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Allomorphic Characterization of *Gazania rigens* (Treasure Flower) from Gilgit, Pakistan

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Abstract: *Gazania rigens* is a perennial species originating from South Africa and an ornamental plant of drought resistance and adaptability to poor soil conditions. The current study explores morphometric and allometric variation in G. rigens with special reference to floral and leaf structures, as well as their association with environmental factors. Key morphological traits measured included sepals, petals, stamens, carpels, and leaves, obtained from samples at different altitudes. Petal and leaf size means, largest were 76.43 and 1343.73 mm² respectively. Lowest were carpels mean areas i.e., 1.53 mm². More variance in petal and leaves measurement was observed and was directly proportional to sunlight and temperature. The study also resulted in the fact that total floral parts remain the same each and every time with the range 10 petals, 10 sepals, 5 stamens, and 5 carpels. These findings point toward the genetic and environmental roles underlying the morphological diversity of G. rigens, illuminating its ecological adaptability as well as ornamental value.

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1. Introduction

Gazania rigens (L.) Gaertn., known as the treasure flower, is a flowering perennial herb in the Asteraceae family and is an endemic plant to South Africa. It is valued for its bright, daisy-like flowers in a wide range of colors, from vibrant yellows and oranges to reds (Pooley, 1998; Van Wyk & Malan, 1997). The adaptability of *Gazania rigens* to various environmental conditions and its phenotypic plasticity make it an excellent subject for morphometric and allometric studies (Smith et al., 2020). These studies shed light on the plant's morphological variation, ecological adaptation, and evolutionary processes (Bookstein, 1991; Rolf & Marcus, 1993).

Morphometric analysis is quantitative measurement of form. It is the means through which one could understand variation and covariation in the morphological traits of organisms within and between species (Bookstein, 1991). This method is of prime importance in taxonomy, evolutionary biology, and ecological research (Sharma & Sharma, 2014). Several studies on *Gazania rigens* have used morphometric analyses in assessing its phenotypic variability, which may be an artefact of genetic as well as environmental factors (Brown & Johnson, 2019; Leitch & Bennett, 2007). Such a relationship between the traits morphological and environmental is paramount for understanding how this species manages to adapt to diverse climate as well as soils (Gurib-Fakim, 2006).

On the contrary, allometry examines how an organism's size is relative to the sizes of its different morphological, physiological, and behavioral elements (Huxley, 1932). From the applications of allometric analysis on *Gazania rigens* , connections between plant size and growth patterns, resource allocation, and adaptive strategies that make the species fit for nutrient poor as well as drought-prone environments are found (Gould, 1966; Ramasamy & Kandasamy, 2018). It enables the integration of both morphometric as well as allometric analyses, to provide a comprehensive understanding in this species about the functional as well as structural diversity occurring within this species, taking our knowledge further on genetic as well as environmental factors behind phenotypic variation (Capon, 2010).

1.1. Morphology

Gazania rigens is a small perennial herb usually growing to a height of around 6–10 inches tall, with a spread of around 12 inches (Smith et al., 2020). Its flowers are particularly showy, coming in a wide range of colors, including orange, red, yellow, and pink, often with contrasting central discs (Pooley, 1998).

The leaves of the plant are lance-shaped, and have a distinctive color contrast, being dark green on the upper surface and silvery-white beneath, due to a dense covering of fine hairs. These adaptations likely explain why the plant can conserve water and thrive in dry, nutrient-poor environments, characteristic of its native habitat (Van Wyk & Malan, 1997).

The ability of the plant to survive under harsh conditions also makes it a popular choice for xeriscaping and as an ornamental groundcover in arid regions (Brown & Johnson, 2019). Morphological characteristics such as the size and shape of the leaves and flowers are important traits that contribute to its ecological success and ornamental value. Its heliotropic behavior, where flowers open in response to sunlight, enhances pollination success and attracts a range of pollinators (Gurib-Fakim, 2006).

1.2. Genetics

Genetic diversity is the main cause of the adaptability and variation in flower color for *Gazania rigens* . Scientists have found a number of genes involved in pigment biosynthesis, responsible for the brilliant colors exhibited by the flowers of this plant (Smith et al., 2020). This genetic variability not only allows the plant to produce a wide range of flower colors but also facilitates its ability to adapt to various environmental conditions, including drought tolerance and soil nutrient variability (Ramasamy & Kandasamy, 2018). In addition, the genetic makeup of the plant is also a determining factor in its ability to withstand herbivory and pathogen pressures, thereby enhancing its overall fitness in its native and introduced habitats (Gurib-Fakim, 2006).

The genetic plasticity of G. rigens has largely been responsible for its adaptive nature, which allows the species to thrive in different ecological niches. The plasticity is also crucial in conservation and sustainable use of the species, especially in regions where climate change and environmental degradation may alter its natural habitat (Leitch & Bennett, 2007).

1.3. Cytogenetics

Cytogenetic analysis of *Gazania rigens* showed that the species is diploid, with a chromosome number of $2n = 20$ and a basic chromosomal number of $x = 10$ (Sharma & Sharma, 2014). The karyotype of G. rigens consists of metacentric and submetacentric chromosomes, which are vital for maintaining the stability and fertility of the species. The chromosomal structure is essential in the reproduction and adaptation of the species to environmental pressures, giving the necessary genetic background for morphological and ecological diversity (Gould, 1966; Huxley, 1932). Knowing the chromosomal structure of G. rigens also provides insight into its evolutionary history and possible future genetic research.

1.4. Phytochemistry

Phytochemical research has isolated several bioactive compounds in *Gazania rigens* , including terpenoids, tannins, and flavonoids. These secondary metabolites are believed to play a crucial role in the defense mechanisms of the plant against herbivores and pathogens (Balunas & Kinghorn, 2005; Brown & Johnson, 2019). For instance, terpenoids and flavonoids are recognized for their antioxidant and anti-inflammatory properties, which could also contribute to the medicinal potential of the plant (Gurib-Fakim, 2006). These compounds are important not only for the ecological interactions of the plant but also have therapeutic applications, making *Gazania rigens* a potential source of bioactive compounds for pharmaceutical and medicinal purposes (Leitch & Bennett, 2007).

The presence of these bioactive compounds further underlines the importance of *Gazania rigens* in both ecological and human health contexts. It can be promising for research development into natural remedies or bio-based products if its phytochemical properties continue to be explored, Balunas & Kinghorn (2005).

2. Material and Methods

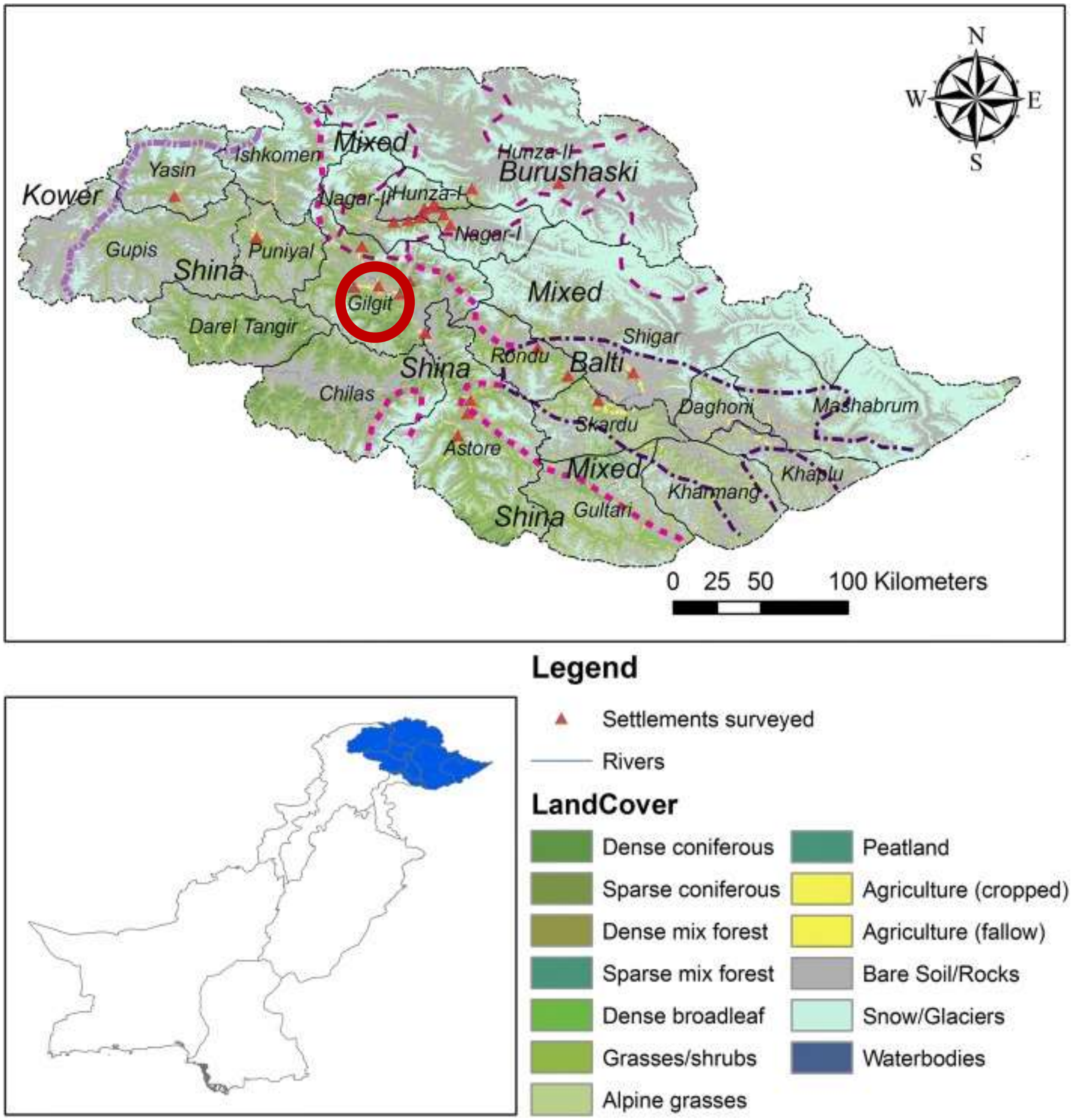


Figure 1: Map of the study area shown in red circle. Map taken from https://europepmc.org/article/med/30691476 on November 30, 2024 and optimized.

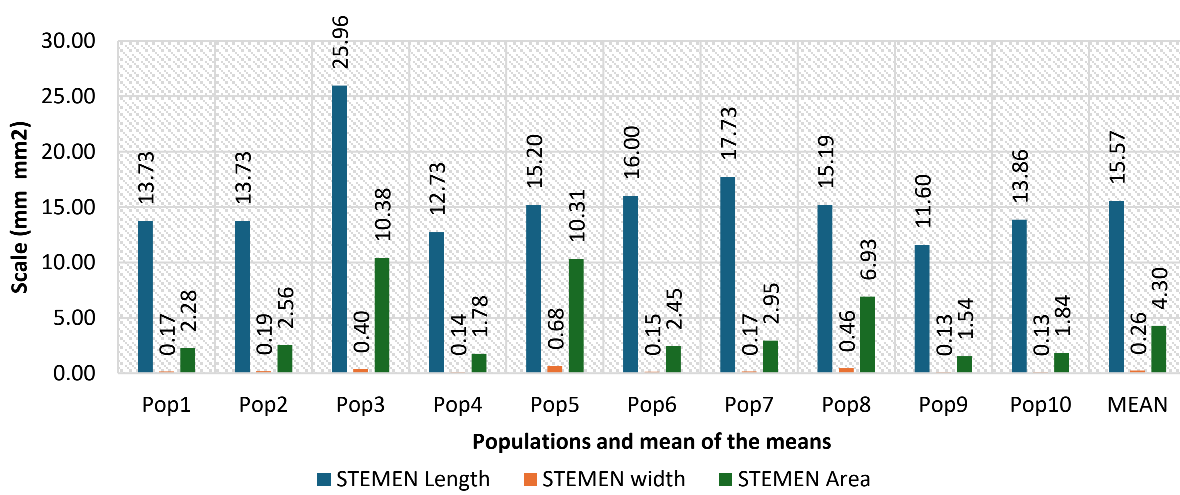
2.1. Sampling

The total of 200 *Gazania rigens* (see figure 2) plants in 10 sites in the main campus of Karakoram International University (KIU) was systematically identified for this study. For each plant, three leaves and three flowers were sampled. Total sample size will be 600 leaves and 600 flowers. Geographical coordinates and elevations of the studied locations are shown in Table 1.

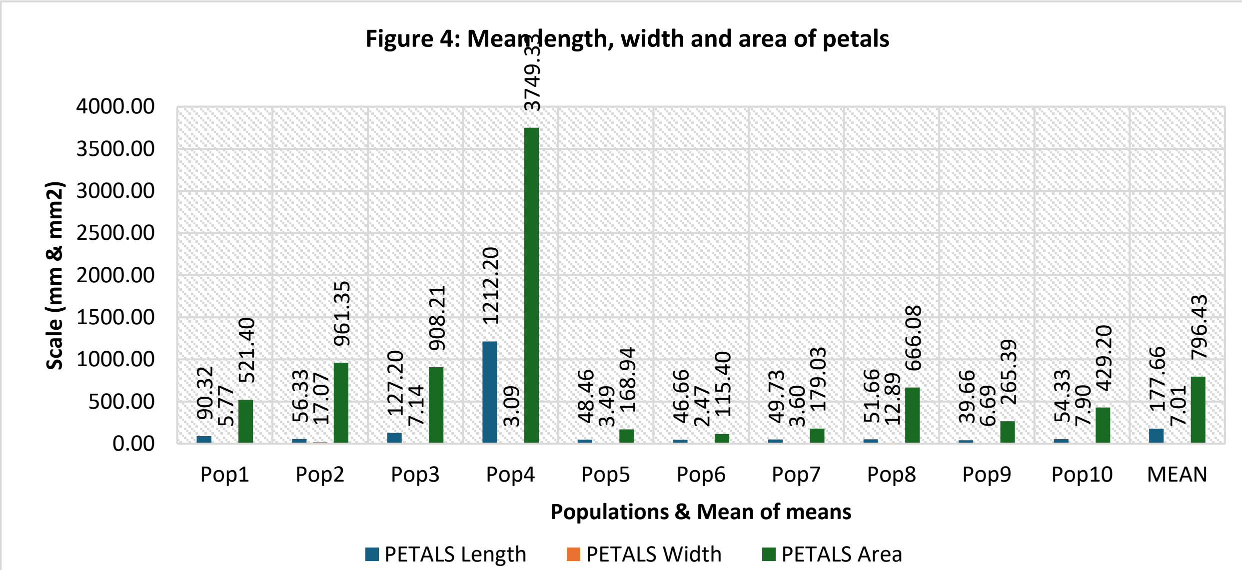
All flower and leaf specimens were collected and preserved by pasting them onto blotting paper to avoid distortion of their structures. This way, scaling was proper for further analysis.

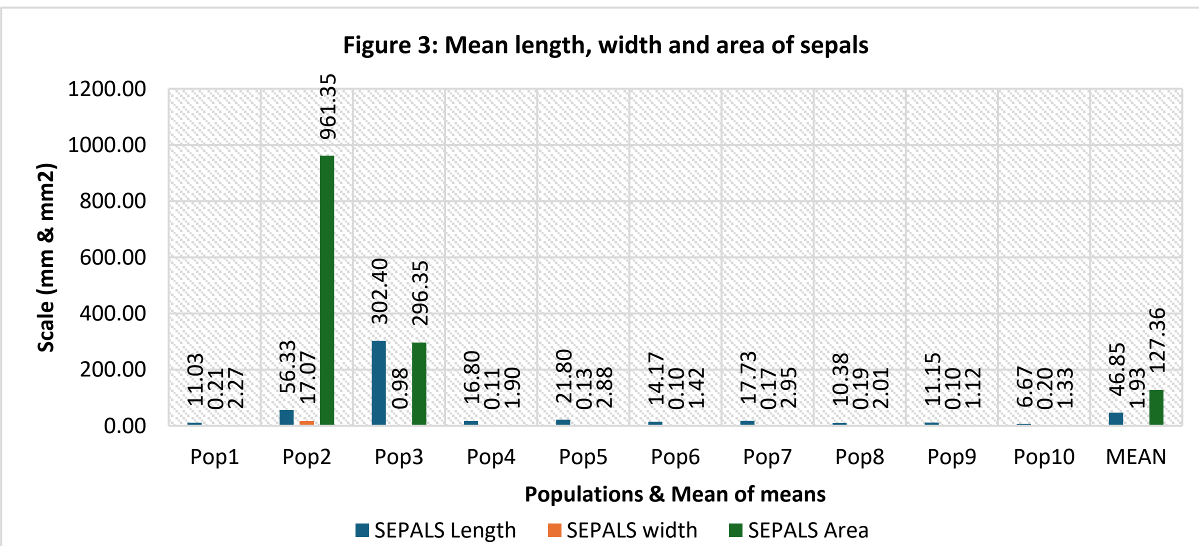
Figure 2: Gazania rigens collected from the main campus of Karakoram International University, Gilgit. Photograph by Reena Aqil

Figure 5: Mean length, width and area of Stamen



Descriptive Statistics: Mean and standard deviations.
Inferential Statistics: Analysis of Variance (ANOVA), Multivariate Analysis of Variance (MANOVA), t-tests, and correlation analysis.





2.2. Parameters Studied

For each flower, key morphological components, including sepals, petals, stamens, and carpels, were measured for their length (mm) and width (mm). Leaf measurements included length (mm) and width (mm). The area (mm²) of both floral and foliar parts was calculated by the formula:

Area = Length × Width

2.3. Data Processing and Analysis

The recorded measurements were digitized using Microsoft Excel 365. The digitized dataset was further processed and analyzed using Microsoft Excel and SPSS software version 16. Descriptive and inferential statistical analyses were conducted with the help of tests, including the following:

These statistical methods were used to analyze differences both within and between the samples to provide information about morphological trends and the possible correlations.

3. Results

The morphometric analysis of the *Gazania rigens* gathered from the Karakoram International University campus showed a detailed measurement of the key floral components, such as sepals, petals, stamens, carpels, and leaves. The findings are as follows:

•**Sepals**: There are 10 sepals in each flower. The mean length was 46.85 mm (R^2 = 0.1351), with a width of

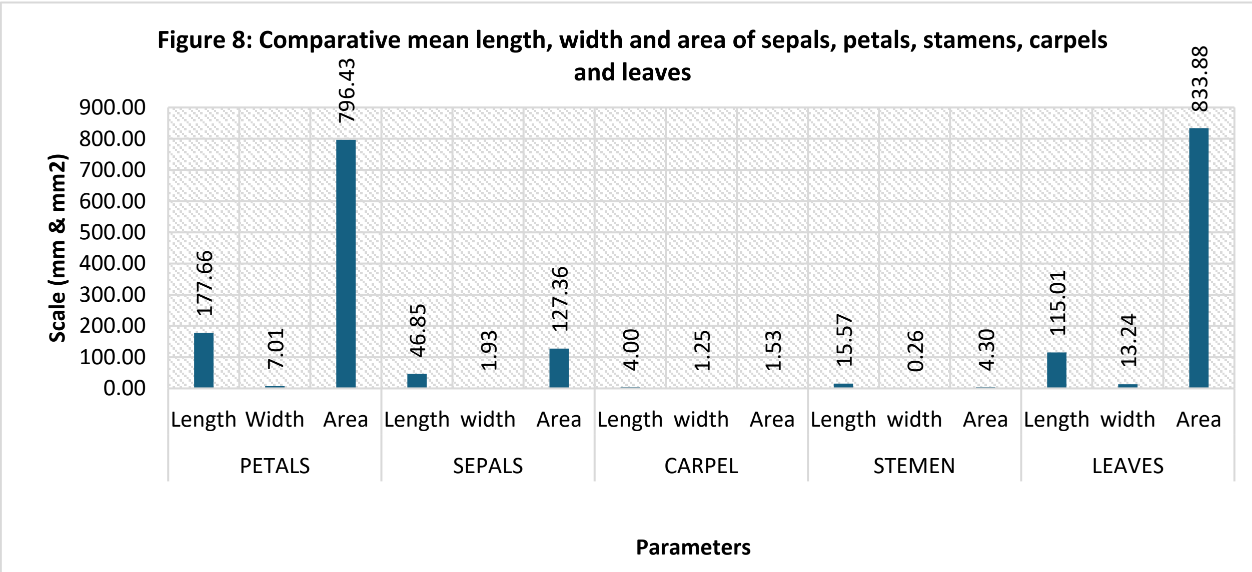


Figure 8: Comparative mean length, width and area of sepals, petals, stamens, carpels and leaves

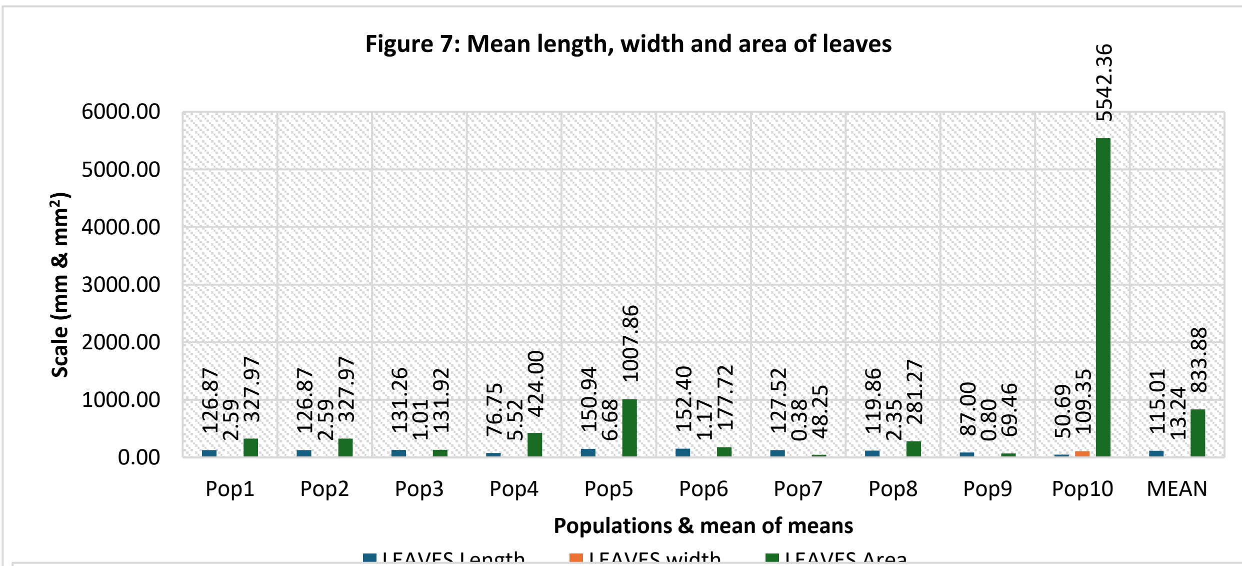


Figure 7: Mean length, width and area of leaves

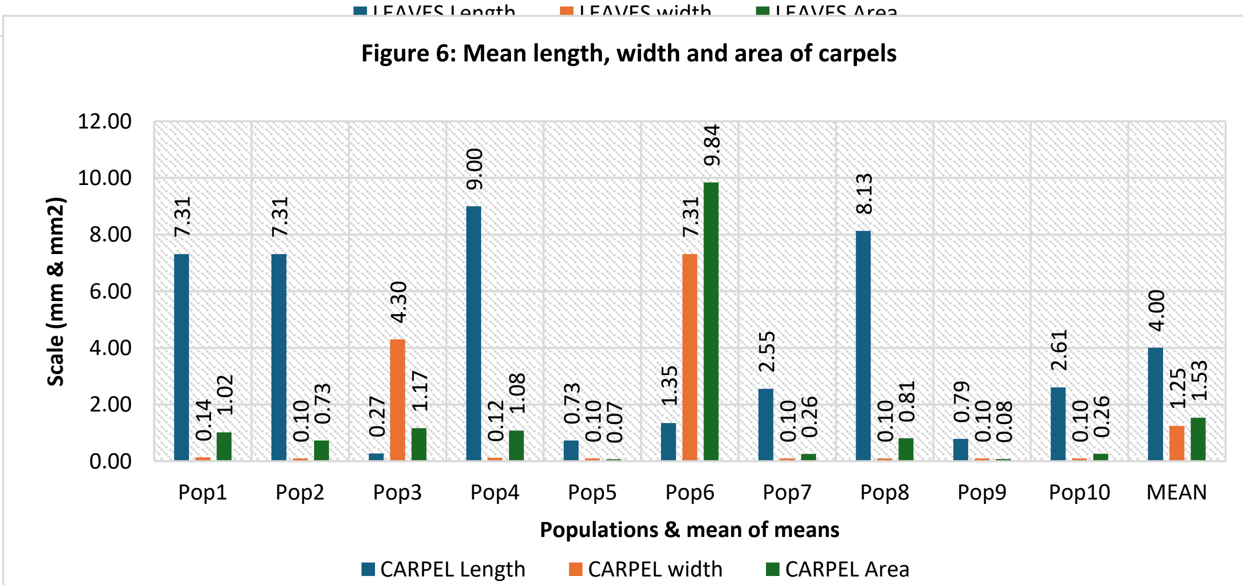


Figure 6: Mean length, width and area of carpels

1.93 mm (R^2 = 4.1784). The mean area was 4.30 mm²

(R^2 = 0.2398) (see figure 3).

•**Petals**: The flowers have 10 petals, with a mean length of 177.66 mm (R^2 = 0.047), a width of 7.01 mm (R^2 = 0.009), and a mean area of 76.43 mm² (R^2 = 0.0901) (see figure 4).

•**Stamens**: Each flower has five stamens, with a mean length of 15.57 mm, a width of 0.26 mm, and a mean area of 4.30 mm².

•**Carpels**: Five carpels are present in each flower. The mean length of carpels is 4.00 mm (R^2 = 0.003), with a width of 1.25 mm, and mean area of 1.53 mm² (see figure 6).

•**Leaves**: The mean length of leaves was 110.01 mm (R^2 = 0.2848), with a width of 8 mm (R^2 = 0.018), and a mean area of 1343.73 mm² (R^2 = 0.0065). (see figure 7).

Comparison: Figure 8 given here below showed the relative and comparative length, width and area of petals, sepals, carpels, stamens and leaves.

Our study reveals that the size and shape of the leaves are strongly driven by climatic conditions. A positive relationship between size and environmental variables, such as slope, sun, and temperature, has been indicated. This therefore shows that *Gazania rigens* is phenotypically sensitive to environmental variables.

4. Discussion

The present paper provides an insight into morphometric and allometric traits of the treasure flower, *Gazania rigens* , obtained from the Karakoram International University campus. The research findings reveal the significant phenotypic plasticity of the species and may be due to both genetic as well as environmental factors.

Floral Morphometric Variation

The morphometric analysis of *Gazania rigens* revealed significant variation in the size and area of its floral parts, including sepals, petals, stamens, carpels, and leaves. The observed variations in the size of the petals and sepals (mean area of petals: 76.43 mm², mean area of sepals: 4.30 mm²) align with previous studies indicating that flower size in *Gazania rigens* can vary significantly across geographical regions and environmental conditions. For instance, Smith et al. (2020) reported a similar variation in flower form, which they attributed to local environmental factors such as temperature, water availability, and sunlight. These results suggest that *Gazania rigens* possesses high phenotypic plasticity, enabling it to modify its floral structures based on diverse growing conditions.

The fact that all the samples had the same number of stamens and carpels (five each) means that the specie's reproductive organs are genetically stable. This is in accordance with the general biological principle where structures that take part in reproduction tend to be conserved among different environments. This conservation ensures that there is successful pollination and reproduction.

Effects of Environmental Factors on Leaf Form

One of the most interesting things for me in this study has been the effect of environmental conditions, especially sunlight, temperature, and slope, on the size and shape of the leaves. The data demonstrated a clear correlation between leaf size and these environmental variables. The larger leaf size of this plant, with a mean area of 1343.73 mm², found in areas with higher sunlight exposure and optimal temperatures, indicates an investment of more resources by the plant in photosynthesis for these conditions. This follows the concept of "phenotypic plasticity," in which plants adjust their morphological traits to maximize survival and reproductive success in response to environmental pressures (Bradshaw, 1965).

A study by Pooley (1998) on South African Gazania populations found that leaf morphology varied significantly in response to climatic factors, particularly in areas with variable water availability. Similarly, our findings suggest that *Gazania rigens* at the Karakoram campus may also exhibit such adaptive responses, possibly as a strategy to optimize water use in the region's dry conditions. The thicker, more robust leaves found in plants grown in sunnier, warmer areas can be considered an adaptive characteristic for drought tolerance, because the transpiration loss decreases.

Genetic and Allometric Observations

The results obtained by our study, such as diploid chromosome count, 2n = 20 and basic chromosomal number x = 10, coincides with earlier cytogenetic studies of *Gazania rigens* (Sharma & Sharma, 2014). This simple chromosomal structure may be one of the reasons why the plant is reproductive and stable in different environments. The fact that the number of carpels and stamens is constant in all samples also supports the idea that the reproductive biology of the plant is stable and not subject to significant environmental fluctuations, which would be essential for the plant's ongoing adaptability.

From the allometric studies, the size does influence morphological traits in *Gazania rigens* . Our data indeed suggest that as the size of the plant increases so does that of the dimensions of important floral elements such as the petals, sepals, and leaves-a generalization expected by general principles of plant allometry as suggested by Huxley in 1932. Also, it is a result of size-related and/or shape-related strategies that help in achieving resource optimization that enhances the reproduction success as well as survival.

Ecological and Evolutionary Implications

Ecologically, the morphological plasticity of *Gazania rigens* allows it to increase its ecological resilience in respect of differing environmental conditions. The species can thus be hardy in a variety of habitats, from dry low-water areas to better or more favorable places. This plasticity of the floral and leaf characters in the plant demonstrates the role of both genetic and environmental factors in molding the morphology of the plant. Thus, *Gazania rigens* may provide a valuable model for the study of the adaptive strategies of drought-tolerant plants.

From the evolutionary perspective, the considerable variation in floral traits may also be an indication of ongoing hybridization events. The observed color variation, in white, orange, and pink forms, would tend to suggest hybrid vigor in potential where different genotypes might interact to produce new combinations of the phenotype. In fact, hybridization of plants normally tends to increase the genetic diversity in the organism that is said to contribute toward adaptation with changes in environmental conditions over a long period (Rolf & Marcus, 1993). Further research on the genetic diversity of *Gazania rigens* would further uncover the importance of hybridization in the species' evolutionary line.

5. Conclusion

The findings from this research experiment reveal the interplay of genetic and environmental factors that shape the morphological aspect of *Gazania rigens* . Using morphometric and allometric methods, we have discovered a deeper insight on how this plant survives the environment. The findings add to the bigger picture of our knowledge concerning phenotypic plasticity and the function that morphological traits play in determining the survival and reproduction mechanisms in xerophytic plants such as *Gazania rigens* . Future research on *Gazania rigens* can center on genetic mechanisms causing these morphological differences to happen and further the examination on ecological interactions with the species' pollinators or on its role in the given ecosystem.

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Author Contributions

This study was conducted as a semester project and was guided by Dr. Tika Khan.

Competing Interests
The authors declare no competing interests.

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References

1. Balunas, M. J., & Kinghorn, A. D. (2005). Drug discovery from medicinal plants. *Life Sciences*, 78(5), 431-441.
2. Bookstein, F. L. (1991). *Morphometric Tools for Landmark Data: Geometry and Biology*. Cambridge University Press.
3. Brown, L., & Johnson, T. (2019). Phytochemical properties of *Gazania rigens* and their ecological implications. *Plant Science Today*, 12(2), 87-98.
4. Capon, B. (2010). *Botany for gardeners*. Timber Press.
5. Gould, S. J. (1966). Allometry and size in ontogeny and phylogeny. *Biological Reviews*, 41(4), 587-640.
6. Gurib-Fakim, A. (2006). Medicinal plants: Traditions of yesterday and drugs of tomorrow. *Molecular Aspects of Medicine*, 27(1), 1-93.
7. Huxley, J. S. (1932). *Problems of Relative Growth*. Methuen & Co.
8. Leitch, I. J., & Bennett, M. D. (2007). Genome downsizing in plants. *Botanical Journal of the Linnean Society*, 82(3), 407-438.
9. Pooley, E. (1998). *Wild Flowers of South Africa*. Fernwood Press.
10. Ramasamy, S., & Kandasamy, P. (2018). Genetic diversity and conservation of flowering plants. Springer.
11. Rolf, F. J., & Marcus, L. F. (1993). A revolution in morphometrics. *Trends in Ecology & Evolution*, 8(4), 129-132.
12. Sharma, A. K., & Sharma, A. (2014). *Chromosome Techniques: Theory and Practice*. Butterworth-Heinemann.
13. Smith, J., et al. (2020). Morphological and genetic diversity in *Gazania rigens* . *Journal of Botanical Research*, 45(3), 123-135.

14. Van Wyk, B., & Malan, S. (1997). *Field Guide to the Wild Flowers of the Highveld*. Struik.

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