**Genetic diversity analysis in *Nerium oleander* L. genotypes**

**ABSTRACT**

Genetic diversity analysis plays a crucial role in plant breeding and horticultural improvements. This study evaluated the morphological and floral characteristics of fifteen nerium genotypes to assess genetic variability and potential for selection. Significant variations were observed in plant height, leaf morphology, flowering traits, and flower yield. Genotype T13 exhibited the tallest plants (167.38 cm), while T5 recorded the shortest (59.25 cm). Leaf blade dimensions varied considerably, with T11 exhibiting the longest leaves (24.01 cm) and T5 the shortest (12.36 cm). Genotypic differences were prominent in floral traits, including flower diameter, corolla throat dimensions and flower yield. T5 exhibited the highest number of flowers (16.7) per plant at full flowering stage ie., two months after first flowering, whereas T3 had the highest total flower yield (65.09 g) during the experimental period. The highest phenotypic (PCV) and genotypic (GCV) coefficients of variation were recorded for flower yield and plant height, indicating substantial genetic diversity. Floral traits demonstrated high heritability (0.70-0.99) with significant genetic advances, particularly in flower yield and corolla throat diameter, suggesting strong selection potential. These findings provide valuable insights for breeding programs aimed at enhancing ornamental and commercial traits in nerium.

**Keywords:** nerium, genetic diversity, morphological traits, floral characteristics, heritability

1. **INTRODUCTION**

*Nerium oleander* L., an evergreen shrub belonging to the Apocynaceae family, is believed to have originated in the Mediterranean region(Herrera, 1991). It is widely grown in tropical, subtropical, and warm temperate regions due to its ornamental appeal, particularly its abundant and long-lasting blooms. The plant is highly adaptable, capable of thriving in diverse environmental conditions, including drought-prone, saline, alkaline, and acidic soils (Staples and Herbst, 2005). *Nerium oleander* is the sole species in the genus *Nerium* (Dey, 2020). The etymology of its name reflects its ecological preferences; ‘*nerion*’ in Greek means ‘wet,’ referring to its affinity for wetlands, while ‘oleander’ is derived from the Italian ‘*oleandro*,’ linked to the Latin *olea*, due to the resemblance of its leaves to those of the olive tree (Ayouaz *et al*., 2023).

*Nerium* is a resilient, fast-growing plant that can reach heights of 2 to 6 meters. It features upright stems that spread as the plant matures, with long, narrow, and leathery leaves measuring 10 to 22 cm in length. Its terminal flower clusters, often pink or white, appear in both single and double forms, enhancing its ornamental appeal (Kiran and Prasad, 2014). Notably, nerium blooms throughout the year, ensuring a continuous floral display. The plant produces elongated seed capsules that split open upon maturity to release numerous fine, downy seeds (Rajiv *et al*., 2018).

In India, nerium holds significant commercial value, particularly for its use in religious offerings at temples. Additionally, it is extensively cultivated in gardens, along roadsides, and in public spaces where it serves both decorative and screening purposes. Beyond its aesthetic and cultural significance, nerium is also recognized for its medicinal properties, making it an important plant in traditional and herbal medicine (Shrikant *et al.*, 2022; Ayouaz *et al*., 2023). Consumption of nerium can lead to severe toxicity in both humans and animals, though the studies exhibited termination of cancer cells in the presence of cardiac glycoside compounds like oleandrin (Sharma *et al.*, 2023).

The aqueous extract of *Nerium oleander* leaves exhibited bio-insecticidal properties, causing up to 43% mortality in newly emerged *Aphidius colemani* adults when exposed to five different concentrations (Kaoutar *et al.*, 2019)

Significant differences in nerium genotypes can be identified using analysis of variance (Mohammadi *et al*., 2017). An association between genotypic and phenotypic coefficient of variance in characters helps to identify the environmental effect on variations in genotype. High heritability and genetic advance will predict the gene action that leads to a possibility for selection and crop improvement (Nithisha, 2023). The nerium flower market is highly dynamic, requiring continuous innovation to meet changing consumer preferences. Significant variation exists among nerium genotypes in terms of growth habit, flower colour, shape, size, and pattern. The selection of suitable genotypes is crucial for different purposes, whether for landscape enhancement, or for commercial cultivation. To address this, genetic improvement programs must focus on evaluating and characterizing existing germplasm based on ornamental traits. This study aimed to evaluate nerium genotypes for growth and flowering characteristics and to systematically classify them using morphological descriptors.

1. **MATERIALS AND METHODS**

The current study was conducted at the Department of Floriculture and Landscaping, College of Agriculture, Vellayani, Kerala Agricultural University, from October 2023 to December 2024. For the experiment, semi-hardwood cuttings of fifteen nerium genotypes were collected from across various locations of Kerala (Table 1) and kept for rooting in the nursery. The experiment was conducted using a randomised block design, comprising two replications, each containing four plants. The Individual plot size was 16 m2. Pits of 30 cm3 size were taken at 2 x 2 m spacing. Each pit was filled with 2 kg of farmyard manure one week before planting, and one-month-old rooted cuttings were planted at one per pit. A second dose of 2 kg of farmyard manure per pit was applied six months later.

All the selected genotypes were analysed for morphological and yield characters to assess genetic diversity and variability. Morphological characters, including plant height, leaf blade length, and leaf blade width, were measured from three randomly selected plants per replication (Table 2). The mean values of these traits were recorded for each genotype. In addition, quantitative floral traits were measured during the flowering period. During the experimental period, flowering was observed in only twelve genotypes. The floral characteristics measured included the number of flowers per plant at full flowering stage ie., two months after first flowering, flower diameter, corolla throat length, corolla throat diameter, corolline appendage length and sepal length (Table 3). Floral characteristics were measured from five flowers per three randomly selected plants in each replication. The yield traits included single flower weight, flower yield and shelf life of flower (Table 4). Genetic differences among 15 *Nerium oleander* L. genotypes were evaluated using ANOVA and variance component analysis. Data analysis was performed using GrapesAgri1 software developed by Gopinath *et al*. (2021) and correlation coefficients were derived from traits showing significant variation. Genetic divergence was analysed using the Average method and Euclidean Distance measures.

1. **RESULTS AND DISCUSSION**
   1. **Genetic diversity analysis of nerium genotypes**

The evaluation of plant growth characteristics among different genotypes revealed significant variations. Genotype T13 exhibited the tallest plants, attaining a mean height of 167.38 cm, whereas genotype T5, characterized by a dwarf growth habit, recorded the shortest height of 59.25 cm. This difference in plant height can be attributed to genetic variability, environmental influences, agronomic practices, and cultural management techniques. A greater plant height is often associated with enhanced meristematic activity, driven by increased rates of cell division and elongation during the growth phase (Preethi *et al.*, 2019). Genetic factors play a crucial role in determining plant stature; however, environmental conditions such as soil fertility, water availability, and climatic factors further influence growth patterns (Rajiv *et al*., 2022; Siddalingappa *et al*., 2024).

The analysis of leaf blade dimensions among the genotypes demonstrated significant variations. Genotype T11 exhibited the longest leaf blade length of 24.01 cm, which was statistically comparable with genotypes T1 and T10. Conversely, genotype T5 recorded the shortest leaf blade length (12.36 cm). In terms of leaf blade width, genotype T13 showed the maximum value of 3.53 cm which was similar to genotype T6, while the minimum width (1.45 cm) was observed in genotype T5. Leaf morphology plays a crucial role in photosynthesis, influencing overall plant growth and flower yield. Rajiv *et al*. (2018), emphasized that chlorophyll content and leaf structure significantly impact plant productivity. Among the evaluated genotypes, the white single-whorled dwarf type, characterized by smaller leaf dimensions, forms a compact canopy, thereby enhancing its ornamental appeal. Variations in leaf size across the genotypes can be attributed to the inherent genetic differences and their adaptability to environmental conditions (Rajiv *et al*., 2022).

Among the fifteen nerium genotypes analysed, only twelve exhibited flowering during the experimental period, indicating variability in their reproductive response (Fig. 1). The study highlights that lighting conditions and physiological stress significantly impact nerium flowering. Variations in light exposure and environmental stressors, such as inadequate water, can delay blooming by disrupting internal mechanisms. Proper light management and optimized growth conditions are crucial for ensuring timely inflorescence emergence and reproductive success (Velmurugan *et al*., 2023).

Regarding the floral characteristics, genotype T5 exhibited the highest number of flowers (16.7) per plant at full floweringie., two months after first flowering, while genotype T8 recorded the lowest number of flowers (2.7), which was statistically on par with genotypes T2, T6, T10, T11, and T13. The number of flowers per plant is influenced by genetic traits linked to regular flowering habits and agro-climatic conditions (Preethi *et* al., 2019). Additionally, variations in yield potential among the genotypes may be attributed to additive gene effects (Rajiv *et al*., 2022).

The evaluation of flower dimensions revealed significant variation among the genotypes. Genotype T13 exhibited the largest flower diameter of 5.75 cm and it was significantly superior to all other genotypes, whereas the smallest flower diameter of 2.05 cm was recorded in genotype T5. Parashuram *et al*. (2019) reported that the variability in flower diameter among cultivars suggests genetic diversity, which can be exploited for breeding purposes to enhance ornamental traits. Rajiv *et al.* (2022) also emphasized that flower diameter variations in nerium accessions are influenced by genetic factors and environmental conditions such as climate and soil, which also affect growth traits like plant height and leaf area.

The maximum corolla throat length was observed in genotype T6 (1.10 cm), which was statistically comparable to genotype T3, while the shortest length was recorded in T4 (0.55 cm). Similarly, the highest corolla throat diameter was found in genotype T13 (1.66 cm), whereas the smallest diameter of 0.39 cm was recorded in genotype T5. Parashuram *et al*. (2019) also reported significant variability in corolla throat length and diameter, with the pink cultivar exhibiting the highest values, aligning with the present findings.

The corolline appendage length was highest in genotype T2 (1.27 cm) and lowest in genotype T13 (0.4 cm). Sepal length was highest in genotype T10 (0.82 cm), whereas genotype T3 recorded the shortest sepal length of 0.43 cm, statistically comparable to T13. The presence and degree of laciniation in corolline appendages serve as key factors in plant identification and provide insights into evolutionary adaptation (Shrikant *et al.*, 2022). Corolla appendages are significant taxonomic characteristics that contribute to the differentiation of various populations (Roofigar *et al.,* 2024).

Genotype T13 recorded the highest single flower weight (756.6 mg), whereas genotype T5 exhibited the lowest of 169.7 mg. Double-whorled genotypes exhibited greater flower weight than single-whorled genotypes. Studies in crossandra (Tejaswi *et al.*, 2020) have indicated a significant positive correlation between flower diameter, petal width, and flower weight, suggesting that larger flowers tend to have higher weights due to their genetic constitution.

Flower yield varied significantly across the genotypes, with genotype T3 producing the highest flower yield (65.09 g), whereas genotype T2 had the lowest yield (3.06 g) and it was statistically on par with T8 and T11. Variations in flower yield are largely attributed to genetic factors, as observed in studies on nerium and *Jasminum sambac*, where specific accessions demonstrated superior yield potential due to their genetic traits (Kumar *et al*.,2021; Rajiv *et al*. 2022).

The longest flower shelf life was recorded in genotype T11 (8.5 hours), comparable to genotypes T3, T6, T10, and T13. Conversely, the shortest shelf life of 3.5 hours was observed in genotypes T5 and T15, statistically on par with T1, T2, T4, and T8. The shelf life of flowers is a critical parameter in the floriculture industry, influencing both the commercial value and consumer satisfaction. Various factors, including genetic makeup, environmental conditions, and post-harvest treatments, can significantly impact the shelf life of flowers (Gopitha *et al*., 2021; Hosagoudar *et al*., 2024).

* 1. **Coefficient of variation**

Plant height exhibited the highest phenotypic (PCV) and genotypic (GCV) coefficients of variation at 28.57% and 26.94%, respectively, while leaf blade length had the lowest values at 14.97% and 14.92%. Among floral traits, PCV ranged from 19.14% to 69.31% and GCV from 18.44% to 65.73%, with flower yield showing the highest variation and sepal length displaying moderate variability (Fig. 2). Flower diameter demonstrated the greatest variability at both levels, followed by the number of flowers per plant. Rajiv *et al*. (2022) observed significant phenotypic variation in nerium accessions for traits like plant height, number of branches, leaf area, days to flowering, and flower yield, influenced by genetic and environmental factors, making them essential for selecting high-yielding genotypes. Similarly, Kumar *et al*. (2024) reported substantial genetic diversity in nerium accessions, particularly in plant height and flower yield, highlighting their importance for breeding programs focused on trait improvement.

* 1. **Heritability and genetic advance**

Floral traits exhibited high heritability (0.70–0.99), with the highest values recorded for single flower weight, flower diameter and corolla throat diameter, while plant traits such as plant height, leaf blade length and leaf blade width also showed high heritability. Significant genetic advances were observed across all traits, with flower yield showing the highest genetic advance (128.43%), followed by the number of flowers per plant (125.05%) and corolla throat diameter (92.46%) (Table 5). Floral traits like flower yield, number of flowers per plant and corolla throat diameter combined high heritability with substantial genetic advances, making them ideal for selection. Rajiv *et al.* (2022) also highlighted significant genetic variability among accessions, particularly for plant height and flower yield, reinforcing that traits with high heritability are highly responsive to selection and valuable for breeding programs.

1. **CONCLUSION**

The genetic diversity analysis of nerium genotypes revealed significant variations in growth, flowering and yield traits, influenced by both genetic and environmental factors. Genotype T13 exhibited the tallest plants and flowers with the largest diameter, which would be suitable as large showy floral hedges and planting along roadsides. The white single genotype (T5), with its dwarf and compact form, is ideal for potted plants by efficient pruning. High-yielding genotypes like T3 and T5 can be used for large-scale loose flower production. High heritability estimates for key characters such as flower yield and number of flowers per plant, indicate strong genetic control, making them ideal for selection in breeding programs. The observed diversity presents valuable opportunities for crop improvement and commercial cultivation. Nerium is a popular choice for pookkalam during the Onam season in Kerala. Utilizing its genetic diversity can help in developing varieties adaptive to the agro-climatic conditions of Kerala, enhancing the ornamental and economic value of nerium.

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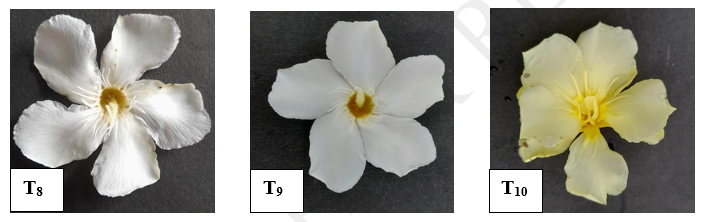




Fig 1. Flowers of the nerium genotypes which flowered during the experimental period.

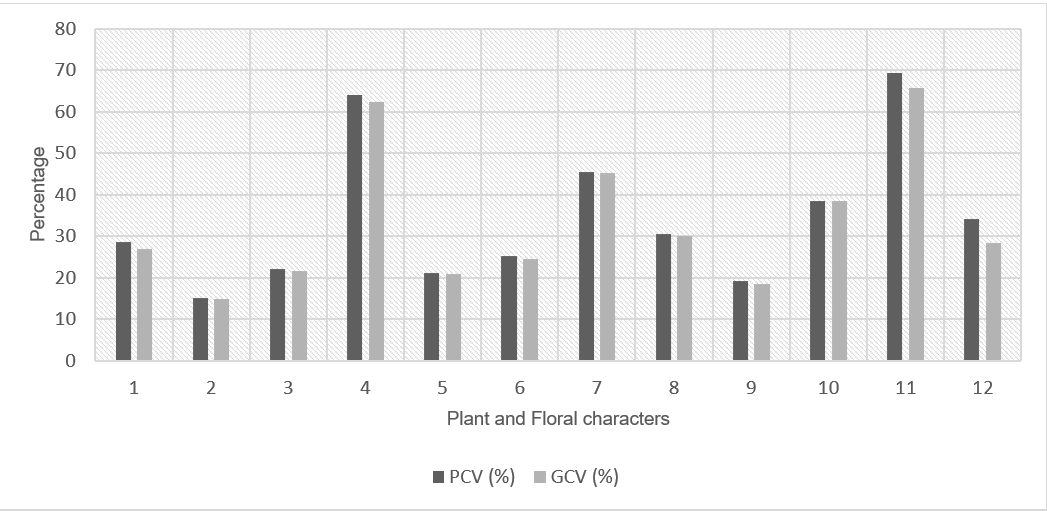


Fig. 2 Phenotypic and genotypic variation in traits of nerium genotypes (1. plant height, 2. leaf blade length, 3. leaf blade width, 4. plant: number of flowers, 5. flower diameter, 6. corolla throat length, 7. corolla throat diameter, 8. corolline appendage length, 9. sepal length, 10. single flower weight, 11. flower yield, 12. shelf life).

**Table 1. Details of the nerium genotypes selected for the study**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Genotype code | Flower colour | Flower type | Plant growth type | Place of Collection | District |
| T1 | Dark pink | Single | Normal | Mukkattukara | Thrissur |
| T2 | White | Double | Normal | Kanjikode | Palakkad |
| T3 | Pink | Single | Normal | Tana | Thrissur |
| T4 | Pink | Single | Normal | Ambalathara | Thiruvananthapuram |
| T5 | White | Single | Dwarf | Kottukal | Thiruvananthapuram |
| T6 | Light pink | Single | Normal | Mukkattukara | Thrissur |
| T7 | Yellow | Single | Normal | Alathur | Palakkad |
| T8 | White | Single | Normal | Mukkattukara | Thrissur |
| T9 | White | Single | Normal | Pachalloor | Thiruvananthapuram |
| T10 | Yellow | Double | Normal | Mukkattukara | Thrissur |
| T11 | Yellow | Double | Normal | Kanjikode | Palakkad |
| T12 | Dark pink | Single | Normal | Manacaud | Thiruvananthapuram |
| T13 | Pink | Double | Normal | Vellayani | Thiruvananthapuram |
| T14 | Dark pink | Double | Normal | Alathur | Palakkad |
| T15 | Pink | Single | Normal | Ambalathara | Thiruvananthapuram |

**Table 2. Growth parameters of the selected nerium genotypes**

|  |  |  |  |
| --- | --- | --- | --- |
| Genotypes | Plant height (cm) | Leaf blade length (cm) | Leaf blade width (cm) |
| T1 | 119.00bc | 23.70ab | 2.80b |
| T2 | 80.75efg | 20.81e | 2.14h |
| T3 | 131.63b | 22.88cd | 2.68bc |
| T4 | 117.38bc | 23.11c | 2.60bcd |
| T5 | 59.25h | 12.36i | 1.45i |
| T6 | 91.13def | 22.91cd | 3.39a |
| T7 | 75.25fgh | 19.26g | 2.54cde |
| T8 | 90.38def | 20.26f | 2.41defg |
| T9 | 89.88def | 19.78f | 2.21defg |
| T10 | 80.00efg | 23.67ab | 2.37efg |
| T11 | 96.88de | 24.01a | 2.27fgh |
| T12 | 69.75gh | 18.81g | 2.40defg |
| T13 | 167.38a | 23.22bc | 3.53a |
| T14 | 79.25efg | 14.37h | 2.44def |
| T15 | 103.50cd | 22.51d | 2.55cde |
| SEm± | 6.595 | 0.17 | 0.072 |
| CD(0.05) | 20.003 | 0.517 | 0.22 |

**Table 3. Floral quantitative characters of the selected nerium genotypes**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Genotypes | Plant: number of flowers\* | Flower diameter  (cm) | Corolla throat length (cm) | Corolla throat diameter (cm) | Corolline appendage length (cm) | Sepal length (cm) |
| T1 | 7.9c | 3.85d | 0.96b | 0.67e | 0.66d | 0.61e |
| T2 | 2.8d | 3.98d | 0.69d | 0.73e | 1.27a | 0.69cd |
| T3 | 13.3b | 3.96d | 1.09a | 0.68e | 0.85c | 0.43g |
| T4 | 7.3c | 3.81d | 0.55e | 0.53f | 0.71d | 0.59ef |
| T5 | 16.7a | 2.05e | 0.80c | 0.39g | 0.84c | 0.55f |
| T6 | 4.6d | 4.74b | 1.10a | 0.88d | 0.74d | 0.72bc |
| T8 | 2.7d | 4.36c | 0.63de | 0.67e | 0.49e | 0.55f |
| T9 | 8.0c | 4.25c | 0.64de | 0.77e | 0.69d | 0.62e |
| T10 | 3.5d | 4.73b | 0.99b | 1.21c | 0.85c | 0.82a |
| T11 | 4.2d | 4.71b | 0.72b | 1.35b | 1.08b | 0.75b |
| T13 | 3.9d | 5.75a | 0.71cd | 1.66a | 0.40e | 0.45g |
| T15 | 7.7c | 3.87d | 0.59e | 0.50f | 0.71d | 0.64de |
| SEm± | 0.698 | 0.075 | 0.029 | 0.034 | 0.032 | 0.017 |
| CD(0.05) | 2.172 | 0.232 | 0.09 | 0.106 | 0.099 | 0.053 |

Genotypes T7, T12 and T14 did not flower during the experimental period.

\* Number of flowers per plant at full floweringie., two months after first flowering

**Table 4. Yield attributes of the selected nerium genotypes**

|  |  |  |  |
| --- | --- | --- | --- |
| Genotypes | Single flower weight (mg) | Flower yield (g) | Shelf life of flower (hrs) |
| T1 | 323.8g | 39.75b | 5.5bcde |
| T2 | 429.5cd | 3.06e | 4.5cde |
| T3 | 409.3de | 65.09a | 7.5ab |
| T4 | 419.3d | 33.76b | 4.0de |
| T5 | 169.7h | 34.62b | 3.5e |
| T6 | 454.4c | 28.30bc | 8.5a |
| T8 | 357.1f | 5.07de | 4.5cde |
| T9 | 381.7ef | 37.54b | 6.0bcd |
| T10 | 720.1b | 17.51cd | 6.5abc |
| T11 | 721.3b | 16.87cde | 8.5a |
| T13 | 756.6a | 17.36cd | 6.5abc |
| T15 | 419.4d | 34.15b | 3.5e |
| SEm± | 10.069 | 4.513 | 0.764 |
| CD(0.05) | 31.341 | 14.048 | 2.377 |

Genotypes T7, T12 and T14 did not flower during the experimental period.

**Table 5. Estimates of heritability and genetic gain for growth, flowering and yield traits in the selected nerium genotypes**

|  |  |  |
| --- | --- | --- |
| Morphological traits | Heritability | Genetic advance (%) (i=5%) |
| Plant height (cm) | 0.89 | 52.34 |
| Leaf blade length (cm) | 0.99 | 30.64 |
| Leaf blade width (cm) | 0.96 | 43.57 |
| Plant: number of flowers | 0.95 | 125.05 |
| Flower diameter (cm) | 0.99 | 42.60 |
| Corolla throat length (cm) | 0.95 | 49.25 |
| Corolla throat diameter (cm) | 0.99 | 92.46 |
| Corolline appendage length (cm) | 0.96 | 60.72 |
| Sepal length (cm) | 0.93 | 36.60 |
| Single flower weight (mg) | 0.99 | 78.91 |
| Flower yield (g) | 0.90 | 128.43 |
| Shelf life (hrs) | 0.70 | 48.79 |

**Disclaimer (Artificial intelligence)**

**Option 1:**

**Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.**

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