



## Allomorphic study of *Zinnia elegans* species collected from Gilgit, Pakistan

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**Abstract:** *Zinnia elegans* is valued for its medicinal and ornamental properties. Moreover, it is preferred for its adaptability in varied environmental conditions. Besides its global presence, cultivated in all agroecological regions in Pakistan. This study was designed to investigate impact of different edaphic and climatic conditions including sunshine, slop, moisture, day length and altitude on the gene expressions controlling length, width and size (area) of leaves, sepals, petals, stamens and carpels. The study also investigated allometric factors and relationships. Three major sample sites were identified with long, short and moderate sunshine, slope and moisture content (Burmash-Gilgit, Sonikot-Gilgit and Daniyore-Gilgit). 100 samples were collected from each sampling site making a total of 300 samples. Current study revealed that there are 6 sepals. Mean length of sepals recorded was 0.86 cm, width 0.40 cm and area was 0.35 cm<sup>2</sup> ( $R^2 = 0.3151$ ). Similarly, there are 6 petals in number. Mean length was 2.51 cm, width 1.03 cm, and area was 2.60 cm<sup>2</sup> ( $R^2 = 0.0131$ ). Mean length of stamens was 1.12 cm, width 0.19 cm and area of 0.21 cm<sup>2</sup> ( $R^2 = 0.3151$ ). Mean length of carpels was 0.09 cm, width 0.01 cm, and area was 0.01 cm<sup>2</sup> ( $R^2 = 0.134$ ). Leaf mean length was 0.49 cm, width 0.29 cm, and area 2.05 cm<sup>2</sup>. Research concluded that different parts of the plant behaved differently towards varied climatic conditions. Stamens and carpels prefer moderate sunshine and day length and plain neutral (non slopy areas). Similarly, leaf area (size) showed an inverse relation to sunshine and day length whereas there was a direct relation between the leaf size and the moisture content. Contrarily, leaf has shortest length in moderate non slopy areas with broadest width. In an overall preference of plant, best growth was recorded in the slop neutral areas (Sonikot in Gilgit) with moderate sunshine, day length and moisture content. Findings from the research suggest that *Zinnia elegans* commercial nurseries can be established better in Sonikot as compared to rest of the areas in Gilgit.

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**Key words:** Morphometry; Allometry; *Zinnia elegans*; Hybridization; Ornamental; Medicinal

### 1. Introduction

Allomorphic refers to the morphometric and allometric study of any species. Morphometrics, the quantitative analysis of form, encompasses the study of size and shape across various organisms or their parts (Ashburner & Ridgway, 2005). Allometry, a sub-discipline of morphometrics, investigates the relative growth of specific parts in relation to the whole organism. It can be studied at different levels: ontogenetic allometry examines growth changes within an individual over time, static allometry focuses on variations among individuals at the same developmental stage, and evolutionary allometry explores differences among species (Sherratt, McCullough, & Painting, 2022).

*Zinnia elegans*, a prominent annual flowering plant from the Asteraceae family, is renowned for its ornamental value and versatility in garden design. Commonly used in borders, beds, cottage containers, and landscapes, Zinnias are cultivated extensively in Pakistan (Nassir, 2004). The planting season begins in April, with flowers typically available until October. Known for attracting butterflies, hummingbirds, and other pollinators, Zinnias are prized for their bright colors and long-lasting blooms (Johnson & Kassler, 2007). They are well-suited to dry, sunny environments, making them ideal for areas where other flowers might struggle (Zamiran et al., 203; Ahmad et al., 205; Pallavi et al., 207).

The study of *Zinnia elegans*' morphometric and allometric characteristics provides insights into how different environmental conditions influence plant growth and development. By analyzing changes in leaf area, flower diameter, and stem growth across various sites, this research aims to understand the morphometric and allometric relationships in *Zinnia elegans*. This understanding is crucial for optimizing cultivation practices and enhancing ornamental and ecological benefits.

*Zinnia elegans* typically grows between 30-90 cm in height, with a corresponding width of up to 45 cm. The flowers vary from single to fully double forms, with a diameter ranging from 5-0 cm, and the leaves are generally 3-7 cm long and -4 cm wide (Gardenia, n.d.). The plant's ability to thrive in various environmental conditions and its aesthetic appeal make it an excellent candidate for studying morphometric and allometric patterns.

In addition to its ornamental value, *Zinnia elegans* has potential applications in medicine and phytoremediation. By investigating the effects of different growing conditions on the plant's traits, this research aims to contribute valuable knowledge to both horticultural practices and scientific understanding of plant growth dynamics.

## 2. Material and Methods

**Study Area:** Samples were collected from three different major sites in the administrative district of Gilgit in Gilgit-Baltistan, Pakistan. These areas were Khur Barmas, Sonikot and Danyore (see figure ). These sampling sites were Sonikot (neutral facing), Danyore (south facing) and Khur Barmas (north facing) at varied altitudinal gradients (See table ).



Figure 1: Map of the study area marked in red circle. Overall map shows administrative districts in Gilgit-Baltistan, Pakistan

**Variables:** These areas were selected to reflect variation in climatic conditions including altitudinal gradient, slop face, water availability, moisture content, temperature, sunshine and day length. These external factors were taken as independent variables. However, growth in length, width and size of leaves, sepals, petals, stamens and carpels were considered as dependent variables.

**Sampling:** Samples were collected purposefully from the selected areas. A total of 00 mature plants were collected for quantitative measurements (see figure 2).



Figure 2: Shows varied flower coloration, behavior and expression. Photograph by Misbah

**Data Processing:** Careful measurements were taken and digitized the data in MS Excel before transported to SPSS for further statistical testing and analysis.

Table 1: Shows latitude, longitude and elevation of sample sites. Elevation in given in mean feet above sea level.

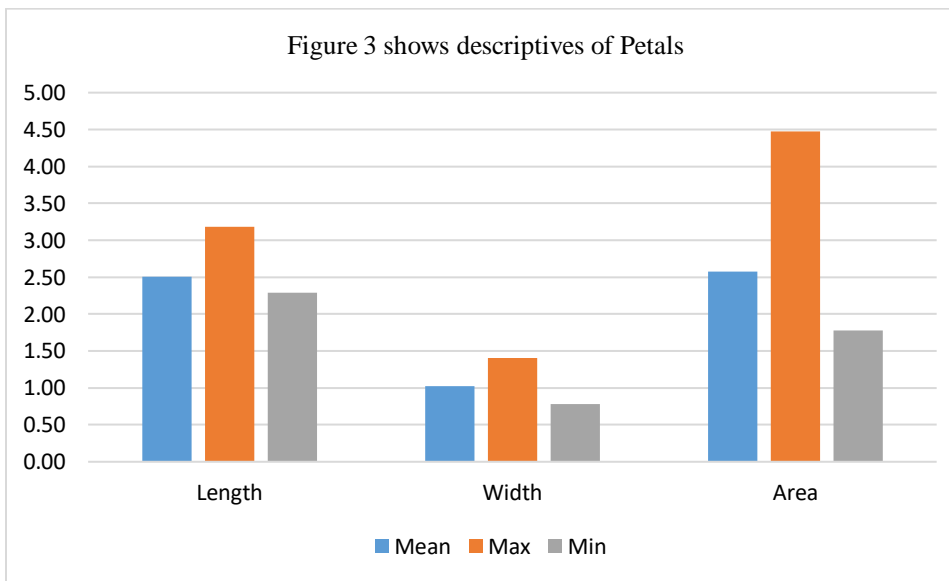
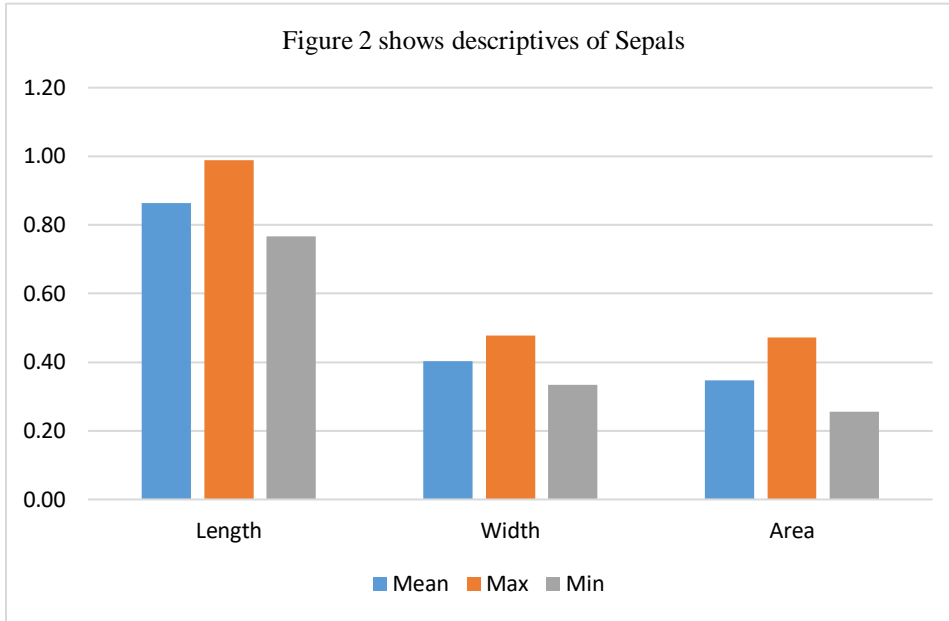
Location	Longitude (E)	Latitude (N)	Altitude (feet)
Sonikot	74.3437° E	35.98° N	4,803.5
Daniyor	74.388° E	35.997° N	6,56.68
Khur Barmas	74.6038° E	35.6884° N	6,758.53

### 3. Result and Discussion:

Careful measurement of leaves, sepals, petals, stamens and carpel for length (cm), width (cm), area (cm<sup>2</sup>) was made. It revealed that there are 6 sepals. The mean length of sepals recorded was 0.86 cm, followed by width of 0.40 cm and the mean area is 0.35 cm<sup>2</sup>. The R<sup>2</sup> value for sepal measurements is 0.35. The range between maximum and minimum for the length and width was 0.9 - 0.7 cm followed by 0.4 0.3 cm respectively (figure 2)

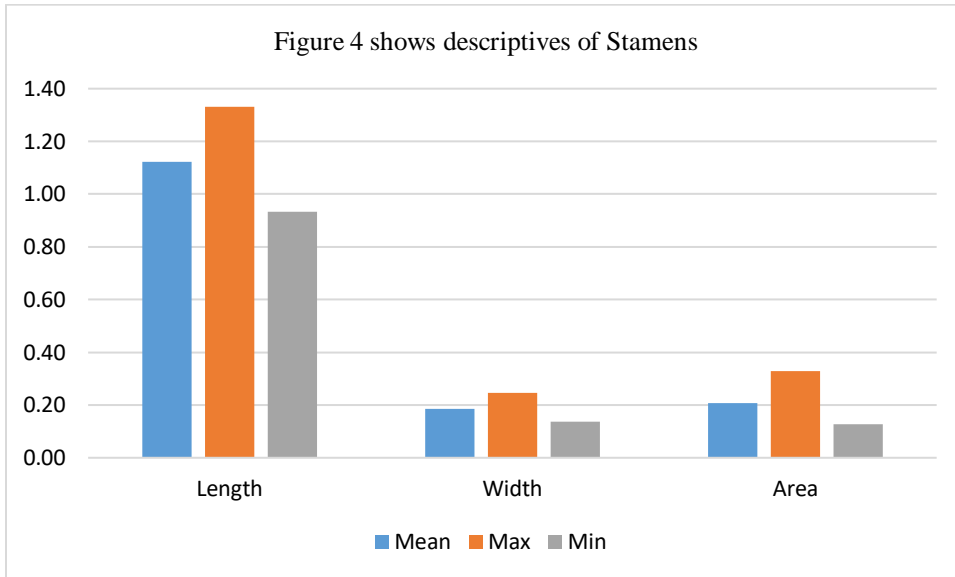
There was no significant variation in sepal characteristics across different environmental conditions, suggesting minimal impact from changes in slope, water availability, temperature, or altitude.

For petals, also recorded as 6, the mean length was 2.5 cm, the mean width was .03 cm, and the mean area was 2.60 cm<sup>2</sup>. The R<sup>2</sup> value for petal measurements was 0.03, reflecting minimal variation. The length of petals ranged from 2.29 cm to 3.8 cm, and the width varied from 0.78 cm to .4 cm (figure 3). Petal parameters are highly responsive to climatic conditions, showing distinct variations based on environmental factors. Extended sunlight exposure, increased water availability, and higher temperatures contribute to the optimal growth and health of petals. In the samples from Sonikot, petals were notably broader and larger compared to other groups. Daniyor also exhibited relatively larger petals compared to Khur Barmas. While Khur Barmas and Daniyor had similar petal lengths, Daniyor's petals were overall larger.



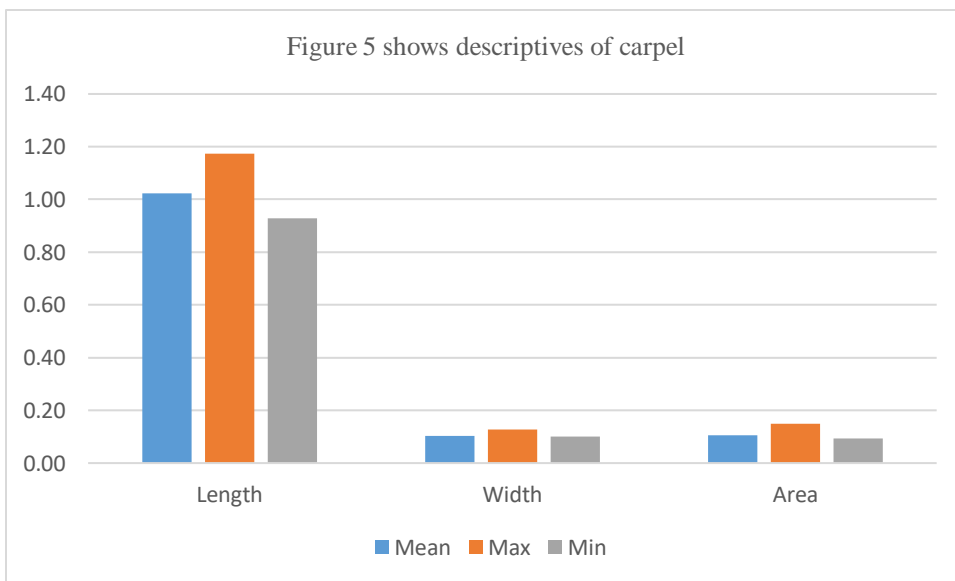
For stamens mean length of stamens is .2 cm, with a mean width of 0.9 cm and a mean area of 0.2 cm<sup>2</sup>. The R<sup>2</sup> value for stamen measurements is 0.35. The length ranges from 0.93 cm to .33 cm, and the width ranges from 0.4 cm to 0.25 cm.(figure 4)

In the Sonikot samples, stamens exhibit the longest mean length, suggesting that stamens in this group are more elongated compared to others. Khur Barmas and Daniyior show similar mean lengths and areas for stamens, with only minor differences in the range of values observed.



For Carpels the parameters of carpel are sensitive to environmental conditions, with noticeable variations across different groups. The mean length of carpels is 0.09 cm, the mean width is 0.0 cm, and the mean area is 0.0 cm<sup>2</sup>, with an R<sup>2</sup> value of 0.34. The length ranges from 0.0 cm to 0.3 cm, and the width ranges from 0.09 cm to 0.2 cm.(figure 5)

In the Sonikot samples, carpels have the longest mean length, indicating more elongated carpels compared to other groups. While Khur Barmas and Daniyori show similar mean lengths and widths, Sonikot exhibits a slightly broader range in carpel length.



Leaf parameters reveal considerable variation across different groups. The mean length of leaves is 0.49 cm, with a mean width of 0.29 cm and a mean area of 2.05 cm<sup>2</sup>. The length ranges from 3.7-5.39 cm, and the width ranges from .2-2.08 cm (figure 6)

Khur Barmas displays the largest mean leaf length and area, indicating the most substantial leaves overall. Daniyori also shows slightly larger mean leaf length and area compared to Sonikot, reflecting marginally larger leaves. Sonikot, on the other hand, has the smallest mean leaf length and area but exhibits a broader range in leaf width.

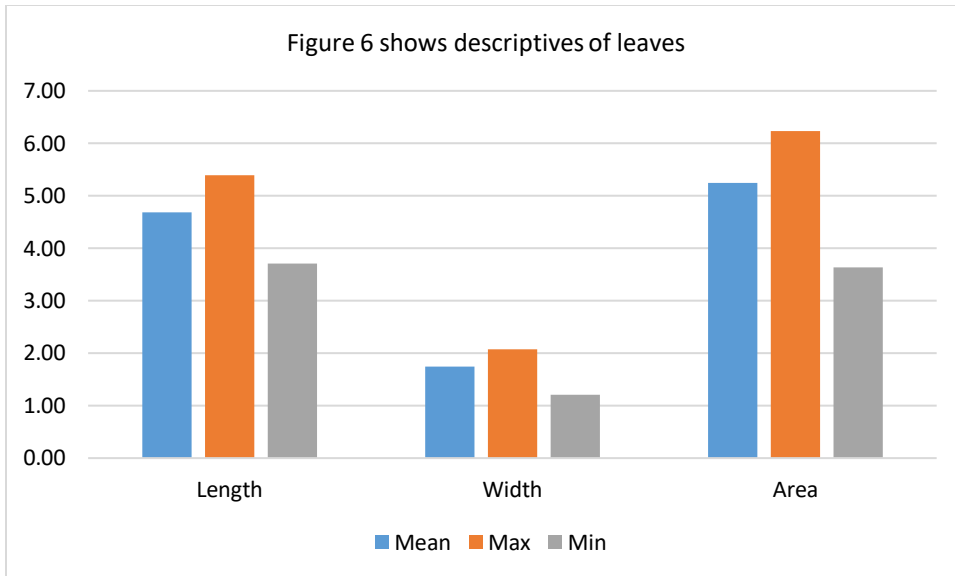
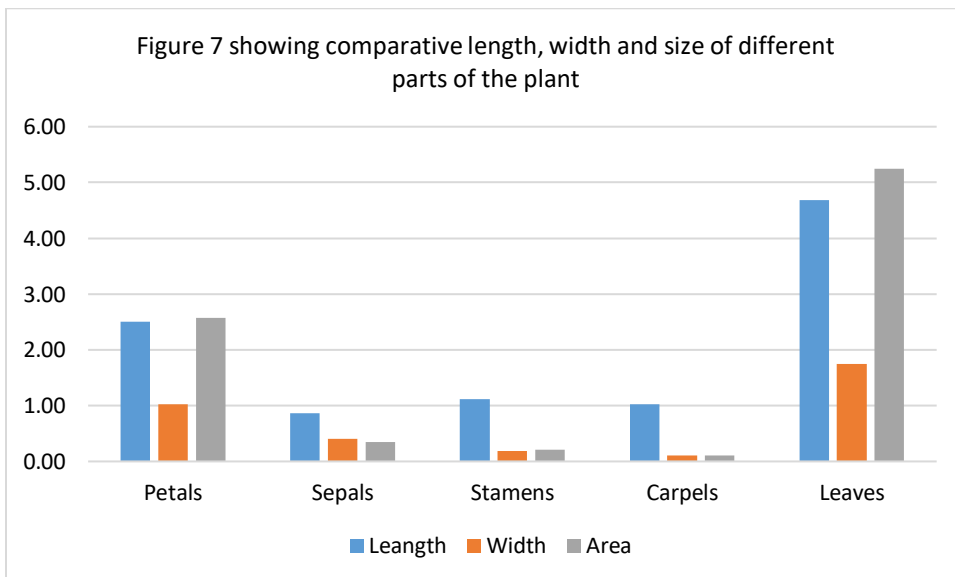
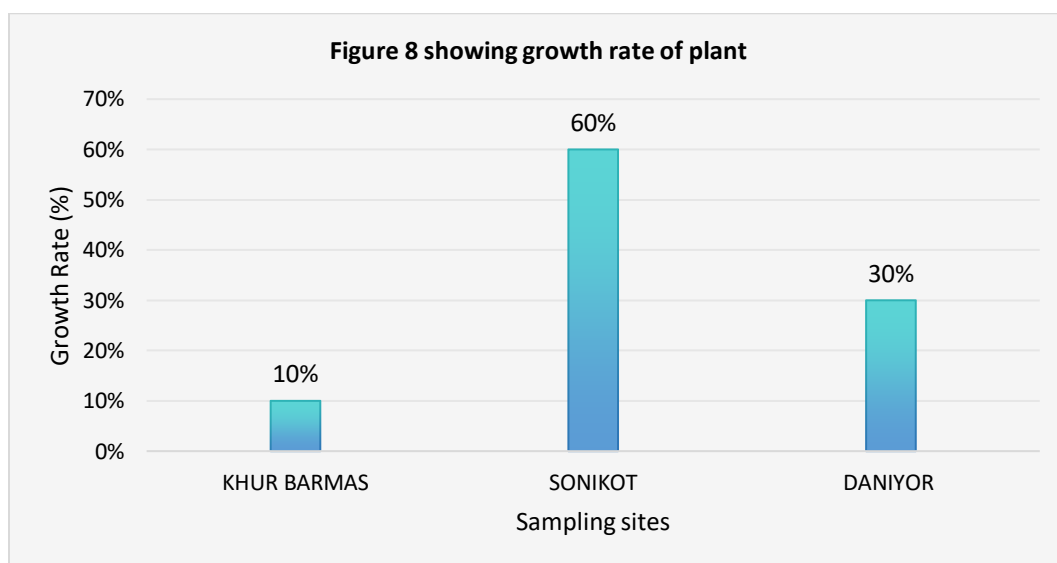


Figure 7 shows relative and comparative characteristics of different plant parts. Where petals are near 86.5% bigger than the sepals and likewise stamens are 49.0% bigger than the carpels. These features showed a consistency in the overall floral characteristics.



From the growth perspective, (figure 8 )The allometric study of *Zinnia elegans* across Sonikot, Daniyori, and Khur Barmas reveals distinctive regional influences on plant traits, guiding effective cultivation strategies. Sonikot stands out with a significant growth rate of 60%, making it the premier location for enhancing floral features. This region excels in producing the largest petal width and area, along with the longest stamens and carpels, supporting substantial floral development. Daniyori, contributing 30% to the growth rate, shows slightly larger leaves compared to Sonikot, with a mean length of 4.85 cm and an area of 8.97 cm<sup>2</sup>, although its sepals are smaller than those in Khur Barmas. Khur Barmas, accounting for 10% of the growth rate, is optimal for sepal development, with the highest mean sepal length, and also produces the longest leaves, averaging 4.84 cm in length and 8.93 cm<sup>2</sup> in area. This distribution allows growers to leverage the strengths of each location Sonikot for superior floral traits, Daniyori for slightly larger leaves, and Khur Barmas for exceptional sepal and leaf size enabling targeted cultivation strategies to maximize plant growth and quality.



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### Author competing interest

Authors declare that there is no competing interest.

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