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# Effect of $GA_3$ Treatment and Nitrogen on Growth and Development of Gladiolus Corms

[1]Yousif S. Siraj and [2]Mahmoud S. Al-Safar
[1]College of Food and Agricultural Sciences, King Saud University, P.O. Box 2460, Riyadh, Saudi Arabia
[2]College of Agricultural and Food Sciences, King Faisal University, P.O. Box 420, Al-Hassa 31982, Saudi Arabia

**Abstract:** A field experiment evaluated the effect of nitrogen and gibberellin pretreatment on growth and development of two cultivars (Topaz and Sancerre) of gladiolus corms during 2003 and 2004 in Al-Hassa, Saudi Arabia. The experimental soil was loamy sand and received four levels of nitrogen (0, 25, 50 and 75 kg N $ha^{-1}$) applied as urea. Gladioli corms were presoaked for 24 h in the gibberellic acid ($GA_3$) solutions at a concentration of 0 and 100 mg $L^{-1}$. Mean stem height, number of leaves per plant, leaf area, shoot dry weight, number of corms per plant, corms dry weight and flower diameter increased significantly with nitrogen and $GA_3$ treatment. A significant difference was observed between the performance of two cultivars and the Topaz proved superior to Sancerre in all growth parameters. This study also confirmed the higher potential of Topaz gladiolus established as a benchmark for nitrogen application rate of 75 kg $ha^{-1}$ for gladioli in Saudi Arabia and suggested that high corm and flower yield of gladioli may be obtained when corms are soaked in $GA_3$ solution of 100 mg $L^{-1}$ before plantation.

**Key words:** Gladiolus, gibberellic acid, nitrogen, pre-soaking treatment, corms yield, Topaz, Sancerre

## INTRODUCTION

Gladiolus is one of the most popular flowers for gardening in Saudi Arabia due to its quick growing ability, excellent floral qualities, high yielding potential and being the most valuable flowering bulbs (Khattab *et al*., 2000a). Previously, many field experiments carried out in different soils showed that nitrogen is one of the most important growth limiting factors (Mangel and Kirkby, 1987).

Gladiolus is grown in Saudi Arabia by traditional practices without proper fertilizer recommendations. There is a general consensus that of all the nutrient amendments applied to soils, nitrogen had shown the most significant effects on plant growth and development. This is true for many different crops grown under a wide variety of plant growth conditions throughout the world. However, some studies on the effect of nitrogen fertilizer on gladiolus have reported contradictory results. Pandey *et al.* (2000) investigated the effect of different levels of nitrogen on the growth of gladiolus and found no significant difference for most of the characters recorded (plant height, leaf length, plant neck diameter, days to colour break, rachis length and number of florets/spike). On the other hand, Singh (2001) reported a significant influence of nitrogen on spike appearance and flowering in gladiolus. Similarly, Sidhu and Arora (1989) found that spike length, total number of flowers/spike, size of flower, number of corms/plant, weight of corms and number of corms/plant showed good responses to nitrogen.

The role of gibberelins is complicated both biologically and biochemically and even today is not fully understood (Arora *et al*., 1992). Moreover, when applied externally, gibberelins influence the organization of the internal chemistry of the plant cell and the interaction among cells, but the degree of interaction still depends mostly upon the plant species, the stage of plant development and the external environment (Arora *et al*., 1992).

The gibberellins are involved in a number of processes including stem extension, flowering and fruit growth (Li *et al*., 1996; Szekeres *et al*., 1996; Yang *et al*., 1996; Nomura *et al*., 1997).

The objectives of this study were to investigate the response of two gladiolus cultivars to nitrogen fertilizer and gibberellin treatment and to determine the effects of these treatments on growth and corm yield of two gladiolus cultivars.

**Corresponding Author:** Mahmoud S. Al-Safar, College of Agricultural and Food Sciences, King Faisal University, P.O. Box 420, Al-Hassa 31982, Saudi Arabia

## MATERIALS AND METHODS

The study was conducted at the Agricultural and Veterinary Training and Research Station, King Faisal University, Al-Hassa, Saudi Arabia during 2003 and 2004. The station is located in Delegia area about 15 km southeast of the University Campus. The total experimental area was 75×22 m. The experimental soil was loamy sandy having 0.12% total nitrogen, 84 mg $L^{-1}$ extractable P, 608 mg $L^{-1}$ extractable K, 0.4% organic matter, cation-exchange-capacity (CEC) of 30 meq/100 g and a pH of 7.6. The seed bed was prepared by plowing followed by cultivation.

Corms of two cultivars of annual gladiolas (Topaz and Sancerre) were presoaked in gibberellic acid ($GA_3$) solutions with a concentration of 0 and 100 mg $L^{-1}$ for 24 h. Gladiolus cultivars were planted on November 18, 2003 and November 3, 2004 to cover two crop seasons. The corms were sown in furrows with a plant to plant distance of 30 cm, row to row distance of 100 cm and with a plot to plot distance of 75 cm.

A basal dose of P and K was applied at the rate of 65 kg $P_2O_5$ $ha^{-1}$ and 20 $K_2O$ $ha^{-1}$, respectively. Nitrogen was applied in 2 equal split doses, one at the time of final land preparation and the other two months after planting. Four levels of nitrogen namely 0, 25, 50 and 75 kg N $ha^{-1}$ were applied in the form of urea (46% N). Each plot contained 15 plants. The plants were irrigated twice per week.

The study was laid out by following a Split-Split-Plot Design and replicated three times. The gladiolus cultivars comprised the main plot, nitrogen fertilizer treatment comprised the sub-plot and the gibberellic acid treatments were in the sub-sub-plot.

Growth parameters of gladiolus such as plant height, number of leaves per plant, leaf area, shoot dry weight, number of corms/plant, corm dry weight, days to flower and flower diameter were recorded.

Data were analyzed using the General Linear Model procedure of SAS (2000). Main effects were compared using ANOVA statistical technique (Steel and Torrie, 1980).

## RESULTS AND DISCUSSION

**Vegetative growth parameters:** Gibralic acid ($GA_3$) and nitrogen application increased significantly the plant height, number of leaves per plant, leaf area and dry weight of shoot per plant as compared to the control treatment (Table 1). The reduction in growth characters was more in the control treatment than all other treatments. The increase in growth attributes may be subjected to the functional role of both $GA_3$ and nitrogen in plant tissues. The main function of nitrogen is cell multiplication, cell elongation, tissue differentiation, while $GA_3$ is known to be involved in various processes of plant development (Hooley, 1994). In various plants, exogenous gibberellin promotes shoot elongation and vegetative growth (Ross *et al*., 1989; Sauter *et al*., 1993; Xu *et al*., 1997). With adequate supply of nitrogen the plants grew taller and produced more leaves with higher chlorophyll content. Thus photosynthesizing area might have increased resulting in greater production of dry matter/plant. Khattab *et al*. (2000a, b). Pandey *et al*. (2000), Ogale *et al*. (2000) and Nazki and Arora (2000) also reported the importance of $GA_3$ and nitrogen for the growth of gladiolus.

Both the cultivars differed in height and leaf production, Topaz being taller and producing more leaves than Sancerre which might be due to the difference in individual cultivar genetic make-up. Topaz cultivar produced significantly more shoot dry weight as compared to Sancerre (Table 1). The higher dry matter might be due to more vegetative growth and was evident from its shoot dry weight which was 13% higher than that of Sancerre. The higher biomass production of Topaz could be attributed to its large root system than the Sancerre cultivar.

**Corm characteristics:** Corms/plant, corm diameter and corm dry weight were significantly affected by $GA_3$ and nitrogen application (Table 2). Corms/plant, corm diameter and corm dry weight were maximum when $GA_3$ and nitrogen were applied. These traits in gladiolus increased significantly with the application of 100 mg $L^{-1}$ $GA_3$ than the control treatment (0 mg $L^{-1}$ $GA_3$). The results of the present investigation were similar to the findings of Suh and Kwack (1990), Roychowdhury (1989) and Arora *et al*. (1992).

Table 1: Effect of $GA_3$, nitrogen and cultivars on gladiolus vegetative growth

| Treatments | Stem height (cm) | No. of leaves/plant | Leaf area ($cm^2$) | Shoot dry weight (g) |
|---|---|---|---|---|
| $GA_3$ mg $L^{-1}$ | | | | |
| 0 | 64.1a | 25.6a | 5.98a | 11.9a |
| 100 | 95.3b | 38.2b | 8.04b | 14.3b |
| $LSD_{0.05}$ | 9.38 | 6.38 | 1.54 | 0.86 |
| N kg $ha^{-1}$ | | | | |
| 0 | 54.8a | 21.3a | 5.74a | 9.8a |
| 25 | 79.6b | 27.8b | 6.78b | 12.3b |
| 50 | 89.0c | 37.4c | 7.39c | 14.7c |
| 75 | 95.3d | 41.1c | 8.13d | 15.5d |
| $LSD_{0.05}$ | 8.97 | 4.74 | 0.38 | 0.91 |
| Cultivar | | | | |
| Topaz | 84.2a | 28.2a | 8.31a | 13.9a |
| Sancerre | 75.2b | 35.6b | 5.71b | 12.3b |
| $LSD_{0.05}$ | 8.39 | 3.08 | 1.27 | 0.79 |

The values in a column followed by the same letter(s) are not significantly different at 5% level of significance ($LSD_{0.05}$).

Table 2: Effect of $GA_3$, nitrogen and cultivars on gladiolus corm characteristics

| Treatments | No. of corms/plant | Corm diameter (cm) | Corm dry weight (g) |
|---|---|---|---|
| $GA_3$ mg $L^{-1}$ | | | |
| 0 | 1.18a | 4.93a | 5.50a |
| 100 | 1.40b | 5.41a | 7.95b |
| $LSD_{0.05}$ | 0.12 | 0.67 | 1.23 |
| N kg $ha^{-1}$ | | | |
| 0 | 1.19a | 3.73a | 4.21a |
| 25 | 1.23a | 4.84b | 6.53b |
| 50 | 1.29a | 5.76c | 7.72c |
| 75 | 1.44b | 6.35d | 8.43d |
| $LSD_{0.05}$ | 0.07 | 0.52 | 0.56 |
| Cultivar | | | |
| Topaz | 1.36a | 5.33a | 7.26a |
| Sancerre | 1.22b | 5.01a | 6.19a |
| $LSD_{0.05}$ | 0.09 | ns | ns |

The values in a column followed by the same letter(s) are not significantly different at 5% level of significance ($LSD_{0.05}$), ns = Non-significant at p = 0.05

Table 3: Effect of $GA_3$, nitrogen and cultivar on gladiolus floral traits

| Treatments | Days to flowering | Spike length (cm) | No. of flowers/spike | Flower diameter (cm) |
|---|---|---|---|---|
| $GA_3$ mg $L^{-1}$ | | | | |
| 0 | 70.8a | 88.3a | 9.3a | 8.95a |
| 100 | 77.4b | 100.0b | 12.6b | 10.39b |
| $LSD_{0.05}$ | 2.43 | 8.06 | 1.42 | 1.27 |
| N kg $ha^{-1}$ | | | | |
| 0 | 68.5a | 84.2a | 6.9a | 5.74a |
| 25 | 72.3b | 89.4b | 10.8b | 9.88b |
| 50 | 76.6c | 97.8c | 12.4c | 10.39c |
| 75 | 78.9d | 105.2d | 13.7d | 12.71d |
| $LSD_{0.05}$ | 1.74 | 4.21 | 0.38 | 0.49 |
| Cultivar | | | | |
| Topaz | 80.5a | 96.1a | 11.7a | 10.33a |
| Sancerre | 67.7b | 92.2d | 10.2b | 9.01b |
| $LSD_{0.05}$ | 9.45 | 3.16 | 0.63 | 1.24 |

The values in a column followed by the same letter(s) are not significantly different at 5%, level of significance ($LSD_{0.05}$)

The nitrogen application at the rate of 75 Kg N $ha^{-1}$ resulted in significantly highest number of corms/plant, corm diameter and accumulation of dry matter/corm. In gladioli when the corms are produced they form strong sink and when supplied with optimum nitrogen, greater translocation of photosynthates occurs from the leaves to the sink sites resulting in better corms and eventually a high corm yield. Singh (2001), Groen and Slangen (1990) and Sidhu and Arora (1989) reported similar results.

There was a significant difference in production of corms between the two cultivars (Table 2), Topaz produced more and heavier corms than Sancerre. The results of this study confirms the superior potential of Topaz in the Eastern Province of Saudi Arabia.

**Floral characteristics:** $GA_3$ and nitrogen application significantly increased the floral traits of gladioli than the control treatment (Table 3). The number of days to flowering, spike length, number of flowers/spike and flower diameter increased significantly with the use of $GA_3$. The increase was mainly owing to the increase in the number of leaves/plant and leaf area which might have increased the production of photosynthates needed to enhance reproductive growth. The findings confirm the result of Groen and Slangen (1990), Roychowdhury (1989) and Sidhu and Arora (1989).

The same characters increased significantly with an increase in nitrogen up to 75 kg $ha^{-1}$ (Table 3). Fertilized plants gave consistently better results compared to unfertilized plants. Apparently, field application of nitrogen to gladioli affected floral characteristics (Steerer and Barta, 1984). An increase in the individual stem weight and number should be translated into increase in the mean and total floral part.

Floral production varied with cultivar (Table 3). Topaz produced longer spikes and higher number of flower/spike. The increase in floral yield of Topaz as compared to that of Sancerre cultivar could be mainly due to its enhanced growth and flower contributing characters. The difference in corm yield between the Topaz and Sancerre further substantiate the superior flora yield of Topaz. This positive response may indicate the capacity of Topaz to produce longer spike, higher number of flowers/spike and larger flowers.

In conclusion, the results of this study confirm the higher potential of Topaz gladiolus established as a benchmark for nitrogen application rate of 75 kg $ha^{-1}$ for gladioli in Saudi Arabia and suggested that high corm and flower yield of gladioli may be obtained when corms are soaked in $GA_3$ solution of 100 mg $L^{-1}$ before plantation.

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