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Sannidhi Sampagavi
PG Scholar, Department of Floriculture and Landscaping, College of Horticulture, Mudigere, Keladi Shivappa Nayaka University of Agriculture and Horticultural Sciences, Shivamogga, Karnataka, India

Hemla Naik B
Director of Education and Senior Professor, Department of Horticulture, Keladi Shivappa Nayaka University of Agriculture and Horticultural Sciences, Iruvakki, Shivamogga, India

Chandrashekar SY
Professor and Head, Department of Floriculture and Landscaping, CASI, Keladi Shivappa Nayaka University of Agriculture and Horticultural Sciences, Iruvakki, Shivamogga, Karnataka, India

Lakshmana D
Professor and Head, Department of Genetics and Plant Breeding, College of Agriculture, V C Farm, Mandya, Karnataka, India

Ganapathi M
Associate Professor, Department of Crop Physiology, College of Agriculture, Shivamogga, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Corresponding Author:
Sannidhi Sampagavi
PG Scholar, Department of Floriculture and Landscaping, College of Horticulture, Mudigere, Keladi Shivappa Nayaka University of Agriculture and Horticultural Sciences, Shivamogga, Karnataka, India

Performance of elite genotypes of lisianthus (*Eustoma grandiflorum* Shinn.) under naturally ventilated polyhouse

Sannidhi Sampagavi, Hemla Naik B, Chandrashekar SY, Lakshmana D and Ganapathi M

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Abstract
An experiment entitled "Performance of elite genotypes of Lisianthus (*Eustoma grandiflorum* Shinn.) under naturally ventilated polyhouse" was conducted during 2024-25 at the Department of Horticulture, College of Agriculture, Shivamogga. The study evaluated 12 Lisianthus genotypes in a Randomized Complete Block Design (RCBD) with three replications. Seedlings at the fourth true leaf stage were transplanted at 15 × 10 cm spacing and data on morphological, flowering, flower quality and yield traits were recorded from five randomly tagged plants per plot. Significant variation was observed among genotypes for all parameters. Morphologically, Rosita 3 Clear Pink (G_3) exhibited the maximum plant height (99.68 cm), number of leaves per plant (35.78), leaf area (2669.78 cm²/plant), number of branches (3.56) and internodal length (12.53 cm). Flowering traits revealed that Rosita 3 Clear Pink (G_3) had the earliest flower bud initiation (63.89 days), flower opening (74.89 days) and stalk harvesting (80.89 days), along with the maximum flowering duration (18.67 days). In terms of flower quality, Rosita 3 Clear Pink (G_3) recorded the highest number of buds per plant (10.89) and stalk length (70.93 cm), while Rosita 3 Blue Picotee Ver 2 (G_8) exhibited maximum stalk girth (1.65 mm) and flower diameter (6.81 cm). Rosita 3 Bright Blue (G_2) displayed the longest vase life (11.00 days). Yield assessment indicated that Rosita 3 Clear Pink (G_3) produced the maximum number of spikes per plant (2.00) and per m² (132.00), whereas Rosita 3 Blue Picotee Ver 2 (G_8) had the lowest spike yield (1.00 spikes/plant and 66.00 spikes/m²). Based on overall performance, Rosita 3 Clear Pink, Rosita 3 Bright Blue and Rosita 3 Lavender Ver 3 were identified as superior genotypes. These genotypes are recommended for commercial cut flower production under naturally ventilated polyhouse conditions. The study underscores the critical role of genotype selection in enhancing growth, flowering, flower quality, and yield traits in Lisianthus, thereby supporting consistent high-quality production in naturally ventilated polyhouse condition.

Keywords: Lisianthus, genotypes, naturally ventilated polyhouse, vase life

Introduction
Lisianthus (*Eustoma grandiflorum* Shinn., syn. *Lisianthus russelianus* Hook., 2n = 36), a member of Gentianaceae is valued as a cut flower, pot plant and bedding ornamental for its rose-like blooms, long stems and excellent post-harvest life. Symbolizing charisma, appreciation and gratitude, it is commonly called Texas Blue Bell or Prairie Gentian, with the genus name derived from the Greek *eu* (beautiful, good, well) and *stoma* (mouth) (Halevy and Kofranek, 1984) [8]. The genus includes three species-*E. grandiflorum*, *E. exaltatum* and *E. barkleyi* are native to U.S. prairies and parts of Mexico, Honduras, Venezuela and the Bahamas (Shinners, 1957) [15].

Recently introduced to India, Lisianthus shows strong adaptability in the mid-Himalayan region, with cultivation practices standardized at ICAR-IARI, Katrain, Himachal Pradesh (Bhatia *et al*., 2020) [6]. For optimal growth, 8-12 weeks old seedlings with 4 to 5 pairs of true leaves are transplanted in September-October or from mid-March to June. High humidity for 10 days post-transplanting, 10 × 15 cm spacing and soil pH 6.3-6.7 are recommended (Wazir, 2014) [20]. Plants thrive at 15 to 25 °C, while excessive heat during early growth can cause rosetting (Harbaugh *et al*., 2000) [9].

This herbaceous annual grows 15 to 60 cm tall with bluish-green succulent leaves and large, funnel-shaped flowers in varied colors.

Cymose inflorescences open sequentially, sepals are small and basally fused, petals form a trumpet-shaped corolla often yellow near the throat, and stamens with slightly twisted anthers surround bilobed stigmas. Global expansion is driven by breeding for year-round flowering, novel colors and F_1 hybrids (Ohkawa and Sasaki, 1999) [12]. Given that flowering time, stem length and floret quality vary with genotype, season and location, comprehensive multi-location and seasonal trials are essential to identify superior cultivars with high yield potential and strong post-harvest attributes, ensuring consistent, high-quality production across diverse agro-climatic regions.

Material and methods

The present study was carried out during 2024-25 in a naturally ventilated polyhouse (NVPH) at the Department of Horticulture, College of Agriculture, Shivamogga, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga. The experimental site lies in the Malnad region of Karnataka's Southern Transitional Zone (Zone-7) at 13°55′ N latitude, 75°34′ E longitude and an elevation of about 650 m above mean sea level.

12 Lisianthus genotypes were used in the investigation *viz.*, G_1-Rosita 3 Lavender Ver 3, G_2-Rosita 3 Bright Blue, G_3-Rosita 3 Clear Pink, G_4-Aube 4 Pure White Ver 2, G_5-Rosita 3 Jade, G_6-Rosita 3 Green, G_7-Rosita 3 Pink Picotee, G_8-Rosita 3 Blue Picotee Ver 2, G_9-Rosita 3 Pure White Ver 3, G_{10}-Rosita 3 Pure White Ver 4, G_{11}-Rosita 3 Type Blue 193 and G_{12}-Robella 3 Type Pink. They were sourced from Sakata Seeds India Pvt. Ltd., Bengaluru and Golden Tulip Floritech Pvt. Ltd., Hosur, Tamil Nadu.

The trial followed a Randomized Complete Block Design (RCBD) with three replications. 90 days old seedlings at the fourth true leaf stage were transplanted onto raised beds of 1 m width and convenient length at a spacing of 15 × 10 cm. Irrigation was provided as required, fertilizers were applied at recommended rates and plant-protection measures were undertaken whenever necessary. Data on morphological, flowering, flower quality and yield traits were recorded from five randomly tagged plants in each plot.

Experimental results

Morphological parameters

Significant variations were observed among the Lisianthus genotypes for all morphological traits (Table 1). Plant height was recorded highest in Rosita 3 Clear Pink (99.68 cm), followed by Rosita 3 Bright Blue (91.17 cm) and the lowest in Rosita 3 Blue Picotee Ver 2 (48.16 cm). The number of leaves per plant was recorded maximum in Rosita 3 Clear Pink (35.78), comparable to Rosita 3 Bright Blue (34.00), while minimum in Rosita 3 Blue Picotee Ver 2 (28.44). Leaf area was maximum in Rosita 3 Clear Pink (2669.78 cm²/plant), followed by Rosita 3 Bright Blue (2152.14 cm²/plant), while the minimum in Rosita 3 Blue Picotee Ver 2 (1001.02 cm²/plant). The number of branches per plant was highest in Rosita 3 Clear Pink (3.56), followed by Rosita 3 Bright Blue (3.33) and lowest in Rosita 3 Blue Picotee Ver 2 (1.22). Internodal length ranged from 12.53 cm in Rosita 3 Clear Pink to 4.22 cm in Rosita 3 Green.

Table 1: Morphological traits of different Lisianthus genotypes under NVPH

Genotype No.	Genotypes	Plant height (cm)	Number of leaves per plant	Leaf area (cm²/ plant)	Internodal length (cm)	Number of branches per plant
G_1	Rosita 3 Lavender Ver 3	83.39	33.78	1836.29	11.02	3.22
G_2	Rosita 3 Bright Blue	91.17	34.00	2152.14	10.51	3.33
G_3	Rosita 3 Clear Pink	99.68	35.78	2669.78	12.53	3.56
G_4	Aube 4 Pure White Ver 2	81.21	32.44	1768.06	6.72	2.67
G_5	Rosita 3 Jade	76.23	32.22	1584.06	5.78	2.33
G_6	Rosita 3 Green	75.29	32.00	1573.47	4.22	1.78
G_7	Rosita 3 Pink Picotee	81.77	32.89	1787.29	10.37	3.00
G_8	Rosita 3 Blue Picotee Ver 2	48.16	28.44	1001.02	5.73	1.22
G_9	Rosita 3 Pure White Ver 3	59.21	30.44	1239.6	4.58	1.24
G_{10}	Rosita 3 Pure White Ver 4	59.6	31.56	1358.51	5.63	1.33
G_{11}	Rosita 3 Type Blue 193	75.19	32.00	1564.98	5.64	1.33
G_{12}	Robella 3 Type Pink	78.03	32.44	1644.82	6.54	2.56
S. Em ±		2.78	0.41	66.26	0.38	**0.08**
CD @ 5%		8.16	1.23	194.32	1.13	**0.22**

Flowering parameters

The Lisianthus genotypes exhibited significant variation in flowering characteristics (Table 2). Rosita 3 Clear Pink recorded minimum number of days for bud initiation (63.89), flower opening (74.89) and stalk harvesting (80.89), while Rosita 3 Blue Picotee Ver 2 exhibited the maximum number of days for all these parameters (95.11, 106.11 and 112.11 days, respectively). The flowering duration was maximum in the genotype Rosita 3 Clear Pink (18.67 days), comparable to Rosita 3 Bright Blue (17.89 days) and Rosita 3 Lavender Ver 3 (17.67 days), while minimum in the genotype Rosita 3 Blue Picotee Ver 2 (16.56 days).

Table 2: Performance of Lisianthus genotypes with respect flowering parameters

Genotype No.	Genotypes	Days taken for			Duration of flowering (days)
		Flower bud initiation	Flower opening	Flower stalk harvesting	
G1	Rosita 3 Lavender Ver 3	70.33	81.33	87.33	17.67
G2	Rosita 3 Bright Blue	67.89	78.89	84.89	17.89
G3	Rosita 3 Clear Pink	63.89	74.89	80.89	18.67
G4	Aube 4 Pure White Ver 2	74.33	85.33	91.33	17.00
G5	Rosita 3 Jade	78.33	89.33	95.33	17.00
G6	Rosita 3 Green	87.44	98.44	104.44	17.00
G7	Rosita 3 Pink Picotee	73.78	84.78	90.78	17.33
G8	Rosita 3 Blue Picotee Ver 2	95.11	106.11	112.11	16.56
G9	Rosita 3 Pure White Ver 3	89.00	100.00	106.00	16.78
G10	Rosita 3 Pure White Ver 4	88.00	99.00	105.00	16.89
G11	Rosita 3 Type Blue 193	87.78	98.78	104.78	16.89
G12	Robella 3 Type Pink	75.00	86.00	92.00	17.00
S. Em ±		1.72	1.40	0.39	0.21
CD @ 5%		5.13	4.21	1.16	0.65

Flower quality parameters

Considerable variation was evident among Lisianthus genotypes with respect to flower quality traits (Table 3). Rosita 3 Clear Pink recorded the highest number of buds per plant (10.89), maximum stalk length (70.93 cm) and flower length (5.72 cm). Rosita 3 Blue Picotee Ver 2 exhibited the lowest number of buds per plant (4.22) and minimum stalk length (41.74 cm) but the maximum stalk girth (1.65 mm) and flower diameter (6.81 cm). Maximum petals per flower were observed in Aube 4 Pure White Ver 2 (28.33), whereas Rosita 3 Lavender Ver 3 (15.00) had the minimum. Vase life was maximum in Rosita 3 Bright Blue (11.00 days) and minimum in Rosita 3 Pure White Ver 3 (8.00 days).

Yield parameters

Significant variation was observed among the Lisianthus genotypes with respect to spike production (Table 4). Rosita 3 Clear Pink recorded the highest number of spikes per plant (2.00), followed by Rosita 3 Bright Blue (1.78), whereas the lowest was observed in Rosita 3 Blue Picotee Ver 2 (1.00). Similarly, the number of spikes per square meter varied significantly, with Rosita 3 Clear Pink (132.00) producing the maximum, followed by Rosita 3 Bright Blue (110.22) and Rosita 3 Lavender Ver 3 (110.20), while the minimum was recorded in Rosita 3 Blue Picotee Ver 2 (66.00).

Table 3: Flower quality parameters of Lisianthus genotypes under NVPH

Genotype No.	Genotypes	Number of buds per plant	Stalk length (cm)	Stalk girth (mm)	Flower length (cm)	Flower diameter (cm)	No. of petals per flower	Vase life (days)
G1	Rosita 3 Lavender Ver 3	10.00	64.66	1.02	5.01	6.57	15.00	10.00
G2	Rosita 3 Bright Blue	10.78	65.04	1.10	5.36	6.59	25.00	11.00
G3	Rosita 3 Clear Pink	10.89	70.93	1.11	5.72	6.60	27.22	10.33
G4	Aube 4 Pure White Ver 2	7.22	61.29	0.96	5.84	5.99	28.33	8.78
G5	Rosita 3 Jade	5.78	60.67	0.68	4.64	5.88	18.33	9.00
G6	Rosita 3 Green	5.33	56.93	0.55	4.57	5.84	18.33	9.00
G7	Rosita 3 Pink Picotee	9.89	61.37	1.13	5.70	6.74	21.67	10.00
G8	Rosita 3 Blue Picotee Ver 2	4.22	41.74	1.65	5.78	6.81	21.67	10.67
G9	Rosita 3 Pure White Ver 3	4.56	51.73	0.38	4.77	5.27	16.67	8.00
G10	Rosita 3 Pure White Ver 4	4.67	55.51	0.44	4.73	5.77	21.67	8.20
G11	Rosita 3 Type Blue 193	5.11	55.62	0.54	4.53	5.81	28.33	8.53
G12	Robella 3 Type Pink	6.44	61.03	0.81	3.89	5.94	17.22	9.67
S. Em ±		0.02	1.90	0.03	0.01	0.02	0.34	0.17
CD @ 5%		0.07	5.56	0.08	0.04	0.05	1.01	0.50

Table 4: Performance of Lisianthus genotypes with respect to yield parameters

Genotype No.	Genotypes	Number of spikes per plant	Number of spikes per m^2
G1	Rosita 3 Lavender Ver 3	1.67	110.20
G2	Rosita 3 Bright Blue	1.78	110.22
G3	Rosita 3 Clear Pink	2.00	132.00
G4	Aube 4 Pure White Ver 2	1.56	102.74
G5	Rosita 3 Jade	1.44	95.26
G6	Rosita 3 Green	1.44	95.26
G7	Rosita 3 Pink Picotee	1.56	102.74
G8	Rosita 3 Blue Picotee Ver 2	1.00	66.00
G9	Rosita 3 Pure White Ver 3	1.11	73.26
G10	Rosita 3 Pure White Ver 4	1.33	87.78
G11	Rosita 3 Type Blue 193	1.33	88.00
G12	Robella 3 Type Pink	1.44	95.26
S. Em ±		0.05	2.91
CD @ 5%		0.14	8.53

Discussion

Plant height, a key morphological trait influencing growth, varied significantly among Lisianthus genotypes. Rosita 3 Clear Pink exhibited the maximum plant height (99.68 cm), whereas Rosita 3 Blue Picotee Ver 2 recorded the minimum (48.16 cm), likely due to genetic factors. Plant height was positively correlated with stalk length, which influences market value (Fig.1). Leaf trait is crucial for photosynthesis and flower yield, also differed among genotypes. Rosita 3 Clear Pink produced the maximum number of leaves (35.78) and leaf area (2669.78 cm²/plant), while Rosita 3 Blue Picotee Ver 2 had the minimum (28.44 leaves; 1001.02 cm²/plant). Branch number and internodal length followed similar trends, contributing to overall plant growth and yield. These variations are likely genetically controlled. Similar findings have been reported in Lisianthus (Uddin *et al*., 2013, Ahmad *et al*., 2017 and Namratha *et al*., 2021) [18, 1, 11], Chrysanthemum (Roopa *et al*., 2018a and Beeralingappa *et al*., 2016a) [14, 4], Alstroemeria (Dhiman *et al*., 2015 and Anand *et al*., 2024) [7, 2] and Carnation (Tarannum and Hemla Naik, 2014) [17].

Rosita 3 Clear Pink exhibited the earliest flower bud initiation (63.89 days), flower opening (74.89 days) and stalk harvesting (80.89 days), as well as the longest flowering duration (18.67 days), while Rosita 3 Blue Picotee Ver 2 recorded the maximum values (95.11, 106.11 and 112.11 days, respectively). These differences are likely due to genetic factors. Similar trends have been reported in Lisianthus (Anitha *et al*., 2013a and Ahmad *et al*., 2017) [3, 1], Chrysanthemum (Suvija *et al*., 2016 and Roopa *et al*., 2018a) [16, 14] and Carnation (Verma *et al*., 2012) [19].

Flower quality traits are critical for evaluating Lisianthus genotypes for commercial cut flower production. Rosita 3 Clear Pink recorded the maximum number of buds (10.89) and stalk length (70.93 cm), while Rosita 3 Blue Picotee Ver 2 had the minimum number of buds (4.22) and stalk length (41.74 cm) but the maximum stalk girth (1.65 mm) and flower diameter (6.81 cm). Aube 4 Pure White Ver 2 exhibited the longest flowers (5.84 cm) and maximum petals (28.33), whereas Robella 3 Type Pink and Rosita 3 Lavender Ver 3 recorded the minimum flower length (3.89 cm) and number of petals (15.00), respectively. Vase life was longest in Rosita 3 Bright Blue (11.00 days) and shortest in Rosita 3 Pure White Ver 3 (8.00 days). These variations are likely governed by genetic factors, with traits such as stalk length and flower size directly influencing commercial value. Similar findings have been reported in Lisianthus (Anitha *et al*., 2013a, Ahmad *et al*., 2017, Bhargav *et al*., 2020 and Uddin *et al*., 2013) [3, 18, 5, 1], Alstroemeria (Rai and Rana, 2019 and Anand *et al*., 2024) [13, 2], Chrysanthemum (Roopa *et al*., 2018a) [14] and Carnation (Medeo *et al*., 2019 and Verma *et al*., 2012) [10, 19].

Flower spike yield is a key determinant of commercial cut flower performance. In this study, Rosita 3 Clear Pink produced the highest spikes per plant and per square meter (2.00 and 132.00), followed by Rosita 3 Bright Blue (1.78 and 110.22), while Rosita 3 Blue Picotee Ver 2 recorded the lowest (1.00 and 66.00). Higher spike yield is likely due to increased leaf number, enhancing photosynthetic capacity and assimilate accumulation. Similar trends have been reported in Lisianthus (Wazir, 2014, Ahmad *et al*., 2017 and Bhargav *et al*., 2020) [20, 1, 5] and Carnation (Medeo *et al*., 2019) [10].

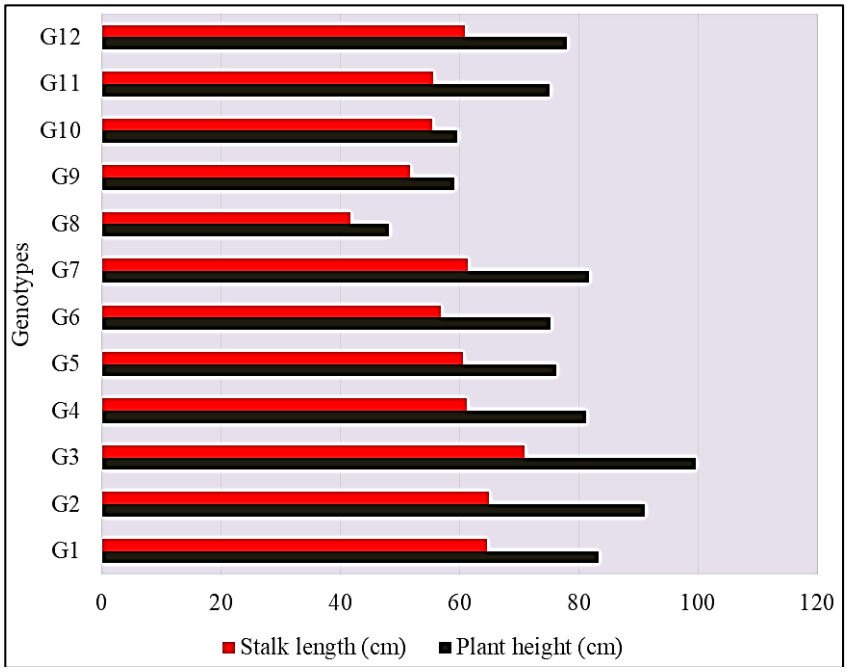

Fig 1: Variation in stalk length and plant height among twelve genotypes of lisianthus

Conclusion

The study demonstrated significant variation among Lisianthus genotypes with respect to growth, flowering, flower quality and yield traits predominantly influenced by genetic factors. Among the genotypes evaluated, Rosita 3 Clear Pink consistently exhibited superior performance across most of the parameters evaluated indicating its high potential for commercial cut flower production. Key traits such as stalk length, flower size, and spike yield were closely associated with market value. In contrast, Rosita 3 Blue Picotee Ver 2 showed comparatively lower performance across most parameters but displayed notable advantages in stalk girth and flower diameter. These results underscore the critical role of genotype selection in

optimizing both quality and yield in Lisianthus cultivation under NVPH conditions.

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