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# Evaluation of physical and chemical mutagens on various genotypes of brinjal (*Solanum melongena* L.) in $M_2$ generation

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## Abstract

Mutation breeding in crop plants such as brinjal (*Solanum melongena* L.) is a successful approach in change of product having narrow genetic base and to explore it a field experiment was conducted toevaluate the effect of physical mutagen such as gamma rays and chemical mutagens such as Ethyl methane sulphonate (EMS) were used on two brinjal genotypes namely Banarasi Gol and Kashi Taru. The seeds were treated with different concentrations of gamma irradiation (5, 10, 15 and 20 kR) and EMS (0.05, 0.10, 0.15 and 0.20%).The increasing concentration of mutagens was recorded with a negative response on all growth and yield attributes of both the genotypes which ultimately reduce the yield. In this context the 5kR gamma rays and 0.05% EMS concentration were recorded with superior values of all characters in $M_2$ generation. Early flowering and early edible fruit maturity was observed under 5kR gamma rays over all other treatments. The fruit yield per plant increased by 19.87% and 20.30% of Banarasi Gol and Kashi Taru, respectively under 5kR gamma rays over control. Lowest value of all characters was recorded under 0.20% EMS as compared to all other treatments including control. Thus it can be concluded on present study basis that the increasing concentration of mutagens were showed an adverse effect for all characters.

**Keywords:** Brinjal, Gamma rays, EMS, Mutagen, Banarasi Gol, Kashi Taru

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## Introduction

Vegetables play a pivotal role in our diet as they are the main source of some important supplements, especially vitamins and minerals. Brinjal (*Solanum melongena* L., often known as Aubergine or eggplant) is a popular vegetable crop produced all over the world, with a strong presence in Asia (Meherunnahar and Paul 2009). Based on production statistics, eggplant is the third most important crop in family Solanaceae, after potato and tomato. Brinjal (*Solanum melongena* L) is an important vegetable crop of Indian origin. The wide range of variation may have the way to bring out a kind of plant architecture, which could enhance its quality, productivity and impart disease resistance. The primary goal of a vegetable breeder is to increase the crop yield, being a complex character

Mutation is the process, in which genes are permanently alternated under environmental conditions while being transferred between generations. As an addition to these alternations in nature, developing science also has provided a chance for mankind to create artificial mutations by using multi techniques. Chemical or physical factors that lead to mutation are called mutagens and living creatures that have had permanent hereditary changes are called mutants.

Mutation breeding has been used effectively in the genetic enhancement of different grain legumes utilizing solo and combination treatments of various physical and chemical mutagens (Laskar (2018) and Laskar et al. (2019). Because of their direct or cumulative influence on genetic background, induced mutations may be used to generate better genotypes (Baisakh et al. 2011). Plant breeders have a powerful weapon in the form of mutation breeding in agricultural plants, especially in crops with a limited genetic basis. Mutation breeding is a well trusted strategy among traditional plant breeding tactics. Radiations are the most effective means of inducing

genetic variety in a short period of time. The development of novel varieties with increased yield and nutritious content through mutant breeding might be especially helpful to the grower-consumer interaction. On the light of above facts, the present investigation was carried out to evaluate the effect of physical and chemical mutagens on various genotypes of brinjal (*Solanum melongena* L.) in $M_2$ generation". These parameters are helpful in determining the effect of mutagens for further mutation breeding programme.

## Materials and Methods

The present experiment was conducted at Horticulture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during three consecutive Rabi season of 2019-20 in randomized block design (RBD) with nine treatments and three replications. Two genotypes of brinjal crop were used *i.e.* Banarasi Gol and Kashi Taru, spaced at 60cm × 45 cm. Physical mutagen like gamma rays and chemical mutagen like EMS ($CH_3SO_2OC_2H_5$) were used in the present treatments. The seed material was irradiated with different 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 of gamma rays employed were 5, 10, 15, and 20 kR while concentrations of EMS (0.05, 0.10, 0.15, and 0.20 %) for 6 hours with repeated stirring. Healthy, well- matured and untreated seeds were used as control. A set of 350 seeds was used for each dose/concentration including the control. Thereafter, the treated as well as untreated seeds were sown in 30 cm diameter earthen pots (50 seeds in each pot) for raising the seedlings. When the seedlings developed 4 to 5 leaves, were transplanted to well prepare experimental field in a randomized block designs (RBD) in three replicates for morphological studies. The row-to-row and plant-to-plant distance was maintained at 60 cm and 45 cm, respectively. Seeds from $M_1$ plants were harvested separately. For raising the $M_2$ generation, 30 $M_1$ plants and 30 seeds from each plant were selected for each treatment, including the control. Recommended agronomical practices were employed for the preparation of field, sowing and subsequent management of $M_2$ generation in RBD. The data were recorded from five randomly selected plants from each treatment of each replication for seedling height, plant height (cm), no. of primary branches, no. of branches per plant, days to 50% flowering, days to edible fruit maturity, no. of fruits per plant, fruit length (cm), fruit diameter (cm) fruit weight per plant, fruit yield per plant (kg/ha), and 1000 seed weight (g/ha). The data was averaged for computation of per plant basis and all the data obtained from experiment was statistically analyzed by using the procedure given by Gomez and Gomez (1984).

## Results and Discussion

**Mutagenic effect on growth attributes:** All the growth attribute of both the genotypes of brinjal were presented in Table no. 1 revealed that there was a significant difference in all the characters. The seedling heights under both the mutagens were lower than control for Banarasi Gol and Kashi Taru. An increased in dwarfness was observed in both the genotypes as the concentration of mutagen increased. Plant height was maximum 51.93 and 55.28 cm under 5 and 10kR, respectively for Banarasi Gol and Kashi Taru and it decreased as the concentration of gamma rays increased. In both the mutagens 0.20% EMS concentration achieved a maximum plant height *i.e.* 35.76 and 43.12 cm of Banarasi Gol and Kashi Taru, respectively. Number of primary branches of Banarasi Gol was recorded an

**Table 1:** Growth attributes of Banarasi Gol, and Kashi Taru as affected by different mutagenic concentrations in $M_2$ 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 | Banarasi Gol | Kashi Taru | Banarasi Gol | Kashi Taru | Banarasi Gol | Kashi Taru | Banarasi Gol | Kashi Taru | Banarasi Gol | Kashi Taru |
| **Control** | 8.87 | 9.87 | 37.03 | 53.31 | 2.09 | 2.04 | 6.09 | 8.56 | 48.70 | 53.68 | 23.47 | 18.52 |
| **Gamma rays** | | | | | | | | | | | | |
| **5 kR** | 7.59 | 8.65 | 51.93 | 47.27 | 2.93 | 3.49 | 9.12 | 11.69 | 43.01 | 45.92 | 19.09 | 14.53 |
| **10 kR** | 7.11 | 8.10 | 51.53 | 55.28 | 2.48 | 3.06 | 8.07 | 10.83 | 46.92 | 49.84 | 19.84 | 15.08 |
| **15 kR** | 6.78 | 7.82 | 48.40 | 53.17 | 2.40 | 3.05 | 7.59 | 10.69 | 48.04 | 50.72 | 21.18 | 16.14 |
| **20 kR** | 6.52 | 7.56 | 45.07 | 52.04 | 2.31 | 2.95 | 6.69 | 9.87 | 43.59 | 49.54 | 23.52 | 18.78 |
| **EMS** | | | | | | | | | | | | |
| **0.05 %** | 8.24 | 9.19 | 43.70 | 47.60 | 2.71 | 2.66 | 6.59 | 8.80 | 45.87 | 44.37 | 20.47 | 16.15 |
| **0.10%** | 6.81 | 7.91 | 43.27 | 44.09 | 2.49 | 2.16 | 6.31 | 7.77 | 46.81 | 48.51 | 21.42 | 16.68 |
| **0.15%** | 5.73 | 6.49 | 41.61 | 44.06 | 1.86 | 1.91 | 5.98 | 7.41 | 49.2 | 49.91 | 23.03 | 19.00 |
| **0.20%** | 5.10 | 5.66 | 35.76 | 43.12 | 1.54 | 1.59 | 5.79 | 7.08 | 50.28 | 54.73 | 23.97 | 19.27 |
| **SEm±** | 0.32 | 0.43 | 1.97 | 1.87 | 0.23 | 0.27 | 0.26 | 0.42 | 1.48 | 1.65 | 1.08 | 0.82 |
| **C.D.(0.05)** | 0.97 | 1.30 | 5.91 | 5.62 | 0.70 | 0.80 | 0.78 | 1.27 | 4.43 | 4.93 | 3.24 | 2.45 |

increased by 40.19, 18.66, 14.83 and 10.52%, while Kashi Taru 71.07, 50.00, 49.50 and 44.60% under 5, 10, 15 and 20 kR, respectively over control. Under EMS concentration both the genotypes followed a trend like 0.05% > 0.10 % > 0.15% > 0.20% in respect to number of primary branches and number of branches per plant. Kashi Taru was recorded higher number of branches per plant than Banarasi Gol with maximum value of 11.69 under 5kR as compared to 9.12 in same treatment of Banarasi Gol. Early 50% flowering and days to edible fruit maturity is expected in best treatment response and in this respect 5kR gamma rays was proved better. The 50% flowering in Kashi Taru under 5kR was about 8 days earlier over control and 4 days earlier in days to edible fruit maturity and it decreases as the concentration of the mutagens. In the present study the increase or decrease in value of characters differ from genotype to genotype but it continuously decreased from lower to higher concentration of mutagens in all genotypes was common and this statement was supported by Makeen and Babu (2010) who also reported that low rate gamma application was more effective. Pushparajan et al. (2014) and Shahab et al. (2018) conclude the similar result where all the growth parameters showed a positive response for lower doses of both physical and chemical mutagens but the higher doses decreases these values at the same time.

**Mutagenic effect on yield attributes:** Number of fruits per plant of both the genotypes was higher in all gamma rays treatments over control but in EMS treatments only 0.05 and 0.10% were responsive over control except 0.15 and 0.20% EMS. Number of fruits per plant of Banarasi Gol was increased by 16.71, 11.21, 9.60 and 7.80% and Kashi Taru 15.70, 15.14, 12.36 and 9.85 % under 5, 10, 15 and 20 kR gamma rays over control.The lower doses of gamma rays and EMS were most effective than higher doses for fruit length (cm), fruit diameter (cm) and fruit weight per plant (g). The fruit length of Kashi Taru was higher than Banarasi Gol while fruit diameter was higher in Banarasi Gol than Kashi Taru.The fruit length of Banarasi Gol was increased by 13.52% under 10 kR while increased by 5.62% less than 5 kR over control. The treatment with 0.05% EMS was recorded higher fruit length *i.e.* 9.53 and 19.25 of Banarasi Gol and Kashi Taru, respectively except all other EMS concentrations. A significant difference was observed in fruit diameter and fruit weight per plant under various treatments. The EMS concentration 0.10% was observed best with fruit diameter of 7.21 and 3.27 cm of Banarasi Gol and Kashi Taru, respectively except other doses of EMS. The fruit weight per plant of Banarasi Gol was increased by 19.87, 16.34, 13.45 and 10.37% while Kashi Taru increased by 20.30, 13.22, 11.25 and 10.27 % under 5, 10, 15 and 20 kR gamma rays, respectively over control. Under EMS treatments 0.05% was most responsive than any other treatments while lowest under 0.20% EMS concentration. Amir et al. (2018) also observed a decrease in the yield parameters *viz.*, number of fruits per plant, number of branches per plant and fruit weight per plant as the concentration increases above 200 Gy gamma rays and this result correlate with the result of Ashadevi et al. (2017).

**Mutagenic effect on yield of brinjal genotypes:** The data regarding the fruit yield per plant (kg.) and 1000 seed weight (g) of both the mutagens under $M_2$generation was presented in Table-3 and Figure 1 which revealed a significant difference in all the treatments of both the characters. Both the mutagens were beneficial and positively responsive for fruit yield per plant but at the same the increasing dose of mutagens showed a negative response for both the characters i.e. fruit yield per plant and 1000 seed weight of Banarasi Gol and Kashi Taru. The fount yield per plant of Banarasi

**Table 2:** Yield attributes of Banarasi Gol, Kashi Taru and Kashi Uttam as affected by different mutagenic concentrations in $M_2$ generation

| Mutagenic Treatments | No. of fruits per plant | | Fruit length (cm) | | Fruit diameter (cm) | | Fruit weight per plant (g) | |
|---|---|---|---|---|---|---|---|---|
| | Banarasi Gol | Kashi Taru | Banarasi Gol | Kashi Taru | Banarasi Gol | Kashi Taru | Banarasi Gol | Kashi Taru |
| **Control** | 9.99 | 10.76 | 8.80 | 19.38 | 5.93 | 3.01 | 147.9 | 169.63 |
| | | | | **Gamma rays** | | | | |
| **5 kR** | 11.66 | 12.45 | 9.52 | 20.47 | 7.49 | 3.43 | 177.29 | 204.07 |
| **10 kR** | 11.11 | 12.39 | 9.99 | 19.53 | 7.25 | 3.64 | 172.07 | 192.06 |
| **15 kR** | 10.95 | 12.09 | 9.32 | 19.56 | 7.23 | 3.41 | 167.80 | 188.72 |
| **20 kR** | 10.77 | 11.82 | 9.27 | 19.31 | 7.19 | 3.36 | 163.25 | 187.06 |
| | | | | **EMS** | | | | |
| **0.05 %** | 10.73 | 11.73 | 9.53 | 19.25 | 7.02 | 3.19 | 159.25 | 172.91 |
| **0.10%** | 10.46 | 11.17 | 9.19 | 18.97 | 7.21 | 3.27 | 151.29 | 162.07 |
| **0.15%** | 9.37 | 10.29 | 8.79 | 18.63 | 6.94 | 3.17 | 142.07 | 161.46 |
| **0.20%** | 8.92 | 9.96 | 8.27 | 16.79 | 6.17 | 2.93 | 136.07 | 156.21 |
| **SEm±** | 0.41 | 0.49 | 0.31 | 0.61 | 0.28 | 0.11 | 7.30 | 7.38 |
| **C.D.(0.05)** | 1.23 | 1.48 | 0.94 | 1.84 | 0.85 | 0.33 | 21.89 | 22.14 |

**Table 3:** Brinjal fruit yield and 1000 seed weight of Banarasi Gol, Kashi Taru and Kashi Uttam as affected by different mutagenic concentrations in $M_2$ generation

| Mutagenic Treatments | Fruit yield per plant (kg) | | 1000 seed weight (g) | |
|---|---|---|---|---|
| | Banarasi Gol | Kashi Taru | Banarasi Gol | Kashi Taru |
| **Control** | 1.62 | 1.78 | 3.50 | 3.81 |
| **Gamma rays** | | | | |
| **5 kR** | 2.32 | 2.62 | 3.56 | 3.91 |
| **10 kR** | 1.97 | 2.25 | 3.12 | 3.73 |
| **15 kR** | 1.87 | 1.94 | 3.05 | 3.51 |
| **20 kR** | 1.82 | 1.93 | 2.51 | 3.10 |
| **EMS** | | | | |
| **0.05 %** | 1.75 | 1.89 | 3.06 | 3.28 |
| **0.10%** | 1.72 | 1.76 | 2.91 | 3.03 |
| **0.15%** | 1.63 | 1.67 | 2.43 | 2.46 |
| **0.20%** | 1.51 | 1.58 | 2.22 | 2.32 |
| **SEm±** | 0.08 | 0.10 | 0.15 | 0.20 |
| **C.D.(0.05)** | 0.24 | 0.30 | 0.45 | 0.59 |

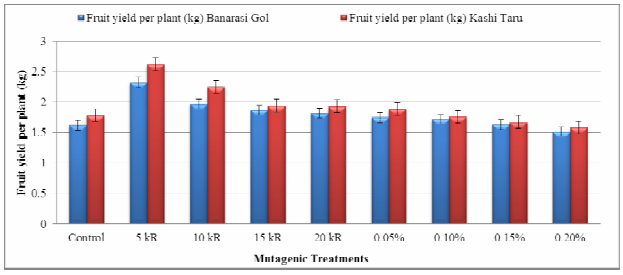


**Figure 1:** Effect of different concentrations of mutagenic treatments on fruit yield per plant (kg) of both the genotypes.

Gol was increased by 43.20, 21.60, 15.43 and 12.34 % while of Kashi Taru 47.19, 26.40, 8.98 of 8.42 % under 5, 10, 15 and 20 kR gamma rays, respectively over control. The fruit yield per plant of Banarasi Gol and Kashi Taru was higher about 8.02 and 6.17 %, respectively under 0.05% over control. Ati (2016) also reported that gamma rays in lower dose were found most effective in increasing yield of okra crop than higher doses. 1000 seed weight of Banarasi Gol and Kashi Taru was recorded maximum 3.56 and 3.91, respectively under 5kR while it was lower in all other treatment than control. All the EMS concentrations were negatively responsive for 1000 seed weight of both the genotypes of brinjal in $M_2$ generation over control. The finding of Laskar et al. 2018 support the findings of present investigation where lower concentration of gamma rays was found effective as well as EMS mutagens than higher concentrations.

## Conclusion

An important conclusion of the present research is that the mutation breeding of vegetables crop like brinjal with the help of gamma rays and EMS can improve the growth and yield. A number of concentrations of physical mutagen gamma rays and chemical mutagen EMS were compared but the lower concentration i.e. 5kR gamma rays and 0.05% EMS was found best in the studied aspects of brinjal crop. The higher doses of mutagens were not effective either on growth parameters or yield of crop. The flowering and fruit maturity was also delayed by the application of higher dose of mutagens.

## Lkkjk'k

बैंगन (*सोलेनम मेलोंजेना* एल.) फसल में उत्परिवर्तन प्रजनन संकीर्ण आनुवांशिक आधार वाले उत्पाद के परिवर्तन में एक सफल दृष्टिकोण है और इसका पता लगाने के लिए गामा किरणों और रासायनिक उत्परिवर्त्य जैसे–भौतिक उत्परिवर्त्य के प्रभाव का मूल्यांकन करने के लिए एक क्षेत्र प्रयोग किया गया। बैंगन के दो किस्मों–बनारसी गोल और काशी तरू पर एथिल मीथेन एल्फोनेट (ई.एम.एस.) का उपयोग किया गया। बीजों को गामा विकिरण (5, 10, 15 और 20 के. आर.) और ई.एम.एस. (0.05, 0.10, 0.15 और 0.20 प्रतिशत) के विभिन्न सांद्रता के साथ उपचार किया गया। उत्परिवर्त्यों की बढ़ती एकाग्रता को सभी वृद्धि और उपज घटकों पर नकारात्मक प्रतिक्रिया के परिणाम प्राप्त हुए जो दोनों किस्मों के उपज को कम किये। इस संदर्भ में 5 के.आर. ग्रामा किरणों के तहत् प्रारम्भिक पुष्पन और शीघ्र खाने योग्य फल की परिपक्कता देखी गयी। किस्म बनारसी गोल और काशी तरू की प्रति पौध फल उपज में क्रमशः 19.87 और 20.30 प्रतिशत की वृद्धि पायी गयी जो 5 के.आर. ग्रामा किरणों के नियंत्रक से थी। नियंत्रक सहित अन्य सभी उपचारों की तुलना में सभी वर्णों का न्यूनतम मूल्य 0.20 प्रतिशत ई.एम.एस. के तहत् दर्ज किया गया था। इस प्रकार वर्तमान अध्ययन के आधार पर यह निष्कर्ष निकाला जा सकता है कि उत्परिवर्त्य की बढ़ती सांद्रता ने सभी लक्षणों पर प्रतिकूल प्रभाव दिखाया।

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