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FLOWERING, PHYSIOLOGICAL AND BIOCHEMICAL RESPONSE OF GLADIOLUS *CV.* ARKA AMAR TO PLANT GROWTH REGULATORS AND ARBUSCULAR MYCORRHIZAL FUNGI (AMF)

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Abstract

The investigation on gladiolus *cv.* Arka Amar was conducted at College of Horticulture, Anantharajupeta, Andhra Pradesh. The 13 treatments consisted of different combinations of plant growth regulators along with AMF which were tested in randomized block design with three replications. Results revealed that among different nutrients tried, the treatment $\mathbf{T_8}$ recorded minimum period for corm sprouting (8.67 days), maximum diameter of 2nd fully opened floret (10.23 cm), rachis length (43.20 cm), chlorophyll 'a' (1.105 mg^{-1} fresh wt.), chlorophyll 'b' (0.200 mg^{-1} fresh wt.) and total chlorophyll content (1.305 mg^{-1} fresh wt.). Whereas, maximum values for reducing sugars (6.20 mg^{-1}) and non reducing sugars (9.29 mg^{-1}) was recorded in the treatment receiving $\mathbf{T_{10}}$. It was concluded that the treatment $\mathbf{T_8}$ found an optimum nutrient combination for enhancing flowering and for various biochemical attributes in gladiolus *cv.* Arka Amar.

Key words: Gladiolus, GA_3, BA, AMF, flowering, biochemical attributes.

Introduction

Gladiolus (*Gladiolus grandiflorus* L.) also known as sword lily is one of the most beautiful and fascinating bulbous cut flowers. It has earned tremendous popularity due to its majestic flower spike with acropetal flower opening, attractive shades, varying sizes of flowers, brilliant color tones, ease of cultivation and long lasting vase life. In India, the total area under gladiolus cultivation was 11.67 thousand hectares with production of 92.89 lakh spikes per hectare during 2013-14. In Andhra Pradesh it was cultivated in an area of 0.02 thousand hectares with a production of 10.00 lakh spikes during 2012-13 (NHB, 2012-13 and 13-14). Plant hormones are the organic substances which at minute doses play an active role in causing tremendous influence on the physiology of plant which in turn put forth changes in plant growth and improves flowering and yield. The plant growth regulators have been used in floriculture to manipulate plant growth in a desired direction (Sharma *et al*., 2004). In case of bulbous ornamental plants, gibberellins, cytokinins and auxins play a key role in promoting cell division, cell elongation, biometric characters and extending vase life etc. (Khan and Bahadur, 2013).

Growth regulators and arbuscular mycorrhizae have been found to be the best for improving growth, quality attributes and postharvest life of gladiolus *cv.* Jessica (Kumar and Gupta, 2013). In this context, the use of growth regulators and bio-fertilizers has been found effective in various ornamental crops. Growth and development behavior of bulbous plants are regulated either by a single or by an interaction of several hormones. While, bio-fertilizers are capable of mobilizing nutritive elements from non-usable resources in the soil to usable form through biological process (Kumar *et al*., 2011b). The conventional nutritional requirement (recommended dose of NPK fertilizers) has been standardized. However for getting more quantity of flowers farmers are using chemical fertilizers unscrupulously which are costly and create threat to soil health. There is limited information regarding the role of micorrhizal fungi in gladiolus and optimum concentrations of growth regulators to be used for improving growth, flower quality and yield of spikes. Therefore the present experiment was conducted to elucidate the information on the effect of growth

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regulators and arbuscular mycorrhizal fungi (AMF) on flowering, physiological and biochemical aspects in gladiolus *cv.* Arka Amar.

Materials and Methods

The present field investigation was carried out at College of Horticulture, Dr YSR Horticultural University, Anantharajupeta, Andhra Pradesh during the year 2015. Commercially cultivated gladiolus variety *cv.* Arka Amar was used for the investigation. Well rotten farm yard manure (25 tonnes/ha) was applied as basal dose and mixed well in the soil at the time of last ploughing and the nutrients *viz.,* N, P and K @ 100:87.50:87.50 kg per ha were applied in the form of urea, single super phosphate and muriate of potash, respectively. Urea was applied in 3 splits; the 1/3 of N was applied as basal in the soil before 15 days of planting and other two split doses were applied at 30 and 60 days after corm sowing. The entire dose of single super phosphate and muriate of potash was applied at the time of preparation of plots as per the recommendations of the Dr YSR Horticultural University for the gladiolus crop. Arbuscular mycorrhizal fungi (AMF) was procured from Agricultural Research Station, Amaravathi, Guntur district. The inoculant was mixed with soil per corm basis @ 20 g per corm.

The treatments used were $\mathbf{T_1}$ (pre-soaking of corms with GA_3 100 ppm+AMF), $\mathbf{T_2}$ (pre-soaking of corms with GA_3 200 ppm+AMF, $\mathbf{T_3}$ (pre-soaking of corms with BA 25 ppm+AMF), $\mathbf{T_4}$ (pre-soaking of corms with BA 50 ppm+AMF), $\mathbf{T_5}$ (pre-soaking of corms with NAA 100 ppm+AMF), $\mathbf{T_6}$ (pre-soaking of corms with NAA 200 ppm+AMF), $\mathbf{T_7}$ (($\mathbf{T_1}$ + foliar spray with GA_3 100 ppm), $\mathbf{T_8}$ ($\mathbf{T_2}$ + foliar spray with GA_3 200 ppm), $\mathbf{T_9}$ ($\mathbf{T_3}$ + foliar spray with BA 25 ppm), $\mathbf{T_{10}}$ ($\mathbf{T_4}$ + foliar spray with BA 50 ppm), $\mathbf{T_{11}}$ ($\mathbf{T_5}$ + foliar spray with NAA 100 ppm), $\mathbf{T_{12}}$ ($\mathbf{T_6}$ + foliar spray with NAA 200 ppm) and $\mathbf{T_{13}}$ (control). The experiment was laid out in randomized block design comprising three replications and five plants were selected randomly in each plot and labeled for recording observations. The observations were recorded on flowering, physiological and biochemical attributes. The experimental data were analyzed as per Panse and Sukhatme (1985).

Results and Discussion

Number of days taken for sprouting of corms

A perusal of the data in the table 1 indicated that number of days taken for sprouting of corms was significantly influenced by different treatments. Among various plant growth promoters, the treatment $\mathbf{T_8}$ took significantly minimum duration (8.67 days) for sprouting of corms. It might be due to promotory effect of GA on cell elongation and by secretion of thiamine, riboflavin, IAA and gibberellins like substances in addition to the production of nutrients by AMF. Free GA_3 is active in breaking down the reserved food material by hydrolytic enzymes**.** The results are in close conformity with the findings of Qayoom (2011) in gladiolus and Kumar *et al*. (2011a) in tuberose reported that pre plant soaking of corms with gibberellic acid hastened to early corm sprouting.

Diameter of second fully opened floret

Diameter of the second fully opened floret differed significantly due to the influence of various nutrient combinations (table 2). Significantly maximum diameter of the second fully opened floret was recorded when the gladiolus are applied with the input $\mathbf{T_8}$ (10.23 cm). This could be attributed due to vigorous growth of plants due to increased nutrient levels along with AMF. The enlargement of flower size caused by drawing photosynthates to the flower as a consequence of intensification of the sink (Sable *et al.,* 2015) in gladiolus. The results are in agreement with the findings of Kumari *et al.* (2013), Kumar and Guptha (2013) in gladiolus.

Length of rachis

The observation recorded on the rachis length (cm) due to the influence of various growth regulators in combination with AMF was presented in table 1. On verification of the data, it was found that the treatments had influenced the length of rachis significantly. An examination of the data revealed that, the maximum rachis length of 43.20 cm was recorded in T8. An increased growth of rachis might be due to enhancement in the anabolic processes (especially photosynthesis) due to better uptake and mobilization of various essential nutrients and water in the presence of AMF. GA_3 cause stem elongation *i.e* rapid elongation of internodes due to both cell division and elongation which would result in longest rachis. These findings are in accordance with findings of Kumar *et al.* (2012) in gladiolus.

Spike girth

The data on the effect of growth regulators and AMF on spike girth was recorded and tabulated in table 1. Spike girth did not vary significantly among the treatment combinations.

Chlorophyll a, b and total chlorophyll

The data furnished in the table 2 recorded on influence of various growth regulators in combination with AMF on chlorophyll content responded significantly to all the treatments. Gibberellic acid 200 ppm applied as corm

Table 1: Flowering attributes in gladiolus *cv.* Arka Amar as influenced by plant growth promoters and AMF.

Treatments	Days taken for of sprouting corms	Diameter of 2nd fully opened floret (cm)	Length of rachis (cm)	Spike girth (cm)
T_1- Pre soaking of corms with GA_3 100 ppm + AMF	11.75^{cd}	9.10^{bc}	36.41^{cde}	3.54
T_2 - Pre soaking of corms with GA_3 200 ppm + AMF	8.80^{h}	9.16^{bc}	37.73^{bcd}	3.56
T_3- Pre soaking of corms with BA 25 ppm + AMF	11.67^{cd}	9.30^{bc}	35.49^{cde}	3.50
T_4 - Pre soaking of corms with BA 50 ppm + AMF	9.42^{gh}	9.36^{bc}	36.57^{cde}	3.52
T_5- Pre soaking of corms with NAA 100 ppm + AMF	13.40^{b}	8.74^{cd}	34.23^{de}	3.48
T_6- Pre soaking of corms with NAA 200 ppm + AMF	11.67^{cd}	8.89^{bcd}	35.53^{cde}	3.43
T_7 -T_1 + foliar spray with GA_3 100 ppm	10.50^{ef}	9.53^{ab}	37.62^{bcd}	3.88
T_8- T_2 + foliar spray with GA_3 200 ppm	8.67^{h}	10.23^{a}	43.20^{a}	3.91
T_9- T_3 + foliar application with BA 25 ppm	11.34^{de}	9.40^{bc}	38.78^{abc}	3.89
T_{10}- T_4 + foliar application with BA 50 ppm	9.67^{fg}	9.57^{ab}	42.00^{ab}	3.86
T_{11}- T_5 + foliar application of NAA 100 ppm	13.66^{b}	8.96^{bcd}	36.42^{cde}	3.70
T_{12}- T_6 + foliar application of NAA 200 ppm	12.33^{c}	9.37^{bc}	37.13^{cde}	3.82
T_{13}- Control	14.67^{a}	8.33^{d}	32.73^{e}	3.26
S.EM ±	0.29	0.25	1.55	0.17
CD (*P* = 0.05)	0.86	0.72	4.53	NS

Table 2 : Physiological and biochemical parameters in gladiolus *cv.* Arka Amar as influenced by plant growth regulators and AMF.

Treatments	Chlorophyll content (mg^{-1} fresh wt.)			Reducing sugars (mg^{-1}) in senescent flowers	Non -educing sugars (mg^{-1}) in senescent flowers
	Chloro-phyll 'a'	Chloro-phyll 'b'	Total Chloro-phyll		
T_1- Pre soaking of corms with GA_3 100 ppm + AMF	0.553^{i}	0.139^{d}	0.692^{h}	3.24^{h}	6.32^{fg}
T_2 - Pre soaking of corms with GA_3 200 ppm + AMF	0.641^{g}	0.149^{c}	0.791^{g}	3.60^{g}	6.60^{e}
T_3- Pre soaking of corms with BA 25 ppm + AMF	0.582^{h}	0.132^{e}	0.714^{h}	3.46^{g}	6.50^{ef}
T_4 - Pre soaking of corms with BA 50 ppm + AMF	0.620^{g}	0.139^{d}	0.759^{g}	4.54^{e}	7.20^{d}
T_5- Pre soaking of corms with NAA 100 ppm + AMF	0.474^{k}	0.095^{g}	0.569^{j}	3.50^{g}	5.90^{h}
T_6- Pre soaking of corms with NAA 200 ppm + AMF	0.504^{j}	0.102^{f}	0.606^{i}	4.00^{f}	6.20^{g}
T_7 -T_1 + foliar spray with GA_3 100 ppm	0.935^{c}	0.189^{b}	1.124^{c}	5.00^{d}	7.50^{c}
T_8- T_2 + foliar spray with GA_3 200 ppm	1.105^{a}	0.200^{a}	1.305^{a}	5.95^{b}	9.20^{ab}
T_9- T_3 + foliar application with BA 25 ppm	0.853^{d}	0.186^{b}	1.039^{d}	5.20^{c}	9.00^{b}
T_{10}- T_4 + foliar application with BA 50 ppm	1.050^{b}	0.190^{b}	1.240^{b}	6.20^{a}	9.29^{a}
T_{11}- T_5 + foliar application of NAA 100 ppm	0.734^{f}	0.149^{c}	0.883^{f}	3.46^{g}	6.34^{efg}
T_{12}- T_6 + foliar application of NAA 200 ppm	0.762^{e}	0.185^{b}	0.947^{e}	4.95^{d}	7.45^{cd}
T_{13}- Control	0.362^{l}	0.095^{g}	0.457^{k}	2.00^{i}	6.20^{g}
S.EM ±	0.009	0.002	0.011	0.05	0.09
CD (*P* = 0.05)	0.027	0.006	0.032	0.14	0.27

dipping and foliar spray + AMF (T_8) recorded highest chlorophyll 'a' (1.105 mg^{-1} fresh wt.), chlorophyll 'b' (0.200 mg^{-1} fresh wt.) and total chlorophyll content (1.305 mg^{-1} fresh wt.).

This increase in chlorophyll content might have good impact on the growth and development of gladiolus plant. The results might be due to the fact that gibberellic acid is able to prevent the degradation of photosynthetic pigment, *i.e.* the chlorophyll content in plants (Sajjad *et al*., 2014). The improved chlorophyll contents of leaves could be attributed to enhanced uptake of Mg, Fe, and Cu in the presence of AMF which are essential for synthesis of chlorophyll. These results are in conformity with the findings of Sajjad *et al*. (2014) in gladiolus, Rani and Singh (2013) in tuberose.

Reducing sugars

The data belongs to reducing sugars is presented in table 2. It is an evident from the table that, in senescent florets, maximum reducing sugars was recorded by $\mathbf{T_{10}}$ (6.20 mg^{-1}). This increase in sugar content might be helpful in increasing longevity of flower spikes. Sugars provide energy required for the respiration. Decrease in reducing sugars during petal senescence might be due to translocation from perianth to other organs (developing embryo). These results are supported by the findings of Sajjad *et al.* (2014) in gladiolus.

Non reducing sugars

The data pertaining to this trait was presented in table 2. The information made available in the table revealed that, in senescent flowers, the treatment $\mathbf{T_{10}}$ recorded significantly highest non reducing sugars (9.29 mg^{-1}).

Conclusion

From the above investigation, it can be concluded that the nutrient combination *i.e.* $\mathbf{T_8}$ found an optimum nutrient combination for enhancing flowering, physiological and $\mathbf{T_{10}}$ for various biochemical attributes in gladiolus cv Arka Amar.

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