



## MORPHOMETRIC AND ALLOMETRIC ANALYSIS OF *N. OLEANDER* L. IN THE GILGIT REGION: IMPLICATIONS FOR GROWTH AND ADAPTATION

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**Abstract:** *N. oleander* L. is a resilient ornamental shrub widely distributed in subtropical regions. This study investigates the morphometric traits and allometric relationships of *N. oleander* populations in the Gilgit region of Pakistan. We measured key morphological parameters—including length, width, and calculated area—of petals, sepals, leaves, stamens, and carpels from multiple samples. Results indicate significant variability in leaf and floral dimensions. Petals showed the highest mean area (218.17 mm<sup>2</sup>), while sepals were the smallest (0.16 mm<sup>2</sup>). Allometric analysis revealed weak to moderate relationships ( $R^2 = 0.0004 - 0.6937$ ) between the dimensions of different plant parts, suggesting complex growth dynamics influenced by local environmental conditions. This research provides a quantitative baseline for the morphology of *N. oleander* in this understudied region and highlights its phenotypic plasticity.

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### 1. Introduction

*N. oleander* L. (Apocynaceae), commonly known as oleander, is a perennial evergreen shrub renowned for its drought tolerance and vibrant flowers (Krüssmann, 1984). Native to the Mediterranean and subtropical Asia, it has become naturalized in many parts of the world, including Pakistan, where it is commonly used in urban landscaping (Ali et al., 2020). The plant is characterized by its leathery, lance-shaped leaves and funnel-shaped flowers that range in color from white and pink to deep red (Erdoğan, 2002).

Despite its beauty, *N. oleander* is notoriously toxic due to the presence of cardiac glycosides, such as oleandrin, in all its parts (Langford & Boor, 1996). This toxicity limits its medicinal application, though research into its potential anticancer properties is ongoing (Pathak et al., 2010). Ecologically, its ability to thrive in arid, polluted environments makes it valuable for erosion control and urban greening, though it can become invasive (Siddiqui & Khan, 2019).

Morphometric studies—the quantitative analysis of form—are crucial for understanding how

plants like *N. oleander* adapt to different environments (Singh et al., 2021). Allometry, the study of the relative growth of parts of an organism, can reveal scaling relationships and resource allocation strategies (Khan & Ali, 2022). While *N. oleander* is widespread, detailed morphometric data from the unique high-altitude environment of Gilgit, Pakistan, is lacking. This study aims to:

1. Quantify the key morphometric traits (length, width, area) of the leaves, petals, sepals, stamens, and carpels of *N. oleander* in the Gilgit region.
2. Analyze the allometric relationships between these traits to understand growth patterns.
3. Discuss the observed variations in the context of local environmental factors.

### 2. Materials and Methods

#### 2.1. Study Area and Sample Collection

Samples of *N. oleander* were collected from three distinct locations within the Gilgit region during the flowering season (June-August 2023). The sites varied in altitude, microclimate, and exposure.

Table 1 describes the geographical coordinates and estimated altitudes of the sampling sites.

Location	Longitude E	Latitude N	Altitude (ft)	Characteristics
Gilgit City	74.3080°	35.9202°	4,921	Urban area, lower altitude
Konodas	74.3314°	35.9264°	4,900	Semi-urban, moderate slope
KIU Campus	72.4400°	33.1400°	6,600	High-altitude

Table 2: Summary of morphometric measurements for *N. oleander* components (n=10 samples).

Plant Part	Mean Length (mm)	Mean Width (mm)	Mean Area (mm <sup>2</sup> )	Size Range (Area)
Petals	23.22	2.45	218.17	117.51 - 412.33
Sepals	0.83	0.21	0.16	0.06 - 0.45
Leaves	84.66	7.06	600.49	350.20 - 950.80
Stamens	18.79	0.08	1.40	0.50 - 3.20
Carpel	20.85	0.14	2.96	1.50 - 4.80

From each location, healthy, fully developed flowers and leaves were randomly selected from multiple shrubs. A total of 10 samples (F1-F10) were analyzed, with each sample comprising measurements from several individual plant parts (e.g., 5 petals, 5 sepals per flower).

## 2.2. Morphometric Measurements

For each sample, the following plant parts were measured using digital calipers (precision 0.01mm): Petals: 5 per flower, Sepals: 5 per flower, Stamens: 5 per flower, Carpel: 1 per flower, and 10 leaves per shrub. Plant sample figures are given in figure 1 below.

The length (L) and width (W) of each component were recorded in millimeters (mm). The surface area was calculated using the formula for the area of an ellipse, which provides a good approximation for these plant structures:

$$\text{Area} = \pi \times (L/2) \times (W/2)$$

Figure 1: Nerium Oleander samples collected showing multi colors.(collected by Sahiba Khatoon and Shabu Sadat).

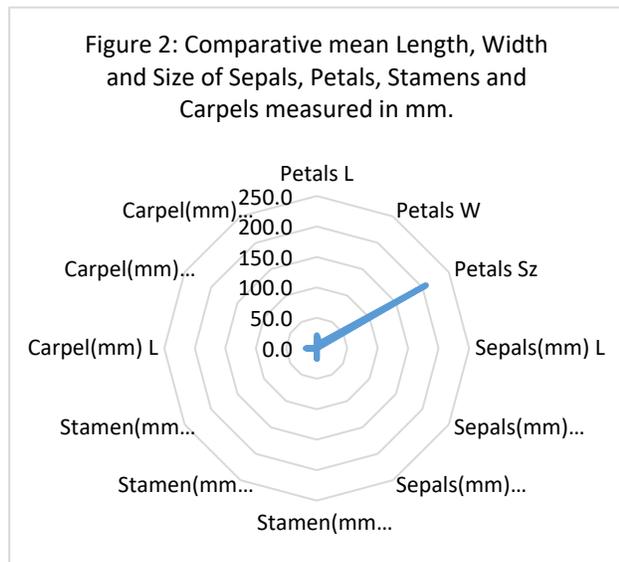
## 2.3. Data Analysis

Mean values for length, width, and area were calculated for each plant part across all samples. Allometric relationships were assessed using simple linear regression, and the coefficient of determination ( $R^2$ ) was used to evaluate the strength of the relationship between the size metrics of different organs. Data was processed and visualized using Microsoft Excel.

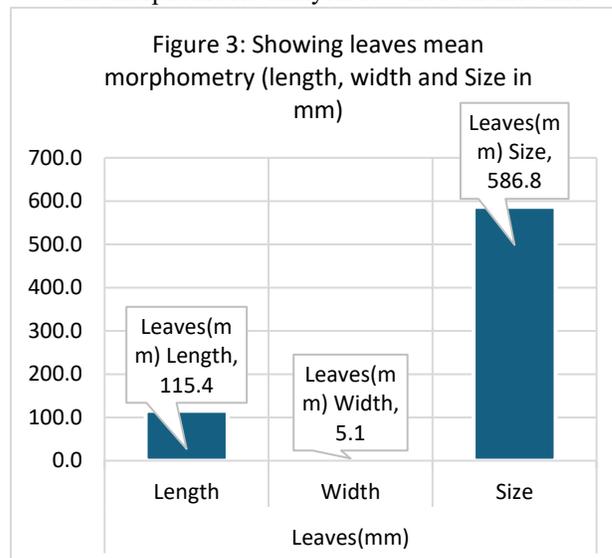


### 3. Results and Discussion

#### 3.1. Summary of Morphometric Traits



The morphometric analysis revealed distinct size



ranges for the different floral and vegetative structures of *N. oleander*. Table 2 summarizes the mean, minimum, and maximum values for the length, width, and area of each plant part.

As expected, leaves had the largest surface area (Mean = 600.49 mm<sup>2</sup>), which is adaptive for photosynthesis. Petals, which serve to attract pollinators, had the second-largest mean area (218.17 mm<sup>2</sup>). The reproductive structures (stamens and carpel) and protective structures (sepals) were significantly smaller.

Table 3: Allometric relationships (R<sup>2</sup> values) between the areas of different plant parts.

	Petal Area	Sepal Area	Leaf Area	Stamen Area	Carpel Area
Petal	1.0000	0.0004	0.0034	0.5210	0.3390
Sepal		1.0000	0.2327	0.4883	0.1666
Leaf			1.0000	0.0592	0.1719
Stamen				1.0000	0.1743
Carpel					1.0000

#### 3.2. Allometric Relationships

Allometric analysis was conducted to explore how the size of one plant part is scaled with another. The coefficient of determination (R<sup>2</sup>) values for the relationships between the areas of different parts are presented in Table 3.

The results show generally weak allometric relationships (low R<sup>2</sup> values). The strongest relationship observed was between petal width and area (R<sup>2</sup> = 0.521), indicating that petal width is a reasonably good predictor of petal area. The weak correlations between most other parts (e.g., Leaf Area vs. Petal Area, R<sup>2</sup> = 0.0034) suggest that these structures may develop somewhat independently,

influenced by different genetic or environmental cues. This lack of strong allometry points towards a high degree of phenotypic plasticity in *N. oleander*, allowing it to modulate the growth of individual organs in response to micro-environmental conditions (Bano & Qureshi, 2019).

#### 3.3. Visual Representation of Data

The following bar chart provides a clear visual comparison of the mean area of the different plant parts, highlighting the vast differences in scale.

Figure 2 and 3: Mean surface area (mm<sup>2</sup>) of different morphological structures in *N. oleander*. The area of leaves and petals is orders of magnitude larger than that of the sepals, stamens, and carpels.

#### 4. Conclusion

This study provides a comprehensive morphometric profile of *N. oleander* from the Gilgit region. The data confirms the basic floral structure (5 petals, 5 sepals, 5 stamens, 1 carpel) but reveals significant quantitative variation in the size of these components. The weak allometric relationships suggest that the growth of floral and vegetative parts is not tightly coupled, which may be an adaptive trait allowing this species to thrive in diverse and variable mountain environments. Future research should correlate these morphological variations with specific soil and climatic data from the collection sites to better understand the drivers of this phenotypic plasticity.

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