

## SCIENTIFIC ARTICLE

# Exogenous gibberellic acid application influences on vegetative and reproductive aspects in gladiolus

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## Abstract

Ornamental plants like gladiolus are suitable option for growers with lower amount of land, as they are highly economic and have lower cost of production. An experiment was conducted with aim to study the exogenous application influence of gibberellic acid on vegetative and reproductive characteristics of gladiolus was conducted under the subtropical conditions. The experiment was laid out in two factors randomized complete block design and replicated three times. Gibberellic acid ( $GA_3$ ) was used in different concentrations (0, 50, 100, 150, 200 mg L<sup>-1</sup>) to corms of two cultivars of gladiolus ('White Prosperity' and 'Red Advance'). Results showed that most of the parameters were significantly influenced by gibberellic acid at 200 mg L<sup>-1</sup>. The maximum sprouting, number of leaves plant<sup>-1</sup>, daughter corms per plant, less number of days to corm sprouting, days to spike emergence and flower opening were recorded in plants treated with 200 mg L<sup>-1</sup> gibberellic acid ( $GA_3$ ). 'Red Advance' produced more number of leaves plant<sup>-1</sup>, corm diameter, corm weight, and less number of days to spike emergence and flower opening. It can be concluded from the present findings that the treatment of corms with 200 mg L<sup>-1</sup> gibberellic acid can improve the growth and yield of cultivar Red Advance than White prosperity under the subtropical conditions.

**Keywords:** *Gladiolus grandiflorus*, plant hormones, corms, vegetative growth.

## Resumo

### A aplicação exógena de ácido giberélico influencia os aspectos vegetativos e reprodutivos do gladiolo

Plantas ornamentais, como gladiolos, são uma boa opção para produtores com área limitada, pois são altamente rentáveis e possuem menor custo de produção. O experimento foi conduzido com o objetivo de estudar a influência da aplicação exógena do ácido giberélico nas características vegetativas e reprodutivas de gladiolos, em condições subtropicais. O delineamento experimental foi em blocos casualizados com dois fatores: cultivares (White Prosperity e Red Advance) e ácido giberélico ( $GA_3$ ) (0, 50, 100, 150, 200 mg L<sup>-1</sup>), com três repetições. Os resultados mostram que a maioria dos parâmetros foi significativamente influenciada pelo ácido giberélico. Maior porcentagem de brotação, número de folhas e cormos planta<sup>-1</sup>, bem como menor **número de dias para brotação**, surgimento da espiga e abertura floral foram registrados nas plantas tratadas com 200 mg L<sup>-1</sup> de ácido giberélico ( $GA_3$ ). A cultivar Red Advance, além de menor número de dias para surgimento da espiga e a abertura da flor, apresentou maior número de folhas por planta e maior diâmetro e peso dos cormos. Conclui-se, com base nos resultados, que o tratamento de cormos com 200 mg L<sup>-1</sup> de ácido giberélico pode incrementar mais o crescimento e o rendimento da cultivar de gladiolo Red Advance do que da White Prosperity nas condições de região subtropical.

**Palavras-chave:** *Gladiolus grandiflorus*, hormônios vegetais, cormos, crescimento vegetativo.

## Introduction

Gladiolus (*Gladiolus grandiflorus*) also known as "Sword Lily" is an ornamental, monocot, flowering bulbous plant of family Irideaceae having one hundred and fifty known species (Negi et al., 1982). Gladiolus has herbaceous stem and narrowly linear leaves, sheathing at

the base with flattened sides (Negi et al., 2014). Gladiolus flower can be found in various colours, with floret shape of round, triangular, flattened, orchid like and petal may be planed, ruffled, lacinated, bent or deeply folded (Wilfret, 1980).

It is commonly used in landscape, beds and gardens as cut flower and frequently used in bouquets, in floral

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arrangements and garland (Halder *et al.*, 2007). Gladiolus is famous for the name as queen of bulbous flowers owing to its flower spikes with pleasant florets of attractive shapes, massive form, and excellent shelf life.

The potential use of growth regulators in flower production has created considerable scientific interest in recent years. Many studies have revealed that applying growth regulators can affect the growth of gladiolus (Jinesh *et al.*, 2011). Plant growth regulators play an important role in enhancing the floriculture industry. Plant growth regulators are involved in improving the growth, yield and quality of flower. Growth regulators are found effective in controlling growth and flowering in gladiolus (Ahmad *et al.*, 2002). Growth and development are to be regulated either by a single or by interaction of several hormones. They play major role in directing the movement of organic metabolites and in establishing the sink (Nuvalle *et al.*, 2010).

Among growth regulators, gibberellic acid are well known for stimulating corm sprouting, plant height, leaves elongation, induction of flowering, corms weight of bulbous plants at different concentrations (Olszewski *et al.*, 2002; Lee and Rhee, 2005; Vijai *et al.*, 2007).

In developing countries where the focus of growers are cereal crops, the demand for this ornamental crop got the attention of growers due to the color variation of its florets and considerable commercial potential for local as well as export market. A number of factors such as planting depth, timing, fertilizer dose, etc, and use of growth regulators ( $GA_3$  and IAA) can enhance the quality and production of gladiolus flowers and corm yield (Uddin *et al.*, 2002, Hussain and Amin, 2018).

The objectives of this study were to investigate the response of two gladiolus cultivars to gibberellic acid treatments and to determine the effects of exogenous application of gibberellic acid on vegetative and reproductive characteristics of gladiolus.

## Materials and Methods

The experiment was conducted during at Horticulture farm, Agriculture Research Institute Tarnab, Peshawar, Pakistan. The experiment was laid out in randomized complete block design with two factors. During the experiment the corms of gladiolus cultivars 'White Prosperity' and 'Red Advance' imported from Holland were treated with five different concentration of gibberellic acid (0, 50, 100, 150 and 200 mg L<sup>-1</sup>) and was replicated three times. A total of 24 corms were used per treatment. The gibberellic acid solution was prepared by dissolving 50, 100, 150, and 200 mg  $GA_3$  in 1 liter of water. Gibberellic acid was first dissolved in 50% ethanol solution, and then volume was raised to 1

liter. Corms were soaked for 24 hours in gibberellic acid solutions before sowing in field.

The experimental field was ploughed thoroughly and well decomposed farm yard manure was incorporated during plot preparation to increase the fertility. The disease free and healthy corms of same size of both cultivars were sown on 30<sup>th</sup> March, 2016 at the plant spacing of 15 cm and row to row spacing of 75 cm. All corms were sown at a depth of 6 cm. Total experimental plot size was 27 m<sup>2</sup>. Hand weeding was practiced in the field. Irrigation was done on weekly basis.

Before planting of corms, soil samples were collected from the field, analyzed showing the nitrogen (0.025 mg Kg<sup>-1</sup>), phosphorus (4.2 mg Kg<sup>-1</sup>), potassium (80 mg Kg<sup>-1</sup>), organic matter (0.51%), soil pH (8.0) and electrical conductivity (0.20 dsm<sup>-1</sup>). During the experiment the following variables were studied, days to corms sprouting (number of days for corms sprouting was counted from the date of corms sowing to the date of corms sprouting; corms sprouting percentage; number of leaves plant<sup>-1</sup>; days to spike emergence (number of days for spike emergence was counted from the date of corm sowing to the first spike emergence); days to flower opening, diameter of daughter corms (cm); corms weight (g); number of daughter corms plant<sup>-1</sup>. The data collected on various parameters were analyzed by using Statistical computer software "Statistix 8.1" for computing both ANOVA and LSD at 5% level of probability (Jan *et al.*, 2009).

## Results and Discussion

### Days to corms sprouting

The analysis of variance showed that the various gibberellic acid concentrations had significant effect on days to corm sprouting of gladiolus. While cultivars and their interaction showed non-significant results (Table 1).

The highest days to corm sprouting was observed in control treatment, while minimum number days to corms sprouting observed in plants treated with 200 mg L<sup>-1</sup> gibberellic acid ( $GA_3$ ). It might be due to the high nutrients preserved and gibberellic acid which can enhance the cell expansion and promotes synthesis of DNA in cells (Jinesh *et al.*, 2011).

### Corms sprouting percentage

Gibberellic acid concentrations having significant effect on sprouting percentage of gladiolus. The cultivars and interaction had no significant results. Sprouting percentage of 96.3% was recorded in plants treated with 200 mg L<sup>-1</sup> gibberellic acid, followed by 91.7% with 150 mg L<sup>-1</sup> gibberellic acid treatment, while less sprouting 71.8% percentage were noted in control treatment (Table 1).

**Table 1.** Effects of different gibberilic acid (GA<sub>3</sub>) levels on days to corm sprouting, sprouting percentage, leaves per plant and spike emergence of different gladiolus cultivars

Cultivar	Corm sprouting (Days)	Corm sprouting (%)	Leaves per plant	Spike emergence (Days)
White Prosperity	20.2	84.1	8.4b	55.3a
Red Advance	20.4	84.3	9.8a	53.8b
F	0.16	0.02	6.23	32.43
<b>Gibberellic acid</b>				
0	22.8a	71.8d	7.6b	60.5a
50	21.5ab	77.2cd	8.1b	57.0b
100	20.1bc	85.4bc	9.0ab	54.3c
150	18.8cd	91.7ab	10.2a	52.2d
200	17.9d	96.3a	10.6a	60.5a
F	11.86	11.89	4.46	215.98
<b>CxG</b>				
F	0.15	2.03	0.87	1.07
<b>CV%</b>	6.89	8.67	16.16	1.36

Means followed by the different letter are significantly different at 5% level of significance by LSD test.

ns= non significant and \* = Significant at 5% level of significance.

The balance between growth promoters hormones and growth retardant hormones can play an important role in plant growth and development. As abscisic acid is dominant and hence responsible for the dormancy in gladiolus corms. The freshly harvested corms of gladiolus having dormancy for the period of three months. Reduction in the level of ABA is the major factor causing endogenous hormonal balance, which promotes the sprouting percentage in gladiolus corms. Gladiolus corms treated with 150 mg L<sup>-1</sup> and 200 mg L<sup>-1</sup> gibberellic acid concentrations resulted in highest sprouting percentage (Table 1). Which shows that, 150 mg L<sup>-1</sup> and 200 mg L<sup>-1</sup> gibberellic acid applications was actively involved in the breaking of reserved food material with the help of hydrolytic enzymes present in GA<sub>3</sub> (Padmalatha et al., 2013).

#### Number of leaves per plant

The mean value of different cultivars of gladiolus studied showed that number of leaves per plant produced by Red Advance (9.8) were higher than White Prosperity (8.4). Data recorded for gibberellic acid treatment (Table 1), reveal that maximum number of leaves per plant (10.6) were produced in plants treated with 200 mg L<sup>-1</sup>, followed by plants treated with 150 mg L<sup>-1</sup> gibberellic acid, while

the minimum numbers (7.6) of were recorded in control treatment.

Various factors play part to enhance the growth of gladiolus plants, like the genetical makeup of cultivars, favorable environmental conditions and soil texture. Hence more number of leaves plant<sup>-1</sup> in Red Advance 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<sub>3</sub> might be the enhanced cell division occurred in shoot tip with cell elongation and growth promoter action of gibberellic acid (Sudhakar and Kumar, 2012). In various studies, gibberellin application exogenously found as a promoter of shoot elongation and vegetative growth (Xu et al, 1997; Chopde et al., 2015).

#### Days to spike emergence

Days to spike emergence (Table 1) for both cultivars studied showed that cultivar Red Advance took less days (53.8) than White Prosperity (55.3). The mean value of different gibberellic acid concentrations proved that less number of days to spike emergence (48.8) was noticed in plants with the application of 200 mg L<sup>-1</sup> GA<sub>3</sub> treatment, while more number (60.5) days were taken

by plants in control treatment. Less number of days to spike emergence in Red Advance cultivar might be due to the presence of more photosynthates. As more number of leaves was produced in Red Advance which served as source of photosynthates synthesis, intern enhanced time for spike emergence (Hussain *et al.*, 2011; Zubair *et al.*, 2006). Minimum days to spike emergence may be due to the stimulating effect of the gibberellic acid (Kumari *et al.*, 2011).

**Days to flower opening**

Data pertaining days to flower opening showed that Red Advance took less number of days (74.5) to than White Prosperity (76.1) to flower opening. Different concentrations of gibberellic acid had significant response for days to flower opening. Less number of days (72.7) to flower opening was found in 200 mg L<sup>-1</sup> GA<sub>3</sub> application, while the more number of days (79.2) to flower opening was recorded in plants with no GA<sub>3</sub> application (Table 2).

**Table 2.** Effects of different gibberillic acid (GA<sub>3</sub>) levels on days to flower opening, corm diameter, corm weight and number of daughter corms of different gladiolus cultivars

Cultivar	Flower opening ( Days)	Corm diameter (cm)	Corm weight (g)	Daughter corms
White prosperity	76.1a	2.8b	12.0b	2.7b
Red Advance	74.5b	3.1a	13.4a	3.0a
F	73.24	4.75	21.61	6.44
<b>Gibberellic acid</b>				
0	79.2a	2.47C	10.7c	2.4c
50	76.6b	2.84b	11.5b	2.5bc
100	75.4c	2.85b	11.9b	2.8b
150	73.9d	3.37a	14.9a	3.3a
200	72.7e	3.25a	14.5a	3.5a
F	77.76	16.39	33.35	17.58
<b>CxG</b>				
F	1.62	0.21	1.25	0.80
CV%	0.92	7.36	6.29	10.41

Means followed by the different letter are significantly different at 5% level of significance by LSD test. ns= non significant and \* = Significant at 5% level of significance.

Early flower opening in Red Advance cultivar might be due to the early vegetative growth. As more photosynthates production was found in the plants of Red Advance which enhance the vegetative growth parameters and resulted in the earlier completion of life cycle, hence promoted the reproductive growth as well (Al-Humaid, 2004; Zubair *et al.*, 2006). Application of GA<sub>3</sub> 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; Dogra *et al.*, 2012).

**Diameter of corms (cm)**

The observation about diameter of corms (cm) is presented in Table 2, indicates that maximum corm diameter was observed (3.04 cm) in Red Advance and minimum (2.87 cm) in White Prosperity. The mean value of different gibberellic acid concentrations revealed that maximum corm diameter was obtained by plants treated with 150 mg L<sup>-1</sup> and 200 mg L<sup>-1</sup> gibberellic acid, respectively. The favorable

environmental and soil conditions for development of corms makes cultivar Red advance to develop thick corm than White prosperity. Maximum corm diameter was due to that gibberellic acid helps plants to produce more photosynthates and carbohydrates accumulation, as a result cause large corm size. Gibberellins lead to increased cell division and cell growth apparently which lead to increased elongation of root and it enhances corm diameter (Chopde et al., 2012).

#### Corm weight (g)

Gladiolus cultivars and different concentrations of gibberellic acid had significant difference for corm weight. Mean Table 2 illustrated that maximum corm weight (13.39 g) was higher for Red Advance than White Prosperity (12.03 g). Maximum corm weight (14.90 g) was produced by the plants treated with gibberellic acid of 150 mg L<sup>-1</sup> and 200 mg L<sup>-1</sup>. Maximum corm weight were obtained in Red Advance, it might be due to the best adaptation of gladiolus cultivar and more accumulation of photosynthates and carbohydrates production in which it had obtained a good and well developed plants, as a result it promoted the best corm weight (Yousif et al., 2006). More food is reserved by larger size corms which help in growth and development, with the combination of 150 mg L<sup>-1</sup> gibberellic acid increases the single corm weight (Bhat et al., 2009; Hossian, 2011; Amin, 2013).

#### Number of daughter corms plant<sup>-1</sup>

Data related to number of daughter corms plant<sup>-1</sup> (Table 2) indicates that gladiolus cultivars Red Advance had more number of daughter corms than White Prosperity. A significant response was observed regarding gibberellic acid for number of daughter corms plant<sup>-1</sup> of gladiolus. More number of daughter corms (3.5) plant<sup>-1</sup> were obtained in plants with the application of 200 mg L<sup>-1</sup> gibberellic acid concentration, and less number (2.4) of daughter corms produced plant<sup>-1</sup> were recorded in control treatment.

Higher number of corms plant<sup>-1</sup> in Red Advance cultivar, it might be due to the more accumulation of photosynthates production and favorable climatic conditions increase concentrations of GA<sub>3</sub> increased the corms number (Khan and Ahmad, 2004; Lahiji, 2013).

### Conclusions

It is concluded from the above results that gladiolus cultivar Red Advance had more positive results as compare to White Prosperity, further the application of gibberellic acid application at higher concentration gave optimum results for vegetative, floral and corm development.

#### Authors Contribution

A.R.<sup>0000-0002-1784-1995</sup> and I.H.<sup>0000-0002-5784-7902</sup> Conceived and designed the experiments; A.R. and Z.<sup>0000-0002-1324-4405</sup>: Performed the experiments; G.N.<sup>0000-0001-9406-5195</sup> and Z.: Contributed reagents/materials/analysis tools; I.H. and A.R.: Wrote the paper.

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