



# Effect of Iron and Boron on Growth, Flowering and Corm Characters in *Gladiolus* cv. Malaviya Shatabdi

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

A study was conducted to determine the optimal iron and boron dosage for enhancing growth, flowering and corm yield in gladiolus (*Gladiolus spp.* cv. Malaviya Shatabdi). The experiment took place at the Horticulture Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, during 2023-24. The treatments included a control (distilled water) and varying concentrations of iron and boron, applied as foliar sprays at 3<sup>rd</sup> and 6<sup>th</sup> leaf stage. The results demonstrated that the combined application of 0.2% B + 0.4% Fe significantly improved plant growth, flowering and corm yield parameters. This treatment results in the highest sprouts count per hill (3.63), compared to the control (2.07). Additionally, plants treated with 0.2% B + 0.4% Fe exhibited the tallest plant height (55.21 cm), length of longest

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leaf (51.81 cm), days to spike emergence, days to opening of 1<sup>st</sup> and last floret, diameter of 1<sup>st</sup> and last floret, length of 1<sup>st</sup> and last floret, number of florets per spike, total flowering duration and spike length. Similarly, corm production was also significantly influenced by Fe and B applications. Maximum weight of cormel per hill (3.03 g), number of corms per hill (3.68) and maximum diameter of corm (40.26 mm) were recorded with 0.2% B + 0.4% Fe. whereas, the control yielded the lowest. These findings suggest that foliar application of 0.2% B + 0.4% Fe optimizes vegetative growth, floral attributes and corm yield in gladiolus cv. Malaviya Shatabdi.

**Keywords:** *Gladiolus corms; foliar spray; ferrous sulphate; boron; flowering; yield.*

## 1. INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.), a member of the Iridaceae family, is a bulbous ornamental plant primarily cultivated for its highly valued cut flowers. Its spikes are widely used in floral decorations and bouquets. Gladiolus is a prominent flowering crop in the floriculture industry and is cultivated commercially across multiple states in India (Singh, 2014). The plant produces an elegant spike adorned with numerous vibrant and graceful florets. Its cultivation dates back to the late sixteenth century and the flowers are widely used in floral arrangements, bouquets and indoor decorations. In India, gladiolus is commercially grown in states including West Bengal, Maharashtra, Uttar Pradesh, Uttarakhand, Punjab, Haryana, Sikkim, Jammu and Kashmir, Karnataka, Gujarat, Himachal Pradesh, Tamil Nadu, Madhya Pradesh, Delhi and Rajasthan (Singh & Sisodia, 2017).

Fertilizers play a crucial role in enhancing gladiolus growth, improving flower quality and boosting corm and cormel production, just as they do in other crops. Robust vegetative growth is vital for producing high-quality flowers and healthy plants. The availability and balance of macro and micro nutrients in the soil significantly impact plant development. While macro nutrients are fundamental for overall growth, micro nutrients play a particularly essential role in optimizing gladiolus cultivation. Boron plays a key role in plant growth by reinforcing the pectic network within the cell wall (Dordas & Brown, 2005). It enhances cell wall stability and rigidity, thereby strengthening plant structure and supporting overall development (Brown et al., 2002). Whereas, iron plays a crucial role in plant metabolism as it is a key component of cytochrome, which participates in the electron transport chain and functions as an oxygen carrier, thereby facilitating respiration. Since certain nutrients are not readily available in the

soil, foliar application of micronutrients serves as an effective method for ensuring their efficient uptake (Kashyap & Tikey, 2020). This approach enhances nutrient availability, promoting plant growth and improving corm yield in gladiolus. The positive impact of iron and boron application on gladiolus has been previously reported (Singh et al., 2016; Singh & Sisodia, 2017; Singh et al., 2024 and Somkuwar et al., 2023). Considering its significance, a field study was undertaken to evaluate the effects of different iron and boron concentrations on the growth and corm yield of gladiolus cv. Malaviya Shatabdi.

## 2. MATERIALS AND METHODS

Present field study was conducted at the Horticulture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India, during the winter season of 2023-24. The experiment followed a Randomized Block Design (RBD), with incorporation of farmyard manure and NPK fertilizers applied as per recommended guidelines. Disease and pest-free corms of the gladiolus variety Malaviya Shatabdi were procured from the Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, and planted at a spacing of 30 cm x 20 cm, at a depth of 10-12 cm. The study comprised eight treatments with three replications. Iron was applied in the form of ferrous sulphate (FeSO<sub>4</sub>), with lime used to neutralize its effect and boron was used in the form of boric acid were applied through foliar spray till runoff stage. These 8 treatments included control (distilled water), B (0.2%), B (0.4%), Fe (0.2%), Fe (0.4%), B (0.2%) + Fe (0.2%), B (0.2%) + Fe (0.4%), B (0.4%) + Fe (0.4%). Foliar application of iron and boron was carried out at 3<sup>rd</sup> and 6<sup>th</sup> leaf stage. All the growth, flowering and corm parameters were recorded and analysed statistically. Essential cultural practices such as earthing up, weeding, hoeing, irrigation and plant protection were performed as needed.

### 3. RESULTS AND DISCUSSION

#### 3.1 Growth Parameters

Growth parameters in gladiolus variety Malaviya Shatabdi were recorded 60 days after planting and found significantly affected by different iron and boron treatments (Table 1). The number of plants per hill is a crucial growth parameter influencing overall yield. The highest number of plants per hill (3.63) were observed in plants treated with 0.2% B + 0.4% Fe, which was statistically comparable to 0.2% B + 0.2% Fe (3.38), 0.4% B + 0.4% Fe (3.07) and 0.4% Fe (2.90) but significantly different from other treatment. Whereas, B and Fe being an essential micronutrient, plays a key role in plant growth by facilitating cell division and multiplication. This could explain the increased number of plants per hill under certain iron and boron treatments. These findings align with the research conducted by Pal et al. (2016) in gerbera.

The maximum plant height (55.21 cm) was observed with 0.2% B + 0.4% Fe treatment, likely due to the role of micronutrients in chlorophyll synthesis and various physiological processes by activating multiple enzymes. The effectiveness of this treatment in promoting plant height can be attributed to the role of iron in activating key enzymes such as catalase, peroxidase and tryptophan synthetase, which are involved in chlorophyll synthesis and various physiological functions that support plant growth and development (Kumar & Arora, 2000). Iron plays a crucial role as a metabolic catalyst, facilitating the biosynthesis of photo assimilates, thereby promoting vegetative growth. Additionally, boron enhances nutrient mobility, RNA metabolism and IAA biosynthesis, all of which contribute to increased plant height, (Jauhari et al., 2005). This observation is supported by studies conducted (Chopde et al., 2015) in gladiolus, (Singh & Sisodia, 2017) in liliium, (Kolukunde et al., 2014) in gerbera, (Verma et al., 2018) in China aster, (Hussain et al., 2020) in marigold, and (Singh et al., 2024) in gladiolus.

The maximum leaf length (51.81 cm) was recorded in plants treated with 0.2% B + 0.4% Fe contributes to reducing ethylene and abscisic acid levels, playing a crucial role in protein synthesis, respiration, photosynthesis and floral development, which likely led to increased leaf length and width. This observation is consistent with (Singh et al., 2024) in gladiolus.

#### 3.2 Flowering Characters

Tables 1 and 2 shows the effect of iron and boron treatments significantly influenced various flowering parameters in gladiolus cv. Malaviya Shatabdi. The lowest duration for spike emergence (78.76 days) was observed in plants treated with 0.2% B + 0.4% Fe, whereas, the longest duration was recorded in the control treatment. Boron plays a crucial role in cell differentiation, particularly in the shoot apical meristem, which may have triggered early flowering. Its involvement in cellular differentiation likely accelerated plant maturity, allowing the shoot meristem to effectively receive and respond to internal and external flowering signals. Similar effects of boron on early flowering were reported by (Ahmad et al., 2010) in roses and (Kumar et al., 2003) in gladiolus.

The maximum number of florets per spike (13.28) were recorded in plants treated with 0.2% B + 0.4% Fe. Essential micronutrients like iron and boron play a critical role in regulating plant growth, aiding bio-assimilation and accelerating floral development, which could explain the enhanced flowering observed. These results are consistent with studies of Hembrom and Singh (2015) and Erao (2005) in gladiolus.

Additionally, the timing of the opening of the 1<sup>st</sup> and last florets were notably influenced by iron and boron treatments. The earliest floret opening (93.83 days) was recorded in plants treated with 0.2% B + 0.4% Fe, which may be attributed to iron and boron role in regulating plant hormone levels, promoting early maturation and floret development. Similar effects were observed in marigold (Kumar et al., 2010) following foliar iron application and in gladiolus by Memon et al. (2013).

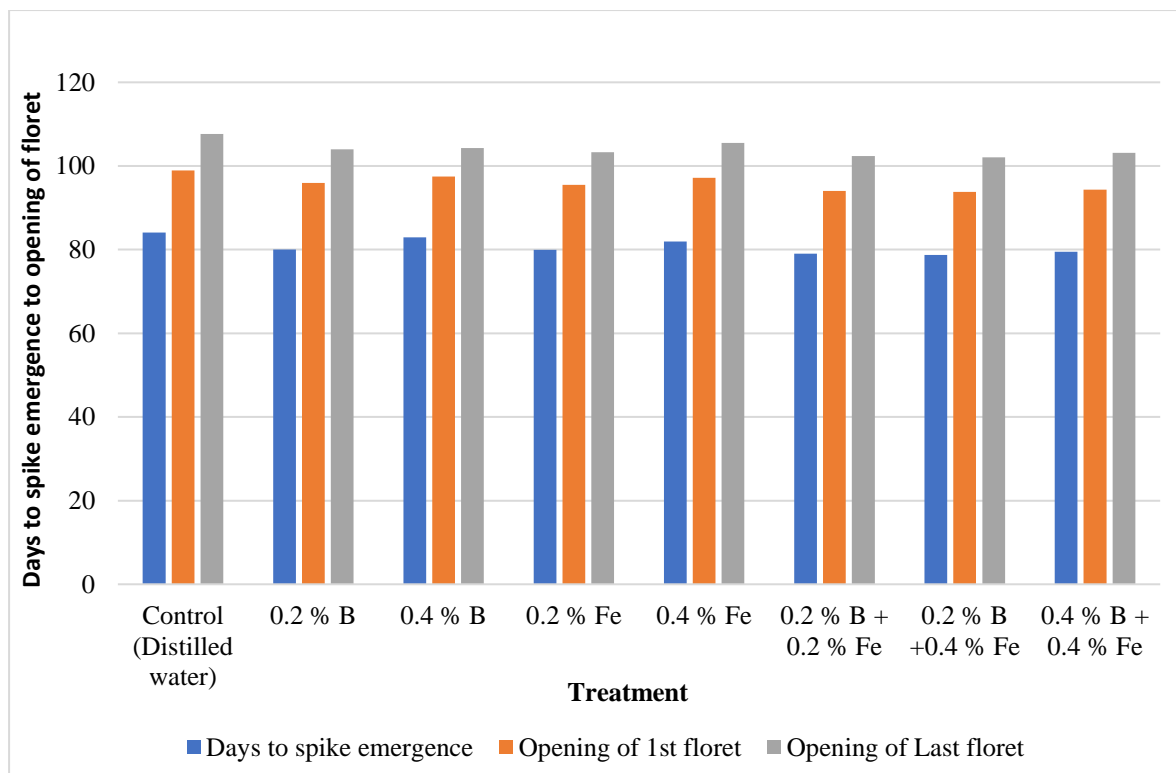
The maximum floret diameter and length of 1<sup>st</sup> and last florets were recorded in treatment 0.2% B + 0.4% Fe. Iron and boron play a vital role in promoting vegetative growth, which subsequently enhances flowering and may contribute to an increase in floret diameter. Similar results were reported by Bhandari et al. (2022) in calendula Chopde et al. (2016) in annual chrysanthemum, Balkrishnan et al. (2007) in marigold and Verma et al. (2018) in China aster. Additionally, the application of 0.2% B + 0.4% Fe showed the longest spike (64.61). The increase in plant

height was closely associated with the elongation of these structures, likely due to enhanced physiological growth and protein synthesis stimulated by iron application in gladiolus plants. Similar observations have been reported by Chopde et al. (2015) and Kumar et al. (2022) in gladiolus, Verma et al. (2017) in chrysanthemum, Pal et al. (2016) in gerbera, Ganga et al. (2009) in orchid and El-Yazal (2008) and Ganesh et al. (2013) in tuberose.

Furthermore, the overall flowering duration, was maximized under the 0.2% B + 0.4% Fe treatment. Iron and boron play important role in growth and development, as well as its function in stimulating metabolic activities and enhancing flower yield. These findings align with research conducted by Misra et al. (2009) in gladiolus, Hajizadeh et al. (2019) in gerbera, Misra et al. (2009) and Kumar et al. (2009) in chrysanthemum.

**Table 1. Effects of different concentrations of iron and boron on growth and flowering attributes in gladiolus cv. Malaviya Shatabdi**

Treatment	Number of leaves/hills	Leaf width (cm)	Scape width (cm)	Floret diameter (cm)		Floret length (cm)	
				3 <sup>rd</sup> floret	Last floret	3 <sup>rd</sup> floret	Last floret
Control (Distilled water)	12.55	2.07	1.90	6.96	7.63	6.96	7.63
0.2 % B	13.16	2.24	2.14	7.23	7.93	7.23	7.93
0.4 % B	13.54	2.27	2.19	7.16	8.00	7.16	8.00
0.2 % Fe	14.50	2.45	2.28	7.26	7.83	7.26	7.83
0.4 % Fe	14.97	2.60	2.37	8.03	8.70	8.03	8.70
0.2 % B + 0.2 % Fe	15.81	2.66	2.48	8.13	9.13	8.13	9.13
0.2 % B +0.4 % Fe	16.04	2.73	2.54	8.23	9.53	8.23	9.53
0.4 % B + 0.4 % Fe	15.78	2.62	2.40	8.03	8.73	8.03	8.73
C.D. at 5%	1.59	0.23	0.20	0.30	0.71	0.30	0.71



**Fig. 1. Effect of iron and boron on days to spike emergence and opening of 1<sup>st</sup> and last floret in gladiolus cv. Malaviya Shatabdi**

**Table 2. Effects of different iron and boron on flowering and corm parameters in gladiolus cv. Malaviya Shatabdi**

Treatment	No. of florets/spike	Spike length (cm)	Total flowering duration (days)	Number of corms/hills	Corm diameter (mm)
Control (Distilled water)	9.66	57.90	12.49	2.21	28.60
0.2 % B	9.71	58.27	13.48	2.92	32.02
0.4 % B	10.40	59.98	14.20	3.06	33.30
0.2 % Fe	11.74	61.39	14.44	3.09	34.85
0.4 % Fe	12.42	63.83	14.61	3.13	36.64
0.2 % B + 0.2 % Fe	12.68	65.44	15.47	3.28	39.98
0.2 % B + 0.4 % Fe	13.28	67.25	15.74	3.68	40.26
0.4 % B + 0.4 % Fe	12.51	64.61	14.81	3.18	38.37
C.D. at 5%	2.26	4.92	1.59	0.49	4.33

### 3.3 Corm and Cormel Parameters

The highest number of corms per hill (3.68) was recorded under the 0.2% B + 0.4% Fe treatment. The application of iron and boron enhanced both vegetative and reproductive growth, leading to an increased corm yield. These results are consistent with the findings of Chopde et al., (015), (Singh et al., 2012), (Naik et al., 2009) and (Erao, 2005) in their studies on gladiolus. The largest corm diameter (40.26 mm) was observed with the 0.2% B + 0.4% Fe treatment, which showed statistical similarity to 0.2% B + 0.2% Fe, 0.4% B + 0.4% Fe, and 0.4% Fe. This increase in corm size may be attributed to the enhanced accumulation of proteins in corms and cormels, a process largely regulated by micronutrients. These findings are consistent with the research conducted by Erao, (2005), (Singh et al., 2012) and (Chopde et al., 2015) in gladiolus.

### 4. CONCLUSION

The findings of this study indicate that the application of 0.2% B + 0.4% Fe treatment resulted in the most favorable growth parameters, while 0.2% B + 0.4% Fe treatment also yielded the best results in terms of corms and cormels yield. Therefore, it can be concluded that foliar application of 0.2% B + 0.4% Fe is optimal for promoting plant growth, and enhancing corms and cormels yield.

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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### COMPETING INTERESTS

Authors have declared that no competing interests exist.

### REFERENCES

- Ahmad, I., Aslam, K.M., Qasim, M., Ahmad, R. and Randhawa, A.M. (2010). Growth, yield and quality of *Rosa hybrida* as influenced by various micronutrients. *Pakistan Journal of Agriculture Science*, 47(1): 5-12.
- Balkrishnan, V.M., Jawaharlal, T., Kumar, B. and Ganga, M. (2007). Response of micro nutrients on flowering, yield and xanthophyll content in African marigold. *Journal of Ornamental Horticulture*, 10(3): 153-156.
- Bhandari, N.S., Srivastava, R.K., Tarakeshwari, K.R. and Chand, S. (2022). Effect of nano and macro iron sprays on growth, flowering, seed and oil yielding attributes in calendula (*Calendula officinalis* L.). *Journal of Horticultural Sciences*, 17(2): 353-362.
- Brown, P.H., Bellaloui, N., Wimmer, M.A., Bassil, E.S., Ruiz, J., Hu, H. and Romheld, V. (2002). Boron in plant biology. *Plant biology*, 4(2): 205-223.

- Chopde N., Nehare N., Maske S.R., Lokhande S. and Bhute P.N. (2015). Effect of foliar application of zinc and iron on growth, yield and quality of gladiolus. *Plant Archives*, 15 (1): 417-419.
- Chopde, N., Borse, G.H., Kuchanwar, O. and Ghodke, A.T. (2016). Effect of zinc sulphate and ferrous sulphate on growth and flowering of annual chrysanthemum. *Plant Archives*, 16(2): 594-596.
- Dordas, C. and Brown, P.H. (2005). Boron deficiency affects cell viability, phenolic leakage and oxidative burst in rose cell cultures. *Plant and soil*, 268: 293-301.
- El-Yazal, M.A. (2008). Physiological studies on effect of foliar application of some micronutrients and ascorbic acid on tuberose. *Fayoum Journal of Agricultural Research and Development*, 22(2): 88-114.
- Erao, K.S. (2005). Influence of iron nutrition on growth, flowering and corm yield in gladiolus. *Journal of Ornamental Horticulture*, 8(4): 293-295.
- Ganesh, S., Soorianathasundaram, K. and Kannan, M. (2013). Studies on effect of plant growth regulators and micronutrients on growth, floral characters and yield of tuberose cv. Prajwal. *Asian Journal of Horticulture*, 8(2): 696-700.
- Ganga, M., Padmadevi, K., Jagadeswari, V. and Jawaharlal, M. (2009). Performance of Dendrobium cv. Sonia 17 as influenced by micronutrients. *Journal of Ornamental Horticulture*, 12(1): 39-43
- Hajizadeh, S., Jabbarzadeh, Z. and Rasouli-Sadaghiani, M.H. (2019). Effect of fulvic acid and iron nano chelate application on flowering and vase life of *Gerbera jamesonii* cv. Dune. *Journal of Horticulture Science*, 33(4): 711-725.
- Hembrom, R. and Singh, A.K. (2015). Effect of iron and zinc on growth, flowering and bulb yield in liliium. *International Journal of Agriculture, Environment and Biotechnology*, 8(1): 61-64.
- Hussain, A., Nabi, G., Ilyas, M., Khan, M.N., Khan, W., Zeb, S. and Khan, A. (2020). Effect of zinc and iron on growth, flowering and shelf life of marigold under the agro-climatic conditions of Sawabi. *Pure and Applied Biology*, 9(1): 180- 192.
- Jauhari, S., Srivastava, R. and Srivastava, P.C. (2005). Effect of Zinc on growth, flowering, corm attributes, post-harvest life, leaf and corm nutrients status in gladiolus cv. Red Beauty. *Progressive Horticulture*, 37(2): 423-428.
- Kashyap, N. and Tikey, T. (2020). Effect of micronutrients on plant growth, flowering and corm production of gladiolus cv. Summer Sunshine. *The Pharma Innovation Journal*, 11(9): 2503-2506.
- Kolukunde S., Sarmah D., Biswas A. and Mandal T. (2014). Effect of micronutrients on growth and flowering of gerbera (*Gerbera jamesonii* L. cv Rosaline) under polyhouse conditions of plains of West Bengal. *Environment and Ecology*, 32(4): 1702-1704.
- Kumar, D., Sahu, T.L., Netam, N., Patel, S., Mandavi, G. and Kumar, N. (2022). Effect of foliar application of zinc and iron on growth, flowering and yield of gladiolus (*Gladiolus grandiflorus* L.). *Journal of Pharmaceutical Innovation*, 11: 2587-2589.
- Kumar, P. and Arora, J.S. (2000). Effect of micronutrients on gladiolus. *Journal of Ornamental Horticulture*, 3(2): 91-93.
- Kumar, P., Kumar, J., Umrao, V.K. and Rajbeer. (2010). Effect of nitrogen and iron on growth and flowering parameters in African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Ganda. *Annual Horticulture*, 3(1): 118-119.
- Kumar, P.N., Mishra, R.L., Dhiman, S.R., Ganga, M. and Kameswari, L. (2009). Effect of micronutrient sprays on growth and flowering of chrysanthemum. *Indian Journal of Agricultural Sciences*, 79(6): 426-428.
- Kumar, R., Singh, G.N. and Misra, R.L. (2003). Effect of boron, calcium and zinc on gladiolus. *Journal of Ornamental Horticulture*, 6(2): 104-106.
- Memon, S.A., Abdul, R.A., Muhammad, A.B. and Mahmooda, B. (2013). Effect of zinc sulphate and iron sulphate on the growth and flower production of gladiolus (*Gladiolus hortulamus*). *Journal of Agricultural Technology*, 9(6): 1621-1630.
- Misra, R.L., Kumar, P.N., Dhiman, S.R., Ganga, M. and Lalitha, K. (2009). Effect of micro nutrient sprays on growth and flowering of chrysnathemum. *Indian Journal of Agricultural Sciences*, 79(6): 426-428.
- Naik, D.V, Dhaduk B.K, Jambhale, S.S. and Kapadia, D.B. (2009). Effect of different micronutrients in gladiolus cv. American Beauty. *Journal of Ornamental Horticulture*, 12(4): 274-277.

- Pal, S., Barad, A.V., Singh, A.K., Khadda, B.S. and Kumar, D. (2016). Effect of foliar application of Fe and Zn on growth, flowering and yield of gerbera (*Gerbera jamesonii*) under protected condition. *Indian Journal of Agricultural Sciences*, 86(3): 394-398.
- Singh A.K. (2014). Breeding and Biotechnology of Flowers, Vol. I: Commercial Flowers. New India Publishing Agency, New Delhi, pp.752.
- Singh A.K., Hamidi M., Sisodia A. & Barman K. (2024). Effect of iron on growth, flowering and corm parameters in gladiolus cv. Malaviya Shatabdi. *International Journal of Advanced Biochemistry Research*, 8 (7): 574-577.
- Singh, A.K. and Sisodia, A. (2017). Text book of floriculture and landscaping, New India Publishing Agency, New Delhi. pp. 350-353.
- Singh, A.K., Hembrom, R., Sisodia, A., Pal, A.K. and Asmita, A. (2016). Effect of iron and zinc on flowering and post-harvest life in gladiolus (*Gladiolus spp.*). *The Indian Journal of Agricultural Sciences*, 86(10): 1316-1319.
- Singh, J.P., Kumar, K., Katiyar, P.N. and Kumar, V. (2012). Influence of zinc, iron and copper on growth and flowering attributes in gladiolus cv. Sapna. *Progressive Agriculture*, 12(1): 138-143.
- Somkuwar, A.R., Singh, A.K., Sisodia, A., Lamsal, A. and Giri, S. (2023). Effect of boron on growth and flowering in gladiolus (*Gladiolus spp.*). *Current Horticulture*, 11(2): 56-59.
- Verma, V.K., Verma, J.P., Verma, H.K. and Meena, R.K. (2017). Response of foliar spray of micronutrients (Zn, Fe and Cu) in respect to growth and flower productivity of China aster [*Callistephus chinensis* (L) NEES] cv. Princess. *Plant Archives*, 17(2): 1643-1646.
- Verma, V.K., Verma, J.P., Verma, H.K. and Meena, R.K. (2018). Efficacy of micronutrients on growth and flower production of China aster [*Callistephus chinensis* (L) NEES] cv. Princess. *International Journal of Agricultural Sciences*, 14(1): 160-164.

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