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Data Article

Analysis of dataset on reduction of high temperature stress by green net shade alleviate oxidative stress and augments the growth and vase life of gladiolus cut flower

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A B S T R A C T

The study was conducted to investigate the effect of green net shade during staggered planting times on growth, biochemical, antioxidant enzymes and vase life of gladiolus cut flowers. The green net shade effectively reduces the internal temperature, particularly during extremely hot planting times. Under the green net shade conditions, high quality morphological and biochemical observations were observed during the months of March and April planting times. These included longer plant height, spike length, a higher number of leaves plant^{-1}, larger leaf area, maximum spike diameter, greater number of florets spike^{-1}, heavier flower diameter,

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higher fresh and dry weight, elevated photosynthetic rate, and reduced time taken for flowering. Additionally, chlorophyll contents and transpiration rate showed significant increases, while antioxidant enzyme activity (POD and CAT) was recorded at higher levels. This resulted in reduced electrolyte leakage and an extended vase life of the gladiolus cut flowers. Moreover, the application of green net shade conditions during the planting in May and June significantly enhanced the quality characteristics of gladiolus cut flowers. Effectiveness of green net shade is evident in reducing temperature of growing environment, leading to improved growth, alleviate oxidative stress, enhanced quality features and vase life of the gladiolus flowers.

Specifications Table

Subject	Agriculture and Plant Sciences
Specific subject area	Agronomy and Horticultural Sciences
Type of data	• Tables and Figures • Raw • Analysed
Data Collection	The data on morphological, biochemical and physiological attributes were collected as per standard methods described in material and methods section and later analysed statistically.
Data source location	Experiment was done 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 green net house in two consecutive years (2019–2020).
Data accessibility	• Within the article • Mendeley: https://data.mendeley.com/datasets/63m8sjtnvh/2
Related research article	Not applicable

1. Value of Data

- The dataset explores detrimental effects of high temperature stress on gladiolus cut flowers.
- The green net shade effectively reduces the internal temperature and exhibited significant results for morphological, physiological, biochemical attributes and post-harvest attributes studied during the March and April planting times.
- The dataset highlights that artificial structures with modified growth conditions protect crops from unfavourable weather circumstances especially for growth and development for cut flowers.
- The dataset displayed that microclimatic conditions of green net shade house, temperature remained lower due to which plants were higher in number of leaves per plant with significant impact on both growth and quality. This information is valuable for researchers working on growth and quality improvement of cut flowers.
- The application of green net shade reduced the detrimental effects of climate change and increased the productivity of cut flowers. This may help farming community to enhance pro-

tected cultivation of horticultural crops for domestic and export flower markets and gaining economic benefits.

2. Background

Gladiolus exerts dominance in the realm of cut flowers, primarily due to its extensive distribution and widespread utilization in floral decorations. Its delicate nature, and exquisite beauty contribute to its superior standing among other cut flowers. Its abundant range of colors and captivating allure earn it a substantial share in both local and international flower markets [1]. The socioeconomic importance of gladiolus compels the farmers to grow it on large scales to earn more profits than the conventional crops. The gladiolus exhibits considerable potential in terms of profitability per acre when compared to conventional crops [2]. In locality of Pakistan, this flower has also attained great value in the floral trade [3]. The planting season, nutrient management, cultivar, and size of planting cormels are the leading factors which influenced the growth and production of gladiolus [4]. Conversely, the production in the summer is very limited due to hostile weather conditions [5].

Due to climate change the temperature stress became serious concern. The climate change is becoming a worldwide concern and complications of these changes have increased additional impacts on production of seasonal crops [6]. Heat stress significantly reduced the production of the plant species by disturbing several biochemical processes involved in plant's growth and development [7]. High temperatures might be occurring in a few days with short periods which increase the temperature of specific area more than 5 °C above normal temperature. These types of temperature stress events during the growing season of a specific crop would be laid most drastic effect on the production of crop species [8]. The optimal growth and development of gladiolus flowers rely on ample light and suitable temperature conditions. Gladiolus plants thrive within a temperature range of 12 °C to 20 °C. Moreover, the growth and development of plants are primarily governed by the air temperature prevailing in their specific growing environment [9]. The growth and development of the plant can be impaired, and flower desiccation may be caused by excessive average temperatures [10]. High temperature imbalance, water relations, accretion of osmolytes and carbohydrates degradations [11], low photosynthetic rate and higher respirational rate [12], variations in hormone and enzymes levels and the thermo stability of cell membrane [13].

The imparities caused a decrease in growth and overall production. The detrimental effects of high temperature stress can be mitigated through the implementation of several strategies [14]. The plant species might be provided shade conditions where the temperature and intensity of light is higher to inhibit the detrimental effects [15]. The negative impacts of intense sunshine, high temperatures, and wind can be lessened by adjusting the light intensity and spectrum inside protective structures like net houses. The production of cut flowers may be efficiently supported using protected culture, which enables adaptation to challenging environmental circumstances. Protected cropping reduces the risk associated with flower production and improves the financial return to producers [16]. Shaded condition provides the suitable conditions for the proper growth and development of the plants. Opportunities exist for underdeveloped economies to promote entrepreneurship in the establishment of export-oriented floriculture units within controlled atmospheric conditions, such as protected structures or greenhouses. Cut flower like gladiolus is one of the high values per acre as compared to the conventional crops [2]. Despite being cultivated in several tropical, subtropical, and temperate areas across the world, there are limited systematic research on the phenology of gladiolus are available. This study was aimed to produce high quality gladiolus cut flower production by application of green net shade so that farmers may be opting to protected cultivation for domestic and export flower markets.

3. Data Description

3.1. Plant morphological characters

The plant morphological characters significantly influenced under green net shade house conditions. It was observed that among all the planting times corms planted in March produced tallest (110 cm) plants under green net house growing conditions. The corms planted in March was given plant height (70.36 cm) in open field that was statistically similar with heights of plants in the April (73 cm) and May (66 cm) under green net house growing conditions. The number of leave produced by the plants which were grown under the microclimatic conditions of green net shade house (6.62) was more than in the open field conditions (5.58). Th corms planted in March (7.52) and April (7.75) produced maximum number of leaves followed by May (5.88). It was observed that gladiolus plant under the protective production system in March had given maximum area of leaf (49.41 cm^2), followed by leaf area in April (38.53 cm^2).

However, leaf area during March (28.3 cm^2) and April (28.05 cm^2) in open field conditions was statistically like leaf area in May (25.52 cm^2) under green net house conditions. It was shown that number of corms and cormels per plant during March (33) were highest in number, followed by April (30.61) planting produced statistically a greater number of corms and cormels per plant as compared to May (22.45) and June (21.74) planting. Among the growing conditions the plant produced (27.28) in protected conditions and (26.66) in open field conditions. The gladiolus plant produced larger sized corms under green net house (3.7 cm) in April, followed by March (3.67 cm) while minimum diameter of corm was observed during May (2.93 cm) and June (2.97 cm) in open field growing conditions. It was observed that gladiolus plant produced early flowering under the green net house conditions (74.5 days) than those which were in open field (92.34 days) conditions. Among the planting times corms planted in April (83 days), May (79 days) and June (80 day) planting got early flowering. March (92 days) planting time was taken more time to get the flowering (Table 1).

3.2. Floral characters of gladiolus

Among planting times corms planted in March (64.59 cm) and April (63.15 cm) produced largest spikes under green net house conditions. The relatively larger spikes in open field conditions in March (47.97 cm) and April (43.58 cm) were recorded. The spike diameter was recorded thickest among all the planting times in March (14.07 mm), followed by April (9.17 mm) under protected green net growing conditions which was statistically similar in March (8.5 mm) under open field conditions. The smallest spike diameter during months of April (6 mm), May (5.77 mm) and June (4.5 mm) in open filed conditions which was statistically similar from the spike diameter in protected field conditions in June (6 mm) was recorded. The flower diameter was documented thickest entirely in the treatments in March (10.02 cm) under green net house conditions, followed by April (6.31 cm) under protected conditions which is statistically like flower diameter in the March (6.72 cm) in open filed conditions. The number of florets were observed maximum among all the treatments in March (14.63), trailed by April (11.51) under green net house growing conditions. Moreover, in open field environment corms planted in March (8.91), April (7.88) and inside green net house conditions in June (8.88) were statistically in similar non-significant grouped. Maximum fresh weight of flowers was recorded in March (7.09 g) under green net house growing conditions. While during March (4.45 g) and April (4.07 g) in open field conditions were statistically similar with the flowers of April (4.82 g) in green net house conditions. The maximum dry weight of flower among all the treatments was recorded in March (3.61 g), trailed by April (2.36 g) under protected growing conditions. Whereas in open field conditions in March (2.16 g) and April (2.01 g) and inside green net shade house conditions in May (1.55 g), June (1.54 g) was noted as statistically similar in same non-significant group (Fig. 1).

Table 1
Plant morphological characteristics of gladiolus as affected by growing conditions and planting times.

Treatments		Plant Height (cm)	Number of Leaves Plant^{-1}	Leaf Area (cm^2)	Days Taken to Flowering	No. of Corms & Cormels Plant^{-1}	Corm's Diameter (cm)
Growing Conditions (GC)	Open Field	54.44±3.5B	5.58±0.51B	22.31±2.03B	92.34±3.76A	26.66±1.44	3.2 ± 0.4
	Green net Shade	75.97±4.8A	6.62±0.5A	32.89±2.26A	74.5 ± 2.86B	27.28±0.93	3.58±0.31
	Significance	**	**	**	**	NS	NS
	LSD	6.28	0.81	3.57	5.64	1.63	0.57
Date of Planting (DP)	Mar 1st	90.19±4.9A	7.52±0.55A	38.86±2.73A	91.68±1.95A	33.07±1.19A	3.63±0.35
	Apr 1st	64.06±3.1B	7.75±0.71A	33.29±2.2B	83.13±2.68B	30.62±1.07B	3.51±0.45
	May 1st	58.97±4.5B	5.88±0.3B	23.51±1.18C	78.57±5.22C	22.46±0.96C	3 ± 0.32
	Jun 1st	47.61±4.9C	3.25±0.47C	14.74±2.48D	80.31±3.4B	21.74±1.52C	3.42±0.31
	Significance	**	**	**	**	*	NS
	LSD	8.88	1.14	5.05	7.99	2.31	0.81
Interaction (GC × DP)	OF × Mar	70.36±4.2B	7.08±0.6	28.3 ± 2.32c	103.64±2.86	33.14±1.32	3.58±0.35
	OF × Apr	54.94±2.4cd	7.01±0.52	28.05±2.09c	94.61±1.8	30.42±1.54	3.32±0.63
	OF × May	51.9 ± 2.3de	5.38±0.23	21.5 ± 0.93cd	84.71±5.83	22.54±1.44	2.93±0.33
	OF × Jun	40.56±4.9c	2.85±0.69	11.4 ± 2.76e	86.4 ± 4.55	20.54±1.44	2.97±0.3
	GNS × Mar	110.01±5.6a	7.96±0.52	49.41±3.14a	79.71±1.04	33±1.06	3.67±0.34
	GNS × Apr	73.17±3.7b	8.48±0.89	38.53±2.3b	71.65±3.55	30.81±0.6	3.7 ± 0.26
	GNS × May	66.03±6.6bc	6.38±0.36	25.52±1.42c	72.42±4.6	22.37±0.48	3.06±0.31
	GNS × Jun	54.66±3.23cd	3.65±0.24	18.08±2.19de	74.22±2.24	22.94±1.59	3.87±0.32
	Significance	*	NS	*	NS	NS	NS
	LSD	12.56	1.62	7.15	11.3	3.26	1.14
CV		11	15.16	14.79	7.73	6.9	19.28

Means sharing same letters are none significant and ± showed the standard error of three means of each replicates.
Abbreviations: DP, Date of planting; OF, Open field; GNS, Green net shade; **, Highly significant; *, Significant; NS, None significant; LSD, Least significant difference; CV, Coefficient of variation.

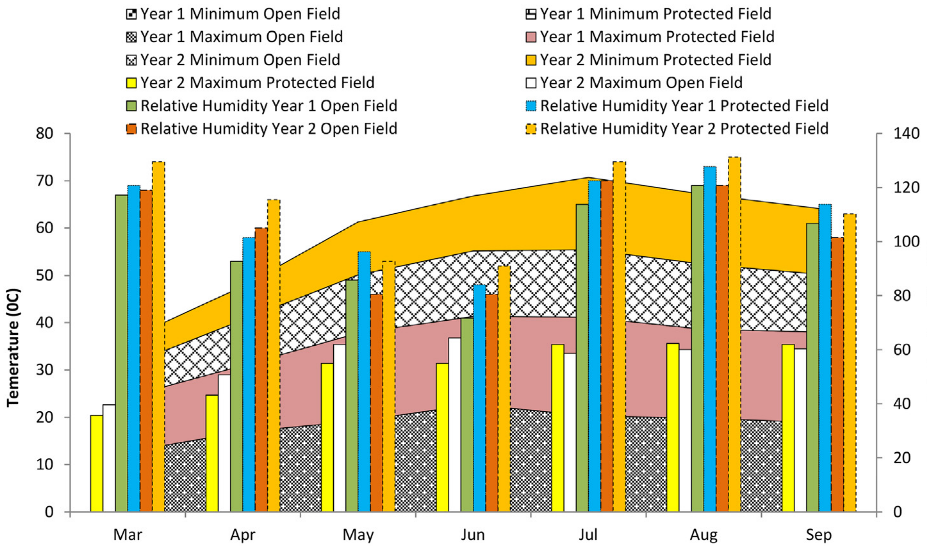

Fig. 1. Average weather measurements during the study period (2019–2020).

3.3. Bio-chemical attributes

The gladiolus grown under the green net house planting (61.72 SPAD) had higher level of chlorophyll contents than the open field (47.72 SPAD) environment. As shown by the mean values of planting times, the plants grown in March (64.92 SPAD), April (58.77 SPAD) had significantly higher level of chlorophyll contents as compared with the plants grown in May (48.13 SPAD) and June (47.07 SPAD). The gladiolus grown under the green net house planting (64.72 SPAD) had greater level of chlorophyll contents than the open field (47.12 SPAD) environment. As shown by the mean values of planting times, the plants grown in March (70.84 SPAD) significantly higher level of chlorophyll contents, followed by April (58.44 SPAD). While in May (43.85 SPAD) minimum level of chlorophyll contents were recorded. The maximum relative water contents were recorded in gladiolus grown under the protective green net shade house planting (90.35%) while minimum in plants grown in the open field (78.24%) environment. The mean values for planting time depicted that relative water contents were remained statistically none significantly in March (86.05%), in April (80.07), in May (81.74%) and June (89.3%) grown plants.

The highest level of relative water contents was noticed in gladiolus grown under the protective green net shade house planting (89.68%) while lower level in plants grown in the open field (77.02%) environment. The mean values for plantings time depicted that relative water contents were endured statistically none significantly in March (86.98%), in April (78.66%), in May (80.55%) and in June (88.2%) grown plants. The photosynthetic rate was higher in gladiolus plants grown under the green net shade house planting (2.35 mol m^{-2} s^{-1}) than in plants produced in field conditions (2.05 mol m^{-2} s^{-1}) environment. As shown by the mean values of planting times, the plants grown in March (2.8 mol m^{-2} s^{-1}), April (2.62 mol m^{-2} s^{-1}) had significantly higher level of photosynthetic rate as compared with the plants grown in May (1.77 mol m^{-2} s^{-1}), June (1.73 mol m^{-2} s^{-1}). The minimum transpiration rate was recorded in gladiolus grown under the green net house structure planting (0.93 mol m^{-2} s^{-1}) while maximum in plants grown in the open field (1.2 mol m^{-2} s^{-1}) environment. The mean values for planting time depicted that transpiration rate were highest in plants grown in March (1.15 mol m^{-2} s^{-1}) whereas lowest in May (0.96 mol m^{-2} s^{-1}) grown plants (Fig. 2).

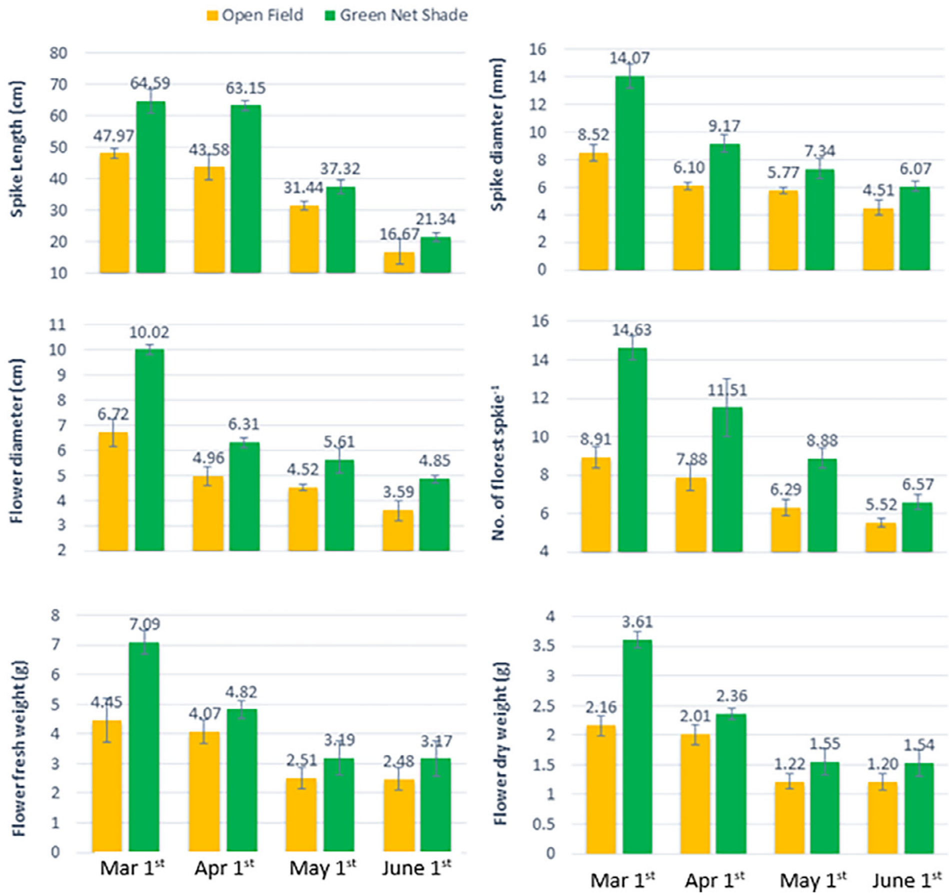

Fig. 2. Floral characteristics of gladiolus as affected by growing conditions and planting times.

3.4. Vase quality attributes

Gladiolus flower spikes had taken two to three days to open the florets amongst all the treatment combinations in both the years. It was observed that among all the planting times corms planted in March (12.93) and April (12.63) under green net house conditions taken longest life in vase. The vase life was longer in spikes produced under open field conditions in March (10.26) and April (11.52) plantings which is statistically similar of the vase life noted in the spikes produced during the May (9.33) planting under protected field conditions. Gladiolus spikes cultivated in the green net house exhibited the highest percentage of opened florets (96%) while minimum in plants spikes grown in the open field (83%) environment. The mean values for planting time depicted that percentage of opened florets were maximum in spike produced in November (97%) followed by December (93%), while minimum during January (84%) and February (83%) grown cut spikes. The highest (114%) average percentage of fresh weight was retained during spikes produced in the green net house in April followed by (104%) in May while minimum in plants spikes grown in June in open field (98.78%) environment throughout the shelf-life period (Fig. 3).

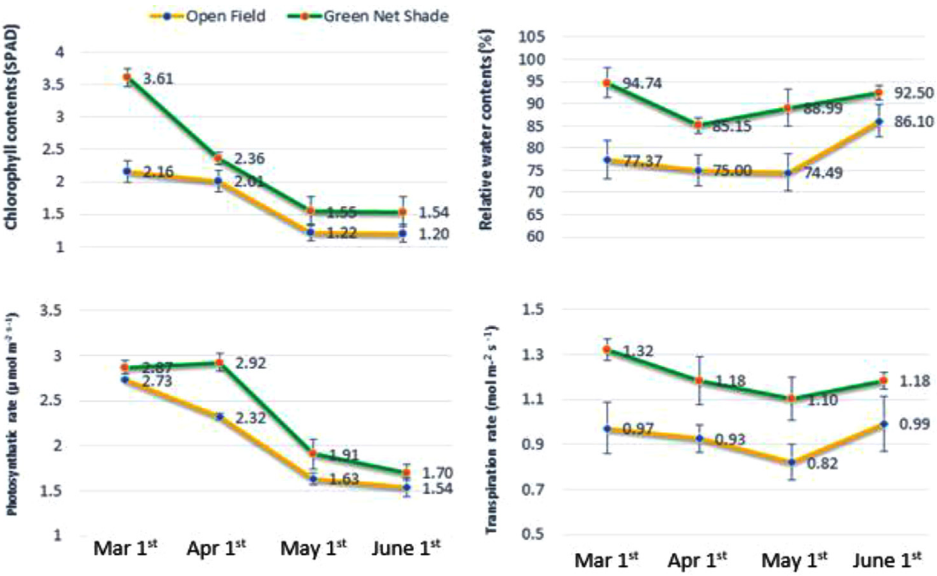

Fig. 3. Biochemical characteristics of gladiolus as affected by growing conditions and planting times.

3.5. Antioxidant enzyme and electrolyte activity

An overall lower electrolyte leakage was observed in green net house growing conditions as compared to field conditions. The gladiolus spikes grown under open field planting demonstrated the highest recorded level of electrolyte leakage in May (43.83%), June (44.53%) followed by March (38.89%), April (38.9%) in open field that is statistically at par with May (41.12%), June (40.42%) under green net house conditions, while minimum in plants spikes grown in the protected green net house conditions in March (35.46%) and April (34.26%) all through the vase life period at day nine. An overall higher activity of peroxidase was observed under green net house conditions and during March, April was highest among all planting times. The gladiolus spikes cultivated under the green net house planting exhibited the highest recorded peroxidase activity in March (42.86 U g^{-1} protein) and April (43.23 U g^{-1} protein) throughout the vase period at day six stage. Least peroxidase activity was noticed during May (25.28 U g^{-1} protein) and June (29.05 U g^{-1} protein) in field environments. Peroxidase activity was increased initially, maximum at day 6 stage and decline afterwards. The highest catalase activity in gladiolus cut flowers was observed in gladiolus spikes grown under the green net house planting during the months of March (11.46 U g^{-1} protein) and April (10.86 U g^{-1} protein), maintaining these conditions consistently throughout the vase period. While the least catalase activity measured during May (5.21 U g^{-1} protein) and June (4.38 U g^{-1} protein) in open environment (Fig. 4).

4. Experimental Design, Materials and Methods

Experiment was done 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 green net house in two consecutive years (2019–2020). Handling the plants/seed were made under the direct supervision of Muhammad Mazhar Qayyum, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan with followed the proper national and international strategies. Initially, the corms were planted for identical germi-

Fig. 4. Vase life characteristics of gladiolus as affected by growing conditions and planting times.

nation 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. The experimental design for the two-factor study followed a randomized complete block design, with three replications. Before planting the corms, well-rotted farmyard manure was mixed into the soil. The 50% green net house 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 green net house (Fig. 5). Uniform cultural operations were carried out homogeneously across all treatments. The following characteristics were recorded during the experiment.

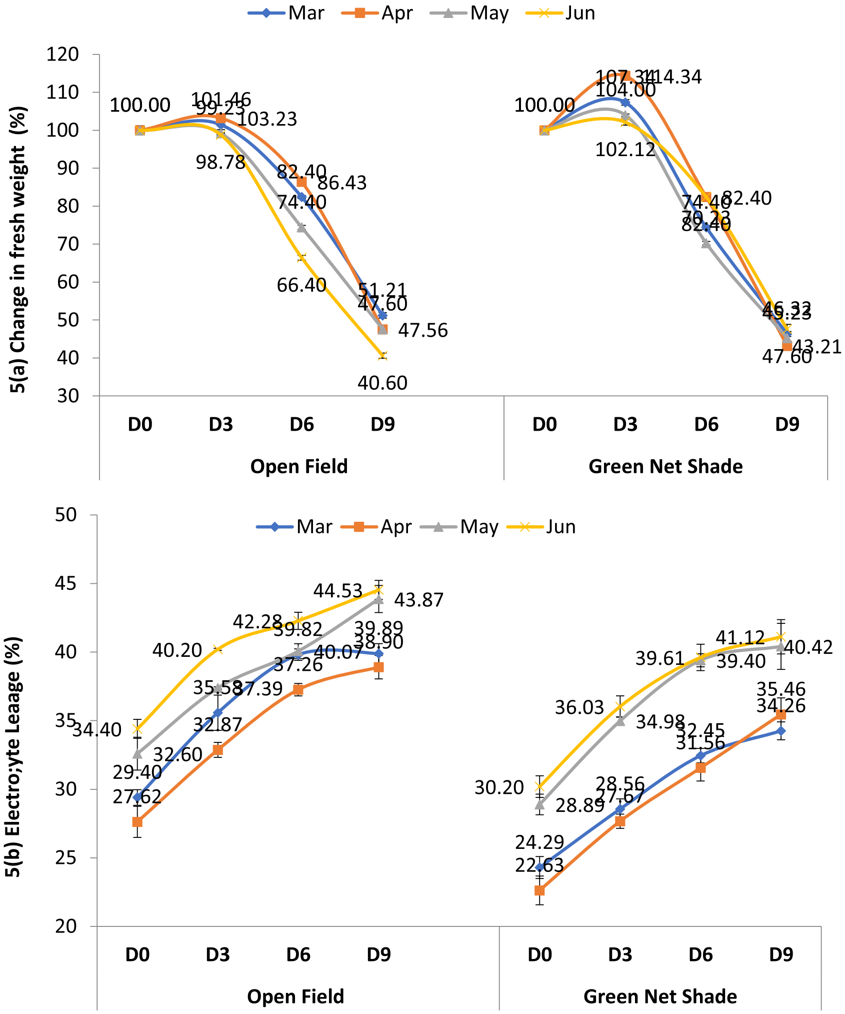

Fig. 5. (a) Change in fresh weight, (b) Electrolyte leakage, (c) Peroxidase activity and (d) Catalyze activity during 9 days in vase life of gladiolus as affected by growing conditions and planting times.

4.1. Morphological and floral measurements

Data were collected for various parameters including plant height (cm), number of leaves plant^{-1}, leaf area (cm^2), number of days taken to flowering, number of cormels per plant, corm diameter (cm), corm weight (g), spike length (cm), spike thickness (mm), number of florets spike^{-1}, flower diameter (cm), fresh weight (g) and dry weight (g) of the spike at the harvest stage.

4.2. Vase life attributes

In each replication, six cut spikes were placed in a vase to assess their vase life attributes. The measurements, number of florets opened percentage and the vase life of the spikes.

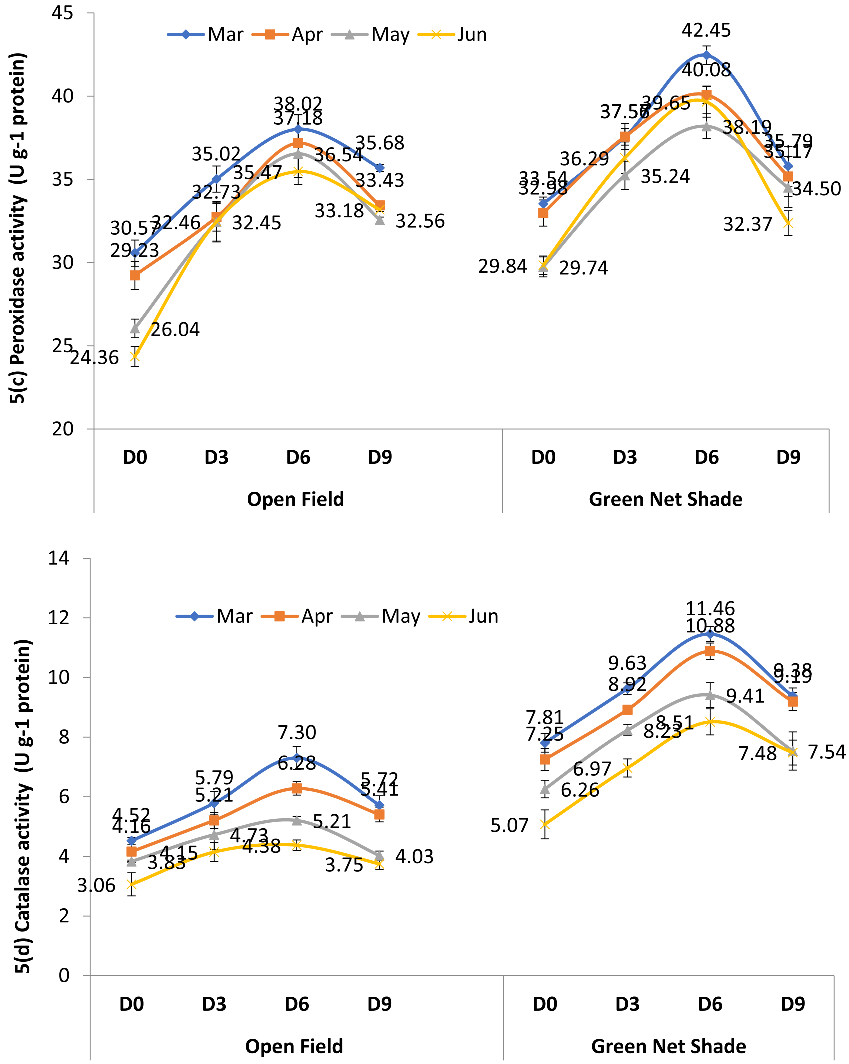

Fig. 5. Continued

4.3. Bio-chemical attribute

Chlorophyll contents were measured by using spade meter (SPAD 502 Konica Minolta, Japan) in gladiolus plant leaves.

4.4. Physiological characteristics

To assess the photosynthetic rate and transpiration rate, measurements were taken using an LCA-4 ADC portable infrared gas analyzer, manufactured by Analytical Development Company in Hoddesdon, England. The data taken between the hours of 12:00 and 15:00, aligning with the prevailing solar radiation during the flowering stage.

4.5. Relative water content

The determination of Relative Water Content (RWC) followed the procedure described by [17]. Leaves were carefully cut from the plant, and their fresh weight (FW) was promptly measured. Following that, soaked the leaves at room temperature for n distilled water for 4 h and recorded the turgid weight (TW). Then dried for 24 h at a temperature of 80 °C, the leaves' dry weight (DW) was measured. The RWC was calculated using the following formula:

RWC (%)=((FW-DW))/((TW-DW))×100

4.6. Electrolyte leakage (EL)

The calculation of electrolyte leakage was conducted following the method described by [18], with slight modifications. For each treatment, five floral petal discs were collected, each measuring 10 mm in diameter, and assembled them in a test tube with 10 mL of distilled water. The test tube was then incubated at 25 °C for a duration of 180 min to measure the initial membrane (C1) leakage using a conductivity meter. Prior to the final (C2) conductivity measurement, the solution was boiled in a water bath for 10 min to release all electrolytes. The membrane leakage was measured using the following equation:

EL(%)=C1/C2×100

4.7. Preparation of enzyme extracts

The flowers underwent rapid freezing using liquid nitrogen and stored in −80 °C, followed by the collection of a sample of one gram from each replication. Then, sample was ground using a pre-cooled mortar and pestle. The floral tissues were suspended in 5 mL of 0.1 M KPO_4 buffer (pH 7.8) containing 0.5% Triton and 0.2 g of PVPP (Polyvinylpolypyrrolidone). The blend was prepared and subsequently centrifuged for 30 min at 4 °C and at a speed of 27,000 x g, following the method described by [19].

4.8. Peroxidase assessment

Peroxidase activity (POD) was determined with slight modifications, following the procedure outlined by [20]. The assay mixture consisted of 1 mM H_2O_2, 0.1 mM guaiacol, and 15 mM $NaKPO_4$ buffer (pH 6.0), combined with 200 µL of the basic enzyme extract. The POD activity was assessed by measuring the changes in optical density (OD) over a three-minute period at 470 nm. The activity was expressed as units per gram of protein.

4.9. Catalase assessment

Catalase activity (CAT) was assessed following the procedure described by [17] with minor modifications. Two buffer solutions were utilized to initiate the reaction. The first buffer contained 50 mM KPO_4, while the second buffer consisted of 12.5 mM H_2O_2 in 50 mM KPO_4 (pH 7.0). For the reaction, 300 µL of the enzyme was added to each buffer in 3 mL cuvettes, and the optical density (OD) was measured at 240 nm. The unit for catalase activity was expressed as units per gram of protein.

4.10. Statistical analysis

The statistical analysis of the data was conducted using the analysis of variance (ANOVA) technique within a Randomized Complete Block Design (RCBD). To determine significant differences between the means, Duncan's multiple range test was employed at a significance level of 5%.

Limitations

Not applicable

Ethics Statement

Experimental research and field studies on plants (either cultivated or wild), including the collection of plant material, complied with relevant institutional, national, and international guidelines and legislation. A prior approval was undertaken from Offices of Research, Innovation and Commercialization, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan.

Credit Author Statement

Muhammad Mazhar Qayyum and Imran Hassan designed the study. Muhammad Mazhar Qayyum perform the experiments and analysis. Muhammad Mazhar Qayyum perform done with the data analysis, software standardization and writing of original draft. Sulaiman Ali Alharbi, Mohammad Javed Ansari, Sajid Fiaz and Shah Masaud Khan provided technical expertise to improve the article and helped in funding acquisition. Mishal Subhan, Shahzad Saleem and Muhammad Mazhar Qayyum helped during revision, critical analysis and editing of the revised manuscript. All authors review and edited the manuscript.

Data Availability

Raw data (Original data) (Mendeley Data)

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Funding

No specific funds have been received to conduct present research.

Availability of data and materials

All data generated or analyzed during this study are included in this article.

Declaration of Competing Interest

Auhtors have no competing intrest to declare.

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