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Performance of Different Gladiolus (*Gladiolus grandiflorus* L.) Varieties on Growth and Flowering attributes under Agro-ecological conditions of Tandojam

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Article Details

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ABSTRACT

during 2024-25 at Horticulture Garden, Sindh Agriculture University, Tandojam to evaluate the growth and flowering performance of different gladiolus varieties under Agro-ecological conditions of Tandojam. The experiment was laid out in Randomized Complete Block Design (RCBD) with four blocks. The corms of four varieties of gladiolus *viz:* Pink, Indian, Yellow and White Prosperity were planted during the month of October, 2024. The results revealed that the maximum plant height (92.65 cm) chlorophyll content of leaves (76.85 SPAD), large size of inflorescence (16.07cm), maximum length of leaves (21.97cm), Leaves plant^{-1} (12.00) and Sturdiness quotient (6.28) were recorded in the Indian variety. Whereas larger flower diameter (82.62mm), maximum fresh weight of flower (4.63 g), number of florets Spike^{-1} (14.00), maximum plant collar diameter (19.65 mm) and maximum sprouts corm^{-1} (3.00) were recorded in white Prosperity variety. However, total soluble solids of petals (9.75 Brix), thickness of leaf (0.66mm) and petal thickness (0.33mm) were recorded maximum in the Pink variety. It is concluded that vegetative grower parameters were observed in Indian while flowering attributes were observed better in White Prosperity variety.

The present research was conducted

Introduction

1. Importance of Gladiolus in Floriculture

Gladiolus s (Gladiolus grandiflorus L.) commonly known as the "Sword Lily," is an important flowering plant cultivated globally for its aesthetic and economic value. Belonging to the Iridaceae family, gladiolus is highly valued in the floriculture industry due to its striking floral spikes, diverse color range, and long vase life. It is widely used in floral arrangements, landscaping, and commercial flower trade. The increasing demand for high-quality cut flowers has made gladiolus cultivation a profitable venture for both small-scale and commercial growers (Singh et al., 2022).

The floriculture industry plays a significant role in Pakistan's agriculture, contributing to employment generation, export potential, and rural development. Among various floricultural crops, gladiolus has gained popularity due to its adaptability to diverse climatic conditions, ease of propagation, and high market demand. However, successful cultivation requires an in-depth understanding of varietal performance under specific environmental conditions (Kumar & Yadav, 2023).

Additionally, gladiolus is known for its ability to thrive in a variety of soil types and climatic conditions, making it an attractive choice for growers worldwide. Its relatively short growth cycle and high commercial value have led to increased research on enhancing its yield, flower quality, and disease resistance (Meena et al., 2022). Research efforts are continuously exploring genetic improvements, nutrient management, and optimal agronomic practices to maximize gladiolus productivity.

2. Agro-Ecological Conditions of Tandojam

Tandojam, located in Sindh, Pakistan, has a semi-arid climate characterized by high temperatures, moderate to low rainfall, and variable soil conditions. These factors influence plant growth, development, and overall performance. The region's agro-ecological conditions provide both opportunities and challenges for the cultivation of ornamental crops, including gladiolus.

The soil in Tandojam is predominantly sandy loam to clay loam, with moderate fertility and good drainage properties, making it suitable for gladiolus cultivation. However, factors such as temperature fluctuations, water availability, and soil fertility management significantly affect the vegetative and reproductive phases of gladiolus (Hussain et al., 2021). Evaluating different varieties under these conditions is crucial for identifying those best suited to the region.

In addition, the climatic conditions in Tandojam necessitate precise irrigation and nutrient management practices. Given the moderate drought susceptibility of gladiolus, appropriate water management strategies, such as drip irrigation or mulching, can enhance its growth and flowering attributes (Khan et al., 2022). Moreover, the role of microclimatic variations in influencing flowering initiation, floret development, and spike quality is an important area of research in ornamental horticulture.

3. Growth and Flowering Attributes of Gladiolus

The performance of gladiolus is primarily assessed based on various growth and flowering attributes. Growth characteristics include plant height, number of leaves per plant, leaf area, and overall vegetative vigor. These attributes are influenced by genetic factors, environmental conditions, and agronomic practices (Sharma et al., 2023).

Flowering attributes, on the other hand, determine the ornamental and commercial value of gladiolus. Key parameters include days to spike emergence, spike length, number of florets per spike, floret size, vase life, and flower durability. The synchronization of growth and flowering characteristics is essential for optimizing yield and marketability (Khan et al., 2022).

Furthermore, flower color, petal arrangement, and fragrance also contribute to the aesthetic appeal and market preference of gladiolus varieties. Certain varieties are bred specifically for their resistance to premature senescence, ensuring longer shelf life in floriculture markets (Patil et al., 2023). The interaction between genetic potential and environmental stimuli influences not only flowering intensity but also the production of secondary metabolites responsible for floral pigmentation and fragrance.

4. Importance of Varietal Evaluation

The selection of appropriate varieties is a fundamental aspect of gladiolus cultivation, as different cultivars exhibit varying growth patterns, flowering responses, and adaptability to environmental conditions. Some varieties may be more tolerant to heat and drought, while others may perform better in cooler conditions. Evaluating the growth and flowering

performance of different varieties under the agro-ecological conditions of Tandojam will help in identifying the best-performing cultivars for commercial cultivation (Patil et al., 2023).

Varietal evaluation also provides insights into disease resistance, pest tolerance, and post-harvest quality, which are crucial for sustainable flower production. The selection of superior varieties can enhance productivity, profitability, and the overall success of the floriculture industry in Sindh (Gupta & Reddy, 2021).

Furthermore, different gladiolus varieties exhibit varying resistance levels to fungal pathogens, insect pests, and physiological disorders such as floret blasting or tip burn. Conducting field trials under local conditions can help in identifying resilient cultivars that require minimal chemical intervention, promoting environmentally sustainable floriculture practices.

5. Objectives of the Study

The primary objectives of this study are:

- To assess the growth performance of different gladiolus varieties under the agro ecological conditions of Tandojam.
- To evaluate key flowering attributes, including spike length, floret count, and vase life.
- To determine the most suitable varieties for commercial production in the region.
- To provide recommendations for optimizing gladiolus cultivation based on local climatic conditions.

6. Significance of the Study

This study will contribute valuable knowledge to the floriculture industry, researchers, and commercial growers by identifying the best-performing gladiolus varieties for Tandojam. The findings will help in developing region-specific cultivation strategies, improving yield potential, and promoting sustainable flower production in Sindh. Moreover, the results will support policy-makers and agricultural extension services in formulating guidelines for gladiolus cultivation in similar agro-ecological zones (Meena et al., 2022).

By understanding the interaction between genetic potential and environmental factors, this research aims to enhance the economic viability of gladiolus farming, create employment opportunities, and strengthen Pakistan's floriculture sector. Additionally, this study will provide scientific insights into the impact of soil amendments, fertilizers, and plant growth regulators on gladiolus performance, further guiding future research efforts.

Materials & Methods:

The present investigation entitled "Performance of Different Gladiolus (Gladiolus grandiflorus L.) Varieties on Growth and Flowering Attributes under Agro-Ecological Conditions of Tandojam" was carried out during the year 2024–2025 at the Horticulture Garden, Department of Horticulture, Sindh Agriculture University, Tandojam, Pakistan. The experiment was undertaken to study the comparative performance of selected Gladiolus varieties under the local environmental conditions. The agro-climatic conditions of Tandojam are characterized by a semi-arid climate, with moderate rainfall, high temperatures during the summer, and mild winters, providing favorable conditions for the cultivation of ornamental plants like Gladiolus.

The experiment was laid out using a Randomized Complete Block Design (RCBD) with three blocks to minimize experimental error and ensure the reliability of results. The experimental material consisted of four commercially important Gladiolus varieties, namely Pink, Indian, Yellow, and White Prosperity. Healthy and uniform-sized corms were selected for planting. The corms were treated with a fungicide solution (Carbendazim 0.2%) prior to sowing to prevent fungal infections. The land was properly prepared by deep ploughing followed by harrowing and leveling to ensure a fine tilth suitable for Gladiolus planting. Beds were prepared with a spacing of 30 cm between rows and 20 cm between plants within a row.

Standard agronomic practices, including regular irrigation, weeding, and hoeing, were carried out uniformly for all plots throughout the growing period. No chemical fertilizers were applied, and only well-decomposed farmyard manure was incorporated into the soil before planting to maintain organic conditions. Pest and disease management was performed using integrated pest management (IPM) practices.

During the growth period, several agronomic observations were recorded, including plant height (cm), number of sprouts bulb^{-1}, number of leaves bulb^{-1}, number of inflorescences bulb^{-1}, length of leaves (cm), width of leaves (cm), thickness of leaves (mm), petal thickness (mm), fresh biomass of flower (g), flower diameter (mm), color diameter (mm), and sturdiness quotient, which was calculated as the ratio of plant height to the stem diameter. Physiological attributes such as the chlorophyll content of leaves were measured using a SPAD-502 chlorophyll meter, while the total soluble solids (TSS) of petals were determined using a hand-held refractometer and expressed in degrees Brix (°Brix). All measurements were taken at the appropriate stages of crop growth to ensure consistency and accuracy.

Data collected from various observations were subjected to statistical analysis using the Statistix 8.1 computer software package (Statistix, 2006). Analysis of variance (ANOVA) was performed to test the significance of differences among the varieties for all measured parameters. Where the F-test indicated significance, the means were compared using the Least Significant Difference (LSD) test at a 5% probability level to determine the superior performance among the tested Gladiolus varieties. The results were interpreted critically based on statistical evidence to draw meaningful conclusions.

Results & Discussion

Vegetative Growth parameters:

The results revealed significant variation among the four gladiolus varieties with respect to all the vegetative growth parameters studied (Table 1). Plant height varied among the varieties, ranging from 31.12 cm in the yellow variety to 92.65 cm in the Indian variety. The tallest plants were recorded in the Indian variety (92.65 cm), followed by the pink variety (39.92 cm), while the shortest plants were observed in the yellow variety (31.12 cm). Leaf length was also significantly affected by variety, with the Indian variety producing the longest leaves (21.97 cm), followed by the pink variety (18.95 cm), and the shortest leaves in the yellow variety (16.40 cm). The maximum leaf width (2.80 cm) was recorded in the pink variety, closely followed by the Indian variety (2.75 cm), while the yellow variety showed the least leaf width (0.97 cm). The number of leaves per sprout was highest in the Indian variety (12.00), statistically on par with the pink variety (11.75), whereas the Yellow and White Prosperity varieties recorded the lowest number (11.00). Regarding the number of spikes per bulb, the highest number (3.00) was observed in the White Prosperity variety, followed by the pink variety (2.00), while the Indian variety recorded the lowest (1.00). The Standardness Quotient showed a significant range from 2.09 to 6.28. The highest value (6.28) was noted in the Indian variety, followed by the pink variety (3.69), while the lowest (2.09) was recorded in the White Prosperity variety. Leaf thickness also varied significantly among the varieties. The Pink variety had the thickest leaves (0.66 mm), followed by the Indian variety (0.42 mm), while the thinnest leaves were recorded in the White Prosperity variety (0.34 mm). In terms of plant collar diameter, significant variation was observed, ranging from 11.27 mm to 19.65 mm. The White Prosperity variety showed the largest collar diameter (19.65 mm), followed by the Indian variety (14.75 mm), while the pink variety recorded the smallest diameter (11.27 mm). These findings clearly indicate a wide range of variability in the vegetative growth characteristics of gladiolus varieties, which is likely attributed to their genetic makeup and the influence of agro-ecological conditions prevailing at Tandojam.

The significant variation observed among the gladiolus varieties in terms of vegetative growth parameters indicates the influence of genetic differences and their interaction with the local environmental conditions at Tandojam. The Indian variety exhibited superior performance for several traits, including plant height, leaf length, number of leaves per sprout, and Standardness Quotient. These findings are consistent with the reports of Bhattacharjee (1984), who emphasized the role of varietal genetics in determining plant vigor and overall growth performance in gladiolus.

Plant height, a critical vegetative trait, showed notable differences among varieties, with the Indian variety recording the maximum height. Similar trends were reported by Kumar et al. (2012), who noted that plant height is strongly governed by genotype and environmental factors, particularly soil fertility and climatic conditions. The shorter plant height in the yellow variety could be attributed to a lower photosynthetic capacity or inherent genetic limitations.

Leaf dimensions, such as length and width, are directly related to the plant's ability to synthesize food and influence overall plant vigor. The greater leaf length and width in the Indian and Pink varieties suggest a higher photosynthetic area, which may contribute to better spike development and flowering potential. These results align with the findings of Singh and Arora (2010), who reported that varieties with larger leaves tend to produce better-quality floral spikes due to increased assimilate production.

The number of leaves per sprout and spikes per bulb are critical indicators of a plant's reproductive efficiency. The Indian and Pink varieties showed a higher number of leaves per sprout, which could potentially support better spike initiation. However, the highest number of spikes per bulb was recorded in the White Prosperity variety, indicating that different varieties may allocate resources differently toward vegetative or reproductive growth. This is in line with studies by Mukhopadhyay and Banker (2000), who suggested that spike production is often cultivar-dependent and influenced by the physiological maturity of the corms.

Standardness Quotient, a trait indicating stem strength and balance, was highest in the Indian variety. Stronger stems are desirable for cut flower quality, suggesting the Indian variety may be more suitable for commercial cut flower production. Leaf thickness and collar diameter, both structural traits, varied significantly, suggesting differential adaptation among the varieties to withstand mechanical stress and environmental challenges.

Overall, the wide phenotypic variation observed can be attributed to the inherent genetic makeup of the varieties and their differential response to the agro-climatic conditions of Tandojam. These findings support the selection and breeding of suitable gladiolus varieties tailored for specific environments and commercial purposes.

Table. 1 Vegetative Growth parameters as effected by different varieties of Gladiolus under Agro-ecological of Tandojam

Varieties	Plant Height (cm)	Length of Leaves (cm)	Width of Leaves (cm)	Number of Leaves Sprout^{-1}	Number of Spike Bulb^{-1}	Standardness Quotient	Thickness of Leaves (mm)	Color Diameter (mm)
Pink	39.92 b	18.95 b	2.80 a	11.75 b	2 b	3.69 b	0.66 a	11.27 d
Indian	92.65 a	21.97 a	2.75 b	12.00 a	1 d	6.28 a	0.34 d	14.75 b
Yellow	31.12 d	16.40 d	0.97 d	11.00 d	1.75 c	2.45 c	0.42 b	12.65 c
White prosperity	37.90 c	17.5 c	1.7 c	11.5 c	3 a	2.09 d	0.36 c	19.65 a
S.E	3.24	1.27	0.21	0.95	0.31	0.32	0.06	1.48
F- Value	76.69	3.6	16.99	0.2	6.89	34.17	4.63	6.11
P- Value	0.0000	0.0589	0.0005	0.8948	0.0104	0.0000	0.0318	0.0149
CV	12.88	13.61	20.8	16.58	32.47	17.87	30.19	20.36
LSD	4.58	1.8	0.30	1.35	0.44	0.45	0.09	2.09

Flowering Characters:

Flowering characteristics of different gladiolus varieties differed significantly when grown under the agro-ecological conditions of Tandojam (Table 2). The largest flower diameter (82.62 mm) was recorded in the White Prosperity variety, followed by the pink variety (63.82 mm), while the smallest flower diameter (21.70 mm) was observed in the Indian variety.

Inflorescence length also showed significant variation among varieties. The Indian variety produced the tallest inflorescence (16.07 cm), followed closely by the pink variety (15.87 cm). The shortest inflorescence length (14.47 cm) was observed in the White Prosperity variety.

The number of florets per spike was highest (14.00) in both the Yellow and White Prosperity varieties. The Indian variety followed with 13.25 florets per spike, while the lowest number of florets (10.50) was recorded in the pink variety.

Petal thickness varied significantly across varieties. The Pink variety showed the highest petal thickness (0.33 mm), followed by the White Prosperity variety (0.19 mm), while the Indian variety had the thinnest petals (0.10 mm).

Fresh weight of the flower also exhibited considerable variation. The maximum flower fresh weight (5.67 g) was recorded in the pink variety, followed by White Prosperity (4.63 g), whereas the Indian variety had the minimum flower weight (2.59 g).

The significant differences observed among gladiolus varieties for flowering traits under the agro-ecological conditions of Tandojam highlight the influence of genetic diversity and environmental interactions on floral performance.

Flower diameter showed substantial variation among the varieties, with White Prosperity producing the largest blooms. This agrees with the findings of Singh and Misra (2000), who reported that flower size is largely dependent on genetic potential and is a key trait influencing ornamental and market value. The small flower diameter recorded in the Indian variety indicates that not all genotypes perform equally in every trait, reinforcing the importance of variety selection for specific objectives.

Inflorescence length is an important indicator of floral quality, particularly in cut flower crops like gladiolus. The Indian and Pink varieties recorded significantly taller inflorescences, consistent with observations by Kumar et al. (2011), who noted that longer spikes are desirable for vase life and floral arrangements. Shorter inflorescence length in White Prosperity may result from a trade-off between spike length and flower size, as this variety also recorded the largest bloom diameter.

The number of florets per spike is a critical trait contributing to the visual appeal and commercial value of gladiolus. The Yellow and White Prosperity varieties exhibited the highest floret counts, which supports earlier work by Kumar and Dey (2006), suggesting that the genetic potential of a variety directly influences its floret number under suitable environmental conditions.

Petal thickness, which affects both the appearance and durability of flowers, was greatest in the pink variety. Thicker petals are generally more robust and better suited for handling and transport (Bhattacharjee, 1984). The thinner petals of the Indian variety may contribute to its lower overall floral weight and reduced market quality.

Fresh weight of flowers, which reflects petal volume and moisture content, was highest in the pink variety, indicating better tissue development and turgidity. This parameter has been correlated with flower freshness and shelf life (Singh et al., 2013). The low flower weight in the Indian variety again suggests weaker development, possibly due to its smaller flower diameter and thinner petals.

Overall, the flowering performance of gladiolus varieties shows that Pink and White Prosperity possess superior ornamental traits, making them more suitable for commercial flower production, while the Indian variety, despite its vegetative strength, may be less favored for floral traits. These findings reaffirm the necessity of evaluating both vegetative and reproductive characteristics when selecting gladiolus varieties for specific cultivation goals.

Table. 2 Flower Characters as effected by different varieties of Gladiolus under Agro-ecological of Tandojam

Varieties	Flower Diameter (mm)	Length of inflorescence (cm)	Number of florets Spike^{-1}	Petal Thickness (mm)	Fresh weight of flower (g)
Pink	63.82 b	15.87 b	10.5 c	0.33 a	5.67 a
Indian	21.7 d	16.07 a	13.25 b	0.10 d	2.59 d
Yellow	59.05 c	15.75 c	14 a	0.15 c	4.53 c
White prosperity	82.62 a	14.47 d	14 a	0.19 b	4.63 b
S.E	5.07	1.05	0.87	0.09	0.19
F- Value	47.29	0.47	3.61	1.17	41.41
P- Value	0.0000	0.7113	0.0585	0.3700	0.0000
CV	19.6	13.62	13.53	94.88	9.14
LSD	**7.17**	1.49	1.23	0.13	0.28

Physiological parameters

Physiological parameters of different gladiolus varieties differed significantly when grown under the agro-ecological conditions of Tandojam (Table 3). The highest total soluble solids (TSS) content (9.75 °Brix) was observed in the Pink variety, followed by the Yellow variety (7.70 °Brix), while the lowest TSS (5.90 °Brix) was recorded in the Indian variety. In terms of chlorophyll content, the Indian variety exhibited the highest SPAD value (76.85), followed by the Pink variety (67.17), whereas the lowest chlorophyll content (51.17 SPAD) was noted in the White Prosperity variety.

The physiological variation observed among different gladiolus varieties under the agro-ecological conditions of Tandojam reflects the genotypic influence on key traits such as total soluble solids (TSS) and chlorophyll content. The Pink variety, which recorded the highest TSS (9.75 °Brix), demonstrates a more efficient translocation and accumulation of sugars, indicating strong photosynthetic activity and effective carbohydrate metabolism. This physiological advantage can contribute to enhanced flower quality and vase life. According to Kumar et al. (2011) and Sarkar et al. (2009), high TSS values are associated with increased osmotic potential and improved postharvest flower durability in gladiolus.

The Yellow variety also exhibited a relatively higher TSS value (7.70 °Brix), suggesting moderate sugar accumulation, whereas the Indian variety, with the lowest TSS (5.90 °Brix), might be less efficient in assimilate partitioning. Similar findings were reported by Patel et al. (2014), where varieties with lower sugar levels showed reduced floral longevity and lower visual appeal.

In terms of chlorophyll content, although statistical analysis showed non-significant differences, numerically the Indian variety recorded the highest SPAD value (76.85), implying a better capacity for light capture and energy conversion. Higher chlorophyll content typically supports vegetative vigor and improved floral induction. As noted by Choudhary et

al. (2012) and Rani & Singh (2017), SPAD readings are positively correlated with net photosynthetic rate, leaf area index, and biomass accumulation in flowering crops.

Conversely, the White Prosperity variety, with the lowest SPAD value (51.17), may possess less chlorophyll pigmentation, which could affect its photosynthetic efficiency and vegetative strength, despite having better floral traits. However, Dhatt and Singh (2007) highlighted thatfloral attributes are not always directly linked to chlorophyll content, as floral size and color expression can also depend on anthocyanin pathways and varietal genetics.

Table.3 Physiological Parameters as effected by different varieties of Gladiolus under Agro-ecological of Tandojam

Varieties	Total soluble solids (Brix)	Chlorophyll Content (SPAD)
Pink	9.75 a	67.17 b
Indian	5.9 d	76.85 a
Yellow	7.7 b	62.77 c
White prosperity	6.2 c	51.17 d
S.E	0.01	6.4
F- Value	14883	2.76
P- Value	0.0000	0.1038
CV	0.39	19.88
LSD	0.02	9.06

Conclusion

The present study revealed significant variation among different gladiolus varieties in terms of vegetative, flowering, and physiological parameters under the agro-ecological conditions of Tandojam. Among the tested varieties, White Prosperity excelled in floral traits such as flower diameter and number of florets, making it suitable for ornamental and commercial display purposes. The Pink variety demonstrated superior physiological performance, particularly in terms of total soluble solids (TSS), indicating its potential for better postharvest quality and extended vase life. On the other hand, the Indian variety, despite showing the highest chlorophyll content, produced the smallest flowers, suggesting its stronger vegetative capacity but weaker floral appeal.

These variations are likely attributed to the genetic makeup of the varieties and their interaction with the local environmental conditions. The findings underscore the importance of varietal selection based on the intended purpose—whether for visual appeal, shelf life, or vegetative robustness. Further research including molecular and biochemical profiling could provide deeper insights into the physiological basis of these traits and aid in the breeding of improved gladiolus cultivars suited for diverse climatic regions.

Suggestion

Based on the results, it is suggested that White Prosperity is the most promising variety for commercial cut-flower production, given its superior flower diameter and number of florets. However, for improved postharvest quality and longer vase life, the Pink variety stands out due to its higher total soluble solids (TSS) content, which indicates better sugar accumulation and storage potential. The Indian variety, while showing excellent chlorophyll content, may require further attention to improve its floral traits, as it exhibited the smallest flowers. Additionally, the findings suggest that varieties with higher chlorophyll content, like the Indian variety, could be more suitable for regions where vegetative growth and leaf health are prioritized. Future studies should focus on the molecular basis of these traits, as well as agronomic practices such as nutrient management, which could optimize gladiolus growth and flower quality across different environmental conditions.

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