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A review on effect of induced mutation on various morphological and flowering characters of gladiolus (*Gladiolus grandiflorus* L.)

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Abstract

Gladiolus is an important cut flower crop which possesses a great potential for export market to European countries especially during winter. The basic chromosome number of gladiolus is $X=15$ (Shukla *et al.* 2018) Gladiolus is an important flower crop and is very popular as cut flower both in the domestic and international market. The demand of gladiolus is increasing therefore; it needs attention towards genetic improvement. These have mostly been evolved through conventional breeding but a few through mutation breeding (Sathyanarayan *et al.* 2022). Mutations are induced in different crops to create variability for further improvement. In vegetatively propagated plants, mutation breeding offers great potentialities as the mutated part can be conveniently perpetuated by vegetative means resulting in the development of new forms. Gladiolus is highly heterozygous in its genetic constitution which makes it promising test material for inducing physical mutagenesis (Sahariya *et al.*, 2017). Corms of different gladiolus variety were treated with different doses of gamma rays, EMS and DES were taken under study. Higher doses of all mutagens adversely affected growth and flowering parameters of gladiolus.

Keywords: Gladiolus, mutation, gamma rays, EMS

Introduction

Gladiolus (*Gladiolus grandiflorus* L.), the queen of bulbous flowers is one of the major commercial flowers, which is being cultivated in various parts of the country and, has ever increasing demand in the flower markets. It is a monocotyledonous flowering bulbous plant, belonging to family Iridaceae and subfamily Ixioideae. It is the largest genus in the family Iridiaceae with 260 species, which are mainly native to South Africa. It is mainly grown for cut spikes, garden decoration and for exhibition. Gladiolus is preferred due to its wide range of adaptability, various coloured florets of different shapes and sizes and good shelf life (Tiwari *et al.* 2010) [13]. Gladiolus is vegetatively propagated by corms and its highly heterozygous nature and polyploidy makes the crop ideal material for genetic manipulation through mutation breeding (Kumari *et al.* 2015) [10]. Mutation breeding has played a major role in the development of many new colour/shape mutants in ornamental plants (Broertjes and Van Harten 1988) [1]. Mutations can be induced chemically with alkylating agents such as ethyl methane sulfonate or by physically by atomic or nuclear (Gamma) radiations (Bhajantri *et al.* 2013) [14]. Induced mutation is one of the most widely used techniques for creating additional variability in flower character.

Morphological characteristics

Number of days required for sprouting

Sathyanarayan *et al.* 2022 [3] Minimum days to sprouting was recorded with 15 Gy (12.19 days) which was at par with 25 Gy and control (0 Gy). In vM2 generation, observation minimum days to sprouting was recorded with lower dose of gamma irradiation i.e., 15 Gy (11.94 days), which was at par with 35 Gy, 25 Gy and control (0 Gy) while among the varieties, Minimum days to sprouting was observed with cv. Saffron (12.18 days). Kaur *et al.* 2022 [6] In Gladiolus cv. White prosperity, early sprouting showed in control and 20 Gy gamma dose. Late sprouting recorded in higher doses (80Gy-100 Gy), as the level of dose increases, the corm takes more time to sprout but it failed to exert any effect on number of sprouts per corm. Less number of sprouts found at higher dose (120 Gy). Patil *et al.* 2017 [7] revealed that minimum days required for sprouting (10.40) with maximum number of sprouts per corm (2.27) was observed in treatment of 0.5% EMS which was at par with 5 kR gamma radiations

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(10.67 days and 2.13, respectively). With the increasing concentration of gamma rays, EMS and DES the days to sprouting were increasing in Cv. American Beauty. Sahariya *et al.* 2017^[9] In cv. Candyman Rose, American Beauty, Chandni, Red beauty, Punjab Morning, White Prosperity, Jester, Srijana, Psittacinous Hybrid and Priscilla earliest sprouting was recorded in 3.0 kr gamma treatment followed by control (untreated) and 1.5 kr gamma treatment. Higher doses of gamma irradiation show lethal effect on sprouting of corms of some varieties results in no sprouting.

Sprouting Percentage

Tirkey *et al.* 2019^[5] Maximum sprouting percent (98.83%) recorded in (control) and minimum sprouting percent (75.90) in were observed with (Gama rays 12kr) The treatment of corms with gamma rays, SEMS and DEMS decreased the sprouting percentage of corms as compared to control in cv. White Prosperity. Sathyanarayan *et al.* 2019^[5] The maximum sprouting percentage (92.85%) was recorded in irradiation dose 25 Gy while minimum sprouting percentage (81.43%) recorded in irradiation dose 55Gy. Variety Saffron noted maximum sprouting percentage (98.68%) and followed by variety Dull Queen, while minimum sprouting percentage (69.61%) observed in variety Candy Man in vM1 generation. nteraction effect of maximum sprouting percentage (99.89%) was recorded in the variety Saffron with irradiation dose at 25 Gy and minimum sprouting percentage (59.17%) is observed in the variety Candy Man with irradiation dose at 55 Gy. Shukla *et al.* 2018^[4] Candyman recorded significantly maximum sprouting percentage (87.50%) followed by Her Majesty (85.00%) and American Beauty (82.50%). Corms treated treatment 30 Gy recorded maximum sprouting percentage (92.36%) which was at par with 15 Gy (89.58%), 30 Gy (85.41%) and 45 Gy (83.33%) gamma radiation doses. Patil *et al.* 2009^[7] percent sprouting was also significantly affected by treatments but not by varieties. 1 kR treatment noted 100 percent sprouting in vM1 generation but started to decrease as the dose rate increased in both the generations. The poorest sprouting was observed in corms which were treated with 7 kR gamma rays (75.81% in vM1 and 74.67% in vM2 generation). Maximum sprouting percentage (93.28% and 90.34%, respectively) was noted in cv. Nova Lux, while minimum in cv. Eurovision in both succeeding generations.

Plant Height

Sathyanarayan *et al.* 2019^[5] Gamma irradiation had significant effect on plant height at 30 and 60 days it is noted that the maximum plant height observed in control (untreated corms of the plants) was 45.09 cm and 68.46 cm at 30 and 60 DAP, respectively. The difference between height of control and 15 Gy treated plants was very less whereas a drastic reduction in plant height was recorded at 55 Gy after 30 as well as 60 days after planting. Among all varieties, cv. Candy Man had produced taller plants (45.18 cm and 76.29 cm at 30 and 60 DAP, respectively). Patil *et al.* 2009^[11] plant height was maximum at 2 kR treatment in both the generations i.e. 106.57 cm and 101.76 cm, respectively. Furthermore, 1 kR and 3 kR also produced taller plants than that were produced by control and other higher doses. Cv. Nova Lux had produced taller plants (93.04 cm and 87.78 cm in the two generations). Shukla *et al.* 2018^[4] reported application of 15 Gy resulted in maximum plant height (82.27 cm) at 75 DAS while, minimum plant height was recorded with 60 Gy

treatment also variety Candyman recorded significantly maximum plant height at 25, 50 and 75 DAS. Tirkey *et al.* 2019^[5] reported Maximum Plant height (98.88 cm) in (control) and minimum Plant height (91.98 cm) were observed with (Gamma Rays 12Kr) at 120 DAP in variety White Prosperity. Tiwari *et al.* 2010^[13] reported in M1 generation, significant increase in plant height and spike length at 5 KRD & stunted growth of plant/spike length -at 10KRD gamma irradiation were observed in cultivars Peter Pear, Advance Red, White Prosperity and Nova Lux of gladiolus

No. of Leaves per plant

Sathyanarayan *et al.* 2022^[3] In vM1 generation 25 Gy enhanced number of leaves per plant (12.88), which was found at par with 15 Gy treatment (12.37), in vM2 generation. maximum was recorded at treatment 15 Gy (15.02) which was found at par with control (13.89) and 25 Gy (13.42) while in both generations' maximum reduction in number of leaves per plant was noted at highest gamma rays treatment i.e. 55 Gy. In vM1 generation Cv. American Beauty reported the highest number of leaves per plant i.e. 14.15 leaves per plant. In vM2 generation maximum number of leaves was noted in cv. Saffron (16.52). Kaur *et al.* 2022^[6] in cultivar White Prosperity reported an amazing result of gamma dose 20gy in the number of leaves per corm. Patil *et al.* 2017^[11] in variety American Beauty observed that In case of leaves produced by plant when were corms treated with EMS @ 0.5% had maximum values i.e. 12.87. Kumari *et al.* 2015^[10] a significant reduction in number of leaves per plant recorded with the gradual increase in gamma rays dose. Maximum number of leaves per mother corm (11.02, 11.06) was recorded in control which was at par with leaf number at 25 Gy (10.80, 11.55) whereas minimum number of leaves were recorded (6.26, 6.56 in vM1 and vM2, respectively) at 70 Gy. Maximum number of leaves was recorded in variety Nathan Red (11.29, 12.92) whereas variety White Friendship had minimum number (7.54, 7.87) of leaves and was at par with Red Majesty (7.61, 7.66). Patil *et al.* 2009^[11] under different irradiation treatments, maximum number of leaves was produced by the corms treated with 2 kR dose of gamma rays (18.52 in vM1 and 17.96 in vM2 generation) which was followed by 1 kR treatment while it decreased as the dose of gamma rays increased irradiation (7 kR) produced minimum number of leaves per plant. Shukla *et al.* 2018^[4] found application of 15 Gy recorded maximum number of leaves (9.16) while, minimum number of leaves was recorded at 60 Gy treatment (7.13) and variety Candyman was found to have maximum number of leaves per plant at 50 and 75 DAS (7.83 and 9.52, respectively).

Length of leaf and leaf area

Kaur *et al.* 2022^[6] in cultivar White Prosperity found that as the dose increases the length and especially the width of the leaf decreases and therefore size of leaf is influenced due to application of gamma irradiation gamma dose 20gy was found best in leaf length and size. Shukla *et al.* 2018^[4] In case of gamma radiation treatments, control (0 Gy) was recorded significantly maximum leaves length at 25, 50 and 75 DAS while minimum leaf length was recorded at 60 Gy treatments. Variety Candyman have maximum length of leaf at 25, 50 and 75 DAS whereas minimum length was recorded in variety American Beauty. Patil *et al.* 2017^[7] observed that

in *Gladiolus* variety American Beauty leaf area was maximum 33.90 cm² when corms treated with EMS @ 0.5%. Kumari *et al.* 2015 [10] observed that Leaf length was reduced at all the gamma rays doses as compare to control whereas leaf width was slightly increased at 25 Gy and further decreased with subsequent increase in gamma rays dose in both the generations. Maximum leaf length (37.50, 38.67) was recorded in variety Red Majesty whereas Jester Gold variety exhibited maximum leaf width (3.41, 3.68).

Floral Characteristics

Days taken to Initiation of Spike

Sathyanarayan *et al.* 2022 [3] reported thatat gamma irradiation 15 Gy exhibited earliest spike emergence in (66.05 and 73.02 days) and delayed spike initiation with increase in doses and maximum number of days was taken by corms (73.02 and 78.39 days) which were treated with the dose of 55 Gy gamma rays vM1 as well as vM2 generation. Minimum number of days for emergence of spike in vM1 generation was recorded in variety Dull Queen (63.99 days) which was found statistically at par to variety American Beauty. Shukla *et al.* 2018 [4] found that the minimum days for spike initiation (64.12) was observed in variety Her Majesty while the maximum days (75.39) was observed in variety Candyman, irradiation dose 15 Gy significantly taken minimum days (63.76) for day to spike initiation while maximum days was taken at 60 Gy (71.33 days). Turkey *et al.* 2019 [5] in variety White Prosperity also observed that earliest spike initiation 79.50 days were recorded in Gamma Rays 8Kr closely followed by 81.00 days Soaked EMS @ 0.25% which were at par with each other. Sahariya *et al.* 2017 [9] investigated in ten varieties of *gladiolus* (*Gladiolus hybrida* L.) namely, Candyman Rose, American Beauty, Chandni, Red beauty, Punjab Morning, White Prosperity, Jester, Srijana, Psittacinous Hybrid and Priscilla and found thatearliest spike emergence was recorded with interaction of 5.0 kr with cv. Candyman Rose. Gamma doses at 4.0 kr, 4.5 kr and 5.0 kr were found lethal in case of cv. Punjab Morning and Psittacinous Hybrid while cv. Chandni failed to produce any spike at 4.5 kR and 5.0 kR. Patil *et al.* 2009 [11] found treatment with 2 kR gamma radiation dose induced fast initiation of spike as it required only 55.70 days in vM₁ generation and 56.27 days in vM₂ generation and meanwhile 1 kR and 3 kR treatments also reduced days to spike initiation as compared to control in both generations. Spike initiation was delayed with increase in doses and maximum number of days was taken by corms which were treated with the dose of 5 kR gamma rays.

Days taken to opening of first floret

Patil *et al.* 2017 [7] in *Gladiolus* variety American Beauty observed that minimum days to first floret open (72.73 days) was observed in corms treated with EMS at 0.5% and maximum number of days (92.93 days) was taken by corms which were treated with the dose of 10 kR gamma rays. Karki *et al.* 2010 [8] During the first year of the experiment plants treated with 0.5 kR of gamma rays took least number of days for opening of lowermost floret i.e. 5.23 days, whereas during second year of the experiment as well as poled data unirradiated plants took minimum days of opening.

Length of the spike

Pawadashettii *et al.* 2022 [2] reported that In vM₁ generation

the maximum length of spike was observed in corms treated with 25 Gy gamma ray doses (110.33 cm) and Minimum length of spike was noticed in corms treated with 55 Gy gamma ray doses (89.02 cm) In vM₂ longer spike observed in corms treated with 25 Gy gamma ray doses (116.27 cm) and shorter spike was observed in corms treated with 55 Gy gamma ray doses (95.50 cm). In M1 generation minimum length of spike was recorded in Arka Pratham (78.20 cm) corms treated with 55 Gy and maximum length of spike was recorded in Arka Gold corms treated with 25 Gy (120.07 cm). In M2 generation highest length of spike was recorded in Arka Gold corms treated with 25 Gy (120.87 cm) and lowest length of spike was recorded in untreated corms of Arka Pratham (94.00 cm). Shukla *et al.* 2018 [4] in his experiment found that the maximum length of spike (69.95 cm) was recorded in variety Candyman while minimum length was observed in variety American Beauty (52.85 cm) and irradiation dose 15 Gy recorded maximum (67.18 cm) spike length, while the minimum was recorded at 60 Gy. Patil *et al.* 2017 [7] in Variety American Beauty found that maximum length of spike (77.46 cm) was recorded in corms treated with 0.5% EMS. Turkey *et al.* 2019 [5] in variety White Prosperity found the length of spike also increased with increase in concentration of EMS treatment. Maximum length of spike (cm) 81.73 cm were recorded in Soaked EMS @ 0.25%.

No. of floret per spike

Sathyanarayan *et al.* 2022 [3], number of florets per spike reduced due to application of gamma doses. At 25 Gy gamma irradiation, the maximum number of florets per spike (10.99) was reported in vM₁ generation and during the vM₂ generation, whereas the 15 Gy dose resulted in a slightly higher number of florets (11.43) Among the varieties, Candyman exhibited maximum number of florets per spike (13.26) in vM₁ generation In vM₂ generation, again the variety Candyman exhibited maximum number of florets per spike (14.54). Shukla *et al.* 2018 [4] observed in respect of gamma Irradiation 15 Gy recorded maximum number of florets (13.42 florets), whereas minimum number of florets (11.21 florets) was recorded at 60 Gy. Patil *et al.* 2017 [7] in *Gladiolus* variety American Beauty reported that maximum number of florets per spike (11.60) when corms were treated with 0.5% EMS. Turkey *et al.* 2019 [5] in variety White Prosperity observed maximum number of florets per spike 14.12 were recorded Soaked EMS @ 0.25%. Sahariya *et al.* 2017 [9] During first year maximum number of florets was recorded with 2.5 kr (13.86) dose of gamma irradiation. However, during second year maximum number of florets per spike were registered with 1.0 kr dose of gamma irradiation. Number of florets per spike reduced due to application of gamma doses, as doses increased and higher doses of gamma rays resulted in minimum number of florets per spike.

Flower diameter

Sathyanarayan *et al.* 2019 [5] reported that maximum floret diameter (78.45 mm) recorded in gamma irradiation dose at 15 Gy and the minimum Flower diameter (66.46 mm) was observed in gamma irradiation dose at 55 Gy. While maximum flower diameter (81.41 mm) recorded in variety Candy Man and minimum flower diameter (67.39 mm) observed in variety American Beauty. Interaction effect of gamma rays and varieties was observed maximum flower diameter (94.93 mm) in variety Candy Man with gamma

irradiation dose at 15 Gy and minimum flower diameter (61.66 mm) founded in variety Dull Queen at 45 Gy. Patil *et al.* 2017^[7] in Gladiolus variety American Beauty noted maximum floret diameter (11.04 cm) when corms were treated with 0.5% EMS).

Vase Life

Shukla *et al.* 2018^[4] reported the maximum vase life of cut spike was recorded in variety American Beauty (8.24 days) while minimum vase life was observed in variety Candyman (7.42 days) and among all the gamma irradiation doses 15 Gy recorded maximum vase life (9.11 days), whereas the minimum vase life was observed at 60 Gy (7.11 days). Tirkey *et al.* 2019^[5] in variety White Prosperity reported maximum Vase life (days) 10.77 days in Soaked EMS @ 0.25%. Patil *et al.* 2009^[11] Gamma radiation treatments at lower doses also helped to increase vase life in all three cultivars (American Beauty, Nova Lux and Eurovision). Significantly higher vase life of 9.46 days and 8.96 days in progressive generations was observed in spikes that were produced by corms treated with 2 kR followed by 1 kR and 3 kR gamma radiation treatments as compared to control in both generations. Higher doses reduced vase life of cut spikes. Cv. Nova Lux had noted maximum vase life of 10.11 days and 9.28 days, respectively, as compared to cvs. American Beauty and Eurovision, in both the generations.

Conclusion

The review concluded that the lower dose of induced mutation either gamma irradiation or EMS treatment performed better in all vegetative and floral characters of Gladiolus in different variety.

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