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Optimizing Gladiolus Production for Off-Season Cultivation by Mitigating High-Temperature Conditions

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ABSTRACT
The study was conducted to investigate the effect of modified poly thene tunnel during staggered planting times on growth and vase life of gladiolus cut flowers. The polythene effectively reduces the internal temperature, particularly during extremely hot and humid planting times. Under the modified polythene conditions, high quality growht and vase life were observed during the months of September and October planting times. These included a higher number of leaves plant^{-1}, larger leaf area, maxium spike length, maximum spike diameter, greater number of florets spike^{-1}, heavier flower diameter and an extended vase life of the gladiolus cut flowers. Effectiveness of modified polythene tunnel is evident in reducing temperature of growing environment, leading to improved growth and enhanced vase life of the gladiolus flowers.

Keywords: Protected Cultivation, Prolonged Season, Heat stress, Vase life

INTRODUCTION
Gladiolus has dominance all over the most of cut flowers, because it is extensively distributed and widely used in decoration of flower arrangements. It has abundant diversity in colors and has eye catching attractiveness because of that it earn a major stake in local and international flower market (Halder, et al., 2007). The planting schedule, nutrient management, cultivar and size of planting cormels are the chief factors which influenced the growth and production of gladiolus. During winter season the gladiolus cut flower commonly exists in local flower markets (Ahmad, et al., 2011). Conversely, the existence in the summer and rainy seasons is very limited because of hostile weather conditions. However, it might be prodigious scope to find out the round the year production of gladiolus (Islam & Haque, 2011). The climate change is became a worldwide concern for plant scientist. Due to climate change the temperature stress became serious concern. Therefore complications of these changes have increased additional impacts on potentials of agriculture (Shah et al., 2011). The stress of temperature has hostile effects over the growth and metabolic processes in plants. There might be optimal boundaries of temperature for theses metabolic and growth processes in each species of plant. Due to climate change the temperature become increasing. Therefore, it is thought that heat stress is the foremost abiotic stress that has serious constraints on metabolism and yield of plant species (Hasanuzzaman, et al., 2013). An approach is protected cultivation to mitigate the detrimental effects of temperature stress. The poly tunnels are suitable for growing high value horticultural crops in off seasom by mitigating high temperature stress (Hanan, 2017). By keeping in mind the above mentioned evidences, the study was designed to pull out the premium gladiolus crop out the the normal season.

MATERIALS AND METHODS
Experiment was conducted at PMAS Arid Agriculture University, Rawalpindi, Pakistan located at latitude 33°38'51" and longitude 73°4'57.72". The gladiolus cultivar "White Prosperity" was grown in open field conditions and in polythene tunnel conditions in two consecutive years (2022-2023). Initially, the corms were planted at first date of July, August, September and October for identical germination in a sand bed and subsequently relocated to the research area once they reached the 4-6 leaf stage. In a raised bed, the corms were spaced with a row-to-row distance of 30 cm, leaving a 20 cm gap between each plant. Before planting the corms, well-rotted farmyard manure was mixed into the soil. The modified poly tunnel of dimensions 12 m in length, 3 m in width, and 2.5 m in height was used. Temperature and humidity data were recorded twice daily for both the open field and the modified poly tunnel (Figure 1). The experimental design for the two-factor

planting dates and growing conditions were studied following a randomized complete block design, with three replications. The growth parameters: number of leaves plant^{-1}, leaf area (cm^2), spike length (cm) and spike diameter (mm) and yield characteristics like number of flowers spike^{-1}, flower diameter and vase life were studied with standard methods. The ANOVA following RCBD two factorial arrangements was used to check the significance of treatment and LSD test at 5 % was used to compare the means.

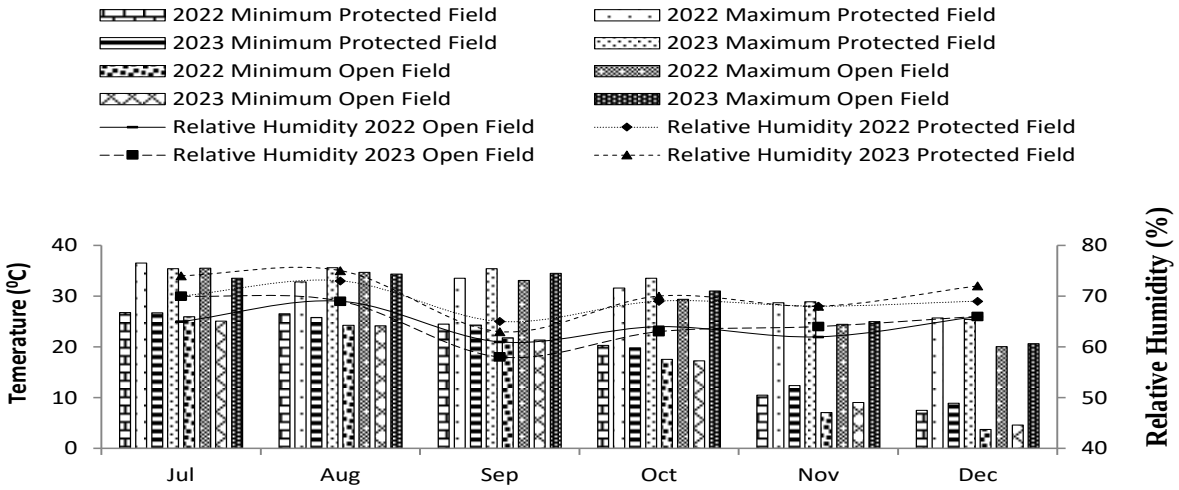

Figure 1. Minimum and maximum temperature (0C) and relative humidity (%) during growing season in open field and under polythene tunnel conditions.

RESULTS

Growth Parameters

The analysis of data related to growth parameters exhibited significant effects of planting time, polythene tunnel and their interaction (Figure 2). The corms planted in September and October produced maximum number of leaves plant^{-1}, leaf area, spike length and spike diameter under polythene tunnel. However, in the month of September and October in open field conditions the planted corms produced similar growth that was statistically similar with plants in August under polythene tunnel conditions respectively. There was minimum growth was observed in open filed conditions in July.

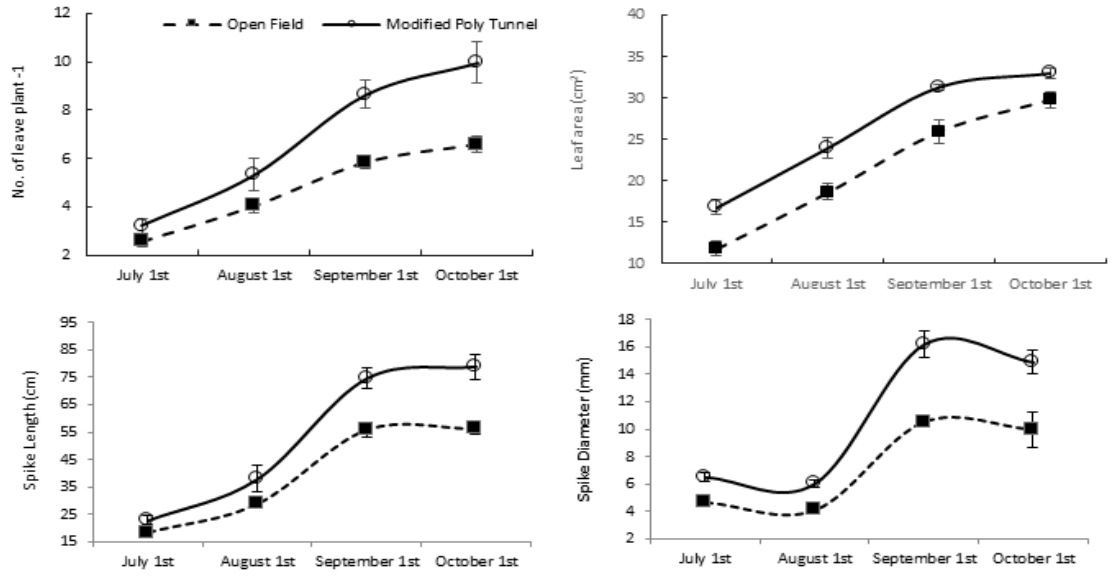

Figure 2. Impact of different growing condition on growth parameter (Number of leaves plant^{-1}, Leaf area (cm^2), Spike length (cm) and Spike diameter (mm)) of gladiolus. Bars shows the standard error between the replications.

Yield Performance

The analysis of data related to yield parameters exhibited significant effects of planting time, polythene tunnel and their interaction (Figure 3). The corms planted in September and October produced maximum number of flowers spike^{-1}, flower diameter and vase life under polythene tunnel conditions. However, in the month of September and October in open field conditions the planted corms produced similar yield that was statistically similar with plants in July and August under polythene tunnel conditions respectively. There was minimum growth was observed in open filed conditions in July and August.

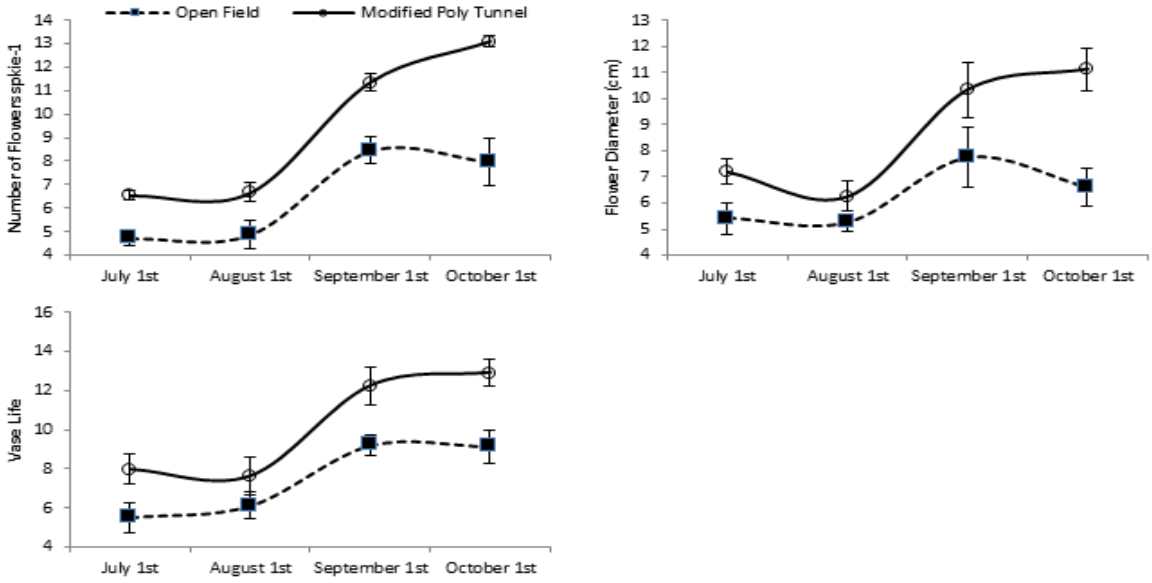

Figure 3. Impact of different growing condition on yield parameter (Number of flowers spike^{-1} and vase life) of gladiolus. Bars shows the standard error between the replications.

DISCUSSION

Results depicted under the modified polythene tunnel conditions the growth of gladiolus plant was better as compared to open field conditions. This might be due the lower light intensities coupled with lower temperature inside tunnel condition; moreover, relative humidity also lower inside protected conditions. Plants perform better in optimal temperature, a balance between air temperature, relative humidity and light. If light levels are high, the plant will heat up, resulting in a difference between plant temperature and air temperature (Kadir, Sidhu, & Al-Khatib, 2006). High temperatures along with high relative humidity influenced the growth of plants adversely (Gupta & Dubey, 2018). High temperatures affect photosynthesis and fresh weight of the crops. Stomatal conductance and the leaf water content were dramatically ceased and plants produce stunted growth (Song, et al., 2014). High temperature may affect the cell division, cell enlargement and plant growth. The taller plants were produced under protected growing conditions probably due to the lower detrimental effects of environmental factors like temperature and relative humidity. The current result supported by rose under protected microclimatic conditions produced taller plants (Iftikhar Ahmad, et al., 2011) and in summer season the height of gladiolus plants remained shorter in open field conditions (Islam & Haque, 2011). Preharvest environmental conditions strongly correlated with changes in morphological and physiological characteristics and the vase life of the cut flowers. Plants grown under high relative humidity (RH) and low VPD during the high temperature stress had less functional stomata and, consequently, higher transpiration from spike leaves after harvest (Lim, et al., 2017). This increased transpiration caused shorter vase life in the cut gladiolus. In addition, supplementary lighting, high photosynthetic photon flux, and CO2 supplementation also increased transpiration and, consequently, shortened vase life (In, Seo, & Lim, 2016).

CONCLUSION

It is concluded that high temperature conditions drastically reduced the growth of gladiolus cut flower and lower vase life. The high temperature with high humidity affects can be mitigated with modified polythene tunnel provided conditions in humid months. Consequently, better quality growth and vase life was achieved by the application of modified polythene tunnel conditions.

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Authors Contributions: The corresponding author conducted the research work and all other authors support in analysis and manuscript write-up process.

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