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# Effect of iron and zinc on flowering and postharvest life in gladiolus (*Gladiolus* spp.)

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ABSTRACT

An experiment was conducted at Banaras Hindu University in the year 2013-14 to find out the effect of foliar application of iron and zinc on flowering and postharvest life in gladiolus (*Gladiolus* spp.). Foliar application of $ZnSO_4$ 0.4% was found to be most effective for enhanced length of rachis (56.89 cm) and duration of flowering (15.33 days). While, days to opening of first floret was earliest with the treatment $FeSO_4$ 0.2% (81.25 days) and was significant to the other treatments. Maximum diameter of third floret (12.40 cm) was recorded with $FeSO_4$ 0.4% + $ZnSO_4$ 0.2% which was statistically at par with the treatment $FeSO_4$ 0.4%, $FeSO_4$ 0.2% and $FeSO_4$ 0.2% + $ZnSO_4$ 0.2%. Among postharvest indices, foliar application of $FeSO_4$ 0.4% prolonged the days to opening of the first floret (3.33 days) followed by $FeSO_4$ 0.2% and $ZnSO_4$ 0.2%. Whereas, days to opening of the third floret was maximum (5.67 days) with the treatment combination $FeSO_4$ 0.4% + $ZnSO_4$ 0.4% followed by $FeSO_4$ 0.4%. Maximum diameter of the first, third and fifth floret was recorded with the treatment combination $FeSO_4$ 0.2% + $ZnSO_4$ 0.2% which was statistically at par with $ZnSO_4$ 0.2%. Solution uptake was recorded maximum (130.00 ml) with the treatment $FeSO_4$ 0.2% followed by $FeSO_4$ 0.2% + $ZnSO_4$ 0.4%. Maximum vase-life was observed with the treatment $ZnSO_4$ 0.4% (15.67 days) followed by $FeSO_4$ 0.2% + $ZnSO_4$ 0.4% whereas; minimum vase life was recorded with the control (12.33 days).

**Key words**: Flowering, Gladiolus, Iron sulphate, Postharvest life, Zinc sulphate

Gladiolus, popularly known as "Queen of bulbous flowers" is one of the important cut flower crop grown in India and the world (Reddy *et al*. 2014). It occupies a prime position among cut flowers both in domestic and international market due to its versatile colours of flower spike which adds elegant beauty to the floral arrangement. Enlarged floret size and prolonged vase life is of considerable economic importance in a flower crop. Vase life is an important parameter which determines its popularity and marketability (Mansouri 2012). Both macronutrients and micronutrients play a key role for proper growth and development thus, enhancing the vase life. Micronutrients although required in small quantity are crucial in flowering plants since they play various roles in the plant metabolism. Senescence of cut flowers is initiated after harvest (Shahri and Tahir 2011) which leads to oxidative stress and leakage of membrane during vase life also accelerates degradation of flowers (Ezhilmathi *et al*. 2007). All these factors deter the postharvest quality of the flower by affecting its vase life. Application of micronutrients along with macronutrients improves various flowering characteristics of gladiolus including its vase life (Usha *et al*. 2006, Fahad *et al*. 2014). Among micronutrient, deficiency of iron and zinc is a major problem. Iron is a redox active material which plays a key role in photosynthesis and mitochondrial respiration. It is also involved in electron transport system being an oxygen carrier. Zinc has antioxidant properties which eventually help in enhancing the vase life of flowers. But usually the application of micronutrients is neglected despite of its beneficial effects. Therefore, supply of adequate amount of nutrients at proper time is imperative for achieving quality flowers for export to the international market. The present research effort aims to elucidate the response of gladiolus cv. American Beauty to different concentrations of iron, zinc and its combination to standardize zinc and iron dose for obtaining better flowering trait and postharvest life.

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## MATERIALS AND METHODS

The present investigation was carried out at the

Horticulture Research Farm and at the Post-harvest Laboratory of Department of Horticulture, Banaras Hindu University, Varanasi, Uttar Pradesh during 2013-14. Varanasi city is located 25° 10' North latitude, 83° 03' East longitudes and at an altitude of 123.23 m above the mean sea level. The climate of Varanasi is sub-tropical with dry hot summers and cool winter with average rainfall of about 1 000 mm per annum. Healthy and disease free corms of uniform size were selected and planted in the prepared beds with a spacing of row to row 30 cm and corm to corm 20 cm during 6 November 2013 as per the recommendation (Bijimol and Singh 2001). There were 27 plots with individual plot size of 1.20 × 0.80 $m^2$. The treatments used were control, $FeSO_4$ 0.2%, $FeSO_4$ 0.4%, $ZnSO_4$ 0.2%, $ZnSO_4$ 0.4%, $FeSO_4$ 0.2% + $ZnSO_4$ 0.2%, $FeSO_4$ 0.2% + $ZnSO_4$ 0.4%, $FeSO_4$ 0.4% + $ZnSO_4$ 0.2% and $FeSO_4$ 0.4% + $ZnSO_4$ 0.4%. There were 9 treatments replicated thrice in Randomized Block Design (RBD). Foliar spray of zinc and iron was done two times, at 3rd and second at 5th leaf stage. Foliar application of these nutrients was done to run-off stage and control plants were treated in same manner with distilled water. Cultural practices like irrigation, weeding, hoeing, earthing up and staking operations were completed according to needs. For post-harvest study, gladiolus spikes were harvested early in the morning with the help of sharp knife when basal floret started to show its colour and placed in the bucket containing water. Then, it was immediately brought to the Post-harvest Laboratory. Stems of flowers were again re-cut to increase the surface area for absorption of vase solution and placed in the 500 ml conical flask containing 200 ml of 8-HQC solution for further study (Kumar and Gupta 2014). Flowering indices like days to 50% spike emergence, length of rachis, days to opening of 1st floret, diameter of 3rd floret and duration of flowering along with various postharvest indices were evaluated and statistically analyzed by using Randomized Block Design. Analysis of variance (ANOVA) was performed according to the procedure suggested by Assaad *et al*. (2014).

## RESULTS AND DISCUSSION

*Flowering indices*

Response of iron and zinc at different concentrations was recorded to assess the flowering behaviour under uniform management condition. The application of iron and zinc significantly influenced the various flowering indices as compared to control (Table 1).

50% emergence of spike in the field was recorded almost at the same day with the treatment combination $FeSO_4$ 0.4% + $ZnSO_4$ 0.4% (61.33 days) and treatment $ZnSO_4$ 0.4% (61.67 days) which was found to be earliest as compared to the other treatments. Foliar application of $ZnSO_4$ 0.4% was most effective for enhanced length of rachis (56.89 cm) and duration of flowering (15.33 days). Maximum length of rachis was observed with the treatment $ZnSO_4$ 0.4% followed by $ZnSO_4$ 0.2% and $FeSO_4$ 0.2% + $ZnSO_4$ 0.2%. Control plants treated with distilled water recorded minimum rachis length. This may be due to the lack of beneficial effect of iron and zinc. Days to opening of first floret was earliest with the treatment $FeSO_4$ 0.2% (81.25 days) and was significant to the other treatments. Maximum diameter of third floret (12.40 cm) was recorded with $FeSO_4$ 0.4% + $ZnSO_4$ 0.2% which was statistically at par with the treatment $FeSO_4$ 0.4%, $FeSO_4$ 0.2% and $FeSO_4$ 0.2% + $ZnSO_4$ 0.2%. The enhanced flowering indices may be due to the fact that zinc plays a key role in bio-assimilation and therefore the growth of floral parts is accelerated. It has a crucial role in synthesis of auxin IAA with the help of tryptophan which is the precursor for IAA. This results in the elongation of internodal length and leads to increase in apical growth. Zinc treated plants have pronounced carbohydrate fixation that might have led to luxurious growth of plant parts. These results are in consonance with the results obtained by Sharma *et al.* (2013) who worked on gladiolus. Iron helps in nitrogen assimilation and together with zinc they actively participate in photosynthesis thus resulting in bioaccumulation which eventually leads to partitioning of floral growth. This finding was confirmed by Lahijie (2012) and Hembrom and Singh (2015). These results are also in congruence with the findings of Keram *et al.* (2014) and Prasad *et al.* (2014).

Table 1 Effect of foliar application of iron and zinc on flowering indices

| Treatment | Days to 50% spike emergence | Length of rachis (cm) | Days to opening of 1st floret | Diameter of 3rd floret (cm) | Duration of flowering (days) |
|---|---|---|---|---|---|
| Control | 63.00 | 48.00 | 86.31 | 10.20 | 10.89 |
| $FeSO_4$ 0.2% | 62.00 | 53.82 | 81.25 | 12.12 | 13.50 |
| $FeSO_4$ 0.4% | 62.67 | 53.86 | 82.83 | 12.27 | 14.22 |
| $ZnSO_4$ 0.2% | 62.33 | 54.75 | 82.50 | 11.91 | 14.08 |
| $ZnSO_4$ 0.4% | 61.67 | 56.89 | 84.53 | 11.95 | 15.33 |
| $FeSO_4$ 0.2% + $ZnSO_4$ 0.2% | 62.00 | 54.71 | 84.50 | 12.03 | 11.83 |
| $FeSO_4$ 0.2% + $ZnSO_4$ 0.4% | 68.00 | 52.45 | 87.42 | 11.87 | 11.92 |
| $FeSO_4$ 0.4% + $ZnSO_4$ 0.2% | 63.67 | 51.91 | 82.92 | 12.40 | 12.08 |
| $FeSO_4$ 0.4% + $ZnSO_4$ 0.4% | 61.33 | 50.67 | 83.58 | 11.86 | 11.58 |
| CD (P=0.05) | NS | 7.13 | NS | 0.97 | 3.91 |

*Postharvest indices*

Postharvest indices were significantly influenced by the foliar application of iron and zinc in the gladiolus cv. American Beauty (Table 2). Foliar application of $FeSO_4$ 0.4% prolonged the days to opening of the first floret (3.33 days) followed by $FeSO_4$ 0.2% and $ZnSO_4$ 0.2% which was significant to the other treatments. Control plants were observed to be earliest (1.67 days) to the opening of first floret as compared to the others. Similar observation was recorded for the days of opening of fifth floret. Treatment

Table 2 Effect of foliar application of iron and zinc on postharvest indices

| Treatment | Days to opening of 1st floret | Days to opening of 3rd floret | Days to opening of 5th floret | Diameter of 1st floret (cm) | Diameter of 3rd floret (cm) |
|---|---|---|---|---|---|
| Control | 1.67 | 3.33 | 5.00 | 11.33 | 10.63 |
| $FeSO_4$ 0.2% | 2.33 | 3.00 | 4.00 | 12.33 | 11.38 |
| $FeSO_4$ 0.4% | 3.33 | 4.33 | 6.33 | 12.48 | 12.50 |
| $ZnSO_4$ 0.2% | 2.33 | 3.67 | 5.00 | 13.08 | 12.50 |
| $ZnSO_4$ 0.4% | 2.00 | 3.00 | 5.00 | 12.52 | 11.53 |
| $FeSO_4$ 0.2% + $ZnSO_4$ 0.2% | 2.00 | 3.00 | 4.67 | 13.32 | 12.40 |
| $FeSO_4$ 0.2% + $ZnSO_4$ 0.4% | 2.00 | 3.00 | 4.33 | 12.45 | 12.00 |
| $FeSO_4$ 0.4% + $ZnSO_4$ 0.2% | 2.00 | 3.00 | 4.67 | 11.77 | 11.40 |
| $FeSO_4$ 0.4% + $ZnSO_4$ 0.4% | 2.00 | 5.67 | 4.33 | 11.72 | 11.68 |
| CD (P=0.05) | 1.26 | 1.44 | 1.49 | 1.38 | 1.79 |

Table 3 Effect of foliar application of iron and zinc on postharvest indices

| Treatment | Diameter of 5th floret (cm) | No. of florets opened at a time | Solution uptake (ml) | Vase life (days) |
|---|---|---|---|---|
| Control | 9.58 | 7.67 | 100.00 | 12.33 |
| $FeSO_4$ 0.2% | 11.37 | 7.00 | 130.00 | 14.33 |
| $FeSO_4$ 0.4% | 10.83 | 7.67 | 126.00 | 14.67 |
| $ZnSO_4$ 0.2% | 10.67 | 7.33 | 120.00 | 14.33 |
| $ZnSO_4$ 0.4% | 10.82 | 9.00 | 114.67 | 15.67 |
| $FeSO_4$ 0.2% + $ZnSO_4$ 0.2% | 11.72 | 7.67 | 115.33 | 15.00 |
| $FeSO_4$ 0.2% + $ZnSO_4$ 0.4% | 10.60 | 9.00 | 126.67 | 15.00 |
| $FeSO_4$ 0.4% + $ZnSO_4$ 0.2% | 10.17 | 8.00 | 109.33 | 14.33 |
| $FeSO_4$ 0.4% + $ZnSO_4$ 0.4% | 11.17 | 7.67 | 118.67 | 14.67 |
| CD (P=0.05) | 1.94 | 1.80 | 18.40 | 3.18 |

$FeSO_4$ 0.4% took more number of days (6.33 days) as compared to others. Floret of treatment $ZnSO_4$ 0.2%, $ZnSO_4$ 0.4% and control opened at the same day (5th day) and were significant to the other treatments. Whereas, days to opening of the third floret was maximum (5.67 days) with the treatment combination $FeSO_4$ 0.4% + $ZnSO_4$ 0.4% followed by $FeSO_4$ 0.4% and $ZnSO_4$ 0.2%. Maximum diameter of the first, third and fifth floret was recorded with the treatment combination $FeSO_4$ 0.2% + $ZnSO_4$ 0.2% which was statistically at par with $ZnSO_4$ 0.2%. Longevity of 1st floret, 3rd floret and 5th floret were also observed to be positively influenced by the foliar application of micronutrients (Fig 1). Solution uptake was recorded maximum (130.00 ml) with the treatment $FeSO_4$ 0.2% followed by $FeSO_4$ 0.2% + $ZnSO_4$ 0.4% and $FeSO_4$ 0.4%. Plants treated with distilled water recorded the minimum solution uptake (100.00 ml). High uptake of vase solution determines the quality and shelf-life of cut flowers (Vinodh *et al*. 2013). Iron governs the respiration rate of flowers and delays the opening of florets. It helps in nitrogen assimilation, osmo-protection, biosynthesis of hormones like ethylene, gibberellic acid, jasmonic acid, production and scavenging of reactive oxygen species and protection against pathogens which leads to prolific growth and differentiation of floral parts (Hansch and Mendel 2009). Similar results were confirmed by Singh *et al.* (2015). Maximum number of opened florets in a vase (9.00) without withering of lowermost floret has paramount importance. Treatment $ZnSO_4$ 0.4% and $FeSO_4$ 0.2% + $ZnSO_4$ 0.4% recorded the maximum number of florets (9.00) opened at a time which also extended the vase life. Maximum vase life was observed with the treatment $ZnSO_4$ 0.4% (15.67 days) followed by $FeSO_4$ 0.2% + $ZnSO_4$ 0.4%, whereas minimum vase life was recorded with the control (12.33 days). Zinc regulates Super Oxide Dismutase activity (Pandey *et al*. 2002). Hence it maintains the membrane integrity by purifying the reactive oxygen species (ROS) and preventing the oxidative damage of cells. It also binds the membrane proteins and prevents the membrane leakage thus maintaining its integrity and extends the vase life (Aravind and Prasad 2003). These results were also in lent credence with the finding of Ganga *et al.* (2008) who worked on chrysanthemum. Singh *et al.* (2015) work on lilium and found the similar result.

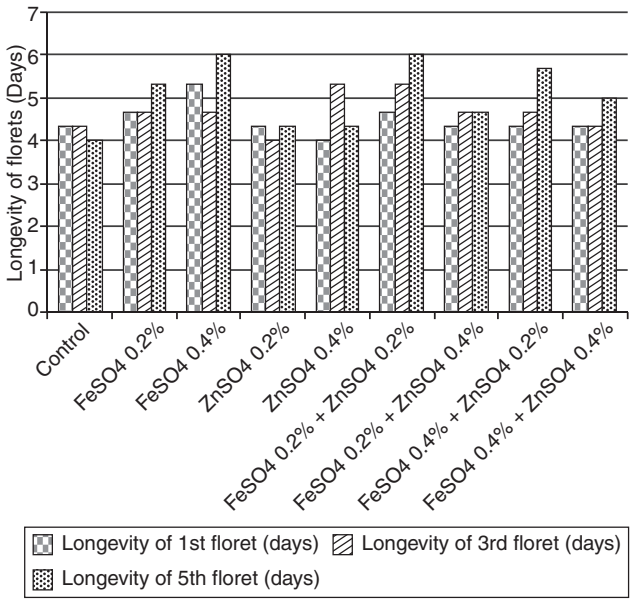


Fig 1 Effect of iron and zinc on longevity of florets

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