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Analysis of effect of ga_3, NAA and BA on growth, flowering and corm production in gladiolus cv. white prosperity

Anant Ram Singh, Satendra Kumar and Sumit B Wasnik

Abstract
Gladiolus is a flower of glamour and perfection which is known as the queen of bulbous flowers. The study was carried on cultivar **'**White Prosperity'**.** An investigation to find out the optimum doses of GA_3, NAA and BA on gladiolus, the best combination of these plant growth regulators for better quality flower and higher yield and the effect of plant growth regulators on the morphological characters of gladiolus was carried out at the Horticulture Research Center, College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.), during the year 2018-19. Three growth regulators *viz.*, GA_3, NAA, and BA at three levels of concentration with three methods of application *viz.*, corm dipping, foliar spray and corm dipping + foliar spray in addition to control comprised 28 treatments of this experiment. The experiment was laid out in a randomized block design (RBD) with three replications. Application of GA_3 at 400 ppm or 800 ppm concentration was significantly superior to other treatments in improving the growth, days of corm sprouting, plant height, length of longest leaf, number of days required for visibility of first spike, days required for opening of first floret, diameter of spike, number of florets per spike, diameter of floret, longevity of spike, weight of corm per plant. NAA at 200, 400 and 600 ppm increase the number of leaves per plant, plant height, and weight of cormels per plant. BA at 100 ppm increased diameter of corms, number of cormels per plant, number of corms per plant and yield of corms and cormels. When the different treatments of application were compared, it was found that corm dipping + foliar spraying treatment was significantly superior to other treatments.

Keywords: GA_3, NAA, BA, gladiolus, randomized block design (RBD), part per million (ppm)

Introduction
Gladiolus (*Gladiolus hybridus* Hort.) is an ornamental cormelous plant native to South Africa. It belongs to monocot family Iridaceae and sub-family Ixioideae. Iridaceace family contains some 106 genera, containing mostly bulbous ornamentals. Gladiolus takes its name from latin word *'Gladius'* because of sword like shape, therefore this is also known as 'Sword lily'.

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) [15]. Gladiolus is cultivated in most of the tropical and subtropical countries of the world. Its spikes take 60 to 100 days after planting to be harvested depending upon the cultivars and time of year (Jenkins *et al.* 1970) [8]. The major gladiolus growing area in India are Kalimpong (West Bengal), New Delhi, Srinagar, Jammu & Kashmir, Pune, Ludhiana, Bengaluru and Uttarakhand. This phenomenal growth of floriculture in India during the last couple of decades has led the world floriculture experts to visualize for country as major player in floriculture trade in future. Gladiolus are grown an area of 9.37 thousand hectare with production of 707 million spikes in India (Anonymous, 2016-2017) [1] In India.

The application of plant growth regulators in agriculture has started in 1930 in United States. Ethylene, a naturally occurring substance, is one of the first plant growth regulators being discovered and used successfully for enhancing flower production in pineapple. (Thimann, 1948) proposed the term phytohormone as these hormones are synthesized in plants. It is known fact that application of growth regulators such GA_3, NAA and BA have positive effects on growth and development of gladiolus plants at different concentrations. GA_3 enhance the growth, development and yield of gladiolus at different concentrations increases the height of plants, number of flowers and induce early flowering (Uddin *et al.* 2013) [25]. Cormels are incapable of producing spikes and are used for the production of flower grade corms only. Each gladiolus plant produces 1-3 corms and 8-10 cormels depending upon variety, spacing, depth of planting, temperature and photoperiod.

Material and Methods

Experimental site and Climatic conditions

The experimental site was located at the Horticultural Research Centre (HRC) of the College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut-250110 (U. P.) where adequate facilities for agriculture implement, labour, irrigation and drainage exist. The experiment was conducted during *rabi* season (October 2018-April 2019). The meteorological data for the experimentation period (2018-19) as recorded by meteorological observatory Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut-250110 (U.P.) is presented in table 1. The soil of the experimental field was sandy loam. The samples were mixed thoroughly and a uniform sample was analyzed for assessing the physico-chemical properties of the soil.

Experimental details

The experiment was laid out in randomized block design (RBD) with 28 treatments in three replications. The growth regulators *viz*., GA_3, NAA and BA were used each at three different concentrations applied as corm dipping, foliar spraying and corm dipping + foliar spraying. A control of untreated corms was also maintained with three replications. Other details of experiments are givens as under.

Crop - Gladiolus (*Gladiolus hybridus* Hort.)
Cultivar - White Prosperity
Design - Randomized Block Design (RBD)
Replication - 3
Number of treatments - 28
Total number of plots - 84
Total area - 20 × 6 m^2
Plot size - 1.0 × 0.5m^2
Spacing - 30 × 25 cm
Width of path - 1 m
Width of bund - 0.25m
Width of main irrigation channel - 1.0 m
Width of sub irrigation channel - 0.25 m
Number of corm / plot - 6
Total number of corms utilized - 504
Depth of planting - 5 cm
Date of planting - 21 October 2018

Details of treatments

1. Untreated control

A. Corm dipping: - The corms were soaked for 3 hours before planting in the following.

2. GA_3 200 ppm
3. GA_3 400 ppm
4. GA_3 800 ppm
5. NAA 200 ppm
6. NAA 400 ppm
7. NAA 600 ppm
8. BA 25 ppm
9. BA 50 ppm
10. BA 100 ppm

B. Foliar spraying

11. GA_3 200 ppm
12. GA_3 400 ppm
13. GA_3 800 ppm
14. NAA 200 ppm
15. NAA 400 ppm
16. NAA 600 ppm
17. BA 25 ppm
18. BA 50 ppm
19. BA 100 ppm

C. Corm dipping + foliar spraying

20. GA_3 200 ppm
21. GA_3 400 ppm
22. GA_3 800 ppm
23. NAA 200 ppm
24. NAA 400 ppm
25. NAA 600 ppm
26. BA 25 ppm
27. BA 50 ppm
28. BA 100 ppm

Preparation of growth regulator solutions

Gibberellic acid (GA_3)

Stock solution of GA_3 was prepared by dissolving 500 mg of GA_3 in small quantity of Alcohol (C_2H_5OH). The distilled water was added in the solution to make the total volume to 1000 ml resulting in to 500 ppm stock solution. The stock solution was used to prepare solution of desired concentration (200, 400 and 800 ppm) using following formula

$$V_1 N_1 = V_2 N_2$$

Where, V_1 = Volume of stock solution to be taken
N_1 = Concentration of stock solution available
V_2 = Volume of desired solution to be made
N_2 = Concentration of desired solution

For example:

To prepare one liter of 1000 and 100 ppm solution from 500 ppm stock solution, above formula was used as follows:
V_1 =? N_1 = 500 ppm
V_2 = 1000 ml N_2 = 100 ppm
$V_1 N_1 = V_2 N_2$

$$V_1 = \frac{V2\ N1}{N1}$$

$$\frac{1000 \quad X \quad 100}{500} = 200 \text{ ml}$$

So, 200 ml of stock solution was dissolved in 800 ml of distilled water to prepare of distilled water to prepare one liter of 100 ppm solution from the stock solution 500 ppm and 400 ppm was dissolved in 600 ml distilled water to prepare one liter of 200 ppm solution from the stock solution of 400 ppm.

Naphthalene Acetic Acid (NAA)

Stock solution of BA was prepared by dissolving 500 mg of NAA in a small quantity of Ammonium hydroxide (NH_4OH). The distilled water was added in the solution to make the total volume to 1000 ml resulting into 500 ppm stock solution. The stock solution was used to prepare the solutions of desired concentration (200, 400 and 600 ppm) using the following formula

$$V_1 N_1 = V_2 N_2$$

Benzayl adinine (BA)

Stock solution of BA was prepared by dissolving 500 mg of BA in a small quantity of Hydrochloric acid (HCl). The distilled water was added in the solution to make the total volume to 1000 ml resulting into 500 ppm stock solution. The stock solution was used to prepare the solutions of desired

concentration (25, 50 and 100 ppm) using the following formula.

$V_1 N_1 = V_2 N_2$

Observations recorded

Vegetative growth characters

All the observations such that Days of sprouting, Plant height (cm), Number of leaves per plant and Length of longest leaf (cm) were recorded from selected four plants taken at random from each treatments and average value calculated.

Flowering characters

The measure the flowering performance only those plants which were measured for the performance of vegetative growth. Mean values of the observations were expressed for representing of each treatment separately. They are Days required for visibility of first spike (Days), Days required for opening of first floret (Days), Number of florets per spike, Diameter of floret (cm), Diameter of spike (cm), Number of spikes per plant and Longevity of spike (Days).

Corm characters

Corm characters such as Number of corms per plant, Diameter of corms (cm), Number of cormels per plant, Weight of corms per plant (g), Weight of cormels per plant (g) and Yield of corms and cormels (q/ha) are observed.

Statistical analysis

The experimental data were analyzed statistically by the techniques of analysis of variance described by Snedecor and Cochran (1967). The significance of the treatments was tested with the help of "F" (variance ratio) test. Critical difference was calculated by the following formula.

$$\text{CD at } 5\% = \frac{\sqrt{2}\text{EMS} \quad X \quad t}{r}$$

Where, CD = Critical difference
EMS = Error means sum of square
r = Number of replications
t = t value at 5% level of significance at error degree of freedom.

Table 1: Mean weekly meteorological data during 15 Oct. 2018 – 31 March 2019

Week	Date	Temperature (^{0}C)			Relative humidity (%)			Total rainfall (mm)
		Min.	Max.	Mean	Min.	Max.	Mean	
2018								
42	15 Oct. - 21 Oct.	15.0	34.4	24.7	51.0	90.0	70.5	1.4
43	22 Oct. - 28 Oct.	13.4	32.7	23.05	49.1	90.6	69.85	0.0
44	29 Oct. - 4 Nov.	12.0	31.7	21.85	45.4	91.1	68.25	0.0
45	5 Nov. - 11 Nov.	11.1	30.9	21.0	47.9	93.4	70.65	0.0
46	12- Nov. - 18 Nov.	12.0	29.4	20.7	57.6	95.3	76.45	0.0
47	19 Nov. -25 Nov.	13.3	28.1	27.35	53.6	89.1	71.35	0.0
48	26 Nov. - 2 Dec.	10.9	28.2	19.55	49.0	96.6	72.8	0.0
49	3 Dec. - 9 Dec.	11.4	28.4	19.9	54.8	94.5	74.65	0.0
50	10 Dec. - 16 Dec.	9.1	26.1	17.6	59.9	94.4	77.15	0.0
51	17 Dec. - 23 Dec.	6.5	21.1	13.8	60.7	96.0	78.35	0.0
52	24 Dec. - 30 Dec.	5.0	19.4	12.2	57.1	92.0	74.55	0.0
2019								
1	31 Dec - 6 Jan.	6.2	20.2	13.2	44.3	84.4	63.35	2.2
2	7 Jan. - 13 Jan.	7.3	21.1	14.2	38.3	75.0	56.65	0.0
3	14 Jan. - 20 Jan.	8.3	21.7	15	45.0	86.3	65.65	28.3
4	21 Jan. - 27 Jan.	20.6	19.0	19.8	48.4	94.6	71.5	13.8
5	28 Jan. - 3 Feb.	8.4	21.1	14.75	47.2	80.3	63.75	0.0
6	4 Feb. - 10 Feb.	10.0	20.2	15.1	47.8	93.0	70.4	23.4
7	11 Feb. - 17 Feb.	12.0	22.4	17.2	46.3	83.1	64.7	5.4
8	18 Feb. - 24 Feb.	13.1	23.2	18.15	46.8	82.2	64.5	5.3
9	25 Feb. - 3 March	9.9	23.4	16.65	64.7	88.6	76.65	0.0
10	4 March - 10 March	12.8	23.6	18.2	46.2	77.9	62.05	0.0
11	11 March - 17 March	15.1	23.9	19.5	50.9	79.9	65.4	0.0
12	18 March - 24 March	18.0	30.1	24.05	48.2	74.3	61.5	0.0
13	25 March - 31 March	19.4	30.4	24.9	41.3	62.2	51.75	0.0

Result and Discussion

Vegetative growth characters

Days of sprouting

Application of GA_3 had significantly reduced the number of days for sprouting of corms. There was a gradual decrease in number of days for sprouting of corms with the decreased concentration of GA_3. The minimum days taken to sprouting of corms was found under treatments of GA_3 at 800 ppm concentration.

Plant height (cm)

There was a gradual increase in the height of the plant with the increase in the concentration of GA_3. The maximum plant height was observed under the treatments of GA_3 at 400 ppm applied as corm dipping alone. A comprehensive study on the data pertaining to height of the plant shows that the application of NAA had a significantly superior effect over the control. There was an increase in height of the plant with increase in the concentration of NAA. Out of all growth regulating chemicals, the maximum height of plant was observed under the plant treatments GA_3 at 400 ppm. Whereas, the minimum plant height was recorded under the control.

Number of leaves per plant

Application of GA_3 had significant effect over the control.

The number of leaves per plant was observed with the application of GA_3 at 400 ppm as corm dipping alone. The data pertaining to number of leaves per plant show that the application of NAA had significantly superior effects over the control. The maximum number of leaves per plant was found under treatment of NAA at 400 ppm applied as corm dipping alone. As regard the different concentration of BA, it was observed that BA applied foliar spraying at the concentration of more than 50 ppm gradually decreased the number of leaves per plant.

Length of longest leaf (cm)

Application of GA_3 had a significantly superior effect over the control.

The data pertaining to the length of longest of the leaf show that the application of NAA at 400 ppm has significantly superior effect over the control. The maximum length of the longest leaf was found under the treatments of NAA at 400 ppm applied as foliar spraying only. As regards the application of BA, it was observed that BA at low concentration (50 ppm) did not any express significant effect over the control. BA at high concentration (100 ppm) produced maximum the length of the leaf in comparison to control. Out of all the growth regulators tested in the present investigation, the maximum length of lo the leaf per plant was found under the treatment GA_3 at 800 ppm.

Table 2: Effect of plant growth regulators on different vegetative characteristics of gladiolus.

S. No.	Treatments	Days of sprouting	Plant Height (cm)			Number of leaves per plant			Length of longest leaf (cm)		
			30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
1.	Control	14.67	40.40	60.61	86.40	2.33	4.13	5.19	25.17	43.40	50.25
Corm dipping											
2.	GA_3 200ppm	11.34	45.38	65.63	90.93	2.67	4.52	5.47	26.32	44.92	54.37
3.	GA_3 400ppm	11.33	45.55	67.26	95.53	2.88	4.54	5.66	26.38	44.81	55.79
4.	GA_3 800ppm	10.28	45.63	66.73	90.89	2.96	4.56	5.37	26.39	45.25	56.65
5.	NAA 200ppm	10.40	45.50	65.81	89.69	2.64	4.56	5.30	25.73	44.28	53.38
6.	NAA 400ppm	10.78	45.61	65.78	88.73	2.67	4.90	5.62	25.79	44.59	55.33
7.	NAA 600ppm	11.43	45.53	65.83	90.48	2.68	4.96	5.38	25.81	44.63	55.20
8.	BA 25ppm	12.33	45.63	68.84	90.83	2.85	4.92	5.41	25.84	44.89	53.72
9.	BA 50ppm	12.46	45.61	66.88	88.74	2.94	4.91	5.30	25.87	44.92	55.42
10.	BA 100ppm	14.25	45.66	66.80	88.90	2.97	4.95	5.43	25.92	44.95	53.73
Foliar spraying											
11.	GA_3 200ppm	14.20	45.80	67.73	90.70	2.91	4.62	5.36	26.17	44.92	54.45
12.	GA_3 400ppm	14.25	45.20	65.63	89.58	2.93	4.65	5.38	25.91	45.86	55.93
13.	GA_3 800ppm	14.51	45.45	66.56	90.73	2.95	4.67	5.62	26.15	45.93	56.83
14.	NAA 200ppm	14.51	46.72	66.91	89.33	2.95	4.93	5.60	26.41	44.85	53.45
15.	NAA 400ppm	13.65	45.90	67.13	88.17	2.97	4.96	5.39	26.50	45.95	55.95
16.	NAA 600ppm	14.23	46.80	66.60	90.39	2.97	4.98	5.37	27.20	45.61	54.18
17.	BA 25ppm	14.20	46.63	67.26	87.69	2.85	4.95	5.25	27.26	45.40	54.45
18.	BA 50ppm	14.44	46.73	67.36	86.77	2.92	4.95	5.24	27.26	45.36	54.86
19.	BA 100ppm	13.45	46.35	67.81	90.72	2.95	4.96	5.34	26.83	44.93	54.71
Corm dipping + foliar spraying											
20.	GA_3 200ppm	11.35	46.45	69.21	91.43	2.96	4.55	5.40	26.13	45.46	55.20
21.	GA_3 400ppm	11.31	46.53	69.30	90.39	2.98	4.60	5.44	27.16	45.66	56.20
22.	GA_3 800ppm	10.23	46.62	68.82	90.70	2.95	4.63	5.30	27.15	45.76	57.23
23.	NAA 200ppm	10.38	46.85	69.25	92.60	2.87	4.50	5.40	25.73	44.93	55.52
24.	NAA 400ppm	10.77	47.62	70.17	92.95	2.90	4.53	5.50	25.84	45.21	55.93
25.	NAA 600ppm	11.46	46.42	70.20	90.56	2.93	4.59	5.56	25.95	45.38	54.43
26.	BA 25ppm	12.46	47.84	70.33	90.83	2.97	4.30	5.34	25.51	44.80	51.87
27.	BA 50ppm	12.51	46.85	70.35	89.34	2.98	4.35	5.64	25.89	44.85	55.91
28.	BA 100ppm	14.22	46.90	70.43	90.65	2.97	4.36	5.36	25.81	44.96	51.77
	C.D. at 5%	0.17	0.12	0.22	1.13	0.026	0.047	0.041	0.06	0.17	3.18
	SE(m)±	0.06	0.04	0.07	0.40	0.009	0.016	0.015	0.02	0.06	1.12

Flowering characters

Days required for visibility of first spike (days)

A comparative study of the data pertaining to days visibility of first spike show that out of these three growths regulating chemicals, earliest flower spike was obtained under the treatments of GA_3 at 800 ppm. The maximum delay in visibility of first spike was recorded under the treatment at BA at 100 ppm.

Days required for opening of first floret (days)

A perusal of the data indicates that the treatments of NAA except at 400 ppm applied as corm dipping alone and significantly influenced days required for complete opening of first floret in comparison to control. The minimum days required for complete opening of first floret were obtained under the treatment of NAA at 400 ppm applied as corm dipping alone. I was also evident from the data that days required for the complete opening of first floret had significantly decreased with the treatment of BA as compared to the control. The minimum days were observed under the GA_3 at 800 ppm. Whereas, maximum days were observed under the BA at 100 ppm.

Number of spikes per plant

Maximum number of spikes per plant was obtained under the treatment of GA_3 at 400 ppm applied as foliar spraying alone. Although the maximum number of spikes per plant was obtained under the treatment of BA at 50 ppm applied as corm dipping alone. The maximum number of spikes per plant (1.080) were observed under the treatment GA_3 at 400

ppm applied as foliar spraying. However, the minimum number of spikes per plant *i.e.* (1.017) was recorded under treatment BA at 100 ppm applied as corm dipping alone.

Number of florets per spike

The maximum increase in the number of florets obtained under the treatment of GA_3 at 800 ppm applied as corm dipping. It is further evident from the data that the number of florets per spike shows that the application of different treatment of NAA had a significantly superior effect over control. The maximum number of florets per spike was recorded under the treatment of NAA at 600 ppm applied as corm dipping alone. The maximum number of florets per spike was observed under the treatment of BA at 25 ppm applied as corm dipping alone. Out of these growth regulator treatments, GA_3 had a significantly superior effect on the number of florets per spike as compared to the other treatments.

Table 3: Effect of plant growth regulators on different flowering characteristics of gladiolus.

S. No.	Treatments	Days required for visibility of first spike (DAP)	Days required for opening of first floret (DAP)	Number of spike per plant	Number of floret per spike	Diameter of floret (cm)	Diameter of spike (cm)	Longevity of spike (Days)
1.	Control	87.93	100.81	1.000	10.72	11.25	0.800	12.95
Corm dipping								
2.	GA_3 200ppm	83.57	98.37	1.023	12.71	11.86	0.867	15.49
3.	GA_3 400ppm	82.40	97.47	1.033	13.27	12.82	0.887	16.81
4.	GA_3 800ppm	81.73	90.67	1.043	14.27	11.54	0.837	17.48
5.	NAA 200ppm	86.26	99.45	1.040	11.20	11.41	0.827	13.59
6.	NAA 400ppm	86.45	99.34	1.047	11.75	11.45	0.853	14.26
7.	NAA 600ppm	86.65	99.61	1.043	11.81	11.31	0.867	14.27
8.	BA 25ppm	86.75	99.75	1.053	10.94	11.32	0.883	14.44
9.	BA 50ppm	86.57	100.06	1.060	10.83	11.37	0.837	15.44
10.	BA 100ppm	86.84	100.17	1.017	10.85	11.48	0.853	15.52
Foliar spraying								
11.	GA_3 200ppm	84.48	96.55	1.060	11.51	11.67	0.853	15.25
12.	GA_3 400ppm	84.32	96.28	1.080	12.66	11.37	0.863	16.38
13.	GA_3 800ppm	84.91	96.81	1.070	13.65	11.54	0.837	15.87
14.	NAA 200ppm	86.64	100.16	1.053	11.33	11.60	0.863	13.92
15.	NAA 400ppm	86.13	99.62	1.063	11.30	11.65	0.880	14.71
16.	NAA 600ppm	86.61	99.87	1.067	11.48	11.58	0.870	15.86
17.	BA 25ppm	86.54	99.16	1.030	10.83	11.25	0.870	14.95
18.	BA 50ppm	86.67	99.28	1.040	10.88	11.37	0.857	15.36
19.	BA 100ppm	86.86	100.12	1.050	10.92	11.39	0.850	15.45
Corm dipping + foliar spraying								
20.	GA_3 200ppm	81.34	96.56	1.053	11.37	11.61	0.870	14.92
21.	GA_3 400ppm	80.70	90.65	1.013	12.49	11.78	0.867	15.81
22.	GA_3 800ppm	78.84	89.71	1.067	11.34	11.42	0.843	16.37
23.	NAA 200ppm	85.92	99.41	1.063	11.75	11.33	0.847	13.69
24.	NAA 400ppm	87.10	100.16	1.070	11.73	11.40	0.850	14.72
25.	NAA 600ppm	87.27	100.05	1.047	11.83	11.36	0.873	15.49
26.	BA 25ppm	87.34	100.03	1.050	10.75	11.37	0.853	15.11
27.	BA 50ppm	87.33	99.91	1.053	10.82	11.41	0.837	15.44
28.	BA 100ppm	87.59	99.95	1.050	10.84	11.51	0.843	15.52
	C.D. at 5%	0.40	0.34	0.029	0.15	0.13	0.029	0.25
	SE(m)±	0.14	0.12	0.010	0.05	0.04	0.010	0.08

Diameter of floret (cm)

Diameter of the floret was significantly influenced with the application of NAA at all concentration as compared to control. The maximum diameter of floret was obtained under the treatment of NAA at 400 ppm applied as foliar spraying alone. The minimum diameter was observed under the control. It is also evident from the data that diameter of floret was significantly affected with the treatment of BA as compared to the control. Out of these growth regulating chemicals, the maximum diameter of floret was observed under the treatment GA_3 at 400 ppm. The minimum diameter of florets (11.25 cm) was noted under BA at 25 ppm treatments applied as dipping alone.

Diameter of spike (cm)

The maximum diameter was obtained with GA_3 at 400 ppm applied as corm dipping alone. The maximum increase in the diameter of the spike was observed under the treatments of NAA at 400 ppm applied as foliar spraying alone. A significantly maximum diameter of the spike was observed under the treatment of BA at 25 ppm applied as corm dipping alone followed by BA at 25 ppm applied as foliar spraying alone.

Longevity of spike (days)

GA_3 had a significantly superior effect on the longevity of spike over the control. The maximum longevity of spike was observed with GA_3 at 800 ppm applied as corm dipping alone. It is also evident from the data that NAA had significantly superior effect on the longevity of the spike over the control. The maximum longevity of spike was obtained under the treatment of NAA at 600 ppm applied as foliar spraying. Appreciable increase in the longevity of whole spike was observed with BA at all concentrations.

Corms and cormels characters

Number of corms per plant

The results clearly indicate that the number of corms per plant was not significantly influenced with the application of GA_3 NAA and BA. Although, the maximum number of corms per plant were obtained under the treatment BA at 100 ppm applied as corm dipping alone.

Number of cormels per plant

The maximum cormels were obtained under the treatment of GA_3 at 800 ppm applied as corm dipping + foliar spraying alone. The maximum number of cormels per plant was obtained under the treatment of NAA at 400 ppm applied as corm dipping alone. The maximum number of cormels was observed under the treatments of BA at 100 ppm applied as foliar spraying alone. However, the minimum number of cormels per plant was observed under the treatments of NAA at 600 ppm foliar spraying alone.

Weight of corm per plant (g)

A perusal of data indicates that the maximum weight of corms per plant was found under the treatment of GA_3 at 400 ppm applied as corm dipping, followed by NAA at 400 ppm applied as corm dipping alone. However, the minimum weight of corms per plant was obtained under the treatment of BA at 50 ppm applied as corm dipping + foliar spraying alone.

Weight of cormels per plant (g)

The maximum weight found with GA_3 at 400 ppm applied as corm dipping + foliar spraying alone. The weight of cormels was significantly influenced with the application of NAA at 400 ppm applied as corm dipping alone as compared to control. The maximum weight was recorded under the application of BA at 100 ppm applied as foliar spraying alone. Out of these growth regulators treatments, the significantly maximum weight of cormels was obtained under the treatments of NAA at 400 ppm applied as corm dipping.

Diameter of corm (cm)

The maximum diameter was obtained with GA_3 at 400 ppm applied as corm dipping alone. It is evident from the data that the application of NAA significantly increased the diameter of corm in comparison to control. The maximum diameter of corm was found under the treatment of BA at 50 ppm applied as foliar spraying alone. Out of growth regulator treatment NAA at 400 ppm had a significantly superior effect on the diameter of corm over other treatments followed by BA at 50 ppm.

Yield of corms and cormels (q/ha)

The maximum weight found with GA_3 at 200 ppm applied as foliar spraying alone. The maximum yield of corms and cormels was obtained under the treatment of NAA at 400 ppm applied as corm dipping + foliar spraying alone. The maximum yield of corms and cormels was recorded under the application of BA at 100 ppm applied as foliar spraying alone.Out of these growth regulators treatments, the significantly maximum yield of corms and cormels was obtained under the treatment of BA at 100 ppm applied as foliar spraying alone.

Table 3: Effect of plant growth regulators on Corms and cormels characteristics of gladiolus.

S. No.	Treatments	Number of corms per plant	Number of cormels per plant	Weight of corms per plant (g)	Weight of cormels per plant (g)	Diameter of corms (cm)	Yield of corms and cormels (q/ha)
1.	Control	1.03	34.20	45.78	5.69	3.23	104.32
Corm dipping							
2.	GA_3 200ppm	1.10	42.47	58.19	7.30	3.91	146.49
3.	GA_3 400ppm	1.05	36.43	60.87	6.87	4.05	136.84
4.	GA_3 800ppm	1.25	35.04	54.69	7.35	3.72	130.16
5.	NAA 200ppm	1.77	38.48	53.67	6.65	3.50	128.43
6.	NAA 400ppm	1.30	49.66	59.15	9.23	4.07	144.40
7.	NAA 600ppm	1.19	42.73	55.67	8.78	3.83	157.65
8.	BA 25ppm	1.48	35.58	49.76	6.71	3.55	119.46
9.	BA 50ppm	1.70	37.70	48.45	5.77	3.50	112.99
10.	BA 100ppm	1.82	38.23	46.88	5.80	3.39	111.78
Foliar spraying							
11.	GA_3 200ppm	1.06	44.87	57.31	7.70	3.91	153.27
12.	GA_3 400ppm	1.33	38.85	51.40	6.84	3.82	127.62
13.	GA_3 800ppm	1.06	41.51	54.60	7.72	3.91	144.06
14.	NAA 200ppm	1.07	37.44	54.71	6.56	4.01	127.56
15.	NAA 400ppm	1.34	36.42	50.15	6.87	3.65	122.52
16.	NAA 600ppm	1.06	34.68	53.26	6.05	3.92	117.64
17.	BA 25ppm	1.45	37.65	48.92	6.85	3.30	122.55
18.	BA 50ppm	1.08	46.24	58.89	8.15	4.04	162.27
19.	BA 100ppm	1.08	50.14	57.06	8.76	4.00	173.70
Corm dipping + foliar spraying							
20.	GA_3 200ppm	1.39	43.50	52.38	7.67	3.84	144.06
21.	GA_3 400ppm	1.40	35.29	56.13	8.46	4.01	141.24
22.	GA_3 800ppm	1.28	45.23	49.39	8.17	3.37	148.00
23.	NAA 200ppm	1.06	40.27	57.48	7.11	3.77	140.34
24.	NAA 400ppm	1.33	48.70	55.15	8.48	3.69	165.31
25.	NAA 600ppm	1.30	46.44	55.81	7.42	3.72	151.03
26.	BA 25ppm	1.33	38.67	51.25	7.16	3.48	129.86
27.	BA 50ppm	1.65	35.63	46.67	6.56	3.35	114.23
28.	BA 100ppm	1.73	48.40	46.71	6.25	3.26	129.55
	C.D. at 5%	0.07	0.59	0.16	0.10	0.13	2.58
	SE(m)±	0.02	0.20	0.05	0.03	0.04	0.91

Conclusion

On the basis of above finding, it can be concluded that GA_3 at 400 ppm or 800 ppm concentration was significantly superior to other treatments in improving the growth, days of sprouting, plant height, length of longest leaf, number of days required for visibility of first spike, days required for opening of first floret, diameter of spike, number of florets per spike, diameter of floret, longevity of spike. NAA at 200, 400 and 600 ppm increase the number of leaves per plant, plant height. When the different treatments of application were compared, it was found that corm dipping + foliar spraying treatment was significantly superior to other treatments.

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