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Growth and flowering response of tulip varieties under subtropical conditions of Punjab

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Abstract

A study was conducted to evaluate the performance of eight tulip (*Tulipa gesneriana* L) varieties, namely Royal Virgin, Christmas Dream, Tom Pouce, Strong Gold, Apeldoorn, Lalibela, Purple Prince and Attila Graffiti, in open-field under subtropical conditions of Punjab. Variety Royal Virgin took significantly less number of days to sprout (43.00 days) along with early flowering (77.22 days), followed by Christmas Dream and Lalibela taking (47.11, 81.00) and (49.22, 81.11) days, respectively. Lalibela had the highest sprouting percentage (100%), flowering percentage (100%), and blossom length (32.33 days), followed by Christmas Dream and Royal Virgin, respectively. Royal Virgin had the maximum leaves (4.22), and the largest flower diameter (7.75 cm). The highest values for plant height (35.00 cm) and scape length (30.89 cm) were observed in Lalibela. Further, the Hierarchical cluster analysis (HCA) was performed and a dendrogram was constructed with three clusters. HCA supported our results as Royal Virgin, Christmas Dream and Lalibela were grouped in cluster I with minimum days to sprouting and flowering along with maximum sprouting and flowering percentage, flower duration, plant height, scape length, number of leaves and desirable bulb traits. Based on the overall performance, Royal Virgin, Christmas Dream and Lalibela varieties were found promising under agro-climactic conditions of Punjab.

Key words: *Tulipa gesneriana* L, tulip varieties, Punjab, sprouting, flowering, flower duration, Hierarchical cluster analysis (HCA), agro-climatic adaptation

Introduction

Tulip (*Tulipa gesneriana* L.) is one of the worlds most distinctive ornamental flower, characterized by bright colors and elegant petals. Presently, it is the third largest traded flower in the world and plays a pivotal role in the ornamental horticulture sector (Sharma *et al.*, 2022). Tulips remain a cornerstone of both commercial and ornamental horticulture, planted in landscape but also as popular cut flowers. Due to the rising popularity of tulips along with high aesthetic value of this crop, there is high demand for tulips even from places where they were not planted historically. Hence, the existence of potential for further floricultural diversification would seem to already dictate that tulips may prove a suitable species for exploitation within wide ranging climate.

Tulip cultivation however comes with distinct challenges since Punjab has a subtropical climate. Climate and environmental issues mean the large-scale farming of tulips is only feasible in some locations. Tulips thrive where winters are mild and springs long and cool, such as higher elevations and northern latitudes. They can be cultivated only in cooler or subtropical climes, unless they are growing under controlled conditions.Even with these problems, the growing demand for decorative plants in landscaping and the cut flower market has made tulips a good choice for both gardens and high-value cut flowers (Kamenetsky, 2008).Most importantly, tulips are deduced from Holland, and their effectiveness is significantly influenced by the climatic state of the area in which they are produced. This means that reduced cultivars developed for temperate climates are not necessarily the suitable ones for regions such as Punjab which are subtropical, with climatic conditions quite different from those for which they were originally selected. However, due to the specificity of tulip growing conditions, flower adaptation, flowering response, and flower quality need to be tested in less than optimal sites to assure the survival of tulips in a wide range of climates. In particular, this kind of assessments are essential in subtropical climates where changes in temperature, erratic precipitation and soil conditions may a impact on tulip growth. Given this, the present work is designed to evaluate eight tulip species in the open fields of subtropical region of Punjab. As this study emphasizes varietal performance, it aims to offer valuable information regarding tulip types that are ideal for this growing climate.

Three essential environmental parameters including temperature, precipitation, and soil condition, must be thoroughly taken into account in tulip cultivation in subtropical climate. Because tulips require a warm-cold-warm cycle to develop properly, temperature is critical. While in the subtropical zone the winter months could be the necessary cold phase, it is critical to sustain this last warm phase at 16 °C to at least 20 °C for approximately 5 months to promote adequate flowering (Alfonso-Villalba *et al.*, 2023). In addition, rainfall and degree of humidity should be monitored to prevent overdrying of the soil, which can also be harmful to plants. The growth of bulbing is also greatly influenced by soil parameters, especially pH and calcium carbonate ratio (Sochacki and Chojnowska, 2005).

Suitable tulip cultivars are crucial for subtropical regions. Such as “Apeldoorn” and “Princess Margaret Rose”, short-lived cultivars capable of surviving mild winters have been successfully evaluated in controlled conditions and are suitable for subtropical

cultivation (Das *et al.*, 2019). Genetic variation within tulip kinds (*e.g.*, bloom size, height) also participates in further influencing their susceptibility to subtropical conditions. Tulip can be the new plant of floral treasure for greenhouses of regions like Punjab which can be grown with local type and environment to control.

The main goal of this work was to investigate the flowering and growth behaviour of eight tulip cultivars in field conditions of Punjab subtropics. With regard to climate elements including temperature, rainfall, and soil characteristics, the aim of this study was to assess the adaptability, flowering tendency, and performance of these cultivars under off-season situations.

Materials and methods

The present study was carried out at the Research farm, Department of Floriculture and Landscaping, PAU, Ludhiana. The experimental field is situated in the south-central plain region of Punjab which is situated at latitude of 30° 45' North, longitude of 75° 48' East and 249 m above mean sea level.

Programmed bulbs of eight tulip varieties were imported from Holland in the month of November. Varieties were: V_1: Royal Virgin, V_2: Christmas Dream, V_3: Tom Pouce, V_4: Strong Gold, V_5: Apeldoorn, V_6: Lalibela, V_7: Purple Prince, V_8: Attila Graffiti.

Uniform flowering grade bulbs were treated with bavistin (0.2%) to avoid bulb rot. Sowing was done at a spacing of 20cm × 20cm and at a depth of 8 to 10cm, under open-field conditions on 26th November. Experiment was laid out in a randomized block design with three replications, having fifty bulbs per treatment per replication. Varieties were evaluated for their vegetative (days to sprouting, sprouting percentage (%), plant height (cm), scape length (cm), number of leaves, scape thickness (mm)) and floral parameters (days to flowering, flowering percentage (%), flower duration (days), flower diameter (cm)). Bulb parameters (number of bulbs per plant, bulb diameter (mm) and number of bulblets per plant) were also recorded at the end of experiment after bulb harvesting. Cultural practices were consistently followed and irrigation was scheduled at an interval of 3-4 days based on soil moisture conditions.

Statistical analysis: The data obtained was subjected to analysis of variance (ANOVA) and mean comparison to calculate significant difference between treatments was performed using Tukey's test using SPSS software (Version 24.0.0). Additionally, Hierarchical cluster analysis was also performed using SPSS software.

Results and discussion

Vegetative parameters: This study evaluated eight distinct varieties of tulips for their growth and physical characteristics. Table 1 depicts significant variation in vegetative characteristics across different variables. Sprouting days varied greatly amongst types, with 'Royal Virgin' taking 43.00 days and 'Attila Graffiti' taking 77.00 days. The third group's sprouting time was intermediate, with 'Christmas Dream,' 'Lalibela,' and 'Tom Pouce' taking 47.11, 49.22, and 59.33 days, respectively. Sprouting percentage varied by cultivar, with 'Lalibela' (100%), equivalent to 'Christmas dream', and significantly higher than 'Royal virgin' and 'Apeldoorn' (Table 3). Contrarly 'Tom Pouce' had the lowest sprouting percentage (74.00). Shah *et al.* (2023) reported that the early germination and positive sprouting rates of 'Royal Virgin,' 'Christmas Dream' and 'Lalibela' could relate to both environmental and genetic causes. Maximum number of leaves was found in Royal Virgin (4.22) and minimum was found in Strong Gold (3.00). According to Kumar *et al.* (2017), the growth and development of pre-formed leaves in bulbs is mostly influenced by their overall health, genetic features, and environmental factors. The tallest variety was 'Lalibela' (35.00 cm), while the lowest growth was noted in 'Royal Virgin' and 'Christmas theme.' The shortest was 'Strong Gold', measuring just 19.00 cm. According to Kumar *et al.* (2017), leaves play a critical role in photosynthesis, resulting in energy production and plant growth. Rana *et al.* (2024) reported similar changes in plant height.

Floral parameters: 'Royal Virgin' had the largest mean flower diameter (7.75 cm) among the three cultivars followed by 'Lalibela' (7.50 cm) and 'Strong Gold' had the smallest mean flower diameter (5.46 cm). The size of flowers varies directly with

Table 1. Vegetative parameters of tulip varieties under sub-tropical conditions of Punjab

Variety	Days to sprouting	Sprouting percentage (%)	Number of leaves	Plant height (cm)
Royal Virgin	43.00^{a}±0.19	96.00^{cd}±1.15	4.22^{c}±0.11	33.55^{c}±0.78
Christmas Dream	47.11^{b}±0.11	97.33^{cd}±0.67	3.44^{ab}±0.11	27.11^{b}±0.44
Tom Pouce	59.33^{d}±0.19	74.00^{a}±1.15	3.22^{ab}±0.11	24.22^{b}±0.11
Strong Gold	63.22^{e}±0.11	93.33^{c}±1.33	3.00^{a}±0.00	19.00^{a}±0.50
Apeldoorn	80.45^{g}±0.22	94.00^{cd}±1.15	3.33^{ab}±0.00	19.83^{a}±0.33
Lalibela	49.22^{c}±0.11	100.00^{d}±0.00	3.55^{b}±0.22	35.00^{c}±0.39
Purple Prince	63.56^{e}±0.11	82.00^{b}±1.15	3.44^{ab}±0.11	20.17^{a}±0.25
Attila Graffiti	77.00^{f}±0.33	84.67^{b}±2.40	3.33^{ab}±0.00	26.44^{b}±1.79

Table 2. Floral parameters of tulip varieties under sub-tropical conditions of Punjab

Variety	Days to flowering	Flowering (%)	Flower duration	Flower diameter (cm)	Scape length (cm)	Scape thickness (mm)
Royal Virgin	77.22^{a}±0.11	96.00^{c}±1.15	26.22^{f}±0.11	7.75^{f}±0.08	28.95^{e}±0.22	5.61^{b}±0.03
Christmas Dream	81.00^{b}±0.00	96.67^{c}±0.67	28.78^{g}±0.11	6.80^{d}±0.05	22.39^{d}±0.64	5.26^{ab}±0.07
Tom Pouce	81.89^{c}±0.22	68.67^{ab}±1.33	21.11^{d}±0.11	7.15^{e}±0.04	19.06^{c}±0.11	5.50^{b}±0.08
Strong Gold	87.89^{e}±0.22	90.67^{c}±0.67	24.89^{e}±0.11	5.46^{b}±0.04	12.11^{a}±0.15	6.17^{c}±0.10
Apeldoorn	101.45^{g}±0.22	61.33^{a}±1.76	17.33^{a}±0.19	6.24^{c}±0.07	15.34^{b}±0.17	6.09^{c}±0.04
Lalibela	81.11^{bc}±0.11	100^{c}±0.00	32.33^{h}±0.00	7.50^{f}±0.07	30.89^{f}±0.22	6.42^{c}±0.04
Purple Prince	87.00^{d}±0.19	77.33^{b}±1.76	20.22^{c}±0.22	4.97^{a}±0.02	15.55^{b}±0.15	5.06^{a}±0.06
Attila Graffiti	98.00^{f}±0.19	76.00^{b}±2.00	19.11^{b}±0.11	6.29^{c}±0.02	21.11^{d}±0.24	5.44^{ab}±0.18

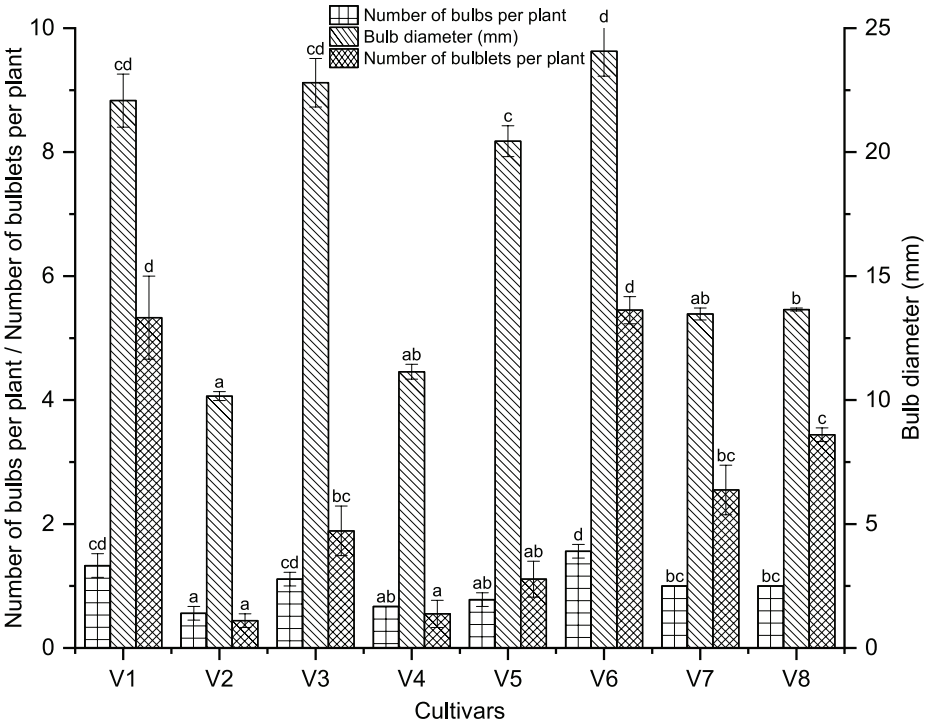

Fig. 1. Bulb parameters of tulip varieties under sub-tropical conditions of Punjab

the health of the parent plant and such variance is modulated in turn by the interaction of genotypic- and environmental- based determinants of phenotypic expression (Shah *et al.*, 2023). During the flowering stage, scape length was measured from the base to the top of the flower. The scape length of "Strong Gold" was shortest (12.11 cm) whereas that of "Lalibela" was longest (30.89 cm). Scape thickness varied little among varieties, with thickness values ranging from 5.06 mm in "Purple Prince" to 6.42 mm in "Lalibela" (thickest).

Bulb parameters: Perusal of data regarding bulb parameters (Fig. 1), divulges that maximum number of bulbs per plant and bulb diameter was observed in variety 'Lalibela' (1.56 and 24.07 mm) followed by 'Royal Virgin' (1.33 and 22.08 cm) and 'Tom Pouce' (1.11 and 22.80 cm). Data recorded for number of bulblets per plant was significantly high in 'Lalibela' (5.45) and 'Royal virgin' (5.33), while 'Christmas Dream' (0.44) followed by 'Strong Gold' (0.55) and 'Apeldoorn' (1.11) recorded for less number of bulblets. Increased number of bulbs and bulblets in 'Lalibela' and 'Royal Virgin' might be due to more number of leaves, which may have enhanced the production and translocation of photosynthates to the storage organs in these genotypes. (Ahmed and Khurshid, 2004; Bhatia *et al.*, 2013). Environmental factors such as humidity, light, temperature and edaphic factors also play a role in the expansion and contraction of bulb sizes (Shah *et al.*, 2023).

Hierarchical cluster analysis: The cluster analysis was performed for eight tulip varieties with mean values of vegetative, floral and bulb parameters to separate data of tulip varieties into groups of increasing similarity. The Euclidean distance was used as a metric to measure similarity among the eight varieties based on 13 parameters. Ward method of linkage was implemented for agglomeration. The dendrogram revealed three distinct groups (Fig. 2). The cluster I (CI) comprised of 3 varieties, cluster II (CII) had two and cluster III (CIII) had three varieties. The result was consistent with the variation that was observed in the data. The Cluster I comprised of variety 'Royal Virgin', 'Christmas Dream' and 'Lalibela'. These varieties took minimum days to sprouting and flowering along with maximum sprouting and flowering percentage. Maximum plant height, number of leaves, scape length, scape thickness, flower diameter, flowering duration along with desirable bulb yield was observed in cluster I (Table 3). This suggested that early flowering varieties exhibited better growth performance and can be used for landscaping as well as cut flower production under Punjab conditions.

Cluster II included 'Apeldoorn' and 'Attila Graffiti'. which took maximum number of days to sprouting and flowering. Flower duration was reduced which may be attributed to the rise in temperature during March, 2024 (Table 4). Also the number of

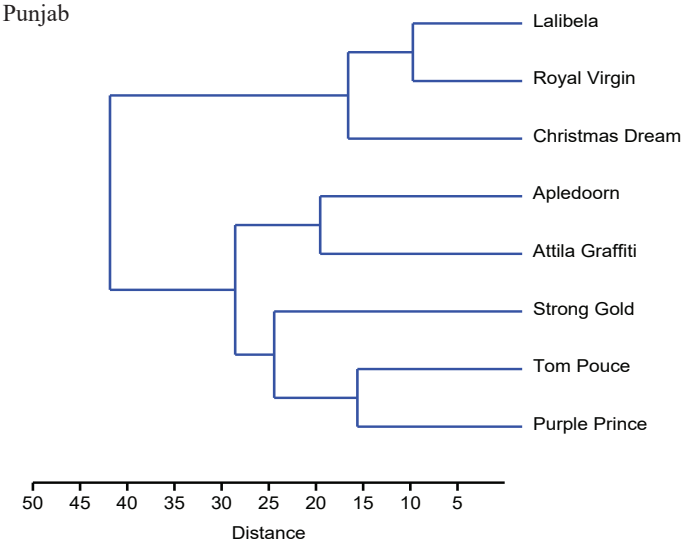

Fig. 2. Dendrogram representing clustering of tulip varieties using squared Euclidean distance.

Table 4. Mean monthly meteorological data from November 2023 to August 2024

Months	Temperature (°C)			Relative Humidity (%)	Rainfall (mm)
	Max.	Min.	Mean		
Nov. 2023	26.2	13.1	32.8	68	28.6
Dec. 2023	20.6	7.8	24.5	73	0.00
Jan. 2024	13.6	6.0	16.6	83	16.4
Feb. 2024	21.2	8.3	25.4	67	20.0
Mar. 2024	26.6	13.0	33.1	61	62.1
Apr. 2024	33.5	18.3	42.7	47	5.0
May 2024	40.3	24.4	32.3	33	10.0
Jun. 2024	40.1	27.6	33.9	43	8.0
Jul. 2024	35.3	28.3	31.8	69	3.9
Aug. 2024	33.4	26.9	30.1	76	6.2

Table 3. Mean values for three clusters based on vegetative, floral and bulb parameters of different varieties

Parameters	Means		
	Cluster I	Cluster II	Cluster III
Days to sprouting	46.44	78.73	62.04
Sprouting percentage (%)	97.78	89.34	83.11
Number of leaves	3.74	3.33	3.22
Plant height (cm)	31.89	23.14	21.13
Days to flowering	79.78	99.73	85.59
Flowering percentage (%)	97.56	68.67	78.89
Flower duration	29.11	18.22	22.07
Flower diameter (cm)	7.23	6.27	5.86
Scape length (cm)	27.41	18.23	15.57
Scape thickness (mm)	5.76	5.77	5.58
Number of bulb per plant	1.15	0.89	0.93
Bulb diameter (mm)	18.77	17.05	15.80

bulb per plant and flowering percentage was minimum in these varieties.

Cluster III comprised of variety 'Strong Gold', 'Tom Pouce' and 'Purple Prince'. Cluster III took more number of days to sprouting and flowering along with reduced flowering percentage as compared to the varieties in cluster I; however, the sprouting percentage was lowest in cluster III (Table 3).

The study demonstrated significant varietal differences in vegetative, floral, and bulb parameters among tulip varieties. 'Lalibela,' 'Royal Virgin,' and 'Christmas Dream' showed superior performance with early sprouting, higher flowering percentages, and better bulb yield, making them suitable for cut flower production and landscaping. These findings highlight the importance of selecting appropriate varieties for optimal cultivation under Punjab conditions.

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