Effect of Gibberellic Acid (GA_3)and Benzyl Adenine (BA) on vegetative growth and flower induction in gladiolus (*Gladiolus grandifloras*)

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ABSTRACT

The present study was carried out during 2021 -2022 at the experimental farm of Division of Floriculture and Landscaping, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, Jammu and Kashmir. The trial was laid out in factorial randomized block design with three replications and twenty-one treatment combinations. The treatment comprised of three gladiolus varieties viz., American Beauty, White Prosperity and Red Beauty and two growth regulators with their three levels of each viz., BA (50, 75 and 100 ppm) and GA3 (100, 150 and 200 ppm), and compared with control. The influence of foliar application of plant growth regulator on vegetative growth and flower induction of three gladiolus cultivars namely American Beauty, White Prosperity and Red Beauty. Growth regulators, viz., gibberellic acid (100, 150 and 200 ppm) and benzyl adenine (50, 75 and 100 ppm) were sprayed at 3 leaves and 6 leaves stage after planting of corms. The results revealed that foliar application of GA3 @ 200ppm on cv. 'White Prosperity' recorded maximum plant height (134.27 cm), number of leaves per plant (8.53), leaf area (74.41 cm2), minimum days to 50% spike emergence (95.00) and 50% basal floret showing colour (107.00 days). It can be concluded from the present investigation that gladiolus variety 'White Prosperity' performed better than other varieties in respect of all the vegetative and flowering parameters. Among interactions, foliar application of GA3 @200 ppm concentration significantly increased vegetative parameters and induced early flowering in variety White Prosperity.

Keywords: Benzyl Adenine, Gibberellic Acid, Gladiolus, Growth Regulators

1. INTRODUCTION

Gladiolus (*Gladiolus grandiflorus*) also known as "Sword Lily" is one of the important ornamental flowering bulbous plant in India as well as in the world. It belongs to the Irideaceae family and is grown as bedding plant in gardens and used in floral arrangements for interior decoration as well as making high-quality bouquets (Lepcha et al., 2007). The flower is in high demand due to its attractive spikes, big florets, dazzling colors and long vase life (Farid-Uddin et al., 2002).

Gibberellic acid is known to be involved in increasing stem height, number of leaves per plant, leaf area, shoot dry weight and flower diameter (Siraj and Al-Safar, 2006). GA3 delays senescence of flowers by reducing the senescence-promoting effect of ethylene (Faraji et al., 2011). However, the role of GA3 in plants is complicated (Arora et al., 1992). Attempts have been made to explore the role of GA3 in growth and flowering of gladiolus by various workers and the application of GA3 was found to shorten number of days to flowering, increase spike length, number of flowers per spike, floret diameter, shoot elongation and vegetative growth significantly (Roychowdhury, 1989; [4]. BAP delays senescence by protecting cells and proteins (Faraji et al., 2011) and increase the postharvest life of different cut flowers by delaying breakdown and degradation of proteins and chlorophyll (Emami et al., 2011; Faraji et al., 2011).

2. MATERIAL AND METHODS

The present study was carried out during 2021 -2022 at the experimental farm of Division of Floriculture and Landscaping, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, Jammu and Kashmir. The trial was laid out in factorial randomized block design with three replications and twenty-one treatment combinations. The treatment comprised of three gladiolus varieties viz., American Beauty, White Prosperity and Red Beauty and two growth regulators with their three levels of each viz., BA (50, 75 and 100 ppm) and GA3 (100, 150 and 200 ppm), and compared with control. Solution of plant growth regulators was sprayed as per the treatment along with control at 30th and 60th day after planting. All the intercultural operations were followed as and when required. Randomly five plants were selected from each plot and labelled for the purpose of recording various parameters. The data was analyzed statistically.

3. RESULTS AND DISCUSSION

3.1 Plant height

The results of the present experiment revealed that the varieties and plant growth regulators showed significant effect on the plant height (Table 1).The mean value of different cultivars of gladiolus studied showed that plant height produced by White Prosperity (125.74 cm) were higher than American Beauty (119.65 cm) and Red Beauty (113.41 cm). Data recorded for plant growth regulators (Table 1) reveal that maximum plant height (124.06 cm) were noticed in plant treated with foliar spray of GA_3 @ 200 ppm, which was found to be statistically at par with GA_3 @ 150 ppm and GA_3 @ 100 ppm (122.02 cm) and (121.53 cm) respectively, while the minimum plant height (113.91 cm) were recorded in control. The interaction effect of varieties and plant growth regulators was also found significant. The maximum plant height (124.06 cm) was noticed in plants treated with GA_3 @ 200 ppm, followed by plants treated with GA_3 @ 150 ppm, while the minimum plant height (113.91 cm) was recorded in control. An increase in growth parameters with the application of GA_3 might have been resulted due to the promotory action of gibberellic acid on dormancy of gladiolus corms and an enhanced cell division in shoot tip and cell elongation. These results can be correlated with the findings of Sudhakar and Rameshkumar [20] in gladiolus. Increasing plant height in with the application of GA_3 has also been reported in gladiolus [4, 15], tulip [17], iris [1] and tuberose [3]. This may be possibly due to its growth promoting effect in stimulating and accelerating cell division and/or cell enlargement.

Table 1: Effect of growth regulators and varieties on plant height (cm) in gladiolus.

Growth regulators	Varieties			
	American Beauty	White Prosperity	Red Beauty	Mean
Control	118.80	120.33	102.60	113.91
BA 50 ppm	120.00	125.00	116.33	120.44
BA 75 ppm	119.47	122.47	112.27	118.07
BA 100 ppm	119.37	120.93	111.20	117.17
GA_3 100 ppm	119.40	128.33	116.87	121.53
GA_3 150 ppm	120.20	128.87	117.00	122.02
$GA_3$200 ppm	120.30	134.27	117.60	124.06
Mean	119.65	125.74	113.41	

	Varieties (A)	Growth regulators (B)	Interaction (A × B)
SE(m)	0.61	0.94	1.62
C.D.	1.76	2.69	4.65

3.2 Number of leaves per plant

The results of the present experiment revealed that the varieties and plant growth regulators showed significant effect on the number of leaves per plant (Table 2).The mean value of different cultivars of gladiolus studied showed that number of leaves per plant produced by White Prosperity (7.77) was statistically at par with that of American Beauty (7.65). Data recorded for plant growth regulators reveal that maximum number of leaves per plant (8.23) were produced in plants treated with GA_3 @ 200 ppm, which was found to be statistically at par with GA_3 150 @ ppm (7.99), while the minimum number of leaves (7.14) were recorded in control. The interaction effect of varieties and plant growth regulators on number of leaves per plant of gladiolus was found to be non-significant. Various factors play part in enhancing the growth of gladiolus plants, like the genetical makeup of cultivars, favorable environmental conditions and soil texture. Hence more number of leaves per plant in White Prosperity may be due to its genetic characteristics that best suits to soil and climatic condition provided (Al-Humaid, 2004). An increase in growth parameter like number of leaves, with the application of GA_3 might be due to enhanced cell division occurred in shoot tip with cell elongation and growth promoter action of gibberellic acid [20]. In various studies, exogenous application of gibberellin was found to be the promoter of shoot elongation and vegetative growth (Xu *et al*, 1997; [4].

Table 2: Effect of growth regulators and varieties on number of leaves per plant in gladiolus.

Growth regulators	Varieties			
	American Beauty	White Prosperity	Red Beauty	Mean
Control	7.20	7.33	6.90	7.14
BA 50 ppm	7.57	7.67	7.53	7.59
BA 75 ppm	7.47	7.50	7.43	7.47
BA 100 ppm	7.40	7.40	7.37	7.39
GA_3 100 ppm	7.80	7.90	7.73	7.81
GA_3 150 ppm	8.00	8.03	7.93	7.99
$GA_3$200 ppm	8.10	8.53	8.07	8.23
Mean	7.65	7.77	7.57	
	Varieties (A)	**Growth regulators (B)**	**Interaction (A × B)**	
SE(m)	0.06	0.08	0.15	
C.D.	0.16	0.24	N/A	

3.3 Leaf area (cm^2)

The results of the present experiment revealed that the varieties and plant growth regulators showed significant effect on the leaf area (cm^2) (Table 3).The mean value of different cultivars of gladiolus studied showed that leaf area (cm^2) produced by White Prosperity (71.09 cm^2) was found to be statistically at par with American Beauty (70.17 cm^2). Data recorded for plant growth regulators reveal that maximum leaf area (73.90 cm^2) were

noticed in plants treated with foliar spray of GA_3 @ 200 ppm, which was statistically at par with GA_3 @ 150 ppm (73.19 cm^2) and GA_3 @ 100 ppm (72.97 cm^2), while the minimum leaf area (63.12 cm^2) were recorded in control. The interaction effect of varieties and plant growth regulators was also found significant. The maximum leaf area (74.41 cm^2) was noticed in the treatment combination of White Prosperity with the foliar application of GA_3 @ 200 ppm which was found to be at par in treatment combination of American Beauty with foliar spray of GA_3 @ 200 ppm, Red Beauty with foliar spray of GA_3 @ 200 ppm, White Prosperity with foliar spray of GA_3 @ 150 ppm, American Beauty with foliar spray of GA_3 @ 150 ppm, Red Beauty with foliar spray of GA_3 @ 150 ppm, White Prosperity with foliar spray of GA_3 @ 100 ppm, American Beauty with foliar spray of GA_3 @ 100 ppm, Red Beauty with foliar spray of GA_3 @ 100 ppm and White Prosperity with foliar spray of BA 50 ppm (74.01 cm^2), (73.27 cm^2), (73.22 cm^2), (73.20 cm^2), (73.16 cm^2) (73.10 cm^2) (72.96 cm^2), (72.85 cm^2)and (72.60 cm^2) respectively while the minimum leaf area (62.80 cm^2) was recorded in control. It may be due to action of gibberellins occurring through the enhancement in auxin by proliferating the site of auxin action. Also, foliar application of growth regulator shows the effect on vegetative parameters (Kirad*et al*., 2001).

Table 3: Effect of growth regulators and varieties on leaf area (cm^2) in gladiolus.

Growth regulators	Varieties			
	American Beauty	White Prosperity	Red Beauty	Mean
Control	62.83	63.73	62.80	63.12
BA 50 ppm	72.49	72.60	72.20	72.43
BA 75 ppm	71.49	72.02	70.99	71.50
BA 100 ppm	64.17	68.54	63.80	65.50
GA_3 100 ppm	72.96	73.10	72.85	72.97
GA_3 150 ppm	73.20	73.22	73.16	73.19
$GA_3$200 ppm	74.01	74.41	73.27	73.90
Mean	70.17	71.09	69.87	
	Varieties (A)	**Growth regulators (B)**	**Interaction (A × B)**	
SE(m)	0.24	0.37	0.64	
C.D.	0.69	1.06	1.83	

3.4 Days to 50% spike emergence

Minimum number of days to 50% spike emergence (102.00 days) was observed in cv. White Prosperity. Among the plant growth regulator treatments, minimum number of days to 50% spike emergence (95.56 days) was recorded with foliar application of GA_3at 200 ppm which was found to be statistically at par with GA_3 150 ppm (96.33 days) whereas control recorded maximum number of days to 50% spike emergence (102.00 days). Interaction effect due to varieties and growth regulators on number of days to 50% spike emergence was found to be significant. The treatment combination of GA_3 200 ppm and White Prosperity variety significantly recorded minimum number of days to 50% spike emergence (95.00 days) which was found to be statistically at par with the treatment combination of American Beauty with GA_3 @ 200 ppm, Red Beauty with GA_3 @ 200 ppm, White Prosperity with GA_3 @ 150 ppm and American Beauty with GA_3 @ 150 ppm (95.67 days), (96.00 days), (96.00 days) and (96.33 days) respectively whereas the treatment combination of control and Red Beauty variety noted maximum number of days to 50% spike emergence (110.67 days) in gladiolus. This might be due to higher concentrations of GA_3associated with

anthocyanin and developed florigen, which induce early flowering, also increase in endogenous level of GA_3 and increased photosynthetic area and respiration which enhanced CO_2 fixation in plant and associated with the early flowering (Ramachandrudu and Thangam, 2007). Neetu*et al*., (2007) and Devadanam*et al*., (2013) also noticed that higher concentration of GA_3 influenced early initiation of spike in gladiolus.

Table 4: Effect of growth regulators and varieties on days to 50% spike emergence in gladiolus.

Growth regulators	Varieties			
	American Beauty	White Prosperity	Red Beauty	Mean
Control	110.00	109.67	110.67	110.11
BA 50 ppm	103.67	103.33	104.00	103.67
BA 75 ppm	105.00	104.67	107.67	105.78
BA 100 ppm	108.67	108.33	109.00	108.67
GA_3 100 ppm	102.33	97.00	102.67	100.67
GA_3 150 ppm	96.33	96.00	96.67	96.33
$GA_3$200 ppm	95.67	95.00	96.00	95.56
Mean	103.10	102.00	103.81	
	Varieties (A)	Growth regulators (B)	Interaction (A × B)	
SE(m)	0.19	0.28	0.49	
C.D.	0.53	0.82	1.41	

3.5 Days to 50% basal floret

The observations on number of days taken for 50% basal floret showing colour have been presented in Table 5. The earliest number of days taken for 50% basal floret showing colour was recorded in White Prosperity (102.00 days) followed by American Beauty (103.10 days). The higher doses of GA_3 @ 200 ppm took lesser number of days (107.33 days) taken for 50% basal floret showing colour as compared control (110.67 days). The interaction of varieties and plant growth regulators significantly influenced days taken for 50% basal floret showing colour. Earliest days (107.00 days) taken for 50% basal floret showing colour was recorded with treatment combination of White Prosperity and foliar spray of GA_3 @ 200 ppm which was found to be statistically at par with the treatment combination of American Beauty with GA_3 @ 200 ppm, Red Beauty with GA_3 @ 200 ppm and White Prosperity with GA_3 @ 150 ppm (107.33 days), (107.67 days) and (108.33 days) respectively. It may be due to the application of GA_3 has positive impact on regulating vegetative growth and early floral initiation. Gibberellic acid promoted vegetative growth and increased the photosynthetic and metabolic activities caused more transport and utilization of photosynthetic products resulted early flowering in gladiolus (Sharma, 2004; Devadanam*et al*., 2007 and Dogra *et al*., 2012).

Table 5: Effect of growth regulators and varieties on days to 50% basal floret showing colour in gladiolus.

Growth regulators	Varieties			
	American Beauty	White Prosperity	Red Beauty	Mean
Control	123.00	122.67	123.67	123.11

BA 50 ppm	118.00	118.00	118.33	118.11
BA 75 ppm	119.00	118.67	121.00	119.56
BA 100 ppm	122.00	121.33	122.33	121.89
GA_3 100 ppm	116.33	109.33	116.67	114.11
GA_3 150 ppm	108.67	108.33	109.00	108.67
$GA_3$200 ppm	107.33	107.00	107.67	107.33
Mean	116.33	115.05	116.95	
	Varieties (A)	**Growth regulators (B)**	**Interaction (A × B)**	
SE(m)	0.18	0.28	0.48	
C.D.	0.52	0.80	1.38	

4. CONCLUSION

It can be concluded from the present investigation that gladiolus variety 'White Prosperity' performed better than other varieties in respect of all the vegetative and flowering parameters and GA_3 @200 ppm significantly increased plant height (cm), number of leaves per plant, leaf area (cm^2), days to 50% spike emergence and number of days to 50% basal floret showing colour. Among interactions, foliar application of GA_3 @200 ppm concentration significantly increased vegetative parameters and induced early flowering in variety White Prosperity.

COMPETING INTERESTS

"Authors have declared that no competing interests exist.".

AUTHORS' CONTRIBUTIONS

'Author A' designed the study, performed the statistical analysis, wrote the protocol, andwrote the first draft of the manuscript. 'Author B' and 'Author C' managed the analyses ofthe study. 'Author C' managed the literature searches…… All authors read and approved the final manuscript."

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