EFFECT OF SUPPLEMENTARY LIGHT ON GROWTH, FLOWERING AND CUT FLOWER QUALITY IN TWO CULTIVAR OF CARNATION PLANT

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ABSTRACT

This study was conducted to investigate the effects of different types of light and some factors on some vegetative growth and flowering of two cultivars of carnation plant (*Dianthus caryophyllus* L.). The results showed the maximum leaves number, leaf area per plant, internodes number and intermodal length were recorded under 14h incandescent (41.09 leaves/plant, 363.91 cm2, 18.70 node/plant, and 7.675 cm) respectively, and the increase was significant. While the effect of triple interaction, which showed a significant effect in all characteristics, the largest leaf area per plant (578.66 cm2) was obtained from the moonlight cultivar when cultured on the media containing 60% local compost and exposed to the 14h incandescent, Also, the maximum vase life was found in the Ormea cultivar (17.47 days) when the cultivar was exposed to the 14h incandescent and was cultured on medium that included 60% local compost. The best grade flower was obtained when the Ormea cultivar was cultured on a medium containing 30% and 60% local compost under 14 hours of incandescent light, reaching 3.89.

Key words: *Dianthus caryophyllus*, Type of Light, Flower Grade.
Part of Ph. D. dissertation of the 1st author

تأثير الضوء الاضافي على النمو ، الإزهار ونوعية الأزهار المقطوفة في صنفين من نبات القرنفل

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المستخلص

جريت هذه الدراسة للتحقيق في تأثيرات انواع مختلفة من الاضاء و بعض المعاملات الخرى على بعض صفات النمو الخضري والإزهارلصنفين من نبات القرنفل هما (الاحمر) ormea و(الابيض) Moonlight.تم الحصول على أفضل النتائج لعدد الأوراق ، مساحة الورقة لكل نبات، عدد السلاميات وطول السلامية عندما تعرضت النباتات للضوء الابيض 14ساعة (41.09 ورقة/ نبات، 363.91 سم ^{2}، 18.70 عقدة / نبات، 7.675 سم) بالترتيب. وكانت هذه المعاملات متفوقة بشكل معنوي. اما بالنسبة لتأثير التداخل الثلاثي بين العوامل والتي اظهرت تأثيرًا معنويًا في جميع الصفات المدروسة المساحة الورقية حيث اعطت أكبر قيمة بلغ (578.66 سم ^{2}) للصنف الابيض عند زراعته على وسط زراعي يحتوي على 60٪ سماد محلي عندما تعرضت النباتات للضوء الابيض 14 ساعة. كذلك تم تسجيل الحد الأقصى للعمر المزهري في صنف Ormea والتي بلغ (17.47 يومًا) عندما تعرضت النباتات للضوء الابيض 14 ساعة والمزروعة على وسط يحتوي على 60٪ سماد محلي.، تم اعتماد النظام العالمي للتدرج،حيث تم الحصول على أفضل تدريج لازهار صنف Ormea المزروعة على وسط يحتوي على 30 و 60٪ سماد محلي لنباتات المعروضة للضوء الابيض 14 ساعة و بلغ 3.89.

الكلمات المفتاحية: نبات القرنفل، انواع الاضاءة ، تدرج الازهار.

جزء من اطروحة الدكتوراه للباحث الاول

Received:11/5/2022, Accepted:14/8/2022

INTRODUCTION

The carnation (*Dianthus caryophyllus* L.) is one of the world's popular cut flowers. It is a member of the Caryophyllaceae family, cultivated in many countries of the world and is thought to be a Mediterranean native (13). There are 280 species of carnation and are found from Siberia to Artic America, Japan, and in Himalayas. Carnation, apart from producing cut flowers has also become useful in gardening for bedding, edging, borders, pots, and rock gardens (4). Its common name carnation was taken from Latin word carnation-cairns which means flesh color on account of similarity of original color of carnation and it is also derived from coronation as the carnation flower which were being used in decorating the crown of athletes Carnations are an herbaceous perennial that is partly hardy. The petals are large with frilled borders, and the calyx is cylindrical with bracts at the base; the flowers are solitary and terminally formed. The everlasting flowering forms of hybrids involving numerous Dianthus species. Carnations at the florist are divided into two categories: "Standard" and "Spray." Larger blooms on longer flower stalks are produced by the standard variety. The spray variety, on the other hand, has many smaller blooms with a weaker stem. The commercial carnation plant can produce between 10 and 20 blossoms each year Carnations require a sufficient amount of light and good ventilation to produce high-quality flowers, thus greenhouse design and orientation are more important. Environmental parameters such as light, growing media and cultivars, as well as cultural methods such as irrigation, fertilization, cultivar, supporting, reduction of the buds, and disease and pest management (21). In such environments, supplemental light is the only option to significantly raise the DLI (3), When there isn't enough natural light in a greenhouse, supplemental lighting can help plants develop by supplying the essential light. Improving greenhouse light conditions and regulating phytochemical concentrations in plants growing in controlled environments promotes growth and yield (1, 14). As a result, supplemental lighting is an important horticultural method for improving crop growth, providing high yields throughout the year, and producing superior-quality plants (22). The light spectrum affects morphology, physiology, biochemistry, and transcriptional expression (7). The leaf structure, palisade mesophyll cell thickness, and epidermis can be impacted by variations in the light spectrum (10). Light emitting diodes (LEDs) have gained widespread attention, since they provide a narrow wavelength band with a high efficiency (7, 20). However, data are still scarce regarding the choice of the light source and how the supplementary light source influences the development of carnations plant. The objective of this study was to investigate the

1. Effects of supplementary light provided by LED-mix and incandescent on carnation cuttings
2. Identify the optimal supplementary light source for greenhouse cutting propagation of carnation.
3. Effects different growing media with different combinations in different cultivars on the growth and flowering of carnation plant grown as production cut flower

MATERIALS AND METHODS

This study was carried out in the glasshouse of the Department of Horticulture nursery, Agriculture Engineering Sciences College, University of Duhok, Kurdistan region, Iraq, for the period from August 1st, 2020 to Mach1st, 2021.To study the effects of supplemental light, which included five types of light (natural light (control), LED-mix light (blue, green, red) for 14h, LED-mix light (blue, green, red) for 18h, incandescent light for 14h, incandescent light for 18h) daily, starting at 6 PM for a 14h and 18h period. Three growing medium (river soil, river soil + 30% local compost, river soil + 60% local compost) by volume on the growth and flowering of two cultivars of carnation (Ormea and Moonlight) plants. Local compost, mixture of (sheep manure: sawdust: hay: lawn grasses clipping) 2:1:1:1 by volume, made by mixing the major components of the medium in an underground place (big hole), then adding some catalysts or stimulants (50 g dry yeast bread, 0.5 kg urea, and 0.5 kg table sugar) per each cubic meter, after being watered till saturation and carefully covered with polyethylene plastic, with

constant stirring every (15–20) day. It is ready for agricultural use after (90) days from the start of the fermentation process. The chemical characteristics of the river soil and local compost receptively are pH (7.81, 7.72), Ec (0.328, 0.342) $ds.m^{-1}$, Co_3 (1.6, 3) $mmol.l^{-1}$, k (0.29, 109.0) $mg.l^{-1}$, P (7.17, 103.03) $mg.l^{-1}$, N (63, 98) $mg.l^{-1}$, organic matter (1.17, 5.47) %, soil texture (sandy 50.5%, clay 31.5%, loam18.0%). Rooted cuttings (1–month age) of the two-cultivar obtained from Antalya nursery–Turkey were planted in pot size (5 liters) by using the three growing media that were determined in this study. After two weeks from planting, the pinched to three nodes were done, and the lighting treatment started on September 1st for three months by installing an iron frame divided into four parts by using thick black clothes to separate the five lighting treatments, which were installed by using blue, green, and red lamps for mixed light treatment and incandescent lamps for other kinds, and using an electric timer to control the timing factor. In this study, the natural light (control) was left out of the frame. The experiment was conducted using a split-split plot design with three factors and five plants for each replicate, 5×3×2×3×5= 450 plants in pots size 5 liters. The studied characteristics included the number of leaves per plant, plant leaf area (cm3), number of internodes per plant, length of internodes (cm), number of petals per plant, vase life per day, and flower grad (cm). This experiment was analyzed using a computer through the SAS program, and the means comparison was done using DMRT under 5% (SAS, 2013). The Duncan Multiple Range test was used to determine differences between treatment means at the 5% level (Duncan, 1955).

RESULTS AND DISCUSSION

1. Influence of supplementary light

Significant variations were observed among the two cultivars of carnation with regard to growth, flowering, quality, and yield parameters. Data in Table 1 shows the effect of different lights on the maximum number of leaves, leaf area per plant, number of internodes, and intermodal length were recorded under 14h incandescent (41.09 leaves/plant, 363.91 cm2, 18.70 node/plant, and 7.675 cm) respectively. The increases was significantly compared with all treatments, and followed by 14h LED-mix (39.38 leaves/plant, 332.56 cm^2, 18.49 node/plant, and 7.71 cm) respectively. The increases did not significantly compared with each other but significantly compared with control, 18-hour incandescent, and 18-hour LED-mix. While the number of leaves under natural light and 18h LED-mix were recorded at 35.87 and 36.30 leaves/plant, respectively, the minimum number of leaves was recorded at 35.11 leaves/plant under 18h incandescent. This could be influenced by the plant height and number of internodes. In the same Table, the leaf area under 18h LED-mix light and natural light was recorded at (281.54 and 283.75), respectively, and the minimum leaf area was recorded under 18h incandescent (249.22 cm^2). However, the number of internodes under 18 h incandescent and LED-mix color was recorded (18.12 and 18.04) node/plant. For the flowering parameter, the maximum number of petals and vase life were recorded at 58.34 petal/flower and 14.31 days, respectively, under 14h incandescent, which increased significantly with all treatments. Followed by 14h LED-mix, the number of petals and vase life were recorded at 53.69 petal/flower and 13.46 days, respectively. Whilst the minimum number of petals was observed at 49.83 petal/flower, 12.14 days), which is statistically under 18 h incandescent and 14 h incandescent, and the increases were significantly with other treatments, Regarding the quality of cut flower parameters, the best flower grade was recorded (3.48 cm) under 14h incandescent, which increased significantly over all the treatments, followed by 14h LED-mix (3.26 cm), which also increased significantly with the other treatments. The worst flower grade of flower was observed (2.89 under 18 h incandescent.

Table 1. Effect of different light on parameters two cultivar of carnation plant

Treatment	no. of leaves / plant	plant leaf area (cm^2)	no of internode/ plant	length of internodes (cm)	no. of petals / plant	vase life / day	flower grad (cm)
Natural	35.87[b]	283.75[c]	17.60[b]	7.206[b]	54.74[b]	12.34[c]	3.12[c]
Mix 14	39.38[a]	332.56[b]	18.49[ab]	7.247[b]	53.69[b]	13.46[b]	3.26[b]
Incandescent 14	41.09[a]	363.91a	18.70[a]	7.675[a]	58.34[a]	14.31[a]	3.48[a]
Mix 18	36.30[b]	281.54[c]	18.04[ab]	7.171[b]	49.88[c]	12.24[c]	3.26[b]
Incandescent 18	35.11[b]	249.22[d]	18.12[ab]	7.188[b]	49.83[c]	12.14[c]	2.89[d]

***According to Duncan's Multiple Range Test, meanings followed by the same letter within each character (column) did not differ significantly (5%). (Duncan, 1955).**

2. Influence of growing media

Results presented in Table 2 show that increasing the compost and adding to the river soil caused an increases in the number of leaves per plant, plant leaf area, number of internodes per plant, length of internodes, number of petals per plant, vase life per day, and flower grad. The number of leaves/plant was found in the range of 41.65 to 37.63 leaves/plant when the plant culture on the medium contained 60% composed and 30% compost, respectively, and the increases were significant between the two culture media. As for the other parameters, plant leaf area, number of internodes per plant, internodes length, petals number per plant, vase life per day, and flower grad, the plant grown on the medium containing 60% composed, recorded the results (357.74cm2, 19.75 no of internode/plant, 7.599 cm, 59.08 no. of petals/plant, 14.00 days, and 3.31cm) respectively, and increases for all parameters was significantly compared with the medium containing 30% and 0% compost. In the same Table, the medium containing 30% composed gave results in terms of no. of leaves per plant, plant leaf area, no of internodes per plant, length of internodes, number of petals per plant, vase life per day and flower grad (37.63 no. of leaves/ plant, 299.76 cm2, 18.07 no. of internode/ plant, 7.243 cm, 53.18 no. of petals/plant, 12.87 days) respectively. All these results were significantly compared with the medium containing only river soil. The lowest results were found on the river soil.

Table 2. Effect of growing media on parameters of two cultivar of carnation plant

Treatment	no. of leaves / plant	plant leaf area (cm^3)	no of internode/ plant	length of internodes (cm)	no. of petals / plant	vase life / day	flower grad (cm)
River soil	33.37[c]	249.09[c]	16.75[c]	7.050[c]	47.63[c]	11.83[c]	3.01[b]
30% compost	37.63[b]	299.76[b]	18.07[b]	7.243[b]	53.18[b]	12.87[b]	3.29[a]
60% compost	41.65[a]	357.74[a]	19.75[a]	7.599[a]	59.08[a]	14.00[a]	3.31[a]

3. Influence of cultivars

The experiments were performed to determine the effects of different significant variations that were observed among the two cultivars of carnation in terms of growth, flowering, quality, and yield parameters. These caused an increase in the number of leaves per plant, plant leaf area, number of internodes per plant, length of internodes, number of petals per plant, vase life per day, and flower grad. The number of leaves per plant, plant leaf area, and number of internodes per plant were found in the range of (40.24 no. of leaves/plant, 338.75 cm2, and 9.76 no. of internodes per plant) respectively, and the increase was significant for the moonlight cultivar compared to the Ormea cultivar. While the length of internodes, number of petals per plant, vase life per day, and flower grad give the significant values (8.219cm, 56.29 no. of petals/plant, 13.92 days, and 3.37cm), respectively, for Ormea compared to the moonlight cultivar.

Table 3. Effect of cultivars on parameters of carnation plant

Treatment	no. of leaves / plant	plant leaf area (cm^3)	no of internode/ plant	length of internodes (cm)	no. of petals / plant	vase life / day	flower grad (cm)
Moonlight	40.24[a]	338.75[a]	19.76[a]	6.376[b]	50.31[b]	11.88[b]	3.03[b]
Ormea	34.86[b]	265.64[b]	16.62[b]	8.219[a]	56.29[a]	13.92[a]	3.37[a]

4. Influence of supplementary light, growing media and two cultivar of carnation plant: The results are shown in Table 4. This shows the effect of three factors (different types of light, and growing media) on the number of leaves of two cultivars of carnation plant. The results from interaction between three factors revealed that more number of leaves could be obtained with the use of supplementary light (14h incandescent) when the moonlight cultivar is cultured on the media containing 60% local compost. The highest number of leaves per plant (54.67 leaves/plant) was obtained from a moonlight cultivar cultured on the media containing 60% local compost and exposed to the 14 incandescents, and the increase was significantly compared to all other treatments. The next highest number of leaves per plant (46.00 leaves/plant) was found in a moonlight cultivar cultured on the media containing 60% local compost and exposed to the 14h LED-mix. Although the moonlight cultivar gave (45.07 leaves/plant) was recorded in medium containing 30% composed when the plant was exposed to 14h incandescent. While the lowest number of leaves per plant (30.53 leaf/plant) was obtained from the Ormea cultivar cultured on the media containing 0% local compost, composed only of river soil, and exposed to the 18h incandescent.

Table 4. Effect of light and growing media on the no. of leaves of two cultivar of carnation plant

Light	Cultivars	Media		
		River soil	30% compost	60% compost
Natural	Moonlight	35.20^{g-k}	39.20^{ef}	39.33^{def}
	Ormea	31.7^{3kl}	33.33^{i-l}	36.40^{f-j}
Mix 14	Moonlight	38.53^{efg}	41.60^{cde}	46.00^{b}
	Ormea	33.20^{i-l}	37.07^{f-i}	39.87^{def}
Incandescent 14	Moonlight	36.00^{f-j}	45.07^{bc}	54.67^{a}
	Ormea	31.07^{l}	36.67^{f-j}	43.07^{bcd}
Mix 18	Moonlight	32.93^{i-l}	38.80^{efg}	43.07^{bcd}
	Ormea	31.33^{kl}	34.00^{h-k}	37.67^{fgh}
Incandescent 18	Moonlight	33.20^{i-k}	37.73^{fgh}	42.27^{b-e}
	Ormea	30.53^{l}	32.80^{jkl}	34.13^{h-k}

*** Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test**

5. Influence of supplementary light, growing media and two cultivar of carnation plant: In table (5), the results of three combinations of supplementary light, growing media, and two cultivars on leaf area per plant are shown. The largest leaf area per plant (578.66 cm2) was obtained from the moonlight cultivar when cultured on the media containing 60% local compost and exposed to the 14 incandescent lights. The increase was significantly compared to all other treatments, followed by (454.11 and 397.01 cm2) was found from the moonlight cultivar when cultured on the media containing 60% and 30% local compost and exposed to the 14h LED mix and 14h incandescent light, respectively. Although the moonlight cultivar gives (45.07 leaves/plant) was recorded in medium containing 30% composed when the plant was exposed to 14h incandescent. While the lowest number of leaves per plant (205.73cm2) was obtained from the Ormea cultivar when cultured on the media containing 0% local composed only of river soil, and exposed to the 18 h incandescent.

Table 5. Effect of light and growing media on the plant leaf area of two cultivar of carnation plant

Light	Cultivars	Media		
		River soil	30% compost	60% compost
Natural	Moonlight	273.19^{f-k}	318.75^{d-g}	337.35^{cde}
	Ormea	227.95^{jkl}	258.77^{g-l}	286.51^{e-k}
Mix 14	Moonlight	295.62^{e-i}	348.11^{cde}	454.11^{b}
	Ormea	253.26^{h-l}	294.95^{e-i}	349.29^{cde}
Incandescent 14	Moonlight	309.36^{e-h}	397.01^{c}	578.66^{a}
	Ormea	227.37^{jkl}	291.01^{e-j}	380.07^{cd}
Mix 18	Moonlight	242.59^{i-l}	327.09^{def}	374.85^{cd}
	Ormea	229.29^{jkl}	263.92^{f-l}	251.48^{h-l}
Incandescent 18	Moonlight	226.55^{jkl}	272.35^{f-k}	325.64^{def}
	Ormea	205.73^{l}	225.61^{kl}	239.43^{i-l}

6. Influence of supplementary light, growing media and two cultivar of carnation plant: Due to the large number of internodes, Table (6) shows increasingly competitive and encouraging results. The interaction between three factors (supplementary light, growing media, and two cultivars) in the carnation plant. The highest number of internodes was recorded when the moonlight cultivar when exposed to the 14h incandescent and cultured on media including 60% local compost reached (25.53) internode/plant and the increase was significantly compared to all the treatments, followed by 22.47 and 22.13 internode/plant for the moonlight cultivar when exposed to the 14h LED-mix and 18h incandescent when cultured on media including 60% local compost, and also the increase was significantly compared to the subsequent treatments. While the Ormea cultivar had the lowest number of internodes (14.80 internodes/plant) when cultured on river soil without compost after a 14-hour incandescent.

Table 6. Effect of light and growing media on the no of internode of two cultivar of carnation plant

Light	Cultivars	Media		
		River soil	30% compost	60% compost
Natural	Moonlight	17.07^{fg}	18.80^{cde}	20.25^{c}
	Ormea	16.80^{g}	16.33^{g}	16.33^{g}
Mix 14	Moonlight	17.40^{efg}	19.87^{cd}	22.47^{b}
	Ormea	16.20^{gh}	17.53^{efg}	17.47^{efg}
Incandescent 14	Moonlight	17.20^{fg}	20.13^{c}	25.53^{a}
	Ormea	14.80^{h}	16.13^{gh}	18.40^{def}
Mix 18	Moonlight	17.13^{fg}	19.80^{cd}	22.13^{b}
	Ormea	16.67^{g}	16.07^{gh}	16.47^{g}
Incandescent 18	Moonlight	17.53^{efg}	19.40^{cd}	21.67^{b}
	Ormea	16.67^{g}	16.67^{g}	16.80^{g}

7. Influence of supplementary light, growing media and two cultivar of carnation plant; Table (7) shows a significant influence of the supplemental light on the internode length of carnation plants. The best significant result was recorded for incandescent lamps for the Ormea cultivar in a growing medium containing 60% compost. The internode length significantly reached 9.066 cm, compared with all other treatments. The second highest value was recorded for 14 h LED-mix for the Ormea cultivar in a growing medium containing 60% compost, and the increased internode length significantly, some treatments reaching 8.680 cm. Also, the interaction between the three factors negatively affected the internode length. Whereas the moonlight cultivar exposed to 14h LED-mix and grown on medium containing only river soil had the shortest internode length of 5.722cm.

Table 7. Effect of light and growing media on the length of internodes of two cultivar of carnation plant

Light	Cultivars	Media		
		River soil	30% compost	60% compost
Natural	Moonlight	5.914^{lm}	6.342^{kl}	6.159^{klm}
	Ormea	7.894^{efg}	8.469^{bcd}	8.458^{bcd}
Mix 14	Moonlight	5.722^{m}	6.137^{klm}	7.226^{i}
	Ormea	7.549^{ghi}	8.167^{def}	8.680^{b}
Incandescent 14	Moonlight	6.505^{jk}	6.793^{j}	7.291^{hi}
	Ormea	7.784^{fg}	8.615^{bc}	9.066^{a}
Mix 18	Moonlight	6.313^{kl}	5.937^{lm}	6.565^{JK}
	Ormea	8.173^{def}	7.663^{gh}	8.376^{bcd}
Incandescent 18	Moonlight	6.766^{j}	6.995^{lm}	5.975^{lm}
	Ormea	7.881^{fg}	8.316^{b-d}	8.194^{c-f}

8. Influence of supplementary light, growing media and two cultivar of carnation plant: Table 8 shows very highly competitive and encouraging results regarding the number of petals. The interaction between all these factors (type of supplementary light, growing media, and two cultivars) of carnation plants The highest number of petals per flower was recorded when the Ormea cultivar, when exposed to the 14h incandescent and cultured

on media including 60% local compost, reached 69.40 petals/flower and the increase was significantly compared to all other treatments. Then, followed by 63,60 and 63.07 petals/flower for the Ormea cultivar when exposed to the 14 h incandescent and 14h LED-mix when cultured on media including 60 and 30% local compost, the increase was significantly compared to some treatments. While the lowest number of petals (40.73 petals/flower) receded from the moonlight cultivar when cultured on river soil without compost after the plant was exposed to 18h incandescent.

Table 8. Effect of light and growing media on the number of petals of two cultivar of carnation plant

Light	Cultivars	Media		
		River soil	30% compost	60% compost
Natural	Moonlight	48.40^{i-n}	51.47^{g-l}	57.47^{def}
	Ormea	51.27^{h-l}	57.13^{def}	62.73
Mix 14	Moonlight	44.67^{nop}	52.33^{f-k}	56.67^{d-g}
	Ormea	47.40^{k-o}	57.47^{def}	63.60^{b}
Incandescent 14	Moonlight	49.53^{i-n}	55.27^{d-h}	58.20^{cde}
	Ormea	54.60^{d-i}	63.07^{bc}	69.40^{a}
Mix 18	Moonlight	42.47^{op}	45.80^{mno}	51.47^{g-l}
	Ormea	46.53^{l-o}	53.20^{e-j}	59.80^{bcd}
Incandescent 18	Moonlight	40.73^{p}	47.60^{k-n}	52.53^{f-k}
	Ormea	50.73^{h-m}	48.47^{j-n}	58.93^{bcd}

9. Influence of supplementary light, growing media and two cultivars off carnation plant: Vase life is an important factor that decides the demand for cut flowers for commercial production. The interaction between all factors (type of supplementary light, growing media, and two cultivars) of the carnation plant in table 9 shows the maximum vase life was recorded in the Ormea variety (17.47 days) when the cultivar was exposed to 14-hour incandescent and cultured on media with 60% local composed receptivity, followed by the same variety (15.80 and 15.73) days when the cultivar was exposed to 14-hour incandescent and 14-hour LED-mix cultured on media with 60% and 30% local composed receptivity. The moonlight variety had the shortest vase life (10.27 days).

Table 9. Effect of light and growing media on the vase life of two cultivar of carnation plant

Light	Cultivars	Media		
		River soil	30% compost	60% compost
Natural	Moonlight	10.47^{k}	10.73^{jk}	12.47^{f-i}
	Ormea	12.40^{ghi}	13.27^{d-g}	14.73^{bcd}
Mix 14	Moonlight	12.00^{g-j}	12.60^{f-i}	12.93^{f-i}
	Ormea	13.40^{c-f}	14.00^{c-f}	15.80^{b}
Incandescent 14	Moonlight	12.07^{g-j}	13.53^{c-g}	13.53^{g-h}
	Ormea	13.53^{c-g}	15.73^{b}	17.47^{a}
Mix 18	Moonlight	10.20^{k}	12.13^{g-j}	11.67^{h-k}
	Ormea	11.67^{h-k}	13.00^{e-h}	14.80^{bc}
Incandescent 18	Moonlight	10.27^{k}	11.40^{ijk}	12.13^{g-j}
	Ormea	12.27^{ghi}	12.33^{ghi}	14.47^{b-e}

10. Influence of supplementary light, growing media and two cultivar of carnation plant: The most important quality parameter to assess the cut flower quality is freshness, or vase life. But it is very difficult to assess the quality and freshness of the flowers

visually (Rickman and Aquino, 2004). Therefore, the global system of gradation was adopted, as shown in table 10. The best grade of carnation flower was recorded when the Ormea cultivar cultured on the medium containing 30 and 60% local compost under light from a 14-hour incandescent lamp reached 3.89, followed by 3.78 and 3.67 when the Ormea cultivar cultured on the medium containing 0 and 60% local compost under light from 18h and 14h LED-mix receptivity. While the lowest value was recorded at 2.39 from the Ormea cultivar cultured on the medium containing 0% (river soil) local compost under natural light. Also, the moonlight cultivar gave good results and was close to the gradient and universal standard.

Table 10. Effect of light and growing media on the flower grad (cm) of two cultivar of carnation plant

Light	Cultivars	Media		
		River soil	30% compost	60% compost
Natural	Moonlight	2.67^{de}	3.44^{a-d}	3.33^{a-d}
	Ormea	2.39^{e}	3.44^{a-d}	3.44^{a-d}
Mix 14	Moonlight	2.78^{cde}	3.00^{a-e}	3.11^{a-e}
	Ormea	3.56^{a-d}	3.44^{a-d}	3.67^{abc}
Incandescent 14	Moonlight	3.11^{a-e}	3.00^{a-e}	3.44^{a-d}
	Ormea	3.56^{a-d}	3.89^{a}	3.89^{a}
Mix 18	Moonlight	2.67^{de}	3.11^{a-e}	3.33^{a-d}
	Ormea	3.78^{ab}	3.44^{a-d}	3.22^{a-e}
Incandescent 18	Moonlight	2.67^{de}	2.89^{b-e}	2.89^{b-e}
	Ormea	2.89^{b-e}	3.22^{a-e}	2.78^{cde}

According to the results of the three interaction between type of supplementary light, growing media and two cultivar of carnation plant. These results, in terms of the number of leaves, were in conformity with the findings of (9), (17). (15).Above given results are found to be similar with the findings of (2) which indicated that when Carnation is grown in mixture of 65 and 35% burned rice husk substrate complemented with coconut coir and rice husk showed maximum growth rate for leaf area and number of leaves. Leaf area is an important determinant of light interception, net photosynthetic rate, transpiration, and other metabolic processes, hence it has a big impact on plant production. Growing media such as peatmoss and cocopeat greatly boosted the leaf area of potted petunia plants in this study. The leaf area of plants at the ideal blooming size was similar in the large and small hybrids (275 cm2 per plant on average), but it was higher in the medium hybrid (517 cm2 per plant). (12). Variations in vase life can be ascribed to differences in the rate of ethylene production and the sensitivity of the cultivars to ethylene, which causes senescence. Differences in vase life among different varieties were reported by (17, 18). Vase life Carnation plants differ in the length of the vase life of cut flowers which is one of the characteristics determining the commercial value of the ornamental flowers. Thus, it is of economic importance to know the vase life of cut carnation flowers of different cultivars. There was significant difference between the carnation cultivars with respect to shelf life. Shelf life was highest in cultivar ‘Tempo’ (8.2 days). The next best cultivar was ‘Nelson’ (6.3 days) and ‘Grand Salam’ (5.2 days). The cultivar ‘Kaly’ and ‘Cinderella’ (4.0 days) were on par to each other. The vase life is one of the important traits which decide its economic value. This variation in vase life among the varieties might be attributed to the variations in accumulation of carbohydrates since these varieties could produce more number of leaves and indicated positive and significant correlation between these characters. Variation in vase life could also be attributed to fact that, the variation in ability to produce ethylene among the different cultivars. Similar variation for vase life in different cultivars was also reported previously

in carnation by (5), (18) and (17). The increased ethylene production promotes the in-rolling of petals resulting in wilting of the flower. The time of onset of ethylene production and the amount of ethylene produced in the flowers vary with the carnation cultivar, and thus influence their vase life (11).

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