International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2025; SP-9(9): 1315-1320
www.biochemjournal.com
Received: 15-06-2025
Accepted: 20-07-2025

Megha Mayuri
Research Scholar and Professor and Head Floriculture and Landscaping, Department of Horticulture Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj, Uttar Pradesh, India

Dr. Vijay Bahadur
Research Scholar and Professor and Head Floriculture and Landscaping, Department of Horticulture Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj, Uttar Pradesh, India

Corresponding Author:
Megha Mayuri
Research Scholar and Professor and Head Floriculture and Landscaping, Department of Horticulture Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj, Uttar Pradesh, India

Effect of micro nutrients on growth and flower yield of Lisianthus *(Eustoma grandiflorum)* under Prayagraj-agro climatic conditions

Megha Mayuri and Vijay Bahadur

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i9Sq.5690

Abstract
An experiment was conducted to assess the differential responses of Boron and Calcium on the growth and flowering of Lisianthus during the period from January to May 2024 at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. The experiment was conducted with a Complete Randomized Design (CRD) with three replications. Collected data on growth and flower yield attribute parameters showed significant variations. According to the results, the maximum plant height (17.54 cm), stem length (42.7 cm), Number of leaves (77.33), Stem diameter (2.19 cm), Plant spread (23.89 cm), Number of branches (3.00), leaf area (12.76 cm^2), SPAD value (67.50), Number of days to taken initiation (123), bud no./plant (11.00), Bud length (2.39 cm),Stalk length(19.44 cm) and number of flower per plant(3.61) were found from the Ca treated plants. The treatment T_8 - Calcium @100 ppm was found superior among other treatments.

Keywords: Lisianthus, boron and calcium, growth yield and flower yield attribute

1. Introduction

Lisianthus is becoming one of the most highly ranked cut flowers in the floriculture market. It is mainly due to its rose like flowers, excellent postharvest life and blue / purple colour. Lisianthus (*Eustoma grandiflorum*) belongs to the family Gentianaceae is an ornamental cut flower native to the southern parts of United States particularly to the eastern slope of Rocky Mountains, USA where it is known as the prairies gentian. *Eustoma* is named after the two Greek words Eu (beautiful, good, well), and stoma (mouth). It is a moderately cold-tolerant annual or biennial plant. There are many cultivars of the well-liked lisianthus that are grown for the cut flower industry.

Lisianthus (*Eustoma grandiflorum*) is becoming one of the most highly ranked cut flowers in the international market. Propagation by seeds is complicated and difficult exercise due to slow germination and growth and seedling populations are disadvantageously variable with respect to flowering time, stem length and flower qualities. Vegetative propagation of selected cultivars might provide a useful alternative to seed propagation as the limited availability of cuttings from each stock resulting in apical dieback is a major setback. Therefore, micro propagation serves as potent tool to develop a method of rapid propagation of selected/ elite genotypes of lisianthus. The clonal multiplication of lisianthus especially through tissue culture might provide a useful alternative to seed propagation, thus resulting in to production of better quality planting stock. *In vitro* multiplication of elite plant genotypes offers immense opportunities to multiply large number of disease free, healthy and vigorous planting material in shortest possible time.

The commercial cultivars of lisianthus are available in blue, purple, plum, white and pink colours including bicolour. Therefore, being a valuable flower for cut flower production, it is very much suitable for commercialization in temperate and tropical regions of the world. The recent annual increase in production of lisianthus can be attributed to progress in breeding with new flower colours, diverse forms, excellent vase life and availability of flowers all-round the year. Several researchers have attempted to improve the agronomic characters of lisianthus through genetics, propagation and field cultures, etc. The propagation of lisianthus through seeds has emerged as a great challenge, as it is a very much complicated and difficult process due to slow germination and growth. Moreover, the seedling populations exhibit high variability with respect to flowering time, stem length and flower qualities besides other traits of commercial importance (Ordogh *et al.*, 2006) [23]. In India and Tamil Nadu, lisianthus is a newly emerging cut flower crop, with the production being concentrated in limited areas in the hilly tracts of Ooty and Kodaikanal. Any attempt made to encourage cut flower production in the hilly regions of Tamil Nadu would not only help the florists and consumers to get fresh and quality cut flowers regularly, but will also help the small and marginal farmers to improve their economic status.

In late decades, raises have built up an assortment of cultivars concerning numerous attributes, for example, uniform flowering consistently, the absence of rosetting, warm resistance, flower shading, and flower size and frame, including twofold flowers, and so forth. (Harbaugh, 2007) [6]. *Eustoma grandiflorum* is generally proliferated by seed or cutting. An expansive number of seedlings can be delivered by seed propagation; however, the quality is not uniform because of varieties in flowering time, plant tallness and the number of flowers. In a few cultivars, for example, those with peripheral variegation, these seedlings demonstrate an extensive variety of variety in view of their heterozygous character.

Lisianthus has the characteristics of a "perfect cut flower" (alluring flowers and long vase life) and should keep on increasing in prominence all through the following century. Smaller scale propagation has been widely utilized for the fast generation of many plant species and cultivars.

The techniques for miniaturized scale propagation of Eustoma grandiflorum have been produced and many plants were recovered from stem, leaf and meristem explants. The increase of those clones through biogenetic aseptic culture ought to be important in Lisianthus as it empowers the massive scale augmentation of those singular plants having attractive attributes, for example, high profitability, predominate propensity, sickness resistance or quicker development rate. The achievement of the smaller scale proliferation strategy relies upon a few factors like genotype, media, plant development regulators and kind of explants, which ought to be seen amid the procedure. The most much of the time utilized development regulators for microprapgation of decorative plants by organogenesis, embryogenesis, and axillary expansion are naphthalene aceticacid (NAA), and benzyl adenine (BA) (Jain and Ochatt, 2010) [24]. Kinetin (KIN) has been connected for small scale proliferation of many plants. The target of the present experiments was to assess the impacts of various centralizations of KIN and NAA on recovery of shoot and root in Eustoma grandiflorum.

Lisianthus is a seed-produced pot plant used in floristry. Its blossoms resemble tulip flowers quite a little. The palette consists of pink, white, and purple. The stem forks apically and is monopodial at the base. The majority of commercially available cultivars have stem lengths ranging from 500 to 750mm. A plant can be in bloom for up to 5 weeks as a whole and individual flowers can endure for 2 weeks.

2. Materials and Methods

The experiment was conducted during rabi season of the year 2024 at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. The experimental site is located in the sub-tropical region which is located at 25°. 27^1 N latitude, 81°. 56^1 E longitude and 98 m above the mean sea level.

Table 1: Details of Treatment Combinations

Treatment Symbol	Treatment Combinations
T_0	Control
T_1	Boron @25 ppm
T_2	Boron @50 ppm
T_3	Boron @75 ppm
T_4	Boron @100ppm
T_5	Calcium@25 ppm
T_6	Calcium@50ppm
T_7	Calcium @75 ppm
T_8	Calcium @100 ppm

3. Results and Discussion

Plant spread (cm) at harvest stage, there was significant difference between the treatments and the maximum plant spread (23.89 cm) was observed the applications of T_8-Calcium @100 ppm, followed by the treatment T_4 (Boron @100ppm) whereas the minimum plant spread (20.28 cm) was observed in treatment T_0 (Control). Plant Height (cm) at harvest stage, there was significant difference between the treatments and the maximum plant height (17.54 cm) was observed the applications of T_8-Calcium @100 ppm, followed by the treatment T_4 (Boron @100ppm) whereas the minimum plant height (11.48 cm) was observed in treatment T_0 (Control). The increased plant spread, plant height and number of leaves, might be due to the fact that weekly application of water soluble fertilizer at the root zone of crop improved the nutrient uptake thereby promoting the synthesis of growth promoting substances which eventually led to increased vegetative growth. The increased plant height with more number of leaves was a result of maintenance of favorable soil moisture in the root zone. Similar findings were reported by Chaudhary *et al.* (2018) [25] in rose, Sreekanth *et al.*, (2006) [26] in tuberose in African marigold, Nirala *et al.*, (2018) [27] in carnation Singh and Kumar (2017) [9].

Among the treatments, more numbers of leaves was observed at T_8 -Calcium @100 ppm (77.33), T_4 -Boron @100ppm (71.89) and T_7 -Calcium @75 ppm) (64.00) at vegetative stage, bud emergence stage and harvesting stage respectively which were on par with T_3,T_6 and T_2 treatments at vegetative stage, respectively. The less numbers of leaves was recorded at T_1 (Control) (46.94) at vegetative stage to harvesting stage. The number of branches per plant for the various treatments ranged between 1.72 to 3.0 harvest time. At the stage of harvest time, there was significant difference between the treatments and the maximum plant number of branches per plant (14.15) was observed the applications of T_8-Calcium @100 ppm, followed by the treatment T_4 (Boron @100ppm) whereas the minimum number of branches per plant (1.72) was observed in treatment T_0 (Control).

The increase in number of leaves could be the result of stimulation of cell division, which improved vegetative growth and biomass. Therefore, the accumulation of carbohydrates created as a result of photosynthesis helped in the expansion of plants and their constituent parts. The results of present investigation are in agreement with the findings of Kakade *et al.* (2009) [8] in china aster and Kendra *et al.* (2013) [28] in chrysanthemum. The increase in the number of branches per plant may be due to the production of tryptophan which might have been extended by Boron and Calcium. As a result, the synthesis of micronutrients was increased the vegetative growth, which increased longitudinal growth and the number of shoots. Seydmohammadi *et al.* (2019) [18] discovered comparable outcomes in Eustoma grandiflorum after treating plant samples with 9 mg/L nano zinc. Hassanein *et al.* (2021) [7] reported that 10 ppm nano zinc increased the number of branches which supported the findings of the present study.

The maximum chlorophyll content in leaves was observed in T_8 -Calcium @100 ppm (67.50 mg g^{-1}) at vegetative stage to harvesting stage, which was on par with T_4 -Boron @100ppm (65.93 mg g^{-1}) and T_7 -Calcium @75 ppm (62.00 mg g^{-1}) at harvesting stage, while the minimum chlorophyll content in leaves was observed at T_0 (Control) (56.07 mg g^{-1}) at harvesting stage.

The maximum stem diameter was observed at T_8 -Calcium @100 ppm (2.19 cm), followed by T_4 (Boron @100ppm (2.11 cm) and T_7 -Calcium @75 ppm (2.09 cm) and all these treatments were on par with each other. The minimum stem diameter was observed at T_0 (Control) (1.83 cm). The yield parameters like number of flower buds per plant and flower stems per unit area were significantly influenced by the fertigation dose. also pointed out that fertigation at every irrigation (two-day intervals) up to 115 days resulted in significant higher yield of chrysanthemum. Obviously, the diameter of flower is contributed by number of petals, petal length and width of flower. This is well supported by Ashok (1998) [28] in rose, in anthurium. Similar results were found by Amin, *et al.*, 2015 in gerbera, Kumar *et al.*, (2017) [9] in calendula and Madhuri *et al.*, (2014) [30] in carnation.

Table 2: Effect of Micronutrients on growth parameter of Lisianthus

Treatment	Plant Spread (cm)	Plant height (cm)	Number of leaves	Number of Branches per Plant	Chlorophyll content (spad value)	Stem Diameter (cm)
	At Harvest					
T_0 (Control)	**20.28**	**11.48**	**46.94**	**1.72**	**56.07**	**1.83**
T_1 (Boron @25 ppm)	20.37	14.86	53.56	2.22	59.03	1.93
T_2 (Boron @50 ppm)	21.25	15.07	57.83	2.33	60.97	2.01
T_3 (Boron @75 ppm)	22.03	16.57	62.28	2.5	61.87	2.08
T_4 (Boron @100ppm)	23.42	16.92	71.89	2.83	65.93	2.11
T_5 (Calcium@25 ppm)	20.5	14.94	56.78	2.28	60	1.94
T_6 (Calcium@50ppm)	21.64	15.67	59.72	2.39	61.13	2.03
T_7 (Calcium @75 ppm)	22.08	16.72	64	2.5	62	2.09
T_8 (Calcium @100 ppm)	23.89	17.54	77.33	3	67.5	2.19
F test	S	S	S	S	S	S
S.E. (m) (±)	0.43	0.57	3.07	0.12	1.14	0.03
$C.D_{0.05}$	0.19	0.28	1.38	0.05	0.51	0.02
C.V Value	5.97	11.77	15.06	15.15	5.54	4.88

3.1 Growth and flower attributes

The maximum leaf area was recorded at T_8 -Calcium @100 ppm (12.76 cm^2) at vegetative stage to harvesting stage respectively which was on par with T_4 -Boron @100ppm (12.61) and T_7 -Calcium @ 75 ppm (12.42) at vegetative stage. The minimum leaf area was recorded at T_0 (Control) (11.01cm^2) at vegetative stage and at harvesting stage, respectively. The maximum stalk length was observed at T_8 (Calcium @100 ppm) (19.44 cm) followed by T_4 (Boron @100 ppm) (19.39cm) while the minimum stalk length was observed at T_0 (Control) (16.11 cm) followed by T_1 (Boron @25 ppm) (16.67 cm) in showed the table. Physiological parameters such as leaf area and chlorophyll content were found significant. The balanced dose of fertilizer application increased the activity of meristematic tissue and promote synthesis of many growth promoting hormones which were involved in the increase of various physiological parameters such as leaf area, total dry matter production shoot to root ratio, RWC and chlorophyll content. Corroborative evidence could be obtained from the results of Ingle *et al.* in chrysanthemum, in calendula, and Singh and Uma (1996) in tuberose.

The maximum bud length was observed at T_8 (Calcium @100 ppm) (2.39 cm) followed by T_4 (Boron @100 ppm) (2.35 cm) while the minimum bud length was observed at T_0 (Control) (1.98 cm) followed by T_1 (Boron @25 ppm) (2.03 cm) in showed the table. The maximum number of bud per plant was observed at T_8 (Calcium @100 ppm) (11.00) followed by T_4 (Boron @100 ppm) (10.67) while the minimum bud length was observed at T_0 (Control) (7.78) followed by T_1 (Boron @25 ppm) (8.00) in showed the table. The number of days taken for first flower bud emergence significantly differed among the treatments (Table 4.11). The less number of days taken for first flower bud emergence was recorded at T_8 (Calcium @100 ppm) (123.00 days), while the more number of days taken for first flower bud emergence was recorded at T_0 (Control) (128.50 days) followed by T_7 (Calcium @75 ppm) (123.72 days). The maximum number of flowers per plant was observed at T_8 (Calcium @100 ppm) (3.61) followed by T_4 (Boron @100ppm) (3.22) and T_7 (Calcium @75 ppm) (2.94) and all these treatments were on par with each other, while the less number of flowers per plant was recorded at T_1 (Control) (2.28).

In the present investigation, optimum nutrition was balanced through fertigation. This might have influenced flower quality parameters like flower diameter and flower length, flower stalk length and stalk girth of flowers and duration of flowering and vase life was recorded in T_4 treatment which might be due to the reason that, this treatment resulted in good vegetative growth in all stages of plant growth thereby resulting in improved quality of flowers. The results are in agreement with. The yield parameters like number of flower buds per plant and flower stems per unit area were significantly influenced by the fertigation dose. also pointed out that fertigation at every irrigation (two-day intervals) up to 115 days resulted in significant higher yield of chrysanthemum. Obviously, the diameter of flower is contributed by number of petals, petal length and width of flower. This is well supported by Ashok (1998) [31] in rose, in anthurium. Similar results were found by Amin, *et al.*, 2015 [32] in gerbera, Kumar *et al.*, (2017) [9] in calendula and Madhuri *et al.*, (2014) [30] in carnation.

This increment in bud diameter might be due to increased glucose formation which promotes cell division and increases bud diameter. The findings of the present investigation are in confirmation with the work of Shaheen *et al.* (2015) [20] in oriental lily who reported that with application of 6 mg zinc sulphate per kg of soil media. The increased floral parameters might be due to the application of micronutrients through fertigation because these are being a constituent of proteins, amino acids, nucleic acid, various enzymes and coenzymes which are associated with the increased shoot length and leaf area resulted in more photosynthesis and thus increased the transformation of manufactured food material from source (leaf) to sink (flower bud). This was in conformity with the findings of Beniwal *et al*., (2005) [33] in chrysanthemum. Similar results were also obtained by Potti and Arora (1986), in chrysanthemum, in Blanket flower and Mukherjee *et al.* (1994) [34] and Sharma and Singh (2002) [12] in gladiolus. Moreover, another possible reason that could have been attributed to early flowering is the abundant availability of phosphorus which promote root growth resulted in efficient absorption of available nutrients from the soil this in turn increase the vegetative growth that would have led to the induction of early flowering. This was confirmed by the reports of Beniwal *et al*. (2005) [33] in chrysanthemum. Crop yield is the reflection of the cumulative effect of all the biotic and the abiotic factors exist and experienced during its different stages of crop growth and development. Higher level of water soluble fertilizers might have served as optimum dose in lisianthus thereby promoting maximum and good yield.

Table 3: Effect of Micronutrients on growth and flower yield of Lisianthus

Treatment	Leaf Area (cm^2)	Stalk Length(cm) (60 DAP)	Bud length (cm)	Number of Bud per Plant	Number of Days Bud Initiation	Number of Flowers per Plant
T_0 (Control)	11.01	16.11	1.98	7.78	128.5	2.28
T_1 (Boron @25 ppm)	11.58	16.67	2.03	8	126.44	2.5
T_2 (Boron @50 ppm)	11.99	17.39	2.08	9	125.28	2.72
T_3 (Boron @75 ppm)	12.26	18.67	2.21	10.33	124.11	2.89
T_4 (Boron @100ppm)	12.61	19.39	2.35	10.67	123.56	3.22
T_5 (Calcium@25 ppm)	11.63	17.28	2.05	8.44	126.11	2.56
T_6 (Calcium@50ppm)	12.15	17.56	2.09	9.39	124.89	2.83
T_7 (Calcium @75 ppm)	12.42	19	2.21	10.5	123.72	2.94
T_8 (Calcium @100 ppm)	12.76	19.44	2.39	11	123	3.61
F test	S	S	S	S	S	S
S.E. (m) (±)	0.25	0.41	0.05	0.41	0.62	0.13
$C.D_{0.05}$	0.13	0.18	0.02	0.18	0.31	0.06
C.V Value	6.69	6.86	7.14	12.89	1.58	21.75

3.2 Economics of Lisianthus flower

The common cost of cultivation of the Lisianthus was recorded Rs. 142200. The maximum cost of production of Lisianthus flower was recorded under T_8 (Calcium @100 ppm) i.e. ₹144380/ha whereas minimum recorded in T_0 (Control) with ₹142200/ha. The maximum gross return was found in (`Rs. 1246666.66/ha) T_8 (Calcium @100 ppm) and lowest in (Rs 901500.003/ha) T_0 (Control). The net return was recorded under T_8 (Calcium @100 ppm) i.e. Rs. 11002286.67/ha whereas minimum recorded in T_0 (Control) with Rs. 759300.00/ha. Higher B:C Ratio was recorded under T_8 (Calcium @100 ppm) i.e. 7.63 meanwhile minimum B:C Ratio recorded in T_0 (Control) with 5.34.

Table 4: Economics of Lisianthus flower

Treatment	Cost of Cultivation (Rs./ha)	Yield (Number of flower /ha)	Gross Return(Rs./ha)	Net return(Rs./ha)	Benefit Cost Ratio
T_0 (Control)	142200.00	45075.00	901500.00	759300.00	5.34
T_1 (Boron @25 ppm)	143500.00	54000.00	1080000.00	936500.00	6.53
T_2 (Boron @50 ppm)	143860.00	55666.00	1113333.00	969473.00	6.74
T_3 (Boron @75 ppm)	144200.00	56916.00	1138333.00	994133.00	6.89
T_4 (Boron @100ppm)	144060.00	59416.00	1188333.00	1044273.00	7.25
T_5 (Calcium@25 ppm)	143750.00	54416.00	1088333.00	944583.00	6.57
T_6 (Calcium@50ppm)	143845.00	56500.00	1130000.00	986155.00	6.86
T_7 (Calcium @75 ppm)	144190.00	57333.00	1146666.00	1002476.00	6.95
T_8 (Calcium @100 ppm)	144380.00	62333.00	1246666.00	1102286.00	7.63

Conclusion

The present investigation, it is concluded that among the different treatments, the treatment T_8 - Calcium @100 ppm was found superior among other treatments in terms of Plant height, Plant spread, Number of leaves, stem diameter, leaf area, bud length, number of buds per plant, stalk length, Number of flowers per plant, number of branches per plant and chlorophyll content, minimum number of days for bud initiation, Flower yield per plant, benefit cost ratio.

References

1. Aktaş H, Akkaya GG, Akyüz Çağdaş E, Haspolat G. Micropropagation of Lisianthus [*Eustoma grandiflorum* (Raf.) Shinn.] leaf explants and single nodes in response to plant growth regulators. Hortic Stud. 2023;40(3):86-97.
2. Bhatia R, Dey SS, Rajkumar R. Lisianthus: new cut flower crop for mid Himalayan region. Indian Hortic. 2020;65(5):34-36.

3. Bose TK, Jana BK, Mukhopadhyay TP. Effects of micro nutrients on growth and flowering in *Hippeastrum hybridum* hort. Sci Hortic. 1980;12(2):195-200.
4. Benny. Effect of micro nutrients, gibberellic acid (GA). Plant Arch. 2017;17(2):803-12.
5. Chandrashekar SY, Kumar P, Hemanth. Investigation on different sources and levels of calcium on flowering, quality and yield in Asiatic lily. Int J Agric Sci. 2023;15:159-63.
6. Harbaugh BK. Lisianthus. In: Anderson NO, editor. Flower breeding and genetics. Dordrecht: Springer; 2007. p. 439-59.
7. Hassanein YZ, Abdel-Rahman SSA, Soliman WS, Salaheldin S. Growth, yield, and quality of roselle (*Hibiscus sabdariffa* L.) plants as affected by nano zinc and bio-stimulant treatments. Hortic Environ Biotechnol. 2021;62(6):879-90.
8. Kakade DK, Rajput SG, Joshi KI. Effect of foliar application of Fe and Zn on growth, flowering and yield of China aster (*Callistephus chinensis* L.). Asian J Hortic. 2009;4(1):138-40.
9. Kumar UJ, Bahadur V, Prasad VM, Mishra S, Shukla PK. Effect of different concentrations of iron oxide and zinc oxide nanoparticles on growth and yield of strawberry (*Fragaria* × *ananassa* Duchcv. Chandler). Int J Curr Microbiol Appl Sci. 2017;6(8):2440-5.
10. Kumar P, Singh A, Laishram N, Pandey RK, Dogra S, Jeelani MI, *et al*. Effects of micro nutrients on quality flower and seed production of marigold (*Tagetes erecta* L.). Bangladesh J Bot. 2020;49(3):567-77.
11. Kumari RV, Karthik DR, Shalini M. Influence of nutrient levels and plant spacing on flowering and flower quality of Lisianthus (*Eustoma grandiflorum*) under poly house condition. Plant Arch. 2024;24(2):908-14.
12. Nair SA, Singh V, Sharma TVRS. Effect of plant growth regulators on yield and quality of gerbera under Bay Island conditions. Indian J Hortic. 2002;59(1):100-5.
13. Parmar AB, Patel HC, Chavda JC, Parmar JR. Effect of micro nutrients on growth, flower yield and quality of spider lily (*Hymenocallis speciosa* L.). Asian J Hortic. 2009;4(1):102-4.
14. Poorani S, Bahadur V, Fatmi U. Effect of plant growth regulators on growth and flower yield of Lisianthus (*Eustoma grandiflorum*) under Prayagraj agro climatic conditions. Int J Plant Soil Sci. 2024;36(7):988-96.
15. Prasad TNVKV, Sudhakar P, Sreenivasulu Y, Latha P, Munaswamy V, Reddy KR, *et al*. Effect of nanoscale zinc oxide particles on the germination, growth and yield of peanut. J Plant Nutr. 2012;35(6):905-27.
16. Raisa I, Dina A, Husna MA, Mahbuba S, Jamal Uddin AFM. Foliar application of Cu-based zinc nano fertilizer. J Agric Sci. 2022;1:1-6.
17. Rostami M, Talarposhti RM, Mohammadi H, Demyan MS. Morpho-physiological response of saffron (*Crocus sativus* L.) to particle size and rate of zinc fertilizer. Commun Soil Sci Plant Anal. 2019;50(10):1250-7.
18. Seydmohammadi Z, Roein Z, Rezvanipour S. Accelerating the growth and flowering of *Eustoma grandiflorum* by foliar application of nano-ZnO and nano-$CaCO_3$. Plant Physiol Rep. 2020;25:140-8.
19. Sharma L, Collis JP. Effect of micro nutrients on growth and flower yield of petunia (*Petunia hybrida* L.). J Plant Dev Sci. 2017;9:513-4.
20. Shaheen R, Hassan I, Hafiz IA, Jilani G, Abbasi NA. Balanced zinc nutrition enhances the antioxidative activities in oriental lily cut-flower leading to improved growth and vase quality. Sci Hortic. 2015;197:644-9.
21. Singh AK, Sisodia A, Sisodia V, Kirti A. Effect of foliar application of boron and zinc on growth and flowering characters in African marigold cv. Pusa Narangi Gainda. J Ornam Hortic. 2018;21(1):1-6.
22. Sultana MN, Maliha M, Husna MA, Raisa I, Uddin AFMJ. Differential responses of boron, calcium and zinc on growth and flowering of Lisianthus. Asian J Crop Soil Sci Plant Nutr. 2022;7(1):272-80.
23. Ördögh M, Jámbor-Benczúr E, Mándy AT, Lelik L. The effects of growth regulators in proliferation of Sorbus redliana'Burokvölgy'. International Journal of Horticultural Science. 2006 Feb 8;12(1):77-83.
24. Jain SM. Protocols for *in vitro* propagation of ornamental plants. Humana Press; 2010.
25. Chaudhary A, Gustafson D, Mathys A. Multi-indicator sustainability assessment of global food systems. Nature communications. 2018 Feb 27;9(1):848.
26. Sreekanth A, Joseph M, Fun HK, Kurup MP. Formation of manganese (II) complexes of substituted thiosemicarbazones derived from 2-benzoylpyridine: Structural and spectroscopic studies. Polyhedron. 2006 Apr 17;25(6):1408-14.
27. Srivastava M, Nirala NR, Srivastava SK, Prakash R. A comparative study of aptasensor vs immunosensor for label-free PSA cancer detection on GQDs-AuNRs modified screen-printed electrodes. Scientific reports. 2018 Jan 31;8(1):1923.
28. Brar GS, Capinera JL, Kendra PE, McLean S, Peña JE. Life cycle, development, and culture of Xyleborus glabratus (Coleoptera: Curculionidae: Scolytinae). Florida Entomologist. 2013 Sep;96(3):1158-67.
29. Ashok M, Turner C, Wilson TG. Insect juvenile hormone resistance gene homology with the bHLH-PAS family of transcriptional regulators. Proceedings of the National Academy of Sciences. 1998 Mar 17;95(6):2761-6.
30. Madhuri M, Tewari HR, Bhowmick PK. Livelihood vulnerability index analysis: An approach to study vulnerability in the context of Bihar. Jàmbá: Journal of Disaster Risk Studies. 2014 Dec 2;6(1):13.
31. Ashok M, Turner C, Wilson TG. Insect juvenile hormone resistance gene homology with the bHLH-PAS family of transcriptional regulators. Proceedings of the National Academy of Sciences. 1998 Mar 17;95(6):2761-6.
32. Amin SA, Hmelo LR, Van Tol HM, Durham BP, Carlson LT, Heal KR, Morales RL, Berthiaume CT, Parker MS, Djunaedi B, Ingalls AE. Interaction and signalling between a cosmopolitan phytoplankton and associated bacteria. Nature. 2015 Jun 4;522(7554):98-101.
33. Agrawal RP, Beniwal R, Kochar DK, Tuteja FC, Ghorui SK, Sahani MS, Sharma S. Camel milk as an adjunct to insulin therapy improves long-term glycemic control and reduction in doses of insulin in patients with type-1 diabetes: a 1 year randomized controlled trial.

Diabetes research and clinical practice. 2005 May 1;68(2):176-7.
34. Mukherjee B, Mukherjee JR, Chatterjee M. Lipid peroxidation, glutathione levels and changes in glutathione-related enzyme activities in streptozotocin-induced diabetic rats. Immunology and cell biology. 1994 Apr;72(2):109-14.