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# Flowering Responses of Dianthus Caryophyllus to Some Organic Matter Treatments

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**Abstract**

and the most cut-flower species around the world. This study was conducted in two experiments using the split-plot design at the Department of Horticulture and Landscape Engineering, College of Agricultural Sciences, University of Baghdad during spring 2023-2024. Seedlings of the 10-12 cm tall Grace variety carnation imported from Turkey were sowed in small pots and transferred to the soil after the appearance of the 4th leaf. Straw wheat and palm waste compost were added to the soil after removing the soil from the panel at a depth of 30 cm and mixing with the removed soil. The concentrations of straw wheat (A1 and A2) and palm waste (A3 and A4) were 2 and 4 kg, respectively, together with the spraying application of aloe vera extract (B1 and B2) at 10 and 20 g/l. Seven growth and flowering characters were measured i.e., number of flowers/plants, flower stem length, flower stem diameter, carbohydrate percentage in flowers, anthocyanin pigment percentage, fresh flower weight (g) before storage, and the vase-life of stored flowers. The results showed a significant effect of using palm waste (4 kg) and 20 g of aloe vera gel over the other treatments and control in all the tested parameters. For instance, number of flowers/plants recorded the highest value at 13.93 together with flower stem length (66.5 cm), carbohydrate percentage (0.893%), flower stem diameter (22.51 mm), fresh flower weight (35.16 g); anthocyanin pigment percentage (94.63%), and the

vase-life of stored flowers (8.574 days). As such the use of 4-kg palm waste and spraying with 20 g of aloe vera gel on carnation plants is recommended to enhance their growth and flowering characteristics.

**Keywords:** Dianthus caryophyllus, Cut flowers, Organic matter, Flowering.

# الاستجابة للتزهير في القرنفل (Dianthus caryophyllus) لبعض المواد العضوية

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## الخلاصة

يعد القرنفل (*Dianthus caryophullus*) أحد محاصيل الزهور الرئيسة، وهو الاول من بين انواع ازهار القطف في معظم انحاء العالم. تضمنت الدراسة تجربة حقلية في أحد البيوت البلاستيكية الواقعة في المحطة البحثية B، التابعة لقسم البستنة وهندسة الحدائق – كلية علوم الهندسة الزراعية – جامعة بغداد/ الجادرية للموسم الخريفي 2023–2024 لدراسة استجابة نمو وازهار نبات القرنفل لبعض المواد العضوية الصديقة للبيئة. تم استيراد شتلات القرنفل "صنف كريس" بطول 10–12 سم من تركيا وتم زراعتها في سنادين صغيرة وبعدها حولت الى التربة مباشرة بعد ظهور الورقة الرابعة على النبات. استخدم تبن الحنطة ومخلفات النخيل بتركيزات 2، 4 كغم على التوالي خلطاً مع التربة اما مستخلص أوراق الالوفيرا تم رشه بواقع 3 رشات حيث كانت الرشة الأولى بعد شهر من الزراعة اما الرشة الثانية فكانت بعد شهر من الرشة الاولى وكانت الرشة الثالثة قبل موعد تفتح الازهار وتم تحليل تربة الزراعة قبل الزراعة واجراء عمليات الخدمة كافة. اشارت النتائج الى ان تأثير المادة العضوية من مخلفات النخيل بتركيز 4 كغم مع جل الصبار بتركيز 20 غم قد تفوق بشكل ملحوظ على تبن الحنطة مقارنة بباقي المعاملات والسيطرة في معالجة جميع خصائص التزهير حيث سجل عدد الازهار لكل نبات 13.93 زهرة وسجل طول ساق الزهرة 66.5 سم وكانت نسبة الكاربوهيدرات وصبغة الانثوسيانين 0.893 % و94.63% بالترتيب وسجل قطر ساق الزهرة 22.51 ملليمتر واخيرا عمر الازهار في الفاظة وصل الى 8.574 يوم. وتوصى النتائج باستخدام مخلفات النخيل بتركيز 4 كغم مع جل الصبار بتركيز 20 غم لتحسين الصفات في نباتات القرنفل.

**كلمات مفتاحية:** Dianthus caryophyllus، ازهار القطف، المادة العضوية، مؤشرات التزهير والخزن.

## Introduction

The carnation (*Dianthus caryophyllus*), a popular fresh-cut flower, is a major floricultural crop and among the most challenging to grow commercially (8 and 20). The global cut-flower industry is an essential sector in agriculture and faces serious challenges. The production of specialty cut flowers has increased in the United States, Australia, Africa, and Europe in the past 20 years (7). Their production and sales could increase further if supported by dynamic marketing campaigns that focus on their strengths compared to traditional flowers such as roses, carnations, gerberas, and chrysanthemums (1 and 3).

A study showed that *D. caryophyllus* L., a perennial herbaceous plant characterized by a long flowering period and rich flower color, is one of the world's most important commercial ornamental flower crops compared to other cut flowers (18). It is popular in the industry due to its easy transportation, simple cultivation facilities, and being a perennial plant. It is a highly discerning gift for holidays and occasions and the most popular indoor potted flower.

(6) studied the effect of 11 different combinations of organic and inorganic nutrient sources (NPK) with biofertilizers on the vegetative and flowering traits of *D. caryophyllus* L. They found that flower yield per meter square was significantly correlated with plant height, number of branches, plant spread, leaf area, dry matter production, and total chlorophyll content. In addition, there was a significant increase in nitrogen rates, stem length, stem circumference, total yield, and vase life.

A recent study by (5) showed that returning crop straw (crop residue) to the soil is a good management process in agricultural production systems because it represents a recycling strategy for these valuable solids. It indicated that the process of returning straw to crops enhances the productivity and sustainability of agricultural ecosystems by improving soil properties, and increasing the availability of organic matter and nutrients in it. This is achieved by enhancing and improving the microbial activity of the soil and the diversity of its various physical and chemical properties (25 and 26). A study by (4) on using agricultural wastes such as leaf fertilizer, peanut shell fertilizer, rice straw, and biochar noted that it promoted plant growth as well as led to a significant increase in the number of flowering parameters. Straw, or wheat straw, is a bio product obtained from wheat grain harvesting, and has an annual global production of 529 million tons (13). A compositional analysis of the straw revealed the presence of cellulose (34-40%), hemicellulose (20-25%), and lignin (20%).

The palm tree has multiple and unique characteristics and is considered a source of goodness and blessings. Recycling palm waste contributes to preserving the environment instead of burning operations to eliminate many wastes such as fronds, grapes, fibers, and date palms (16). In addition, palm waste has high water retention capacity compared to peatmoss and perlite, and can absorb water at a rate of 8.5 times dry weight (9).

Aloe vera is a natural ingredient that contains sugars, fatty acids, amino acids, vitamins, and minerals, and has antioxidant, antifungal, antibacterial, and antiviral properties (10). (24) studied the effect of aloe vera extracts on seed germination and early growth of *D. barbatus* L. The results showed that their aqueous extracts at 5%

positively affected seed germination while that at 15% improved shoot and root length and fresh mass of the plant's seedlings (2 and 15).

Chemical fertilizers are an important source of plant nutrition, but are costly and a source of environmental pollution (11 and 21). Also, the long-term use and high rates of chemical fertilizer application may increase the risk from chemical residues on plant tissues as well as on human and animal health (19 and 23). Accordingly, plant growers and growers of medicinal and aromatic products are turning to plant extracts to improve and stimulate plant growth, activity, and components, instead of chemical compounds (22). The main objective of this study was to evaluate some organic matter on the flowering parameters of *D. caryophyllus* under normal conditions (12, 14 and 17) as a means to reduce environmental waste and find alternatives ways to produce fresh-cut flowers.

## Materials and Methods

A field experiment was conducted in the greenhouses at Research Station B of the Department of Horticulture and Landscape, College of Agricultural Engineering Sciences, University of Baghdad, Al-Jadriyah, Iraq during the 2023-2024 fall season. It aimed to study the effects of some organic matter on the vegetative growth of *D. caryophyllus* under normal conditions.

The experiment employed a split-plot design involving 15 treatments at 5 levels and 3 levels of aloe vera gel spraying. Each treatment comprised ten plants and three replicates. Seedlings of the 10-12 cm-long Grace variety plants were obtained from Turkey, planted in small pots, and then transplanted 25-cm apart with 10 plants per panel when the 4th leaf emerged.

The concentrations of straw wheat (A1 and A2) and palm waste (A3 and A4) were 2 and 4 kg, respectively, while aloe vera extracts (B1 and B2) were 10 and 20 g/l. Aloe vera leaf extract was sprayed thrice, the first after 30 days of planting, the second after 60 days, and the third before the flowers bloomed. The flowering parameters assessed were number of flowers/plants, flower stem length, flower stem diameter, flower diameter, carbohydrate percentage in flowers, anthocyanin pigment percentage, fresh flower weight (g) before storage, and vase life of stored flowers.

The data was analyzed using ANOVA, with the least significant difference (LSD) of 0.05 to determine the difference between means.

## Results and Discussion

Vegetive parameters:

Number of flowers/plants: Table 1 illustrates the significant differences in the organic matter treatments with the A4 and A2 (4 kg) registering the highest number of flowers/plants at 13.93 followed by 13.80 flowers/plant, respectively with the 20 g/l B2 aloe vera extract. The control recorded the lowest average number of flowers at 9.60 flowers/plant. For spraying with aloe vera gel extract, treatment B2 excelled at an average 12.36 flowers/plant, while the control recorded the lowest number. The interaction between the two study factors showed significant differences between treatments with A4B2 having the highest value of 13.93 flowers/plant while A2B2 registered 13.80 and the comparison A0B0 recording the lowest at 8.64 flowers/plant.

Flower stem length: Flower stem length of the carnation plants due to organic matter and aloe vera gel treatments showed significant differences with A2, A3, and A4 at 58.53, 59.83 and 62.10 cm, respectively while the control registered 52.97 cm (Table 1). The application of aloe vera gel on flower stem length showed a significant difference for B2 (60.56 cm) over the control (52.58 cm). Also, the A4B2 interaction between organic matter and aloe vera extract application produced the highest results for flower stem length at 66.5 compared to 55.7 cm for the control.

**Table 1: Flower stem length and number of flowers/plants for carnations treated with different organic matter and aloe vera gel extract.**

| Organic matter | Number of flowers/plants | | | | Flower stem length (cm) | | | |
|---|---|---|---|---|---|---|---|---|
| | Aloe vera gel extract | | | Mean (A) | Aloe vera gel extract | | | Mean (A) |
| | B0 | B1 | B2 | | B0 | B1 | B2 | |
| **A0** | 8.64 | 9.54 | 10.61 | 9.60 | 51.2 | 52.4 | 55.3 | 52.97 |
| **A1** | 8.82 | 11.32 | 11.44 | 10.52 | 50.4 | 54.7 | 55.3 | 53.47 |
| **A2** | 10.29 | 12.37 | 13.80 | 12.15 | 51.8 | 61.4 | 62.4 | 58.53 |
| **A3** | 8.93 | 11.55 | 12.05 | 10.84 | 53.8 | 62.4 | 63.3 | 59.83 |
| **A4** | 10.07 | 12.52 | 13.93 | 12.17 | 55.7 | 64.1 | 66.5 | 62.10 |
| **Mean (B)** | 9.35 | 11.46 | 12.36 | | 52.58 | 59 | 60.56 | |
| **A** | 0.52 | | | 0.05 | **A** | 4.52 | | 0.05 |
| **B** | 0.40 | | | | **B** | 3.40 | | |
| **AB** | 0.90 | | | | **AB** | 3.90 | | |

* A0, B0: control; A1, A2: straw wheat (2 and 4 kg); A3, A4: palm waste (2 and 4 kg); B1, B2: aloe vera extract at 10 and 20 g/l, respectively.

Carbohydrate percentage in flowers: Table 2 shows the significant differences between different organic matter treatments with aloe vera gel extract spraying on carbohydrate percentages in the carnations. Treatment A4 at 0.881% gave the largest carbohydrates percentage, A2 registered 0.860%, while A0 had lowest at 0.765%. As for spraying aloe vera gel extract, treatment B2 was superior, recording the highest average carbohydrate value of 0.862% while B0 at 0.798% was the lowest. The results of the interaction between the two study factors, showed significant differences between the treatments with A4B2 producing the highest value at 0.893%. Treatments A2B2, A4B1, A4B0, A3B2, A2B1, and A1B2 differed significantly, amounting to 0.891, 0.877, 0.873, 0.860, 0.857, and 0.853%, respectively while the A0B0 control treatment recorded the lowest at 0.720%.

Flower stem diameter: The analysis of variance in Table 2 showed a significant difference between the control and both treatments for the carnation flower stem diameter. The average control values for organic matter and aloe vera gel spraying were the lowest compared to other treatments at 19.07mm (A0) and 18.60mm (B0) compared to the highest at 21.12mm (A4) and 21.52mm (B2). The B2A4 intervention achieved the highest value in the flower stem diameter (22.51mm). As seen in the table, there was a significant difference between the organic matter and aloe vera gel treatments on the flower stem diameter values.

**Table 2: Carbohydrate values and flower stem diameters of carnations treated with different organic matter and aloe vera gel extract.**

| Organic matter | Carbohydrate (%) | | | | Flower stem diameter (mm) | | | |
|---|---|---|---|---|---|---|---|---|
| | Aloe vera gel extract | | | Mean | Aloe vera gel extract | | | Mean |
| | B0 | B1 | B2 | (A) | B0 | B1 | B2 | (A) |
| **A0** | 0.720 | 0.766 | 0.810 | 0.765 | 18.48 | 18.66 | 20.08 | 19.07 |
| **A1** | 0.740 | 0.845 | 0.853 | 0.813 | 18.55 | 20.78 | 21.34 | 20.22 |
| **A2** | 0.833 | 0.857 | 0.891 | 0.860 | 18.76 | 21.68 | 22.48 | 20.98 |
| **A3** | 0.825 | 0.840 | 0.860 | 0.842 | 18.52 | 21.15 | 21.19 | 20.29 |
| **A4** | 0.873 | 0.877 | 0.893 | 0.881 | 18.69 | 22.15 | 22.51 | 21.12 |
| **Mean (B)** | 0.798 | 0.837 | 0.862 | | 18.60 | 20.89 | 21.52 | |
| **A** | 0.025 | | | 0.05 | **A** | 0.72 | | 0.05 |
| **B** | 0.019 | | | | **B** | 0.56 | | |
| **AB** | 0.043 | | | | **AB** | 1.25 | | |

* A0, B0: control; A1, A2: straw wheat (2 and 4 kg); A3, A4: palm waste (2 and 4 kg); B1, B2: aloe vera extract at 10 and 20 g/l, respectively.

Fresh flower weight (g): The analysis of variances in Table 3 shows the impact of various levels and concentrations of organic matter and aloe vera gel extract on fresh carnation flower weight. As seen, significant differences are found between A2 (33.08g) and A4 (33.49g) treatments for this trait of organic matter of wheat straw and palm leaves waste with AO recording the lowest at 29.21g. Significant differences are also apparent between treatments B1 (32.69g) and B2 (34.16g) compared with the control (28.45 g). The highest value for interaction was between B2A4 with an average of 35.16g compared to the control's 30.44g, indicating a significant difference and the effect of those treatments on fresh flower weight.

Percentage of anthocyanin pigment: The colors in flowers are related to pigment concentrations, the most important being anthocyanin. Table 3 shows the significant differences between treatments that included organic matter and aloe vera gel. Treatment A2 was superior with the highest anthocyanin pigment concentrations of 90.44%, followed by A4 at 89.36%. In contrast, spraying with aloe vera gel shows the B2 treatment outperforming the others in pigment values at 88.74% followed by B1 at 85.09%. The lowest anthocyanin pigment values were for the BO treatment of 82.95%. No significant differences appeared for the interaction between the organic matter and aloe vera gel treatments. The control values were at least 84.02% in the interaction for the treatment with 4 kg palm leaves.

**Table 3: Fresh flower weight before storage and anthocyanin pigment percentages of carnations treated with different organic matter and aloe vera gel extract.**

| Organic matter | Fresh flower weight (g) | | | | Anthocyanin pigment (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | Aloe vera gel extract | | | Mean | Aloe vera gel extract | | | Mean |
| | B0 | B1 | B2 | (A) | B0 | B1 | B2 | (A) |
| **A0** | 27.14 | 27.65 | 32.85 | 29.21 | 78.33 | 80.60 | 83.43 | 80.79 |
| **A1** | 27.67 | 32.88 | 32.57 | 31.04 | 83.20 | 83.90 | 83.97 | 83.69 |
| **A2** | 28.98 | 34.92 | 35.34 | 33.08 | 86.67 | 88.00 | 96.65 | 90.44 |
| **A3** | 28.04 | 33.14 | 34.91 | 32.03 | 82.53 | 83.53 | 85.00 | 83.69 |
| **A4** | 30.44 | 34.87 | 35.16 | 33.49 | 84.02 | 89.43 | 94.63 | 89.36 |
| **Mean (B)** | 28.45 | 32.69 | 34.16 | | 82.95 | 85.09 | 88.74 | |
| **A** | | 1.26 | | 0.05 | **A** | | 5.69 | 0.05 |
| **B** | | 0.98 | | | **B** | | 4.41 | |
| **AB** | | 2.18 | | | **AB** | | NS | |

* A0, B0: control; A1, A2: straw wheat (2 and 4 kg); A3, A4: palm waste (2 and 4 kg); B1, B2: aloe vera extract at 10 and 20 g/l, respectively.

Vase life: The marketing process of flowers are linked to their vase life (days) after picking and storage. The longer the vase life, the greater the marketing opportunities and earnings for the flower growers and businesses. The flower life of carnations treated with organic matter and aloe vera gel in this study showed significant differences. The A4 and A2 treatments were superior at 9.35 and 9.30 days compared to the 8.85 and 8.05 days for A3 and A1, while the control recorded 5.89 days. On the other hand, with the aloe vera extract, treatment B2 recorded the highest value at 8.574 days compared to B1 and the control at 8.402 and 7.892 days, respectively. There was no noticeable difference in the interaction between using organic fertilizers and aloe vera gel.

**Table 4: Vase life of carnations treated with different organic matter and aloe vera gel extract.**

| Organic matter | Vase life (days) | | | |
|---|---|---|---|---|
| | Aloe vera gel extract | | | Mean |
| | B0 | B1 | B2 | (A) |
| **A0** | 5.33 | 6.18 | 6.17 | 5.89 |
| **A1** | 7.69 | 7.66 | 8.81 | 8.05 |
| **A2** | 8.78 | 9.40 | 9.71 | 9.30 |
| **A3** | 8.85 | 8.79 | 8.91 | 8.85 |
| **A4** | 8.81 | 9.98 | 9.27 | 9.35 |
| **Mean (B)** | 7.892 | 8.402 | 8.574 | |
| **A** | | 1.20 | | 0.05 |
| **B** | | 1.09 | | |
| **AB** | | NS | | |

* A0, B0: control; A1, A2: straw wheat (2 and 4 kg); A3, A4: palm waste (2 and 4 kg); B1, B2: aloe vera extract at 10 and 20 g/l, respectively.

These results match (15) who used compost as a growing media and studied the impact of palm waste on the growth and nutritional status of *Lilium* spp., as well as (18) who noted an increase in the height of *D. Caryophyllus* L. following the application of two growth retardants. Other studies have indicated the importance and role of organic

matter for soil, plants, and living organisms in the soil after adding these organic materials. For instance, (22 and 24) noted that the addition of organic matter to soil made it conducive for soil microbes that contribute to storing nutrients and working to cultivate these beneficial microbes in the soil.

This study is also consistent with (10) who studied the effect of eleven different combinations of organic and inorganic nutrient sources with biofertilizers on the carnation plant. They noted the relationship between organic nutrients with the vegetative and flowering traits of carnation and their effect on flower productivity. Meanwhile, (16) studied the effect of organic fertilizer on the growth, flowering, quality, and yield of the carnation. They found that vermicompost at 1.25 kg/$m^2$ contributed significantly to all the studied factors of plant height, number of primary branches, days taken to start the first buds, flower diameter, stem length, flower age, number of cut flowers per plant, and number of cut flowers.

Studies by (7) showed returning crop straw (crop residues) into soil is a good management practice in agricultural production systems, as it represents a recycling strategy for these valuable solid materials. Another study indicated that such a practice can enhance the productivity and sustainability of agro-ecosystems by improving soil properties. This increases the availability of soil organic matter and nutrients arising from the higher soil microbial activity and expanding the diversity of its various physical and chemical properties (28 and 29).

The results of this study match (27) that aloe vera leaf extract improves vegetative growth, and that organic solutions as flower preservatives for extending the shelf life of cut flowers is a cheaper and environmentally friendly alternative to inorganic solutions. A study was conducted to evaluate the use of aloe vera and moringa (*Moringa oleifera* Lam) gels compared to calcium chloride and salicylic acid solutions for improving the post-harvest shelf life of Heliconia ‘Golden Torch’ flowers. It reported that all treatments improved the flowering life of cut carnations compared to the control, except moringa solutions which resulted in the highest percentage of peduncles wilting at day 10. Flowers treated with 5% aloe vera gel and 4% sucrose showed the best results in water uptake, biomass increase (67.4%), and relative water content (78.9%).

## Conclusions

The use of organic materials such as agricultural waste is a feasible way to manage the environment while providing adequate nutrients to plants. This study showed the positive effect of using organic fertilizers and spraying with aloe vera gel extract on the vegetative and flowering growth characteristics of the carnation plant. Agricultural waste, especially palm waste at 4 kg concentration achieved high vegetative and flowering growth averages in the plant followed by the application of the same concentration of wheat straw. Also, 20 mg aloe vera gel had a noticeable effect on those traits in the plant.

Recommendation: More extensive use of alternative means other than chemical fertilizers for producing healthier cut flowers is a key factor in addressing the issue of environmental pollution. In this context, the use of agricultural waste as a component

of plant growth media and a comparative evaluation of the best potting methods for flower production should be further explored.

**Supplementary Materials:**

No Supplementary Materials.

**Author Contributions:**

Author 1: Implementing the project involving the field experiment and financial experience, and draft writing. Author 2: Title selection and preparing a search plan. Both authors have read and agreed to the published version of the manuscript.

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The study was conducted following the protocol authorized by the Head of the Ethics Committee, University of Baghdad, Iraq Republic.

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Data available upon request.

**Conflicts of Interest:**

The authors declare no conflict of interest.

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