield

Introduction

The primary aim of induced mutation is to enlarge the frequency and spectrum of mutations and also increase the incidence of viable mutations as an approach towards directed mutagenesis. With this view, the present investigation was undertaken to study the mutagenic effects of gamma rays and ethyl methane sulphonate (EMS) on quantitative traits in M_1, F_1M_1 and M_2, F_2M_2 generations in desi cotton. Induced mutation is an important tool in cotton breeding worldwide. Mutation techniques are very important tools to study the genetic variability, function, action and regulation of genes, moreover in plant breeding. In this paper we propose the use of mutation technique to directly select mutants affecting yield traits of cotton. Ionizing radiations have been successful in inducing genetic variability in cotton. A number of attempts have been made by different group of workers in the direction to determine the most effective mutagenic treatments for the induction of desirable and economical traits in cotton.

Materials and Methods

The dry seeds (contains12 percent moisture,) of the two varieties and hybrid of this varieties of desi cotton, namely, PA 402, PA 255 and hybrid PA 402 x PA 255 were exposed to mutagenic treatments. Two hundred seeds were taken for each mutagenic treatment from both the varieties. The seeds were sealed in polythene bags and irradiated to 10 kR, 20 k, 30 kR and 40 kR doses of gamma rays (^{60}Co source) at BARC, Trombe, Mumbai. Four concentrations of chemical mutagens, viz, ethyl methane sulphonate (EMS) from Sigma Chemical Company, USA were employed in the present investigation.

The various concentration of EMS (0.1%, 0.2%, 0.3M and 0.4%) were used. For chemical treatments, the seeds were soaked in distilled water for eight hours to ensure complete hydration of the seeds. Thereafter, the seeds were treated with solution of EMS for a period of eight hours in the laboratory conditions. The seeds were intermittently shaken throughout the period of treatment to maintain uniformity. After treatment, the seeds were thoroughly washed in running water for one hour to remove traces of residual chemicals.

The field experiment was conducted at the Cotton Research Station, Mahboob Baugh Farm, VNMKV, Parbhani (MS). The M_1, F_1M_1 generation was grown during kharif 2014 while the M_2, F_2M_2 generation was grown in kharif, 2015 in RBD with three replications. The recommended cultural practices were followed during the crop growth period. The observations regarding micro mutational studies in the M_1, F_1M_1 and M_2, F_2M_2 generation were recorded on number of boll plant$^{-1,}$ average boll weight (g) and seed cotton yield plant^{-1} (g). The data for these traits were recorded on 100 normal looking plants from each treatment and also from the control from each replication of both the varieties in M_1,F_1M_1 and M_2,F_2M_2 generations.

Results and Discussion

The data on induced variability as reflected by the range, mean and coefficient of variation (CV) in PA-402, PA-255 and PA-402 X PA-255 are presented in Tables 1-6.

Number of boll plant^{-1}

Improvement in the number of bolls plant-1 is an important goal for cotton breeders. Therefore, naturally the number of bolls plant-1 attracts the attention of breeders in selection programmes for improving productivity. In the present investigation wide range of variability induced in all populations by both mutagens in both generation i.e. M_1, F_1M_1 and M_2, F_2M_2 except few treatments in M_1, F_1M_1. Among the different mutagens employed 10 kR and 0.1% EMS in PA-402, 0.2% EMS in PA-255 and F_2M_2 population were observed to induce highest mean and significantly superior mutants than control.

Similar type of results obtained by Remya (2011) and Badigannavar *et al.,* (2000). Mean values for number of bolls plant-1 reveals that under the effect of different radiation doses, mean value of number of bolls plant-1 decreases in higher doses. The present result regarding the decrease in the number of bolls plant-1 in higher doses of radiation are in agreement with those forwarded by Khan *et al.*, (2014). The gamma irradiation at 30 kR in PA-402, 20 kR in PA-255 and 20 kR in F_2M_2, induced higher magnitude of GCV and PCV.

Whereas in chemical mutagenic treatments, 0.2% and 0.3% EMS concentrations were observed to induce highest magnitude of variability parameters for this trait. These finding were supported by the studies conducted Kuliv and Mustafgaev (1978), Basu (1982) and Rafat (1995).

Table.1 Range, mean, variance and coefficient of variance (CV) for number of bolls plant^{-1} in s in M_1, F_1M_1 generation of cotton

Sr. No.	Treatments	Range	Mean ± SE	Variance	CV.
PA-402					
1	10 kR Gamma rays	4-18	10.6±0.75	11.41	31.86
2	20 kR Gamma rays	4-17	12.75±0.84	14.19	29.55
3	30 kR Gamma rays	7-19	12.45±0.78	12.47	28.36
4	40 kR Gamma rays	5-16	10.85±0.67	10.85	27.45
5	0.1 % EMS	10-19	14.50±0.54	5.84	16.66
6	0.2 % EMS	12-20	15.15±0.48	4.66	14.24
7	0.3 % EMS	8-17	13.15±0.66	8.87	22.64
8	0.4 % EMS	6-18	12.45±0.75	11.10	26.76
9	Control	12-18	14.15±0.38	2.87	11.97
PA-255					
10	10 kR Gamma rays	8-19	13.5±0.55	6.16	18.38
11	20 kR Gamma rays	8-18	12.90±0.59	6.94	20.42
12	30 kR Gamma rays	6-16	10.95±0.63	8.05	25.91
13	40 kR Gamma rays	6-15	10.25±0.63	7.88	27.38
14	0.1 % EMS	12-18	14.2±0.40	3.32	12.84
15	0.2 % EMS	9-18	13.25±0.59	7.14	20.17
16	0.3 % EMS	8-19	14.65±0.55	6.02	16.76
17	0.4 % EMS	8-15	11.00±0.52	5.47	21.26
18	Control	11-18	13.6±0.37	2.88	12.84
PA-402 x PA-255					
19	10 kR Gamma rays	9-20	14±0.62	7.58	19.66
20	20 kR Gamma rays	9-23	14±0.74	10.95	23.63
21	30 kR Gamma rays	6-21	12.4±0.80	13.67	28.70
22	40 kR Gamma rays	9-18	12.05±0.61	7.52	22.76
23	0.1 % EMS	12-21	15.00±0.54	5.79	16.04
24	0.2 % EMS	11-23	14.75±0.69	9.56	20.96
25	0.3 % EMS	9-22	13.6±0.69	9.62	22.80
26	0.4 % EMS	5-19	13.5±0.67	8.89	22.09
27	Control	11-20	15.45±0.55	6.16	16.05

Table.2 Range, mean, phenotypic and genotypic coefficient of variation, heritability and genetic advance for number of boll plant^{-1} in M_2, F_2M_2 generation of cotton genotypes

Sr. No.	Treatment	Range	Mean ± SE	Phenotypic variance	Genotypic variance	CV (%)	PCV (%)	GCV (%)	H^2 (%)	GA (%)	GAM
PA-402											
1	10 kR	2-28	16.90±1.49	155.27	148.59	15.31	73.73	72.12	95.69	24.56	145.35
2	20 kR	1-27	15.20±1.83	144.41	134.25	20.97	79.06	76.23	92.96	23.01	151.41
3	30 kR	2-30	10.83±1.52	173.63	166.67	25.30	126.38	123.82	95.99	26.05	249.91
4	40 kR	4-29	11.07±1.54	113.13	105.93	24.24	96.04	92.93	93.63	20.51	185.24
5	0.1 % EMS	2-25	15.33±1.52	144.62	137.68	17.18	78.43	76.52	95.20	23.58	153.81
6	0.2 % EMS	3-28	13.43±1.19	155.82	151.53	15.4	92.92	91.63	97.25	25.00	186.16
7	0.3 % EMS	3-27	14.97±1.36	149.46	143.87	18.24	94.28	92.50	96.25	24.24	186.95
8	0.4 % EMS	4-25	11.50±1.51	114.82	107.94	22.81	93.18	90.34	94.00	20.75	180.45
9	Control	10-18	15.03±1.24	16.61	11.96	14.33	27.11	23.01	72.04	6.04	40.23
PA-255											
10	10 kR	3-30	10.93±1.25	127.81	123.07	19.91	103.40	101.46	96.29	27.42	205.11
11	20 kR	3-29	10.40±1.20	145.75	141.43	19.98	116.08	114.35	97.03	24.13	232.05
12	30 kR	2-23	8.30±1.41	90.22	84.24	29.47	114.47	110.61	93.37	18.26	220.17
13	40 kR	2-23	9.13±0.74	100.29	98.65	14.02	109.64	108.74	98.36	20.29	222.18
14	0.1 % EMS	2-28	14.10±1.51	126.46	119.59	19.7	84.55	82.22	94.57	21.90	164.72
15	0.2 % EMS	2-30	11.80±1.12	160.46	156.67	16.49	107.35	106.07	97.64	25.47	215.92
16	0.3 % EMS	3-27	10.13±1.07	141.96	138.48	18.43	117.58	116.13	97.54	23.94	236.27
17	0.4 % EMS	2-22	8.17±1.29	87.53	82.48	27.53	114.56	111.20	94.22	18.16	222.37
18	Control	8-19	11.67±1.06	26.54	23.17	15.75	44.16	41.25	82.27	9.26	79.40
PA-402 x PA-255											
19	10 kR	3-36	13.70±1.82	225.08	215.06	23.79	112.80	110.26	95.55	29.53	222.03
20	20 kR	2-32	11.60±1.27	209.35	204.52	18.95	124.73	123.28	97.69	29.11	251.02
21	30 kR	2-39	13.83±1.89	265.40	254.65	23.7	117.76	115.35	95.95	23.20	232.77
22	40 kR	3-23	9.07±1.26	112.61	107.77	24.23	116.92	114.38	95.70	20.92	230.52
23	0.1 % EMS	5-32	16.83±3.16	196.47	166.35	32.61	83.27	76.62	84.66	24.44	145.23
24	0.2 % EMS	2-33	12.35±1.03	251.91	248.72	14.46	128.50	127.69	98.73	32.28	261.37
25	0.3 % EMS	3-36	13.27±2.00	272.13	260.13	26.11	124.34	121.57	95.59	32.48	244.85
26	0.4 % EMS	2-30	11.73±1.43	182.32	176.14	21.17	115.07	113.11	96.61	26.87	229.03
27	Control	9-28	13.03±1.30	66.32	61.19	18.68	67.12	64.47	92.25	15.47	127.56

Table.3 Range, mean, variance and coefficient of variance (CV) for average boll weight in M_1, F_1M_1 generation of cotton

Sr. No.	Treatments	Range (g)	Mean ± SE	Variance	CV.
PA-402					
1	10 kR Gamma rays	1.90-2.40	2.18±0.028	0.016	5.80
2	20 kR Gamma rays	1.80-2.46	2.21±0.050	0.051	10.24
3	30 kR Gamma rays	1.70-2.30	1.99±0.041	0.033	9.23
4	40 kR Gamma rays	1.70-2.70	1.95±0.048	0.046	11.04
5	0.1 % EMS	1.90-2.20	2.04±0.0221	0.009	4.70
6	0.2 % EMS	1.98-2.18	2.06±0.013	0.003	2.94
7	0.3 % EMS	1.78-2.33	2.10±0.031	0.019	6.67
8	0.4 % EMS	1.75-2.14	1.94±0.029	0.017	6.70
9	control	1.90-2.20	2.04±0.009	0.009	4.70
PA-255					
10	10 kR Gamma rays	1.69-2.60	1.98±0.057	0.066	12.93
11	20 kR Gamma rays	1.60-2.10	1.92±0.034	0.023	8.04
12	30 kR Gamma rays	1.60-2.10	1.88±0.032	0.020	7.62
13	40 kR Gamma rays	1.40-2.10	1.83±0.04	0.042	11.28
14	0.1 % EMS	1.08-2.20	1.92±0.44	0.051	11.73
15	0.2 % EMS	1.70-2.10	1.92±0.44	0.020	7.52
16	0.3 % EMS	1.90-2.50	2.07±0.47	0.045	10.27
17	0.4 % EMS	1.70-2.10	1.86±0.42	0.011	5.59
18	Control	1.80-2.90	2.02±0.47	0.053	11.38
PA-402 x PA-255					
19	10 kR Gamma rays	1.90-2.10	2.01±0.015	0.0048	3.44
20	20 kR Gamma rays	1.90-2.12	2.02±0.016	0.0055	3.68
21	30 kR Gamma rays	1.80-2.80	2.10±0.020	0.0098	8.72
22	40 kR Gamma rays	1.80-2.12	1.96±0.017	0.0063	4.06
23	0.1 % EMS	1.90-2.15	2.00±0.016	0.0053	3.64
24	0.2 % EMS	1.90-2.15	2.03±0.016	0.0054	3.61
25	0.3 % EMS	1.80-2.10	1.99±0.018	0.0068	4.90
26	0.4 % EMS	1.90-2.12	1.99±0.014	0.0039	3.15
27	Control	1.90-2.20	2.00±0.021	0.0039	4.89

Table.4 Range, mean, phenotypic and genotypic coefficient of variation, heritability and genetic advance for average boll weight in M_2, F_2M_2 generation of cotton genotypes

Sr. No.	Treatment	Range (g)	Mean ± SE	Phenotypic variance	Genotypic variance	CV (%)	PCV (%)	GCV (%)	H^2 (%)	GA (%)	GAM
PA-402											
1	10 kR	1.40-3.00	2.13±0.107	0.671	0.636	8.73	38.51	37.51	94.86	1.60	75.27
2	20 kR	1.80-3.30	2.33±0.145	0.741	0.677	10.83	35.95	35.33	91.41	1.62	69.58
3	30 kR	1.20-3.40	2.30±0.145	1.44	1.37	11.29	53.83	52.63	95.60	2.36	106.01
4	40 kR	1.40-3.30	2.13±0.203	1.18	1.06	16.53	51.09	48.34	89.53	2.01	94.23
5	0.1 % EMS	1.80-2.30	2.02±0.042	0.108	0.102	3.61	16.28	15.87	95.08	0.64	31.89
6	0.2 % EMS	1.20-3.10	2.16±0.127	0.694	0.645	10.17	38.47	37.10	93.00	1.59	73.71
7	0.3 % EMS	1.30-2.90	2.06±0.153	0.630	0.560	14.45	43.30	40.82	88.87	1.45	79.27
8	0.4 % EMS	1.20-2.80	1.90±0.156	0.626	0.554	12.24	41.73	39.22	88.35	1.44	75.95
9	Control	1.80-2.30	2.09±0.107	0.070	0.036	8.88	12.71	9.09	51.19	0.28	13.40
PA-255											
10	10 kR	1.50-3.20	2.03±0.122	0.690	0.645	10.45	40.92	39.56	93.47	1.60	78.80
11	20 kR	1.40-3.40	2.34±0.125	0.998	0.951	9.27	42.77	41.76	95.30	1.96	83.98
12	30 kR	1.80-2.90	2.24±0.134	0.607	0.553	10.36	34.74	33.16	91.102	1.46	65.20
13	40 kR	1.70-2.80	2.13±0.120	0.476	0.433	9.76	32.37	30.87	90.91	1.29	60.43
14	0.1 % EMS	1.30-3.20	2.19±0.190	0.878	0.769	15.05	42.71	39.97	87.59	1.69	77.07
15	0.2 % EMS	1.30-3.10	2.05±0.119	0.467	0.424	10.11	33.39	31.83	90.83	1.27	62.49
16	0.3 % EMS	1.20-3.20	2.04±0.102	0.896	0.865	8.69	46..49	45.67	96.50	1.88	92.43
17	0.4 % EMS	1.18-3.14	2.09±0.099	0.670	0.640	8.21	39.07	38.20	95.58	1.61	76.94
18	Control	1.60-2.40	2.03±0.079	0.146	0.127	6.75	18.86	17.61	87.18	0.68	33.87
PA-402 x PA-255											
19	10 kR	1.70-3.20	2.60±0.135	0.217	0.162	9.94	19.80	17.13	74.84	0.718	30.54
20	20 kR	1.20-3.80	2.34±0.111	1.60	1.57	8.27	54.25	53.62	97.67	2.55	109.17
21	30 kR	1.50-3.40	2.19±0.150	0.720	0.652	11.85	38.69	36.84	90.62	1.58	72.24
22	40 kR	1.30-3.20	1.98±0.184	0.731	0.628	16.08	42.95	39.83	85.99	1.51	76.08
23	0.1 % EMS	1.90-2.80	2.22±0.152	0.517	0.447	11.86	32.35	30.10	86.55	1.28	57.69
24	0.2 % EMS	1.80-2.90	2.18±0.113	0.265	0.226	9.00	23.58	21.80	85.43	0.906	41.50
25	0.3 % EMS	1.74-3.50	2.29±0.157	0.157	0.367	11.93	29.04	26.48	83.11	1.13	49.73
26	0.4 % EMS	1.10-3.10	1.97±0.120	0.571	0.527	10.64	38.43	36.93	92.33	1.43	73.10
27	Control	1.70-2.80	2.09±0.104	0.175	0.143	8.63	20.09	18.14	81.54	0.704	33.75

Table.5 Range, mean, variance and coefficient of variance (CV) for seed cotton yield plant^{-1} in M_1, F_1M_1 generation of cotton

Sr. No.	Treatments	Range (g)	Mean ± SE	Variance	CV.
PA-402					
1	10 kR Gamma rays	9.30-38.20	22.63±1.53	47.33	30.39
2	20 kR Gamma rays	7.20-39.00	28.13±2.07	85.81	32.93
3	30 kR Gamma rays	10.48-36.10	24.37±1.67	55.88	30.66
4	40 kR Gamma rays	8.40-33.10	20.94±1.46	42.80	31.24
5	0.1 % EMS	19.98-40.00	29.24±1.10	24.93	17.07
6	0.2 % EMS	24.50-41.21	30.98±1.02	21.03	14.80
7	0.3 % EMS	15.78-39.00	27.45±1.52	46.36	24.80
8	0.4 % EMS	10.60-35.60	23.98±1.61	52.25	30.13
9	control	22.60-36.10	28.32±0.71	10.24	11.30
PA-255					
10	10 kR Gamma rays	12.70-38.60	26.16±1.34	35.80	22.87
11	20 kR Gamma rays	11.58-36.89	24.70±1.45	41.98	26.23
12	30 kR Gamma rays	11.32-31.58	20.54±1.41	39.76	30.69
13	40 kR Gamma rays	10.00-29.00	18.85±1.35	36.95	32.24
14	0.1 % EMS	22.60-37.60	27.70±1.01	20.68	16.41
15	0.2 % EMS	15.10-36.42	25.46±1.46	42.85	25.70
16	0.3 % EMS	15.80-39.28	29.35±1.24	30.94	18.95
17	0.4 % EMS	12.72-29.49	20.15±1.24	30.76	27.53
18	Control	22.33-37.40	26.54±0.89	16.01	15.07
PA-402 x PA-255					
19	10 kR Gamma rays	17.00-41.30	27.89±1.35	36.69	21.71
20	20 kR Gamma rays	17.00-48.00	28.86±1.64	53.56	25.71
21	30 kR Gamma rays	16.78-43.82	25.07±1.47	43.62	26.33
22	40 kR Gamma rays	17.00-36.00	23.26±1.33	35.68	25.67
23	0.1 % EMS	22.00-43.22	29.25±1.33	35.63	20.40
24	0.2 % EMS	21.19-47.89	29.58±1.53	46.94	23.15
25	0.3 % EMS	17.17-46.00	26.44±1.48	43.99	25.07
26	0.4 % EMS	17.00-39.00	26.83±1.18	28.01	19.72
27	Control	20.00-43.40	30.54±1.41	40.09	20.70

Table.6 Range, mean, phenotypic and genotypic coefficient of variation, heritability and genetic advance for seed cotton yield plant^{-1} in M_2, F_2M_2 generation of cotton genotypes

Sr. No.	Treatment	Range (g)	Mean ± SE	Phenotypic variance	Genotypic variance	CV (%)	PCV (%)	GCV (%)	H^2 (%)	GA (%)	GAM
PA-402											
1	10 kR	3.90-80.00	31.92±3.84	1532.04	1487.84	20.83	122.62	120.84	97.11	78.30	245.32
2	20 kR	2.80-72.60	29.05±2.24	989.44	974.28	13.40	108.27	107.44	98.46	63.80	219.63
3	30 kR	6.30-80.20	24.93±2.09	1555.23	1543.12	13.96	158.15	157.54	99.22	80.60	323.27
4	40 kR	5.30-56.10	21.92±1.63	565.42	55.74	12.86	108.47	107.70	98.59	48.29	220.31
5	0.1 % EMS	3.00-55.10	26.16±1.67	454.24	445.90	11.04	81.46	80.71	98.16	43.09	164.74
6	0.2 % EMS	3.80-57.20	26.32±1.80	793.23	783.45	11.88	107.00	106.34	98.76	57.30	217.71
7	0.3 % EMS	3.72-70.93	29.31±3.07	980.20	951.90	18.15	106.80	105.25	97.11	62.63	213.66
8	0.4 % EMS	4.31-61.54	20.15±3.96	767.60	720.20	26.13	105.91	102.91	93.86	53.56	204.81
9	Control	14.90-30.70	26.58±1.06	37.73	34.35	6.91	23.10	22.05	91.04	11.52	43.34
PA-255											
10	10 kR	4.30-58.60	22.32±2.31	730.08	713.99	17.97	121.02	119.69	97.79	54.43	243.82
11	20 kR	4.20-82.00	24.48±1.43	1423.01	1416.83	10.15	154.09	153.75	99.56	77.37	316.05
12	30 kR	4.10-71.80	18.42±3.42	981.69	946.53	28.49	150.51	147.79	96.41	62.23	298.96
13	40 kR	3.80-61.54	19.67±3.60	644.90	605.84	31.78	129.11	125.14	93.94	49.14	249.87
14	0.1 % EMS	4.20-81.98	30.24±2.59	1343.50	1323.33	14.85	121.22	120.30	98.49	74.37	245.97
15	0.2 % EMS	3.90-69.78	24.43±3.99	809.13	761.13	28.35	116.41	112.91	94.06	55.12	225.60
16	0.3 % EMS	5.78-58.77	19.92±1.60	647.73	639.98	13.97	127.76	126.99	98.80	51.80	260.04
17	0.4 % EMS	3.50-45.13	15.00±2.25	341.65	326.48	25.96	123.19	120.42	95.55	36.38	242.51
18	Control	16.20-42.61	23.53±1.87	124.61	114.05	13.81	47.42	45.37	91.52	21.04	89.42
PA-402 x PA-255											
19	10 kR	6.00-86.13	35.09±3.15	1827.63	1797.74	15.58	121.80	120.80	98.36	86.62	246.82
20	20 kR	5.80-89.08	27.92±2.60	1665.24	1644.92	16.15	146.17	145.28	98.77	83.03	297.44
21	30 kR	5.40-77.95	29.61±3.78	820.02	777.14	33.39	146.04	142.171	94.77	55.90	285.11
22	40 kR	5.68-53.43	17.69±1.94	590.37	579.04	17.09	123.39	122.20	98.08	49.09	249.31
23	0.1 % EMS	9.80-65.86	37.76±3.24	1169.49	1137.86	15.30	93.03	91.77	97.29	68.54	186.47
24	0.2 % EMS	4.31-80.13	27.21±3.40	1758.31	1723.71	21.62	154.09	152.57	98.03	84.68	311.19
25	0.3 % EMS	7.20-63.77	26.21±3.62	1046.66	1007.29	23.93	123.41	121.07	96.23	64.13	244.68
26	0.4 % EMS	4.21-56.88	21.30±2.83	956.44	932.26	23.09	145.21	143.37	97.47	62.09	291.58
27	Control	17.20-58.70	26.81±2.30	384.69	368.69	14.92	73.14	71.61	95.83	38.72	144.41

Boll weight

High boll weight is also important factor which is contributed to seed cotton yield. The mutagenic agents like gamma rays and EMS, proved to be highly efficient in inducing an immense amount of variability for particular trait that to in favorable direction. Several mutants were found to be superior than the parents. The range of variation for average boll weight was found to be more in mutagenic treatments than their respective controls, indicating that mutagenic treatments created variability and it's proportion was higher as compared to control. The heritability estimates in M_2, F_2M_2 generation for this characters was found to be high enough in both mutagenic treatments. Thus scope for selection is more to those having high heritability for the trait. Variability induced both in positive and negative direction are useful for this trait. Thus selection could be operated in both direction. Egamberdiev and Paiziev (1972), Bhat and Dani (1993) and Sahood *et al.*, (1998) independently reported higher means and variance for boll weight in cotton under mutation.

Seed cotton yield plant^{-1}

The mutagenic treated population recorded significantly higher variability for seed cotton yield than control. Being the ultimate goal, the increase variability upon mutagenic treatment offers possibility for further selection and improvement of this character. Gamma irradiation and EMS induce wide range of variability in seed cotton yield-1 in both generation i.e. M_1, F_1M_1 and M_2, F_2M_2 generation. Among all populations of M_2, F_2M_2 the mean for seed cotton yield was highest recorded in 10 kR and 0.3% EMS in PA-402, 20 kR and 0.1% EMS in PA-255 while, 10 kR and 0.1% EMS in F_2M_2. These observation are reasonably in full confirmity with those reported by Muthusamy and Jaybalan (2011) and Khan *et al.,* (2014) who stated that some lower doses of both chemical and physical mutagen induce positive mutation for increasing seed cotton yield plant-1. Phenotypic and genotypic variance for this trait was higher in F_2M_2 than F_2 and M_2 population of both parents, also the other variability parameters like PCV, GCV, heritability and genetic advance observed higher in treated population than untreated population of F_2. Similar findings were reported by Talwar and Kajjidoni (2010) in cotton for gamma irradiation.

The increase in yield is attributed to the fact that there occurred some favourable gene mutations which could improve the trait. Yield being complex character governed by a large number of genes with small cumulative effect, the mutation might have occurred at several genes. So also this yield improvement has an impact on several characters which contribute to yield. The heritability estimates found to be high in all the treatments in both the mutagenic treatments indicating a reliable yield advantage over the control upon selection.

References

Badigannavar, A. M., Katageri, I. S. and B. M. Khadi, 2000. Effect of gamma rays and EMS on quantitative characters in cotton. *DAE BRNS symposium Mumbai*, pp. 230-235

Basu, A.K., 1982. Note on induced variability in upland cotton by one and two cycles for gamma irradiation. *Indian J. Agric. Sci.*, 52(6): 402-403.

Bhat, M. G. and Dani, R. G., 1993. Improvement in productivity and oil content of cotton (*Gossypium hirsutum* L.) cultivars through induced polygeni c mutations. *J. Cotton Res. dev.* 7(1): 9 -13.

Egamberdiev, A. and Paiziev, P., 1972. Variability of characters in cotton after irradiation. *Khlopkovodstvo*, 22(5):30-32.

Khan, S., Muhammad, I. K., Asim, M., Khan, F. and Khan, A. R., 2014. Gamma rays induced variations in some cotton (*Gossypium hirsutum* L.) genotypes and their evaluation in the environment of Bannu. *Inter. J. Adv. Res.* 2(10): 512-518.

Kuliev, A. A. and Mustafgaev, S. A., 1978. Mutational changes in cotton after treatment of growing plants with different physical factors. *Referativnyi zhurnal*, 5: 65-140.

Muthusamy, A. and Jaybalan N., 2011. In vitro induction of mutation in cotton (*Gossypium hirsutum* L.) and isolation of mutants with improved yield and fiber characters. *Acta Physiol Plt*. 33: 1793–1801.

Rafat, M. A. A., 1995. Effect of seed irradiation on genetic variability and recombination of some economic yield components in Egyptian cotton. In proceedings of Beltwide Cotton Conference, USA, 4-7 January, 1995.

Remya, R. V., 2011. Mutagenesis, screening and evaluation for biotic (jassid, bacterial leaf blight) and abiotic (drought) stresses in cotton *(Gossypium hirsutum* L.*)*. Ph.D. Thesis unpub. Univ. Agril. Sci. Dharwad.

Sahood, A., Siddiqui and Malik, M. N. A., 1998. Significant enhancement of genetic variability by promoting positive mutagenesis X hybridisation interaction in *G. hirsutum*, World Cotton Ref. Conference-2 Athens, Greece.

Talawar, A. M. and Kajjidoni, S. T., 2010. Frequency of superior segregants as influenced by hybridization (F_2) and hybridization followed by irradiation (F_2M_2) using selected parents for important component traits in desi cotton. *Electronic J. of Plt. Breed*. 1(4): 675-679.