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Performance of Lisianthus (*Eustoma grandiflorum*) varieties for growth, yield and quality parameters under naturally ventilated polyhouse

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Abstract

The current study, titled “Evaluation of Lisianthus (*Eustoma grandiflorum*) for growth, yield and quality parameters under naturally ventilated polyhouse”, was carried out at Horticulture Research and Extension Centre, Kanabargi, Belagavi, during 2024. The experiment was conducted in a Randomized Complete Block Design with nine varieties replicated three times to assess growth, yield and quality parameters under naturally ventilated polyhouse. The variety Rosita 3 Clear Pink exhibited superior vegetative performance with maximum plant height, number of leaves, stem girth, plant spread (E-W and N-S), leaf length, width, area and area index and number of branches. Rosita 3 Clear Pink recorded minimum number of days to flower bud initiation and days taken for bud to flower opening. Aube 4 Pure White attained the peak flower diameter. In terms of yield Rosita 3 Clear Pink exhibited the maximum spike count per plant, gross and net returns and the highest B:C ratio, followed by Rosita 3 Pink Picotee.

Keywords: Lisianthus, *Eustoma grandiflorum*, evaluation, yield, quality

Introduction

Lisianthus, botanically referred as *Eustoma grandiflorum* (Raf.) Shinn., (2n=36) has swiftly gained prominence in the global flower market and occupied a significant place among the top ten cut flowers in a short period of time. Eustoma is named after the two Greek words Eu (beautiful, good, well) and stoma (mouth) thanks to its enchanting rose- like blossoms and diverse spectrum of hues. Beyond its role as a cut flower, Lisianthus find extensive application as both a flowering potted plant and staple in landscaping schemes. In addition to blue, a wide range of flower colours as well as floral patterns are available in this crop. Belongs to the Gentianaceae family, this flower originated from southern regions of United States, where it also recognized as “Texas Blue Bell” and “Prairie Gentian”. Lisianthus represents a recent addition to the cultivated ornamental plant palette, yet its rapid rise underscores its exceptional beauty and versatility (Harbaugh, 2007) ^[4]. Lisianthus (*Eustoma grandiflorum*) is an herbaceous annual species that typically grows between 15 and 60 cm in height, featuring bluish-green, slightly succulent leaves (Harbaugh, 2007) ^[4]. The plant bears large, funnel-shaped flowers on long, straight stems either as single erect stems or as branching stems that may extend up to approximately 180 cm in height. The flowers, measuring up to 5 cm (two inches) in diameter, occur in a wide range of colours. Lisianthus produces long-stemmed inflorescences arranged in cymes, often with only a few flowers open simultaneously. The sepals are fused only at the base and are markedly smaller than the petals. Given that the performance of cultivars can vary according to region, season, and genotype, it is essential to evaluate the available varieties for their suitability and adaptability with respect to flowering behaviour, flower quality, and yield-related parameters.

Materials and Methods

Climatic condition

The experiment is carried out in naturally ventilated polyhouse at experiment block of the

Horticulture Research and Extension Centre, Kanabargi, Belagavi which is situated in foothills of the Sahyadri mountain range (Western Ghats) of Karnataka and lies at 15° 52' North latitude and 74° 30' East longitude with an altitude of 762m above Mean Sea Level (MSL).

Design and layout of experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) which had nine treatments with three replication each with the spacing 20 x 20 cm. Nine Lisianthus varieties were procured from Golden Tulip Flori-tech pvt. Ltd viz. Sanadanapally village, Krishnagiri Dist. Tamilnadu. T₁ - Aube - 4 - Pure White, T₂ - Rosita - 3 - Green, T₃ - Rosita - 3 - Lavender, T₄ - Rosita - 3 - Bright Blue, T₅ - Rosita - 3 - Clear pink, T₆ - Rosita - 3 - Pink Picotee, T₇ - Rosita - 3 - Pure White, T₈ - Rosita - 4 - Blue Picotee, T₉ - Rosita - 3 - Pink Imp.

Transplanting

About ninety-day old seedlings at the four-leaf stage were transplanted onto raised beds measuring 0.90 m in width and of convenient length. Irrigation was provided as required and fertilizers were applied according to the recommended dosage. Plant protection measures were implemented as needed. Data on various growth, flowering, and flower quality parameters were recorded from five randomly selected and labelled plants in each plot.

Statistical analysis

The experimental data were subjected to analysis of variance (ANOVA) using a Randomized complete block design. When significant differences among treatment means were detected at $p \leq 0.05$, mean separation was carried out using Duncan's Multiple Range Test (DMRT) as described by Duncan (1955)^[3]. Statistical analyses were performed using OP-STAT. Treatment means sharing the same letter were not significantly different at the 5% level of probability.

Results and Discussion

Vegetative parameters

Plant height (cm)

The highest plant height was observed in Rosita 3 Clear Pink (88.33 cm) which was on par with the varieties Aube 4 Pure White (79.60 cm) and Rosita 3 Green (77.2 cm). While the minimum was recorded in the variety Rosita 3 Blue Picotee (48.33 cm). This research explored the possibility that a genetic

component may be the cause of the differences in plant height across the Lisianthus varieties as earlier reported in Lisianthus by Bhargav *et al.* (2020)^[2], Uddin *et al.* (2013)^[10] and Ahmad *et al.* (2017)^[11].

Number of leaves

The maximum number of leaves noticed in Rosita 3 Pink Picotee (61.47) which is on par with Rosita 3 Pink Picotee (61.13), Rosita 3 Green (56.93) and Rosita 3 Pink Imp (56.93) and minimum in Rosita 3 Blue Picotee (38.40). Leaves play a vital role in photosynthesis, transpiration, and defence, collectively contributing to overall plant health and the production of high-quality blooms. Variation in leaf number among varieties is primarily attributed to genetic differences, with higher leaf production reflecting inherent varietal characteristics. In Lisianthus, stems are harvested in accordance with both production requirements and plant physiological functions, similar findings by Sandesh (2019)^[7] in lilies.

Leaf area (cm²)

The leaf area was noticed maximum in Rosita 3 clear pink (63.13 cm²) which is on par with Rosita 3 lavender (55.00 cm²), Rosita 3 Blue Picotee (54.45 cm²), Rosita 3 Pink Picotee (50.26 cm²) and Aube 4 pure White (48.22 cm²) and minimum in Rosita 3 pure white (31.67 cm²). The variation can be attributed to differences in growth rate and genetic factors. Varieties possessing robust root systems and elevated chlorophyll content demonstrate superior water and nutrient uptake efficiency, thereby optimizing photosynthetic performance and promoting the growth of larger, more vigorous leaves as earlier noticed by Shwetha *et al.* (2014)^[8] in Gerbera, Jose *et al.* (2017)^[5] in Carnation.

Number of branches

The number of branches per plant varied significantly among different varieties of Lisianthus. The maximum number of branches per plant was observed in the variety Rosita 3 Clear Pink (7.40) followed by Rosita 3 Pink Picotee (6.20) and Rosita 3 Bright Blue (4.90). Whereas, the minimum branches per plant was recorded in the variety Rosita 3 Pink imp (2.60). The varieties genetic behaviour might be the source of variation in this trait. When there are more branches, more leaves are produced, which increases the number of blooms produced. The findings support those of Ahmad *et al.* (2017)^[11].

Table 1: Vegetative parameters of different varieties of Lisianthus

Varieties	Plant height (cm)	Number of leaves (cm)	Leaf area (cm)	Number of branches
V ₁ - Aube 4 Pure White	79.6 ^{ab}	54.67 ^{ab}	48.22 ^{abc}	3.83 ^{cd}
V ₂ - Rosita 3 Green	77.2 ^{ab}	56.93 ^{ab}	41.87 ^{bc}	2.87 ^d
V ₃ - Rosita 3 Lavender	73.93 ^b	47.87 ^{ab}	55 ^{ab}	2.8 ^d
V ₄ - Rosita 3 Bright Blue	72.33 ^b	53.73 ^{ab}	42.43 ^{bc}	4.9 ^{bc}
V ₅ - Rosita 3 Clear Pink	88.33 ^a	61.47 ^a	63.13 ^a	7.4 ^a
V ₆ - Rosita 3 Pink Picotee	74.27 ^b	61.13 ^a	50.26 ^{ab}	6.2 ^{ab}
V ₇ - Rosita 3 Pure White	57.87 ^{cd}	46.8 ^{ab}	31.67 ^c	2.97 ^d
V ₈ - Rosita 3 Blue Picotee	48.33 ^d	38.4 ^b	54.45 ^{ab}	2.83 ^d
V ₉ - Rosita 3 Pink Imp	68.47 ^{bc}	56.93 ^{ab}	45.49 ^{abc}	2.6 ^d
Mean	71.15	53.10	48.06	2.6
S. Em ±	3.82	5.98	5.41	0.30
CD (P = 0.05)	11.45	17.92	16.21	0.89

Note: Means with the same letter are not significantly different (DMRT, $P \leq 0.05$).

Flowering parameters

Days taken for bud initiation

The varieties varied significantly with respect to days taken for bud initiation. Among the different varieties studied, earliest flower bud initiation was observed in the variety Rosita 3 Clear Pink (56.00 days) which is on par with Rosita 3 Bright Blue (61.83 days) and Rosita 3 Pink Picotee (62.33 days) and maximum days required for the variety Rosita 3 green (82.67 days). Flower availability is primarily determined by the duration required for bud initiation, a key indicator of flowering earliness in *Lisianthus*. Significant varietal variation was observed in this trait. Early bud initiation facilitates quicker harvesting and typically requires fewer resources, as early-flowering varieties tend to utilize water and nutrients more efficiently than late-maturing ones. While this variation is predominantly governed by genetic factors, environmental conditions also exert a considerable influence. Such variation is likely influenced by the inherent genetic traits of the varieties. Related findings have been documented by Ahmad *et al.* (2017)^[1] in *Lisianthus* and Jose *et al.* (2017)^[5] in *Carnation*.

Days taken for bud to flowering

The varieties varied significantly with respect to days taken for bud to flowering. Among the different varieties studied, the variety Rosita 3 Clear Pink exhibited the minimum duration to flower opening (11.01 days) which is on par with Rosita 3 pure White (12.17 days), Rosita 3 Pink Imp (13.00 days) and Rosita 3 Green (13.17 days) and maximum days required for the variety Rosita 3 Lavender (18.33 days). Early flowering varieties possess genetic factors that accelerate floral initiation through enhanced meristem activity, further supported by favorable light, temperature and moisture conditions. In contrast, delayed flowering may result from slower hormone synthesis, extended vegetative growth or specific photoperiodic requirements. Similarly, were reported by Uddin *et al.* (2015)^[9] in *chrysanthemum*.

Quality parameters

Flower diameter (cm)

The different varieties of *Lisianthus* varied significantly with respect to flower diameter. The maximum flower diameter was recorded in the variety Aube 4 Pure White (7.12 cm) which is on par with Rosita 3 Lavender (6.46 cm), whereas the minimum flower diameter was recorded in the variety Rosita 3 Pure White (5.18 cm). Differences in flower diameter could be explained by the genetic constitution of the varieties and their tendency to produce larger blooms, similar patterns observed by Wazir (2014)^[13] in *Lisianthus* and Verma *et al.* (2012)^[11] in *Carnation*.

Stalk length (cm)

Rosita 3 Clear Pink (4.37 mm) had the maximum stalk girth, in contrast to Rosita 3 Green (1.90 mm), which showed the minimum. Stalk girth is an important factor that contributes to the durability and sturdiness of the flower pedicle. The observed variation in girth may stem from genetic differences among *Lisianthus* varieties. Related findings have been reported by Vetrivel and Jawaharlal (2014)^[13] in *chrysanthemum*.

Chlorophyll content (SPAD values)

The amount of chlorophyll in leaves increased photosynthetic activity, which yields carbohydrates. Carbohydrates are used as an energy source for developing buds, opening flowers, and extending their lifespan. There were significant variances in the amount of chlorophyll across the *Lisianthus* varieties. The maximum chlorophyll was recorded in the variety Rosita 3 bright Blue (81.24) which is on par with Rosita 3 Blue Picotee (77.72), Aube 4 pure White (74.26), Rosita 3 Pink Picotee (73.96) and Rosita 3 Lavender (65.50) whereas the minimum was recorded in the variety Rosita 3 pure White (47.77). The leaf chlorophyll content is a genetic character that differs according to the variety. variation in chlorophyll content was previously observed in Uddin *et al.* (2013)^[10] and Ahmad *et al.* (2017)^[1] in *Lisianthus*.

Table 2: Flowering and quality parameters of different varieties of *Lisianthus*

Varieties	Days taken for bud initiation	Days taken for bud to flowering	Flower diameter (cm)	Stalk length (cm)	Chlorophyll content (SPAD values)
V ₁ - Aube 4 Pure White	70.67 ^e	14.95 ^d	7.12 ^a	13.66 ^{bc}	74.26 ^{ab}
V ₂ - Rosita 3 Green	82.67 ^a	13.17 ^f	5.87 ^{bc}	15.43 ^{bc}	59.99 ^{bc}
V ₃ - Rosita 3 Lavender	65.33 ^f	18.33 ^a	6.46 ^{ab}	10.99 ^{cd}	65.5 ^{abc}
V ₄ - Rosita 3 Bright Blue	61.83 ^h	17.67 ^b	5.47 ^{bc}	8.39 ^d	81.24 ^a
V ₅ - Rosita 3 Clear Pink	56 ⁱ	11.01 ⁱ	5.22 ^c	24.39 ^a	49.12 ^c
V ₆ - Rosita 3 Pink Picotee	62.33 ^g	16.65 ^c	5.63 ^{bc}	16.01 ^b	73.96 ^{ab}
V ₇ - Rosita 3 Pure White	78.33 ^c	12.17 ^h	5.18 ^c	14.69 ^{bc}	47.77 ^c
V ₈ - Rosita 3 Blue Picotee	73.67 ^d	13.67 ^e	5.42 ^{bc}	10.66 ^{cd}	77.72 ^{ab}
V ₉ - Rosita 3 Pink Imp	81.67 ^b	13 ^g	5.69 ^{bc}	12.5 ^{bcd}	54.5 ^c
Mean	70.28	14.51	5.78	10.66	64.90
S. Em ±	2.30	0.76	0.33	1.50	5.62
CD (P = 0.05)	6.90	2.27	0.99	4.50	16.84

Note: Means with the same letter are not significantly different (DMRT, $P \leq 0.05$).

Yield parameters

Number of flowers stalks

Flower yield is a key factor in commercial cut flower production under protected conditions and productivity serves as the benchmark for evaluating the performance of any varieties. In the present investigation, significant variations were found among the varieties with respect to spike yield. Rosita 3 Clear Pink recorded the highest number of spikes per plant (3.96), per

sq. m (99.00) and per 560 sq. m (55440.00) whereas Rosita 3 Blue Picotee produced the lowest spikes per plant (1.32), per sq. m (33.00) and per 560 sq. m (18480.00). The observed difference could be due to improved stem firmness, higher production of photosynthetic assimilates and the genetic background of the varieties. Comparable results on stalk yield were reported by Ahmad *et al.* (2017)^[1] in *Lisianthus*.

Table 3: Yield parameters of different varieties of Lisianthus

Varieties	Number of spikes per plant	Number of spikes per square meter	Number of spikes per 560 m ²
V ₁ - Aube 4 Pure White	2.37 ^{cd}	59.17 ^{cd}	33133.328 ^{cd}
V ₂ - Rosita 3 Green	2.23 ^{cd}	55.83 ^{cd}	31266.67 ^{cd}
V ₃ - Rosita 3 Lavender	1.77 ^{de}	44.17 ^{de}	24733.33 ^{de}
V ₄ - Rosita 3 Bright Blue	3.23 ^b	80.83 ^b	45266.672 ^b
V ₅ - Rosita 3 Clear Pink	3.96 ^a	99 ^a	55440 ^a
V ₆ - Rosita 3 Pink Picotee	3.59 ^{ab}	89.67 ^{ab}	50213.328 ^{ab}
V ₇ - Rosita 3 Pure White	2.9 ^{bc}	72.5 ^{bc}	40600 ^{bc}
V ₈ - Rosita 3 Blue Picotee	1.32 ^e	33 ^e	18480 ^e
V ₉ - Rosita 3 Pink Imp	2.07 ^d	51.67 ^{de}	28933.33 ^{de}
Mean	2.60	65.09	28933.33
S. Em ±	0.22	5.48	3068.17
CD (P = 0.05)	0.66	16.43	9198.79

Note: Means with the same letter are not significantly different (DMRT, $P \leq 0.05$).

Economics

The best indicators of the economic variability of any project are the cost of cultivation, gross returns, net returns, and returns per rupee expenditure. Table 16 displays the results of a one-year calculation of the cultivation cost, gross returns, net returns, and returns per rupee spent for a 560 m² area. Among the evaluated varieties, Rosita 3 Clear Pink recorded the highest gross returns

(₹11,08,800.00), net income (₹8,05,316.15) and benefit-cost ratio (1:3.7) due to its superior yield. In contrast, Rosita 3 Blue Picotee recorded the lowest gross returns (₹3,69,600.00), net income (₹66,116.15) and benefit-cost ratio (1:1.2), which can be attributed to its lower yield. These observations are supported by Bhargav *et al.* (2020)^[2] in Lisianthus and Manisha *et al.* (2021)^[6] in Gerbera.

Table 4: Economics different varieties of Lisianthus

Varieties	Total cost (₹)	Number of spikes (Thousands)	Gross return (₹)	Net return (₹)	BCR
V ₁ - Aube 4 Pure White	2.37 ^{cd}	59.17 ^{cd}	33133.328 ^{cd}	359116.15	2.2
V ₂ - Rosita 3 Green	2.23 ^{cd}	55.83 ^{cd}	31266.67 ^{cd}	321916.15	2.1
V ₃ - Rosita 3 Lavender	1.77 ^{de}	44.17 ^{de}	24733.33 ^{de}	191116.15	1.6
V ₄ - Rosita 3 Bright Blue	3.23 ^b	80.83 ^b	45266.672 ^b	601916.15	3.0
V ₅ - Rosita 3 Clear Pink	3.96 ^a	99 ^a	55440 ^a	805316.15	3.7
V ₆ - Rosita 3 Pink Picotee	3.59 ^{ab}	89.67 ^{ab}	50213.328 ^{ab}	720716.15	3.4
V ₇ - Rosita 3 Pure White	2.9 ^{bc}	72.5 ^{bc}	40600 ^{bc}	508516.15	2.7
V ₈ - Rosita 3 Blue Picotee	1.32 ^e	33 ^e	18480 ^e	66116.15	1.2
V ₉ - Rosita 3 Pink Imp	2.07 ^d	51.67 ^{de}	28933.33 ^{de}	275116.15	1.9
Mean	2.60	65.09	36451.85	427760.59	2.42
S. Em ±	0.22	5.48	3068.17	359116.15	2.2
CD (P = 0.05)	0.66	16.43	9198.79	321916.15	2.1

Note: Price of flower spike: Rs. 20

Means with the same letter are not significantly different (DMRT, $P \leq 0.05$).

Conclusion

The evaluation of nine Lisianthus (*Eustoma grandiflorum*) varieties revealed significant variability in growth, flowering, physiological, and yield-related traits. Among the evaluated varieties, Rosita 3 Clear Pink emerged as the most superior, exhibiting maximum plant height, leaf area, branching, flower bud production and ultimately the highest economic returns. Globally, Lisianthus has gained immense popularity as a premium cut flower due to its elegant rose-like appearance, diverse colour range, and long vase life, making it a preferred choice for floral arrangements, weddings, and export markets. As consumer demand for high-quality ornamental flowers continues to rise, Lisianthus cultivation offers a lucrative opportunity for growers. With proper variety selection particularly high-performing cultivars like Rosita 3 Clear Pink and the adoption of improved production and post-harvest technologies, Lisianthus can serve as a high-value, income-generating crop for both domestic and international flower markets, contributing significantly to the floriculture industry and rural economy.

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