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EFFECT OF GAMMA RAYS AND DIETHYL SULPHATE (DES) ON GERMINATION, GROWTH, FERTILITY AND YIELD COMPONENTS IN BROAD BEAN (*Vicia faba* L.)

Priyanka[1], Sushil Kumar[2]* and R.S. Yadav[2]

[1]Sushila Girls Inter College, Ghaziabad, Uttar Pradesh, India.

[2]Department of Botany, K.K.P.G. Collige, Etawah, Uttar Pradesh, India.

*Corresponding author E-mail: sushilsiretw@gmail.com

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ABSTRACT

Broad bean is one of the most important grain legume in the world because of its multiple uses and its ability to grow over a wide range of climatic conditions. The objectives of this study was to evaluate the effect of individual and combined doses of gamma rays and DES on germination, growth, fertility and various yield parameters. The result revealed that germination, survival percentage, plant height, number of branches, days to flower and pollen fertility were adversely affected by all the mutagenic treatments but in case of pods per plant, seeds per plant and seed yield, the lowest radiation dose applied individually had a promoting effect while higher doses had a retarding effect. There were no significant effect of mutagenic treatments on seeds per pod and test weight. Pollen sterility has been found to increase in all the mutagenic treatments, the increase being dose dependent. Highest dose of gamma rays individually or in combination with DES was found to be more effective in almost all the traits under study.

Key words : Mutagen, Gamma rays, DES, Growth, Yield.

Introduction

Broad bean (*Vicia faba* L.) is a multiple legume crop both as human food and animal feed. It also play a vital role in crop rotation, nitrogen fixation and improvement in soil structure (Abohegazi *et al*., 2025). Successful breeding pro-gramme depends on the magnitude of genetic variation in the population. Induced mutagenesis had played a significant role in inducing new genetic variability for certain characters, so that selection of superior genotypes is considerably enhanced. Micke *et al*. (1990) used induced mutations for obtaining desirable genetic changes for agronomic traits such as high yield, flower colour, disease resistance and early maturity in various crop, fruit and ornamental plants. Being a self fertilized crop, induced mutagenesis in the recent past has produced appreciable results in faba bean (Gulfishan *et al*, 2015; Sharma *et al*., 2009; Khursheed *et al*., 2018). As per the reports of FAO, 2019, there are about 20 mutant varieties developed to date and recently released mutant variety Geca-5 has improved attributes including good quality and early maturity. In the present study, the effects induced by separate and simultaneous application of a physical and a chemical mutagen was undertaken. This paper reports the effects of gamma rays and DES on M_1 generation in *Vicia faba* L.

Materials and Methods

Dry and dormant seeds of uniform size and shape of a local cultivar of *Vicia faba* were subjected to 5Kr, 10Kr and 15Kr of gamma ray dose. Some seeds from each irradiation treatment and some fresh seeds were also treated with 0.75% aquous solution of Diethyl sulphate (DES) for six hours at room temperature. A sample of untreated seeds was soaked in water for the same period to serve as soaked control. In case of chemical mutagen, the solution was drained off and replaced by freshly prepared solution after every one hour. Thus, there were a total of nine treatments *viz*.; three treatments of gamma rays, one treatment of DES,

three treatments each of combined application of gamma rays with DES, a water soaked and an unsoaked control. After chemical treatments, the seeds were thoroughly washed in running tap water.

Twenty five seeds from each treatment were, sown in a sand culture laboratory experiment providing adequate moisture to the seeds to study the germination percentage. Hundred seeds from each treatment were immediately sown in the field in a randomized row design to raise the M_1 generation in 450 cm long row with 45 × 45cm spacing. Recommended optimum agronomic and cultural practices were adopted. Observations were recorded on germination percentage after 14th days of sowing, survival percentage at maturity, Days taken to first flower, Plant height, Number of branches, Pollen sterility, Pods per plant, Seeds per pod, Seeds per plant, 100 seed weight and Yield per plant. The mean and C.D. Values for all treatments in all parameters are presented in Table 1.

Results and Discussion

Germination and Survival percentage : It is apparent from the table that final germination percentage recorded on 14th days from sowing was reduced in most of the mutagenic treatments. There was a slight increase in germination percentage in water soaked control revealing that water soaking hastened the germination. A dose dependent reduction in germination percentage was induced by varying gamma ray doses both individually and in combination with DES. Combined doses of gamma rays and DES was found to be more effective to reduce the germination percentage. Survival percentage recorded at maturity reveals the same pattern as germination percentage. Soaking in distilled water had not affect survival percentage.

Plant height and Number of branches : Plant height was retarded in all the mutagenic treatments. Highly significant decrease was induced by gamma rays at 15Kr, DES individually and by all the combined treatments of the two mutagens. Soaking in water or radiation at two lower doses showed slight reduction in plant height which was statistically non-significant. Number of branches reduced in the mutagenic treatments while soaking in water induced a slight increase. In two of the mutagenic treatments *i.e.*; 15Kr gamma dose individually and 5Kr gamma dose combined with DES, the reduction in branching was highly significant while in other treatments, it was non-significant.

Days to flower : Flowering was delayed in all the mutagenic treatments except soaking in water and radiation at lowest gamma dose. In individual treatment of DES, day taken to flower were slightly higher than that in the control but the difference was non-significant. Highest gamma ray treatments individually and all the combined treatments showed a highly significant increase in number of days to flower.

Pollen sterility : In gamma ray treatments both individually or in combination with DES pronounced increase in pollen sterility was noted. Percentage of pollen sterility increased with an increase in radiation dose both in individual and in combined treatments. Highest pollen sterility was noted in combined treatments involving highest dose of gamma rays with DES. However DES alone was less drastic to pollen fertility than gamma ray doses.

Pods per plant : Soaking in water and radiation at lower doses brought about an increase in pod number while radiation at highest dose, DES individually and all the combined treatments reduced the number of pods. Highly significant reduction in pod number was induced by 15Kr gamma dose individually and by 10Kr and 15Kr in combination with DES while a highly significant increase was noticed in soaked control and 5Kr gamma treatments.

Seeds per pod and seeds per plant : The average number of seeds per pod showed only a slight variation from the control in different treatments. In some cases there was a slight increase while in others there was a dicrease but these differences was not significant. Seeds per plant also showed a significant decrease by gamma rays at 15Kr and by 10Kr and 15Kr in combination with DES while a highly significant increase was brought about by soaking in water or 5Kr gamma ray dose. other treatments did not differ significantly over that of the control.

Test weight of 100-seed and yield per plant : Variation in test weight of 100-seeds among different mutagenic treatments was non-significant. Only slight variation over the control positive or negative was noted in various treatments. But seed yield per plant showed significant variation among the treatments. The trend of variation for seed yield was highly significant in all the gamma ray treatment individually and two higher doses of gamma rays combined with DES. Water soaking also showed significant increase in yield per plant. Individual DES and lower doses of gamma rays with DES did not showed significant variation over control.

Mutagens physical as well as chemical are known to produce adverse effects on germination, survival and plant growth in M_1 generation in several legumes including broad bean (Kumar and Dubey, 1993; Khursheed *et al.*, 2016, 2018; Haridy *et al.*, 2022; Abohegazy *et al.*, 2025), Khesari (Kumar and Dubly, 1998; Dubey and Kumar,

Table 1 : Effects of mutagenic treatments on germination, survival, growth and yield parameters in broad bean (*Vicia faba* L).

Treatments	Germina-tion(%)	Survival (%)	Plant height (cm.)	No. of branches	Days to flower	Pollen sterility (%)	Pods/Plant (%)	Seeds/Pod (%)	Seeds/Plant (%)	100 seed weight (gm)	Yield/Plant (gm.)
Cortrol Unsoaked	100.00	81.67	43.11	5.40	110.47	9.16	14.45	1.81	26.40	8.16	2.23
Soaked	104.35	81.67	41.75	5.68	110.03	12.30	21.26**	1.99	42.65**	8.65	3.83**
Gamma rays 5kr	91.30	74.17	35.47	4.58	109.86	21.17	19.00**	1.98	35.91**	8.56	3.31**
10Kr	52.17	58.33	35.47	5.46	112.13**	33.63	15.78	1.87	24.69	8.94	2.76**
15Kr	43.91	35.83	27.72**	3.88**	112.11**	33.28	4.17**	1.45	6.21**	7.30	0.42**
DES 0.75%	65.22	63.33	31.26**	4.32	111.91	18.73	13.09	1.77	23.87	8.07	2.01
Gamma rays+ DES (0.75%) 5Kr+DES	52.17	56.67	30.43**	3.99**	112.29**	20.18	12.27	1.74	21.00	8.01	1.74
10 Kr + DES	38.43	49.17	31.06**	4.46	112.36**	30.07	9.23**	1.82	18.47**	7.87	1.58**
15kr +DES	37.13	31.67	28.39**	4.24	113.30**	36.06	9.62**	1.71	17.37**	7.73	1.52**
C.D At 5% Level	NAS	NAS	8.65	1.30	1.49	NAS	2.49	NS	5.81	NS	0.65
At 1 % Level	NAS	NAS	8.84	1.33	1.30	NAS	2.55	NS	5.94	NS	0.66

* = Significant at 5% level
** = Significant at 1% level
NAS = Not analyzed Statistically
NA = Not Significant

1999; Meena, 2011), Soybean (Priyanka *et al*., 2020) and various other legumes. The above mentioned attributes are generally taken as an index of the efficiency of various treatments in inducing mutation. Both physical and chemical mutagen applied during the present study produced adverse effects on germination and survival percentage. Highest dose of gamma rays combined with DES was found more toxic while individual application of DES found to be less toxic. Soaking in water brought about a slight increase in germination percentage, pods per plant, seeds per plant and yield per plant.

In the present study, some abnormal looking plants were also screened out in all the mutagenic treatments. These include stunted growth, variation in size of leaflets, bushy habit, flower colour and size, pod size and high seed yield. According to Kamble and More (2019), the changes in the morphology of leaflets have been produced due to alteration in physiological and metabolic activities developing primordial and the irregularities produced in the meristem. Numansyah *et al*. (2018) stated that these are the result of physiological damage and direct chromosomal aberrations induced by physical or chemical mutagen.

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