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Sanjana Koti
Department of Floriculture
and Landscaping, College of
Agriculture, Keladi Shivappa
Nayaka University of
Agricultural and Horticultural
Sciences, Shivamogga,
Karnataka, India

B Hemla Naik
Senior Professor of
Horticulture and Director of
Education, Keladi Shivappa
Nayaka University of
Agricultural and Horticultural
Sciences, Shivamogga,
Karnataka, India

Chandrashekar SY
Professor and Head,
Department of Floriculture
and Landscaping, College of
Agriculture, Hiriya,
Karnataka, India

Sudharani N
Assistant Professor,
Department of Food and
Nutrition, ICAR-KVK
Shivamogga, Karnataka, India

Divya M
Assistant Professor of
Microbiology, Organic
Farming Research Centre,
Keladi Shivappa Nayaka
University of Agricultural and
Horticultural Sciences,
Shivamogga, Karnataka, India

Corresponding Author:
Sanjana Koti
Department of Floriculture
and Landscaping, College of
Agriculture, Keladi Shivappa
Nayaka University of
Agricultural and Horticultural
Sciences, Shivamogga,
Karnataka, India

Effect of foliar application of biostimulants on the morphology and flowering of Lisianthus hybrid Rosita 3 Clear Pink under protected cultivation

Sanjana Koti, B Hemla Naik, Chandrashekar SY, Sudharani N and Divya M

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Abstract

The present study entitled “Effect of foliar application of biostimulants on the morphology and flowering of Lisianthus hybrid Rosita 3 Clear Pink under protected cultivation” was carried out during 2025-26 at the Department of Horticulture, College of Agriculture, Shivamogga. The experiment was conducted in Naturally Ventilated Polyhouse (NVPH) using a Randomized Complete Block Design (RCBD) with 15 treatments, comprising Panchagavya, Jeevamrutha and PGPR at different concentrations and in combinations, along with an untreated control replicated thrice. The results revealed that foliar application of Panchagavya @ 6% + Jeevamrutha @ 15% + PGPR @ 4% recorded significantly higher plant height (92.75 cm), plant spread (10.85 cm E-W and 11.50 cm N-S), stem girth (8.90 mm), internodal length (7.80 cm), number of leaves per plant (52.50), leaf area (2420 cm²/plant) and number of branches per plant (3.80). The same treatment also resulted in the earliest bud initiation (66.85 days), flower opening (76.25 days), 50 percent flowering (80.35 days) and flower stalk harvesting (84.70 days) and recorded the longest duration of flowering (24.20 days). Therefore, foliar application of Panchagavya @ 6% + Jeevamrutha @ 15% + PGPR @ 4% was found to be an effective biostimulant combination for enhancing morphological growth and flowering attributes of Lisianthus under protected cultivation.

Keywords: *Eustoma grandiflorum*, protected cultivation, Panchagavya, Jeevamrutha and PGPR

Introduction

Lisianthus, scientifically *Eustoma grandiflorum* (Raf.) Shinn., syn. *Lisianthus russelianus* Hook. (2n = 36) belongs to the family Gentianaceae, which is commonly known as ‘Texas Blue Bell’ and ‘Prairie Gentian’ (Halevy and Kofranek, 1984) [7]. *Eustoma* is named after two Greek words, Eu (beautiful, good, well) and stoma (mouth). Lisianthus is derived from Greek words, lysis (dissolution) and anthos (flower). It is an important ornamental plant, ranked among top 10 cut flowers worldwide for its elegant, rose-like blooms in bright and pastel colours and excellent post-harvest life (Musembi *et al.*, 2015) [14]. It is herbaceous annual to short-lived perennial with funnel-shaped flowers on long, straight stems with simple, slightly succulent bluish-green leaves. The growth and quality are variety-specific, thriving best within a pH range of 6.3 to 6.7 (Harbaugh and Woltz, 1991) [8]. The ideal range of temperature is between 15 °C and 25 °C. Excessively high temperatures during seedling growth may lead to rosetting with up to 3 pairs of leaves (Harbaugh, 2007) [9]. The optimum light intensity for Lisianthus is 4,000-6,000 foot-candles. These plants are mainly propagated by seeds, vegetatively by rooted cuttings and through micropropagation. Lisianthus is slow-growing ornamental crop that takes about 5-6 months from seed sowing to flowering under optimum growing conditions (Halevy and Kofranek, 1984) [7]. Transplantation is generally done after 8-12 weeks, at 4-6 pair of true leaves stage. A spacing of 10 cm × 10 cm (100 plants/m²) was optimum for improving growth, flower quality, yield and profitability of Lisianthus under naturally ventilated polyhouse conditions (Ganiger *et al.*, 2025) [5]. Lisianthus flowers are available in various colours, such as blue, purple, white, pink, and bicolour, that are widely used as cut flowers, for bridal bouquets, as flowering pot plants, floral displays and in many other special flower arrangements. In recent decades, floriculture has increasingly shifted towards sustainable and eco-friendly production practices to overcome limitations of intensive cultivation.

Among these, biostimulants have gained importance for enhancing plant growth, flower quality and productivity while promoting environmentally responsible cultivation (Wezel 2014) [24]. Biostimulants are substances or microorganisms, other than fertilizers, that stimulate natural plant processes, improve nutrient use efficiency, enhance tolerance to abiotic stress and ultimately improve crop growth and quality (Zhang and Schmidt, 2000; Traon *et al.*, 2014) [25, 22]. Therefore, the present investigation entitled "Effect of foliar application of biostimulants on the morphology and flowering of Lisianthus hybrid Rosita 3 Clear Pink under protected cultivation" was undertaken with the following objectives:

1. To study the effect of foliar application of biostimulants on the morphology of Lisianthus
2. To study the effect of foliar application of biostimulants on flowering of Lisianthus

Materials and Methods

Experimental site

The experiment was conducted during 2025-26 in naturally ventilated polyhouse at the Department of Horticulture, College of Agriculture, Shivamogga, located in Southern Transition Zone (Zone 7) of Karnataka and lies at 13°55' N latitude, 75°34' E longitude and 650 m above MSL. The study was conducted using Randomized Complete Block Design (RCBD), comprising fifteen treatments, each replicated three times. Lisianthus seedlings were transplanted on raised beds at spacing of 10 × 10 cm, accommodating 100 plants per 1.0 × 1.0 m² plot.

Planting material

The Lisianthus seedlings used for the experiment were procured from Sakata Seed India Pvt. Ltd., Bengaluru.

Biostimulants

Organic manures like farmyard manure (FYM) 2kg/m² and vermicompost were applied as soil application as basal dressing. *Trichoderma harzianum* and Mycorrhiza were commonly applied for all treatments except for the control. The recommended fertilizer dose for Lisianthus was 15 g N, 18 g P₂O₅ and 18 g K₂O m⁻², supplied through urea, single superphosphate (SSP) and muriate of potash (MOP), respectively. The biostimulants Panchagavya and Jeevamrutha were prepared as recommended by TNAU Organic Farming Practices "Panchagavya" and "Jeevamrutha" (Anon., 2014). The PGPR consortium was procured from the Organic Farming Research Centre (OFRC), comprising *Azospirillum brasilense*, *Pseudomonas fluorescens* and *Bacillus subtilis*. These biostimulants were applied as foliar sprays at 15, 30 and 45 days after transplanting (DAT).

Treatment details

- T₁ (Panchagavya @ 4%)
 T₂ (Panchagavya @ 6%)
 T₃ (Jeevamrutha @ 10%)
 T₄ (Jeevamrutha @ 15%)
 T₅ (PGPR @ 2%)
 T₆ (PGPR @ 4%)
 T₇ (Panchagavya @ 4% + Jeevamrutha @ 10%)
 T₈ (Panchagavya @ 6% + Jeevamrutha @ 15%)
 T₉ (Panchagavya @ 4% + PGPR @ 2%)
 T₁₀ (Panchagavya @ 6% + PGPR @ 4%)

- T₁₁ (Jeevamrutha @ 10% + PGPR @ 2%)
 T₁₂ (Jeevamrutha @ 15% + PGPR @ 4%)
 T₁₃ (Panchagavya @ 4% + Jeevamrutha @ 10% + PGPR @ 2%)
 T₁₄ (Panchagavya @ 6% + Jeevamrutha @ 15% + PGPR @ 4%)
 T₁₅ (Untreated Control)

Planting and after-care

Ninety-day-old seedlings were transplanted on 20th December, 2025. Standard aftercare practices, including irrigation (overhead system), staking, netting, gap filling, weeding, foliar spray of micronutrients and plant protection measures, were adopted.

Observations

Five plants were randomly selected, tagged and observations were recorded in each treatment at appropriate stages and statistically analysed for different growth parameters like plant height (cm), plant spread (E-W and N-S) (cm), internodal length (cm), stem girth (mm), number of leaves, leaf area per plant (cm²), leaf area index, number of branches at peak growth stage. Flowering parameters like days taken for flower bud initiation, flower opening (days), 50 percent flowering (days), flower stalk harvesting (days) and duration of flowering (days) were recorded.

Results and Discussion

Morphological parameters

The effect of foliar application of biostimulants on the morphological parameters of Lisianthus hybrid Rosita 3 Clear Pink, recorded at 75 Days After Transplanting (DAT) was assessed and the results of the experiment are presented in Table 1. Among the various treatments, Panchagavya @ 6% + Jeevamrutha @ 15% + PGPR @ 4% (T₁₄) recorded maximum plant height (92.75 cm), plant spread (10.85 cm E-W and 11.50 cm N-S), stem girth (8.90 mm), internodal length (7.80 cm), number of leaves per plant (52.50), leaf area (2420 cm² plant⁻¹) and number of branches per plant (3.80) as depicted in figure 1.

The significantly superior vegetative growth recorded in T₁₄ (Panchagavya @ 6% + Jeevamrutha @ 15% + PGPR @ 4%) could be attributed to the combined action of three biostimulants in enhancing plant growth and development. Panchagavya is a rich source of essential macro and micronutrients, beneficial microorganisms, amino acids, vitamins and naturally occurring plant growth regulators such as auxins and gibberellins, which stimulate cell division, cell elongation and overall vegetative growth (Natarajan, 2002) [15]. The presence of these bioactive compounds promotes vigorous shoot growth, resulting in increased plant height, stem girth and canopy spread. Similar results have been documented by Praveen *et al.* (2021) [18] in floribunda Rose cv. Mirabel, Rajiv *et al.* (2025) [19] in Jasmine, Ghosh (2024) [6] in Tuberose and Sendhilnathan *et al.* (2021) [20] in Celosia.

Jeevamrutha acts as an effective microbial inoculant that enhances microbial activity in rhizosphere, accelerates nutrient mineralization and improves nutrient availability, thereby promoting root growth and efficient nutrient uptake (Palekar, 2006) [17]. Enhanced nutrient absorption supports greater leaf production, increased leaf expansion and higher biomass accumulation, which ultimately contributes to larger leaf area and improved plant architecture. These

findings are agreement with those of Praveen *et al.* (2021)^[18] in floribunda Rose cv. Mirabel, Singh *et al.* (2015)^[21] and Choudhary *et al.* (2021)^[4] in Marigold and Paikra *et al.* (2022)^[16] in African marigold cv. Pusa Narangi Gaiinda. Further, PGPR organisms such as *Azospirillum brasilense*, *Pseudomonas fluorescens* and *Bacillus subtilis* may have enhanced plant growth through improved nutrient uptake, mineralization and mobilization, atmospheric nitrogen fixation, phosphorus solubilization, phytohormone production and root development (Vessey, 2003; Backer *et al.*, 2018)^[23, 2]. These effects may have stimulated cell division and elongation, leaf initiation and expansion, resulting in vigorous vegetative growth. Enhanced nutrient availability and root development could have improved photosynthetic capacity and assimilate production, thereby

promoting canopy development. Increased assimilate availability, together with phytohormonal activity and improved vascular development, may have contributed to thicker stems, longer internodes and increased lateral branching through enhanced axillary bud activation. These findings are in agreement with those of Rajiv *et al.* (2025)^[19] in Jasmine, Borah *et al.* (2022)^[3] in Gerbera and Moghadam and Shoor (2013)^[13] in Petunia. The combined application of Panchagavya, Jeevamrutha and PGPR therefore exerted a synergistic effect by improving nutrient availability, stimulating beneficial microbial activity and enhancing endogenous growth regulators, resulting in superior vegetative growth compared to individual applications and untreated control.

Table 1: Effect of foliar application of biostimulants on morphological parameters of Lisianthus hybrid Rosita 3 Clear Pink under protected cultivation

Treatments	Plant height (cm)	Plant spread (cm)		Number of leaves per plant	Leaf area (cm ² /plant)	Leaf area index	Number of branches per plant	Intermodal length (cm)	Stem girth (mm)
		E-W	N-S						
Panchagavya @ 4% (T ₁)	68.50	8.60	9.25	32.00	1305	13.05	1.90	5.41	6.50
Panchagavya @ 6% (T ₂)	71.55	8.85	9.55	34.00	1270	12.70	2.00	5.63	6.70
Jeevamrutha @ 10% (T ₃)	65.95	8.35	9.05	36.50	1225	12.25	1.90	5.40	6.25
Jeevamrutha @ 15% (T ₄)	67.15	8.40	8.80	35.50	1200	12.00	1.85	5.43	6.05
PGPR @ 2% (T ₅)	70.10	8.75	9.45	38.00	1340	13.40	2.10	5.75	6.65
PGPR @ 4% (T ₆)	73.30	8.90	9.60	41.00	1475	14.75	2.20	6.10	6.90
Panchagavya @ 4% + Jeevamrutha @ 10% (T ₇)	77.15	9.25	10.10	42.00	1600	16.00	2.35	6.37	7.25
Panchagavya @ 6% + Jeevamrutha @ 15% (T ₈)	81.50	9.50	10.35	45.00	1685	16.85	2.50	6.55	7.70
Panchagavya @ 4% + PGPR @ 2% (T ₉)	78.40	9.50	10.35	43.00	1860	18.60	2.45	6.59	7.45
Panchagavya @ 6% + PGPR @ 4% (T ₁₀)	83.10	9.85	10.75	44.50	1915	19.15	2.65	6.73	7.90
Jeevamrutha @ 10% + PGPR @ 2% (T ₁₁)	79.55	9.70	10.55	45.50	1805	18.05	2.65	6.80	7.60
Jeevamrutha @ 15% + PGPR @ 4% (T ₁₂)	84.80	10.15	11.10	46.00	2105	21.05	2.75	7.00	8.20
Panchagavya @ 4% + Jeevamrutha @ 10% + PGPR @ 2% (T ₁₃)	88.50	10.20	11.05	49.50	2310	23.10	3.15	7.55	8.60
Panchagavya @ 6% + Jeevamrutha @ 15% + PGPR @ 4% (T ₁₄)	92.75	10.85	11.50	52.50	2420	24.20	3.80	7.80	8.90
Untreated (Control) (T ₁₅)	61.05	7.50	8.25	30.00	1115	11.15	1.55	5.10	5.80
S.Em±	3.68	0.37	0.41	2.18	56.94	0.57	0.16	0.20	0.45
C.D at 5%	11.27	1.14	1.24	6.66	174.39	1.74	0.48	0.62	1.39

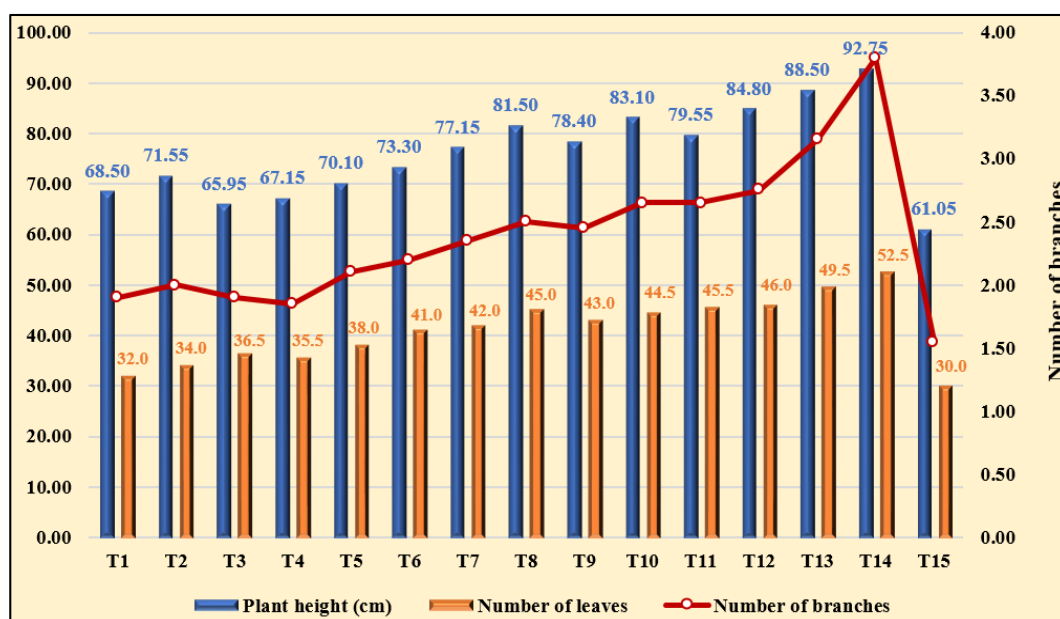


Fig 1: Effect of foliar application of biostimulants on morphological parameters at the peak growth stage of Lisianthus hybrid Rosita 3 Clear Pink

Flowering parameters

The results of the experiment are presented in Table 2. Among various treatments, Panchagavya @ 6% + Jeevamrutha @ 15% + PGPR @ 4% (T₁₄) recorded minimum days taken for flower bud initiation (66.85), flower opening (76.25 days), 50 percent flowering (80.35 days) and flower stalk harvesting (84.70 days), besides recording the longest duration of flowering (24.20 days).

The significantly fewer days taken for flower bud initiation, flower opening, 50 percent flowering and flower stalk harvesting, along with the longest flowering duration observed in T₁₄ (Panchagavya @ 6% + Jeevamrutha @ 15% + PGPR @ 4%), may be attributed to the enhanced physiological efficiency and balanced hormonal activity induced by the combined application of the bio-stimulants. Panchagavya supplies natural growth regulators, vitamins

and essential nutrients that promote early floral differentiation, while Jeevamrutha improves nutrient availability through enhanced microbial activity (Natarajan, 2002; Palekar, 2006) ^[15, 17]. PGPR facilitates the synthesis of phytohormones and improves nutrient acquisition, leading to efficient assimilate production and translocation towards developing floral buds (Vessey, 2003) ^[23]. The continuous availability of nutrients and photoassimilates favoured early reproductive development and sustained flower production, thereby extending the flowering duration. These findings conform with the reports of Harshavardhan *et al.* (2016) ^[10] in Carnation, Kumari *et al.* (2016) ^[12] in Chrysanthemum, Indhumathi *et al.* (2023) ^[11] in Gaillardia and Ghosh *et al.* (2024) ^[6] in Tuberose, who also reported earlier flowering and prolonged flowering duration following the application of organic biostimulants.



Fig 2: Different developmental stages of Lisianthus hybrid Rosita 3 Clear Pink flower (a) Bud initiation, (b) flower development and (c) Fully opened flower

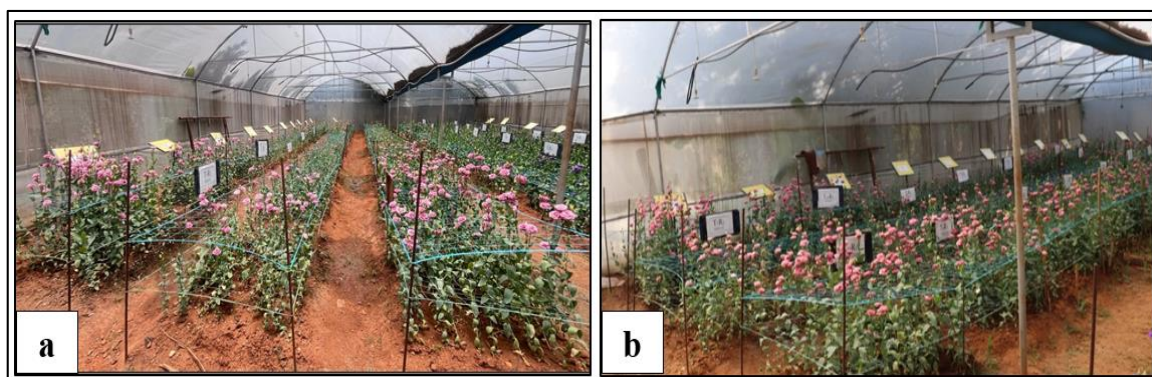


Fig 3: General view of the field at (a) 75DAT and (b) at peak flowering stages of Lisianthus hybrid Rosita 3 Clear Pink

Table 2: Effect of foliar application of biostimulants on flowering parameters of Lisianthus hybrid Rosita 3 Clear Pink under protected cultivation

Treatments	Days taken for flower bud initiation	Days taken for flower opening	Days taken for 50 percent flowering	Days taken for flower stalk harvesting	Duration of flowering (days)
Panchagavya @ 4% (T ₁)	73.75	84.25	89.10	94.30	19.00
Panchagavya @ 6% (T ₂)	73.60	82.85	88.10	92.90	18.80
Jeevamrutha @ 10% (T ₃)	74.50	85.35	89.50	94.80	18.50
Jeevamrutha @ 15% (T ₄)	73.20	84.75	88.90	94.00	18.10
PGPR @ 2% (T ₅)	72.20	83.85	88.00	93.10	19.90
PGPR @ 4% (T ₆)	71.45	83.20	87.35	92.85	19.70
Panchagavya @ 4% + Jeevamrutha @ 10% (T ₇)	72.00	82.60	86.95	92.10	20.50
Panchagavya @ 6% + Jeevamrutha @ 15% (T ₈)	71.20	82.00	86.65	91.80	20.80
Panchagavya @ 4% + PGPR @ 2% (T ₉)	70.45	81.50	85.70	91.10	21.40
Panchagavya @ 6% + PGPR @ 4% (T ₁₀)	70.00	81.00	85.10	90.85	22.10
Jeevamrutha @ 10% + PGPR @ 2% (T ₁₁)	69.50	80.45	84.60	90.20	21.80
Jeevamrutha @ 15% + PGPR @ 4% (T ₁₂)	69.00	79.25	83.65	89.00	22.90
Panchagavya @ 4% + Jeevamrutha @ 10% + PGPR @ 2% (T ₁₃)	68.00	78.30	82.75	88.20	23.10
Panchagavya @ 6% + Jeevamrutha @ 15% + PGPR @ 4% (T ₁₄)	66.85	76.25	80.35	84.70	24.20
Untreated Control (T ₁₅)	74.90	85.10	89.80	96.00	17.30
S.Em±	0.77	1.33	1.31	1.43	0.34
C.D at 5%	2.37	4.07	4.00	4.37	1.05

Conclusion

From the present investigation, it can be said that combined foliar application of Panchagavya @ 6%, Jeevamrutha @ 15% and PGPR @ 4% significantly gave the best results in terms of morphological parameters and promoted early and prolonged flowering in Lisianthus hybrid Rosita 3 Clear Pink under protected cultivation, indicating synergistic effect of biostimulants in improving plant vigour and overall growth. Therefore, biostimulant combination may be suggested for commercial production of Lisianthus.

References

- Anonymous. TNAU-Organic farming practices: Panchagavya and Jeevamrutha. 2014. Available from: https://agritech.tnau.ac.in/org_farm/orgfarm_farming_practices_treatment_preparation.html
- Backer R, Rokem JS, Ilangumaran G, Lamont J, Praslickova D, Ricci E, *et al.* Plant growth-promoting rhizobacteria: context, mechanisms of action, and roadmap to commercialization of biostimulants for sustainable agriculture. *Front Plant Sci.* 2018;9:1473.
- Borah N, Mahanta P, Choudhury M, Talukdar D, Borah N, Barooah M. Influence of biofertilizers in combination with organic and inorganic nutrients on growth characteristics of a Gerbera (*Gerbera jamesonii* Bolus) plant. *Pharma Innov J.* 2022;11(3):1406-1410.
- Choudhary S, Kashyap B, Choudhary RC, Jat M. Effect of jeevamrit on growth and flowering of marigold. *Pharma Innov J.* 2021;10(8):1037-1040.
- Ganiger TB, Hemla-Naik B, Hemanthkumar P, Thippesha D, Kantharaj Y. Optimizing plant density and spacing for morphological traits, floral characteristics, yield and economic returns in Lisianthus (*Eustoma grandiflorum*). *Int J Adv Biochem Res.* 2025;9(9):946-950.
- Ghosh. Performance of tuberose (*Polianthes tuberosa* L.) cv. Prajwal in response to organic manure and biostimulants [PhD thesis]. Mohanpur, Nadia, West Bengal, India: Bidhan Chandra Krishi Viswavidyalaya; 2024. 227 p.
- Halevy AH, Kofranek AM. Evaluation of lisianthus as a new flower crop. *HortScience.* 1984;19:845-847.
- Harbaugh BK, Woltz SS. Eustoma quality is adversely affected by low pH of root medium. *HortScience.* 1991;26(10):1279-1280.
- Harbaugh BK. Lisianthus (*Eustoma grandiflorum*). In: Anderson NO, editor. Flower breeding and genetics. Springer; 2007. p. 645-663.
- Harshavardhan M, Kumar DP, Rajesh A, Yathindra MH, Shivanand H. Growth and development of carnation (*Dianthus caryophyllus* L.) as influenced by integrated nutrient management. *Bioscan.* 2016;11(4):2691-2694.
- Indhumathi M, Chandrashekar SY, Srinivasa V, Shivaprasad M, Girish R. Effect of integrated nutrient management on flowering, flower quality and flower yield of Gaillardia (*Gaillardia pulchella* Foug.) under hill zone of Karnataka. *Biological Forum-An International Journal.* 2023;15(1):119-123.
- Kumari A, Goyal RK, Choudhary M, Sindhu SS. Effects of some plant growth promoting rhizobacteria (PGPR) strains on growth and flowering of chrysanthemum. *J Crop Weed.* 2016;12(1):7-15.
- Moghadam MZ, Shoor M. Effects of vermi-compost and two bacterial bio-fertilizers on some quality parameters of Petunia. *Not Sci Biol.* 2013;5(2):226-231.
- Musembi NN, Hutchinson MJ, Waithaka K. The effects of 6-benzylaminopurine and gibberellic acid on postharvest physiology of Lisianthus (*Eustoma grandiflorum*) flowers: I. Novel synergism improves

- water balance and vase life. *Acta Hort.* 2015;1077:25-30.
15. Natarajan K. *Panchgavya: a manual*. Goa, India: Other India Press; 2002. 33 p.
 16. Paikra MK, Gupta P, Agrawal S, Patel A. Effect of integrated nutrient management practices on the growth, flower yield and economics of African marigold cv. Pusa Narangi Gaiinda. *Pharma Innov J.* 2022;11(9):1773-1777.
 17. Palekar S. *The philosophy of spiritual farming. Zero Budget of Natural Farming* Amrit Subash Palekar. Amravati, Maharashtra; 2006.
 18. Praveen TM, Patil SR, Patil BC, Seetharamu GK, Rudresh DL, Pavankumar P, *et al.* Influence of biostimulants on growth and yield of floribunda rose cv. Mirabel. *J Pharmacogn Phytochem.* 2021;10(1):2701-2705.
 19. Rajiv G, Kalaimani M, Jiji AJ, Shakila S, Gopu B. Biostimulant applications for sustainable flower production of Jasmine (*Jasminum auriculatum* L.). *Agric Res J.* 2025;62(1):122-125.
 20. Sendhilnathan R, Balaraman E, Rajkumar M, Sureshkumar R, Barathkumar TR. Influence of organic nutrients and bio regulators on certain growth and flower quality attributes of celosia (*Celosia cristata* L.). *Plant Arch.* 2021;21(1):2220-2223.
 21. Singh M, Dwivedi DH, Kumar M. Efficiency of organic and biodynamic manures on growth and flowering in marigold (*Tagetes patula* L.). *Prog Agric.* 2015;15(1):134-137.
 22. Traon D, Amat L, Zotz F, Du Jardin P. *A legal framework for plant biostimulants and agronomic fertiliser additives in the EU: report to the European Commission, DG Enterprise & Industry.* Brussels, Belgium: Arcadia International; 2014. 115 p.
 23. Vessey JK. Plant growth promoting rhizobacteria as biofertilizers. *Plant Soil.* 2003;255(2):571-586.
 24. Wezel A, Casagrande M, Celette F, Vian JF, Ferrer A, Peigne J. Agroecological practices for sustainable agriculture: a review. *Agron Sustain Dev.* 2014;34(1):1-20.
 25. Zhang X, Schmidt RE. Hormone-containing products impact on antioxidant status of tall fescue and creeping bent grass subjected to drought. *Crop Science.* 2000;40:1344-1349.