The Pharma Innovation Journal 2023; 12(6): 4318-4326

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 4318-4326

www.thepharmajournal.com
Received: 12-04-2023
Accepted: 16-05-2023

**Sumit Pal**
Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

**Anil K Singh**
Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

**Anjana Sisodia**
Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

**Corresponding Author:**
**Sumit Pal**
Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

# Effect of physical and chemical mutagens on flowering and seed attributes of balsam (*Impatiens balsamina*)

**Sumit Pal, Anil K Singh and Anjana Sisodia**

**Abstract**
A field experiment was carried out to see the effect of gamma irradiation and oryzalin on flowering and seed attributes in balsam genotypes for two years. Uniform and healthy seeds of 29 genotypes (BDR-22, BDR-1, BDV-1, BS-39, BS-14, BS-20, BS-39, BS23, BSW-7, BSP-32, BDR-2, BSW-6, BDP-13, BDR-3, BDV-17, BD- Rosi, BDR-4, BDR-5, BDR-6, BSV-11, BS-28, BSP-9, BSP-1, BSW-27, BSR-16, BDV-2, BDP-1, BDP-2, BDR-7) of balsam were used for treatment with physical mutagen (Gamma ray) and chemical mutagen (Oryzalin) in the study. Seeds were irradiated with different doses (35 and 40 kR) of gamma rays from $^{60}$Co source and treated with aqueous solution of oryzalin (50 µmol, 100 µmol and 150 µmol). The treated seeds were shown in nursery and seedling were transplanted in pots after 21 days of sowing. The experiment was laid out in Randomized Block Design with three replications. Treated plants showed deleterious effect of gamma irradiation and oryzalin although at lowest dose plants were not affected much. Minimum days to bud initiation were taken by genotype BSP-1 (35.97 days) and genotype BD-Rosi (36.43 days) in $M_1$, whereas in $M_2$ generation genotype BDR-6 (37.78) and genotype BDR-5 (38.13) were taken minimum days in bud initiation. In $M_1$ generation, minimum days to flowering was recorded in untreated plants (45.24 days)' whereas, maximum days flowering was recorded in plants treated with gamma rays 35 kR (49.41 days) followed by plants treated with gamma rays 40 kR (48.57 days) and oryzalin 150 µmol (47.84 days). Maximum number of seeds per pod was recorded in untreated plants (12.21) and Minimum number of seeds per pod was recorded in plants treated with gamma rays 40 kR (11.43) $M_1$ generation.

**Keywords:** Physical, chemical mutagens, flowering, seed attributes, balsam, *Impatiens balsamina*

## Introduction

Balsam (*Impatiens balsamina*) is an ornamental flowering plant, native to southern Asia especially in India and Myanmar. Now it is widely cultivated in subtropical parts of the world. Nearly 91% of Indian species of *Impatiens* are endemic. *Impatiens balsamina* also known as *Gulmehndi* is one of the popular species of North India. The generic name *Impatiens balsamina* is derived from Latin word impatiens (Impatient), which means an impatient behaviour of the pods which, ripe, burst open on a slight pressure and scattering the seeds (Randhawa and Mukhapathay, 2004) [15]. Balsam is widely used for garden display and as order plant in landscaping. It is a rainy season annual flowering plant and grown in both summer and rainy season. Balsam produces flowers of pink, rose, white, purple, scarlet, red, etc. colour (Singh and Sisodia, 2017) [16]. It can with stand with heavy rains and high humidity in atmosphere. Balsam has several medicinal properties, plant has been used as traditional Chinese, Taiwanese and Thai medicine for treating rheumatism, isthmus and crural aches, fractures, superficial infections, fingernail inflammation and has antifungal, antibacterial, antipruritic and antitumor activities (Aras *et al.*, 2014) [2]. Moreover, active compounds such as peptides from seeds, quinones, balasquinone, flavonoids can be isolated from this plant (Maurya *et al.*, 2015) [10, 20]. It is a well-known fact that genetic variations have practical implication in crop improvement. Mutation breeding has played a major role in the development of many new colour or shape mutants in ornamental plants (Broertjes and Harten, 1988) [4]. Radiation technology has proven to be useful for mutation breeding and has contributed towards improvements in ornamental crops. Among the mutant varieties, about 90% of these mutants were generated by using radiation. Gamma rays (γ) are ionizing radiations and interact with atoms and molecules to produce free radicals in cells. The advantages of ionizing radiations as mutagens are accurate dosimetry, reasonable reproducibility and uniform penetration of multicellular system particularly by gamma rays. Morphological changes due to gamma doses were observed in gladiolus (Singh and Sisodia, 2015 and Sisodia and Singh, 2015) [15, 22, 23]. Plant growth and flowering were influenced due to gamma irradiation in tuberose (Singh *et al*., 2017 and Sah *et al*., 2017) [18, 22, 16, 21]. Chemical induction mutations have been widely used and have been shown to increase genetic diversity. Seed germination were affected by mutagen of oryzalin and gamma rays. *Rubus fraxinifolius* and *Rubus rosifolius* seeds were still able to germinate after treated by 100 µM of oryzalin (Mori *et al*., 2021) [11]. Therefore, keeping this in view the present experiment was conducted to study the effect of gamma irradiation and oryzalin on flowering and seed attributes in balsam with the objective of creating genetic variations in the subjected plant material.

## Material and Methods

The research work was carried out the under Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, during the year 2017 and 2018. The main objectives of the studies are to develop promising genotype through mutations using chemical and physical mutagens and to study the effect of induced mutagenesis on different characters of balsam. The healthy seeds of 29 genotype of balsam were used for treatment with physical mutagen (Gamma ray) and chemical mutagens oryzalin were used in the study. Gamma rays treatment were done at Division of Floriculture, Botanic Garden & Eco-education, C.S.I.R. - National Botanical Research Institute, Lucknow (India). On the following day the irradiated seeds were shown in raised nursery beds of 3 × 1 meter size. The oryzalin treatment was done in Horticulture Laboratory, Department of Horticulture. The seeds were first soaked in water for 6 hours, then the seeds were soaked in oryzalin solution for 12 hours with a concentration level of 0 µmol (control), 50 µmol, 100 µmol and 150 µmol. The treated seeds were shown in nursery and seedling were transplanted in pots after 21 days of sowing. The experiment was laid out in Randomized Block Design with three replications. Standard package of practices were followed accordingly. For collection of morphological data, 5 plants per replication were observed and average was calculated. Various flowering and seed related parameters were observed during $M_1$ and $M_2$ generation such as, days to bud initiation, days to flowering, bud diameter, flower diameter, days to seed ripening, number of pods per plant, number of seeds per pod, 1000 seed weight, seed yield per plant etc. were calculated and analyzed statistically at different period of time. The analysis of variance of data was done as per design of the experiment as suggested by Panse and Sukhatme (1954) [14].

## Result and Discussion

### Flowering attributes

Days to bud initiation increased with increase in mutagen doses in both of $M_1$ and $M_2$ generations. In $M_1$ generation, minimum days to bud initiation was observed in untreated plants (35.81 days) which were statistically significant over plants treated with gamma rays 40 kR (40.69 days), gamma rays 35 kR (41.25 days), oryzalin 100 µmol (41.35 days), oryzalin 50 µmol (41.74 days) and oryzalin 150 µmol (42.49 days). Maximum days to bud initiation was observed in plants treated with oryzalin 100 µmol (43.10 days) followed by plants treated with oryzalin 50 µmol (43.06 days) and oryzalin 150 µmol (42.88 days) in $M_2$ generation. In $M_1$ generation minimum days to bud initiation was recorded in BS-20 treated with oryzalin 100 µmol (32.83 days), whereas maximum days to bud initiation was recorded in genotype BDV-1 treated with oryzalin 50 µmol (62.70 days). These results are corroborated with the results of Sarhan *et al.* (2019) [17] and Bhusari *et al.* (2017) [3] the observed earlier flower bud initiation in African marigold treated with 5kR gamma doses and 25Gy gamma dose respectively. In a experiment Padhi and Singh (2022) [13] also observed lower dose of gamma resulted in late maturing of florets and maximum length of spike in gladiolus. Delay in bud initiation at higher dose of gamma radiation has been attributed to the destruction of auxins due to inhibition of auxin synthesis (Gordon, 1956) [7]. In $M_1$ generation, minimum days to flowering was recorded in untreated plants (45.24 days) whereas, Maximum days flowering was recorded in plants treated with gamma rays 35 kR (49.41 days) followed by plants treated with gamma rays 40 kR (48.57 days) and oryzalin 150 µmol (47.84 days). During $M_1$ generation, all genotypes showed delayed initiation of flowering at higher mutagen doses except BSW-6, BDP-13, BDR-6 and BSP-1 showed early flowering at higher gamma irradiation dose while, genotype BDV-17, BD-Rosi, BDR-4, BDR-5, BDR-6, BSV-11, BSP-1, BSW-27, BSR-16, BDP-2 and BDR-7 had early flowering at high concentration of oryzalin treatment. Delay in flowering might be due to disturbance in biochemical pathway which plays important role in flower initiation. Sarhan *et al.* (2019) [17] recorded earlier flowering at lower dose of gamma irradiation in *Tagetes erecta* plant. Dilta *et al.* (2003) [5] in chrysanthemum and Singh and Sisodia (2015) [15] in gladiolus also found similar results were delayed flowering was observed at higher dose of gamma radiation. In $M_1$ the maximum length of peduncle was recorded in 50 µmol (1.57 cm) and 150 µmol (1.57 cm) oryzalin which was statistically at par with 100 µmol oryzalin (1.56 cm) and statistically significant over rest of the treatments. In $M_2$ length of peduncle found maximum in 35 kR (1.60 cm) gamma rays and 50 µmol (1.60 cm) oryzalin followed by 100 µmol (1.59 cm) and 150 µmol (1.59 cm) oryzalin concentration. While minimum length of peduncle was found in 40 kR gamma rays. These results were similar to the findings of Kole and Meher (2005) [9] in zinnia who noted reduction in length of peduncle at higher dose of mutagen, Bhusari *et al.* (2017) [3] in African marigold and Momin *et al.* (2012) [12] in chrysanthemum recorded similar trends of reduction in peduncle length at higher dose of gamma radiation. Maximum number of petals per flower in $M_1$ generation were observed in 35 kR (6.75) gamma dose followed by 40 kR (6.73) gamma dose and 100 µmol (6.69) oryzalin concentration. Interaction effect of mutagens and genotype was found non-significant in $M_1$ and significant in $M_2$ generations of research. Sisodia *et al*. (2015) [15] also observed maximum length of spike with control in gladiolus.

### Seed attributes

Increase in dose of gamma rays and oryzalin dose significantly delayed seed ripening in $M_1$ as well as in $M_2$ generation in most of the genotypes except genotype BS-39, BS-23, BDR-3, BDV-17, BDR-5, BSV-11, BS-28 and BSP-1, BSR-16 and BDV-2 during $M_1$ generation. Similar findings were also recorded in the findings of Aney (2013) [1], who observed delay in seed ripening during a research on pea (*Pisum sativum* L.) by using gamma radiation, whereas, Singh *et al.* (2017) [18, 22] found similar results of delay in seed maturity in pea at higher concentration of EMS. Number of pods per plant decreased with increased dose of mutagen. In $M_1$ generation maximum number of pod per plant was recorded in untreated plants (238.35) which were statistically significant plant treated with gamma rays 35 kR (230.79), gamma rays 40 kR (230.79), oryzalin 50 µmol (216.93), oryzalin 100 µmol (213.70) and oryzalin 150 µmol (210.46). In $M_2$ generation results were found different from $M_1$ generation where number of pods increase in higher dose of mutagens. These results are in conformity with the results of Verma and Purbiya (2017) [24], who recorded decrease trend for number of pods per plants in pea (*Pisum sativum* L.) at higher dose of gamma radiation. Maximum number of seeds per pod was recorded in untreated plants (12.21) and Minimum number of seeds per pod was recorded in plants treated with gamma rays 40 kR (11.43) followed by plants treated with gamma rays 35 kR (11.68) in $M_1$ generation. In $M_2$, minimum number of seeds per pod was recorded in plants treated with gamma rays 40 kR (11.44) followed by plants treated with oryzalin 150 µmol (11.72). These results are in conformity with the results of Aney (2013) [1] recorded maximum number of seeds per pod in control and minimum number of seeds per pod at higher dose (250 Gy) dose of gamma radiation in Pea (*Pisum sativum* L.). In $M_1$ generation maximum 1000 seed weight (12.73 g) was noted in BDR-7 treated with 50 µmol of oryzalin whereas minimum in untreated BS- 20 (6.83 g). Maximum 1000 seed weight was noted in treatment combination BDP-13 treated with 50 µmol of oryzalin and minimum in treatment combination BS-20 treated with 50 µmol of oryzalin (7.43). These results are in conformity with the findings of Aney (2013) [1] who found decrease in 100 seed weight in pea at 250 Gy dose of gamma rays. 1000 seed weight was decrease in higher dose of gamma radiation recorded in pea by Khan *et al.* (2013) [8], similarly Singh *et al.* (2015) [19] also observed decrease trend in 1000 seed weight in field pea at higher concentration (0.15%) of EMS. The interaction between genotype and various doses gamma radiation and oryzalin were found non-significant in $M_1$ and significant during $M_2$ generations for the traits number of seeds per plant. In $M_1$ generation, maximum number of seed per plant was recorded in untreated plants (2902.75), whereas minimum number of seeds per plant was found in 150 µmol oryzalin (2508.22) concentration. These results were similar to the findings of Gnanamurthy *et al.* (2012) [6] they recorded decrease in seed yield per plant as dose of gamma radiation increases at 35 kR gamma rays in cow pea (*Vigna unguiculata* L.).

**Table 1:** Effect of mutagens on days to bud initiation in different genotypes of balsam.

| | 2017 | | | | | | | 2018 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gamma rays | | | Oryzalin | | | | Gamma rays | | | Oryzalin | | | |
| **Treatment Genotype** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** |
| BDR-22 | 34.22 | 48.22 | 48.22 | 42.48 | 39.84 | 43.97 | 42.82 | 40.44 | 40.11 | 39.66 | 39.50 | 39.66 | 39.83 | 39.87 |
| BDR-1 | 33.33 | 39.33 | 40.00 | 42.81 | 42.19 | 44.16 | 40.30 | 39.55 | 36.66 | 37.11 | 42.66 | 43.33 | 43.33 | 40.44 |
| BDV-1 | 40.78 | 44.22 | 45.11 | 62.70 | 61.82 | 61.92 | 52.76 | 39.88 | 41.00 | 41.00 | 60.83 | 60.16 | 56.83 | 49.95 |
| BS-39 | 34.11 | 42.00 | 42.66 | 44.96 | 48.14 | 45.23 | 42.85 | 39.00 | 40.00 | 39.00 | 55.00 | 58.00 | 56.50 | 47.91 |
| BS-14 | 35.11 | 41.78 | 40.11 | 53.81 | 51.67 | 52.21 | 45.78 | 41.77 | 39.66 | 40.00 | 57.00 | 55.00 | 54.83 | 48.04 |
| BS-20 | 35.77 | 39.66 | 39.44 | 35.08 | 32.83 | 43.06 | 37.64 | 33.55 | 40.00 | 47.00 | 43.83 | 43.83 | 42.66 | 41.81 |
| BS-39 | 34.55 | 44.77 | 42.33 | 40.00 | 38.90 | 38.00 | 39.76 | 39.55 | 46.55 | 45.00 | 43.83 | 44.00 | 43.66 | 43.76 |
| BS23 | 33.44 | 39.66 | 38.22 | 42.56 | 42.51 | 42.80 | 39.86 | 34.44 | 40.44 | 41.55 | 43.00 | 42.16 | 42.83 | 40.74 |
| BSW-7 | 34.67 | 39.00 | 38.33 | 39.81 | 41.78 | 43.08 | 39.44 | 39.33 | 41.44 | 41.55 | 39.83 | 42.66 | 42.66 | 41.25 |
| BSP-32 | 33.22 | 39.44 | 37.78 | 39.47 | 37.49 | 41.72 | 38.19 | 33.55 | 41.00 | 41.77 | 40.33 | 40.66 | 41.16 | 39.74 |
| BDR-2 | 33.89 | 37.44 | 37.66 | 40.55 | 39.34 | 37.89 | 37.79 | 34.77 | 41.00 | 41.00 | 43.16 | 42.33 | 43.00 | 40.87 |
| BSW-6 | 35.22 | 37.33 | 38.11 | 42.96 | 43.15 | 40.61 | 39.56 | 40.33 | 47.89 | 47.66 | 48.83 | 44.00 | 39.00 | 44.62 |
| BDP-13 | 39.77 | 47.33 | 38.77 | 46.34 | 48.13 | 48.48 | 44.80 | 44.89 | 43.00 | 42.55 | 42.66 | 43.83 | 42.66 | 43.26 |
| BDR-3 | 34.11 | 37.89 | 38.44 | 38.85 | 37.84 | 38.72 | 37.64 | 34.89 | 41.00 | 41.00 | 37.66 | 37.83 | 40.50 | 38.81 |
| BDV-17 | 38.33 | 44.44 | 44.44 | 42.67 | 39.17 | 45.41 | 42.41 | 40.11 | 41.66 | 41.00 | 38.50 | 39.33 | 38.83 | 39.90 |
| BD- Rosi | 36.22 | 43.22 | 44.33 | 35.93 | 36.50 | 36.43 | 38.77 | 35.11 | 38.33 | 38.88 | 39.16 | 39.50 | 39.00 | 38.33 |
| BDR-4 | 36.00 | 47.00 | 46.77 | 42.24 | 40.89 | 42.75 | 42.61 | 35.89 | 39.55 | 39.00 | 38.16 | 38.16 | 38.83 | 38.26 |
| BDR-5 | 33.89 | 45.77 | 45.11 | 37.04 | 37.03 | 38.00 | 39.47 | 35.22 | 39.00 | 39.89 | 38.33 | 38.33 | 38.00 | 38.13 |
| BDR-6 | 34.00 | 36.44 | 37.11 | 39.10 | 38.64 | 37.45 | 37.12 | 33.55 | 40.00 | 38.33 | 38.16 | 38.16 | 38.50 | 37.78 |
| BSV-11 | 35.22 | 35.00 | 36.33 | 36.67 | 35.25 | 36.77 | 35.87 | 37.77 | 45.33 | 38.78 | 38.83 | 38.16 | 38.33 | 39.53 |
| BS-28 | 33.11 | 38.77 | 38.55 | 35.79 | 35.43 | 39.11 | 36.79 | 33.55 | 39.11 | 44.11 | 43.66 | 43.50 | 44.00 | 41.32 |
| BSP-9 | 34.33 | 37.77 | 37.33 | 36.11 | 37.22 | 38.60 | 36.89 | 33.33 | 38.99 | 38.33 | 42.83 | 41.83 | 42.50 | 39.63 |
| BSP-1 | 33.55 | 36.66 | 36.00 | 36.91 | 36.62 | 36.11 | 35.97 | 34.55 | 41.00 | 40.33 | 39.33 | 39.83 | 40.50 | 39.25 |
| BSW-27 | 40.78 | 47.89 | 46.33 | 46.38 | 46.30 | 48.08 | 45.96 | 40.11 | 42.11 | 46.44 | 44.83 | 46.66 | 43.33 | 43.91 |
| BSR-16 | 38.89 | 46.78 | 45.88 | 39.71 | 42.52 | 40.71 | 42.41 | 39.33 | 52.77 | 53.11 | 43.83 | 42.50 | 44.00 | 45.92 |
| BDV-2 | 38.44 | 44.11 | 41.77 | 45.44 | 45.59 | 46.30 | 43.61 | 39.44 | 41.00 | 41.00 | 44.00 | 44.83 | 48.50 | 43.13 |
| BDP-1 | 41.33 | 36.89 | 38.33 | 46.41 | 45.14 | 46.34 | 42.40 | 40.44 | 42.66 | 41.33 | 44.00 | 44.33 | 43.00 | 42.63 |
| BDP-2 | 37.55 | 38.33 | 38.11 | 40.13 | 40.50 | 40.78 | 39.23 | 40.44 | 41.33 | 41.55 | 38.50 | 39.33 | 38.66 | 39.97 |
| BDR-7 | 34.66 | 39.11 | 38.55 | 37.69 | 36.62 | 37.65 | 37.38 | 32.99 | 53.33 | 52.22 | 38.50 | 38.16 | 38.16 | 42.23 |
| Mean | 35.81 | 41.25 | 40.69 | 41.74 | 41.35 | 42.49 | | 37.51 | 41.93 | 42.07 | 43.06 | 43.10 | 42.88 | |
| Factors | 2017 | | 2018 | | | | | | | | | | | |
| | C.D. | SE (m) | C.D. | SE (m) | | | | | | | | | | |
| Genotype | 1.45 | 0.52 | 0.87 | 0.31 | | | | | | | | | | |
| Treatment | 0.66 | 0.23 | 0.39 | 0.14 | | | | | | | | | | |
| Genotype ×Treatment | 3.57 | 1.28 | 2.13 | 0.76 | | | | | | | | | | |

**Table 2:** Effect of mutagens on days to flowering in different genotypes of balsam.

| | 2017 | | | | | | | 2018 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gamma rays | | | Oryzalin | | | | Gamma rays | | | Oryzalin | | | |
| **Treatment Genotype** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** |
| BDR-22 | 46.44 | 53.55 | 53.22 | 47.34 | 46.38 | 48.30 | 49.20 | 45.89 | 46.77 | 45.33 | 43.83 | 44.83 | 45.00 | 45.27 |
| BDR-1 | 40.33 | 50.77 | 47.33 | 48.35 | 45.75 | 47.33 | 46.64 | 47.22 | 42.44 | 42.55 | 46.50 | 45.66 | 45.66 | 45.00 |
| BDV-1 | 47.00 | 54.11 | 54.22 | 65.59 | 65.35 | 65.99 | 58.71 | 48.44 | 51.00 | 52.88 | 63.50 | 64.00 | 60.50 | 56.72 |
| BS-39 | 45.00 | 48.78 | 47.44 | 50.80 | 52.24 | 51.60 | 49.31 | 42.55 | 47.00 | 44.11 | 58.83 | 60.50 | 58.33 | 51.88 |
| BS-14 | 42.66 | 50.89 | 46.77 | 60.75 | 62.67 | 62.08 | 54.30 | 43.55 | 47.55 | 47.11 | 61.33 | 60.50 | 60.16 | 53.37 |
| BS-20 | 46.33 | 48.67 | 48.89 | 39.20 | 36.38 | 48.03 | 44.58 | 41.33 | 53.66 | 53.66 | 54.33 | 49.33 | 54.33 | 51.11 |
| BS-39 | 45.11 | 51.00 | 49.99 | 46.78 | 44.14 | 45.12 | 47.02 | 47.00 | 54.55 | 50.00 | 52.33 | 52.33 | 51.83 | 51.34 |
| BS23 | 40.33 | 43.77 | 44.00 | 48.40 | 46.18 | 48.03 | 45.12 | 40.44 | 46.00 | 47.89 | 47.00 | 46.50 | 47.00 | 45.80 |
| BSW-7 | 44.33 | 46.88 | 44.44 | 42.79 | 44.95 | 47.52 | 45.15 | 44.43 | 50.553 | 52.447 | 43.83 | 44.50 | 45.66 | 46.90 |
| BSP-32 | 40.44 | 44.22 | 43.00 | 47.37 | 44.99 | 45.48 | 44.25 | 39.33 | 49.88 | 52.78 | 45.00 | 45.16 | 46.16 | 46.38 |
| BDR-2 | 43.89 | 43.44 | 44.11 | 46.22 | 45.81 | 43.51 | 44.49 | 45.44 | 55.00 | 54.55 | 51.83 | 51.33 | 51.66 | 51.63 |
| BSW-6 | 44.44 | 48.00 | 42.22 | 47.81 | 48.03 | 48.18 | 46.44 | 47.00 | 50.00 | 53.66 | 55.83 | 51.50 | 44.00 | 50.33 |
| BDP-13 | 52.89 | 56.33 | 47.33 | 55.69 | 57.07 | 58.32 | 54.60 | 50.11 | 50.89 | 49.44 | 47.50 | 50.50 | 49.00 | 49.57 |
| BDR-3 | 43.77 | 45.89 | 48.78 | 44.76 | 44.49 | 46.02 | 45.62 | 44.55 | 51.44 | 47.44 | 42.00 | 41.33 | 48.66 | 45.90 |
| BDV-17 | 50.44 | 57.11 | 56.22 | 46.31 | 45.49 | 50.05 | 50.94 | 48.22 | 54.78 | 55.77 | 42.33 | 42.66 | 43.83 | 47.93 |
| BD- Rosi | 45.00 | 52.77 | 52.22 | 39.65 | 39.81 | 40.94 | 45.06 | 41.67 | 43.67 | 48.33 | 41.66 | 44.16 | 42.50 | 43.66 |
| BDR-4 | 46.78 | 55.11 | 54.77 | 46.29 | 46.25 | 45.23 | 49.07 | 47.11 | 48.33 | 47.89 | 42.83 | 42.66 | 42.66 | 45.25 |
| BDR-5 | 43.44 | 52.11 | 50.44 | 42.95 | 41.88 | 41.99 | 45.47 | 43.66 | 47.00 | 46.22 | 42.16 | 42.16 | 43.33 | 44.09 |
| BDR-6 | 43.89 | 40.66 | 42.22 | 43.66 | 43.98 | 41.63 | 42.67 | 43.11 | 46.77 | 44.22 | 42.66 | 41.66 | 42.16 | 43.43 |
| BSV-11 | 42.2 | 40.44 | 42.33 | 40.83 | 38.83 | 41.19 | 40.97 | 43.88 | 45.55 | 45.66 | 42.66 | 42.66 | 41.66 | 43.68 |
| BS-28 | 38.78 | 41.66 | 42.88 | 45.68 | 45.29 | 46.10 | 43.40 | 40.7 | 48.55 | 50.33 | 51.00 | 50.66 | 53.83 | 49.19 |
| BSP-9 | 36.89 | 40.55 | 40.44 | 39.06 | 41.04 | 41.30 | 39.88 | 40.11 | 47.44 | 49.33 | 46.33 | 46.16 | 47.83 | 46.20 |
| BSP-1 | 41.66 | 38.66 | 40.33 | 40.63 | 40.11 | 41.20 | 40.43 | 42.33 | 51.78 | 51.55 | 42.33 | 42.16 | 43.66 | 45.63 |
| BSW-27 | 55.11 | 60.55 | 56.89 | 53.03 | 53.32 | 54.57 | 55.58 | 53.00 | 55.33 | 56.22 | 52.66 | 52.00 | 53.33 | 53.75 |
| BSR-16 | 50.55 | 56.55 | 55.67 | 46.00 | 46.01 | 45.03 | 49.97 | 46.89 | 56.77 | 56.78 | 50.16 | 48.00 | 48.16 | 51.13 |
| BDV-2 | 50.22 | 50.11 | 50.33 | 53.74 | 51.64 | 51.63 | 51.28 | 47.22 | 56.00 | 58.00 | 50.00 | 49.66 | 48.66 | 51.59 |
| BDP-1 | 50.66 | 57.89 | 53.44 | 53.76 | 53.01 | 53.57 | 53.72 | 55.55 | 48.55 | 48.11 | 47.01 | 46.57 | 46.90 | 48.78 |
| BDP-2 | 48.00 | 51.44 | 54.11 | 44.43 | 45.46 | 46.05 | 48.25 | 48.44 | 50.00 | 48.22 | 43.33 | 47.83 | 48.83 | 47.77 |
| BDR-7 | 45.44 | 51.00 | 54.66 | 41.26 | 41.77 | 41.34 | 45.91 | 42.55 | 58.22 | 58.89 | 42.50 | 42.66 | 42.16 | 47.83 |
| Mean | 45.24 | 49.41 | 48.57 | 47.21 | 46.84 | 47.84 | | 45.23 | 50.19 | 50.32 | 48.04 | 47.92 | 48.19 | |
| Factors | 2017 | | 2018 | | | | | | | | | | | |
| | C.D. | SE (m) | C.D. | SE (m) | | | | | | | | | | |
| Genotype | 1.89 | 0.68 | 1.21 | 0.43 | | | | | | | | | | |
| Treatment | 0.86 | 0.31 | 0.55 | 0.19 | | | | | | | | | | |
| Genotype ×Treatment | 4.64 | 1.66 | 2.97 | 1.07 | | | | | | | | | | |

**Table 3:** Effect of mutagens on length of peduncle (cm) in different genotypes of balsam.

| | 2017 | | | | | | | 2018 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gamma rays | | | Oryzalin | | | | Gamma rays | | | Oryzalin | | | |
| **Treatment Genotype** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** |
| BDR-22 | 1.28 | 1.36 | 1.38 | 1.51 | 1.36 | 1.19 | 1.34 | 1.54 | 1.53 | 1.57 | 1.38 | 1.74 | 1.86 | 1.60 |
| BDR-1 | 1.76 | 1.82 | 2.01 | 1.44 | 1.42 | 1.35 | 1.63 | 1.67 | 1.69 | 1.61 | 1.76 | 1.54 | 1.51 | 1.63 |
| BDV-1 | 1.66 | 1.52 | 1.87 | 1.51 | 1.48 | 1.76 | 1.63 | 1.65 | 1.55 | 1.89 | 1.74 | 1.63 | 2.04 | 1.75 |
| BS-39 | 1.57 | 1.26 | 1.29 | 1.73 | 1.79 | 1.46 | 1.51 | 1.57 | 1.31 | 1.50 | 1.64 | 1.43 | 1.25 | 1.45 |
| BS-14 | 2.02 | 1.28 | 1.53 | 1.44 | 1.56 | 1.56 | 1.56 | 2.12 | 1.30 | 1.54 | 1.41 | 1.44 | 1.73 | 1.59 |
| BS-20 | 1.38 | 1.30 | 1.44 | 1.40 | 1.78 | 1.51 | 1.47 | 1.41 | 1.31 | 1.53 | 1.72 | 1.84 | 1.41 | 1.53 |
| BS-39 | 1.32 | 1.373 | 1.38 | 1.54 | 1.43 | 1.73 | 1.46 | 1.31 | 1.73 | 1.69 | 1.32 | 1.33 | 1.50 | 1.48 |
| BS23 | 1.28 | 1.373 | 1.39 | 1.51 | 1.49 | 1.61 | 1.44 | 1.75 | 1.67 | 1.85 | 1.63 | 1.29 | 1.33 | 1.59 |
| BSW-7 | 1.473 | 1.34 | 1.38 | 1.67 | 1.53 | 1.48 | 1.48 | 1.64 | 1.97 | 1.67 | 1.42 | 1.73 | 1.35 | 1.63 |
| BSP-32 | 1.31 | 1.36 | 1.34 | 1.64 | 1.30 | 1.58 | 1.42 | 1.47 | 1.42 | 1.44 | 1.52 | 1.77 | 1.81 | 1.57 |
| BDR-2 | 1.44 | 1.34 | 1.36 | 1.42 | 1.52 | 1.66 | 1.46 | 1.62 | 1.71 | 1.52 | 1.91 | 2.01 | 1.64 | 1.73 |
| BSW-6 | 1.63 | 1.30 | 1.34 | 1.51 | 1.64 | 1.53 | 1.49 | 1.93 | 1.94 | 1.42 | 1.40 | 1.56 | 1.58 | 1.64 |
| BDP-13 | 1.38 | 1.33 | 1.40 | 1.99 | 1.67 | 1.42 | 1.53 | 1.23 | 1.48 | 1.39 | 1.40 | 1.37 | 1.28 | 1.36 |
| BDR-3 | 1.38 | 1.43 | 1.52 | 1.71 | 1.42 | 1.49 | 1.49 | 1.45 | 1.25 | 1.45 | 1.67 | 1.70 | 1.14 | 1.44 |
| BDV-17 | 2.01 | 1.38 | 1.62 | 1.55 | 1.48 | 1.46 | 1.58 | 1.47 | 1.92 | 1.54 | 1.39 | 1.60 | 1.55 | 1.58 |
| BD- Rosi | 1.54 | 1.56 | 1.52 | 1.52 | 1.65 | 1.66 | 1.57 | 1.67 | 1.72 | 1.54 | 1.48 | 1.35 | 1.61 | 1.56 |
| BDR-4 | 1.38 | 1.44 | 1.59 | 1.45 | 1.52 | 1.71 | 1.51 | 1.54 | 1.54 | 1.71 | 2.00 | 1.53 | 1.66 | 1.66 |
| BDR-5 | 1.30 | 1.467 | 1.39 | 1.51 | 1.58 | 1.70 | 1.49 | 1.69 | 1.34 | 1.50 | 1.78 | 1.78 | 1.44 | 1.58 |
| BDR-6 | 1.24 | 1.43 | 1.33 | 1.57 | 1.51 | 1.53 | 1.43 | 1.36 | 1.37 | 1.2 | 1.55 | 1.56 | 1.45 | 1.43 |
| BSV-11 | 1.36 | 1.36 | 1.44 | 1.44 | 1.61 | 1.43 | 1.44 | 1.74 | 1.14 | 1.60 | 1.63 | 1.50 | 1.84 | 1.57 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BS-28 | 1.42 | 1.40 | 1.62 | 1.52 | 1.51 | 1.597 | 1.51 | 1.32 | 1.44 | 1.27 | 1.74 | 1.72 | 1.61 | 1.52 |
| BSP-9 | 1.62 | 1.50 | 1.58 | 1.64 | 1.51 | 1.72 | 1.59 | 1.50 | 1.58 | 1.84 | 1.72 | 1.78 | 1.93 | 1.72 |
| BSP-1 | 1.43 | 1.55 | 1.50 | 1.58 | 1.40 | 1.95 | 1.57 | 1.47 | 1.93 | 1.52 | 1.89 | 1.75 | 1.62 | 1.69 |
| BSW-27 | 1.56 | 1.43 | 1.54 | 1.66 | 1.59 | 1.83 | 1.60 | 2.04 | 1.81 | 1.45 | 1.45 | 1.62 | 1.68 | 1.67 |
| BSR-16 | 1.36 | 1.59 | 1.50 | 1.48 | 1.60 | 1.62 | 1.52 | 1.36 | 1.82 | 1.69 | 1.53 | 1.40 | 1.68 | 1.58 |
| BDV-2 | 2.01 | 1.70 | 1.54 | 1.41 | 2.00 | 1.53 | 1.70 | 1.78 | 1.81 | 1.72 | 1.54 | 1.66 | 1.66 | 1.69 |
| BDP-1 | 1.92 | 1.51 | 1.50 | 1.95 | 1.57 | 1.59 | 1.67 | 1.50 | 1.55 | 1.68 | 1.75 | 1.54 | 1.73 | 1.62 |
| BDP-2 | 1.40 | 1.48 | 1.48 | 1.68 | 1.45 | 1.44 | 1.49 | 1.52 | 1.82 | 1.39 | 1.46 | 1.71 | 1.64 | 1.59 |
| BDR-7 | 1.367 | 1.67 | 1.57 | 1.66 | 1.87 | 1.54 | 1.616 | 1.55 | 1.76 | 1.65 | 1.62 | 1.32 | 1.49 | 1.56 |
| Mean | 1.514 | 1.44 | 1.49 | 1.57 | 1.56 | 1.57 | | 1.58 | 1.60 | 1.57 | 1.60 | 1.59 | 1.59 | |
| Factors | 2017 | | 2018 | | | | | | | | | | | |
| | C.D. | SE (m) | C.D. | SE (m) | | | | | | | | | | |
| Genotype | 0.126 | 0.045 | 0.193 | 0.069 | | | | | | | | | | |
| Treatment | 0.057 | 0.021 | N/S | 0.032 | | | | | | | | | | |
| Genotype ×Treatment | 0.308 | 0.111 | N/S | 0.170 | | | | | | | | | | |

**Table 4:** Effect of mutagens on number of petals per flower in different genotypes of balsam.

| | 2017 | | | | | | | 2018 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gamma rays | | | Oryzalin | | | | Gamma rays | | | Oryzalin | | | |
| **Treatment Genotype** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** |
| BDR-22 | 9.50 | 9.61 | 9.83 | 9.53 | 9.00 | 9.23 | 9.45 | 9.50 | 10.06 | 10.13 | 9.83 | 10.00 | 9.66 | 9.86 |
| BDR-1 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BDV-1 | 9.16 | 9.83 | 8.61 | 9.46 | 9.53 | 8.80 | 9.23 | 10.00 | 10.06 | 10.06 | 10.66 | 9.66 | 9.40 | 9.97 |
| BS-39 | 9.00 | 9.83 | 10.11 | 9.66 | 8.53 | 9.00 | 9.35 | 9.50 | 10.20 | 6.86 | 8.80 | 9.66 | 10.33 | 9.22 |
| BS-14 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BS-20 | 8.66 | 8.11 | 7.61 | 8.80 | 8.50 | 8.80 | 8.41 | 8.83 | 9.80 | 9.46 | 9.13 | 9.00 | 8.33 | 9.09 |
| BS-39 | 9.1 | 9.94 | 10.33 | 9.43 | 9.33 | 9.13 | 9.55 | 8.83 | 10.20 | 9.66 | 9.06 | 9.33 | 9.00 | 9.35 |
| BS23 | 3.00 | 3.00 | 3.00 | 3.00 | 3.0 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BSW-7 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BSP-32 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BDR-2 | 7.16 | 8.00 | 7.22 | 7.66 | 8.66 | 7.66 | 7.73 | 7.66 | 9.8 | 9.93 | 9.00 | 8.00 | 7.33 | 8.62 |
| BSW-6 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BDP-13 | 9.83 | 10.27 | 10.66 | 8.50 | 10.40 | 9.13 | 9.80 | 9.83 | 8.13 | 10.26 | 9.66 | 9.66 | 9.66 | 9.53 |
| BDR-3 | 10.33 | 11.00 | 11.05 | 10.00 | 11.00 | 10.66 | 10.67 | 10.16 | 9.93 | 9.86 | 7.53 | 10.66 | 10.00 | 9.69 |
| BDV-17 | 9.16 | 10.89 | 11.16 | 10.26 | 11.16 | 10.16 | 10.47 | 8.50 | 10.40 | 10.33 | 9.86 | 10.40 | 10.0 | 9.91 |
| BD- Rosi | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BDR-4 | 9.50 | 10.00 | 10.00 | 10.66 | 9.86 | 10.00 | 10.00 | 10.00 | 9.93 | 9.93 | 10.80 | 10.33 | 10.13 | 10.18 |
| BDR-5 | 7.16 | 7.77 | 7.27 | 7.20 | 8.33 | 7.93 | 7.61 | 7.83 | 10.46 | 10.3 | 10.0 | 9.60 | 9.60 | 9.63 |
| BDR-6 | 8.16 | 8.16 | 7.72 | 8.46 | 8.80 | 9.20 | 8.42 | 9.16 | 9.66 | 9.80 | 9.26 | 7.83 | 9.00 | 9.12 |
| BSV-11 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BS-28 | 3.00 | 3.00 | 3.00 | 3.00 | 3.000 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BSP-9 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BSP-1 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BSW-27 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.0 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BSR-16 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 3.93 | 4.00 | 4.00 | 4.00 | 4.00 | 3.98 |
| BDV-2 | 13.00 | 11.94 | 12.61 | 12.50 | 12.33 | 12.00 | 12.39 | 12.66 | 10.93 | 10.93 | 9.86 | 11.33 | 10.33 | 11.01 |
| BDP-1 | 17.00 | 16.11 | 17.16 | 16.83 | 16.00 | 16.66 | 16.62 | 15.33 | 12.20 | 12.46 | 14.00 | 15.33 | 15.66 | 14.16 |
| BDP-2 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| BDR-7 | 10.66 | 11.33 | 11.00 | 11.66 | 9.66 | 9.73 | 10.67 | 11.66 | 11.46 | 11.40 | 12.00 | 11.33 | 9.66 | 11.25 |
| Mean | 6.56 | 6.75 | 6.73 | 6.67 | 6.69 | 6.59 | | 6.63 | 6.76 | 6.70 | 6.63 | 6.73 | 6.59 | |
| Factors | 2017 | | 2018 | | | | | | | | | | | |
| | C.D. | SE (m) | C.D. | SE (m) | | | | | | | | | | |
| Genotype | 0.45 | 0.16 | 0.47 | 0.17 | | | | | | | | | | |
| Treatment | N/S | 0.07 | N/S | 0.07 | | | | | | | | | | |
| Genotype ×Treatment | N/S | 0.39 | 1.15 | 0.41 | | | | | | | | | | |

**Table 5:** Effect of mutagens on days to seed ripening in different genotypes of balsam.

| | 2017 | | | | | | | 2018 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gamma rays | | | Oryzalin | | | | Gamma rays | | | Oryzalin | | | |
| **Treatment Genotype** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** |
| BDR-22 | 32.33 | 31.66 | 29.33 | 28.86 | 28.33 | 26.16 | 29.45 | 31.33 | 27.83 | 26.83 | 27.83 | 27.50 | 24.83 | 27.69 |
| BDR-1 | 34.83 | 30.00 | 29.66 | 30.83 | 33.66 | 35.00 | 32.33 | 33.16 | 32.16 | 28.66 | 38.66 | 38.33 | 38.16 | 34.86 |
| BDV-1 | 30.33 | 28.83 | 28.66 | 30.00 | 31.66 | 30.23 | 29.95 | 31.83 | 30.50 | 28.66 | 36.83 | 36.50 | 35.66 | 33.33 |
| BS-39 | 28.83 | 26.83 | 27.33 | 29.40 | 28.93 | 30.00 | 28.55 | 27.00 | 27.00 | 29.33 | 31.16 | 30.00 | 29.00 | 28.91 |
| BS-14 | 27.33 | 25.00 | 27.00 | 26.10 | 26.43 | 23.83 | 25.95 | 29.66 | 30.33 | 22.83 | 23.66 | 25.50 | 23.83 | 25.97 |
| BS-20 | 32.00 | 33.83 | 29.83 | 25.60 | 26.83 | 25.83 | 28.98 | 22.33 | 28.66 | 26.50 | 22.00 | 22.50 | 25.83 | 24.63 |
| BS-39 | 27.00 | 32.16 | 29.16 | 23.66 | 25.33 | 21.83 | 26.52 | 29.50 | 29.83 | 32.66 | 26.50 | 26.00 | 23.33 | 27.97 |
| BS23 | 27.00 | 28.83 | 27.50 | 28.33 | 33.00 | 32.33 | 29.50 | 31.50 | 33.16 | 24.83 | 30.50 | 29.33 | 27.16 | 29.41 |
| BSW-7 | 32.66 | 31.66 | 30.83 | 35.83 | 31.66 | 29.00 | 31.94 | 30.66 | 36.00 | 28.16 | 33.66 | 33.50 | 30.50 | 32.08 |
| BSP-32 | 24.33 | 24.33 | 20.00 | 22.00 | 24.33 | 24.66 | 23.27 | 21.66 | 29.66 | 25.33 | 23.83 | 24.50 | 22.00 | 24.50 |
| BDR-2 | 30.33 | 27.16 | 22.83 | 28.33 | 26.26 | 28.56 | 27.25 | 33.83 | 25.00 | 22.50 | 30.50 | 30.33 | 26.50 | 28.11 |
| BSW-6 | 34.33 | 31.83 | 28.83 | 33.16 | 29.00 | 30.93 | 31.35 | 31.83 | 30.50 | 31.00 | 34.50 | 35.16 | 33.66 | 32.77 |
| BDP-13 | 38.33 | 27.83 | 29.50 | 34.66 | 35.00 | 28.96 | 32.38 | 33.83 | 33.83 | 34.83 | 32.00 | 31.66 | 25.33 | 31.91 |
| BDR-3 | 27.00 | 34.50 | 32.33 | 23.83 | 24.33 | 29.10 | 28.51 | 29.16 | 33.00 | 30.33 | 23.83 | 24.33 | 27.50 | 28.02 |
| BDV-17 | 24.50 | 25.83 | 31.16 | 26.33 | 21.16 | 25.33 | 25.72 | 22.50 | 29.00 | 29.16 | 24.00 | 24.16 | 27.66 | 26.08 |
| BD- Rosi | 24.83 | 23.83 | 25.66 | 27.66 | 25.50 | 23.57 | 25.17 | 27.66 | 22.83 | 26.16 | 27.66 | 28.50 | 30.66 | 27.25 |
| BDR-4 | 32.50 | 31.83 | 31.50 | 32.00 | 31.83 | 27.33 | 31.16 | 31.83 | 27.66 | 33.66 | 33.16 | 34.33 | 31.00 | 31.94 |
| BDR-5 | 32.33 | 33.16 | 33.16 | 34.50 | 29.90 | 31.33 | 32.40 | 31.16 | 33.00 | 32.00 | 32.83 | 32.50 | 31.33 | 32.13 |
| BDR-6 | 32.33 | 33.33 | 32.33 | 30.83 | 31.66 | 26.66 | 31.19 | 30.83 | 33.50 | 32.00 | 31.16 | 30.83 | 31.00 | 31.55 |
| BSV-11 | 23.66 | 25.00 | 29.33 | 27.16 | 28.23 | 25.83 | 26.53 | 22.66 | 23.83 | 28.00 | 25.50 | 25.66 | 25.83 | 25.25 |
| BS-28 | 30.33 | 29.16 | 26.50 | 29.83 | 29.10 | 32.66 | 29.60 | 32.66 | 34.66 | 23.50 | 31.50 | 31.16 | 28.00 | 30.25 |
| BSP-9 | 29.16 | 24.16 | 27.00 | 23.50 | 27.66 | 27.63 | 26.52 | 27.50 | 27.50 | 26.66 | 25.83 | 25.00 | 23.50 | 26.00 |
| BSP-1 | 25.50 | 28.66 | 30.83 | 27.30 | 30.00 | 28.83 | 28.52 | 23.66 | 30.16 | 32.83 | 25.16 | 26.33 | 25.66 | 27.30 |
| BSW-27 | 32.00 | 25.83 | 23.50 | 25.70 | 23.50 | 27.66 | 26.36 | 22.33 | 21.83 | 22.66 | 22.16 | 23.50 | 22.00 | 22.41 |
| BSR-16 | 27.00 | 34.16 | 33.66 | 26.93 | 25.50 | 26.36 | 28.93 | 30.66 | 31.66 | 27.33 | 23.83 | 25.50 | 23.50 | 27.08 |
| BDV-2 | 23.83 | 23.83 | 31.16 | 27.83 | 26.00 | 23.16 | 25.97 | 22.83 | 22.16 | 31.50 | 25.66 | 26.00 | 23.16 | 25.22 |
| BDP-1 | 33.33 | 25.83 | 22.00 | 26.53 | 25.83 | 29.66 | 27.20 | 27.16 | 23.50 | 22.83 | 22.50 | 23.33 | 23.66 | 23.83 |
| BDP-2 | 28.50 | 33.83 | 26.500 | 29.10 | 31.66 | 31.66 | 30.21 | 32.66 | 31.00 | 33.00 | 31.00 | 33.00 | 31.66 | 32.05 |
| BDR-7 | 31.16 | 29.00 | 28.667 | 33.00 | 29.00 | 35.66 | 31.08 | 31.33 | 33.00 | 32.16 | 29.33 | 30.83 | 30.66 | 31.22 |
| Mean | 29.57 | 29.03 | 28.477 | 28.58 | 28.32 | 28.27 | | 28.78 | 29.40 | 28.48 | 28.51 | 28.82 | 27.67 | |
| Factors | 2017 | | 2018 | | | | | | | | | | | |
| | C.D. | SE (m) | C.D. | SE (m) | | | | | | | | | | |
| Genotype | 1.14 | 0.41 | 0.71 | 0.25 | | | | | | | | | | |
| Treatment | 0.52 | 0.18 | 0.32 | 0.11 | | | | | | | | | | |
| Genotype ×Treatment | 2.80 | 1.00 | 1.75 | 0.63 | | | | | | | | | | |

**Table 6:** Effect of mutagens on number of pod per plant in different genotypes of balsam.

| | 2017 | | | | | | | 2018 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gamma rays | | | Oryzalin | | | | Gamma rays | | | Oryzalin | | | |
| **Treatment Genotype** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** |
| BDR-22 | 310.66 | 301.00 | 228.66 | 258.33 | 244.00 | 236.66 | 263.22 | 235.66 | 270.33 | 191.66 | 175.00 | 210.66 | 166.66 | 208.33 |
| BDR-1 | 257.66 | 287.00 | 250.00 | 216.33 | 223.00 | 124.00 | 226.33 | 220.00 | 293.33 | 303.33 | 133.33 | 127.66 | 124.00 | 200.27 |
| BDV-1 | 231.00 | 246.00 | 247.33 | 225.33 | 239.00 | 209.00 | 232.94 | 135.66 | 283.33 | 213.66 | 105.33 | 205.00 | 205.00 | 191.33 |
| BS-39 | 229.33 | 242.66 | 213.33 | 181.00 | 205.00 | 197.33 | 211.44 | 212.00 | 239.00 | 268.00 | 89.33 | 235.33 | 226.00 | 211.61 |
| BS-14 | 252.00 | 257.66 | 271.66 | 190.66 | 227.66 | 232.66 | 238.72 | 157.33 | 176.00 | 191.00 | 109.33 | 240.00 | 174.33 | 174.66 |
| BS-20 | 250.66 | 274.00 | 219.00 | 220.00 | 251.33 | 179.66 | 232.44 | 203.66 | 267.66 | 202.33 | 153.66 | 174.00 | 176.66 | 196.33 |
| BS-39 | 260.33 | 295.33 | 259.66 | 277.66 | 214.00 | 214.00 | 253.50 | 232.33 | 301.00 | 256.66 | 214.33 | 207.33 | 224.33 | 239.33 |
| BS23 | 223.00 | 218.66 | 209.33 | 238.66 | 220.66 | 229.33 | 223.27 | 139.33 | 281.00 | 218.33 | 109.66 | 204.66 | 193.66 | 191.11 |
| BSW-7 | 215.33 | 123.00 | 184.33 | 214.33 | 177.33 | 223.00 | 189.55 | 146.33 | 172.33 | 177.66 | 127.66 | 191.00 | 197.00 | 168.66 |
| BSP-32 | 291.00 | 238.66 | 216.33 | 225.00 | 197.00 | 200.33 | 228.05 | 179.33 | 272.00 | 273.66 | 158.00 | 217.33 | 165.00 | 210.88 |
| BDR-2 | 236.00 | 236.66 | 214.33 | 205.00 | 269.33 | 185.66 | 224.50 | 225.00 | 332.33 | 239.66 | 143.66 | 208.33 | 128.00 | 212.83 |
| BSW-6 | 153.00 | 178.66 | 205.00 | 150.00 | 223.66 | 172.66 | 180.00 | 213.00 | 248.66 | 180.00 | 134.66 | 144.33 | 119.00 | 173.27 |
| BDP-13 | 210.00 | 258.00 | 234.33 | 213.66 | 221.33 | 183.00 | 220.06 | 241.66 | 260.00 | 240.33 | 183.33 | 169.33 | 175.00 | 211.61 |
| BDR-3 | 207.00 | 269.33 | 247.33 | 230.33 | 204.33 | 237.33 | 232.61 | 204.33 | 177.66 | 160.66 | 212.33 | 167.00 | 155.00 | 179.50 |
| BDV-17 | 233.33 | 238.00 | 190.00 | 215.00 | 187.33 | 255.66 | 219.88 | 183.00 | 179.00 | 151.33 | 199.66 | 153.33 | 155.00 | 170.22 |
| BD- Rosi | 158.33 | 251.00 | 169.33 | 153.66 | 172.00 | 201.00 | 184.22 | 137.66 | 151.33 | 145.33 | 151.00 | 211.00 | 184.66 | 163.50 |
| BDR-4 | 263.00 | 271.33 | 206.00 | 224.33 | 191.00 | 212.66 | 228.05 | 181.33 | 259.33 | 237.00 | 200.66 | 155.66 | 176.00 | 201.66 |
| BDR-5 | 291.33 | 247.66 | 255.33 | 272.66 | 237.66 | 283.33 | 264.66 | 125.33 | 200.66 | 212.00 | 203.66 | 202.00 | 242.00 | 197.61 |
| BDR-6 | 254.33 | 253.00 | 235.00 | 270.33 | 286.66 | 237.00 | 256.05 | 149.66 | 239.00 | 229.66 | 252.33 | 185.33 | 268.00 | 220.66 |
| BSV-11 | 253.66 | 209.00 | 229.00 | 200.66 | 172.00 | 213.66 | 213.00 | 209.00 | 166.00 | 179.00 | 193.66 | 142.00 | 224.66 | 185.72 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BS-28 | 192.66 | 232.66 | 202.66 | 136.00 | 201.00 | 266.66 | 205.27 | 220.00 | 140.66 | 242.33 | 131.33 | 169.00 | 244.66 | 191.33 |
| BSP-9 | 255.00 | 190.33 | 200.00 | 226.00 | 213.66 | 251.33 | 222.72 | 161.66 | 238.33 | 236.66 | 156.00 | 181.33 | 270.66 | 207.44 |
| BSP-1 | 247.66 | 195.00 | 206.00 | 212.66 | 180.00 | 206.66 | 208.00 | 223.00 | 186.00 | 167.33 | 139.00 | 185.00 | 261.00 | 193.55 |
| BSW-27 | 209.66 | 231.00 | 223.66 | 237.33 | 225.00 | 257.33 | 230.66 | 207.33 | 249.66 | 214.33 | 92.00 | 253.66 | 257.00 | 212.33 |
| BSR-16 | 224.66 | 180.33 | 171.33 | 182.66 | 138.00 | 168.00 | 177.50 | 195.33 | 216.66 | 246.33 | 159.33 | 184.00 | 183.66 | 197.55 |
| BDV-2 | 243.33 | 173.00 | 191.66 | 199.33 | 167.33 | 157.00 | 188.61 | 174.33 | 240.00 | 190.00 | 183.33 | 200.00 | 168.00 | 192.61 |
| BDP-1 | 246.33 | 144.00 | 208.66 | 239.33 | 265.66 | 164.33 | 211.38 | 150.00 | 188.66 | 216.00 | 138.00 | 253.66 | 166.00 | 185.38 |
| BDP-2 | 240.00 | 243.00 | 207.66 | 195.33 | 219.00 | 163.66 | 211.44 | 177.66 | 210.33 | 212.00 | 197.33 | 269.00 | 175.33 | 206.94 |
| BDR-7 | 272.00 | 207.00 | 208.00 | 279.33 | 223.33 | 240.33 | 238.33 | 203.00 | 280.33 | 250.33 | 246.33 | 208.00 | 205.33 | 232.22 |
| Mean | 238.35 | 230.79 | 217.41 | 216.93 | 213.70 | 210.46 | | 187.72 | 231.74 | 215.40 | 161.83 | 195.00 | 193.50 | |
| Factors | 2017 | | 2018 | | | | | | | | | | | |
| | C.D. | SE (m) | C.D. | SE (m) | | | | | | | | | | |
| Genotype | 28.10 | 10.09 | 25.19 | 9.05 | | | | | | | | | | |
| Treatment | 12.78 | 4.59 | 11.45 | 4.11 | | | | | | | | | | |
| Genotype ×Treatment | 68.83 | 24.73 | 61.70 | 22.17 | | | | | | | | | | |

**Table 7:** Effect of mutagens on number of seed per pod in different genotypes of balsam.

| | **2017** | | | | | | | **2018** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Gamma rays** | | | **Oryzalin** | | | | **Gamma rays** | | | **Oryzalin** | | | |
| **Treatment Genotype** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** | **0 kR** | **35 kR** | **40 kR** | **50 µmol** | **100 µmol** | **150 µmol** | **Mean** |
| BDR-22 | 11.33 | 10.66 | 9.61 | 11.33 | 12.00 | 11.81 | 11.12 | 11.40 | 11.20 | 9.40 | 11.53 | 11.33 | 9.13 | 10.66 |
| BDR-1 | 12.66 | 9.77 | 10.83 | 11.99 | 12.22 | 10.93 | 11.40 | 12.80 | 10.80 | 11.40 | 12.40 | 11.26 | 11.53 | 11.70 |
| BDV-1 | 10.83 | 11.77 | 11.00 | 10.92 | 11.69 | 11.55 | 11.29 | 11.20 | 14.20 | 11.13 | 12.13 | 12.00 | 11.13 | 11.96 |
| BS-39 | 12.16 | 10.44 | 11.89 | 13.06 | 12.90 | 12.83 | 12.21 | 11.80 | 11.40 | 12.53 | 12.40 | 11.46 | 12.06 | 11.94 |
| BS-14 | 11.16 | 11.16 | 9.83 | 10.90 | 11.82 | 10.25 | 10.85 | 11.60 | 12.86 | 9.26 | 11.86 | 13.40 | 9.86 | 11.47 |
| BS-20 | 13.33 | 11.89 | 12.00 | 13.16 | 12.53 | 12.72 | 12.60 | 12.80 | 12.66 | 11.40 | 12.13 | 12.40 | 10.40 | 11.96 |
| BS-39 | 10.16 | 9.55 | 11.94 | 11.43 | 11.13 | 12.43 | 11.11 | 12.00 | 11.53 | 12.40 | 11.93 | 12.00 | 12.93 | 12.13 |
| BS23 | 11.50 | 12.00 | 11.39 | 11.42 | 10.76 | 10.71 | 11.29 | 11.66 | 11.60 | 12.13 | 11.40 | 12.06 | 10.80 | 11.61 |
| BSW-7 | 11.33 | 8.55 | 9.11 | 10.50 | 9.10 | 10.14 | 9.79 | 10.80 | 8.40 | 9.40 | 12.53 | 8.73 | 10.86 | 10.12 |
| BSP-32 | 12.00 | 12.77 | 12.05 | 12.50 | 12.65 | 12.60 | 12.43 | 12.20 | 11.86 | 12.06 | 12.13 | 12.20 | 12.06 | 12.08 |
| BDR-2 | 12.00 | 11.55 | 11.94 | 12.66 | 12.85 | 12.36 | 12.23 | 11.93 | 12.46 | 12.00 | 11.86 | 12.13 | 12.33 | 12.12 |
| BSW-6 | 11.66 | 12.33 | 12.39 | 13.16 | 11.76 | 13.20 | 12.41 | 12.06 | 12.73 | 13.33 | 15.80 | 11.73 | 12.00 | 12.94 |
| BDP-13 | 14.83 | 13.16 | 11.94 | 15.16 | 15.86 | 15.13 | 14.35 | 16.40 | 13.60 | 10.66 | 11.66 | 15.80 | 13.73 | 13.64 |
| BDR-3 | 10.00 | 11.33 | 10.50 | 11.10 | 11.03 | 10.03 | 10.66 | 11.66 | 12.00 | 12.13 | 11.93 | 11.60 | 9.26 | 11.43 |
| BDV-17 | 12.66 | 11.33 | 9.55 | 10.53 | 11.41 | 11.10 | 11.10 | 11.73 | 11.80 | 13.26 | 13.53 | 11.93 | 12.53 | 12.46 |
| BD- Rosi | 14.16 | 11.55 | 11.27 | 10.93 | 12.19 | 12.50 | 12.10 | 14.93 | 13.06 | 12.46 | 10.53 | 13.53 | 13.66 | 13.03 |
| BDR-4 | 11.66 | 11.77 | 11.11 | 12.56 | 13.20 | 13.16 | 12.24 | 12.60 | 12.86 | 9.33 | 12.73 | 12.73 | 13.66 | 12.32 |
| BDR-5 | 10.33 | 8.94 | 9.22 | 10.20 | 10.60 | 9.86 | 9.86 | 10.80 | 9.40 | 12.20 | 11.33 | 11.33 | 9.60 | 10.77 |
| BDR-6 | 10.00 | 10.22 | 11.83 | 10.76 | 10.73 | 11.64 | 10.86 | 10.86 | 11.46 | 12.20 | 11.26 | 11.06 | 12.00 | 11.47 |
| BSV-11 | 15.50 | 11.44 | 11.33 | 12.70 | 12.20 | 13.36 | 12.75 | 12.80 | 12.13 | 12.33 | 11.60 | 11.53 | 13.40 | 12.30 |
| BS-28 | 13.00 | 13.11 | 12.16 | 11.23 | 11.90 | 11.60 | 12.16 | 12.26 | 13.26 | 11.46 | 11.93 | 11.93 | 12.80 | 12.27 |
| BSP-9 | 11.66 | 12.05 | 11.50 | 11.86 | 11.73 | 12.30 | 11.85 | 12.00 | 11.60 | 11.26 | 11.40 | 11.40 | 12.33 | 11.66 |
| BSP-1 | 12.50 | 11.11 | 11.11 | 12.33 | 12.76 | 12.53 | 12.05 | 12.40 | 12.13 | 11.13 | 12.33 | 12.33 | 11.80 | 12.02 |
| BSW-27 | 13.00 | 11.50 | 12.00 | 10.36 | 10.56 | 9.70 | 11.18 | 12.80 | 11.93 | 11.40 | 12.40 | 12.40 | 11.93 | 12.14 |
| BSR-16 | 13.50 | 13.66 | 29.77 | 13.86 | 13.53 | 12.66 | 16.16 | 12.86 | 13.33 | 13.06 | 13.20 | 13.26 | 12.13 | 12.97 |
| BDV-2 | 15.16 | 13.11 | 11.39 | 15.20 | 14.16 | 14.60 | 13.93 | 15.20 | 12.46 | 12.33 | 13.93 | 13.93 | 11.93 | 13.30 |
| BDP-1 | 12.50 | 13.22 | 11.83 | 12.46 | 12.90 | 12.90 | 12.63 | 13.06 | 12.73 | 9.86 | 12.93 | 12.86 | 12.66 | 12.35 |
| BDP-2 | 12.50 | 9.83 | 7.83 | 12.73 | 14.16 | 13.33 | 11.73 | 12.60 | 9.13 | 10.26 | 13.06 | 13.73 | 10.46 | 11.54 |
| BDR-7 | 11.00 | 11.61 | 10.50 | 11.46 | 11.17 | 11.66 | 11.23 | 12.40 | 11.00 | 10.00 | 12.66 | 12.66 | 11.06 | 11.63 |
| Mean | 12.21 | 11.43 | 11.68 | 12.01 | 12.12 | 12.05 | | 12.40 | 11.92 | 11.44 | 12.29 | 12.23 | 11.72 | |
| Factors | 2017 | | 2018 | | | | | | | | | | | |
| | C.D. | SE (m) | C.D. | SE (m) | | | | | | | | | | |
| Genotype | 1.61 | 0.58 | 0.36 | 0.13 | | | | | | | | | | |
| Treatment | N/S | 0.26 | 0.16 | 0.05 | | | | | | | | | | |
| Genotype ×Treatment | N/S | 1.42 | 0.89 | 0.32 | | | | | | | | | | |

**Table 8:** Effect of mutagens on 1000 seed weight (g) in different genotypes of balsam.

| | 2017 | | | | | | | 2018 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gamma rays | | | Oryzalin | | | | Gamma rays | | | Oryzalin | | | |
| Treatment Genotype | 0 kR | 35 kR | 40 kR | 50 µmol | 100 µmol | 150 µmol | Mean | 0 kR | 35 kR | 40 kR | 50 µmol | 100 µmol | 150 µmol | Mean |
| BDR-22 | 8.66 | 8.73 | 8.23 | 9.80 | 8.55 | 8.45 | 8.74 | 8.45 | 8.70 | 8.20 | 8.06 | 8.85 | 8.03 | 8.38 |
| BDR-1 | 9.43 | 8.30 | 9.13 | 10.25 | 8.32 | 8.18 | 8.93 | 8.93 | 8.40 | 8.98 | 8.66 | 8.43 | 9.00 | 8.73 |
| BDV-1 | 9.56 | 8.76 | 9.06 | 9.43 | 9.53 | 9.46 | 9.30 | 9.21 | 8.58 | 9.25 | 8.95 | 8.25 | 9.25 | 8.91 |
| BS-39 | 7.73 | 8.46 | 7.97 | 8.02 | 9.04 | 8.23 | 8.24 | 8.20 | 8.36 | 8.56 | 7.75 | 8.40 | 8.83 | 8.35 |
| BS-14 | 10.60 | 10.23 | 10.13 | 9.84 | 10.12 | 9.97 | 10.15 | 9.98 | 10.00 | 10.60 | 9.85 | 9.71 | 9.71 | 9.97 |
| BS-20 | 6.83 | 8.53 | 7.80 | 9.12 | 9.61 | 9.55 | 8.57 | 7.48 | 8.75 | 7.93 | 7.43 | 9.01 | 8.03 | 8.10 |
| BS-39 | 8.30 | 8.43 | 8.59 | 8.89 | 8.94 | 8.67 | 8.63 | 8.38 | 8.20 | 8.70 | 8.68 | 8.30 | 8.08 | 8.39 |
| BS23 | 7.10 | 7.46 | 8.06 | 7.75 | 8.19 | 7.79 | 7.72 | 7.58 | 8.46 | 8.10 | 7.58 | 8.41 | 8.25 | 8.06 |
| BSW-7 | 10.20 | 9.86 | 9.89 | 9.55 | 8.69 | 8.70 | 9.48 | 9.86 | 9.68 | 9.71 | 9.73 | 9.88 | 9.63 | 9.75 |
| BSP-32 | 9.53 | 9.13 | 9.55 | 9.98 | 9.21 | 9.21 | 9.43 | 9.33 | 8.98 | 9.66 | 9.21 | 8.68 | 9.26 | 9.19 |
| BDR-2 | 9.10 | 9.46 | 8.89 | 9.06 | 8.72 | 9.46 | 9.11 | 9.00 | 9.35 | 8.10 | 8.76 | 9.31 | 8.50 | 8.83 |
| BSW-6 | 10.56 | 9.70 | 9.63 | 10.02 | 8.63 | 9.03 | 9.59 | 10.45 | 9.86 | 9.98 | 10.80 | 9.70 | 9.66 | 10.07 |
| BDP-13 | 9.60 | 9.26 | 8.90 | 9.06 | 9.28 | 7.56 | 8.94 | 12.18 | 12.11 | 12.55 | 12.16 | 12.38 | 12.46 | 12.31 |
| BDR-3 | 9.03 | 9.26 | 9.50 | 8.57 | 8.32 | 9.21 | 8.98 | 9.35 | 9.26 | 9.25 | 9.31 | 8.65 | 9.21 | 9.17 |
| BDV-17 | 9.53 | 9.13 | 9.73 | 7.43 | 8.27 | 9.00 | 8.85 | 9.23 | 9.08 | 9.28 | 9.23 | 8.85 | 9.00 | 9.11 |
| BD- Rosi | 9.26 | 9.16 | 8.46 | 9.56 | 9.30 | 8.00 | 8.96 | 9.45 | 8.53 | 8.71 | 9.73 | 8.13 | 8.00 | 8.76 |
| BDR-4 | 9.20 | 9.06 | 8.76 | 9.80 | 8.88 | 8.61 | 9.05 | 8.88 | 9.05 | 8.71 | 8.63 | 8.88 | 8.61 | 8.79 |
| BDR-5 | 10.03 | 9.66 | 7.30 | 9.33 | 8.39 | 9.39 | 9.02 | 10.06 | 9.65 | 9.08 | 10.15 | 9.71 | 9.20 | 9.64 |
| BDR-6 | 11.56 | 11.40 | 10.87 | 12.13 | 10.08 | 10.64 | 11.11 | 11.38 | 10.00 | 10.88 | 10.80 | 12.21 | 10.33 | 10.93 |
| BSV-11 | 8.60 | 8.46 | 8.76 | 9.30 | 9.68 | 8.17 | 8.83 | 8.56 | 8.33 | 8.91 | 8.03 | 8.35 | 8.76 | 8.49 |
| BS-28 | 8.30 | 8.66 | 8.53 | 9.21 | 8.42 | 8.52 | 8.60 | 8.35 | 8.633 | 9.283 | 8.00 | 8.96 | 7.98 | 8.53 |
| BSP-9 | 10.33 | 10.23 | 9.66 | 8.78 | 9.34 | 9.44 | 9.63 | 10.85 | 10.26 | 9.36 | 10.91 | 10.01 | 9.31 | 10.12 |
| BSP-1 | 9.36 | 9.20 | 8.93 | 9.94 | 9.00 | 8.75 | 9.19 | 9.20 | 8.81 | 8.70 | 8.86 | 9.00 | 8.75 | 8.88 |
| BSW-27 | 8.56 | 8.56 | 8.56 | 8.96 | 8.68 | 7.96 | 8.55 | 8.11 | 8.75 | 8.61 | 7.96 | 8.68 | 7.96 | 8.35 |
| BSR-16 | 8.30 | 7.73 | 8.00 | 7.57 | 9.29 | 8.21 | 8.18 | 8.31 | 7.91 | 8.20 | 8.36 | 7.50 | 8.21 | 8.08 |
| BDV-2 | 9.36 | 9.56 | 9.23 | 9.84 | 9.53 | 10.16 | 9.61 | 9.15 | 9.10 | 8.58 | 9.50 | 8.45 | 8.63 | 8.90 |
| BDP-1 | 9.43 | 9.46 | 9.23 | 10.26 | 9.33 | 9.99 | 9.61 | 8.90 | 9.38 | 8.63 | 8.91 | 8.65 | 8.83 | 8.88 |
| BDP-2 | 11.36 | 11.33 | 10.76 | 11.63 | 10.98 | 10.32 | 11.06 | 11.25 | 11.13 | 11.08 | 11.00 | 11.31 | 10.78 | 11.09 |
| BDR-7 | 11.16 | 10.93 | 10.90 | 12.73 | 10.96 | 10.55 | 11.20 | 10.91 | 11.18 | 10.65 | 9.38 | 11.25 | 10.55 | 10.65 |
| Mean | 9.33 | 9.24 | 9.07 | 9.51 | 9.15 | 9.00 | | 9.34 | 9.26 | 9.25 | 9.18 | 9.24 | 9.06 | |
| Factors | 2017 | | 2018 | | | | | | | | | | | |
| | C.D. | SE (m) | C.D. | SE (m) | | | | | | | | | | |
| Genotype | 0.40 | 0.14 | 0.32 | 0.11 | | | | | | | | | | |
| Treatment | 0.18 | 0.06 | 0.14 | 0.05 | | | | | | | | | | |
| Genotype ×Treatment | 0.99 | 0.35 | 0.80 | 0.28 | | | | | | | | | | |

**Table 9:** Effect of mutagens on seed yield per plant (g) in different genotypes of balsam.

| | 2017 | | | | | | | 2018 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gamma rays | | | Oryzalin | | | | Gamma rays | | | Oryzalin | | | |
| Treatment Genotype | 0 kR | 35 kR | 40 kR | 50 µmol | 100 µmol | 150 µmol | Mean | 0 kR | 35 kR | 40 kR | 50 µmol | 100 µmol | 150 µmol | Mean |
| BDR-22 | 30.28 | 27.61 | 18.06 | 28.57 | 25.04 | 23.61 | 25.53 | 22.73 | 26.24 | 14.76 | 16.37 | 21.16 | 12.23 | 18.92 |
| BDR-1 | 30.89 | 22.95 | 24.84 | 26.45 | 22.74 | 11.11 | 23.16 | 24.96 | 26.88 | 31.09 | 14.35 | 12.02 | 12.72 | 20.34 |
| BDV-1 | 23.68 | 25.45 | 24.74 | 24.36 | 26.68 | 22.80 | 24.62 | 14.03 | 34.44 | 21.98 | 11.45 | 20.47 | 21.07 | 20.57 |
| BS-39 | 21.45 | 21.48 | 20.26 | 19.39 | 23.86 | 20.77 | 21.20 | 20.50 | 22.85 | 28.75 | 8.67 | 22.62 | 24.09 | 21.25 |
| BS-14 | 29.88 | 29.54 | 27.26 | 21.00 | 27.06 | 23.68 | 26.40 | 18.11 | 22.39 | 18.64 | 12.74 | 31.28 | 17.00 | 20.03 |
| BS-20 | 22.66 | 27.65 | 20.75 | 26.44 | 30.13 | 21.89 | 24.92 | 19.43 | 29.64 | 18.16 | 13.87 | 19.48 | 14.53 | 19.18 |
| BS-39 | 21.74 | 23.78 | 26.95 | 28.88 | 21.26 | 22.98 | 24.26 | 23.47 | 28.46 | 27.78 | 22.12 | 20.67 | 23.46 | 24.32 |
| BS23 | 18.25 | 19.47 | 18.88 | 21.33 | 18.93 | 19.11 | 19.33 | 12.54 | 27.63 | 21.38 | 9.40 | 20.85 | 17.16 | 18.16 |
| BSW-7 | 24.91 | 10.24 | 16.39 | 21.59 | 14.10 | 19.560 | 17.80 | 15.55 | 14.08 | 16.31 | 15.59 | 16.40 | 20.60 | 16.42 |
| BSP-32 | 21.31 | 28.00 | 25.04 | 27.83 | 22.64 | 23.22 | 24.67 | 20.39 | 29.14 | 31.90 | 17.65 | 23.10 | 18.42 | 23.43 |
| BDR-2 | 25.79 | 25.95 | 22.63 | 23.37 | 30.37 | 21.68 | 24.96 | 24.20 | 38.93 | 23.27 | 14.86 | 23.69 | 13.21 | 23.03 |
| BSW-6 | 18.94 | 21.29 | 25.07 | 19.77 | 22.55 | 20.48 | 21.35 | 26.90 | 31.15 | 23.93 | 22.75 | 16.25 | 13.79 | 22.46 |
| BDP-13 | 30.06 | 31.48 | 24.77 | 29.47 | 32.57 | 20.81 | 28.19 | 48.24 | 43.16 | 32.40 | 26.02 | 33.27 | 29.77 | 35.47 |
| BDR-3 | 18.68 | 29.01 | 24.83 | 21.97 | 18.76 | 21.77 | 22.50 | 22.28 | 19.53 | 17.83 | 23.45 | 16.94 | 13.50 | 18.92 |
| BDV-17 | 28.25 | 24.41 | 17.62 | 16.72 | 17.66 | 25.55 | 21.70 | 19.61 | 19.42 | 18.58 | 24.96 | 16.02 | 17.73 | 19.39 |
| BD- Rosi | 21.05 | 26.65 | 16.44 | 16.14 | 19.54 | 20.06 | 19.98 | 19.49 | 16.95 | 15.87 | 15.41 | 23.26 | 20.07 | 18.50 |
| BDR-4 | 28.59 | 28.99 | 20.28 | 27.93 | 22.30 | 24.39 | 25.41 | 20.33 | 30.20 | 19.20 | 21.93 | 17.50 | 20.72 | 21.64 |
| BDR-5 | 30.06 | 21.49 | 18.17 | 26.15 | 21.12 | 26.18 | 23.86 | 13.70 | 18.33 | 23.45 | 23.46 | 22.40 | 21.48 | 20.47 |
| BDR-6 | 29.54 | 29.46 | 30.17 | 35.07 | 31.07 | 29.27 | 30.76 | 18.56 | 27.94 | 30.42 | 30.73 | 24.85 | 33.20 | 27.62 |
| BSV-11 | 33.47 | 20.06 | 22.88 | 23.97 | 20.32 | 23.62 | 24.05 | 22.81 | 16.85 | 19.65 | 18.05 | 13.78 | 26.50 | 19.60 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BS-28 | 20.76 | 26.34 | 21.00 | 14.16 | 19.98 | 26.45 | 21.45 | 22.43 | 16.03 | 25.78 | 12.44 | 18.13 | 25.15 | 19.99 |
| BSP-9 | 30.84 | 23.59 | 22.18 | 23.53 | 23.45 | 29.19 | 25.46 | 20.90 | 28.59 | 25.14 | 19.54 | 21.05 | 31.04 | 24.38 |
| BSP-1 | 28.72 | 19.74 | 20.53 | 26.31 | 20.75 | 22.63 | 23.11 | 25.38 | 19.79 | 16.15 | 15.16 | 20.53 | 26.97 | 20.66 |
| BSW-27 | 23.16 | 22.76 | 22.90 | 22.63 | 20.74 | 19.99 | 22.03 | 21.46 | 25.94 | 20.98 | 9.02 | 27.49 | 24.46 | 21.56 |
| BSR-16 | 25.13 | 19.39 | 41.20 | 19.20 | 17.10 | 17.35 | 23.23 | 21.11 | 22.83 | 26.36 | 17.59 | 18.35 | 18.16 | 20.73 |
| BDV-2 | 34.51 | 21.75 | 20.28 | 29.74 | 22.48 | 23.58 | 25.39 | 24.33 | 27.41 | 20.09 | 24.54 | 23.62 | 16.99 | 22.83 |
| BDP-1 | 29.00 | 17.95 | 22.93 | 30.73 | 31.95 | 21.16 | 25.62 | 17.45 | 22.64 | 18.31 | 15.93 | 28.32 | 18.61 | 20.21 |
| BDP-2 | 34.28 | 27.37 | 19.43 | 29.11 | 34.20 | 22.29 | 27.78 | 25.26 | 21.54 | 23.96 | 28.92 | 41.92 | 19.69 | 26.88 |
| BDR-7 | 33.51 | 26.46 | 23.17 | 40.59 | 27.50 | 29.45 | 30.11 | 27.45 | 34.49 | 26.62 | 29.82 | 29.77 | 23.97 | 28.68 |
| Mean | 26.53 | 24.15 | 22.75 | 24.91 | 23.68 | 22.57 | | 21.85 | 25.64 | 22.71 | 18.51 | 22.25 | 20.56 | |
| Factors | 2017 | | 2018 | | | | | | | | | | | |
| | C.D. | SE (m) | C.D. | SE (m) | | | | | | | | | | |
| Genotype | 4.14 | 1.48 | 3.11 | 1.12 | | | | | | | | | | |
| Treatment | 1.88 | 0.67 | 1.41 | 0.50 | | | | | | | | | | |
| Genotype ×Treatment | 10.15 | 3.64 | 7.63 | 2.74 | | | | | | | | | | |

## References


1. Aney A. Effect of Gamma irradiation on yield attributing characters in two varieties of pea (*Pisum sativum* L.), Biology; c2013.
2. Aras A, Cevahir G, Yentur S, Eryilmaz F, Sarsag M, Cag C. Investigation of anthocyanin localization in various parts of *Impatiens balsamina* L., Biotechnology and Biotechnological Equipment, 2014;21(1):69-73,
3. Bhusari A, Deshmukh M, Bhagat SR. Effect of gamma irradiation on morphological characters of marigold (*Tagetes erecta* L.). World Journal of Biology and Biotechnology. 2017;2(3):165-167.
4. Broertjes C, Van Harten AM. Applied mutation breeding for vegetatively propagated crops. *Elsevier*, Amsterdaml; c1988. p. 345.
5. Dilta BS, Sharma YD, Gupta YC, Bhalla R, Sharma BP. Effect of gamma-rays on vegetative and flowering parameters of chrysanthemum. Journal of Ornamental Horticulture. 2003;6(4):328-334,.
6. Gnanamurthy S, Mariyammal S, Dhanavel D, Bharathi T. Effect of gamma rays on yield and yield components characters $R_3$ generation in cowpea (*Vigna unguiculata* L.). International Research Journal of Plant Science. 2012;2:39-42.
7. Gordon SA. The biosynthesis of netural auxins. In Wain, R.L. and Wighman, F. eds. The chemistry and mode of action of plant growth substances. New York, Acedemic Press; c1956. p. 65-75.
8. Khan TN, Aasia R, Ghulam J, Tariq M. Morphological performance of peas (*Pisum sativum*. L) genotypes under rainfed conditions of potowar region. Indian Journal of Agricultural Research. 2013;51(1):51-60,.
9. Kole PC, Meher SK. Effect of gamma rays of some quantitative and qualitative characters in *Zinnia elegans* N.J. Jacguin in $M_1$ generation. Journal of Ornamental Horticulture. 2005;8(4):303-305,.
10. Maurya JK, Pal AK, Singh BK, Singh SV, Singh AK. Evaluation of different type single whorled germplasm of balsam (*Impatiens balsamina* L.). Indian Journal of Agriculture and Allied Sciences. 2015;1(3):44-47,.
11. Mori S, Yahata M, Kuwahara A, Shirono Y, Ueno Y, Hatanaka M, *et al.*, Morphological characterization of tetraploids of *Limonium sinuatum* produced by oryzalin treatment of seeds. Horticulturae. 2021;7(8):248,.
12. Momin KC, Gonge VS, Dalal SR, Bharad SG. Radiation induced variability studies in chrysanthemum under net house, Asian Journal of Horticulture, 2012;7(2):524-527.
13. Padhi M, Singh AK., Effect of gamma rays on flowering, post-harvest life and morphological changes in gladiolus varieties. International Journal of Agriculture, Environment and Biotechnology. 2022;15(2):229-237,.
14. Panse VG, Sukhatme PV. Statistical Methods for agricultural workers. ICAR, New Delhi; c1954.
15. Randhawa GS, Mukhopadhyay A. Floriculture in India. Allied Publishers, New Delhi; c2004. p. 318.
16. Sah R, Singh AK, Sisodia A, Padhi M. Influence of gamma dose on growth, flower and bulb parameters in tuberose varieties. International Journal of Current Microbiology and Applied Sciences. 2017;6(8):2038-2043.
17. Sarhan AZ, Nasr AA, Elsheinhab NAA, Elsawy MAA. Studies on the effect of radiation mutagens on the growth and flowering of *Tagetes erecta* plant. Middle East Journal of Agriculture Research. 2019;8(3):954-958.
18. Singh AK, Sisodia A. Textbook of Floriculture and Landscaping. New India Publishing Agency, New Delhi; c2017. p.16,
19. Singh AK, Sisodia A. Effect of gamma irradiation on morphological changes, flowering and induced mutants in gladiolus. Indian Journal of Horticulture. 2015;72(1):84-87.
20. Singh AK, Maurya JK, Pal AK, Singh BK, Singh SV. Studies on genetic parameters and correlation in single whorled balsam (*Impatiens balsamina*). Indian Journal of Agriculture and Allied Sciences, 2015;1(3):21-26.
21. Singh AK, Sah R, Sisodia A, Pal AK. Effect of gamma irradiation on growth, flowering and postharvest characters in tuberose varieties. International Journal of Current Microbiology and Applied Science. 2017;6(8):1985-1991.
22. Sisodia A, Singh AK. Influence of gamma irradiation on morphological changes, post-harvest life and mutagenesis gladiolus. Indian Journal of Agriculture, Environment and Biotechnology. 2015;85(1):79-86,.
23. Sisodia A, Singh AK, Vandana S. Morphological changes and induced mutagenesis in gladiolus varieties through gamma irradiation. Indian Journal of Agricultural Sciences. 2015;85(8):1059-1064.
24. Verma RC, Purbiya R., Effects of gamma radiation on seed germination and morphological characteristics of pea (*Pisum sativam* L.). Indian Journal of Plant Sciences. 2017;6(3):121-125.