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Effect of foliar application of zinc and iron on growth, flowering and yield of gladiolus (*Gladiolus grandiflorus* L.)

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Abstract
The present investigation entitled "Effect of foliar application of zinc and iron on growth, flowering and yield of gladiolus (*Gladiolus grandiflorus* L.)" was carried out during the year of 2020-21 in rabi season *i.e.* from November - April, at Department of Floriculture and Landscape Architecture, Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon (C.G.). The micro-nutrient used were T_1 control (water spray), T_2 zinc 0.3%, T_3 zinc 0.6%, T_4 zinc 0.9%, T_5 iron 0.3%, T_6 iron 0.6%, T_7 0.9%, T_8 zinc 0.3% + iron 0.3%, T_9 zinc 0.6% + iron 0.6%, T_{10} zinc 0.9% + iron 0.9% and T_{11} zinc 0.9% + iron 0.3%. The experimental results revealed that the minimum number of days taken for spike initiation (68.07 days), maximum length of spike (88.37cm), maximum length of rachis (54.31cm), higher number of florets (13.93), more longevity of flower (11.40 days) and maximum vase life of cut flower (11.53 days) was found in foliar application of 0.3% zinc + 0.3% iron (T_8).

Keywords: Gladiolus (*Gladiolus grandiflorus* L.), micro-nutrient, foliar application, zinc, iron, and flowering parameters

1. Introduction
The name gladiolus was originally coined by Pliny the Elder (23-79 A.D.) and derived from the Latin word "gladius" meaning a sword, due its sword-like foliage and hence, sometimes called as sword lily. Gladiolus originated from South Africa and belongs to monocot family Iridaceae. (Negi *et al.*, 1982) [13]

It is used for cut flower, garden display, herbaceous borders, beddings, pots, floral arrangements and interior decorations as well as making high quality bouquet. It has second rank after tulip among the bulbous flowers in India and has occupied fourth position in international trade of cut flowers.

Gladiolus is grown throughout the world Large scale production of gladiolus cut flower have done in USA, Holland, Italy, France, Poland, Bulgaria, Brazil, Australia and also Israel. In India, it is commercially cultivated in West Bengal, Madhya Pradesh, Maharashtra, Chhattisgarh, Assam, Uttarakhand, Karnataka, Haryana, Himachal Pradesh and Telangana (National horticulture board, 2015-16) [1].

Gladiolus is commercially cultivated in all districts of C.G. in Chhattisgarh, the area and production of gladiolus is 2461 ha and 12667 metric tonnes (Anonymous, 2019-20) [2]. In Chhattisgarh gladiolus grown in last month of October and 1st week of November and bloom in December, January & February month but the demand of flower on market throughout the year.

Micronutrients are essentially as important as macronutrients for better growth, yield and quality in plants. Micronutrients are involved in all metabolic and cellular functions and play a vital role in the growth and development of plants, due to their stimulatory and catalytic effects on metabolic processes and ultimately on flower yield and quality (Khosa *et al*., 2011 and Lahijie, 2012) [10, 12].

The Foliar application of zinc and iron recorded significantly maximum vegetative growth in respect of plant height and leaf area, yield in respect of spikes plant-^{1} and corms plant-^{1}, quality parameters *viz*. length of spike, length of rachis, florets spike-^{1}, diameter of spike, and diameter of corm and the earliest 50 percent flowering. (Farahat *et al.*, 2007) [3].

2. Materials and Methods

The research was conducted at the Horticultural Research cum Institutional Farm, Pt. K.L.S. College of Horticulture and Research Station Pendri, Rajnandgaon. I.G.K.V. Raipur, Chhattisgarh, during the year 2020-21. The field is geographically located at about 21.10^0 N latitude and 81.03^0 E longitudes with an average altitude of 307 m above the mean sea level.

The soil property of experimental site was 6.6 pH, Electrical conductivity (0.22dSm^{-1}), Available nitrogen (225.03 kg/ha.), Phosphorus (1.38 kg/ha.), Potassium (276.02 kg/ha.), Zinc (1.30 mg/kg) and iron (11.26 mg/kg).

The experiment was conducted in Randomized Block Design having eleven treatments including three replication. Corm was sown on November 08, 2020 at the spacing of 30 cm x 30 cm. Eleven treatment comprising of T_1 control (water spray), T_2 zinc 0.3%, T_3 zinc 0.6%, T_4 zinc 0.9%, T_5 iron 0.3%, T_6 iron 0.6%, T_7 0.9%, T_8 zinc 0.3% + iron 0.3%, T_9 zinc 0.6% + iron 0.6%, T_{10} zinc 0.9% + iron 0.9% and T_{11} zinc 0.9% + iron 0.3%. The micro-nutrients representing their treatment combination was sprayed at 3rd and 6th leaf stage.

Observation were taken for flowering parameters *viz.* number of days taken for spike initiation, length of spike (cm), rachis length (cm), number of florets per spike, flowering duration (days) and vase life (days) of gladiolus flower.

3. Results and Discussion

1. **Number of days taken for spike initiation:** The treatment T_8 took non-significantly minimum day's period (68.07) for spike initiation where as the treatment T_1 took maximum (74.16 days).
2. **Length of spike (cm):** The treatment T_8 produced significantly maximum length of spike (88.37cm) and the treatment T_1 i.e. control produced minimum length of spike (65.60 cm). The positive impact of zinc might be due to the ability in activating several enzymes catalase, peroxidase, tryptophan synthase and its involvement in chlorophyll synthesis and various physiological activities, ultimately leading to an increase in the spike length of flower. Similar results were recorded by Yadav *et al.* (2003) [16] in tuberose, Jauhari *et al.* (2005) [7] in gladiolus, Rao (2005) [14] in gladiolus, Kumar *et al.* (2009) [11] in chrysanthemum and Lahije (2012) in gladiolus.
3. **Length of rachis (cm):** The maximum length of rachis (54.31cm) was observed in treatment T_8 with significant effect and followed by T_2 (52.69 cm), T_9 (51.42 cm) and T_5 (50.07 cm). However, minimum length of rachis (40.30 cm) was recorded in the control treatment i.e. T_1 (water spray). This might be due to the fact that enhanced vegetative growth due to optimum supply of zinc would have been reflected on the production of maximum rachis length in gladiolus iron might be attributed to the fact that, the application of suitable dose of iron might have promoted the production of healthy green leaves which in turn resulted in assimilate synthesis and partitioning of flower growth. These results are in accordance with the findings of Katiyar *et al.* (2005) [9] and Lahijie (2012) [12] in gladiolus.
4. **Number of floret per spike:** The treatment T_8 was recorded with significantly higher number of florets (13.93) in a single spike which was at par with treatment T_2 (12.82) and T_4 (12.80) and the minimum number of florets (10.29) was found in the control T_1. This might have been due to an important role of suitable dose of zinc in carbon dioxide evolution, utilization of carbohydrates and phosphorus metabolism and also in synthesis of RNA. Iron would have helped in biosynthesis of photo assimilates; thereby enhanced vegetative growth of plant which in turn might have improved the quality of flower by increasing number of florets spike^{-1}. Similar results i.e. application of zinc and iron increased the number of florets spikes^{-1} has been reported by Lahijie (2012) [12] and Saeed *et al.* (2013) [15] in gladiolus.
5. **Flowering duration (days):** The data showed that significantly more longevity of flower (11.40 days) was found in the treatment T_8 followed by the treatment T_9 (10.60 days) and T_2 (10.53 days). While, minimum longevity of flower (7.93 days) was found in the control treatment T_1. It is clear that the longevity of flower was increased with the combined application of zinc and iron. Similar results have been reported by Rao (2005) [14] in gladiolus, Jat *et al.* (2007) [6] in African marigold and Jagtap *et al.* (2012) [5] in rose.
6. **Vase life of cut spike (days):** The treatment T_8 recorded significantly maximum vase life of cut flower (11.53 days). However, minimum vase life of flower (7.33 days) was observed with the treatment T_1 control. This might be due to higher carbohydrate deposition in the vegetative cells that resulted in thickening of cells and hence, the vase life of gladiolus flower might have been increased due to foliar of zinc and the involvement of iron in the synthesis of plant hormones and its influence on vase life of flower. Similar result was recorded by Ganga *et al.* (2008) [4] in chrysanthemum and Kakde *et al.* (2009) [8] in China aster.

Table 1: Effect of foliar application of zinc and iron on flower parameters of gladiolus (*Gladiolus grandiflorus* L.)

Notation	Treatment	Number of days taken for spike initiation	Spike length (cm)	Rachis length (cm)	Number of florets per spike	Flowering duration (days)	Vase life of cut spike (days)
T_1	Control (water spray)	74.16	65.60	40.30	10.29	7.93	7.33
T_2	Zinc (0.3%)	68.73	87.30	52.69	12.82	10.53	10.41
T_3	Zinc (0.6%)	68.13	82.17	47.75	11.40	10.20	9.83
T_4	Zinc (0.9%)	70.29	75.82	46.65	12.80	10.06	8.49
T_5	Iron (0.3%)	69.00	82.63	50.07	11.62	10.13	9.51
T_6	Iron (0.6%)	69.27	79.85	44.71	11.60	9.46	8.66
T_7	Iron (0.9%)	71.93	77.19	45.33	11.26	9.08	8.50
T_8	Zinc (0.3%) + Iron (0.3%)	68.07	88.37	54.31	13.93	11.40	11.53
T_9	Zinc (0.6%) + Iron (0.6%)	70.53	85.12	51.42	12.33	10.60	10.03

T_{10}	Zinc (0.9%) + Iron (0.9%)	73.33	74.60	44.45	11.31	9.53	8.66
T_{11}	Zinc (0.3%) + Iron (0.9%)	73.40	80.61	46.92	11.20	9.16	9.01
S.Em±		2.17	2.48	1.83	0.46	0.29	0.19
C.D. at 5%		N/S	7.37	5.44	1.37	0.87	0.58
C.V. (%)		5.33	5.37	6.65	6.74	5.18	3.67

4. Conclusion

On the basis of present investigation, it may be concluded that the treatment T_8 (zinc 0.3% + iron 0.3%) performed better for minimum number of days taken for spike initiation, spike length, rachis length, number of florets per spike, flower duration and vase life of cut spike. In research T_1 (water spray) was found most inferior among the all treatments which was treated by foliar application of micro-nutrient (zinc & iron).

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