Effect of micronutrients on growth and flowering of gladiolus (*Gladiolus grandiflorus* L.) under subtropics of Jammu

ABSTRACT

An open field experiment was conducted during 2019-20 at the Experimental Farm, Division of Vegetable Science & Floriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, to evaluate the effect of micronutrients on growth, flowering and yield of gladiolus (*Gladiolus grandiflorus* L.) cv. 'Nova Lux'. The experiment was laid out in Randomized Block Design with three replications and nineteen treatments. The different micro-nutrient like Fe, Zn and Mn was taken in different concentrations along with control. The results revealed that maximum plant height (97.74 cm), number of leaves per plant (9.04), leaf length (74.36 cm) and leaf area index (4.14) was recorded with the application of ZnSO4 at 0.2 % and FeSO4 at 0.2 %. Further, among the flowering traits, minimum duration for days taken for 1st floret opening, the maximum spike length (81.86 cm), rachis length (56.76 cm), number of florets per spike 917.69) and weight of the spike (74.78 g) was recorded with the application of ZnSO4 at 0.2 % and FeSO4 at 0.2 %. Thus, foliar application of micronutrients *i,e.* ZnSO4 at 0.2 % and FeSO4 at 0.2 % proved to be most effective in increasing the growth, flowering and corm production in gladiolus.

Keywords: Micronutrients, Gladiolus, Iron, zinc, manganese and Corm production

INTRODUCTION:

"Gladiolus (*Gladiolus grandiflorus* L.) is a bulbous ornamental plant, which belongs to family *Iridiaceae*. It is popularly known as Queen of bulbous flower because of attractive spike, having florets of huge forms, dazzling colors and longer keeping quality" (**Luo *et al.*, 2012**). "Gladiolus is one of the most important bulbous flowering crops grown commercially for cut-flower trade in India. To catch the early and late demands in the cut flower market besides increasing the production of corms and cormel production of gladiolus, the micronutrients play crucial and vital role in gladiolus" (**Bhattacharjee *et al.*, 1984**). "The quality production is the need for standard agricultural and nutrient management practices. The deficiencies of micronutrients create various abnormalities like chlorosis, rosetting and scorching etc. Soil applied micronutrients have low efficiency (3 – 5 %) of absorption to the crop, whereas foliar applied micronutrients have an efficiency of 20 – 40 %" (**Edward, 2009**). "Micronutrients application play important role in growth and development of plants, due to their stimulatory and catalytic effects on metabolic processes the flower yield (**Lahijie, 2012**) and quality (**Khosa *et al.*, 2011**) will be enhanced".

"The micronutrient iron is involved in chlorophyll, protein synthesis and in root tip meristem which affects plants growth. Iron being associated with chlorophyll formation, activity of several enzyme systems and plant compounds (catalase and cytochrome-oxidase) causing shoot growth and helps improve the growth and flowering of gladiolus. Zinc is also important micronutrient which is necessary for sugar regulation and various enzymatic activity related to plant growth" (**Khosa *et al.*, 2011**). Manganese is essential for the development of chlorophyll, photosynthesis, respiration, assimilation of nitrates and the action of several enzymes. It is also involved in evolution of oxygen during photosynthesis. Iron deficiency impairs many plant physiological processes as it is involved in chlorophyll, protein synthesis and in root tip meristem growth. **Tagliavini and Rombola (2001)** illustrated that "iron deficiency (chlorosis) is a common disorder which affects plants grown on soils of high pH". "This may lead to serious yield and quality losses, demanding the implementation of suitable plant iron deficiency correction strategies. Thus, Iron micronutrient applied through foliar spray is a common practice to cure iron deficiency" (**Mortvedt, 1991**).

Owing to the beneficial nutritional help, micronutrients are rapidly gaining momentum among flower growers and guarantees better harvest and returns at the same time. Increased demand for flower production would require a detailed understanding of the relationship between micronutrients and crop growth. Keeping the above under consideration the study was planned to investigate the effect of different micronutrients on growth and flowering characters in gladiolus under sub-tropics of Jammu.

Materials and Method

A field experiment was conducted during *Rabi* season of 2018-19 at the Experimental Farm, Division of Vegetable Science & Floriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. The experimental site is located at 32 °40'N latitude and

74° 58’ E longitude at an elevation of 332 m above mean sea level falling in the sub-tropical foot hill lands of Shiwaliks in Jammu and Kashmir. The climate of this place is bestowed with hot and dry early summers followed by hot and humid monsoon season and cold winters. The soil at the experimental site was sandy loam in texture with 7.40 pH and low in organic carbon. The soil was low in available N, available P_2O_5 and medium in K_2O. It also contains 2.88 ppm available zinc, available iron (10.17 ppm) and available manganese (5.14 ppm).

The experiment was conducted in a randomized block design with 19 micro nutrient treatments *i.e.*, T_1- Control (Water spray) ,T_2 - $ZnSO_4$ @0.2% , T_3 -$ZnSO_4$ @ 0.4% ,T_4- $FeSO_4$ @ 0.2% ,T_5 -FeSO4@ 0.4%, T_6- MnSO4 @ 0.2% ,T_7- MnSO4 @ 0.4% ,T_8- ZnSO4 @ 0.2% + $FeSO_4$ @ 0.2%, T_9- $ZnSO_4$ @ 0.2% + $FeSO_4$ @ 0.4% ,T_{10}- $ZnSO_4$ @ 0.4% + $FeSO_4$ @ 0.2% ,T_{11}- $ZnSO_4$ @ 0.4% +$FeSO_4$ @ 0.4%, T_{12}- $FeSO_4$ @ 0.2% + $MnSO_4$ @ 0.2%, T_{13}- $FeSO_4$ @ 0.2% + $MnSO_4$ @ 0.4%, T_{14}- $FeSO_4$ @ 0.4% + $MnSO_4$ @ 0.2%, T_{15}- $FeSO_4$ @ 0.4% + $MnSO_4$ @ 0.4%, T_{16}- $ZnSO_4$ @ 0.2% + $MnSO_4$ @ 0.2%, T_{17}- $ZnSO_4$ @ 0.2% + $MnSO_4$ @ 0.4%, T_{18}- $ZnSO_4$ @ 0.4% + $MnSO_4$ @ 0.2% and T_{19}- $ZnSO_4$ @ 0.4% + $MnSO_4$ @ 0.4% which were replicated thrice. The Foliar spraying of micronutrients was done after sowing at 3rd and 6th leaf stage. The planting distance of 40 cm × 20 cm was maintained and the micronutrients like Fe, Zn and Mn given in the form of $FeSO_4$, ZnSO4 .7H_2O and $MnSO_4$, respectively.

The experimental field was prepared to a fine tilth and beds of the required dimension were made according to the lay out plan. The corms of uniform size were selected and dipped in 0.2 % Bavistin solution for 30 minutes before planting at a spacing of 40 x 20 cm, at a depth of 5 cm keeping the terminal buds upward followed by light irrigation to ensure the rapid sprouting of the corms. A basal dose of 100 g P_2O_5 per square meter was applied at the time of planting and nitrogen at 5 g per square meter was applied in two equal split doses each at 3rd leaf stage and 6th leaf stage. All other intercultural operations were carried out as and when required during the crop growth. No disease incidence was recorded during the experiment.

The data related to various growth and flowering parameters were collected from tagged five plants in a plot. The data were analyzed following the method described by **Gomez and Gomez (1984)**. Significant difference of sources of variation was tested at the probability level of 0.05. The standard error of the mean (SEm±) and the CD value were indicated in the tables to compare the difference between the mean values.

Results and discussion

Growth parameters

The data presented in Table 1 with respect to vegetative traits is measured morphologically in terms of plant height, number of leaves per plant, leaf length, leaf width and leaf area index (LAI). Among the different growth parameters, Maximum height of the plant was reported by spraying the crop with $ZnSO_4$ at 0.2 % and $FeSO_4$ at 0.2 %. This may be due to fact that application of zinc spray plays a role in tryptophan synthesis, which is an auxin precursor (IAA) and necessary for the metabolism of nitrogen that stimulates growth (**Naik *et al*., 2009**).

The maximum number of leaves per plant was observed by the application of $ZnSO_4$ with 0.2 % and $FeSO_4$ with 0.2%. Further, Foliar application of $FeSO_4$ (0.5 % or 1 %) and $ZnSO_4$ (0.5 % or 1 %) alone or in combination significantly increased the number of leaves per plant at the 2^{nd} and 6^{th} leaf level in gladiolus. Similar results with respect to variation in number of leaves were reported by **Kumar and Arora (2000)** in gladiolus; **Khalifa *et al*. (2011)** in iris and **Khosa *et al*. (2011)** in gerbera.

The data revealed that maximum leaf length and leaf width was recorded by spraying $ZnSO_4$ with 0.2 % and $FeSO_4$ with 0.2 % combination (Table 1). The increased vegetative growth with 0.4 % zinc and 0.4 % iron foliar spray may be due to the fact that zinc added at optimum concentrations is closely involved in the metabolism of RNA and ribosomal content in plant cells, contributing to the stimulation of carbohydrates, proteins and DNA formation and iron acts as a important catalyst during enzymatic reaction which ultimately promotes division and elongation of cells [**Reddy and Chaturvedi (2009) and Subbareddy *et al*. (2014)]** in gladiolus.

The leaf area index of the crop differed significantly among various treatments of foliar spray. Maximum leaf area index was recorded with the application of $ZnSO_4$ at 0.2 % and $FeSO_4$ at 0.2 % which was statistically at par with the application of $FeSO_4$ at 0.4 % and $ZnSO_4$ at 0.4 % The increase in leaf area index is due to the fact that many enzymes such as catalase, peroxidase, tryptophan synthase, carbonic dehydrogenase, etc. are activated by micronutrients, thereby controlling different metabolic and physiological activities (**Chopde**

***et al*., 2015**).

Flowering

The flowering traits was measured in terms of days taken for spike emergence, days taken for 1st floret opening, spike length, rachis length, number of florets per spike, diameter of the floret, weight of the spike and vase life.

The data presented in Table 2 revealed that foliar sprays of various micronutrients and their combinations influenced significantly on the days taken for spike emergence and 1st floret opening. Earlier spike emergence was recorded by foliar spray of $ZnSO_4$ at 0.4 % which was statistically at par with the application of $ZnSO_4$ at 0.4 % + $FeSO_4$ at 0.4 % and $ZnSO_4$ at 0.4 % + $FeSO_4$ at 0.2 %. The maximum number of days taken for 1st floret opening was observed in control. This variation may be due to the effect of zinc participation in plant hormone synthesis. In plants, optimal zinc supply exhibits sufficient hormonal levels (**Cakmak, 2000**).

The data presented in Table 3 revealed that the application of $ZnSO_4$ with 0.2 percent and $FeSO_4$ with 0.2 percent resulted in maximum spike duration among the micronutrients used which was statistically at par with application of $ZnSO_4$ with 0.4 percent + $FeSO_4$ with 0.4 percent and 0.4 percent $ZnSO_4$with 0.4 percent. The improvement in spike length due to optimum zinc supply level will increase the growth of the plant and require photosynthesis and increase the chlorophyll, protein content, thus improving the spike length in gladiolus (**Ingle *et al*., 2016 and Fahad *et al*., 2014**).

The maximum rachis length was obtained in $ZnSO_4$ with 0.2 % and $FeSO_4$ with 0.2 % which was statistically at par with $ZnSO_4$ at 0.4 % with $FeSO_4$ at 0.4 % and $ZnSO_4$ with 0.4 %. This may be the attributing factor to the beneficial efficacy of the optimal dose of zinc and iron in improved photosynthetic and other cell division and elongation-related metabolic activities. Similar results were obtained by **Chopde *et al*. (2015). 2017)**.

For the gladiolus cut flower market, the number of florets per spike is one of the most important characteristics, as it determines the beauty of the spike, longevity, and vase life of the spike. The foliar spray of $ZnSO_4$ at 0.2 % with $FeSO_4$ at 0.2 % recorded maximum number of florets per spike (Table 3). Improvement of growth characteristics due to the application of micronutrients could essentially be due to enriched photosynthetic and other metabolic activities that could eventually increase gladiolus flower yield. Similar results were reported by **Chopde *et al*. (2015),** and **Lahijie (2012)** in gladiolus.

The data with respect to the diameter of the florets was found non-significant although application of various treatments has improved overall flowering traits. For a cut flower variety, application of $ZnSO_4$ at 0.2 % with $FeSO_4$ at 0.2 % recorded maximum weight of the spike. Difference with respect to weight of the spike may be associated with the spike and rachis length. Micronutrients play important role during storage of carbohydrates and in overall metabolic function of the plant which may improve the weight of spike.

Vase life of cut flowers has recognized as important post harvest factor for their beautiful display over a period of time. From the result study it was observed that maximum vase life was reported by foliar spray of $ZnSO_4$ at 0.4 % + $FeSO_4$ at 0.4 % which was statistically at par with $ZnSO_4$ at 0.4 % + $FeSO_4$ at 0.2 %, $ZnSO_4$ at 0.2 % + $FeSO_4$ at 0.2 % and $ZnSO_4$ at 0.4%. This may be due to application of micronutrients could therefore regulate anti-oxidative activity in plants under stress as an activator of certain enzymes. The role micronutrients in the synthesis of protein and starch and therefore involves in the accumulation of amino acids and the reduction of sugar in plant tissue that could have enhanced bloom life.

Conclusion

Based on the result of the present study it is concluded that foliar application of $ZnSO_4$ with 0.2 % and $FeSO_4$ with 0.2 % significantly increased plant height, number of leaves per plant, leaf length, leaf area index, minimum duration for days taken for 1^{st} floret opening, spike length, rachis length and number of florets per spike. Thus, application of $ZnSO_4$ with 0.2 % and $FeSO_4$ with 0.2 % will enhance the growth and flowering in Gladiolus.

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Table 1. Effect of micronutrient treatments on growth parameters in gladiolus

Treatments	Concentration of Micronutrients (mg/l)	Plant height (cm)	Number of leaves perplant	Leaf length (cm)	Leaf Width (cm)	Leaf Area Index (LAI)

T_1	Control (Water spray)	79.17	8.12	66.33	3.43	3.35
T_2	$ZnSO_4$ @ 0.2%	93.61	8.57	69.77	3.88	3.72
T_3	$ZnSO_4$ @ 0.4%	97.02	8.85	71.97	3.92	3.85
T_4	$FeSO_4$ @ 0.2%	95.44	8.61	72.61	3.94	3.76
T_5	$FeSO_4$ @ 0.4%	95.03	8.79	72.13	3.99	3.86
T_6	MnSO4 @ 0.2%	89.56	8.46	69.79	3.56	3.63
T_7	MnSO4 @ 0.4%	88.44	8.43	69.20	3.58	3.64
T_8	$ZnSO_4$ @ 0.2% + $FeSO_4$ @ 0.2%	97.74	9.04	74.36	3.91	4.14
T_9	$ZnSO_4$ @ 0.2% + $FeSO_4$ @ 0.4%	87.65	8.80	68.90	3.52	3.65
T_{10}	$ZnSO_4$ @ 0.4% + $FeSO_4$ @ 0.2%	86.74	8.44	67.87	3.55	3.56
T_{11}	$ZnSO_4$ @ 0.4% + $FeSO_4$ @ 0.4%	93.48	8.56	70.15	3.46	3.71
T_{12}	$FeSO_4$ @ 0.2% + MnSO4 @ 0.2%	86.44	8.35	67.49	3.26	3.55
T_{13}	$FeSO_4$ @ 0.2% + MnSO4 @ 0.4%	83.44	8.31	68.84	3.39	3.52
T_{14}	$FeSO_4$ @ 0.4% + MnSO4 @ 0.2%	92.11	8.71	69.98	3.64	3.76
T_{15}	$FeSO_4$ @ 0.4% + MnSO4 @ 0.4%	89.67	8.41	70.05	3.59	3.65
T_{16}	$ZnSO_4$ @ 0.2% + MnSO4 @ 0.2%	82.56	8.33	66.27	3.42	3.51
T_{17}	$ZnSO_4$ @ 0.2% + MnSO4 @ 0.4%	82.40	8.22	66.70	3.36	3.49
T_{18}	$ZnSO_4$ @ 0.4% + MnSO4 @ 0.2%	79.37	8.18	66.34	3.66	3.43
T_{19}	$ZnSO_4$ @ 0.4% + MnSO4 @ 0.4%	81.27	8.19	65.57	3.56	3.45
S. Em ±		0.95	0.18	1.43	0.16	0.10
C. V		1.86	3.65	3.59	7.64	4.82

Table 2. Effect of micronutrient treatments on days taken for spike emergence and 1st floret opening in gladiolus

Treatments	Concentration of Micronutrients (mg/l)	Days taken for spike emergence (days)	Days taken for 1st floret opening (days)
T_1	Control (Water spray)	71.64	89.79
T_2	$ZnSO_4$ @ 0.2%	65.22	84.86
T_3	$ZnSO_4$ @ 0.4%	61.35	84.45
T_4	$FeSO_4$ @ 0.2%	68.74	87.29
T_5	$FeSO_4$ @ 0.4%	64.92	85.25
T_6	MnSO4 @ 0.2%	66.49	86.52
T_7	MnSO4 @ 0.4%	67.53	86.70
T_8	$ZnSO_4$ @ 0.2% + $FeSO_4$ @ 0.2%	64.94	80.96
T_9	$ZnSO_4$ @ 0.2% + $FeSO_4$ @ 0.4%	68.11	87.21
T_{10}	$ZnSO_4$ @ 0.4% + $FeSO_4$ @ 0.2%	61.99	83.28
T_{11}	$ZnSO_4$ @ 0.4% + $FeSO_4$ @ 0.4%	61.71	82.70
T_{12}	$FeSO_4$ @ 0.2% + MnSO4 @ 0.2%	69.49	87.59
T_{13}	$FeSO_4$ @ 0.2% + MnSO4 @ 0.4%	69.77	88.23
T_{14}	$FeSO_4$ @ 0.4% + MnSO4 @ 0.2%	65.74	85.67
T_{15}	$FeSO_4$ @ 0.4% + MnSO4 @ 0.4%	65.82	86.24
T_{16}	$ZnSO_4$ @ 0.2% + MnSO4 @ 0.2%	70.77	88.76
T_{17}	$ZnSO_4$ @ 0.2% + MnSO4 @ 0.4%	69.78	88.88
T_{18}	$ZnSO_4$ @ 0.4% + MnSO4 @ 0.2%	70.93	88.51
T_{19}	$ZnSO_4$ @ 0.4% + MnSO4 @ 0.4%	71.12	89.08
S. Em ±		1.18	1.31
C. V		3.05	2.63

Table 3**. Effect of micronutrient treatments on flowering characteristics in gladiolus**

Treatments	Concentration of Micronutrients (mg/l)	Spike length (cm)	Rachis length (cm)	Number of florets per spike	Diameter of the florets (cm)	Weight of the spike(g)	Vase life (days)
T_1	Control (Water spray)	63.44	43.27	14.15	10.01	65.72	8.96
T_2	$ZnSO_4$ @ 0.2%	73.44	50.73	15.75	10.12	71.89	10.82
T_3	$ZnSO_4$ @ 0.4%	79.56	53.60	17.60	10.54	73.64	12.01
T_4	$FeSO_4$ @ 0.2%	76.89	51.40	15.63	10.30	73.18	11.28
T_5	$FeSO_4$ @ 0.4%	78.02	49.27	15.70	10.45	73.53	10.39
T_6	MnSO4 @ 0.2%	76.33	46.90	15.26	10.51	69.53	10.73
T_7	MnSO4 @ 0.4%	77.11	46.23	15.83	10.37	69.29	10.91
T_8	$ZnSO_4$ @ 0.2% + $FeSO_4$ @ 0.2%	81.86	56.76	17.69	10.73	74.78	12.07
T_9	$ZnSO_4$ @ 0.2% + $FeSO_4$ @ 0.4%	78.10	46.23	15.73	10.09	68.66	10.82
T10	$ZnSO_4$ @ 0.4% + $FeSO_4$ @ 0.2%	78.17	44.20	15.40	9.64	68.37	12.09
T11	$ZnSO_4$ @ 0.4% + $FeSO_4$ @ 0.4%	80.78	54.73	16.53	10.31	70.99	12.27
T12	$FeSO_4$ @ 0.2% + MnSO4 @ 0.2%	66.11	44.20	15.15	10.25	68.15	11.02
T13	$FeSO_4$ @ 0.2% + MnSO4 @ 0.4%	73.67	43.80	15.25	10.32	67.80	10.56
T14	$FeSO_4$ @ 0.4% + MnSO4 @ 0.2%	74.22	48.70	15.19	10.16	70.56	10.03
T15	$FeSO_4$ @ 0.4% + MnSO4 @ 0.4%	77.11	47.37	15.69	10.06	70.67	10.97
T16	$ZnSO_4$ @ 0.2% + MnSO4 @ 0.2%	69.56	42.50	15.65	10.17	67.35	10.91
T17	$ZnSO_4$ @ 0.2% + MnSO4 @ 0.4%	71.44	45.43	15.62	10.16	67.12	10.01
T18	$ZnSO_4$ @ 0.4% + MnSO4 @ 0.2%	71.89	43.43	15.62	10.19	66.27	9.28
T19	$ZnSO_4$ @ 0.4% + MnSO4 @ 0.4%	74.89	44.03	14.42	10.33	66.79	9.89
S. Em ±		**1.06**	**1.37**	**0.57**	**0.28**	**0.92**	**0.29**
C. V		**2.45**	**5.00**	**6.28**	**3.63**	**2.29**	**4.72**