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Study the effect of plant growth regulators on vase-life of gladiolus

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Abstract
An experiment was conducted to study the Impact of plant growth regulators on growth and flowering of gladiolus cv. Candyman during 2015-16 at Department of Floriculture and Landscape Architecture, IGKV, Raipur. Three growth regulators with three concentration viz., NAA (25 ppm, 50 ppm and 100 ppm) GA_3 (200 ppm, 250 ppm and 300 ppm) CCC (150 ppm, 200 ppm and 250 ppm) each at three concentrations in addition to distilled water spray as control comprised ten treatments of this experiment. The experiment was laid out in a Randomized Block Design (RBD) with three replication. All the growth and flowering parameters were periodically observed. The results revealed that the treatment of GA_3 200 ppm (T_4) attributed to superior results regarding the plant height, number of leaves, length of leaves, length of spike, length of rachis, number of floret per spike, diameter of florets, and vase life over all other treatments.

Keywords: Gladiolus, gibberellic acid, NAA, CCC, growth regulator

Introduction
Gladiolus is a flower of glamour and perfection which is known as the queen of bulbous flowers due to its flower spikes with florets of massive form, brilliant colours, attractive shapes, varying size and excellent shelf life. Gladiolus is grown as flower bed in gardens and used in floral arrangements for interior decoration as well as making high quality bouquets (Lepcha *et al*., 2007) [11]. Gladiolus is grown on all types of soils having good structure and drainage. It is a winter season crop but can be grown during rainy season in low rainfall areas with mild climate. To enhance of yield and quality of any flower crop various cultural management practices like good planting material, spacing, irrigation, plant protection etc., are required. The planting material i.e. corm is the important factor which governs the growth and development of gladiolus. The physiological functions inside the corms are controlled by plant growth regulators. Plant growth regulators are the organic chemical compounds which modify or regulate physiological processes in an appreciable measure in plants when used in small concentrations. They are readily absorbed and move rapidly through tissues when applied to different parts of the plant. It has generally been accepted that many plant processes including senescence are controlled through a balance between plant hormones interacting with each other and with other internal factors (Mayak and Halevy, 1980) [12]. Although growth retarding chemicals did not increase the number of flowers, they produced flowers with compact shape, developed short stalk, flowers remained fresh for a longer period and they suppressed the height of the plant. It is known fact that application of growth regulators such as CCC, NAA, and GA_3 had positive effects on growth and development of gladiolus plants at different concentrations. The reports indicate that the growth and flowering of gladiolus was enhanced by application of GA_3 (UmraoVijai *et al*., 2007 and Rana *et al*., 2005) [20, 15], NAA (Kumar *et al*., 2008) [8, 18], CCC by (Patel *et al*., 2010 and Ravidas *et al*., 1992) [4, 9, 10]. Hence the present study was conducted to find the Impact of plant growth regulators on growth and flowering of gladiolus cv. Candyman.

Materials and Methods
This experiment was conducted in Floriculture and Landscape Architecture Research cum Instructional Farm, College of Agriculture, IGKV, Raipur (C.G.). Soil of the experimental plot was sandy loamy, uniform in texture and well drained. The experimental design was R.B.D. with 3 replications and the plot size was 1.5 x 1.0m. In total ten treatments comprised of three growth regulators at three levels of each viz., NAA @25, 50 and 100 ppm, GA3 @200, 250 and 300 ppm and CCC @150, 200 and 250 ppm with control (distilled water) were applied. The gladiolus variety Candyman was planted on ridges and furrow at 30 x 20 cm on 21 October, 2015.

Uniform basal dose of well rotten FYM was applied @ 5 kg/m2 at the time of soil preparation. The fertilizer dose given to the crop was 300:200:200 kg N: P: K/ha as per recommendation. One third dose of nitrogen and potash as well as full dose of Phosphorus was applied at the time of corn planting. The growth and yield parameters for each treatment were observed in five plants selected by random sampling method. The data were statistically analysed and critical differences were worked out at five percent level to draw statistical conclusions as suggested by Panse and Sakhatme (1978) [14].

Results and Discussion

Morpho-physiological traits 4.2 yield traits 4.3 morpho-physiological traits

Plant height (cm)

The observation on plant height were recorded periodically at 30, 45 and 60 DAP as influenced by different treatments and the data are given in table 1. The observed data at 30 and 45 DAP clearly indicates that the maximum plant height (55.44 cm and 75.04 cm, respectively) was in treatment T4 (GA3 @ 200 ppm) and it was at par with the treatments T6 (GA3 @ 300 ppm) whereas T4 was significantly superior over other treatments (T1, T2, T3, T7, T8, T9). The minimum plant height at 30 DAP and 45 DAP was (42.27 cm and 63.63, respectively) recorded in T10 Control (distilled water). The maximum plant height (86.56 cm) at 60 DAP was found under the treatment T5 (GA3 250 ppm) which was significantly superior over the treatments T7, T8, T9 and T10 (control), whereas the rest of treatments were statistically at par with T5. The minimum plant height (76.06 cm) was recorded with treatment T9 (CCC @ 250 ppm). The height enhanced by application of GA3 is due to increase in the endogenous level of gibberellins in different phases of growth and development of plants which promotes vegetative growth by inducing active cell division and cell elongation in the apical meristem (Sharma *et al*, 2006) [6]. Another probable reason of significant increase in plant height might be due to the effect of gibberellins on photosynthetic activity resulted in efficiently utilizing photosynthetic products by the plants. These findings are in commensurate with the reports of Kumar *et al*. (2008) [15] and Chopde *et al*. (2013) [1] in gladiolus.

Number of leaves per plant

The data recorded on number of leaves per plant at different growth stages are presented in the Table 1. The maximum number of leaves (4.23) at 30 DAP was observed in treatment T4 (GA3 @ 200 ppm) which was significantly superior over all the treatments except T5 (GA3 @ 250 ppm) statistically at par with T5 treatment. The minimum number of leaves per plant (2.80) was observed in treatment T10 Control (distilled water). The maximum number of leaves (6.13) in 45 DAP was recorded in treatment T6 (GA3 @ 300 ppm) which was significantly superior over all the treatments except T5 (GA3 @ 250 ppm) while at par with T5 treatment. Minimum number of leaves per plant (4.16) was observed in treatment T10 Control (distilled water). The maximum number of leaves (9.20) at 60 DAP was observed in treatment T4 (GA3 @ 200 ppm) which was at par with treatment T5 (GA3 @ 250 ppm) and T6 (GA3 @ 300 ppm). Minimum number of leaves per plant (7.26) was recorded in treatment T9 (CCC @ 250 ppm). An increase in number of leaves with the application of GA3 might have been resulted due to 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 *et al*. (2012) [8] and Ravidas *et al*. (1992) [10] in gladiolus.

Length of leaves (cm)

The data recorded on number of leaves per plant at different growth stages are presented in the Table 1 and illustrated in fig 4.3. The maximum length of leaves (40.46 cm) at 30 DAP was observed in treatment T4 (GA3 @ 200 ppm) which was significantly superior over treatments T1, T7, T8, T9, and T10 it was statistically at par with T2, T3, T5, and T6. The minimum length of leaves (32.60) was observed in treatment T8 (CCC @ 250 ppm). The maximum length of leaves (54.42 cm) at 45 DAP was recorded in treatment T4 (GA3 @ 200 ppm) which was significantly superior over treatments T1, T2, T8, T9, and T10. However, it was statistically at par with T3, T5, T6 and T7 treatments. Minimum length of leaves (42.12 cm) was observed in treatment T10 Control (distilled water). The maximum length of leaves (64.13 cm) at 60 DAP was observed in treatment T4 (GA3 @ 200 ppm) which was significantly superior over treatments T1, T2, T7, T8, T9 and T10.It was statistically at par with treatment T2 (NAA @ 50 ppm), T5 (GA3 @ 250 ppm foliar spray) and T6 (GA3 @ 300 ppm). Minimum length of leaves per plant (53.72 cm) was counted in treatment T8 (CCC @ 200 ppm). After studying the observation of length of leaves it can be said that maximum length of leaves might be due to the application of gibberellic acid which increases cell division and cell elongation in plants resulting in more number of cells and increase in cell length which ultimately affects plant growth and length of leaves (Tawar *et al*., 2002) [19] These results are in close conformity with the findings of Gaur *et al*. (2003) [2], Kumar *et al*. (2008) [15] and Rana *et al*. (2005) [15] in gladiolus.

Number of days taken to first spike emergence

The data on number of days taken to first spike emergence were recorded and are presented in the table 1. The data reveals that the minimum number of days to first spike emergence (64.66 days) was taken by the treatment T4 (GA3 @ 200 ppm) and it was superior over other treatments. The maximum number of days taken to first spike emergence (76.00) was taken by the treatment T3 (NAA @ 100 ppm). After studying the observation number of days taken to first spike emergence it can be said that application of GA3 shortened the period of spike emergence resulting in precocity to spike emergence which was almost 10 days earlier as compared to application of CCC. The earliness in spike emergence by the application of GA3 might be attributed to the enhanced vegetative growth in early phase due to increased photo synthesis and CO2 fixation. Further exogenous application of GA3 would have favoured the convenience factors influencing floral initiation i.e., carbohydrate pathway and photo periodic pathway with GA3 pathway. These results are in close conformity with the findings of Ram *et al*. (2001) [5] and Kumar *et al*. (2005) [15] in gladiolus.

Length of spike (cm)

It is evident from the table 1 that the maximum length of spike (80.00 cm) was recorded in the treatment T4 (GA3 @ 200 ppm) which was significantly superior over treatments T1, T2, T3, T6, T9, T10. However, it was statically at par with T5, T7, and T8 treatments. The minimum length of the spike (66.82 cm) was obtained in treatment T9 (CCC @ 250 ppm). Increase in spike length in treatment may be attributed due to the fact that optimum level of GA3 promoted the efficacy of plants in terms of photosynthetic activity enhanced the uptake of nutrients and their translocation, better partitioning of assimilates into reproductive parts. Similar result was recorded by Chopde *et al*. (2013) [1] and Padmalatha *et al*. (2013) [3] in gladiolus.

Length of rachis (cm)

The data recorded on length of rachis were presented in table 1. It is revealed from the data that average length of rachis was significantly influenced by various treatments under investigation. The maximum length of rachis (47.33cm) was observed in treatment T4 (GA3 @ 200 ppm) which was significantly superior over treatments T7, T8, T10. However, it was statically at par with T1, T2, T3, T5, T6 and T9 treatments. The minimum length of rachis (39.00 cm) was observed with treatment T8 (CCC @ 200 ppm). This increase in the length of rachis may be attributed to an increased plant height and length of spike as influenced by the GA3 treatment. Another probable reason for this increase might be due to direct growth regulating action of GA3. The presence of GA3 might have increased the growth promoting enzymes thereby synthesizing more nucleic acid etc. in the plants. These results are in conformity with the findings of Tawar *et al*. (2002) [19] and Chopde *et al*. (2013) [1].

Inter nodal length of floret (cm)

The observations in respect to inter nodal length of floret are presented in the table 1. The data recorded on the maximum inter nodal length of floret (5.40 cm) was noticed in the treatment T4 (GA3 @ 200 ppm) which was significantly superior over treatments T3, T7, and T10. However it was statistically at par with T5 and T8. The minimum inter nodal length of floret (3.97 cm) was recorded in the treatment T3 (NAA @ 100 ppm). There was significant difference among the other treatments. The superiority of treatment T4 amongst the various treatments may be due to cell proliferation and elongation at the intercalary meristem level by GA3, thus leading to inter nodal growth. These results are in close conformity with the findings of Devi *et al*. (2007). They reported that maximum Inter floret length was found with foliar application of GA3 @ 100 ppm in gladiolus.

Number of days taken to first floret open/bloom

The data on number of days taken to first floret open were recorded and are presented in the table 1 and it reveals that the minimum days taken to first floret open (84 days) was taken by the treatment T4 (GA3 @ 200 ppm) which was significantly over treatments T1, T2, T3, T7, T8, and T9. However it was statistically at par with T5, T6 and T10. The maximum number of days taken to first floret open (92.66 days) was noted by the treatment T1 (NAA @ 25 ppm). The reason for such result may be the availability of optimum quantity of GA3 under this treatment resulting in significantly reduced days to first floret open. This is in accordance with the findings of Kumar *et al*. (2010) [15]. They reported that the minimum number of days taken to first floret open was found with treatment of GA3 @200 ppm foliar spray in gladiolus cv. Candyma

Number of florets per spike

The data on number of florets per spike of observation for each treatment is presented in the table 1which reveals that the maximum number of florets per spike (14.00) was counted in the treatment T4 (GA3 @200 ppm) which was significantly superior over treatments T1, T8, T9 and T10. However it was statistically at par with T2, T3, T5, T6 and T7. The minimum number of florets per spike (10.66) was observed in the treatment T9 (CCC @ 250 ppm). The superiority of treatment T4 (GA3 @ 200 ppm foliar spray) over the rest of the treatments might be due to the activity of gibberellic acid that optimum level promoted the auxiliary buds to grow vigorously and their flowering (Mohanty *et al*, 1994). Another probable reason for more number of floret may be the availability of optimum quantity of GA3 under these treatments as a result spike length and rachis length are increased which are positively related to number of floret. Similar views have also been expressed by Ravidas *et al*. (1992) [10], Kumar *et al*. (2005) [15] and Chopde *et al*. (2013) [1] in gladiolus.

Diameter of floret (cm)

Marked differences were noticed among growth regulators applications on diameter of floret (Table 1. The perusal of data clearly indicated that maximum diameter of floret (12.43 cm) was recorded by the treatment T5 (GA3 @ 250 ppm) which was significantly superior over treatments T1, T2, T3, T6, T7, T9 and T10. However it was statistically at par T4 (GA3 @ 200 ppm).The minimum diameter of floret (10.65 cm) was recorded in treatment T2 (NAA @ 50 ppm). The superiority of treatment T5 (GA3 @ 250 ppm foliar spray) amongst the various treatments may be due the role of GA3 which in optimum level improving the bud size may be ascribed to the translocation of metabolites at the site of bud development. Increase in diameter of floret might be due to cell elongation in the flower. Gibberellins are also known to increase the sink strength of actively growing parts. The similar findings were also noted by Ram *et al*. (2001) [5], Patel *et al*. (2013) [4, 9], and Chopde *et al*. (2013) [1] in gladiolus

Vase life of cut spikes (Days)

The data with regard to vase life of cut spikes is presented in the table 1, which reveals that 5% sucrose the longest vase life was recorded in treatment T4 (GA3 @ 200 ppm) (12.16 days) which was significantly superior over treatments T1, T2, T3, T7, T8, T9 and T10. However it was statistically at par with T1, T3 T5 and T6. The minimum vase life (9.86 days) was obtained in treatment T9 (CCC @ 250 ppm). Cut spikes obtained from plants treated with GA3 @200 ppm foliar spray (T4) shown progressive increase in their vase life which decrease gradually at their higher concentration. The higher effectiveness of GA3 might be attributed to higher auxin activity which has been reported to delay senescence and enhance the translocation of metabolites. The higher concentration of GA3 decreases the vase life of cut flowers. The possible reason behind it might be due to increase in the production of ethylene. The similar result of increased shelf life with application of GA3 was also reported by Tawar *et al*., (2002) [19], Gaur *et al*. (2003) [2], Umrao *et al*. (2007) [20] and Chopde *et al*. (2013) [1] in gladiolus.

Yield attributes

Number of spike per square meter

The data on number of spike per meter square observation for each treatment is presented in the table 1. Which reveals that the maximum number of spike per square meter (9.40) was counted in the treatment T4 (GA3 @ 200 ppm) and it was significantly superior over treatments T1, T2, T5, T7, T8 and T10. However it was statistically at par with treatment T6 (GA3 @ 300 ppm) The minimum number of spike per meter square (7.10) was observed in the treatment T9 (CCC @ 250 ppm). The superiority of treatment T4 (GA3 @ 200 ppm) over the rest of the treatments might be due to the activity of gibberellic acid that optimum level promoted the auxiliary buds to grow vigorously and their maximum number of spike. (Mohanty *et al*. 1994). Another probable reason for more number of floret may be the availability of optimum quantity of GA3 under these treatments as a result spike length and rachis length are increased which are positively related to number of floret. Similar views have also been expressed by Kumar *et al*. (2005) [15], and Chopde *et al*. (2013) [1] in gladiolus. 4.2.2 Number of corms per plant. The observation with reference to number of corms per plant is presented in the table 1. It is observed from the data that the maximum number of corm per plant (2.33) was noticed in the treatment T8 (CCC @ 200 ppm) which was significantly superior over treatments T1, T2, T3, T4, T5, T7 and T10. However it was statistically at par with treatments T9 (CCC @ 250 ppm).The minimum number of corms per plant (1.26) was recorded in the treatment T1 (NAA 25 ppm). The yield attributes related to corms and cormels are significantly increased by the application of growth retardants like CCC in the concentration when compared to control and other growth regulators. Significantly higher number of corms per plant was notices under CCC@ 200 ppm among all other treatments. This might be due to influence of growth retardants in delaying floral initiation, which would have enhanced source to sink ratio by reducing the partition of carbohydrates to floral spike which is evident from the reduction in spike length due to CCC application when compared to control. These results are in accordance with findings of Sudhakar *et al*., (2012) [8] and Patel *et al*., (2011) [4, 9], in gladiolus.

Diameter of corm (cm)

The data on diameter of corm has been presented in the table 1. It is revealed from the data that the maximum diameter of corm (7.34 cm) were noticed in the treatment T4 (GA3 @ 200 ppm foliar spray) which was significantly superior over treatments T1, T7 and T10. However it was statistically at par with treatments T2, T3, T6, T8 and T9 (CCC @ 250 ppm).The minimum diameter of corm (5.60 cm) was observed in the treatment T1 (NAA @ 25 ppm). However significant difference was recorded with rest of the treatments. The minimum diameter of corm was found in the treatment T1 (NAA @ 25 ppm). The increase in diameter of corms per plant in treatment T4 may be due to assimilation of carbohydrate resulting in better vegetative growth of plant. This probably helped in better tuberization of corm and increases their weight and size (diameter). This is in accordance with the findings of Singh *et al*., (2002) [7, 20] and Kumar *et al*., (2005) [15] in gladiolus.

Weight of corm per plant (g)

The data recorded on average weight of corm per plant as influenced by various treatments have been presented in table 1. The data exhibited in the table revealed that the weight of corm per plant was significantly influenced by various treatments under investigation. The maximum corm weight per plant (109.67 g) was recorded with treatment T8 (CCC @ 200 ppm) which was found at par with treatments T5 (GA3 @ 250 ppm) and T7 (CCC @ 150 ppm). The lowest weight of corm per plant 84.53 g) was observed in treatment T3 (NAA @ 100 ppm). The yield attributes related to corms and cormels are significantly increased by the application of growth retardants like CCC in the concentration when compared to control and other growth regulators. Significantly higher weight of corms per plant was notices under CCC@ 250 ppm among all other treatments. This might be due to influence of growth retardants in delaying floral initiation, which would have enhanced source to sink ratio by reducing the partition of carbohydrates to floral spike which is evident from the reduction in spike length 56 due to CCC application when compared to control. These results are in accordance with findings of Sudhakar *et al*. (2012) [8] and Patel *et al*. (2011) [4, 9], in gladiolus.

Number of cormel per plant

Marked differences were noticed among growth regulators applications on number of cormels per plant (Table 1. The perusal of data clearly indicates that maximum number of cormels per plant (43.30) was recorded by the treatment T7 (CCC @ 150 ppm) which was significantly superior over treatments T1, T4, T5 and T10.However it was statistically at par with treatments T6 (GA3 @ 300 ppm). The minimum number of cormels per plant was recorded (24.06) in the treatment T5 (GA3 @ 200 ppm). The yield attributes related to corms and cormels was significantly increased by the application of growth retardants like CCC in the concentration when compared to control and other growth regulators. Significantly higher number of cormels per plant was notices under CCC @ 250 ppm among all other treatments. This might be due to influence of growth retardants in delaying floral initiation, which would have enhanced source to sink ratio by reducing the partition of carbohydrates to floral spike which is evident from the reduction in spike length due to CCC application when compared to control. These results are in accordance with findings of Sudhakar *et al*., (2012) [8] and Patel *et al*., (2011) [4, 9] in gladiolus.

Weight of cormel per plant (g)

The result in respect to weight of cormels per plant is presented in the table 1. The perusal of data clearly indicates that the maximum weight of cormels per plant (31.40 g) was obtained in the treatment T7 (CCC @ 150 ppm) which was significantly superior over treatments T5 and T6. However it was statistically at par with treatment T8 and T9. The minimum weight of cormels per plant (14.60 g) was recorded in the treatment T6 (GA3 @ 300 ppm). The yield attributes related to corms and cormels are significantly increased by the application of growth retardants like CCC in the concentration when compared to control and other growth regulators. Significantly higher weight of cormels per plant was notices under CCC@ 250 ppm among all other treatments. This might be due to influence of growth retardants in delaying floral 63 initiation, which would have enhanced source to sink ratio by reducing the partition of carbohydrates to floral spike which is evident from the reduction in spike length due to CCC application when compared to control. These results are in accordance with findings of Sudhakar *et al*. (2012) [8] and Patel *et al*. (2011) [4, 9] in gladiolus.

Table 1: Study the effect of plant growth regulators on vase- life of gladiolus

Treatment	Plant height (cm)	Number of leaves per plant	Length of leaves per plant (cm)	Length of spike (cm)	Length of Rachis (cm)	Number of floret per spike	Diameter of florets (cm)	Vase life (days)
NAA 25 ppm (T_1)	82.11	8.40	57.36	72.66	44.66	11.83	10.76	11.00
NAA 50 ppm (T_2)	81.60	8.06	59.18	71.66	45.33	13.26	10.65	9.96
NAA 100 ppm (T_3)	79.95	7.86	55.46	72.00	45.00	13.13	11.22	11.00
GA_3 200 ppm (T_4)	84.83	9.20	64.13	80.00	47.33	14.20	12.41	12.16
GA_3 250 ppm (T_5)	86.56	8.90	60.78	75.00	45.66	12.93	12.43	11.24
GA_3 300 ppm (T_6)	84.21	9.16	62.16	72.00	46.00	12.20	11.21	11.06
CCC 150 ppm (T_7)	76.75	7.73	57.19	75.33	41.66	12.53	11.18	10.66
CCC 200 ppm (T_8)	77.05	7.83	53.72	75.00	39.00	11.66	11.06	10.50
CCC 250 ppm (T_9)	76.06	7.26	54.77	66.82	44.33	10.66	10.90	9.86
Control (T_{10})	78.43	7.93	55.56	73.00	42.00	11.00	11.17	10.26
SE(m)	2.33	0.24	1.91	2.15	1.58	0.65	0.36	0.43
C.D.	6.99	0.72	5.71	6.46	4.73	1.95	1.09	1.29

Conclusions
Application of GA3 @ 200 ppm corm foliar spray found to be more effective for better performance of different attributes namely plant height, number of leaves per plant length of leaves, number of days taken to first spike emergence, length of spike, length of rachis, inter nodal length of floret, number of days taken to first floret open, number of florets per spike, diameter of floret, vase life of cut spike days, number of spike per square meter, diameter of corm per plant. While maximum number of corms per plant, number of cormel per plant, weight of corm per plant, weight of cormel per plant was recorded with the treatment CCC @ 200 ppm.

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