Production of Dianthus Caryophyllus L. Cultivar (Haytor White) as Cut Flowers Using Day-Extension Treatment and Mulching

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Abstract

The experiment was carried out in the greenhouse of the Agricultural Research and Experiment Station - Kirkuk University - College of Agriculture for the agricultural season 2020-2021. The experiment was started on 20-11-2020. Carnations were taken from the mothers before the start of the experiment and planted in culture dishes to complete the rooting process. Carnations were planted on terraces with a length of (20 m) and width (75 cm), and the distance between one line and another (30 cm) and between one plant another (30 cm) as well. Artificial lighting (white LED light factor, 40 watts) was used for four hours in addition to the natural light which started half hour before sunset. The intensity of lighting was measured by a light meter (Lux 6612). As for the mulching factor, the industrial mulching was used with white polyethylene and the natural mulching with shredded yellow corn residue with a thickness of 2.5 cm, in addition to the control treatment. The experiment was carried out in a split-plot system in a randomized complete block design (RCBD) and the treatment of illumination was placed in the main plots, while mulching was placed in the secondary plots, and the results were tested according to Duncan's multiple range test at a probability level of 5%. The following characteristics were studied: plant height (cm), plant total chlorophyll content (CCI), number of days required for flowering (day), number of flower/m², and flower stem length (cm).

The results showed the superiority of lighting and mulching treatment in all vegetative and flowering traits under study.

Keywords: Dianthus, Day-extension, Mulching.

1. Introduction

Dianthus caryophyllus L. belongs to the Caryophyllaceae family. It grows in the temperate regions of the northern hemisphere. This family includes 2100 species and 89 genera. The genus Dianthus contains nearly 300 species that grow in Asia, Europe, and North Africa [1]. Carnations need special agricultural operations such as disbudding, fertilization, pinching, and consolidation. Their roots are very sensitive to heavy soils and poor drainage which affects the growth and production of the plant [2]. The volatile oil of carnation flowers is used for medicinal purposes. It is considered a strong diaphoretic and works to strengthen the heart. It is also used in the industry such as in baby food, sweets, and perfumes [3,4]. The boiled flower tops are also considered a gas repellent, a mouth freshener, an analgesic for pain, especially the teeth, an anti-emetic, an anti-colic, a memory booster, and an appetizer [5]. Carnations are very affected by diseases, humidity, and heavy rain. One of the things that must be done to obtain high commercial quality flowers is to produce them under the protected environment because the flowers that grow in open fields do not comply with international flower production standards if compared to using a greenhouse or glasshouse [6]. Carnation is a responding quantitative long-day plant, and six-leaf pairs are sufficient to receive the floral response [7].

Light is an essential environmental factor affecting plant survival, dry mass distribution, and crop yield [8,9]. Long-day treatment in which the day is extended by supplemental light often leads to an increase in the dry weight of the plant compared to plants grown in short-day conditions even when the same light source is used [10]. Through research conducted by [11] on the effect of artificial lighting and shortening the night on a plant Chrysanthemum cv. cultivar Snowball, as it showed a noticeable effect on several vegetative and flowering characteristics such as plant height and the number of leaves, which reached (45 cm, 60 leaves) respectively compared to untreated plants (24.25 cm, 47.83 leaves). In addition to the significant difference in the full blooming of the flower (135.72 days) compared to the control treatment (108.22 days).

Soil mulching is an important process used in landscaping as well as in garden engineering to reduce soil water evaporation and weed competition [12]. In soil management, mulching acts as a protective covering over the soil to retain moisture and provide nutrients by creating a suitable environment for the growth of microorganisms. In addition to encouraging seed
germination and preventing the growth of weeds. Proper application of mulching can improve the contents of organic matter in the soil and improve soil properties. [13]. Generally, straw, rice husks, crop residues, or plastic mulching can be used as artificial mulching in ornamental crops [14,15].

In research conducted by [12] to find out the effect of four thicker sawdust (0, 2.5, 5, 10 cm) on soil water content, weeds, soil temperature, height, diameter, and the number of stems, the first date was verified. Penstemon (Husker Red) flowers open, and it was proved that adding mulching at all levels conserve soil water compared to no mulching, and the numbers of weeds were significantly higher (0 and 2.5 cm) thickness compared to (5 and 10 cm) thickness. In general, midday soil temperatures were highest at shallow soil depths in the uncovered plots, while there were no significant differences in the number of flower stalks. Plant⁻¹. Although there was a tendency for fewer stalks than treatment mulching and these results indicate that sawdust helped conserve soil water, which in turn had some effect on plant growth. In a study done by [16] on the Dianthus caryophyllus L. cultivar Loris using different mulching of mushroom compost, grass, and pine needle leaves after 15 days of planting, the study showed that covering with mushroom compost gave the maximum flowering period (28.77, 28.97 days) and the minimum number of days to reach the harvest stage (141, 132.33 days), the largest number of cut flowers per plant (6.50, 9.47), flowering age (18.30, 23.37 days) during the first and second flows of the experiment, respectively, compared to the control plants.

Given the lack of studies on the production of carnations as cut flowers and with high commercial specifications at the level of the greenhouse, the experiment aims to produce carnations as cut flowers and to know its response to the treatment of lengthening the day during the winter production season. This might solve the problem of the scarcity of obtaining its flowers at this time of the year. As well as its response to the thickness of the layer of mulching with organic residues of plant origin and its comparison with coverage with polyethylene and knowing the extent to which the plant benefits from them by protecting the soil from water loss and weed growth, which negatively affects the productivity of the plant. As well as working to increase the diameter of the flower holder, which is one of the characteristics of cut flowers by using low concentrations of plant growth retardant.

2. Materials and Methods

The experiment was carried out in the greenhouse of the Agricultural Research and Experiment Station - Kirkuk University - College of Agriculture for the agricultural season 2020-202. The experiment was started on 20-11-2020. Carnations were taken from the mothers before the start of the experiment and planted in culture dishes to complete the rooting process. Carnations were planted on terraces with a length of (20 m) and width (75 cm), and each terrace contained two lines of cultivated plants, the distance between one line and another (30 cm) and between one plant (30 cm) as well. A white LED light factor of (40 watts) and its symbol L2 was used, and it was compared with the natural light factor, which has a symbol L1, and that the period of artificial lighting was 4 hours in addition to the hours of natural lighting, which started half an hour before sunset, that is, the entire period that plants were exposed to is 14 Lighting hour day⁻¹.

One LED light source was used above each experimental unit at a height of (1 m) and thus the experiment consisted of (18) LED light sources, and natural lighting was separated from artificial lighting by using a dark-colored cover to ensure that there was no interference between them, and the intensity of lighting was measured by a light device Meter and it was 6612 Lux. As for the mulching agent, the industrial mulching was used with white polyethylene, which was symbolized by M2, and the natural coverage with shredded yellow corn residue, with a thickness of 2.5 cm, which was symbolized by M3, in addition to the control treatment, which was symbolized by M1. Various agricultural operations were carried out such as irrigation and weeding whenever needed. Fertilization was carried out monthly by mixing compound fertilizer (NPK 20:20:20) with irrigation water by drip irrigation method at a rate of 0.5 g.l⁻¹ until the end of the experiment. The insecticide (CONFIDOR) and the fungicide (PREVICUR) were used at a concentration of 50 ml.100 liters⁻¹ water to protect plants from insect and fungal infections by spraying them on plants periodically by three sprays and a month apart from one spray to another.

The experiment was carried out in a split-plot system in a randomized complete block design (RCBD) and the treatment of illumination was placed in the main plots, while coverage was placed in the secondary plots, and the results were tested according to Duncan’s multiple range test at a probability level of 5% according to [17]. The following characteristics were studied: plant height (cm), plant total chlorophyll content (CCI), number of days required for flowering (day), number of flower/m², and flower stem length (cm).
Table 1. Shows the maximum temperatures during the experiment period.

|               | November       | December       |
|---------------|----------------|----------------|
|               | First week     | Second week    | Third week | Fourth week | First week | Second week | Third week | Fourth week |
| November      | 35.14          | 34.65          | 28.70      | 25.26       | 29.51       | 23.05       | 25.60      | 23.37       |
| January       | 32.15          | 20.80          | 29.15      | 29.40       | 24.35       | 31.34       | 30.46      | 33.21       |
| March         | 32.27          | 26.21          | 25.10      | 24.11       | 37.27       | 38.70       | 36.25      | 35.56       |
| May           | 40.33          | 42.22          | 46.11      | 43.64       |

3. Results and discussion

3.1. The production of Dianthus caryophyllus L. cultivar (Haytor white) as cut flowers by using factors of day lengthening and mulching in characteristics of plant height and total chlorophyll content of the plant

Table (2) showed significant differences in the characteristics of plant height (cm) and plant total chlorophyll content (CCI), as the artificial lighting factor was superior in both traits (64.11cm and 7.29CCI) compared to the comparison factor (59.52cm and 5.91CCI), respectively. The reason for this may be due to the fact that the increase in lighting hours using lamps leads to an increase in the production of gibberellins. This stimulates the elongation of the stem resulting from the elongation of cells, thus, increasing the height of the plant. The height of plants resulting from the increased accumulation of photosynthetic products and what was reached by [18].

As for the increase in the plant’s total chlorophyll content, the reason may be due to the increase in the number of chloroplasts, which leads to an increase in chlorophyll pigment, which increases the efficiency of photosynthesis and thus the entry of carbohydrates into the path of glycolysis and thus the entry of the products of this decomposition into the pyruvic acid cycle to give the main compound Acetyl-COA. It is the primary and basic substance in the production of chlorophyll [19,20] and this is what was reached [21]. Whereas, the mulching effect was significantly superior to the mulching with yellow corn waste (63.17cm and 6.75CCI) in the treatment group compared to the control treatment (59.44 cm and 6.38 CCI), respectively. The reason may be due to the fact that the mulching with plant residues acts as a protective cover over the soil that maintains moisture. It reduces water loss and providing nutrients by creating a suitable environment for the growth of microorganisms. In addition to providing CO2 for the plants accumulated under the cover. In addition to preventing the growth of weeds and improving soil properties, increasing its contents of organic matter, which in turn led to an increase in the plant's total chlorophyll content, thus led to an increase in plant height [22,13].

This is consistent with the findings of [23]. As for the interaction ratio between the two factors, the lighting factor with the mulching with yellow corn waste was significantly superior to the comparison treatment for both workers and both characteristics (65.43cm and 7.38CCI) and (55.56cm and 5.61CCI), respectively.
Table 2. The production of Dianthus caryophyllus L. cultivar (Haytor white) as cut flowers by using factors of day lengthening and mulching in characteristics of plant height and total chlorophyll content of the plant.

| Mulching factor | Lighting factor | Mulching effect rate | Lighting factor | Mulching effect rate |
|-----------------|-----------------|---------------------|-----------------|---------------------|
|                 | L1 | L2 |                | L1 | L2 |                |
| M1              | 55.56 | 62.08 | 59.44 | M1 | 5.61 | 6.00 | 6.38 |
|                 | b  | a | b | b | b | b |
| M2              | 63.08 | 61.33 | 62.84 | M2 | 5.95 | 7.18 | 6.66 |
|                 | a  | a | ab | a | a | ab |
| M3              | 63.59 | 65.43 | 63.17 | M3 | 7.32 | 7.38 | 6.75 |
|                 | a  | a | a | a | a | a |
| Lighting effect rate | 59.52 | 64.11 | b | 5.91 | 7.29 | b |

The averages with similar letters for each factor separately and their interactions did not differ significantly according to Duncan’s polynomial test at the 5% probability level.

3.2. The production of Dianthus caryophyllus L. cultivar (Haytor white) as cut flowers by using factors of day lengthening and mulching in characteristics of a number of days required for flowering (day), number of flower/m², and flower stem length (cm)

Table (3) showed significant differences in the characteristics of the number of days required for flowering, the number of flowers, and the length of the flower stem (cm). The artificial lighting factor was earlier in the number of days required for flowering (152.30 days) compared to natural lighting (164.1 days). Also, there were significant differences in the rest of the characteristics as well. The artificial lighting factor was greater (70.71 flowers/m² and 43.11 cm) compared to the comparison factor (66.68 flowers/m² and 38.13 cm), respectively. This result might be due to the increase in the number of hours of lighting, which leads to an increase in the process of photosynthesis thus leads to an increase in the manufacture of carbohydrates. These will in turn lead to the early days of flowering and an increase in the number of flowers [24]. Or it may be because the increase in lighting hours leads to an increase in the flowering principles and thus leads to an increase in the number of flower buds, which in turn leads to an increase in the number of flowers [25].

This is consistent with his findings [26]. As for the increase in the flower stem length, the reason might be due to the exposure of the plant to additional lighting causes an increase in the plant’s content of chlorophyll by increasing the number of chloroplasts. This will in turn increases the photosynthesis process and stimulates the production of gibberellins responsible for the elongation of cells and thus the elongation of the flower stem length. This is consistent Also with the findings concluded by [18]. While the mulching effect was significantly superior to the mulching with yellow corn waste in the characteristic of flowering stem length (43.07 cm) compared to the control treatment (38.49 cm). The reason may be due to what was mentioned above in the two characteristics of chlorophyll and plant height [22,13]. This is consistent with his findings [27].

As for the interaction between the two factors, the factor of artificial lighting with mulching with yellow corn waste was significantly earlier in the flowering date (152.30 days) compared to the natural lighting and non-mulching (164.68 days), as well as gave significant differences in the other characteristics (72.88 flowers/m² and 45.54cm), respectively, compared with the factor of lighting and non-mulching for the number of flowers (66.25 flowers/m²), and the comparison treatment for the length of the flower stem (35.47cm).
Table 3. The production of *Dianthus caryophyllus* L. cultivar (Haytor white) as cut flowers by using factors of day lengthening and mulching in characteristics of a number of days required for flowering (day), number of flower/m² and flower stem length (cm)

| Mulching factor | Lighting factor | Mulching effect rate | Number of days required for flowering (day) | Number of flower/m² | Flower stem length (cm) |
|-----------------|-----------------|----------------------|-------------------------------------------|---------------------|------------------------|
|                 | L1              |                      | M1 164.68 a                               | 66.66 b             | 35.47 c                 |
|                 | L2              |                      | M2 165.12 ab                              | 68.99 ab            | 43.08 ab               |
|                 |                 |                      | M3 152.18 bc                              | 71.33 ab            | 42.26 ab               |
|                 | Light effect    |                      | M1 164.1 a                               | 66.68 b             | 38.13 bc               |
|                 | rate            |                      | M2 152.30 a                              | 70.71 a             | 43.11 ab               |

The averages with similar letters for each factor separately and their interactions did not differ significantly according to Duncan’s polynomial test at the 5% probability level.

Conclusions

We concluded from the experiment that the lighting factor was significantly greater in all the studied vegetative and flowering traits. The superiority appeared in the characteristic of plant height and the plant’s total chlorophyll content, as well as earlier in the number of days required for flowering. Also, the superiority appeared in the characteristic of the number of flowers and the length of the flower stem. As for the factor of mulching with yellow corn waste, it was also significantly greater in most of the previously mentioned vegetative and flowering characteristics, except for the number of days required for flowering and the number of flowers.

References

[1] Anon. 2002. Office of the Gene Technology Regulator application for licence International Release of GMOS in to the environment application. www.ogtr.gov.au.
[2] Zhang, F., Wang, Y., Liu, T., and Li, L. 2014. Low temperature phosphate fumigation for postharvest control of *Liriomyza huidobrensis* Blanchard (Diptera: Agromyzidae) on carnation. Postharvest biology and technology, 88, 40-45.
[3] Abu Zaid, Al-Shahat Nasr. 2000. volatile oils. Arab House for Publishing and Distribution, Cairo, Egypt, first edition.
[4] Al-Mayah, Abdul-Ridha Akbar Alwan. 2001. Medicinal plants and herbal medicine. Ebadi Center for Studies and Publishing, Yemen.
[5] Al-Dajwi, Ali. 1996. Encyclopedia of medicinal and aromatic plants production, the second book, first edition. Madbouly Library, Books for Printing and Publishing, University of Mosul, Iraq.
[6] Ryagi, V. Y., S. M. Mantur and B. S. Reddy. 2007. Effect of Pinching on Growth, Yield and Quality of Flowers of Carnation Varieties Grown under Polyhouse. Karnataka J. Agric. Sci., 20 (4):816-818.
[7] Al-Batal, Nabil. 2005. Production of protected ornamental plants. Damascus University Publications. The Syrian Arab Republic.
[8] Janda T., Majlath I., Szalai A. 2012. Interaction of temperature and light in the development of freezing tolerance in plants. J Plant Growth Regul 30:460-469.
[9] Salman, S.R., Hassan, H.B., Mohammed, M.A., (2018), The Hydrogen and Sulfur Surfaces Effect on the Structural and Electronic Properties of Graphene Nano Ribbon, Journal of Global Pharma Technology, 10 (6), pp. 386-392.
[10] Adams, S.R. and F.A. Langton. 2005. Photoperiod and plant growth: A review. J. Hort. Sci. Biotechnol. 80:2-10.
[11] Thakur, Tanya and H.S. Grewal. 2018. Influence of Photoperiodic Night Interruption on Sustainable Potted Flower Production of *Chrysanthemum* cv. Snowball. International Journal of Current Microbiology and Applied Sciences. 2319-7706 Volume 7 Number 02 : 1282-1287.
[12] Al-Bayati HJ, Ibraheem FF, Allela WB and AL-Taey D. K.A. 2019. ROLE OF ORGANIC AND CHEMICAL FERTILIZER ON GROWTH AND YIELD OF TWO CULTIVARS OF PEA (*PISUM SATIVUM* L.). Plant Archives Vol. 19, Supplement 1, 2019 pp. 1249-1253.
[13] Harris R.W., J.R. Clark and N.P. Matheny. 2004. Arboriculture. 4th Ed. Prentice Hall Inc., New Jersey.
[14] Wilhoit, J.H., R.D. Morse and D.H. Vaughan. 1990. Strip tillage production of summer cabbage using high residue levels. Agric. Res. 5:338-342.
[15] Stowell, B. (2000). Organic kiwifruit production–maintaining soil fertility and yields. Kiwifruit 139:18-21.
[16] Parmar, Tanika, HS Baweja, BS Dilta and PK Baweja. 2020. Impact of environmental factors and mulching on growth, quality and yield of carnation (Dianthus caryophyllus L.) cv. ‘Loris’. International Journal of Chemical Studies. 8(5): 1879-1882.

[17] Roger Mead, R.N.C. and A.M. Hasted. 2003. Statistical Methods in Agriculture and Experimental Biology Champan. Hall, CRC, A CRC Press Co., Washington, D. C.

[18] Datta, J.P., and Ramadas, S. 2006. Growth, development and flowering of Chrysanthemum (Dendranthema grandiflora Tzelev.) as influenced by long-day exposures. Orissa J. Horti. 28(1): 7-13.

[19] Al-Nuaimi, Saadallah Najm Abdullah. 1999. Fertilizer and soil fertility. House of books for printing and publishing. Ministry of Higher Education and Scientific Research. The University of Al Mosul. The Republic of Iraq.

[20] Alsultani, M.J., Abed, H.H., Ghazi, R.A., Mohammed, M.A. . (2020), Electrical Characterization of Thin Films (TiO2: ZnO)1-x (GO)x / FTO Heterojunction Prepared by Spray Pyrolysis Technique, Journal of Physics: Conference Series, 1591(1), 012002.

[21] Al-Tikriti, Ahmad Nazir Hussain. 2020. Effect of dark break treatment and spraying with paclobutrazol on growth, flowering, and coordination value of Dendranthema grandiflora. Master Thesis, College of Agriculture, University of Tikrit, Ministry of Higher Education and Scientific Research, Republic of Iraq.

[22] Al-Taey, D.K.A., AL-Naely, I J.C., Kshash B.H. 2019. A study on effects of water quality, cultivars, organic and chemical fertilizers on potato (Solanum tuberosum L.) growth and yield to calculate the economic feasibility. Bulgarian Journal of Agricultural Science, 25 (6) 1239 -1245.

[23] Muttaleb, Anmar. 2018. The Effect of Three Different Mulches on Weed Presence, Soil Characteristics, and Zinnia Growth. Murray State Theses and Dissertations. 77.

[24] Tawajen, Ahmad Muhammad Musa. 1985. Greenhouse Environment, Ministry of Higher Education and Scientific Research. Albasrah university. The Republic of Iraq.

[25] Muhammad, Abd al-Azim Kazim and Muayyad Ahmad al-Younes. 1991. Fundamentals of Plant Physiology Part 3. Ministry of Higher Education and Scientific Research, University of Baghdad, College of Agriculture, Iraq.

[26] Al-Alawi, Rasha Hashem Abdel-Aziz. 2003. Effect of photoperiod and licorice extract on vegetative and flowering growth characteristics of three cultivars of Dendranthema grandiflorum Kitam. Master Thesis, College of Agriculture, University of Baghdad, Ministry of Higher Education and Scientific Research, Republic of Iraq.

[27] Bhat, N.R. , M.K. Suleiman, R.R. Bellen and L. AL-Mulla. 2004. Mulching effect on selected ornamental plants. Journal of Applied Horticulture, 6(2):102-105.