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Article

Effect of Prolonging Daylight, Foliar Application of Salicylic Acid and Micronutrients on Inflorescence Characteristics and Leaf Anatomy of *Gerbera jamesonii* Plant Photoperiod Extension

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Abstract: This study was conducted in the fields and laboratories of the Department of Horticulture and Landscape design, College of Agriculture and Forestry, University of Mosul. The experiment included a study of exposing plants to natural daylight or with prolonging daylight with red and blue light, which obtained from diodes, Figure 1 for four hours (one hour before sunrise and continuing one hour after, then two hours at sunset, one hour before sunset and continuing for one hour after sunset), and spraying with salicylic acid at 300 mg l^{-1}, or spraying with a mixture of micronutrients, include $FeSO_4$, $ZnSO_4$ and $CuSO_4$, at a concentration of 40 mg l^{-1} for both iron and zinc, and copper was added at 10 mg l^{-1} or an interaction between salicylic acid and micronutrient. The results showed that growing plants with prolonging daylight combined with spraying with salicylic acid and a mixture of micronutrients led to the significant increase in values for inflorescence yield, inflorescence stalk length, and the ratio of ray to disc florets, as well as the glucose content of the flowers. The anatomical study showed that the above treatment led to an increase in the thickness of the spongy layer and the lower leaf epidermis. On other hand, the diameter of the vascular bundle in the midrib vein of the leaf and the total number of vascular bundles and small vascular bundles also increased. The above treatment also led to an increase in the diameter of the vascular bundle in the leaf petiole, the outer sclerenchyma layer, and the xylem.

Keywords: Spectrum Type, Salicylic Acid, Fertilization with Microelements, *Gerbera jamesonii*

Introduction

The most important ornamental plants economically are *Gerbera jamesonii,* which belongs to the Asteraceae family. The plant is classified as one of the important cut flowers in the world [1 and 2]. According to global trends in flower cultivation, it ranks fourth among cut flowers after roses, carnations, and chrysanthemums [3]. It is in high demand in local and international markets due to its variety of colors, sizes, and ability to last a long time in a vase, as it can remain in a vase for more than

14 days [4]. The total area of gerbera cultivation in India is 870 hectares with a productivity of 21,300 tons ha^{-1} [5].

Light, as an environmental factor, is an essential element in plant morphological differentiation, as it regulates plant growth and development, and also affects hormone levels and many other physiological activities [6 and 7]. The use of artificial lighting has become increasingly important in agriculture because of its association with increased productivity and improved quality. One form of artificial lighting is the Light Emitting Diode (LED), which is widely used because it can be tuned to give a narrow and specific spectral composition, as well as other features [8]. The type of spectrum produced by LEDs can significantly affect plant morphology and anatomical structure, as well as nutrient uptake and disease development. Red LEDs are used to enhance photosynthesis, as they are efficient in generating a wavelength of 660 nm, close to the peak absorption of chlorophyll. Using blue light alone leads to a decrease in net photosynthesis. Combining red (R) and blue (B) light may increase net photosynthesis and the dry weight of shoots. Red light may affect stem elongation, chlorophyll content, and soluble sugar content, while blue light stimulates phototropins receptors to induce physiological responses that regulate leaf elongation, stomatal opening, leaf anatomical structure, enzyme and chloroplast synthesis, and carotenoid and soluble sugar content [9; 10; 11]. [12] noted that the thickest mesophyll layers of *Gerbera jamesonii* were in the cross-sections of tissue cultured leaves exposed to blue light from LED lamps versus those grown under red light. The leaves grown under LED lamps also contained larger vascular bundles compared to those grown under fluorescent lighting. The researchers indicated that the different light types used led to a change in the thickness of the leaf blade and petioles (except for the width of the vascular bundles), as well as a change in the density, area, and width of the stomata on the lower epidermis. The thickness of the leaf layers varied according to the type of spectrum to which they were exposed. The palisade tissue was thickest in the leaves exposed to blue light and a mixture of red and blue light, while the spongy tissue was widest under 100% blue light. [13] reported in their study of LED lamps with different light spectra on *Gerbera jamesonii* 'Bayadere' that the greatest inflorescence stalk diameter, stalk diameter at neck, and inflorescence fresh weight were observed when plants were grown under red, blue, or a mixture of red and blue light, compared to the control treatment grown under natural light, The greatest values for leaf length, inflorescence diameter, number of flowers per plant, and inflorescence fresh weight were recorded when plants were grown under red or a mixture of red and blue light, compared to the other treatments. In their study on *Gerbera jamesonii* cultivar Bayadere, [14] explained that the calcium content of the leaves did not differ significantly in its values under the different types of lighting used, but it increased significantly and reached its maximum compared to other treatments when the plants were grown under a mixture of red and blue light and sprayed with calcium chloride at a concentration of 1.5 g L^{-1}. The lowest significant values for the nitrite content of the leaves were recorded when plants grown under a mixture of red and blue light. The highest significant values for the diameters of the inflorescence stalks were recorded when grown under any type of supplemental lighting, red or blue LED lamps or a mixture of them, compared to when grown under natural light. On the other hand, the highest values for flower curvature were recorded under natural light, while they were significantly lower under any type of supplemental lighting.

Salicylic acid was first naturally extracted in 1928 from willow plants (Salix), as it is synthesized in plants from the amino acid phenylalanine [15 and 16]. It is an aromatic carboxylic acid of a phenolic nature, with a low molecular weight, colorless, and soluble in water and polar organic solvents [17]. Salicylic acid plays a role in many physiological activities, as it has a role in inducing flowering, regulating ion absorption, hormonal balance and stomata movement. It also plays a role in regulating the response of plants to environmental stress conditions such as salt stress, drought, heat stress and stress resulting from metals. It affects the biosynthesis of ethylene and has an opposing role to the growth inhibitor abscisic acid. It also accelerates the formation of chlorophyll, carotene and anthocyanin pigments and accelerates the process of photosynthesis, transpiration, ion absorption and transport and increases the activity of some important enzymes, as well as increasing the plant's resistance to disease and insect infestation [18; 15 and 16]. The results obtained by [19] indicated that adding SA to the vase's flower preservation solution (holding solution) prolonged the flower life of *Gerbera jamesonii* inflorescences compared to spraying the flowers or pulse treatment. [20] in their study on the effect of foliar spraying with salicylic acid on *Gerbera jamesonii* cultivar Pink Elegance, reported that the largest inflorescence diameter, shortest growth period to flowering, and highest number of inflorescences were associated with treatment with 75 μM salicylic acid, while the highest values for inflorescence diameter were recorded with treatment at 150 μM. [21] investigated the effect of foliar spraying with salicylic acid on Egyptian lupin (*Lupinus termis*). The maximum significant effect was obtained when the plants were sprayed with a 75 mg l^{-1}. This resulted in earlier flowering, a significant increase in the number of leaves and leaf area, and a marked increase in stem diameter. This increase was attributed to the thickening of epidermal cells, cortex, vascular bundles, phloem, and xylem, as well as an increase in the thickness of the parenchyma tissue filling the pith. [22] studied the effect of salicylic acid on the growth and flowering of three *Zinnia elegans* cultivars: Dreamland, Lilliput, and Zinnia Dahlia Flower. Treatment with a 100 mg l^{-1} increased the number of leaves, leaf area, number of flowers, the duration of inflorescence retention on the plant, flower stalk length, and the diameter of the inflorescence for the three varieties was also increased, while the fewest days to flowering were recorded when spraying with a 200 mgl^{-1}. The researchers concluded that increasing the concentrations of salicylic acid used improved the values of most of the studied traits.

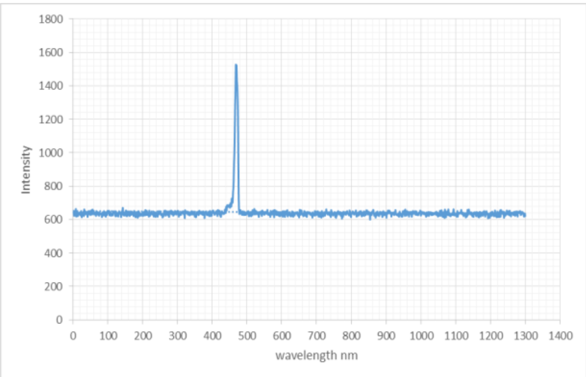
Micronutrient nutrition is as essential as macronutrient nutrition for optimal crop growth, yield, and quality [23]. Iron is an essential component in the enzymatic system and plays a role in electron transport, chlorophyll formation, and the oxidation stage in respiration, In addition, it is necessary for the production of NADP and the reduction of NO_3^- and SO_4^{2-}, as well as nitrogen metabolism, Symptoms of its deficiency in plants include yellowing of young leaves and scorching at the tips and margins [24; 25]. Zinc plays various roles in plant physiological processes, as it activates enzymes involved in the metabolism of sugars and proteins, stabilizes protein structure, and regulates gene expression [26]. Copper is involved in carbohydrate and protein metabolism and nitrogen fixation [27]. Copper (Cu) is an active transition element in oxidation-reduction reactions, which underpins its role as a catalyst in many enzymes and proteins [28]. [29], in their study on the effect of foliar micronutrient fertilization on the growth and flowering productivity of *Gerbera jamesonii*, reported that the highest values for flower stalk length (69.56 cm), number of cut flowers (6.27 flowers plant^{-1}), and the duration of inflorescence retention on the plant (6.67 days) were observed when the foliage was sprayed with 0.2% zinc sulfate, 0.2% manganese sulfate, and 0.1% iron sulfate. As [30] reported in their study on the effect of foliar spraying with 0.2% and 0.3% iron and zinc sulfates and their low-level interaction on the growth, flowering, and yield of *Gerbera jamesonii* under protected conditions, the highest significant values for the number of flowers per plant (15.70 flowers plant^{-1}), inflorescence stalk length (54.00 cm), and vas life (10.28 days) were recorded when the micronutrients ferrous and zinc sulfates were sprayed at a 0.2% each. [31] indicated that spraying *Gerbera jamesonii* cultivar Rosaline with 0.6% ferrous sulfate resulted in the highest number of flowers per plant (14.7 inflorescences plant^{-1}), and that spraying with ferrous sulfate, magnesium sulfate, and zinc sulfate significantly increased growth and flowering.

This experiment aims to evaluate the exposure of gerbera plants to different types of light spectra at specific times before sunrise and after sunset, with spraying with salicylic acid and fertilization with micronutrients, and to study the effect of this on flowering as well as on other characteristics, in addition to studying the effect of these factors on the anatomical structure of the leaves and their effect on the flowering age of the cut inflorescence.

Materials and Methods

The experiment was carried out in a plastic house structure, Department of Horticulture and Landscape design, College of Agriculture and Forestry, University of Mosul, during the period from December 2024 to May 2025, using *Gerbera jamesonii* cv. Esmara plant, pink in color, with double flowers, available in the horticulture field. The experiment included a study of exposing plants to natural daylight or with prolonging daylight with red wavelength of (659 nm), intensity of (47750) + blue light wavelength of (468 nm), intensity of (1526), which obtained from diodes, Fig (1) placed 100 cm over the plants, for four hours (one hour before sunrise and continuing one hour after, then two hours at sunset, one hour before sunset and continuing for one hour after sunset), and spraying with salicylic acid at 300 mg l^{-1}, or spraying with a mixture of micronutrients, namely iron, zinc, and copper in the form of sulfates for the three elements, at a concentration of 40 mg l^{-1} for both iron and zinc, and copper was added at 10 mg l^{-1} or an interaction between salicylic acid and micronutrient. This was added after signs of growth appeared on the plant. Thus, the experiment included the following treatments: The plants were not prolonged daylight (natural daylight) or sprayed with any of the other treatments (control), or mixed with spraying with a 300 mg l^{-1} of salicylic acid, or spraying with a mixture of micronutrients, or spraying with a mixture of salicylic acid and micronutrients at their concentrations above. In addition, the plants were placed under prolonged daylight for four hours with red and blue light (control), or mixed with spraying with salicylic acid, or spraying with a mixture of micronutrients individually, or spraying with a mixture of salicylic acid and micronutrients. The factorial experiment was carried out with a completely randomized block design with three blocks and with 15 plants per treatment.

Blue



Red

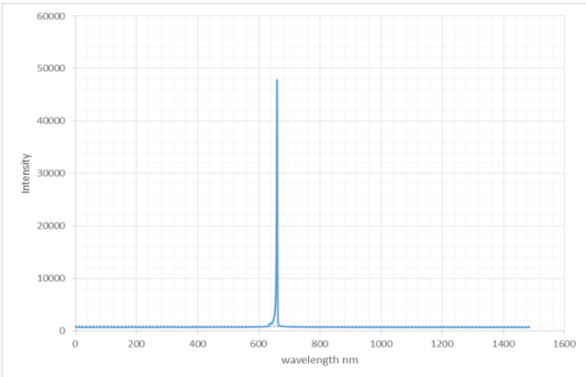


Figure 1. The red and blue light spectrum used to prolong daylight, emitted from a red diode with a wavelength of (659 nm), intensity of (47750) and a blue diode with a wavelength of (468nm), intensity of (1526), placed at a distance of 100 cm from the plants.

The field soil consisted of 3 parts of new river soil and 1 part of fully decomposed animal manure. The land was divided into two parts. The first part, where the plants exposed to prolonging daylight, contained raised beds 30 cm wide and 195 cm long. The plants were planted at distance of 25 cm between lines and 30 cm between plants. The plants were watered one week after planting with the fungicide Beltanol at 2.5 ml l^{-1} [32]. Maintenance operations were performed identically for all plants, including hoeing, weeding, and watering as needed. The plants were exposed to supplemental lighting as soon as they showed signs of growth and they were sprayed until wet with salicylic acid and micronutrients at the concentrations studied, once every two months. All plants used in the experiment were also sprayed with GA_3 at 200 mg l^{-1}, and this spraying continued monthly throughout the experiment [33]. Anatomical sections were taken from leaves vein and petiole by a sharp blade. They were then placed in FAA solution for fixation, and successive operations were performed to make fixed slides. Safranin and Fast green dyes were used to stain the living and dead tissues, and then the data were recorded using a light microscope.

Result and Discussion

The results in Table 1 indicate that the highest number of inflorescences (1.92 and 1.91 infloresc. $Plant^{-1}$) were obtained when spraying with salicylic acid and micronutrients mixture under natural daylight or prolonging it, respectively.

Table 1. The effect of red and blue light spectrum to prolong daylight, salicylic acid and fertilization with a mixture of micronutrients on some flower characters of *Gerbera jamesonii* var. Esmara.

Treatments		Infloresc. yield (infloresc plant^{-1})	Infloresc. stalk length (cm)	Ray to disc florets ratio (%)	Nitrogen cont. in flowers (mg g DW^{-1})	Glucose cont. in flowers (mg g DW^{-1})	Fructose cont. in flowers (mg g DW^{-1})	Vase life (day)
(h.)	(mgl^{-1})							
Without prolong daylight	Control	1.28 b	37.75 c	129.48 e	1.6 b	2.73 c	1.37 d	20.58 b
	SA	1.61 ab	38.02 bc	129.79 e	2.02 ab	4.23 ab	2.89 a	22.05 ab
	Micronut.	1.69 a	38.47 bc	132.26 d	2.09 ab	3.66 a-c	2.12 bc	22.33 ab
	SA+ micronut.	1.92 a	39.22 a-c	135.30 c	2.25 a	4.71 a	2.69 ab	23.31 a
With prolong daylight for 4 h	Control	1.64 a	38.21 bc	134.33 c	1.57 b	3.38 bc	1.76 cd	22.45 ab
	SA	1.64 a	39.98 ab	135.6 c	1.81 ab	2.97 c	1.58 cd	23.83 a
	Micronut.	1.60 ab	40.82 a	138.54 b	1.73 ab	3.74 a-c	2.04 bc	23.67 a
	SA+ Micronut.	1.91 a	41.02 a	140.41 a	1.83 ab	4.65 a	2.66 ab	23.22 a

Values sharing the same letters within each character do not differ significantly according to Duncan's Multiple Range Test at the **%5** probability level.

These two treatments did not differ significantly from all other treatments but differed significantly from the control treatment under natural daylight conditions. The longest inflorescences stalks were recorded when spraying with micronutrients mixture alone or with salicylic acid, reaching 40.82 and 41.02 cm respectively, when prolonged the daylight. Spraying with salicylic acid and micronutrients mixture under prolonged daylight resulted in the highest ratio of ray to disc florets, reaching 140.41%, which differed significantly from the values of all other treatments.

On the other hand, spraying with salicylic acid and a micronutrient mixture under the natural day condition significantly increased the nitrogen content of the flowers compared to the control treatments (under natural day or prolonged daylight). The highest values for flower glucose content (4.71 and 4.65 mg g DW^{-1}) were recorded when spraying with salicylic acid and a micronutrient mixture (under natural day or prolonged daylight, respectively). The highest significant value for flower fructose content (2.89 mg g DW^{-1}) was recorded when spraying with salicylic acid under natural daylight. The vase life results showed the highest values (23.83, 23.67, and 23.22 days), recorded when prolonged the daylight and spraying with salicylic acid, a micronutrient mixture, or both. These values did not differ significantly from most other treatments, but differed significantly from the control treatment (under natural daylight).

The results in the table above, which shows that the highest values were recorded when the photoperiod was extended in conjunction with spraying with salicylic acid and a mixture of micronutrients for the characteristics of inflorescence yield, inflorescence length, and ratio of ray to disc florets, may be explained by the availability of nutrients in the plant, which supported growth in general. This is supported by the results obtained for the inflorescence content of nitrogen, glucose, and fructose. In the same direction, the length of flowering life was recorded. A previous study confirmed that the type of light spectrum directly affects photosynthesis and carbohydrate production, which is reflected in the soluble sugar content of the plant [34]. This is supported by [35 and 36]. [9] and [37] stated that red light can increase the soluble sugar content of the plant, while blue light promotes the accumulation of soluble proteins. [38] confirmed that a suitable combination of these red and blue light can increase both soluble sugars and proteins. On the other hand, variations in inflorescence diameter and inflorescence stalk length may be subject to genetic and environmental control [39; 40]. The increase in inflorescence diameter and inflorescence stalk length may be due to the role of iron in stimulating metabolic activity, which in turn stimulates cell wall elasticity, thus leading to cell elongation, division, and expansion. This may result in increased values for the aforementioned traits [41]. These results are largely consistent with the findings of [31] on gerbera. The increase in the number of ray florets may be attributed to the increase in the growth of some vegetative traits such as the number or area of leaves or the concentration of chlorophyll, which contributes to an increase in the photosynthesis process, and thus the accumulation of a larger amount of dry matter, which in turn leads directly or indirectly to an increase in the number of florets in the inflorescence [42]. The increase in the number of inflorescences may be due to the use of $ZnSO_4$, which plays an important role in the photosynthesis process, the breakdown of IAA and protein synthesis, which leads to the production of more nutrients that are used in turn in the growth of flowers [43]. [44] and [45] obtained similar results in tuberose. Micronutrients such as zinc help regulate cell wall permeability, allowing more water to reach the flowers, and increase iron synthesis, which stimulates flower size and weight [45]. This has helped protect plants from yellowing and produce healthy green leaves, which has led to increased production and distribution of nutrients for flower growth and thus an increase in their size [30]. The difference in flowering age may be explained by anatomical differences [46]. It may be due to a difference in the number of vascular bundles of the inflorescence stem, their diameters, or the way they are arranged to facilitate greater water uptake. Here, the role of salicylic acid in supporting the antioxidant response to remove free radicals by activating the superoxide dismutase enzyme to remove O_2 from within plant tissues, which causes severe damage to cells if they accumulate at levels higher than the critical limit, thus delaying aging and prolonging flowering life [47]. [48] stated that spraying with salicylic acid leads to an increase in the diameter of the basal floret of the Tuberose plant, which is a result of good vegetative growth and positive synergy between auxins and salicylic acid. In addition, salicylic acid plays a role in regulating many physiological and biochemical activities and molecular mechanisms. [49] confirmed that spraying with salicylic acid improved the total content of free amino acids such as proline, spermidine, and total polyamines by increasing the absorption and transport of nutrient ions.

The data in Table 2 and Figure 2 regarding leaf tissue thickness, which varied according to the studied treatments, show that the highest thickness of the upper epidermis was recorded at 24.18 and 23.3 μm when prolonging the daylight, with no spraying of any of the studied treatments or with salicylic acid spraying, respectively. Conversely, the highest values for the palisade layer were recorded at 103.42 and 100.28 μm when spraying with salicylic acid under natural daylight or prolonged the daylight, respectively. The data also indicate that spraying the plants with salicylic acid and micronutrients mixture, under natural daylight or with prolonged daylight, resulted in a highest increase in the thickness of the spongy layer, reaching 188.64 and 193.32 μm, respectively, compared to 135.23 μm for the control treatment under the natural daylight. Spraying with the micronutrient mixture or with salicylic acid, under the prolonged daylight, resulted in a highest increase in the thickness of the lower epidermis compared to the other treatments.

Table 2. The effect of red and blue light spectrum to prolong daylight, salicylic acid and fertilization with a mixture of micronutrients on leaf tissues size (μm) of *Gerbera jamesonii* var. Esmara.

Treatments		Thickness of Upper epidermis (μm)	Thickness of palisade cells (μm)	Thickness of spongy cells (μm)	Thickness of Lower epidermis (μm)
(h.)	(mgl^{-1})				
Without prolong daylight	Control	21.32	94.4	135.23	18.09
	SA	22.80	103.42	163.71	14.75
	Micronut.	21.88	86.44	172.59	19.23
	SA+ micronut.	20.82	71.96	188.64	15.79
With prolong daylight for 4 h	Control	24.18	96.38	152.03	18.40
	SA	23.3	100.28	140.74	18.78
	Micronut.	18.72	77.53	177.95	24.98
	SA+ micronut.	19.55	87.42	193.32	25.70

This result may be explained by the role of blue light or a mixture of blue and red light in the development of thicker leaf blades [12], since a mixture of red and blue light may positively affect the efficiency of photosynthesis, and did not reduce the level of secondary metabolism or the content of monosaccharides in gerbera plants [50], and it can be concluded that the increase in leaf blade thickness may be attributed to an increase in the thickness of the spongy tissue [51].

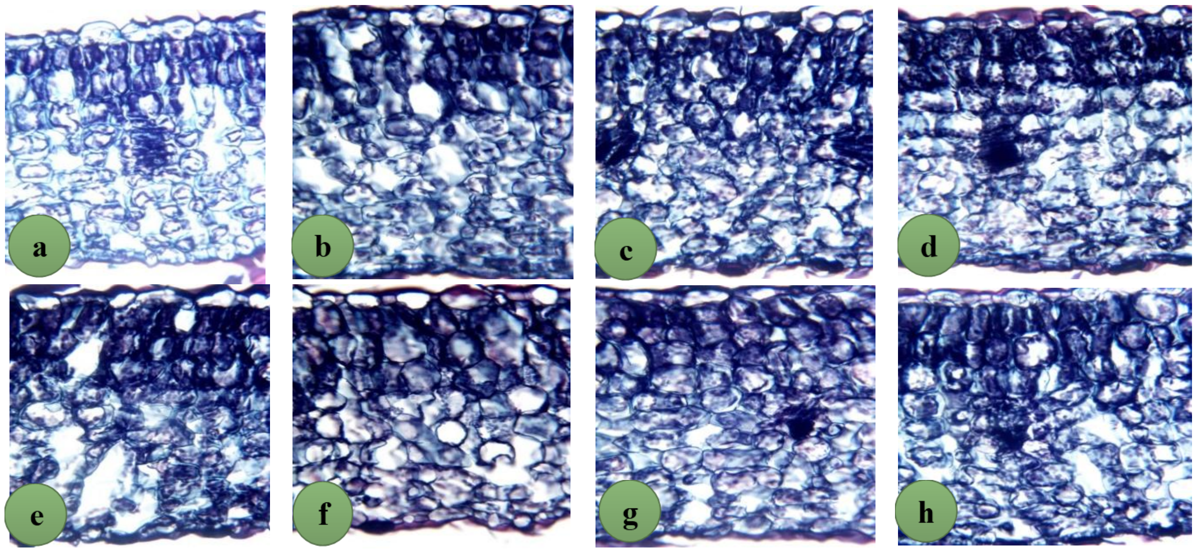


Figure 2. Anatomical sections of a *Gerbera jamesonii* leaf blade. Sections (a-d) are taken from plants grown under natural day condition. a: Control; b: Plants sprayed with salicylic acid; c: Plants sprayed with a micronutrient mixture; d: Plants sprayed with salicylic acid and a micronutrient mixture. (e-h) Sections are taken from plants grown under prolonged day by red and blue light spectra for 4 hours. e: Control; f: Plants sprayed with salicylic acid; g: Plants sprayed with a micronutrient mixture; h: Plants sprayed with salicylic acid and a micronutrient mixture. Magnification: 40x.

The results in Table 3 and Figure 3 show that the greatest vascular bundle length was recorded when plants were sprayed with salicylic acid and a micronutrient mixture, with or without prolonging daylight, reaching 531.26 and 533.80 µm, respectively. The highest total number of vascular bundles in the leaf midrib vein, 10 bundles, was recorded with prolonged daylight and spraying with either the micronutrient mixture or salicylic acid. The two treatments mentioned above also recorded the highest number of small vascular bundles, 4 and 5 respectively. No differences were observed in the number of large vascular bundles among the treatments. Furthermore, the highest number of parenchyma cells around the vascular bundles, 102 cells μm^2, was recorded in the control treatment plants under prolonged daylight. Spraying with the micronutrient mixture and salicylic acid, with or without prolonged daylight, resulted in similar values of 83 and 85 cells μm^2, respectively, with all values being lower than those in all other treatments is the subject of the study.

These results may be explained by the plant's nutritional status, which plays a significant role in recording the highest values for vascular bundle diameter, number, and the number of small vascular bundles, as well as the number of parenchyma cells around the vascular bundles in the main vein of the leaf. On other hand, [21] confirmed that salicylic acid plays a role in increasing the thickness of both the midrib and the leaf blade of Egyptian lupin due to an increase in the thickness of the palisade and spongy tissues, as well as an increase in the size of the midrib and leaf blade. An increase in vascular bundle diameter is beneficial, as it facilitates the downward transport of manufactured materials from the leaf and the upward transport of water and minerals. Furthermore, the vascular bundles enhance the plant's strength.

Table 3. The effect of red and blue light spectrum to prolong daylight, salicylic acid and fertilization with a mixture of micronutrients on leaf midrib tissues of *Gerbera jamesonii* var. Esmara.

Treatments		**Diameter of the vascular bundles (µm)**	**Total No of vascular bundles**	**No of small vascular bundles**	**No of large vascular bundles**	**No of cells (cell μm^2)**
(h.)	**(mgl^{-1})**					
Without prolong daylight	Control	514.66	6	1	5	65
	SA	464.12	7	2	5	71
	Micronut	463.98	8	3	5	56
	SA+ micronut	531.26	8	2	6	83
With prolong daylight for 4 h	Control	480.73	7	2	5	102
	SA	495.7	8	2	6	70
	Micronut	488.93	10	4	6	59
	SA+ micronut.	533.8	10	5	5	85

The data in Table 4 and Figure 4 indicate that the longest vascular bundle reached 749.96 µm when prolonged daylight and sprayed with salicylic acid and a micronutrient mixture, representing a 34.2 % increase compared to the control treatment under natural daylight. The highest values for the sclerenchyma cells layer, 252.19 µm, were recorded when sprayed with salicylic acid and a micronutrient mixture during prolonged daylight.

Table 4. The effect of red and blue light spectrum to prolong daylight, salicylic acid and fertilization with a mixture of micronutrients on leaf petiole tissues of *Gerbera jamesonii* var. Esmara.

Treatments (h.)	Treatments (mgl^{-1})	Diameter of vascular bundle (µm)	Outer Sc (µm)	Outer phloem (µm)	Xylem (µm)	Inner phloem (µm)	Inner Sc (µm)	Total No. of vascular bundles
Without prolong daylight	Control	559.01	192.46	80.59	184.61	47.15	54.20	18
	SA	624.34	166.60	115.64	218.32	41.51	82.27	21
	Micronut.	583.79	162.17	104.33	177.49	40.54	63.26	17
	SA+ micronut.	674.84	216.42	100.98	214.89	57.43	85.12	18
With prolong daylight for 4 h	Control	597.61	150.83	113.32	217.73	40.61	75.12	20
	SA	666.26	151.44	88.52	250.58	49.13	126.59	12
	Micronut.	619.63	181.86	113.61	214.80	63.69	45.67	19
	SA+ micronut.	749.96	252.19	104.66	274.41	38.45	80.25	20

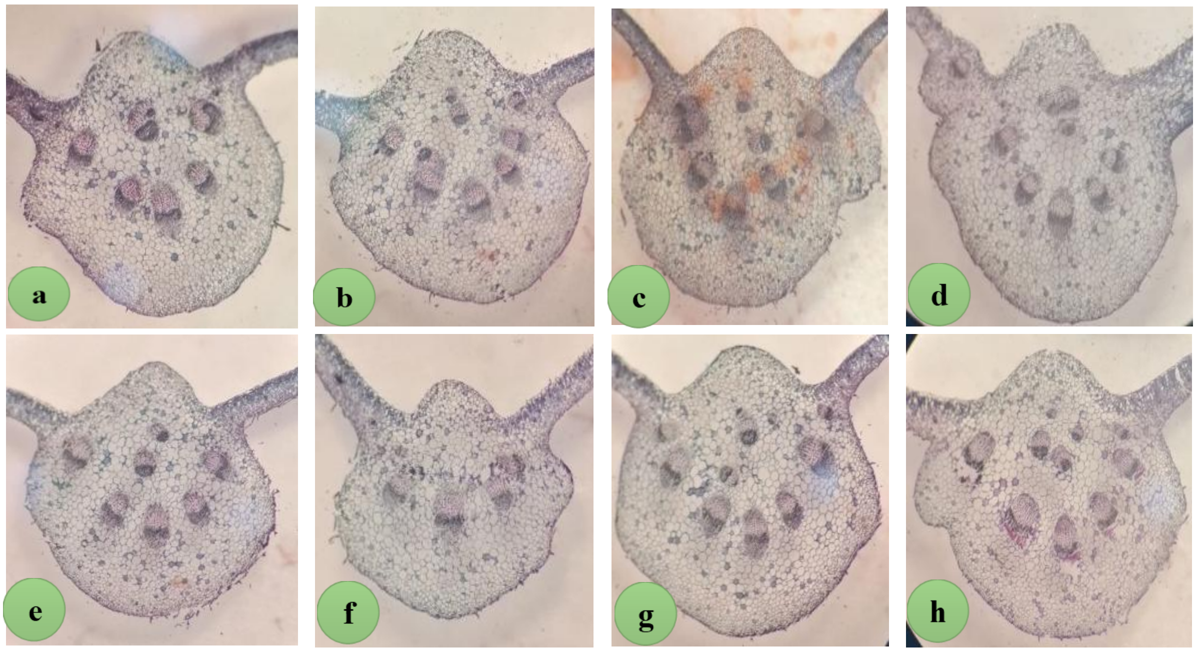


Figure 3. Anatomical sections of the leaf midrib vine of a (Gerbera jamesonii var. Esmara). (a-d) Sections taken from plants grown under natural daylight. a: Control b: Plants sprayed with salicylic acid c: Plants sprayed with a micronutrient mixture d: Plants sprayed with salicylic acid and a micronutrient mixture. (e-h) Sections taken from plants grown under prolonged day by red and blue light spectra for 4 hours. e: Control f: Plants sprayed with salicylic acid g: Plants sprayed with a micronutrient mixture h: Plants sprayed with salicylic acid and a micronutrient mixture. Magnification: 40x

The greatest xylem thickness in the vascular bundle of the leaf petiole, 274.41 µm, was observed when plants were sprayed with salicylic acid and a micronutrient mixture during prolonged daylight extension. This value was 32.72% higher than the lowest values recorded in the control treatment under natural daylight. The greatest thickness of the inner phloem, 63.69 µm, was recorded when plants were sprayed with a micronutrient mixture during prolonged daylight. The treatment with spraying with salicylic acid when prolonged daylight was distinguished by recording the highest values of sclerenchyma, reaching 126.59 μm, and the values of all other treatments were lower than it by an increase of 133.56 % compared to the control treatment under natural daylight.

The results in the table above show that day lengthening with spraying with salicylic acid and a micronutrient mixture led to the highest values for the most of the studied traits, which may be due to the nutritional status of the plant, see Table 1. [52] indicated that salicylic acid led to a significant increase in leaf blade thickness, vascular bundle diameter, and xylem, phloem, and epidermal thickness in date palm plants. The better performance of salicylic acid in stimulating epidermal tissue formation may be attributed to its role as a signaling regulator for many physiological processes through the activation of antioxidant enzyme systems [53]. In addition, salicylic acid helps maintain cellular redox balance, plasma membrane stability, and biosynthesis of plant cell wall components in the epidermis, thus promoting cell division and expansion necessary for tissue growth [54].

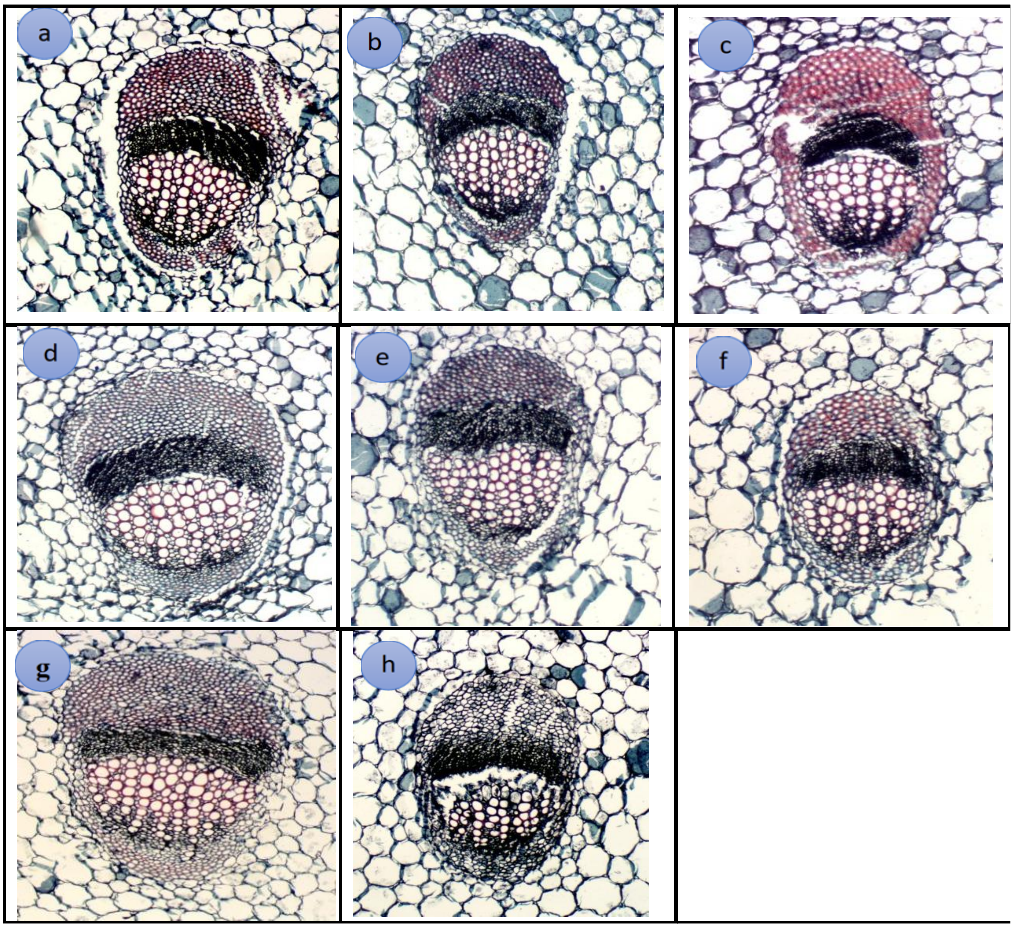


Figure 4. Anatomical sections of the petiole of a *Gerbera jamesonii* leaf. Sections (a-d) were taken from plants under normal day condition. a: Control; b: Plants sprayed with salicylic acid; c: Plants sprayed with a micronutrient mixture; d: Plants sprayed with salicylic acid and a micronutrient mixture. Sections (e-h) taken from plants grown under prolonged day by red and blue light spectra for 4 hours. e: Control; f: Plants sprayed with salicylic acid; g: Plants sprayed with a micronutrient mixture; h: Plants sprayed with salicylic acid and a micronutrient mixture. Magnification: 100x.

Conclusion

It can be said that prolonging the daylight with spraying with salicylic acid and a mixture of micronutrients has led to anatomical changes in the plant leaf and its midrib tissues, as well as the vascular bundles in the leaf petiole, which have been reflected directly or indirectly in the growth of the inflorescences and their flowering vase life.

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