Journal of Global Biosciences
ISSN 2320-1355
Volume 7, Number 3, 2018, pp. 5403-5410
Website: www.mutagens.co.in

Research Paper

EFFECTS OF GAMMA RADIATION ON SEED GERMINATION, PLANT SURVIVAL AND GROWTH CHARACTERISTICS IN *Dianthus caryophyllus* var. Chabaud

Deshmukh, P.D. and S.N. Malode

Cytology and Genetics Laboratory
Department of Botany,
Govt. Vidarbha Institute of Science and Humanities,
Amravati-444604, (M.S), India.

Abstract

The present study was conducted to evaluate the performance of *Dianthus caryophyllus* L. var. Chabaud for agronomic traits through induced mutation by gamma radiation. Seeds were exposed to different doses of gamma radiations 0, 80Gyres, 160Gyres, 240Gyres, 320Gyres, 400Gyres, 500Gyres, 600Gyres and 700Gyres to examine their effect on germination and survival percentage, growth traits and morphological variations. Highest germination percentage recorded in control, whereas increase in dose of gamma radiations there is a considerable decrease in germination percentage and plant survival percentage. Higher gamma radiations doses there are considerable decrease in plant height. 320Gyr dose recorded dwarf plant type 1 (0.02%) with increased in number of branches and number of flowers per branches. Lower doses showed variations in plant height and other morphological parameters. High yield and good plant type mutant with more number of flowers (18) was recorded in 240Gyr and 400Gyr dose respectively in M_2 generations. Doses 240Gyr, 320Gyr and 400Gyr caused morphological variations and growth traits in *Dianthus caryophyllous.* The effect of these radiations is dose dependent, as these rays stimulate growth in plants at lower doses. Therefore, these radiations are important in modifying the plant genome for *Dianthus caryophyllus* crop improvement programme.

Key words: *Dianthus caryophyllus*, germination, plant survival, agronomic traits, gamma irradiation.

INTRODUCTION

Carnation (*Dianthus caryophyllus* L.) 2n = 30 belongs to the angiospermic family Caryophyllaceae, is an important floriculture crop all over the world and ranks just next to rose in popularity in western countries (Staby *et al.*, 1978). It is well known cut flower with its variegated petals colour, high spicy fragrance and long shelf life of flowers. It is mostly found in temperate climate throughout the world with high

ISSN 2320-1355

worldwide demand. In western countries, such as USA, it ranks next only to rose in popularity.This genus is important due to its pharmacological properties, aromatic things and polymorphism in morphology, genetics and hybridization (Facciola, 1990 and Hughes, 1993). Any sudden change either in the amount or in the arrangement of structure of DNA of a living being is called mutation. As the frequency of natural mutation is very low in nature, mutation can also be artificially induced for bringing the desired attributes in living organisms. Such mutation is called as induced mutation.

Induce mutation is highly effective in enhancing natural genetic resources and have been used to develops improved cultivars of cereals, fruits and other crops. Similarly it is simple relatively cheap to perform and equally usable on a small and large scale (Siddiqui and Khan, 1999). A huge range of chemical and physical mutagens have been investigated for their use in crop improvement. Induced mutation by using physical and chemical mutagens is a way to produce genetic variation, resulting in the creation of new verities with better characteristic (Wongpiyasatid, 2000).Physical mutagens especially the ionizing radiation i.e. Gamma rays, have been widely and routinely used to generate variability in various crop species including pulses (Tomlekova, 2010). A highest majority of mutant varieties i.e. 64% were developed by the use of gamma radiations (Ahlowalia *et al*., 2004). The effects of gamma radiation have been well studied and it is known to generate point mutation mostly. Due to this, they may lead to a complete or partial loss of gene function or less frequency to some other alterations in normal gene function. A high degree of mutational saturation can be achieved by gamma rays that does not cause a lot of collateral DNA damage (Bhosale and More, 2013 b).

MATERIALS AND METHODS:

Seeds of *Dianthus caryophyllus* L. var., Chabaud were collected from Universal Seed Company, Pune,(M.S.) India. These seeds were treated with Co^{60} radio isotope for gamma irradiation at Sophisticated Instrumentation and Analytical Faculty, RSTM Nagpur University, Nagpur .The doses like 80Gy, 160Gy, 240Gy, 320Gy, 400Gy, 500Gy, 600Gy and 700Gy were selected for experimental work. The experiments were performed in the Cytology and Genetics Laboratory, Department of Botany, Govt. Vidarbha Institute Of Science And Technology, Amravati (M.S.). Seeds were sown immediately after irradiation in petriplate as well as in germination slots at 21 ^{0} C with 90% moisture. The rhythmic light of 9hrs was provided by using 40watts tungsten bulb. In each petriplate, 50 seeds were sown in triplicates, observed for germination percentage and also fixed for mitotic studies. The slots (15cm X 4 cm) were prepared from blotting papers and seeds of equal numbers (10seeds/slot) were allowed and observed for germination and survival percentage. Similarly seeds were sown in field (in triplicates) and analyzed for growth traits and other morphological variations for M_1 and M_2 generations. Desirable mutants were screened from M_2 generation, characterized and selected for raising M_3 generations. The values of seed germination and survival percentage were determined by using the following formulae.

$$\textbf{Germination percentage} = \frac{\textbf{Total seeds germinated}}{\textbf{Total seeds sown}} \times 100$$

$$\textbf{Survival percentage} = \frac{\textbf{Total plants survived}}{\textbf{Total plant germinated}} \times 100$$

RESULT AND DISCUSSION

It was noted that mutagenic effectiveness and efficiency increased with the decreased in dose or concentrations. Similar finding were noted by V. Ravichandran and S. Jayakumar (2015) in sesame (*Sesamum indicum* L.). They also reported that gamma rays and EMS are produced a high frequency as well as a wide spectrum of mutation and rays was proved to be more effective and efficient in causing mutations as compared to EMS treatments. Hence effect of gamma radiations on seed germination percentage, seedling survival, M_2mutant screening, its characterization and frequency were tabulated and studied in following discussion.

1) Seeds germination percentage:

Gamma radiation doses 0 (control), 80Gyr, 160Gyr, 240Gyr, 320Gyr, 400Gyr, 500Gyr, 600Gyr and 700Gyr were selected and evaluated for germination and survival percentage study. It was noted that mutagenic doses and germination percentage was inversely proportional to each others. The values of germination percentage were decreased with corresponding increased in gamma doses. Dose 80Gyr showed 75% germination, 160Gyr showed 69% , 240Gyr showed 64% , 320Gyr showed 61%, 400Gyr showed 58% and 500Gyres showed 53%, 600Gyr showed 51% and 700Gyr showed 48% germination over control 82%. Dose 80Gyr shows maximum germination percentage (75%) followed by 160Gyr (69%), 240Gyr (64%), 320Gyr (61%), 400Gyr (58%) and 500Gyres (53%), 600Gyr (51%) and 700Gyr (48%) germination. Similar report were also noted by (corresponding decreased in germination percentage with increased doses) Bharti *et al*.,(2013) in *Withania,* in *Solanum lycopersicum* L. by Sikder et al.,(2013), (Bhosale and More,2014) in *Coriandrum sativum* L.,(Sikder et al.,2013) in Isabgol, The minimum germination percentage was recorded for 700Gyr (42%).

Table1.1: Effect of different concentrations of gamma irradiations on seed germination percentage and shoot length in *Dianthus caryophyllus* L. var. Chabaud.

Treatment	Germination (%)	Seedling Survival (%)
Gamma Irradiations		
Control	82	76
80Gyr	75	71
160Gyr	69	64
240Gyr	64	61
320Gyr	61	57
400Gyr	58	54
500Gyr	53	51
600Gyr	58	45
700Gyr	53	42

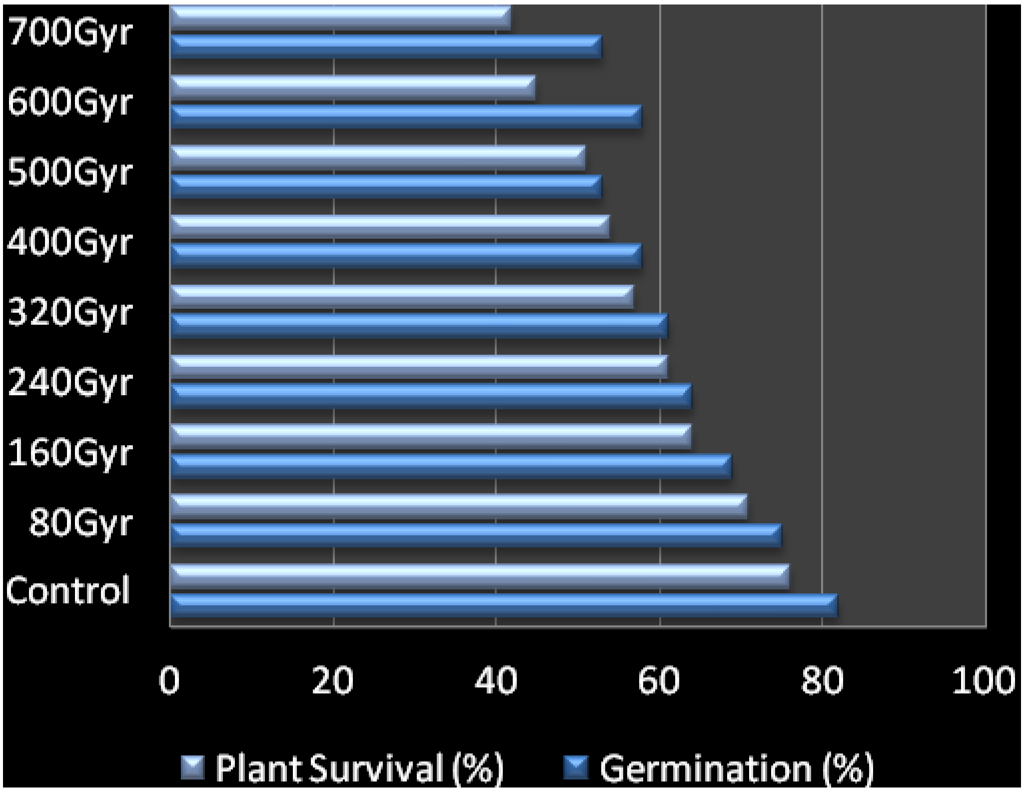


Fig.1.1: Showing effect of different concentrations of gamma irradiations on seed germination and plant survival in *Dianthus caryophyllus* L. var. Chabaud.

2) Seedling survival percentage:

Seedling survival percentage were also found to be decreased with increase in gamma doses. Control showed 76% survival percentage followed by 80Gyr (71%), 160Gyr (64%), 240Gyr (61%), 320Gyr (57%), 400Gyr (54%), 500Gyr (51%), 600Gyr (45%) and 700Gyr (42%). Lower doses showed corresponding decreased in value of germination percentage and seedling survival but doses 600Gyr and 700Gyr were recorded for prominent difference in the value of germination percentage and plant survival percentage.

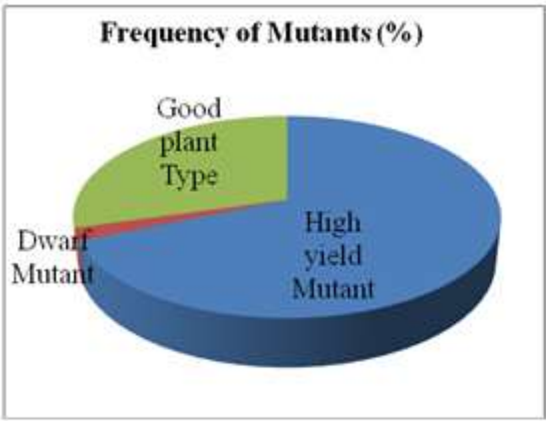
3) Screening and characterization of mutants:

Mutants were recorded from M_2 genration on the basis of phenotypic characterization. Three mutants (Good Plant Type, High Yield Mutant and Dwarf Mutant) were scored after screening M_2 population for all the agronomic traits like plant height, total number of branches per plant, total number of leaves per plant, total number of flowers per plants, size of flowers, weight of flower, shelf life of flower, total number of seeds per plant, total number of pods in one season, seeds per pod, weight of single seed and weight of 100 seeds. S. J. Jambhulkar (2002) also reported an extreme dwarf mutant observed in the M_9 generation of the diploid sunflower variety 'Surya' is reported through gamma irradiation. High yielding mutants in *Ocimum sanctum* Linn. was reported by P.N. Nasare (2011) through physical mutagen (gamma rays), as well as the chemical mutagens (SA and EMS)**.**Maximum mutants were recorded for doses 400Gyres followed by 320Gyres and 240Gyres.

Table 1.2: Screening of gamma irradiated M_2 population for mutants of *Dianthus caryophyllous* L. var. Chabaud during 2014 - 2016.

Sr. No.	No. of plant screened	Types of Mutant scored	Total No. of Mutants recorded	Frequency of Mutants (%)	Non-segregating mutants	Segre-gating mutants
1	3654	**High yield Mutant**	08 (240gyres)	0.70	3	5
2		**Dwarf mutant**	11 (320gyres)	0.02	3	8
3		**Good plant Type**	15 (400gyres)	0.30	2	13

Fig 1.2: Showing frequency and types of mutants recorded in M_2 generation of *Dianthus caryophyllus* L. var. Chabaud in respective gamma doses.
Fig 1.3: Graph showing phenotypic characterization of three mutants with respect to control.



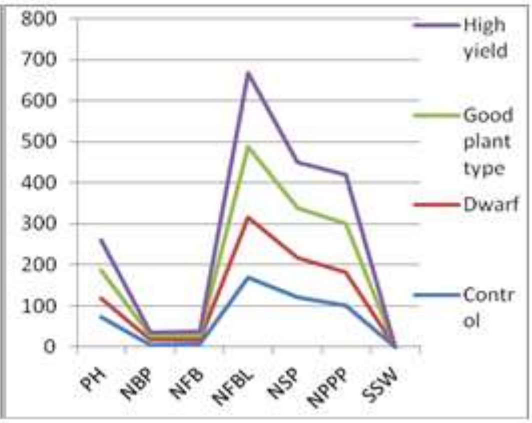


Fig: 1.2 **Fig:1.3**

(PH - Plant Height, NBP-No. of branches per plant, NFB - No. of flowers per branch, NFBL - No. of flower per bloom, NSP - No. of seeds per plants, NPPP - No. of pod per plant, SSW- Single seed weight).

Maximum mutant were recorded for Good Plant Type (frequency 0.30) followed Dwarf Mutant (0.02) and High Yield Mutants (0.70). Mutants characterization showed that Dwarf mutant recorded increased in number of branches per plant (11) over control (06) followed by Good plant type (10) and High yield mutant (09). Total number of flowers per plant were also recorded maximum for Dwarf mutant (11) followed by Good plant Type (10) and High Yield (09) over control (07).

Reduction in plant height and incresed in primary branches per plant were noted in M_2 generation.The same result were also recorded in rapeseed (B*rassica napus* L.) by **Siddiqui *et al.,***2009. Maximum plant height were recorded for control (73.5) followed by High Yield (71.5), Good Plant Type (69.3) and Dwarf mutant (45.2). Maximum yield were showed by High Yield Mutant (seeds per pod value 112 and total number of pods121) followed by Good plant type mutant (seeds per pod value 120 and total number of pods 118), Dwarf (seeds per pod value 96 and total number of pods 81) over control (seeds per pod value 122 and total number of pods101). Maximum flower size were recorded for mutant Good plant type (3.1) followed by Dwarf (3.1), High yield (2.9) over Control (3.1).

Table 1.3: Phenotypic characterization of M_3 non-segregating mutants of *Dianthus caryophyllous* L. Var. Chabaud during 2015 – 2016

Sr. No	Character	Control	High yield	Dwarf	Good plant type
1	Plant height (cm)	73.5	71.5	45.2	69.3
2	No. of branches per plant	6	9	11	10
3	Total no. of flowers per branches	07	09	11	10
3	Total no. of leaves per plant	276	295	187	286
4	Total no. of flower per bloom	169	179	148	171
5	Size of flower (cm)	3.2	2.9	3.1	3.2
6	Weight of single flower (gm)	1.3	1.3	1.1	1.4
7	Shelf life of flower (days)	9	9	8	9
8	No. of seeds per pod	122	112	96	120
9	Total no. of pods per plant	101	121	81	118
10	Single seed weight (gm)	0.0031	0.0029	0.0025	0.0026
11	100 seeds weight (gm)	0.3476	0.3521	0.0032	0.0034

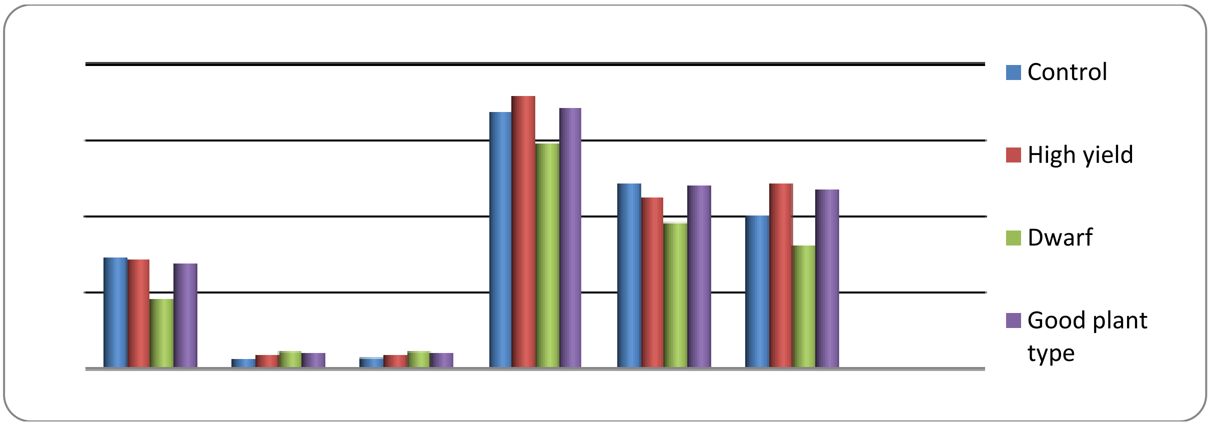


Fig.1.4: Phenotypic characterization of M_3 non-segregating mutants of *Dianthus caryophyllous* L. Var. Chabaud during 2015 – 2016

Lower doses like 240Gyr, 320Gyr and 400Gyr were found to be more effective in increased morphological variations. Begum and Dasgupta (2010) also reported that the use of lower doses of chemical and physical mutagens does not cause drastic chromosomal damage and hence may be more effective in increasing the amount of variability.

CONCLUSIONS:

Gamma doses 240Gyr, 320Gyr and 400Gyr were found to be more prominent and can be used very effectively in inducing desirable variations. Mutants of *Dianthus caryophyllus* var. Chabaud. obtained from M_2 generation viz., Good Plant Type, High Yield and Dwarf can be used for commercial cultivation as a new floriculture crop for this region for farmer.

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