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Effect of micronutrients on plant growth, flowering and corm production of *Gladiolus* cv. summer sunshine

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Abstract
An investigation to study the "To study the effect of micronutrients on plant growth, flowering and corm production of *Gladiolus* cv. summer sunshine" was conducted in Rabi season during the year 2020-21 at Horticulture Research cum Instruction Farm, Floriculture and Landscape Architecture Department, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. Four micronutrients $ZnSO_4$, H_3BO_3, $CuSO_4$, $FeSO_4$ and its interaction effect at various concentrations with foliar spraying method in addition to this experiment's control included eleven treatments. The experiment was designed with a Randomized block design (RBD) and three replications.
The application of micronutrient ($ZnSO_4$ 0.4 + H_3BO_3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%) with foliar spray (T_{11}) was initiate to be most successful for superior performance of different parameters such as days taken to 50% sprouting, plant height, maximum number of shoots per mother corm, leaf width, days to open first floret, spike length, rachis length, intermodal length between florets, floret diameter, amount of florets per spike, diameter of floret, vase life and yield attributes like quantity of cormel per plant, weight of cormels per plant, number of cormels per plot, weight of cormels per plot, number of leaves per plant, time to spike emergence, days to 50 floret open, number of floret per spike, maximum number of corm, diameter of corm per plant. Whereas treatment T_{10} ($ZnSO_4$ 0.2% + H_3BO_3 0.2% + $CuSO_4$ 0.2% + $FeSO_4$ 0.2%) found to be more successful for enhanced performance of other attributes such as length of leaves, flowering duration, weight of corm per plant, weight of corm per plot.

Keywords: $ZnSO_4$, H_3BO_3, $CuSO_4$ and $FeSO_4$

Introduction
The word "*gladiolus*" is derived from the Latin word "gladius" meaning "a sword" shape leaves of the plant. *Gladiolus* is belong to family Iridaceae and it is native of South Africa and Asia Minor. The agro-ecological conditions of the country are very conducive for its survival and culture as a crop. It is a winter season crop but can be grown in July-August at low rainfall areas with mild climatic conditions. The flowers are variously colored, pink to reddish or light purple with white, contrasting markings or white to cream or orange to red. *Gladiolus* grown commercially for its bewitching flowers symbolizes purity, peace, beauty, love and passion. *Gladiolus* corm and cormels are used for commercial propagation. The essentiality of micronutrients was proved long before their role in crop production was recognized. The micronutrients though required in minute quantities plays significant role in plant growth and development. Zinc, Boron, Copper and Iron are important micronutrients needed for better flower production.
Role of Zinc (Zn) is well established in the formation of auxin and RNA. It regulates themetabolic process and enhances plant growth (Sarwar *et al*. 2012) [17] and flower production.
Zinc is an important micronutrient which necessary for sugar regulation and various enzymatic activities related to plant growth (Khosa *et al*., 2011) [11]. Boron plays a very important role in various plant processes. It controls he meristamatic growth in plants. It has relationship with number of 'histological processes in plants such as auxin synthesis, protein synthesis, calcium metabolism, and translocation of sugar (Weiessar *et al*., 1964). Copper is involved in a number of physiological processes such as the photosynthetic and respiratory electron transport chains (Van assche and clijsters 1990) [20]. Copper activates some enzymes in plant metabolism of carbohydrates and proteins. Copper also serves to intensify color in flowers. Iron functions in redox reactions, cytochrome and for rodoxin structural elements, and

Enzyme activation. There are confirmations that iron deficiency impairs many plants physiological processes as it is involved in chlorophyll, protein synthesis and in root tipmeristem growth. Tagliavini and Rombola (2001) [19] illustrated that iron deficiency (chlorosis) is a common disorder which affects plants grown on soils of high pH.

Material and Methods

The experiment was carried out during the Rabi season of the year 2021-22 to study the effect of micronutrients on plant growth, flowering and corm production of *Gladiolus* cv. summer sunshine at college premises, Horticultural Research cum Instructional farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur. The experiment was laid out in Randomized Block Design (RBD) with eleventh treatments and three replications to analyses the effect of micronutrients on plant growth, flowering and corm production of *Gladiolus* cv. summer sunshine. Healthy and uniform corms were sown in the experimental plots with a row spacing of 30 cm × 20 cm between the rows and plants, respectively. One corm per hill at about 5-6 cm depth. The field experiment comprised of eleventh treatments i.e., T_1: Control, T_2: $ZnSO_4$ 0.2%, T3: $ZnSO_4$ 0.4%, T_4: H_3BO_3 0.2%, T_5: H_3BO_3 0.4%, T_6: CuSO4 0.2%, T_7: $CuSO_4$ 0.4%, T_8: FeSO4 0.2, T9: FeSO4 0.4%, T10: ZnSO4 0.2 + H_3BO_3 0.2% + $CuSO_4$ 0.2% + $FeSO_4$ 0.2% and T_{11}: $ZnSO_4$ 0.4 + H_3BO_3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%. The growth, flowering parameters and corm production for each treatment were Observed in five tagged plants selected by random sampling method. The data were statistically analysed and critical differences were work out at five percent level to draw statistical conclusions as suggested by Panse and Sukhatme (1985)

Results and Discussion

Floral characters

Days to spike emergence

Treatment T11 ($ZnSO_4$ 0.4%+ H_3BO_3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%) noticed minimum days to first spike emergence (71.36 days) whereas it was observed significantly better with respite of the other treatment. The maximum days (76.40 days) for first spike emergence were observed in treatment T_1 (Control). The number of days of spike emergence is a significant predictor of the planned harvest period. The explanation for the early induction of spike emergence and color display may be due to the proper nutritional status i.e. nitrogen, potassium, zinc, copper, etc. and hormonal level within the plants, Similar results were also reported by Muthumanickam *et al*. (1999) [14], Chakmak (2002) [1] and Chaturvedi (2009) [22] in *gladiolus*.

Days to first floret open/bloom

The minimum days (75.10 days) for open first floret in treatment T_{11} ($ZnSO_4$ 0.4 + H_3BO_3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%) and the earlier days required to open first floret (82.75 days) noticed with treatment T_6 ($CuSo_4$ 0.2%). Micronutrients like zinc, manganese, boran and iron favour the availability of more carbohydrates through photosynthesis, which might be the attributing factor for the positive effective of micronutrients on early opening of floret. The similar results were reported by the Jadhav (2005) [7] in Gerbera. Days to 50 floret open

The minimum days require for 50 floret open (81.08 days) was noticed with the treatment T_{11} ($ZnSO_4$ 0.4% + H_3BO_3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%) However, it was recorded significantly better with respite of the treatments. The greatest days to open 50 flower (87.56 days) has been observed in treatment T1 (Control).The explanation for minimum days required for 50 floret open with application of

treatment T_3 ($ZnSO_4$ 0.4%) may be due to the plant sprayed significantly influenced with application of micronutrient ferrous sulphate is an essential components of several dehydrogenase, proteinase, peptidase and promotes growth hormones and closely associated with plant growth, all these factors contributed to cell multiplication, cell division and cell differentiation availability of optimal quantity of micronutrient and that their effect on floral primordial and might be enhance to early flowering of *gladiolus*. This result can be close conformity with the finding of Kumar *et al*. (2010) [10] in *gladiolus*. Length of the spike (cm)

The data noticed that the greatest spike length (69.12) has been noticed with the application of treatment T_{11} (ZnSO4 0.4 + H_3BO_3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%), whereas, treatment T1 (Control) has be present the lowest spike length (62.85 cm). Improvement in spike length due to these micronutrients, application might basically be due to enhanced photosynthetic and other metabolic activities related to cell division and elongation. These findings are in line with the observations of earlier workers *viz*. of Nath and Biswas (2002) [23] in tuberose, Kumar *et al*. (2003) [8, 9], Ganga *et al*. (2009) [9] in dendrobium, Khalifa *et al*. (2011) [12] in iris, Fahad *et al*. (2014) and Naik *et al*. (2015) in *gladiolus*.

Length of rachis (cm)

The greatest length of the rachis (43.31 cm) noticed with the application of treatment T11 (($ZnSO_4$ 0.4 + H_3BO_3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%). The lowest rachis length (30.85 cm) noted with treatment T1 (control). Micronutrients serve as energy for synthesis of auxin which help in increase length of spike and rachis. Similar results were obtained by Kumar and Arora (2000) [8], Singh *et al*. (2012) [18], Chopde *et al*. (2015) [3], Devarakonda *et al*. (2017) [4] and Lahijie (2012) [13] in *gladiolus*.

Internodal length between floret (cm)

The data revealed that the internodal length of the floret is highest (4.01 cm) in treatment T_{11} ($ZnSO_4$ 0.4 + H3BO3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%), the minimum Internodal length of floret (3.67 cm) is noticed in treatment T_2 (ZnSo4 0.2%).

The superiority of treatment T_{11} amongst the various treatments may be due to cell proliferation, cell wall formation and elongation by micronutrients, thus leading to inter nodal growth. These results are in close conformity with the findings of Devi *et al*. (2007) [24] in *gladiolus*.

Diameter of floret (cm)

The data showed that treatment T_{11} ($ZnSO_4$ 0.4 + H3BO3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%) shows maximum floret diameter (11.01 cm) which differed significantly to all other treatment. The least value of diameter of floret (8.37 cm) is

seen in treatment T_1 (Control). The result of diameter of floret may be due to the relationship of micronutrients such as zinc, manganese and iron in regulating semi permeability of cell walls, thus mobilizing more water into flowers and also increase the synthesis of iron which promotes the flower size and weight of the flowers. Improvement in length may be due to enhanced photosynthetic and other metabolic activities related to cell division and elongation. Similar, observations were reported earlier Kumar *et al*. (2003) [9], by Khalifa *et al*. (2011) [12] in iris and Fahad *et al*. (2014) [5] in *gladiolus*.Flowering duration (days) The data with respect to maximum flowering duration (12.93 days) was noted in treatment T_{10} ($ZnSO_4$ 0.2% + H_3BO_3 0.2% + $CuSO_4$ 0.2% + $FeSO_4$ 0.2%). However, the least flowering duration (9.91 days) is noticed in treatment T_1 (control).The result might be due to the association of micronutrients such as zinc, manganese and iron in regulating semi permeability of cell walls, thus mobilizing more water into flowers and also increase the synthesis of iron which promotes flower size and weight of flowers. Similar results were also reported by Nag and Biswas (2003) [16] and Hardee Kumar *et al*. (2003) in tuberose. Vase life (days) The data on vase life of cut spikes (days) revealed that the longest vase life (9.61 days) of *gladiolus* spike observed in treatment T_{11} ($ZnSO_4$ 0.4 + H_3BO_3 0.4% + $CuSO_4$ 0.4%+ $FeSO_4$ 0.4%) and the minimum vase life (7.00 days) has been observed with treatment T1 (Control). The critical look into observations of vase life of flower seems to be influenced by foliar sprays of micronutrient another probable justification is the number of florets per spike is one of the most important characters for a *gladiolus* cut flower, as it decides the attractiveness of the spike, durability and vase life of the spike. Higher number of florets per spike having increased number of florets generally results in enhanced vase life.

Table 1: Effect of micronutrients on floral characters of *Gladiolus* cv. summer sunshine

Treatment	Days to spike emergence	Days to first floret open/bloom	Days to 50% Floret open	Length of the spike (cm)	Length of rachis (cm)	Intermodal length between Flore (cm)	Diameter of floret (cm)	Flowering duration (days)	Vase life (days)
T1	76.40	80.62	87.56	62.85	30.85	3.27	8.37	9.91	7.0
T2	73.10	76.58	81.34	64.25	34.85	3.67	9.53	10.19	8.0
T3	72.00	77.91	82.76	66.82	35.81	3.81	9.86	12.95	8.91
T4	73.45	77.19	82.01	64.48	34.21	3.53	8.51	10.65	9.89
T5	71.46	77.95	82.71	65.63	37.33	3.69	9.81	12.24	8.95
T6	75.33	82.75	86.97	64.27	35.17	3.70	9.12	11.26	8.35
T7	71.82	76.42	82.59	64.78	35.56	3.73	9.77	10.77	8.31
T8	74.67	81.28	86.71	65.12	31.33	3.26	9.23	10.77	8.19
T9	74.59	80.77	87.00	65.23	35.16	3.57	9.61	10.23	8.25
T10	71.44	76.23	81.40	67.55	38.71	3.76	10.38	12.93	8.54
T11	71.36	75.10	81.08	69.12	43.31	4.01	11.01	12.54	9.61
S. Em ±	1.10	1.82	1.30	1.20	2.02	0.20	0.41	0.50	0.52
CD @ 5%	3.22	5.40	3.92	3.54	6.04	0.59	1.22	1.32	1.44

Conclusion

The application of micronutrient ($ZnSO_4$ 0.4 + H_3BO_3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%) with foliar spray (T_{11}) was initiate to be most successful for superior performance of different parameters such as days taken to 50% sprouting, plant height, maximum number of shoots per mother corm, leaf width, days to open first floret, spike length, rachis length, internodal length between florets, floret diameter, amount of florets per spike, diameter of floret, vase life and yield attributes like quantity of cormel per plant, weight of cormels per plant, number of cormels per plot, weight of cormels per plot, number of leaves per plant, time to spike emergence, days to 50 floret open, number of floret per spike, maximum number of corm, diameter of corm per plant. Whereas treatment T_{10} ($ZnSO_4$ 0.2% + H_3BO_3 0.2% + $CuSO_4$ 0.2% + $FeSO_4$ 0.2%) found to be more successful for enhanced performance of other attributes such as length of leaves, flowering duration, weight of corm per plant, weight of corm per plot.

Recommendation

T_{11} ($ZnSO_4$ 0.4 + H_3BO_3 0.4% + $CuSO_4$ 0.4% + $FeSO_4$ 0.4%) could be recommended for reasonable batter flower production in *Gladiolus*.

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