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RESEARCH ARTICLE

Evaluation of lisianthus (*Eustoma grandiflorum*) cultivars under polytunnel conditions in upper Pulney hill

C Ravindran[1*], V R Subash[2], K R Rajadurai[2], A Beaulah[3], R Manivannan[4] & S Shenbagavalli[5]

[1]Department of Horticulture, Horticultural and Forestry Research Station, Tamil Nadu Agricultural University, Kodaikanal 624 103, Dindigul, Tamil Nadu, India

[2]Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University,Periyakulam 625 604, Theni, Tamil Nadu, India

[3]Department of Post-Harvest Technology, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam 625 604, Theni, Tamil Nadu, India

[4]Department of Soil Science and Agricultural Chemistry, Horticultural and Forestry Research Station, Tamil Nadu Agricultural University, Kodaikanal 624 103, Dindigul, Tamil Nadu, India

[5]Department of Natural Resource Management, Horticultural College and Research Institute, Tamil Nadu Agricultural University,Periyakulam 625 604, Theni, Tamil Nadu, India

*Correspondence email - ravindran.c@tnau.ac.in

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Abstract

Lisianthus (*Eustoma grandiflorum*) is a popular ornamental cut flower native of the America, known for its rose-like appearance, vibrant colours and long post-harvest life. A field experiment was conducted to evaluate different lisianthus cultivars under poly-tunnel conditions, focusing on various growth and floral characteristics, at the Horticultural and Forestry Research Station, TNAU, Kodaikanal, Dindigul District, Tamil Nadu, during 2024-2025. The study involved five lisianthus cultivars: Rosita 3 Clear Pink (V_1), Rosita 3 Bright Blue (V_2), Rosita 3 Pink Picotee (V_3), Rosita 3 Blue Picotee (V_4) and Aube 4 Pure White (V_5). Among these cultivars, Rosita 3 Clear Pink (V_1) exhibited the highest plant height (106.33 cm), number of leaves (60.40), longest internodal length (8.82 cm), earliest flower bud initiation (91.18 days) and had the shortest time from flower bud initiation to flower opening (24.59 days). The Cultivar Aube 4 Pure White (V_5) highest shoots per plant (4.84), number of flowers per stem (10.70) and number of petals per flower (31.34). Aube 4 Pure White (V_5) shows the longest bud length (4.82 cm), flower length (6.25 cm) and flower diameter (9.74 cm). The results suggest that cultivar Aube 4 Pure White (V_5) exhibits the best performance in terms of growth and floral qualities for producing quality blooms of commercial standards, followed by Rosita 3 Bright Blue (V_2), Rosita 3 Clear Pink (V_1), Rosita 3 Pink Picotee (V_3) and Rosita 3 Blue Picotee (V_4).

Keywords: cultivar evaluation; cut flower; *Eustoma grandiflorum*; post-harvest value

Introduction

Lisianthus (*Eustoma grandiflorum*), also known as prairie gentian or Texas bluebell, which belongs to the family Gentianaceae, is one of the highly-demand ornamental cut flowers, native to the warm regions of Northern South America, the Southern United States, Mexico and the Caribbean island (1). It is an herbaceous annual that grows between 60 and 80 cm tall, with slightly succulent bluish-green leaves and produces large, funnel-shaped flowers. Lisianthus grows well in a temperate climate and at elevations between 1000 and 1800 m above sea level. For optimal growth and high-quality flower production, the ideal temperatures are 20-24 °C during the day and 16-18 °C at night. For lisianthus flowers, light levels between 4000 and 6000 feet are ideal. High light intensities may cause plants to generate more florets, but they may also yield less vibrant flower colours (2, 3). Lisianthus produce flowers in the form of cymes, with only a few openings at a time. The sepals of lisianthus are much smaller than the petals and are fused only at the base (4). Traditionally, lisianthus are propagated through cuttings (vegetative) and seeds (sexual) propagation. In recent years, lisianthus has become one of the top 10 cut flower harvests in the international flower market. This well-known cut flower has been grown since 1960 (5). It is a relatively new cut flower in the global market and has gained recent recognition in India. While in the United States, its popularity continues to grow, not just as a cut flower but also as a bedding and potted plant (6). The growth stages of lisianthus vary depending on its genotype and are influenced by environmental factors like temperature, humidity and light intensity. These factors ultimately impact the plant's commercial value, helping it achieve the highest market potential (7). However, lisianthus is gaining popularity in the floriculture sector because of its outstanding post-harvest life, thornless stems and rose-like appearance. These flowers have a variety of colours, including white, blue, purple, pink and even bicoloured types (6).

Since the performance of cultivars varied based on the region, season and genotype, it's essential to test how different genotypes perform in terms of flowering, flower quality and yield. Even with advancements in polyhouse production, farmers need to improve and evaluate lisianthus cultivars for their growth and yield.

Advantage of using polytunnel: Polytunnel provide protection from adverse weather such as frost, wind and intense sunlight, creating a warmer and more stable environment compared to open fields. This leads to earlier growth and flowering, reduced disease incidence (notably root diseases like *Fusarium* and *Pythium*) and improved stem quality and yield. Therefore, the objective of this study focuses on which lisianthus cultivars are more suitable and adaptable for specific regions and cultivation under a low-cost polytunnel as an affordable solution to recommend to farmers. A field experiment was conducted to choose the most suitable lisianthus cultivars for the upper Pulney Hill zone of Kodaikanal, Tamil Nadu.

Materials and Methods

A field experiment was carried out in a 1.88 m × 2.13 m polytunnel at the Horticultural & Forestry Research Station, TNAU, in Kodaikanal during the period from October 2024 to March 2025. Throughout the trial period, the average maximum temperature ranged from 31.7 to 39.2 °C, while the average minimum temperature ranged from 6.2 to 15.8 °C. An average relative humidity of 46.2-98.9% was present. The experiment was laid out in Randomized Block Design along with 4 treatments and 3 replications. The five commercial lisianthus cultivars used in this study are Rosita 3 Clear Pink (V_1), Rosita 3 Bright Blue (V_2), Rosita 3 Pink Picotee (V_3), Rosita 3 Blue Picotee (V_4) and Aube 4 Pure White (V_5). Two-month-old seedlings were planted on raised beds that were 1 feet tall and 3 feet wide, with a 15 cm × 30 cm space between each plant and row (Fig. 1).

Data on growth parameters viz., plant height (cm), number of leaves per plant, leaf length (cm), leaf breadth (cm), number of shoots per plant and internodal length (cm). Data on floral parameters, viz., days taken to flower bud initiation, days taken to flower bud initiation to flower opening, number of buds per plant, flower bud length (cm), flower bud diameter (cm), number of flowers per plant, number of petals per flower, flower length (cm), flower diameter (cm) and vase life (days). Biochemical analysis viz, chlorophyll a, chlorophyll b and total chlorophyll, were collected to compare the performance of the cultivars.

Results and Discussion

Growth parameters

The mean performance of the growth parameters varied among lisianthus cultivars, as shown in Table 1. The cultivars demonstrated significant differences in all growth characteristics.

Plant height (cm)

Notable differences were observed across the various lisianthus lines regarding plant height at maturity. According to Table 1, Rosita 3 Clear Pink (V_1) exhibited the maximum plant height (106.33 cm),

Fig. 1. Lisianthus cultivated in polytunnel at H&FRS, Kodaikanal.

followed by Aube 4 Pure White (96.46 cm) and Rosita 3 Blue Picotee (V_4) recorded the minimum plant height (80.24 cm). Genotype and environmental conditions are crucial for controlling plant height and overall performance. Greater plant height fetches a high flower value in the market. Similar findings have been reported in earlier studies (4, 8).

Number of leaves per plant

The number of leaves in the lisianthus lines showed considerable variation in the study. From Table 1, the line Rosita 3 Clear Pink (V1) recorded the highest number of leaves (60.40), while Rosita 3 Blue Picotee (V4) had the lowest with (46.40) leaves. This variation in leaf count is consistent with previous findings (9) as a higher number of leaves used for floral arrangements. Similar differences in leaf number have also been reported in other flowers like rose (10, 11).

Leaf length and leaf breadth (cm)

A leaf length and breadth have a significant impact on photosynthesis, light absorption and flower production. From Table 1, the line Aube 4 Pure White (V_5) recorded the maximum leaf length (10.64 cm) followed by Rosita 3 Clear Pink (V_1) (9.72 cm). The line Aube 4 Pure White (V_5) reported the maximum leaf breadth (6.47 cm) followed by Rosita 3 Clear Pink (V_1) (5.80 cm). The genetic traits present in each line are responsible for the observed variations and similar results have been reported in previous studies (12, 13).

Number of shoots per plant

The number of shoots showed significant variation among the different lines of lisianthus under study. The number of shoots contributes significantly to the overall output of plants, especially when it comes to cut flowers. A higher number of shoots favours more flowering stems, which can be harvested, leading to a increased yield. From Table 1, the maximum number of shoots was recorded in Aube 4 Pure White (V_5) (4.84) and the minimum was observed in Rosita 3 Blue Picotee (V_4) (3.74). A similar variation among lisianthus lines was also reported in previous study (9).

Table 1. Plant growth characters of lisianthus cultivars grown under polytunnel condition

Cultivar	Plant height (cm)	Number of leaves per plant	Leaf length (cm)	Leaf breadth (cm)	Number of shoots per plant	Internodal length (cm)
Rosita 3 Clear Pink	106.33^{a}	60.40^{a}	9.72^{b}	5.80^{b}	4.23^{b}	8.82^{a}
Rosita 3 Bright Blue	94.05^{c}	59.00^{a}	8.94^{d}	5.48^{c}	4.39^{b}	8.72^{a}
Rosita 3 Pink Picotee	83.35^{d}	52.00^{b}	9.46^{bc}	4.26^{d}	4.00^{c}	8.36^{b}
Rosita 3 Blue Picotee	80.24^{e}	46.40^{c}	9.22^{cd}	5.00^{e}	3.74^{d}	8.22^{b}
Aube 4 Pure White	96.46^{b}	59.60^{a}	10.64^{a}	6.47^{a}	4.84^{a}	8.77^{a}
S. Em	0.677	1.339	0.101	0.037	0.061	0.073
C.D (5 %)	2.031	4.013	0.302	0.111	0.182	0.218
CV (%)	1.649	5.395	2.345	1.529	3.200	1.899

Internodal length

Internodal length plays a significant role in enhancing both the yield and quality of cut flowers. From Table 1, the longest internodal length was recorded in Rosita 3 Clear Pink (V_1) (8.82 cm), followed by Aube 4 Pure White (V_5) (8.77 cm). The differences in internodal length among cultivars are likely influenced by genetic factors and previous studies have also noted that a greater internodal length tends to result in taller plants (4, 8).

Floral parameters

The performance of floral characteristics varied across the different lisianthus cultivars, as shown in Table 2 and 3. All floral characteristics showed significant variation across the lisianthus cultivars under investigation.

Days taken to flower bud initiation

There was variation in the number of days required for flower bud initiation among different lisianthus cultivars. From Table 2, the shortest duration was observed in Rosita 3 Clear Pink (V_1) (91.18 days), followed by Rosita 3 Pink Picotee (V_3) (97.27 days). Similar differences in the time taken for flower bud initiation and suggested that the plant's genotype mainly controls these variations and those are also reported in previous findings (9, 14, 15).

Days taken to flower bud initiation to flower opening

There was significant variation in the number of days it took for flower bud initiation to flower opening across lisianthus cultivars. From Table 2, the shortest duration was recorded in Rosita 3 Clear Pink (V_1) (24.59 days), followed by Rosita 3 Pink Picotee (V_3) (28.26 days). In contrast, the longest time was observed in Rosita 3 Blue Picotee (V_4) (35.66 days). These results are consistent with findings from earlier studies (14, 15).

Table 2. Floral characters of lisianthus cultivars grown under polytunnel condition

Cultivar	Days taken to flower bud Initiation	Days taken to flower bud Initiation to flower opening
Rosita 3 Clear Pink	91.18^{e}	24.59^{e}
Rosita 3 Bright Blue	106.33^{c}	32.26^{c}
Rosita 3 Pink Picotee	97.27^{d}	28.26^{d}
Rosita 3 Blue Picotee	114.15^{a}	35.66^{a}
Aube 4 Pure White	110.17^{b}	32.53^{b}
S. Em	0.855	0.118
C.D (5 %)	2.562	0.354
CV (%)	1.841	0.862

Flower quality and yield parameters

Number of buds per plant

The number of flower buds per plant varied significantly among the lisianthus lines. A higher number of flower buds is important because it usually leads to more fully bloomed flowers, which is a key quality trait in cut flowers like lisianthus. Table 3 shows that Rosita 3 Bright Blue (V_2) recorded the maximum number of buds (25.17), whereas Rosita 3 Blue Picotee (V_4) had the least number of buds (18.41). This variation in the number of flower buds has also been reported in previous studies (15, 16).

Bud length (cm)

Variation was observed in the case of flower bud length in lisianthus cultivars. From Table 3, the maximum flower bud length was recorded in Aube 4 Pure White (V_5) (4.82 cm) line and minimum was observed in Rosita 3 Blue Picotee (V_4) (3.57 cm). Similar results were also reported in earlier studies on lisianthus lines (8).

Bud diameter (cm)

There was a significant variation in bud diameter was observed in lisianthus lines. From Table 3, the largest flower bud diameter was recorded in Rosita 3 Blue Picotee (V_4) (5.28 cm), while the smallest was observed in Rosita 3 Clear Pink (V_1) (4.71). A similar variation has been reported in the previous study (17).

Number of flowers per plant

Lisianthus lines exhibited significant variation in the number of flowers per stem. According to Table 3, Aube 4 Pure White (V_5) recorded the maximum number of flowers per plant (10.70), whereas Rosita 3 Blue Picotee (V_4) had the minimum (7.25). The number of flowers per plant in lisianthus ranged from 8 to 18 in a previous study conducted (18).

Number of petals per flower

Lisianthus flowers are classified as single or double based on the number of petals. Single flowers typically have 5-6 petals, while double flowers have 9 or more. The number of petals per flower varied significantly among the lisianthus lines. From Table 3, Aube 4 Pure White (V_5) had the highest petal count (31.34), while Rosita 3 Blue Picotee (V_4) had the lowest (16.48). The number of petals varied significantly among lisianthus lines. Each category has different consumer preferences and market potential, as reported in earlier studies (8).

Flower length (cm)

Flower length significantly affects the market quality and price of lisianthus. Longer flowers are generally more valued because they enhance the visual appeal and overall aesthetics of the flower

Table 3. Flower quality and yield parameters of lisianthus cultivars grown under polytunnel condition

Cultivar	Number of buds per plant	Bud length (cm)	Bud diameter (cm)	Number of flowers per stem	Flower length (cm)	Flower diameter (cm)	Number of petals per flower	Vase life of flowers (Days)
Rosita 3 Clear Pink	23.75^{b}	4.21^{c}	4.71^{c}	9.11^{c}	4.81^{c}	6.42^{d}	17.42^{d}	19.25^{c}
Rosita 3 Bright Blue	25.17^{a}	4.38^{b}	4.75^{bc}	9.72^{b}	5.70^{b}	8.28^{b}	28.57^{b}	20.00^{b}
Rosita 3 Pink Picotee	19.24^{c}	3.73^{d}	5.28^{a}	7.48^{d}	4.82^{c}	7.83^{c}	19.76^{c}	17.21^{d}
Rosita 3 Blue Picotee	18.41^{c}	3.57^{e}	5.19^{a}	7.25^{d}	4.89^{c}	7.73^{c}	16.48^{e}	16.51^{e}
Aube 4 Pure White	24.21^{ab}	4.82^{a}	4.91^{b}	10.70^{a}	6.25^{a}	9.74^{a}	31.34^{a}	20.97^{a}
S. Em	0.460	0.045	0.056	0.097	0.054	0.047	0.136	0.171
C.D (5 %)	1.380	0.135	0.167	0.291	0.162	0.141	0.407	0.512
CV (%)	4.643	2.425	2.498	2.449	2.280	1.314	1.335	2.032

bunch, making them more attractive to consumers and florists. The study of different lisianthus lines after full bloom showed variation in flower length. From Table 3, Aube 4 Pure White (V_5) had the longest flowers (6.25 cm), Whenever Rosita 3 Clear Pink (V_1) had the shortest (4.81 cm). Similar variations in flower length have also been reported in previous findings (9, 15, 18).

Flower diameter (cm)

Flower diameter is positively correlated with flower visual quality and larger flowers tend to attract premium pricing as they stand out more prominently in bouquets and floral arrangements. The study of different lisianthus lines after full bloom revealed variation in flower diameter. The larger flower diameter fetches a higher price in the market. From Table 3, Aube 4 Pure White (V_5) recorded the largest flower diameter (9.74 cm), while Rosita 3 Clear Pink (V_1) had the smallest (6.42 cm). Similar differences in flower diameter have also been reported in earlier studies (9, 15, 18).

Vase life of flowers (days)

Cut flowers with extended vase lives reduce waste and increase the value perceived by buyers. There was significant variation in vase life among the different lisianthus lines studied. From Table 3, the longest vase life was observed in Rosita 3 Bright Blue and Aube 4 Pure White (V_5) (20.97 days), while the shortest was observed in Rosita 3 Blue Picotee (V_4) (16.51 days). Similar variation in vase life ranges from 12.5 to 25 days in different lisianthus lines and which is longer than that of flowers like roses, tuberoses and gladioluses (7-15 days), making lisianthus an ideal cut flower were observed in the previous studies (9, 15).

Biochemical analysis

Chlorophyll (%)

The total chlorophyll content was estimated from a fully expanded leaf from the top at specified phenophases following the procedure described in earlier studies (19). The amount of chlorophyll in leaves plays a crucial role in enhancing photosynthetic activity, which yields carbohydrates and provides energy for the development of buds, flower opening and even longevity. In lisianthus, as shown in Table 4, chlorophyll content showed significant variation across different genotypes. The amount of chlorophyll "a" was significantly higher in the Rosita 3 Bright Blue (V_2) (2.448 mg/g) and lower in Rosita 3 Blue Picotee (V_4) (1.853 mg/g), while the amount of chlorophyll "b" was significantly higher in the genotype Rosita 3 Bright Blue (V_2) (1.821 mg/g) and lower in Rosita 3 Blue Picotee (V_4) (1.047 mg/g). The amount of total chlorophyll was significantly higher in the genotype Rosita 3 Bright Blue (V_2) (2.332 mg/g) and lower in Rosita 3 Pink Picotee (V_3) (1.234 mg/g). This variation in chlorophyll content is a genetic trait that differs between genotypes. Such differences in chlorophyll content have been reported in previous studies in lisianthus (14, 16), in roses (20) and in carnations (21).

Conclusion

From the present study, it can be concluded that among the cultivars, Aube 4 Pure White (V_5) followed by Rosita 3 Bright Blue (V_2) and Rosita 3 Clear Pink (V_1) have performed well under poly-tunnel conditions of upper Pulney hills of Kodaikanal in view of cut flower attributes like plant height, number of shoots per plant, simultaneous flowering, vase life, larger flower length and flower diameter. These varieties are especially suitable because they offer a wide range of colours that are popular in floral arrangements. Therefore, it can be popularised for cut flower production under poly-tunnel conditions in this region. However, further authentication regarding various aspects like yield parameters and standardization of cultural practices in this region.

Authors' contributions

VRS conceptualized the review article and designed the methodology for the literature search. CR guided the review by formulating the review concept and approved the final manuscript. AB critically reviewed and edited the manuscript for intellectual content. RM and SS assisted in editing, summarizing and revising the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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Table 4. Chlorophyll analysis of lisianthus cultivars grown under polytunnel condition

Cultivar	Chlorophyll a	Chlorophyll b	Total chlorophyll
Rosita 3 Clear Pink	1.859^{c}	1.181^{b}	1.409^{c}
Rosita 3 Bright Blue	2.448^{a}	1.821^{a}	2.332^{a}
Rosita 3 Pink Picotee	1.744^{d}	1.068^{c}	1.234^{e}
Rosita 3 Blue Picotee	1.853^{c}	1.047^{c}	1.363^{d}
Aube 4 Pure White	1.893^{b}	1.210^{b}	1.463^{b}
S. Em	0.010	0.020	0.005
C.D (5 %)	0.031	0.059	0.015
CV (%)	1.173	3.464	0.699

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