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RESEARCH PAPER

Performance of exotic tulip cultivars under agro-climatic conditions of Multan

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Key Message: This research evaluates twelve exotic tulip cultivars under Multan's agro-climatic conditions, and contributes to enhancing local floriculture practices, addressing challenges like limited propagation materials and production costs, thereby fostering the growth of the cut-flower industry and meeting market demands in Multan, Pakistan.

Abstract

The tulip (Tulipa spp.) is a widely recognized ornamental flower, appreciated for its aesthetic appeal and diverse varieties. This research aimed to evaluate the performance of twelve exotic tulip cultivars namely Syneda King, Amesterdam, Apricot Fox, White Density, Benvan Zanteen, Yellow King, Leen VD Mark, Syneda Orange, Red Gender, White Prince, Escape, and Antarcia under the agro-climatic conditions of Multan, Pakistan. The study conducted at the Horticultural Research Substation for Floriculture and Landscaping during 2016-17, employed a Randomized Complete Block Design (RCBD) with three replications. Results indicated significant variability among the cultivars in terms of days to sprouting, number of leaves per plant, days to flowering, number of flowers per plant, plant height, number of bulbs per plant, bulb diameter, and bulb weight. The cultivar Red prince exhibited the shortest sprouting time (19.38 days), while Antarcia took the longest time for flowering emergence (90.59 days). Syneda King yielded the highest number of leaves per plant (6.87), flowers per plant (3.00), and bulbs per plant (3.20), as well as the largest bulb diameter (3.82 cm) and heaviest bulbs (16.62 g). The findings provide valuable insights for tulip cultivation in Multan addressing challenges such as lack of awareness, limited propagation material availability, and high production costs. The results contribute to the promotion of the floriculture industry in Multan, facilitating local farmers in cut-flower production and meeting the demands of the local market.

Keywords: Agro-climatic conditions, Cut-flower production, Exotic cultivars, Multan Tulip (Tulipa spp.)

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Introduction

The tulip (Tulipa spp.) holds significant prominence in modern era by decorating homes, offices, and shops. With over 3000 varieties, this bulbous flower has become an indispensable part of aesthetic expressions. Originally hailing from Turkey and central Asia, Holland is now widely recognized as the tulip's home (Ali et al., 2015). Globally, tulips are typically planted in various seasons in late winter to late spring. With a diverse array of colors, these flowers exhibit a lifespan of 10 to 20 days, accompanied by an appealing fragrance (Ali et al., 2015). The tulip's versatility extends to its cultivation, thriving in garden beds, alongside other bulbs, and even indoors in pots. Beyond its visual appeal, the tulip serves practical purposes. Extracts from the flower find applications in cosmetics and medicines, contributing to various formulations. Moreover, the bulbs themselves are edible, offering an onion like taste (Larson, 1980).

The optimal conditions for the flower formation of various cultivars include a temperature range of 17-20 °C, with bulb size demonstrating a direct correlation with flower size; larger bulbs yield bigger flowers (Rasmussen, 1980). In a previous research study conducted by Hertogh et al. (1978), the emphasis was placed on the selection of early and late forcing and concluded that the cultivars "Topsiore" and "Pink Supreme" were found to be the most optimal choices. Dosser and Larson (1981) also made significant observations indicating that increased day or night temperatures led to a reduced time to flowering for a range of cultivars including Red Queen, Utopia, Roland, Madami, Spoor, and Charles. Furthermore, Safiullah and Ahmad (2001) assessed various varieties and identified Blue Isle, Blad Jack, and City of Light as particularly promising cultivars in their research.

Pakistan recognized as a growing market for floral products specifically cut flowers (Manzoor et al., 2001) offers a myriad of prospects for businesses. This is particularly true in central Punjab, where the potential for tulip cultivation is significant and holds promising opportunities. The cultivation of flowers has evolved into a lucrative venture for small landholding farmers in Pakistan, with an estimated annual production ranging from 10 to 12 thousand tons (Khan, 2011), and a notable surge in demand (Rehman, 2004). There is a dire need to introduce novel flower crops in the country and it becomes crucial to align with contemporary production practices that are harmonious with local environmental and climatic conditions (Sajjad et al., 2014). However, tulips encounter challenges in plain areas as opposed to hilly areas, primarily due to their high chilling requirements (Ahmed et al., 2013). This stems from the fact that the majority of tulip cultivars are developed in cooler regions globally, necessitating an extended period of cold temperatures for their optimal growth and subsequent flower stem development (Asghari, 2014). Throughout the winter season, specific components of the tulip flower undergo gradual development, while the spring season witnesses rapid elongation of the stalk as elucidated by de Hertogh & le Nard (1993). This highlights the distinct seasonal requirements essential for the successful cultivation of tulips in Pakistan.

Tulip production in Pakistan faces significant challenges including lack of awareness about cultivation practices, the availability of propagation materials, market values, and wider consumer preferences (Anonymous, 2006). One crucial obstacle is the limited availability of propagation materials, leading to high production costs due to the exclusive import of materials from the Netherlands (Danish & Rose, 2018). The absence of local breeding and production of tulip plant material is a notable gap in Pakistan, largely attributed to a lack of attention from research staff in the agriculture sector. The insufficient production of local planting material for commercial purposes hampers the promotion of crop diversity in the local agricultural system and also the export potential of fresh flowers and planting materials to foreign markets, particularly in the Middle East and Southeast Asia (Sajjad et al., 2014). Tulip bulbs are typically propagated vegetatively sustained for extended periods in well-drained soil (Jaap & Marjan, 2007). Recognizing the significance of the tulip flower, various cultivars have been introduced and evaluated to enhance the floriculture industry by leveraging the region's potential. In the current study, multiple tulip cultivars were assessed to identify the most suitable ones for cultivation under the agro-climatic conditions of Multan. The goal is to recommend optimal cultivars to local farmers for cut-flower production, contributing to the local market's supply.

Materials and Methods

Research location and duration

This research was carried out at the Horticultural Research Substation for Floriculture and Landscaping, Multan during the year 2016-17.

Selection of tulip cultivars and experimental design

Twelve tulip cultivars, including Syneda King, Amesterdam, Apricot Fox, White Density, Benvan Zanteen, Yellow King, Leen VD Mark, Syneda Orange, Red Gender, White Prince, Escape, and Antarcia, were selected for evaluation. The experiment followed a Randomized Complete Block Design (RCBD) with three replications.

Fertilization and cultural practices

A recommended dose of chemical fertilizer (N: P: K @ 200: 100: 100 kg ha^{-1}) was applied, and plant-to-plant and row-to-row distances were maintained at 15 cm and 30 cm, respectively. Cultural practices were consistently applied, and irrigation was scheduled at 7–10-day intervals based on soil moisture conditions.

Data collection statistical analysis

Data were recorded on days to flowering, number of leaves per plant, plant height (cm), and the number of bulbs produced per plant. The collected data were subjected to analysis of variance (ANOVA), and the least significant difference (LSD) test was employed for the separation and comparison of means, following the approach proposed by Steel et al. (1997).

Results

Days to sprouting

Table 1 presents the number of days taken for the sprouting of various tulip cultivars. Among the cultivars, "Red prince" exhibited the shortest sprouting time, taking only 19.38 days. In contrast, "Amesterdam" had the longest sprouting period, requiring 56.93 days. Syneda king demonstrated a relatively quick sprouting time of 26.51 days, while "White density" and "Yellow king" also took comparatively longer durations at 56.12 and 45.36 days, respectively. These results provide insights into the varied growth rates of different tulip varieties, which could be crucial information aiming to optimize cultivation practices of tulip cultivation.

Number of leaves/plant

Table 2 illustrates the number of leaves per plant for various tulip cultivars, providing insights into their foliage density. Among the cultivars, "Antarcia" shows the highest number of leaves per plant (5.24). "Escape" follows closely behind with 4.62 leaves per plant, demonstrating a vigorous foliage profile. On the other hand, "Yellow king" displays the lowest leaf count (3.16) suggesting a comparatively less leafy growth pattern. Noteworthy variations are observed in the leaf numbers of other cultivars, such as "Syneda king" with 6.87 leaves and "White density" with 3.38 leaves.

Table 1 Number of days taken to sprouting of different tulip cultivars

Varieties	Days taken to sprouting
Syneda king	26.51
Amesterdam	56.93
Apricot fox	43.55
White density	56.12
Benvan Zanteen	30.49
Yellow king	45.36
Leen VD Mark	41.69
Syneda orange	44.00
Red gender	44.61
Red prince	19.38
Escape	36.85
Antarcia	28.96

Table 2 Number of leaves/plant of different tulip cultivars

Varieties	No. of leaves/Plant
Syneda king	6.87
Amesterdam	4.08
Apricot fox	4.23
White density	3.38
Benvan Zanteen	4.32
Yellow king	3.16
Leen VD Mark	3.15
Syneda orange	4.00
Red gender	3.83
Red prince	4.20
Escape	4.62
Antarcia	5.24

Days to flowering

The number of days taken for flowering emergence was measured among various tulip cultivars, providing essential information about transition into the flowering stage (Table 3). Red prince exhibited the shortest duration, requiring only 51.49 days for flowering appearance. On the other hand, Antarcia took the longest time, with flowering emergence occurring after 90.59 days. Benvan Zanteen and Red gender also displayed relatively shorter durations at 58.36 and 72.28 days, respectively.

Table 3 Number of days taken to flowering emergence of different tulip cultivars

Varieties	Days taken to flowering appearance
Syneda king	68.42
Amesterdam	70.64
Apricot fox	77.38
White density	82.37
Benvan Zanteen	58.36
Yellow king	72.96
Leen VD Mark	78.14
Syneda orange	83.19
Red gender	72.28
Red prince	51.49
Escape	79.65
Antarcia	90.59

Number of flowers/plant

Table 4 displays the number of flowers per plant for various tulip cultivars. "Syneda king" had a higher count, boasting 3.00 flowers per plant. In contrast, the remaining cultivars, including "Amesterdam," "Apricot fox," "White density," "Benvan Zanteen," "Yellow king," "Leen VD Mark," "Syneda orange," "Red gender," "Red prince," "Escape," and "Antarcia," each exhibited a consistent and more modest flower count of 1.00 per plant. These findings provide valuable information for informed decisions when selecting tulip varieties based on their desired floral display.

Table 4 Number of flowers/plant of different tulip cultivars

Varieties	No. of flowers/plant
Syneda king	3.00
Amesterdam	1.00
Apricot fox	1.00
White density	1.00
Benvan Zanteen	1.00
Yellow king	1.00
Leen VD Mark	1.00
Syneda orange	1.00
Red gender	1.00
Red prince	1.00
Escape	1.00
Antarcia	1.00

Plant height (cm)

Among the different varieties, Syneda King exhibited the tallest plants, reaching an impressive height of 60.94 cm (Table 5). Following closely behind were Red prince and Benvan Zanteen, with plant heights of 48.82 cm and 52.60 cm, respectively. Other cultivars such as Syneda Orange, White Density, and Apricot Fox, displayed moderate heights ranging from 13.61 cm to 15.76 cm. Yellow King, Escape and Antarcia recorded heights below 12 cm, with Yellow King being the shortest at 10.51 cm. These measurements provided valuable insights into the varying growth characteristics of tulip cultivars, offering useful information for deciphering and selecting tulip varieties based on their height preferences.

Table 5 Plant height (cm) of different tulip cultivars

Varieties	Plant height (cm)
Syneda king	60.94
Amesterdam	12.32
Apricot fox	13.61
White density	15.19
Benvan Zanteen	52.60
Yellow king	10.51
Leen VD Mark	11.70
Syneda orange	15.76
Red gender	11.35
Red prince	48.82
Escape	10.54
Antarcia	10.04

Number of bulbs/plant

Understanding the reproductive tendencies, number of bulbs per plant for various tulip cultivars were studied (Table 6). Syneda King exhibited the highest number of bulbs per plant, with an impressive 3.20 bulbs. Following closely behind, Antarcia displayed a notable number of bulbs at 3.00 per plant. Red prince, with 2.00 bulbs per plant, and Apricot Fox, with 2.43 bulbs, also demonstrated healthy reproductive capabilities. Amsterdam, Benvan Zanteen and Red Gender exhibited moderate bulb production, ranging from 1.83 to 2.33 bulbs per plant. Conversely, cultivars such as Syneda Orange, White Density, Yellow King, Leen VD Mark and Escape showed lower reproductive rates, ranging from 1.00 to 1.40 bulbs per plant. These findings contribute valuable insights for growers and researchers interested in tulip cultivation.

Table 6 Number of bulbs/plant of different tulip cultivars

Varieties	No. of bulb/plant
Syneda king	3.20
Amesterdam	2.33
Apricot fox	2.43
White density	1.07
Benvan Zanteen	2.17
Yellow king	1.40
Leen VD Mark	1.08
Syneda orange	1.00
Red gender	1.83
Red prince	2.00
Escape	1.33
Antarcia	3.00

Bulb diameter (cm)

Table 7 offers valuable information on the size and potential vigor of the bulbs. Syneda King produced the largest bulb diameter (3.82 cm). Red Gender follows with a substantial bulb diameter of 3.17 cm, indicating excellent bulb development. Benvan Zanteen and Escape also exhibited relatively larger bulbs measuring 3.28 cm and 2.83 cm, respectively. Conversely, Yellow King, Amsterdam, and Antarcia had smaller bulb diameters, ranging from 2.02 cm to 2.28 cm. The remaining cultivars, including Apricot Fox, White Density, Leen VD Mark, Syneda Orange, Red prince, and Antarcia showed the mid-range of bulb diameters between 2.38 cm and 2.89 cm.

Table 7 Bulb diameter of different tulip cultivars

Varieties	Bulb diameter (cm)
Syneda king	3.82
Amesterdam	2.28
Apricot fox	2.89
White density	2.58
Benvan Zanteen	3.28
Yellow king	2.02
Leen VD Mark	2.79
Syneda orange	2.48
Red gender	3.17
Red prince	2.38
Escape	2.83
Antarcia	2.15

Bulb weight (g)

Syneda King emerged as the cultivar with the heaviest bulbs (16.62 g) (Table 8). Escape, Red Gender, and Yellow King also exhibited substantial bulb weights, ranging from 10.49 to 10.63 g. Benvan Zanteen and Red prince fell within a similar weight range, both recording bulb weights around 10.40 to 10.87 g. Amsterdam, Apricot Fox, Syneda Orange, and White Density displayed moderate bulb weights, ranging from 8.50 to 10.43 g. Leen VD Mark and Antarcia, on the other hand, had comparatively lighter bulbs, weighing 7.56 and 6.98 g, respectively.

Table 8 Bulb weight (g) of different tulip cultivars

Varieties	Bulb weight (g)
Syneda king	16.62
Amesterdam	10.43
Apricot fox	8.50
White density	9.02
Benvan Zanteen	10.40
Yellow king	9.88
Leen VD Mark	7.56
Syneda orange	8.58
Red gender	10.49
Red prince	8.87
Escape	10.63
Antarcia	6.98

Discussion

The developmental processes of perennating organs and aerial parts in plants are intricately influenced by various environmental stimuli such as light, humidity, and temperature, ultimately shaping their growth and flowering patterns (de Hertogh & le Nard, 1993). The study revealed significant variations in morphological, floral, and bulbous characteristics among the examined cultivars. Indicators such as leaf morphology, leaf area, and stem diameter emerged as important parameters for gauging optimal temperature conditions across various growth stages (Samach, 2012). However, these parameters alone might not fully capture the complicated environmental factors influencing the completion of the short duration of the plant life cycle, particularly during the spring season (de Hertogh & le Nard, 1993). Previous studies have highlighted the differential regulation of leaf expansion in various genotypes of Arabidopsis (Massonnet et al., 2015).

The increased leaf count observed in the Antarcia and Escape cultivars can be attributed to the favorable agro-environmental conditions and their enhanced compatibility with the current surroundings. This phenomenon may also be linked to a positive genotype-environment interaction, allowing these cultivars to proficiently generate a higher quantity of leaves. Optimal temperature and relative humidity during the vegetative growth phase played a crucial role in facilitating the efficient coordination of nutrient absorption and the assimilation of photosynthates. This coordination contributed to the leaf proliferation observed in certain cultivars. These results align with the findings of Wilson (1972), where more production of leaves was associated with environmental factors that expedite photosynthetic processes enabling the plant to develop an increased number of leaves.

The early onset of flowering in Red prince can be attributed to its enhanced responsiveness to environmental temperatures and the prompt formation of flower buds. These results align partially with the observations of Moore et al. (1979) who suggested that early flowering may result from increased resistance to physiological disorders. Variations in plant heights can be attributed to environmental influences, which may have either accelerated or delayed the activity of natural plant hormones in the stems. Additionally, variations in genetic makeup among different genotypes could contribute to these height differences. These findings are consistent with those reported by Khan et al. (2012), indicating that the growth parameters of these cultivars are indeed influenced by specific environmental conditions.

Variations in bulb sizes can be attributed to the presence of an increased number of leaves, facilitating a process of photosynthesis that likely led to the development of larger bulbs. Environmental factors, including light exposure, humidity, temperature, and susceptibility to soil diseases, may have influenced the expansion and contraction of bulb sizes. These findings align with the research of Moore et al. (1979) who studied various tulip cultivars and identified susceptibility to bulb diseases as a factor contributing to variations in bulb sizes. Furthermore, a combination of environmental and genetic factors may have contributed to the overall increase in bulb size (Ahmad & Gul, 2002). Nard et al. (1997) reported that a greater number of leaves could enhance food availability, thereby promoting larger bulb sizes. The differences in bulb weight observed among the tulip cultivars under study may stem from genetic variations and local environmental conditions. The number of leaves and leaf area could play a critical role in supplying a greater amount of food to the bulb, thereby influencing its weight. Soil structure and texture also emerge as significant factors affecting bulb weight. These results are similar to the findings of Ahmad and Khurshid (2004) who stated that varietal differences and genetic variations among specific cultivars contribute to disparities in bulb weight.

In the growth phase, rapid cell division is prevalent at relatively higher temperatures such as 18 °C during the day and 14 °C at night in the majority of bulbous flower crops. This environment fosters accelerated flowering. However, it is noteworthy that the flower size tends to remain smaller within this temperature range (Gandin et al., 2011). The adaptability of these crops in terms of growth and quality indices driven by biomass production is enhanced in favorable environments (Ens et al., 2013). Consequently, a warmer spring has been observed to yield a lower quantity of bulbs compared to plants exposed to relatively lower temperatures (12/8°C). The latter conditions sustain prolonged freshness as reported by Badri et al. (2007); Lundmark et al. (2009). In tulips, an earlier emergence of flower buds leads to an accelerated life cycle completion, especially when exposed to low temperature conditions resulting in improved floral attributes (Noy-Porat et al., 2009). It is crucial to note that flower initiation and development necessitate a specific duration of exposure to low temperatures for proper florogenesis. In warmer temperatures, this requirement may activate various sucrose-cleaving enzymes in the bulbs. This activation prompts a rapid shift from cell elongation to cell maturation, hindering starch accumulation as documented by Lundmark et al. (2009); Gandin et al. (2011). Moreover, in higher temperature regimes, carbon assimilation beyond the optimum temperature worsens the incorporation capacity of carbon in the bulbs. This, in turn, may result in feedback inhibition in the rate of photosynthesis, highlighting the complex relationship between temperature, floral development, and carbon metabolism in bulbous flower crops.

The current study observed a significant increase in bulb germination and sprouting when fresh bulbs were planted. Early germination and a high percentage of sprouted bulbs with subsequent flowering, particularly in yellow varieties, were likely influenced by a strong correlation with environmental temperature. These findings align with the previous research study conducted by Moore et al. (1979) who reported that early flowering in varieties resistant to physiological disorders caused by rapid temperature changes. The resistance against physiological disorders could be attributed to the presence of endogenous growth promoters which facilitate early flowering pattern development (Pharis & King, 1985). The observed variation in bulb sizes with more instances of larger bulbs may be linked to the increased number of leaves. A higher leaf count promotes photosynthesis leading to large size underground bulbs. Environmental components such as humidity, light, temperature, and edaphic factors likely might have played essential roles in the expansion and contraction of bulb sizes (Moore et al., 1979). The combination of genetic and environmental factors may have also contributed to the larger bulb sizes (Ahmad & Gul, 2002). Nard et al. (1997) support the idea that bigger sister bulbs with more leaves and larger mother bulbs are linked to favorable environmental conditions.

Conclusion

The study provided valuable insights into the variability among cultivars concerning various growth and flowering parameters. Syneda King emerged as the best cultivar displaying remarkable characteristics such as quick sprouting, abundant leaves, flowers, and bulbs, as well as large bulb diameter and weight. However, the performance of other cultivars varied across different parameters, providing a range of options for local farmers based on their preferences and cultivation goals. The findings of this study contribute valuable information for the promotion of tulip cultivation in Multan. By identifying cultivars that perform well under local conditions, the study provides a foundation for enhancing the floriculture industry in the region. Local farmers can benefit from this research by selecting specific tulip cultivars that align with their production objectives, leading to increased cut-flower production and meeting the demands of the local market. Recommendations based on the performance characteristics of specific cultivars offer practical guidance for growers, promoting sustainable and economically viable tulip production in the region. Overall, this research contributes to the advancement of tulip cultivation in Multan, opening doors for local farmers to explore the opportunities presented by the floriculture industry and participate in the broader market for fresh flowers and planting material.

References

Ahmad, M. J., & Gul, S. (2002). Evaluation of exotic cultivars of Dahlia (*Dahlia coccineae*). *Asian Journal of Plant Science*, *1*, 565-567.

Ahmad, M. J., & Khurshid, S. (2004). Performance of tulip (Tulipa gesnerana) cultivars under Rawalakot conditions. *Asian Journal of Plant Science*, *3*(2), 170-173.

Ahmed, Z., Sheikh, M. Q., Siddique, M. A. A., Jeelani, M. I., Singh, A., Nazir, G., Laishram, N., & Rehman, S. I. (2013). Enhancing early blooming and flower quality of tulip (*Tulipa gesneriana* Linn.) through application of plant growth regulators. *African Journal of Agricultural Research*, *8*, 4780–4786.

Ali, M., Khattak, A. M., Ullah, K., & Ibrahim, M. (2015). Performance of exotic tulip cultivars under agro-climatic conditions of Peshawar. *Journal of Bioresource Management*, *2*(3), 1-8. doi: 10.35691/JBM.5102.0026

Anonymous. (2006). Issues, challenges and opportunities in floriculture. Retrieved from https://www.dawn.com/news/188009/issueschallenges-and-opportunities-in-floriculture

Asghari, R. (2014). Effect of cold treatment (below 5 °C) and different growth medium on flowering period and characteristics of tulip (*Tulipa gesneriona* L.). *Journal of Experimental Biology and Agricultural Sciences*, *2*(4), 428-431

Badri, M. A., Minchin, P. E., & Lapointe, L. (2007). Effects of temperature on the growth of spring ephemerals: *Crocus vernus*. *Physiology of Plant, 130*, 67–76.

Danish, M. H., & Rose, S. (2018). Yea Power of flowers. Retrieved from https://nation.com.pk/Columnist/muhammad-hassan-danish-and-dr-sobia-rose

de Hertogh, A. A., & le Nard, M. (1993). Tulipa. In A. A. de Hertogh & M. Le Nard (Eds.), The Physiology of Flower Bulbs (pp. 617–682). Amsterdam, Netherlands.

Dosser, A. L., & Larson, R. A. (1981). Influence of various growth chamber environments on growth, flowering, and senescence of tulip cultivar. *Paul Richter Journal of the American Society for Horticultural Science, 106*, 247-250.

Ens, J., Farrell, R. E., & Belanger, N. (2013). Effects of edaphic conditions on site quality for Salix purpurea 'Hotel' plantations across a large climatic gradient in Canada. *New Forests, 44*(7), 899–918.

Gandin, A., Gutjahr, S., Dizengremel, P., & Lapointe, L. (2011). Source-Sink imbalance increases with growth temperature in the spring geophyte *Erythronium americanum*. *Journal of Experimental Botany, 62*(10), 3467–3479.

Hertogh, A. A., Barret, J. E., & Dilly, D. R. (1978). Effect of low pressure storage on tulip, hyacinth and daffodil bulb. *Journal of the American Society for Horticultural Science, 103*, 206-265.

Jaap, M. V. T., & Marjan, G. M. V. C. (2007). Chapter 23: Tulip. In: N. O. Anderson (Ed.), Flower Breeding and Genetics (pp. 623-641). Springer. https://doi.org/10.1007/978-1-4020-4428-1_23

Khan, M. A. (2011). Horticulture in Pakistan: Planning Perspective (pp. 1–17). Presentation at international seminar on horticulture and agribusiness in developing countries at UAF.

Khan, M. S. (2012) Assessing genetic variation in growth and development of potato. PhD Thesis Wageningen University, Wageningen

Larson, R. A. (1980). Introduction to Floriculture. New York: Academic Press, pp. 89-95.

Lundmark, M., Hurry, V., & Lapointe, L. (2009). Low temperature maximizes growth of *Crocus vernus* (L.) Hill via changes in carbon partitioning and corm development. *Journal of Experimental Botany, 60*(8), 2203–2213.

Manzoor, R., Shaukat, A. S., & Mazahar, H. B. (2001). Economics of floriculture in Pakistan: A case study of Lahore market. *Pakistan Economic and Social Review, 2*, 87–102.

Massonnet, C., Dauzat, M., Bediee, A., Vile, D., & Granier, C. (2015). Individual leaf area of early flowering Arabidopsis genotypes is more affected by drought than late flowering ones: a multi-scale analysis in 35 genetically modified lines. *American Journal of Plant Sciences, 6*, 955-971.

Moore, W. E., Brunt, A. A., Price, D., & Rees, A. K. (1979). Diseases of bulbs. *Journal of the Ministry of Agriculture, Fisheries and Food, 19*, 23-25.

Nard, M. E., Biot, M., Le-Nard, M., Lilien, K. H., Kipis, H., & Haivey, A. H. (1997). Measurement of variation tulip in different conditions. Proceedings of seventh International Symposium on flower bulbs. Herzliya, Israel. *Acta Horticulturae, 43*, 837-841.

Noy-Porat, T., Flaishman, M. A., Eshel, A., Sandler-Ziv, D., & Kamenetsky, R. (2009). Florogenesis of the Mediterranean geophyte Narcissus tazetta and temperature requirements for flower initiation and differentiation. *Scientia Horticulturae, 120*, 138–142.

Pharis, R. P., & King, R. W. (1985). Gibberellins and reproductive development in seed plants. *Plant Physiology, 36*, 517-568. https://doi.org/10.1146/annurev.pp.36.060185.002505

Rasmussen, E. (1980). Experiments on different storage temperatures for tulip bulbs. *Acta Horticulturae, 109*, 43-47.

Rehman, F. (2004). Rose Cut Flowers. Farming Outlook, January-March.

Safiullah, & Ahmad, M. J. (2001). Evaluation of exotic cultivars of Gladiolus under Rawlakot conditions. *Sarhad Journal of Agriculture, 17*, 172–174.

Sajjad, Y., Jaskani, M. J., Ashraf, M. Y., Qasim, M., & Ahmad, R. (2014). Response of morphological and physiological growth attributes to foliar application of plant growth regulators in gladiolus 'white prosperity'. *Pakistan Journal of Agricultural Sciences, 51*, 123–129.

Samach, A. (2012). Control of flowering. In: Plant Biotechnology and Agriculture: Prospects for the 21st Century (p. 387). Altman, A. (Ed.). Academic Press, London, UK.

Steel, Torry, & Dickey. (1997). *Principles and Procedures of Statistic a Biometrical Approach*. The McGraw Hill Companies, Inc.

Wilson, J. W. (1972). Control of crop processes. In: A. R. Rees, K. Kockshull, D. W. Hand, R. G. Hurd (Eds.), Crop Processes in Controlled Environments (pp. 7–30). Academic Press, New York.