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Effect of different gamma rays and EMS concentrations on growth and yield of brinjal genotypes in M_3 generation

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Abstract

A field experiment was conducted at Horticultural Research Farm, Department of Horticulture, Institute of Agricultural Sciences, B.H.U., Varanasi, UP to investigate the effect of different gamma rays and EMS concentrations on growth and yield of brinjal genotypes in M_3 generation. The experimental material comprised of three genotypes of brinjal *i.e.* Banarasi Gol, Kashi Taru and Kashi Uttam and the different concentration of mutagens i.e. gamma rays (5, 10, 15 and 20kR) and EMS (0.05, 0.10, 0.15 and 0.20% EMS). These mutagens were studied for growth, yield attributes and yield of all three genotypes. The result recorded all the growth and yield traits were decreased as the concentration of both the mutagens increased. The 5kR gamma rays and 0.05% EMS was recorded superior with maximum value of all characters in these treatments. The fruit yield per plant was increased under 5kR by 39.77, 31.32 and 18.26 % and under 0.05% EMS 6.62, 4.81 and 2.56% in Banarasi Gol, Kashi Taru and Kashi Uttam, respectively over control. The overall experimental findings showed that the seed treatments with higher dose of mutagens were negatively responsive for all characters including yield of genotypes.

Key words: Gamma rays, EMS, Mutagens, Brinjal

Introduction

Eggplant, often known as brinjal (*Solanum melongena* L.; 2n = 2x = 24) belongs to the Solanaceae family. It may be cultivated in a wide range of climatic conditions and ecological zones. The genus Solanum belongs to the Solanaceae family and is a vast and significant genus. Brinjal is the most widely produced vegetable crop in the world's tropics and subtropics. It is widely grown in India, Bangladesh, Pakistan, China, the Philippines, France, Italy, and the United States. Eggplant (*Solanum melongena* (L.)), often known as aubergine, is a nightshade that belongs to the Solanaceae family. There are 75 genera and about 2000 species in the Solanaceae family. There are around 200 tuber-bearing and 1800 non-tuber-bearing species in the Solanum genus. Brinjal is a vegetable that originated in India, which is also known for its versatility (Concelin et al. 2004). It's considered a self-pollinated plant. Genetic variability is the initial stage in plant breeding for crop improvement, and it is instantly available for germplasm, which is thought to be a reservoir of variations for many traits **(**Baghery et al. 2016).

Tüylü et al. (2009) defined mutation as the process by which genes are permanently altered under environmental circumstances while being passed down through generations. Physical mutagens provide a lower danger than chemical mutagens since no procedures are required to remove the mutagens from the material (Khan et al. 2000), and they are non-toxic and do not require detoxification after use (Mba 2013). Mutations are instruments for studying the nature and foundation of plant growth and development, resulting in raw materials for crop genetic modification (Adamu and Aliyu 2007). Induced mutations in crops can quickly produce heterogeneity in quantitative and qualitatively inherited properties (Maluszynski et al. 1995 and Maduli and Mishra 2007). One of the most important processes in genetic research and selective breeding is mutagenesis. Ionizing radiation and chemical mutagens are among the mutagenic agents used to cause favourable mutations at a high rate (Ahloowalia and Maluszynski 2001). The use of effective mutagens is crucial for successful mutant isolation. Ethyl methanesulfonate (EMS), a chemical mutagen used in plant research, causes single base

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changes with various mutation spectra. In compared to normal plants, these chemo mutagens cause a wide range of morphological and yield structural characteristics (Khan et al. 2009). The physical mutagen like gamma rays was also used by different researchers and found quite effective in improvement of various characters of vegetables crops including legumes. Gamma rays, a kind of intense electromagnetic radiation, are the most often used mutagens due to their ease of use, excellent penetration, repeatability, high mutation frequency, and lack of disposal issues (Ariraman et al. 2016). An attempt was, therefore, made in the present investigation to investigate the effect of different gamma rays and EMS concentrations on growth and yield of brinjal genotypes in M_3 generation.

Materials and Methods

Plant materials and treatments: The present trial was conducted at Horticultural Research Farm, Department of Horticulture, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh to investigate the effect of different gamma rays and EMS concentrations on growth and yield of brinjal genotypes in M_3 generation. The experimental material comprises of three eggplant (*Solanum melongena* L.) genotypes Banarasi Gol, Kashi Taru and Kashi Uttam. Physical mutagen like gamma rays and chemical mutagen like EMS were used in the present treatments. The seed material was irradiated with different doses/ concentrations of gamma radiation at the National Botanical Research Institute, Lucknow. The source of Gamma irradiation used in the present study was ^{60}Co. The doses employed were 5, 10, 15, and 20 kR of gamma rays. EMS ($CH_3SO_2OC_2H_5$), an alkylating agent having molecular weight 124.16 was used in the present study. For the treatment of EMS, the seeds were pre-soaked in distilled water for hours in order to make them relatively more sensitive to mutagenic action. Pre soaked seeds were treated with different concentrations of EMS (0.05, 0.10, 0.15, and 0.20%) for 6 hours with repeated stirring. After the chemical treatment, the treated seeds were washed thoroughly in running tap water to remove the residues of the chemicals. Healthy, well-matured and untreated seeds were used as control. For micromutational studies, the bulk sample of the seeds of normal looking plants taken from all the treatments of all the genotypes from M_2 generation were sown in M_3 in randomized block design (RBD) with 3 replications during Rabi season of 2020-21. The row-to-row and plant-to-plant distance was maintained at 60 cm and 45 cm, respectively. Recommended agronomical practices were employed for the preparation of field, sowing and subsequent management of M_3 generation.

Observations recorded: Five plants were randomly selected from each plot and their average was calculated for the different parameters needed. The observations were recorded on growth parameters for plant height (cm), number of primary braches, number of branches per plant, days to 50 percent flowering, days to fruit maturity, yield parameters like fruit length (cm), fruit diameter (cm), fruit weight per plants (g), fruit yield per plant (kg) and 1000 seed weight. Irrigation was applied as and when needed other plant protection practices were also taken up for the control of insect pest and decreases during crop duration. All the data obtained from experiment was statistically analyzed by using the procedure given by Gomez and Gomez (1984).

Table 1: Growth attributes of Banarasi Gol, Kashi Taru and Kashi Uttam as affected by different mutagenic concentrations in M_3 generation

Mutagenic Treatments	Seedling height (cm)			Plant height (cm)			No. of primary branches			No. of branches per plant			Days to 50% flowering			Days to edible fruit maturity		
	Banarasi Gol	Kashi Taru	Kashi Uttam	Banarasi Gol	Kashi Taru	Kashi Uttam	Banarasi Gol	Kashi Taru	Kashi Uttam	Banarasi Gol	Kashi Taru	Kashi Uttam	Banarasi Gol	Kashi Taru	Kashi Uttam	Banarasi Gol	Kashi Taru	Kashi Uttam
Control	9.13	10.97	11.52	39.25	53.31	75.17	2.24	2.71	2.02	6.24	8.82	9.55	46.53	48.23	68.24	22.30	17.23	17.90
Gamma rays																		
5 kR	8.07	11.67	10.91	54.27	62.92	79.58	3.16	3.71	3.51	9.16	11.86	11.93	42.88	46.82	66.04	18.12	13.23	15.70
10 kR	7.58	12.47	13.79	53.56	58.98	77.26	2.94	3.31	3.28	8.33	11.36	11.80	43.10	45.57	67.87	18.67	13.82	16.25
15 kR	6.69	11.36	13.18	50.58	56.93	76.53	2.67	3.24	3.16	7.68	10.93	11.10	48.26	48.12	68.50	20.02	14.90	18.57
20 kR	5.79	12.25	13.59	48.54	55.54	77.02	2.63	3.13	2.59	6.74	9.96	10.65	44.81	50.27	71.74	22.50	17.52	19.50
EMS																		
0.05 %	5.98	12.87	14.29	48.05	55.94	75.43	2.63	2.95	2.43	6.59	8.94	9.83	45.26	45.51	65.20	19.33	14.85	16.73
0.10%	6.09	10.35	12.27	45.92	53.79	73.39	2.39	2.18	2.37	6.47	8.91	9.56	45.91	47.38	67.57	20.25	15.40	17.13
0.15%	6.59	10.85	12.79	44.12	44.09	72.26	2.01	1.97	2.09	6.14	7.56	8.75	46.38	49.72	70.11	21.83	17.40	18.65
0.20%	7.79	11.57	13.38	38.47	43.12	68.82	1.65	1.89	1.85	5.88	7.22	7.89	50.19	51.18	72.41	22.83	18.67	20.17
SEm±	0.44	0.43	0.50	2.07	2.38	2.28	0.28	0.26	0.21	0.33	0.42	0.49	1.40	1.21	1.37	0.82	0.70	0.80
C.D.(0.05)	1.31	1.30	1.49	6.22	7.12	6.84	0.84	0.77	0.63	0.99	1.27	1.48	4.21	3.62	4.10	2.46	2.09	2.39

Results and Discussion

Growth attributes of various brinjal genotypes: All the growth attributes of Banarasi Gol, Kashi Taru and Kashi Uttam were presented in Table-1 which showed that were significantly affected by both the mutagens. The maximum seedling height of Banarasi Gol, Kashi Taru and Kashi Uttam was 8.07 cm (5kR gamma rays), 12.87 cm (0.05% EMS) and 14.29 cm (0.05% EMS), respectively. The range of plant height of Banarasi Gol (34.47 to 54.27 cm), Kashi Taru (43.12 to 62.92 cm) and Kashi Uttam varied from 68.82 to 79.58 cm under various concentrations of both the mutagens. Number of primary branches of all brinjal genotypes revealed that, it was found maximum under gamma rays as compared to EMS concentrations. The no. of primary branches under 5 kR was highest with an increase of 41.07, 36.90 and 73.76%, for Banarasi Gol, Kashi Taru and Kashi Uttam, respectively over control. The number of primary branches and no. of branches per plant decreased increasingly as the concentration of both the mutagens increased of all three genotypes. Both days to 50% flowering and days to edible fruit maturity was considered best with lower value and both the values were increased as the concentrations of mutagens increased in all three genotypes. For all genotypes, the EMS concentration of 0.20% was proved very poor responsive in both the parameters. Similar result found for days to 50% flowering by Balas et al. (2019). Aruna et al. (2013) also **o**bserved a significant increase in the number of branches, plant height and other growth characters of eggplant (*Solanum melongena L.*) in M_3 generations with the application of lower concentration of gamma rays, Ethyl Methane Sulphonate (EMS) and diethyl sulphate (DES).

Yield attributes of various brinjal genotypes: The yield of brinjal genotypes i.e. no. of fruit per plant, fruit length, fruit diameter and fruit weight per plants were presented in Table-2 revealed a significant difference in all treatments but their respective values were decreased as the concentrations of mutagens (gamma rays and EMS) increased. The no. of fruits per plant of Banarasi Gol ranged from 9.17 (0.20% EMS) to 12.58 (5kR), Kashi Taru 10.16 (0.20% EMS) to 12.58 (5 kR), Kashi Uttam, 9.37 (0.20% EMS) to 12.38 (5kR) in which the lowest value was found under 0.20% EMS and highest with 5kR gamma rays. The fruit length under 5kR gamma rays was increased by 11.22, 7.50 and 6.30% in Banarasi Gol, Kashi Taru and Kashi Uttam, respectively over control. Both fruit length and fruit diameter are an important deciding factor in ultimate fruit yield. In respect to fruit diameter of Banarasi Gol and Kashi Taru was followed a trend like 10kR>5kR>15kR>20kR of gamma rays treatments while maximum fruit diameter of all genotypes under EMS treatments found with 0.05% EMS. Fruit diameter of Kashi Uttam under gamma rays followed a different trend rather than two other varieties of *i.e.* 15kR>5kR>10kR>20kR but under EMS treatments the maximum fruit diameter (8.42cm) was found with same concentration (0.05%) as in two other genotypes. The fruit weight per plant decreased with increasing concentration of mutagens but it was highest in all gamma rays treatments over control. The result found in this experiment were partially agree with the findings of Banerjee et al. (2018) and Patel et al. (2015) for fruit length and fruit diameter of brinjal crop. The application of lower concentration of mutagens like gamma rays and EMS improved the yield attributes of brinjal like fruit length, fruit diameter and fruit yield per plant (Aruna et al. 2013).

Yield and 1000 seed weight of all brinjal genotypes: The fruit yield per plant and 1000 seed weight of Banarasi

Table 2: Yield attributes of Banarasi Gol, Kashi Taru and Kashi Uttam as affected by different mutagenic concentrations in M_3 generation.

Mutagenic Treatments	No. of fruits per plant			Fruit length (cm)			Fruit diameter (cm)			Fruit weight per plant (g)		
	Banarasi Gol	Kashi Taru	Kashi Uttam	Banarasi Gol	Kashi Taru	Kashi Uttam	Banarasi Gol	Kashi Taru	Kashi Uttam	Banarasi Gol	Kashi Taru	Kashi Uttam
Control	10.21	11.30	11.01	8.91	20.38	9.83	7.01	3.32	8.53	159.56	183.29	251.07
Gamma rays												
5 kR	11.97	12.58	12.38	9.91	21.91	10.45	7.42	3.51	8.62	191.03	212.94	275.61
10 kR	11.25	12.51	11.92	9.52	20.86	10.53	7.57	3.66	8.61	187.94	206.12	272.45
15 kR	11.16	12.25	11.83	9.32	20.56	10.21	7.39	3.50	8.93	178.43	197.43	269.30
20 kR	11.06	11.96	11.65	9.53	20.86	10.14	7.24	3.47	8.49	176.24	195.26	267.22
EMS												
0.05 %	10.96	11.85	11.51	9.62	20.15	10.22	7.18	3.43	8.42	165.29	186.52	267.22
0.10%	10.62	11.38	10.50	9.34	19.94	9.86	7.06	3.36	8.31	164.92	172.59	259.51
0.15%	9.63	10.47	9.89	8.89	19.50	9.54	6.43	3.04	7.77	153.41	171.57	256.41
0.20%	9.17	10.16	9.37	8.51	18.19	9.41	6.22	2.98	7.27	147.03	164.57	248.07
SEm±	0.46	0.52	0.51	0.27	0.64	0.24	0.28	0.11	0.11	6.52	5.55	6.12
C.D.(0.05)	1.37	1.56	1.53	0.81	1.93	0.71	0.83	0.33	0.33	19.54	16.64	18.36

Table 3: Brinjal fruit yield and 1000 seed weight of Banarasi Gol, Kashi Taru and Kashi Uttam as affected by different mutagenic concentrations in M_3 generation

Mutagenic Treatments	Fruit yield per plant (kg)			1000 seed weight (g)		
	Banarasi Gol	Kashi Taru	Kashi Uttam	Banarasi Gol	Kashi Taru	Kashi Uttam
Control	1.81	2.49	3.12	3.52	3.84	4.26
Gamma rays						
5 kR	2.53	3.27	3.69	3.61	3.93	4.57
10 kR	2.21	3.11	3.53	3.24	3.80	4.13
15 kR	2.17	2.93	3.51	3.05	3.55	4.05
20 kR	1.94	2.63	3.27	2.47	3.20	3.95
EMS						
0.05 %	1.93	2.61	3.20	3.12	3.26	4.19
0.10%	1.89	2.39	3.17	2.93	3.09	4.03
0.15%	1.77	1.97	2.91	2.53	2.76	3.89
0.20%	1.64	2.21	2.67	2.27	2.42	3.53
SEm±	0.13	0.13	0.16	0.17	0.22	0.15
C.D.(0.05)	0.40	0.39	0.48	0.50	0.67	0.46

Gol, Kashi Taru and Kashi Uttam genotypes of brinjal was presented in Table-3 and observed that both characters were significantly differing under various treatments. The fruit yield per plant was increased by 39.77 and 6.62 % of Banarasi Gol, 31.32 and 4.81 % of Kashi Taru and 18.26 and 2.56 % of Kashi Uttam, under 5kR gamma rays and 0.05% EMS, respectively over control. The fruit yield per plant of all the genotypes in M3 generation followed a trend like 5>10>15>20kR gamma rays and 0.05>0.10>0.15>0.20% EMS concentrations. The EMS concentrations of 0.15% and 0.20% were showed a negative response over control for fruit yield per plant of all three genotypes of brinjal, while 0.05% showed contrast effect. All gamma rays were showed a positive response over control for fruit per plant with decreasing value with increasing concentration. David et al. (2018) also conclude a similar result that eggplant (*Solanum aethiopicum* L.) exposed to 40 Gy and 60 Gy doses of gamma rays recoded with maximum fruit yield per plant as compared to higher dose like 100Gy. 1000 seed weight was found maximum i.e. 3.61, 3.93 and 4.57g for Banarasi Gol, Kashi Taru and Kashi Uttam, respectively with the treatments of 5 Gamma rays as compared to all other concentrations of mutagens. In all three genotypes of brinjal, Kashi Uttam was recorded with the maximum 1000 seed weight. Amina et al. (2019) resulted that 50 Gy of gamma rays enhanced the fruit yield per plant and 1000 seed weight of eggplant than other treatments (0 and 100 Gy).

Conclusion

From the findings of this present experiment, it can be concluded and suggested that the improvement in various characters of brinjal crop including yield can be achieved with appropriate dose of mutagens i.e. gamma rays and EMS. The concentration of gamma rays 5kR and EMS 0.05% was showed best result for improvement of all traits and yield was highest at this dose. Days to 50% flowering and days to edible fruit maturity was attained earlier under 5kR gamma rays and 0.05% EMS as compared to control and other doses of mutagens and in the same treatments long plant was recorded. It can be concluded that higher dose of both the mutagens effect all characters of brinjal genotypes in negative directions and it also reached lower than control.

सारांश

भारत में बैंगन की खेती अधिक ऊँचाई वाले क्षेत्रों के अलावा सभी जगहों पर सुगमता से की जाती है। यह एक सब्जी फसल है, जिसका उत्पादन चीन के बाद सबसे ज्यादा भारत में किया जाता है। वर्तमान समय में बैंगन के फल हरे, बैंगनी, पीले और सफेद रंगों में उगाये जाते हैं। इसकी खेती को पूरे वर्ष आसानी से किया जा सकता है। बैंगन सोलेनसी जाति की फसल है, जो मूल रूप से भारत की फसल है। उत्परिवर्तित रसायनिक और भौतिक उत्परिवर्तन या संयोजन द्वारा प्रेरित किया जा सकता है। सब्जियों की फसलों में उत्परिवर्तन द्वारा उच्च उपज, विभिन्न विटामिन सामग्री में वृद्धि, पराग की व्यवहार्यता और विभिन्न प्रकार की बीमारियों के प्रतिरोध को प्राप्त किया जा सकता हैं। वर्तमान अध्यन में सुधार के साथ सब्जी फसलों में उत्परिवर्तन प्रजनन सफलताओं की समीक्षा की गई है। वर्तमान प्रयोग से यह निष्कर्ष निकलता है कि उपज सहित बैंगन की फसल के विभिन्न लक्षणों में सुधार म्यूटाजेन की उचित मात्रा जैसे गामा किरणों और ई.एम.एस. के साथ प्राप्त किया जा सकता है। गामा किरणों की सांद्रता 5 के.आर. और 0.05 प्रतिशत ई.एम.एस. सभी लक्षणों में सुधार के लिए सबसे अच्छा परिणाम दर्शाया और इस मात्रा पर उपज उच्चतम थी। नियंत्रण और म्यूटाजेन की अन्य खुराक की तुलना में 50 प्रतिशत फूल और खाद्य फल परिपक्वता के दिन पहले 5 के.आर. गामा किरणों और 0.05 प्रतिशत ई.एम.एस. के तहत प्राप्त किए गए थे और उसी उपचार में अधिकतम पौध लम्बाई भी प्राप्त हुई। इससे यह निष्कर्ष निकाला जा सकता है कि दोनों उत्परिवर्तजनों की उच्च मात्रा बैंगन प्रभेदों के सभी लक्षणों को नकारात्मकता दिशाओं में प्रभावित करती है और यह नियंत्रण मूल्यों से भी कम पायी गयी।

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