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Original Research Article

Effect of Bioregulators on Vegetative Growth and Flower Production of Gladiolus (*Gladiolus x hybridus* Hort.)

P. Chaudhary*, S. K. Moond and P. Bola

College of Horticulture and Forestry, Jhalawar -326023, (Agriculture University, Kota), Rajasthan, India
**Corresponding author*

A B S T R A C T

A field study on effect of 6-benzylaminopurine (BAP), Gibberellic acid (GA_3) and Indole-3-butyric acid (IBA) @ 50, 100 & 200 ppm on vegetative growth and flower production in two varieties of gladiolus was carried out at College of Horticulture and Forestry, Jhalawar during 2015-16. It was found that cv. American Beauty with treatment of 200 ppm GA_3 recorded the minimum number of days taken for sprouting (10.20 day), days to spike emergence (71.40), days to first floret opening from spike emergence (14.07) and maximum leaf length (44.13 cm), leaf width (3.19 cm), number of florets per spike (13.67) and floret diameter (9.87 cm). The maximum plant height (105.53 cm), number of leaves per plant (9.33), spike length (88.13 cm), and rachis length (47.33 cm) were recorded at GA_3 200 ppm in cv. *Psittacinus* Hybrid.

Keywords

BAP, GA3, IBA, growth, flowering

Introduction

Gladiolus (*Gladiolus* x *hybridus* Hort.) is an important cut flower crop, grown commercially in many parts of the world. It is also called as the 'Queen of bulbous flowers'. It has gained popularity owing to its uncomparable beauty, attractive colours, variable sizes and shapes of florets, variable spike length and long vase life. The genus Gladiolus belongs to the family Iridaceae and comprises about 250 species which are widely distributed in central Europe, the Mediterranean region, central and South Africa. IBA (Indole-3-butyric acid) is a phyto-hormone of auxin group produced in the shoot and root apices from where it is transported to other plant parts. The primary physiological effects of auxin are cell division and cell enlargement in the shoots and roots. Hence, the highest concentration of IBA is found in growing shoot tips, young leaves and developing auxiliary shoots that promote spike length, leaf length and number of corms (Tonecki, 1979).

GA_3 (gibberellic acid) induces the formation of hydrolytic enzymes which regulate the mobilization of food reserves, ultimately resulting in early sprouting of gladiolus corms (Groot and Karssen, 1987). GA_3 was also very much effective for seed germination, growth promotion, flowering and senescence inhibition (Murti and Upreti, 1995). BAP (6-benzylaminopurine) is a first generation synthetic cytokinin that elicits plant growth and development responses and setting blossoms by stimulating cell

division. It is an inhibitor of respiratory kinase in plants, and increases post-harvest life of green vegetables. Influence of cytokinin as 6-benzylaminopurine in combination with other methods on postharvest green colour retention on broccoli heads and asparagus spears, showed positive results for quality retention (Siddiqui *et al.,* 2011).

Therefore, considering the important role of bioregulators on various plant life processes, the present experiment was planned to evaluate effect of BAP, GA_3 and IBA on vegetative growth and flower production in gladiolus under Jhalawar conditions.

Materials and Methods

The experiment was laid out at the Instructional Farm, Department of Floriculture & Landscaping, College of Horticulture and Forestry, Jhalarapatan, Jhalawar during Rabi season of 2015-16 at 316 m above mean sea level. Jhalawar falls in the South-Eastern Rajasthan between 23°4' to 24°52' North latitude and 75°29' to 76°56' East longitude.

The experiment was conducted using 20 treatments having two varieties of gladiolus American Beauty (V_1) and *Psittacinus* Hybrid (V_2) with three bioregulators *viz.* BAP, GA_3 and IBA (each at 50, 100 and 200 ppm) in a Randomized Block Design (RBD) with three replications. The bioregulator treatments were given as corm soaking for 12 hours before planting followed by two sprays at 40 and 60 days after planting of corms. The corms were also pretreated with bavistin (0.2%) before planting thereafter were planted in field in well prepared beds at a spacing of 20 cm x 30 cm (P x R). Uniform cultural practices except for the treatments were followed for all the treatment plots.

Results and Discussion

The vegetative growth parameters in both varieties of gladiolus were significantly affected by the different bioregulators (Table 1). The earliest sprouting of corms was recorded in V_1G_3 (10.20 days) and was at par with V_2G_3 (10.27 days), V_1G_2 (10.40 days), V_2G_2 (10.53 days) and V_1G_1 & V_2G_1 (10.60 days), whereas the maximum number of days taken for sprouting was recorded in control V_1 (14.93 days). Bioregulators promote vegetative growth by increasing both cell division and cell elongation (Kumar *et al.,* 2008).

GA_3 has been reported to activate α-amylase enzyme that stimulates the hydrolyzation of stored starch into simple sugar and provides energy during sprouting of bulbs (Kucera *et al.,* 2005).

The maximum plant height was recorded with V_2G_3 (105.53 cm) whereas the minimum plant height in control V_1 (91.87 cm). However, the plant height in V_2G_3 was at par with V_2G_2 (104.53 cm), V_2G_1 (103.20 cm), V_2I_3 (104.87 cm), V_2I_2 (103.87 cm), V_2I_3 (102.20 cm), V_1G_2 (101.33 cm), V_1G_1 (100.70 cm), V_1I_3 (100.20 cm) and V_1I_2 (99.13 cm).

The production of tall plants with GA_3 application may be due to GA_3 induced active cell division and cell elongation resulting in enhancement in plant height in gladiolus (Baskaran *et al.,* 2014). The results were also supported by Sharma *et al.,* (2006) and Montessori *et al.,* (2013) in gladiolus.

The highest number of leaves was observed with V_2G_3 (9.33) which was at par with V_2G_2 (9.27), V_2G_1 (9.23), V_1G_2 (9.17), V_1G_1 (9.13), V_2I_3 (8.70) and V_1I_3 and V_2I_2 (8.63) whereas the minimum number of leaves was recorded in control V_1 (7.50).

Table.1 Effect of bioregulators on vegetative growth parameters of gladiolus

Treatment	Number of days taken for sprouting	Plant height (cm)	Number of leaves per plant	Leaf length (cm)	Leaf width (cm)	Stem diameter (cm)	Number of sprouts per corm
V_1	14.93	91.87	7.50	39.33	2.77	1.28	2.54
V_1B_1	12.80	94.17	8.02	40.60	2.80	1.33	4.00
V_1B_2	12.47	93.27	8.05	40.40	2.83	1.31	4.20
V_1B_3	12.40	92.80	8.10	40.13	2.84	1.30	4.40
V_1G_1	10.60	100.70	9.13	42.00	3.09	1.42	3.53
V_1G_2	10.40	101.33	9.17	43.87	3.14	1.41	3.57
V_1G_3	10.20	102.47	9.20	44.13	3.19	1.40	3.66
V_1I_1	12.33	97.27	8.57	41.47	2.89	1.38	2.63
V_1I_2	12.27	99.37	8.60	42.53	2.91	1.36	2.67
V_1I_3	12.00	100.20	8.63	44.00	2.93	1.35	2.70
V_2	13.80	96.27	7.67	37.53	2.69	1.17	2.07
V_2B_1	12.60	99.13	8.07	38.40	2.75	1.21	3.40
V_2B_2	12.53	98.33	8.10	38.33	2.77	1.20	3.53
V_2B_3	12.27	97.27	8.13	38.27	2.81	1.19	3.67
V_2G_1	10.60	103.20	9.23	41.40	3.07	1.27	3.09
V_2G_2	10.53	104.53	9.27	41.57	3.12	1.26	3.13
V_2G_3	10.27	105.53	9.33	42.07	3.14	1.25	3.17
V_2I_1	11.87	102.20	8.57	39.73	2.86	1.24	2.40
V_2I_2	11.67	103.87	8.63	40.07	2.89	1.23	2.47
V_2I_3	11.27	104.87	8.70	41.07	2.90	1.22	2.53
CD (at 5%)	1.07	8.21	0.72	3.40	0.24	0.11	0.31
SEm±	0.53	4.05	0.35	1.68	0.12	0.05	0.15
C.V. (%)	5.46	4.99	5.09	5.04	5.05	5.07	5.92

B_1- BAP 50 ppm, B_2- BAP 100 ppm & B_3- BAP 200 ppm, G_1- GA_3 50 ppm, G_2- GA_3 100 ppm & G_3- GA_3 200 ppm & I_1-IBA 50 ppm, I_2-IBA 100 ppm & I_3-IBA 200 ppm

Table.2 Effect of bioregulators on flowering parameters of gladiolus

Treatment	Days to spike emergence	Days to first floret opening from spike emergence	Number of florets per spike	Spike girth (cm)	Spike length (cm)	Rachis length (cm)	Floret diameter (cm)
V_1	85.40	17.67	9.47	0.60	68.40	33.20	7.64
V_1B_1	78.47	16.27	10.73	0.72	70.40	35.33	8.79
V_1B_2	77.47	16.13	10.67	0.73	71.47	36.40	8.29
V_1B_3	76.13	16.03	10.47	0.74	72.33	37.50	8.18
V_1G_1	73.60	14.20	13.53	0.63	78.20	39.53	9.73
V_1G_2	72.27	14.13	13.60	0.64	79.40	41.07	9.84
V_1G_3	71.40	14.07	13.67	0.65	80.13	42.40	9.87
V_1I_1	74.73	15.63	12.33	0.68	76.40	38.33	9.09
V_1I_2	73.60	15.53	12.53	0.71	77.20	38.73	9.14
V_1I_3	72.60	15.47	12.60	0.72	78.07	39.40	9.23
V_2	78.73	20.93	10.13	0.68	76.40	37.60	6.02
V_2B_1	77.33	19.47	11.67	0.75	77.13	39.53	6.55
V_2B_2	76.13	19.40	11.53	0.76	78.07	41.47	6.40
V_2B_3	75.67	19.33	11.40	0.77	79.07	42.87	6.37
V_2G_1	74.07	17.67	13.00	0.69	86.33	45.27	8.01
V_2G_2	73.60	17.60	13.07	0.70	87.20	46.33	8.05
V_2G_3	72.53	17.53	13.13	0.71	88.13	47.33	8.12
V_2I_1	75.40	18.33	12.07	0.72	83.40	43.80	7.29
V_2I_2	74.47	18.27	12.13	0.73	84.60	44.47	7.35
V_2I_3	73.27	18.20	12.27	0.74	85.20	45.47	7.43
CD (at 5%)	6.42	1.43	1.03	0.03	6.69	3.39	0.68
SEm±	3.17	0.71	0.51	0.06	3.31	1.67	0.33
C.V. (%)	5.15	5.07	5.18	5.23	5.13	5.02	5.08

B_1- BAP 50 ppm, B_2- BAP 100 ppm & B_3- BAP 200 ppm, G_1- GA_3 50 ppm, G_2- GA_3 100 ppm & G_3- GA_3 200 ppm & I_1-IBA 50 ppm, I_2-IBA 100 ppm & I_3-IBA 200 ppm

The increased number of leaves with application different bioregulators may be due increased cell division, cell enlargement and elongation that might have produced more nods and internodes leading to the production of more number of leaves. The present findings are in line with the reports of Chopde *et al.,* (2012) and Baskaran *et al.,* (2014) in gladiolus. The longest and broadest leaves were observed in V_1G_3 (44.13 cm length and 3.19 cm width) whereas the shortest and narrowest leaves were recorded in control V_2 (37.53 cm and 2.69 cm, respectively). The growth regulators promoted cell division, cell elongation and further enhanced the translocation of sugars there by significantly influencing the leaf size (Kumar *et al.,* 2008). The present results find support from Ram *et al.,* (2002), Sharma *et al.,* (2006), Joshi *et al.,* (2011) and Neetu *et al.,* (2013) in gladiolus.

The thickest stems were recorded in V_1G_1 (1.42 cm) however they were at par to V_1G_2 (1.41 cm), V_1G_3 (1.40 cm), V_1I_1 (1.38 cm), V_1I_2 (1.35 cm) and V_1B_1 (1.33 cm) whereas the thinnest stems were recorded in control V_2 (1.17 cm). Production of thicker stems with BAP, GA_3 and IBA could be due to their responses on cell division, cell elongation and enlargement as well higher rate of carbohydrate assimilation due to increased photosynthetic area resulting in thickening of stems. Similar results on increased stem diameter with BAP in gladiolus have been reported by Kumar *et al.,* (2010) and with application of GA_3 and IBA in carnation by Kumar *et al.,* (2012).

The highest number of sprouts per corm was recorded with V_1B_3 (4.40) which was at par with V_1B_2 (4.20) while the lowest number of sprouts per corm was recorded in control V_2 (2.07). Kucera *et al.,* (2005) reported that during sprouting of bulbous crops GA_3 activate α-amylase enzyme that stimulates the hydrolyzation of stored starch into simple sugar and provide energy. Similarly, Baskaran *et al.,* (2014) reported that BA due to promotion of cell division and shoot differentiation increased the number of shoots per corm in gladiolus.

The significant effects of different bioregulators on various flowering parameters of gladiolus varieties were observed in the present study (Table 2). The earliest spikes emergence was observed in V_1G_3 (71.40 days) however it was at par to the rest of treatments except V_1B_1 (78.47 days), control V_2 (78.73 days) and control V_1 (85.40 days). Ramachandrudu and Thangam (2007) reported anthocyanin and florigen development and early flowering with higher endogenous level of GA_3, which also increased photosynthetic area and respiration which enhanced CO_2 fixation in plants associated with early flowering. The observed results also lend support from findings of Montessori *et al.,* (2013) and Baskaran *et al.,* (2014) in gladiolus. The earliest first floret opening from spike emergence was observed in V_1G_3 (14.07 days) however it was at par to V_1G_2 (14.13 days), V_1G_1 (14.20 days) and V_1I_3 (15.47 days) whereas the most late first floret opening was observed in control V_2 (20.93 days). The accelerated flowering with application of bioregulators could be due promotion of vegetative growth and increased photosynthetic and metabolic activities causing more transport and utilization of photosynthets (Dogra *et al.,* 2012). The comparatively delayed first floret opening in BA treatments may be due to the role of BA in cell division and splitting and formation of two competitive sinks i.e. inflorescence and corm production ultimately delaying the first floret opening from spike emergence in gladiolus (Aier *et al.,* 2015).

The maximum number of florets per spike was recorded with V_1G_3 (13.67) though it was at par to V_1G_2 (13.60), V_1G_1 (13.53), V_2G_3 (13.13), V_2G_2 (13.07) and V_2G_1 (13.00) whereas the minimum number of florets was recorded in V_1B_3 (10.47). The increased number of leaves and leaf area per plant due to application bioregulators might have increased the photosynthetic reserves for enhanced reproductive growth resulting in higher number of florets per spikes (Aier *et al.,* 2015). Similar results in gladiolus have also been reported by Sharma *et al.,* (2006) and Montessori *et al.,* (2013). The thickest spikes were recorded in V_2B_3 (0.77 cm) however these were at par to spikes produced in V_2B_2 (0.76 cm) and V_2B_1 (0.75 cm) whereas the thinnest spikes were produced in V_1G_1 (0.63). Enhanced spike girth of spikes with application of bioregulators may be attributed to promoted vegetative growth due to active cell division and cell enlargement significantly affecting spike diameter (Sajjad *et al.,* 2014 and Kumar *et al.,* 2010).

The longest spikes were produced in V_2G_3 (88.13 cm) however they were at par to spikes produced in V_2G_2 (87.20 cm), V_2G_1 (86.33 cm), V_2I_3 (85.20 cm), V_2I_2 (84.60 cm) and V_2I_3 (83.40 cm) whereas the shortest were produced in V_1 (68.40 cm) and The longest rachis was observed with V_2G_3 (47.33 cm) however it was at par to V_2G_2 (46.33 cm), V_2I_3 (45.47 cm), V_2G_1 (45.27 cm) and V_2I_2 (44.47 cm) while the shortest rachis was recorded in V_1 (33.20 cm). The production of longer spike and rachis length with application of GA_3 may be due to increased cell division and enlargement and elongation of cells of stalk ultimately resulting into longer spike and rachis (Joshi *et al.,* 2011). The length of rachis appeared to be directly correlated to spike length as the treatments having longer spikes also had longer rachis. The present results are in agreement with Montessori *et al.,* (2013), Bhaskaran *et al.,* (2014) and Sable *et al.,* (2015) in gladiolus.

The largest floret was observed with V_1G_3 (9.87 cm diameter) however it was at par with V_1G_2 (9.84 cm), V_1G_1 (9.73 cm) and V_1I_3 (9.23 cm) while the smallest was recorded in V_2 (6.02 cm diameter). Gibberellins are the component of florigen required for formation of flowers in the plants and rapid mobilization and accumulation of metabolites which influence the floral morphogenesis and resulting in larger flower diameter (Neetu *et al.,* 2013). The increased flower size due to bioregulators might be owing to increased number of leaves and leaf area per plant which might have accumulated more photosynthets needed for reproductive growth (Aier *et al.,* 2015). The experimental results on flower size also lend support from Kumar *et al.,* (2008) and Dogra *et al.,* (2012) in gladiolus.

The results of the experiment proved that improved vegetative parameters *viz.* lesser time taken for sprouting, taller plant height, more number of leaves, larger leaf size for higher photosynthesis, stronger stems and enhanced flowering parameters *viz.* earlier spike emergence and first floret opening from spike emergence, more number of florets per spike, better spike girth, longer spikes and rachis and larger florets could be produced in gladiolus with application on bioregulators especially GA_3 50 ppm may be suggested for application in gladiolus cvs. American Beauty and *Psittacinus* hybrid.

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