A REVIEW ON QUALITY, GROWTH AND YIELD PARAMETERS OF GLADIOLUS AS AFFECTED BY MICRONUTRIENTS OF FOLIAR APPLICATION

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ABSTRACT

Growth, quality and yield of gladiolus plants are directly influenced by foliar application of micronutrients and play an important role in changing vegetative and reproductive characteristics. Foliar application enhances the nutrient use efficiency of plants and reduces the environmental pollution. During the bud development stage, combine applications of micro-nutrients perform well and significant concentrations of nutrients improves the quality, and shelf life of flowers and corm production. Keeping in view these observations, effects of micronutrients on the growth, quality and yield of gladiolus are studied and reviewed in this paper.

Key words: Gladiolus; Growth; Micronutrients; Quality; Yield

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.) is belonging to the family Iridaceae. Flower is called Queen of bulbous flowers, for its excellent aesthetic value, and display life. Importance of macronutrients, micronutrients also play important role in flower and corm yield and production. Micro nutrients apply as a foliar to absorb quickly by the plants [1]. Most necessary and essential micronutrients, such as Zn, Fe, Mn, Cu and B have an important role in the physiology of gladiolus plant and important part of catalytic enzymatic reaction. They are required in minute quantity but are important during different stages of plant's growth such as respiration, meristamatic development, chlorophyll formation, photosynthesis, energy system, protein, oil synthesis, gossypol, tannin and phenolic compound development. All of the micronutrients may help to enhance uniform emergence, fast seedling growth and healthy plant stand. Some beneficial effects on corm yield and quality as reflected in possibility may be realized by applying these nutrients [2]. Effects of foliar application of different micronutrients on gladiolus yield and flower quality have been extensively deliberated. Generally, the plant requires a variety of nutrients for improve growth, quality and yield. Boron, Calcium and Magnesium are more efficiently used for the performance of rapid cell division, enlargement, metabolism and postharvest life [3]. In gladiolus plant, flowering is a continuous process of development. However, sometime due to nutritional stress some flowers retained while remaining are highly affected. Hence timely management of proper micronutrients to produce more number of quality flowers, improved post-harvest life and yield is necessary [3]. Physiological and biochemical processes in the plant is directly affected by these micronutrients, which enables a rapid change in the physiology of plant within one season to attained desirable results [4]. The essential mineral elements which are required in higher concentrations by the plant, having sufficient need for reproduction of gladiolus often produces more vegetative growth, than needed for maximum corm production and yield especially when climatic condition favors vegetative growth, these by directing the nutrients and photo assimilates towards vegetative growth relatively than reproductive growth [4].

[4] noticed that, leaf area, plant height, yield in respect of spikes plant^{-1} and number of corms plant^{-1}, quality parameters *viz*. length of spike, rachis, florets spike^{-1}, diameter of spike and diameter of corm and the earliest 50 per cent flowering increased with the application of 0.4% zinc and 0.4% iron, however, growth, quality, flowering and yield were found non-signifacant with the interaction of Zinc and Boron. [5] reported that, application of Zinc sulphate ($ZnSO_4$) and Iron sulphate ($FeSO_4$) applied @ 40 g $ZnSO_4$ + 20 g $FeSO_4$ respectively increased 14.44 leaves per plant, 115.70 cm leaves length, 22.88% per plant spike life, 14.55 florets spike^{-1}, 1.22 corms plant^{-1} and 17.33 cormllets plant^{-1} of gladiolus plant. [6] Reported that, application of 1 % Iron sulphate ($FeSO_4$) produced earlier flowering than Zinc sulphate ($ZnSO_4$), and also reduce days (21.49) to emergence of spike, and opening of first floret (38.28). Similarly, 2% of both

$FeSO_4$ and $ZnSO_4$ in combination in solution form decreased days to basal floret opening and florets number at a same time. Parameters including height (83.47 cm), spike length (66.03cm), number of leaves plant^{-1} (9.52), number of florets spike^{-1} (11.55), and floret diameter (8.53cm) were significantly difference than other treatments when an equal mixed solution of 2% $FeSO_4$ and $ZnSO_4$ were applied.

Table 1. Gladiolus growth and yield response to micronutrients

Micronutrient	Parameter	Level	Result	Reference
Boron	Corm weight	2 kg/ha	26.07 g	[24]
FeSO4	No. of leaves/plant	1.00%	9.4	[6]
FeSO4	No. of florets/plant	1.00%	10.84	[6]
FeSO4	Leaf length	20 g	115.70 cm	[26]
Calcium	Longevity of spike	0.50%	17.61 days	[29]
Boron	Number of cormels/plant	2 kg/ha	9.78	[24]
Zinc	Flower Stalk	0.30%	65.61 cm	[27]
FeSO4	Plant height	0.50%	76.15	[6]
Boron	Vase life days	0.10%	11.05	[27]
FeSO4	Floret per spike	1.00%	18.5	[6]
Zinc	Vase life	0.30%	10.19	[27]
FeSO4	Plant height	1.00%	87.12	[6]
Boron	Weight of cormels/plant	2 kg/ha	31.94 g	[24]
Zinc	Weight of cormels/plant	4.5 kg/ha	51.67 g	[24]
FeSO4	Length of spike	1.00%	64.99 cm	[6]
Zinc	Corm weight	4.5 kg/ha	27.58 g	[24]
ZnSO4	Number of leaves/plant	40 g	12.44	[26]
FeSO4	Diameters of florets	1.00%	7.79 cm	[6]
FeSO4	Length of floret	1.00%	8.73 cm	[6]
Zinc	Number of cormels	4.5 kg/ha	14.43	[24]
FeSO4	Days to floret opening	1.00%	24	[6]
ZnSO4	Days to floret opening	0.50%	22.4	[6]
Zinc	Plant height	0.75%	79.55 cm	[29]

Calcium	Plant height	0.50%	79.39 cm	[29]
Boron	Plant height	0.20%	78.85 cm	[29]
Boron	Flower Stalk	0.10%	56.75 cm	[27]
Zinc	Number of corm	0.75%	3.3	[29]

[7] revealed that, 2% zinc increased plant height, leaf number, length, width and leaf area, more number of days (97.63) to first floret appearance and 50% flowering (103.32**),** first floret appearance and 50% flowering, number of spikes (1.33), spike length (112.19 cm), number of florets per spike and highest spike growth rate (0.68 cm/day), while in combination of 2% zinc and 6 weeks after planting the interaction effect recorded maximum spike length (118.36 cm) and number of florets (13.40), corm size (4.47 cm), corm weight (37.97 g), number of cormels (32.90) and cormel weight corm^{-1} (10.72 g). Similarly [8] Reported that, flower and corm yield, and quality effected significantly by essential micronutrients application. [9] Studied that, mixture of 3.0g Zinc/liter with 100 ppm bautric acid (BA), and 1.5g (Zn/liter) with 50 ppm BA, significantly affected the seedling growth of gladiolus. However, [10] stated that, Zinc and Iron and Zn Copper in combine applications increase the number of corms per plant, cormels yield per plant. The application of zinc (44.97) followed by copper (43.18) and iron (42.11) significantly affected by the (Zn, Fe and Cu) interaction, whereas the number of corms plant^{-1} reaveled by Zinc (1.74), iron (1.66) and Cupper (1.68) as compare to control treatment. [11] Studied that $FeSO_4.7\ H2O$ at 0.2% increased the number of flowers. [12] Found that, interactive effect of Boron and Zinc sulphate influenced days to flowering (66.13 days). Similarly, [13] Observed that, flower parameters, such as weight and length of spike and rachis, weight and number of florets spike^{-1}, stick weight and size of the florets highly effected with the increase of B and Zn but increased in amount of B and Zn levels (B 2 and Zn 3 kg ha^{-1}) reduce the flower yield. [14] Studied that, Zn performs better in response to yield parameters of gladiolus but in

combination they cannot perform obviously. [15] Stated that, Fe and Zn in combination with B, shows positive effect on gladiolus. [16] Reported that, vegetative growth, after seedling emergence and yield of gladiolus grown in partially sodic soil were significantly increased with application of Zinc. [17] Showed that, zinc application performs better on the following parameters such as leaf area, floret length and number of florets of gladiolus plant. [18] Observed that, macro and micronutrients are very important for plant growth and other characteristics of the plant. [19] Found that, longevity of the spikes and hastened flower opening increased with treatment of $FeSO_4$ as compare to control in gladiolus. [20] Studied that, flowers number and number of flowering stems in gladiolus plant were increased by micronutrients. [21] Found that, 0.2% FeSO4 alone and also in various combinations at three or six leaf stages induce earlier flowering. [22] Reported that flowering duration and Corm production per plant was improved with 0.4% $FeSO_4$+0.2% $ZnSO_4$ in gladiolus. [23] Observed that, corm size increased with foliar spray of Agromin (3000 ppm) and reported that nutrient present in Agromin might have increased the accumulation of nitrogen and proteins. [24] Reported that, the interactive effect of B and Zn significantly contributed to the yield of individual corm weight and number of cormels and weight of cormels plant^{-1}. [25] Stated that, Foliar application of macro and micro nutrients in gladiolus plant influenced the days to first flower appearance, number of leaves plant^{-1}, number of branches plant,$^{-1}$number of carmels/plant and carmel weight compared to control where no foliar spray of macro and micro nutrients was applied. [26] reported that overall growth and flower production performance of gladiolus was remarkable when the plants were supplied with combined application of 40 g ZnSO4 + 20 g FeSO4. [27] Reveled that foliar application of B and Zn significantly affects the post-harvest life of Gladiolus. [28] Stated that foliar application of boron and zinc alone at all rates and in combination significantly influenced plant growth, spike yield and flower quality. [29] Informed that foliar application of Zinc, Calcium and Boron has a positive effect on vegetative and flowering parameters of Gladiolus plant. [30] Observed that the foliar application of zinc positively affect plant height, number of branches/plant, number of leaves/plant, number of carmels/plant and carmel diameter in gladiolus. [31] Stated that the vegetative and floral characters of gladiolus were significantly affected by the foliar application of borax, iron sulphate and Manganese sulphate.

Table 2. Gladiolus parameters response to micronutrients

Micronutrient	Parameter	Level	Result	Reference
Borax	Number of leaves	72ppm	47.4cm	[33]
FeSO4	plant height	0.30%	45.29 cm	[31]
FeSO4	flowers per spike	0.20%	45.74	[32]
Borax	Spike length	0.30%	61.62 cm	[31]
ZnSO4	spike length	0.50%	100.59 cm,	[32]
Zinc	Number of leaves	200mg/l	7.39	[1]
Borax	Number of leaves	0.30%	45.23	[31]
MN	spike length	42ppm	101cm	[33]
H3BO3	plant height	0.10%	49.56 cm	[32]
MO	Corm weight	24ppm	26g	[33]
manganese	plant height	300mg/l	95.60cm	[1]
MnSO4	Plant height	0.30%	38.99	[31]
boron	number of carmels/plant	100mg/l	29.4	[1]
MO	Corm weight	20ppm	24g	[34]
Mn	Vase life	0.40%	11	[34]

CONCLUSION

Conclusion made on the above review study, that micronutrients application as a foliar give quick response and leads to better results than direct soil application. Foliar application is frequently efficient when it is require in minute quantity and roots are unable to absorb sufficient amount from soil due to low soil temperature, high degree of fixation, losses from leaching, soil pH, lack of soil moisture, mobility of nutrients in soil and plants, hence foliar application of micronutrients in gladiolus can be considered as a beneficial practice for enhanced gladiolus growth, quality and yield.

DATA AVAILABILITY

The data that support the findings of this study are listed in the article and are available from the corresponding authors upon reasonable request.

DECLARATION OF INTEREST

We declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere. The authors certified that there is no conflicts of interest associated with this publication, and there has been no significant financial support for publishing this work that could have influenced its outcome. As corresponding Author, I conform that the manuscript has been read and approved for submission by all the named authors.

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