



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(9): 773-777
Received: 19-06-2026
Accepted: 23-07-2026

Monica E
PG Scholar, Department of
Floriculture and Landscaping,
College of Horticulture, Mudigere,
KSNUAHS, Shivamogga,
Karnataka, India

Chandrashekar SY
Professor and Head, Department
of Floriculture and Landscaping,
College of Horticulture, Hiriyur,
KSNUAHS, Shivamogga,
Karnataka, India

Naik BH
Director of Education and Senior
Professor (HAG), Department of
Horticulture, Iruvakkki,
KSNUAHS, Shivamogga,
Karnataka, India

Shivaprasad M
Professor, Department of
Agronomy, College of Horticulture,
Mudigere, KSNUAHS,
Shivamogga, Karnataka, India

Maheswarappa V
Associate Professor, Department of
Forestry and Environmental
Sciences, College of Agriculture,
Navule, KSNUAHS, Shivamogga,
Karnataka, India

Corresponding Author:

Monica E
PG Scholar, Department of
Floriculture and Landscaping,
College of Horticulture, Mudigere,
KSNUAHS, Shivamogga,
Karnataka, India

Studies on foliar application of bio-stimulants on growth and flowering of Petunia

Monica E, Chandrashekar SY, Naik BH, Shivaprasad M and Maheswarappa V

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i9k.6602>

Abstract

The present investigation entitled “Studies on Foliar Application of Bio-Stimulants on Growth and Flowering of Petunia” was conducted during 2025–26 at the Main Agricultural and Horticultural Research Station (MAHRS), College of Agricultural Sciences, Iruvakkki, under Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga the experiment was laid out in a Randomized Complete Block Design (RCBD) with nine treatments, viz., T₁ (Humic acid @ 0.4%), T₂ (Humic acid @ 0.8%), T₃ (GA₃ @ 150 ppm), T₄ (GA₃ @ 300 ppm), T₅ (Biovita @ 0.4%), T₆ (Biovita @ 0.8%), T₇ (Spic Cytozyme @ 0.4%), T₈ (Spic Cytozyme @ 0.8%) and T₉ (Untreated control) each replicated thrice. Among the treatments, GA₃ @ 300 ppm (T₄) recorded maximum plant height (29.37 cm), plant spread E-W (43.57 cm) and N-S (41.77 cm) directions, number of leaves per plant (143.20), number of branches per plant (21.33), leaf length (8.57 cm), leaf width (5.27 cm) and leaf area index (4.75) and minimum days taken for flower bud initiation (35.55), first flower opening (7.01) and 50 per cent flowering (49.63). Hence, foliar application of (GA₃ @ 300 ppm) at 30, 45 and 60 days after transplanting may be recommended as an effective bio-stimulant improving growth, flowering, flower quality, seed production and quality landscaping performance of Petunia.

Keywords: Petunia, bio-stimulants, flower, growth and plant

Introduction

Flowers are an inseparable part of human life and hold great importance from birth to death. Nowadays, with the increasing standard of living, social and religious ceremonies are considered incomplete without the use of flowers in various forms. Their beauty and fragrance have the power to make people feel happy, relaxed and cheerful. Apart from their aesthetic value, flowers also play an important economic role.

Petunia hybrida, commonly known as garden petunia, belongs to the family Solanaceae and is one of the most important ornamental bedding plants cultivated worldwide. It originated in South America, and the name *Petunia* is derived from ‘Petun’, the Brazilian name for tobacco (Sink, 1984) [22]. *Petunia* is considered one of the earliest cultivated bedding plants and has remained commercially important due to its attractive flowers, wide range of colours and prolonged flowering period (Griesbach, 2007) [9]. Modern petunias are mainly derived from species such as *Petunia axillaris* and *P. violacea*. The crop is widely used for landscape beautification as bedding plants, borders, potted plants, window boxes and hanging baskets.

Petunia is an annual herbaceous plant with attractive, colourful flowers available in shades of pink, red, white, purple and yellow, including several bi-coloured forms. It is commercially propagated through seeds and is widely cultivated as a seasonal ornamental crop. However, its growth and flowering are affected by drought, high temperature, frost and excessive rainfall during the flowering period (Jundan *et al.*, 2004; Ando *et al.*, 2001) [2, 11]. Hence, suitable crop management practices are essential for obtaining vigorous growth, profuse flowering and better seed production.

Excessive dependence on chemical fertilizers may adversely affect soil properties and increase production costs. Therefore, sustainable nutrient management through the use of bio-stimulants has gained importance in modern floriculture. Bio-stimulants are substances or microorganisms

that stimulate natural plant processes, improve nutrient use efficiency, enhance tolerance to abiotic stresses and contribute to better crop quality (Traon *et al.*, 2014; Drobek *et al.*, 2019) [8, 25]. Humic substances, seaweed extracts and other bio-stimulants have been reported to improve plant growth, nutrient uptake, flowering and quality in flower crops (Suguna, 2005; Bulgari *et al.*, 2015) [5, 24].

Thus, the use of bio-stimulants offers considerable potential for improving growth, flowering, seed yield and seed quality of *Petunia* while promoting sustainable floricultural production.

Material and Methods

The present investigation was conducted during 2025–26 at the Main Agricultural and Horticultural Research Station (MAHRS), College of Agricultural Sciences, Iruvakk, under Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga. The experimental site is situated in the Western Ghats and represents the Hill Zone (Zone-9) of Karnataka, at 14°25' N latitude and 75°11'59.23" E longitude, with an altitude of 650 m above mean sea level. The experiment was conducted under open field conditions during the *Rabi* season using *Petunia* (*Petunia hybrida* Vilm.) cv. Supercascade Pink. The experiment was laid out in a Randomized Complete Block Design (RCBD) comprising nine treatments with three replications. The treatments consisted of T₁ (Humic acid @ 0.4%), T₂ (Humic acid @ 0.8%), T₃ (GA₃ @ 150 ppm), T₄ (GA₃ @ 300 ppm), T₅ (Biovita @ 0.4%), T₆ (Biovita @ 0.8%), T₇ (Spic Cytozyme @ 0.4%), T₈ (Spic Cytozyme @ 0.8%) and T₉ (untreated control with water spray). The experiment was conducted in plots of 2.1 × 1.2 m with a spacing of 30 × 30 cm, accommodating 84 plants per treatment. A basal dose of vermicompost and cocopeat at the rate of 2:1 Kg per m² was mixed in the soil and levelling of bed was done using straight stick, after bed preparation, irrigation was given before transplanting.

Healthy seedlings were transplanted on flat beds, and the respective bio-stimulants were applied as foliar sprays at 30, 45 and 60 days after transplanting (DAT). The required concentrations of humic acid, Biovita and Spic Cytozyme were prepared at 0.4 and 0.8 per cent, while GA₃ solutions were prepared at 150 and 300 ppm by dissolving the required quantity of the respective bio-stimulant and making the final volume with water. The untreated control received water spray at the same intervals. Irrigation, weeding and other necessary intercultural and plant protection measures were carried out uniformly for all the treatments throughout the crop period.

The observations were recorded from randomly selected and tagged plants at appropriate growth and flowering stages for different parameters such as plant height, plant spread, internodal length, stem girth, number of leaves, leaf area, leaf area index and days taken for flower bud initiation, flower opening, 50 per cent flowering and days taken for peak flowering were statistically analysed to determine the significance of differences among the treatments.

Results and Discussion

Growth parameters

The data presented in Table 1 shows that growth parameters were significantly affected by the application of different bio-

stimulants. The treatment GA₃ @ 300 ppm (T₄) recorded the maximum plant height (29.37 cm), number of leaves (143.20), leaf area index (4.75), plant spread (43.57 cm and 41.77 cm in E-W and N-S directions, respectively), number of branches (21.33 plant⁻¹), leaf length (8.57 cm) and leaf width (5.27 cm), followed by GA₃ @ 150 ppm (T₃), which recorded plant height (21.83 cm), number of leaves (125.13 plant⁻¹), leaf area (3.20 cm²), plant spread of 35.06 cm (E-W) and 36.00 cm (N-S), number of branches (16.37 plant⁻¹), leaf length (7.70 cm) and leaf width (4.53 cm). In contrast, the untreated control (T₉) recorded the minimum plant height (15.60 cm), number of leaves (90.83), leaf area index (1.36), plant spread of 24.70 cm (E-W) and 25.43 cm (N-S), number of branches (10.23 plant⁻¹), leaf length (5.40 cm) and leaf width (3.85 cm).

The pronounced increase in plant height observed in response to (GA₃ @ 300 ppm) may be attributed to the growth-promoting action of gibberellic acid, which stimulates cell division and cell elongation. In addition, GA₃ enhances cell wall extensibility, promotes active meristematic growth and improves photosynthetic efficiency, resulting in increased assimilate production and efficient translocation of photosynthates to the growing tissues. These physiological and biochemical processes collectively contribute to vigorous vegetative growth and greater plant height. Similar findings were reported by and Sravya *et al.* (2024) [23] in *Petunia* and Vinutha *et al.* (2017) [26] in China aster. The maximum number of leaves recorded under GA₃ @ 300 ppm may be attributed to the stimulatory effect of gibberellic acid on shoot apical meristem activity, which accelerated the initiation and development of leaf primordia. In addition, GA₃ promoted the expansion of newly formed leaves and delayed leaf senescence. These responses resulted in continuous leaf production and a significantly higher number of leaves. These results are supported by Manasa *et al.* (2017) [14] in *Gladiolus*, Vyshnavi *et al.* (2023) [27] in *Chrysanthemum* and Sharma and Collis (2017) [19] in *Petunia*.

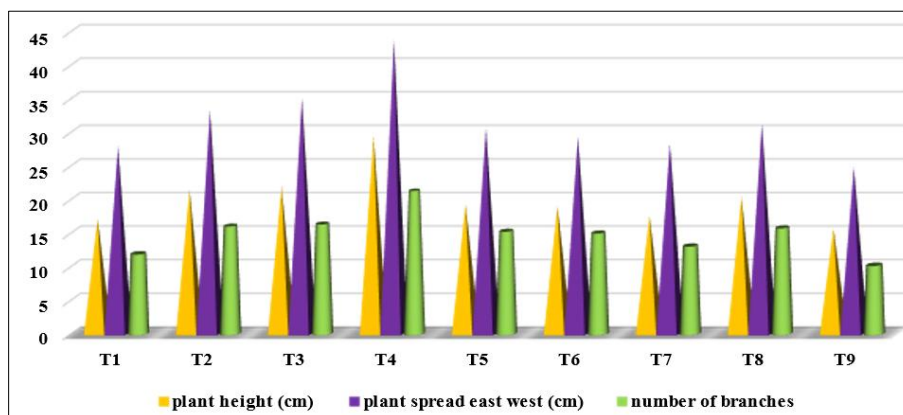
The superior branch production recorded under GA₃ @ 300 ppm may be attributed to the enhanced responsiveness of axillary buds to gibberellin signalling, promoted the growth of already established axillary buds into lateral shoots, thereby increasing the number of branches. Similar findings were reported by Ragini *et al.* (2019) [17] in Asiatic lily and Patra *et al.* (2015) [16].

The higher leaf area, leaf length and leaf width under GA₃ @ 300 ppm may be attributed to the prolonged expansion phase of developing leaves through delayed leaf maturation, allowing the lamina to attain a larger final size. In addition, gibberellin stimulates cell wall remodelling through the activation of expansion and xyloglucan-modifying proteins, facilitating greater lateral expansion of the leaf blade and resulting in increased leaf area. Similar findings were reported by Singh and Singh (2024) [21] in *Petunia*, Jayashree *et al.* (2020) [10] in Asiatic lily and Vyshnavi *et al.* (2023) [27] in Annual chrysanthemum.

The enhancement in leaf area index with (GA₃ @ 300 ppm) may be explained by the role of gibberellins in maintaining favorable hormonal balance during vegetative growth. This promoted continuous canopy establishment and reduced premature leaf abscission, resulting in greater cumulative leaf area per unit ground surface. These results are supported by Kumar *et al.* (2015) [13] in China aster and Ragini *et al.* (2019) [17] in Asiatic lily.

Table 1: Effect of foliar application of bio-stimulants on growth parameters of Petunia under Hill zone of Karnataka

Treatments	Plant height (cm)	Number of leaves	Leaf area index	Plant spread (cm)		Number of branches per plant	Leaf length (cm)	Leaf width (cm)
				E-W	N-S			
Humic Acid @ 0.4%	17.03	102.40	1.75	27.73	29.13	11.93	6.03	3.87
Humic Acid @ 0.8%	21.37	119.63	2.96	33.20	33.93	16.07	7.50	4.52
GA ₃ @ 150 ppm	21.83	125.13	3.20	35.06	36.00	16.37	7.70	4.53
GA ₃ @ 300 ppm	29.37	143.20	4.75	43.57	41.77	21.33	8.57	5.27
Biovita @ 0.4%	19.20	118.23	2.41	30.53	31.27	15.30	6.80	4.08
Biovita @ 0.8%	18.93	108.63	2.10	29.23	30.03	15.03	6.63	3.98
Spic Cytozyme @ 0.4%	17.51	104.90	1.96	28.17	29.50	13.10	6.40	3.91
Spic Cytozyme @ 0.8%	20.27	116.40	2.49	31.17	33.27	15.80	7.07	4.14
Untreated control	15.60	90.83	1.36	24.70	25.43	10.23	5.40	3.85
S.Em±	1.05	5.81	0.17	1.68	1.22	0.68	0.22	0.20
C.D at 5%	3.16	17.43	0.53	5.05	3.65	2.03	0.66	0.61

**Fig 1:** Effect of foliar application of bio-stimulants on plant height, plant spread(east-west) and number of branches at the peak growth stage of Petunia

Flowering parameters

The data presented in Table 2 shows that flowering parameters were significantly affected by the application of different bio-stimulants. The treatment receiving GA₃ @ 300 ppm (T₄) recorded the minimum days taken for flower bud initiation (35.55), days taken for flower opening (7.01), days taken for 50 per cent flowering (49.63) and days taken for peak flowering (54.33), followed by GA₃ @ 150 ppm (T₃), which recorded (37.18) days for flower bud initiation, (7.76) days for flower opening, (52.76) days for 50 per cent flowering and (57.75) days for peak flowering. In contrast, the untreated control (T₉) recorded the maximum days taken for flower bud initiation (46.38), flower opening (9.18), 50 per cent flowering (59.85) and peak flowering (66.58).

The earliness in flowering under (GA₃ @ 300 ppm) may be

associated with increased activity of enzymes involved in carbohydrate metabolism. GA₃ enhances photosynthetic efficiency and respiratory activity and metabolic energy required for rapid floral bud differentiation. It also improves the availability and utilization of assimilates at the shoot apex, favouring early floral induction and bud development, resulting in an extended flowering duration and increased flower production compared to the untreated plants. Similar observations were reported by Sharma and Collins (2017) ^[19] in Petunia, Munikrishnappa and Chandrashekar (2014) ^[15] in China aster, Delvadia *et al.* (2009) ^[7] in Gaillardia, Salem *et al.* (2016) ^[18] in Gerbera, Shreshtha *et al.* in Calendula, Chaithra *et al.* (2020) ^[6] in Spider lily, Acharya *et al.* (2021) ^[1] in African marigold, Bordolui and Ray (2020) ^[4] in Marigold and Kaur *et al.* (2021) ^[12] and Bhargavi *et al.* (2018) ^[3] in Chrysanthemum.

Table 2: Effect of foliar application of bio-stimulants on flowering parameters of Petunia under Hill zone of Karnataka

Treatment No	Treatments	Days taken for flower bud initiation	Days taken for flower opening	Days taken for 50 per cent flowering	Days taken for peak flowering
T ₁	Humic Acid @ 0.4%	45.99	8.84	58.00	64.80
T ₂	Humic Acid @ 0.8%	39.88	7.80	53.11	57.68
T ₃	GA ₃ @ 150 ppm	37.18	7.76	52.76	57.75
T ₄	GA ₃ @ 300 ppm	35.55	7.01	49.63	54.33
T ₅	Biovita @ 0.4%	39.00	8.15	53.90	60.53
T ₆	Biovita @ 0.8%	43.44	8.31	56.71	61.45
T ₇	Spic Cytozyme @ 0.4%	44.45	8.37	58.90	63.66
T ₈	Spic Cytozyme @ 0.8%	40.36	8.03	55.09	59.03
T ₉	Untreated control	46.38	9.18	59.85	66.58
	S.Em±	0.88	0.24	0.99	1.02
	C.D at 5%	2.66	0.72	2.97	3.06

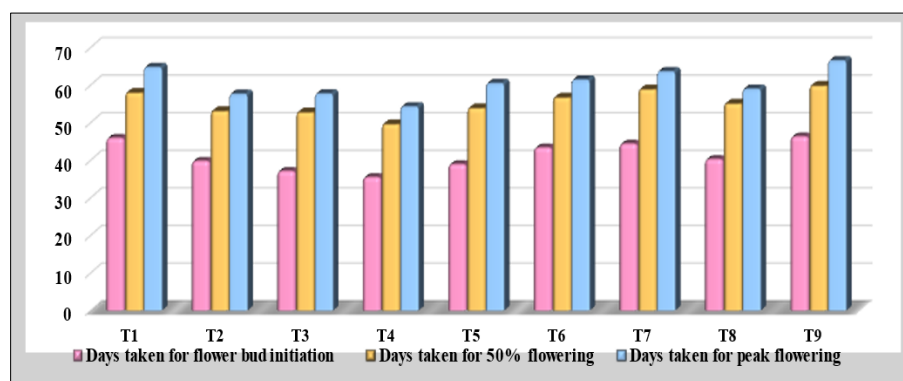


Fig 2: Effect of foliar application of bio-stimulants on days taken for flower bud initiation and days taken for peak flowering of Petunia



Fig 3: Different development stages of Petunia var. Supercascade Pink



Fig 4: General view of the field at a) vegetative and b) peak flowering stage of Petunia

Conclusion

From the present study, it can be concluded that foliar application of GA₃ @ 300 ppm (T₄) significantly enhanced the growth and flowering performance of Petunia. The application of GA₃ @ 300 ppm promoted better vegetative development with improved plant height, number of leaves, leaf area, plant spread, number of branches, leaf length and leaf width. In addition, it induced early flower bud initiation, flower opening, 50 per cent flowering and peak flowering compared to the untreated control. Thus, foliar application of GA₃ @ 300 ppm can be recommended as an effective growth regulator treatment for obtaining vigorous plants with early and uniform flowering, thereby improving the ornamental performance of Petunia.

References

- Acharya S, Ghimire B, Gaihre S, Aryal K, Chhetri LB. Effect of gibberellic acid on growth and flowering attributes of African marigold (*Tagetes erecta*) in inner Terai of Nepal. *J Agric Nat Resour.* 2021;4(2):134-147.
- Ando T, Nomura M, Tsukahara J, Watanabe H, Kokubun H, Tsukamoto T, *et al.* Reproductive isolation in a native population of *Petunia sensu* Jussieu (Solanaceae). *Ann Bot.* 2001;88(13):403-413.
- Bhargavi SP, Naik BH, Chandrashekar SY, Ganapathi M, Kantharaj Y. Efficacy of biostimulants on morphology, flowering and yield of chrysanthemum (*Dendranthema grandiflora*) cv. Kolar local under fan and pad greenhouse. *Int J Chem Stud.* 2018;6(5):1831-1833.
- Bordolui SK, Ray J. Effect of GA₃ on marigold seed production in Gangetic alluvial zone. *J Crop Weed.* 2020;16(1):120-126.
- Bulgari R, Cocetta G, Trivellini A, Vernieri P, Ferrante A. Biostimulants and crop responses: a review. *Biol Agric Hortic.* 2015;31(1):12-17.
- Chaithra PV, Naik H, Chandrashekar SY, Ganapathi M, Kantharaj Y. Standardization of plant growth regulators on growth and flowering of spider lily (*Hymenocallis speciosa* L.). *Int J Chem Stud.* 2020;8(5):1748-1751.
- Delvadia DV, Ahlawat TR, Meena BJ. Effect of different GA₃ concentration and frequency on growth, flowering and yield in gaillardia (*Gaillardia pulchella* Foug.) cv. Lorenziana. *J Hortic Sci.* 2009;4(1):81-84.
- Drobek M, Frac M, Cybulska J. Plant biostimulants: importance of the quality and yield of horticultural crops and the improvement of plant tolerance to abiotic stress—a review. *Agronomy.* 2019;9(6):335-339.
- Griesbach JR. Petunia. In: Anderson NO, editor. *Flower breeding and genetics*. Dordrecht: Springer; 2007. p.301-336.
- Jayashree N, Chandrashekar SY, Hemla Naik B, Hanumantharaya L, Ganapathi M. Influence of benzyl adenine and gibberellic acid on morphological behaviour of Asiatic lily. *Int J Chem Stud.* 2020;8(5):2028-2031.
- Jundan W, Yuanlei H, Xiao W, Pengzhi Y, Daidi C, Zhongping L. Dehydrin gene transformed petunia showed strong resistance to drought stress. *Mol Plant Breed.* 2004;2(3):369-374.
- Kaur H, Yadav KS, Kumari S. Effect of various plant growth regulators on vegetative and flowering parameters of chrysanthemum cv. Thai Chen Queen. *Int J Bot Res.* 2021;11:97-102.
- Kumar KP, Padmalatha T, Pratap M, Narendar RS. Effect of plant bio-regulators on growth, flowering and seed yield in

- China aster (*Callistephus chinensis* L. Nees) cv. Kamini. Indian J Agric Res. 2015;49(4):348-352.
14. Manasa MD, Chandrashekar SY, Hanumantharaya L, Ganapathi M, Hemanth Kumar P. Influence of growth regulators on vegetative parameters of gladiolus cv. Summer Sunshine. Int J Curr Microbiol Appl Sci. 2017;6(11):1299-1303.
 15. Munikrishnappa PM, Chandrashekar SY. Effect of growth regulators on growth and flowering of China aster (*Callistephus chinensis* L.). Agric Rev. 2014;35(1):57-63.
 16. Patra SK, Beura S, Shasani T. Efficacy of GA3 on growth and flowering regulation of *in vitro* raised hybrid gerbera under shade net. Agric Sci Dig. 2015;35(3):173-177.
 17. Ragini BK, Chandrashekar SY, Naik BH, Shivaprasad M, Ganapathi M. Effect of bio-regulators on vegetative parameters of Asiatic lily var. Pavia under protected condition. Int J Chem Biol Sci. 2019;1(1):11-14.
 18. Salem RAA, Saravanan S, Prasad VM. Effect of gibberellic acid spraying on yield and flowers of gerbera (*Gerbera jamesonii*) cv. Dennis. Int J Sci Res. 2016;5(3):376-377.
 19. Sharma L, Collis JP. Effect of plant growth regulators on growth and flower yield of petunia (*Petunia × hybrida*). J Plant Dev Sci. 2017;9:513-514.
 20. Shrestha B, Karki A, Shrestha J. Effect of foliar application of gibberellic acid (GA3) on quality attributes of calendula flowers (*Calendula officinalis*) cv. Gitana Fiesta in Chitwan, Nepal. J Agric Sci Pract. 2020;5(4):168-173.
 21. Singh D, Singh J. Effect of plant growth regulators on growth of petunia (*Petunia hybrida* L.) var. Grandiflora Rose. J Exp Agric Int. 2024;46(9):20-23.
 22. Sink KC. Introduction and taxonomy. In: Sink KC, editor. Petunia. Monographs on theoretical and applied genetics. Vol. 9. Berlin: Springer-Verlag; 1984. p.1-7.
 23. Sravya K, Dilda BS, Verma R, Bhatia S, Jnanesha AC, Kumar SR, *et al.* The impact of varying levels of gibberellic acid (GA3) on plant growth, flowering, flower quality, seed yield and quality of petunia (*Petunia × hybrida* Vilm.). Ecol Genet Genom. 2024;33:1-8.
 24. Suguna M. Effect of growth regulators and bio-stimulants on growth and yield of carnation (*Dianthus caryophyllus* L.) var. Mistral [MSc thesis]. Coimbatore: Tamil Nadu Agricultural University; 2005. p.5.
 25. Traon D, Du Jardin P, Van Der Straeten D, Rouphael Y. Plant biostimulants: definition, concept, main categories and regulation. Sci Hortic. 2014;19(6):3-14.
 26. Vinutha DB, Hemla Naik B, Chandrashekar SY, Thippeshappa GN, Kantharaj Y. Efficacy of bio-stimulants on growth, flowering and quality of China aster cv. Kamini. Int J Plant Soil Sci. 2017;20(2):1-5.
 27. Vyshnavi DJ, Chandrashekar SY, Hemla Naik B, Hanumantharaya L, Ganapathi M. Effectualness of biostimulants on annual chrysanthemum (*Chrysanthemum coronarium* L.) flowering, quality and yield. Biol Forum. 2023;15(10):250-254.