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Effect of plant growth regulators on yield and corm production of gladiolus (*Gladiolus hybridus* Hort.) cv. white prosperity

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Abstract
The present investigation entitled "Effect of plant growth regulators on yield and corm production of gladiolus (*Gladiolus hybridus* Hort.) cv. White Prosperity" was conducted at Horticulture Research Center (HRC), College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut-250110 (U. P.) during the *rabi* season of 2018-2019. The investigation revealed that plant growth regulators showed significant results on gladiolus as GA_3 at 400 ppm or 800 ppm concentration was significantly superior to other treatments in improving the weight of corm per plant. NAA at 200, 400 and 600 ppm increases the weight of cormels per plant. BA at 100 ppm increased diameter of corm, number of cormels per plant, number of corm 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: Gladiolus, plant growth regulators, dipping, spraying

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) [6].

Gladiolus is cultivated in most of the tropical and subtropical countries of the world. Its spikes takes 60 to 100 days after planting to be harvested depending upon the cultivars and time of year (Jenkins *et al.* 1970) [3].

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 decade has led the world floriculture experts to visualize for country as major player in floriculture trade in future.

The propagating material of gladiolus is called "corm" which is a food-storing underground stem. While the new daughter corm is forming on the top of old one, small new corms called cormels or cormlets are produced from the base. These corms and cormels are the chief means of gladiolus propagation. Cormels are usually graded in to three sizes: large more than 1.0 cm diameter, medium 0.5 cm to less than 1.0 cm, and small less than 0.5 cm. Cormels are treated before storage with hot water solution to eradicate latent fungi, insect and nematodes (Larson, 1992) [5].

To enhance yield and quality of any flower crop various cultural management practices like good planting material, suitable time of planting, spacing, irrigation included plant protection measure are required. The planting material corm is important factor which governs the growth and development of gladiolus. Plant growth regulators or phytohormones are organic substances produced naturally in higher plants, controlling growth or other physiological functions at a site remote from its Place of production and active in minute amounts. The application of plant growth regulators is one of the most important factors in improving the growth, yield and flower quality (Nuvale *et al.* 2010) [8].

Gibberellic acids has an important role in different plant processes, including seed germination, stem elongation, leaf expansion and flower development (Olszewski *et al.* 2002) [9] and was found highly effective for increasing the sprouting percentage of corm, increased cormel production and cormel size in gladiolus (Padmalatha *et al.* 2013) [10].

Material and Methods

An experiment was conducted at Horticulture Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (UP) during the *rabi* season (October 2018-April 2019).

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.

The experimental field was prepared by repeated tractor plough followed by harrowing. Weeds and crop residue were removed and the land was levelled. Thus pulverized field was later divided into plots. Irrigation channel, bunds and path were left around the experimental field according to the requirement. Analysis for estimation of growth and flowering characters was done.

Corm characters

At the time of harvesting the following corm characters were recorded.

Number of corms per plant

The number of corms per plant were counted for four plants and then averaged.

Diameter of corms (cm)

Diameter of corm was measured for four plants with the help of vernier calipers.

Number of cormels per plant

The numbers of cormels per plant were counted for four plants and then average was worked out.

Weight of corms per plant (g)

The weight of corm/plant was measured with the help of electronic balance (Simandzu, Japan) and mean values were expressed in g.

Weight of cormels per plant (g)

The weight of cormels/plant was measured with the help of electronic balance (Simandzu, Japan) and mean values were expressed in g.

Yield of corms and cormels (q/ha)

The yield of corm and cormels per plant q/ha were recorded with the help of electronic balance and mean values were expressed in q/ha

Statistical analysis

The experimental data were analyzed statistically by the techniques of analysis of variance described by Snedecor and Cochran (1967) [13]. 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.

Result and Discussion

The data on the number of corms per plant as presented in table showed that the maximum corms per plant (1.82) was recorded under BA at 100 ppm applied as corm dipping and minimum number of corms per plant (1.05) was harvested at GA_3 at 400 ppm applied as corm dipping. These results are similar to the findings of Baskaran *et al.* (2014) [2] in gladiolus.

The minimum number of cormels per plant (34.20) was recorded under the control. Out of the growth regulating chemicals the maximum cormels per plant (50.14) was recorded under the treatment BA at 100 ppm applied as foliar spraying alone and the minimum number of cormels per plant (34.68) was obtained under the treatment of NAA at 600 ppm applied as foliar spraying alone. The similar results have been also reported by Kumar *et al.* (2009) [4] and Baskaran *et al.* (2014) [2] in gladiolus.

A perusal of the data presented in table indicate that the weight of corm (45.78 g) was recorded minimum under control while GA_3 at 400 ppm maximized the weight of corm (60.87 g) when applied as corm dipping alone. The similar results with the application of GA_3 have been also reported by Misra *et al.* (1993) [7], Singh *et al.* (2002) [12] and Yadav and Bhatia (2018) [14] in gladiolus.

The weight of cormels per plant (5.69 g) being minimum was recorded under control while NAA at 400 ppm maximized weight of cormels per plant (9.23 g) when applied as corm dipping alone. The similar result has been also reported by Patil and Gohil (2005) [11] in gladiolus.

The diameter of corm (3.23 cm) was recorded minimum under control and maximum diameter of corms (4.07 cm) was recorded under the treatment of NAA at 400 ppm applied as corm dipping alone. Similar results were reported by Kumar *et al*. (2009) [4] in gladiolus.

It is evident from the data presented in the given table that the yield of corms and cormels (104.32 q/ha) was recorded minimum under control. However, maximum yield of corms and cormels (173.70 q/ha) was recorded under the treatment of BA at 100 ppm applied as foliar spraying alone. The similar results were also reported by Bairwa and Mishra (2017) [1] in marigold.

Table 1: Effect of plant growth regulators on number of corms per plant in gladiolus cv. White Prosperity

S. No.	Treatments	Number of corms per plant
1.	Control	1.03
	Corm dipping	
2.	GA_3 200 ppm	1.10
3.	GA_3 400 ppm	1.05
4.	GA_3 800 ppm	1.25
5.	NAA 200 ppm	1.77

6.	NAA 400 ppm	1.30
7.	NAA 600 ppm	1.19
8.	BA 25 ppm	1.48
9.	BA 50 ppm	1.70
10.	BA 100 ppm	1.82
	Foliar spraying	
11.	GA_3 200 ppm	1.06
12.	GA_3 400 ppm	1.33
13.	GA_3 800 ppm	1.06
14.	NAA 200 ppm	1.07
15.	NAA 400 ppm	1.34
16.	NAA 600 ppm	1.06
17.	BA 25 ppm	1.45
18.	BA 50 ppm	1.08
19.	BA 100 ppm	1.08
	Corm dipping + foliar spraying	
20.	GA_3 200 ppm	1.39
21.	GA_3 400 ppm	1.40
22.	GA_3 800 ppm	1.28
23.	NAA 200 ppm	1.06
24.	NAA 400 ppm	1.33
25.	NAA 600 ppm	1.30
26.	BA 25 ppm	1.33
27.	BA 50 ppm	1.65
28.	BA 100 ppm	1.73
	C.D. at 5%	0.07
	SE(m)±	0.02

Table 2: Effect of plant growth regulators on number of cormels per plant in gladiolus cv. White Prosperity

S. No.	**Treatments**	**Number of cormels per plant**
1.	Control	34.20
	Corm dipping	
2.	GA_3 200 ppm	42.47
3.	GA_3 400 ppm	36.43
4.	GA_3 800 ppm	35.04
5.	NAA 200 ppm	38.48
6.	NAA 400 ppm	49.66
7.	NAA 600 ppm	42.73
8.	BA 25 ppm	35.58
9.	BA 50 ppm	37.70
10.	BA 100 ppm	38.23
	Foliar spraying	
11.	GA_3 200 ppm	44.87
12.	GA_3 400 ppm	38.85
13.	GA_3 800 ppm	41.51
14.	NAA 200 ppm	37.44
15.	NAA 400 ppm	36.42
16.	NAA 600 ppm	34.68
17.	BA 25 ppm	37.65
18.	BA 50 ppm	46.24
19.	BA 100 ppm	50.14
	Corm dipping + foliar spraying	
20.	GA_3 200 ppm	43.50
21.	GA_3 400 ppm	35.29
22.	GA_3 800 ppm	45.23
23.	NAA 200 ppm	40.27
24.	NAA 400 ppm	48.70
25.	NAA 600 ppm	46.44
26.	BA 25 ppm	38.67
27.	BA 50 ppm	35.63
28.	BA 100 ppm	48.40
	C.D. at 5%	0.59
	SE(m)±	0.20

Table 3: Effect of plant growth regulators on weight of corms per plant (g) in gladiolus cv. White Prosperity

S. No.	Treatments	Weight of corms per plant (g)
1.	Control	45.78
	Corm dipping	
2.	GA_3 200 ppm	58.19
3.	GA_3 400 ppm	60.87
4.	GA_3 800 ppm	54.69
5.	NAA 200 ppm	53.67
6.	NAA 400 ppm	59.15
7.	NAA 600 ppm	55.67
8.	BA 25 ppm	49.76
9.	BA 50 ppm	48.45
10.	BA 100 ppm	46.88
	Foliar spraying	
11.	GA_3 200 ppm	57.31
12.	GA_3 400 ppm	51.40
13.	GA_3 800 ppm	54.60
14.	NAA 200 ppm	54.71
15.	NAA 400 ppm	50.15
16.	NAA 600 ppm	53.26
17.	BA 25 ppm	48.92
18.	BA 50 ppm	58.89
19.	BA 100 ppm	57.06
	Corm dipping + foliar spraying	
20.	GA_3 200 ppm	52.38
21.	GA_3 400 ppm	56.13
22.	GA_3 800 ppm	49.39
23.	NAA 200 ppm	57.48
24.	NAA 400 ppm	55.15
25.	NAA 600 ppm	55.81
26.	BA 25 ppm	51.25
27.	BA 50 ppm	46.67
28.	BA 100 ppm	46.71
	C.D. at 5%	0.16
	SE(m)±	0.05

Table 4: Effect of plant growth regulators on weight of cormels per plant (g) in gladiolus cv. White Prosperity

S. No.	Treatments	Weight of cormels per plant (g)
1.	Control	5.69
	Corm dipping	
2.	GA_3 200 ppm	7.30
3.	GA_3 400 ppm	6.87
4.	GA_3 800 ppm	7.35
5.	NAA 200 ppm	6.65
6.	NAA 400 ppm	9.23
7.	NAA 600 ppm	8.78
8.	BA 25 ppm	6.71
9.	BA 50 ppm	5.77
10.	BA 100 ppm	5.80
	Foliar spraying	
11.	GA_3 200 ppm	7.70
12.	GA_3 400 ppm	6.84
13.	GA_3 800 ppm	7.72
14.	NAA 200 ppm	6.56
15.	NAA 400 ppm	6.87
16.	NAA 600 ppm	6.05
17.	BA 25 ppm	6.85
18.	BA 50 ppm	8.15
19.	BA 100 ppm	8.76
	Corm dipping + foliar spraying	
20.	GA_3 200 ppm	7.67
21.	GA_3 400 ppm	8.46
22.	GA_3 800 ppm	8.17
23.	NAA 200 ppm	7.11
24.	NAA 400 ppm	8.48
25.	NAA 600 ppm	7.42
26.	BA 25 ppm	7.16
27.	BA 50 ppm	6.56

28.	BA 100 ppm	6.25
	C.D. at 5%	0.10
	SE(m)±	0.03

Table 5: Effect of plant growth regulators on Diameter of corms (cm) in gladiolus cv. White Prosperity

S. No.	Treatments	Diameter of corms (cm)
1.	Control	3.23
	Corm dipping	
2.	GA_3 200 ppm	3.91
3.	GA_3 400 ppm	4.05
4.	GA_3 800 ppm	3.72
5.	NAA 200 ppm	3.50
6.	NAA 400 ppm	4.07
7.	NAA 600 ppm	3.83
8.	BA 25 ppm	3.55
9.	BA 50 ppm	3.50
10.	BA 100 ppm	3.39
	Foliar spraying	
11.	GA_3 200 ppm	3.91
12.	GA_3 400 ppm	3.82
13.	GA_3 800 ppm	3.91
14.	NAA 200 ppm	4.01
15.	NAA 400 ppm	3.65
16.	NAA 600 ppm	3.92
17.	BA 25 ppm	3.30
18.	BA 50 ppm	4.04
19.	BA 100 ppm	4.00
	Corm dipping + foliar spraying	
20.	GA_3 200 ppm	3.84
21.	GA_3 400 ppm	4.01
22.	GA_3 800 ppm	3.37
23.	NAA 200 ppm	3.77
24.	NAA 400 ppm	3.69
25.	NAA 600 ppm	3.72
26.	BA 25 ppm	3.48
27.	BA 50 ppm	3.35
28.	BA 100 ppm	3.26
	C.D. at 5%	0.13
	SE(m)±	0.04

Table 6: Effect of plant growth regulators on yield of corms and cormels (q/ha) in gladiolus cv. White Prosperity

S. No.	Treatments	Yield of corms and cormels (q/ha)
1.	Control	104.32
	Corm dipping	
2.	GA_3 200 ppm	146.49
3.	GA_3 400 ppm	136.84
4.	GA_3 800 ppm	130.16
5.	NAA 200 ppm	128.43
6.	NAA 400 ppm	144.40
7.	NAA 600 ppm	157.65
8.	BA 25 ppm	119.46
9.	BA 50 ppm	112.99
10.	BA 100 ppm	111.78
	Foliar spraying	
11.	GA_3 200 ppm	153.27
12.	GA_3 400 ppm	127.62
13.	GA_3 800 ppm	144.06
14.	NAA 200 ppm	127.56
15.	NAA 400 ppm	122.52
16.	NAA 600 ppm	117.64
17.	BA 25 ppm	122.55
18.	BA 50 ppm	162.27
19.	BA 100 ppm	173.70
	Corm dipping + foliar spraying	
20.	GA_3 200 ppm	144.06
21.	GA_3 400 ppm	141.24
22.	GA_3 800 ppm	148.00
23.	NAA 200 ppm	140.34

24.	NAA 400 ppm	165.31
25.	NAA 600 ppm	151.03
26.	BA 25 ppm	129.86
27.	BA 50 ppm	114.23
28.	BA 100 ppm	129.55
	C.D. at 5%	2.58
	SE(m)±	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 weight of corm per plant. NAA at 200, 400 and 600 ppm increases the weight of cormels per plant. BA at 100 ppm increased diameter of corm, number of cormels per plant, number of corm 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.

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