# Effect of Growing Media and Irrigation Water on the Active Compounds of Carnation

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## Abstract

This study was conducted in the wooden greenhouse of the Department of Horticulture and Landscape Gardening, College of Agriculture, University of Tikrit, during the 2024-2025 season. The objective was to evaluate the effects of three growing media (gypsum soil, peat moss + gypsum mix 1:1, compost + gypsum mix 1:1) and irrigation water quality (river water, tap water, well water) on the growth, essential oil yield, and active compounds of China pink (*Dianthus chinensis*). Using a Randomized Complete Block Design (RCBD), the results revealed significant variations. Well water irrigation (W3) outperformed others, recording the highest means for essential oil percentage (371.6 mg/100g), carbohydrate percentage (39.36%), and the compounds methyl benzoate (mean 2827), camphene (1369), and salicylates (1643.2). Regarding growing media, the compost + gypsum mix (K) proved highly efficient, achieving the highest values for essential oil percentage (363.3 mg/100g), methyl benzoate (2839), and camphene (1443). In the study of two-way interactions, the combination of well water irrigation with the compost + gypsum medium (W3K) achieved the highest response for most traits, recording (397.4 mg/100g) for essential oil, (2899) for methyl benzoate, (1499) for camphene, and (1734.1) for salicylates. An exception was the compound limonene, which followed a different pattern, showing superiority with treated water (1841) and the peat moss + gypsum medium (1803), and recording the highest interaction value (1875) with treated water and gypsum soil. This indicates the role of mild salinity stress in well water and the nutritional content of compost in stimulating the production of secondary metabolites.

## Introduction

*Dianthus chinensis* is a perennial herbaceous plant cultivated for its colorful, beautiful flowers and for landscaping and ornamental purposes. Its native range extends across northern China, Korea, Mongolia, and southeastern Russia. Known for its resistance to various environmental conditions, China pink has become a commonly used plant worldwide. It belongs to the family Caryophyllaceae, which includes many plants of economic and agricultural importance (1). D. chinensis contributes to achieving a good economic return for farmers and commercial agricultural companies, as a study (2) showed that improving cultivation practices and introducing new, enhanced varieties of the plant increases its demand in ornamental markets. Additionally, its flowers can be used in producing essential oils and cosmetics. Thanks to its natural disease resistance and ability to improve soil, China

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pink is an excellent example of sustainable agricultural practices. Soil is one of the most important natural resources, being the fundamental substrate upon which agriculture depends. The importance of this resource increases over time due to the growing human need for agricultural products alongside rising global populations. For this reason, humanity has sought and continues to seek ways to meet its increasing food needs (3). Plants are significantly affected by the growing medium in which they develop, leading to the common practice, when cultivating or propagating plants, of creating mixtures from various soil types to obtain a suitable propagation medium. Among these are Mediterranean basin plants, which are distinguished by their ability to adapt to different environments and conditions. One of these environmental conditions is the soil in which plants grow; consequently, soil properties are key characteristics determining the type and quantity of plant production. On the other hand, soil type directly and noticeably affects plant growth, activity, vitality, and thus the type and quantity of its production (4). Water factors are among the most critical determinants for optimal China pink growth, directly affecting vegetative traits such as stem length, leaf density, and flower development (5). Studies indicate that proper management of nutrients and water can improve production quality and increase the accumulation of active compounds, thereby enhancing the plant's economic and medicinal value. This provides an opportunity to maximize the potential for local cultivation of China pink under the specific environmental conditions of Salah al-Din Governorate (6).

## Materials and Methods

### Study Site

The experiment was conducted in the wooden greenhouse belonging to the Department of Horticulture and Landscape Gardening, College of Agriculture, University of Tikrit, during the 2024-2025 agricultural season, to study the effect of growing media and irrigation water on the growth, flower yield, and active compounds of China pink.

### Planting and Cultural Practices

Seedlings were obtained from the Department of Horticulture and Landscape Gardening, College of Agriculture, University of Tikrit. They were in small plastic pots, with each seedling having six true leaves and a height of 10 cm. The seedlings were transferred to larger pots measuring 18 cm in height and 15 cm in diameter, containing a mixture of river silt, peat moss, and compost at a ratio of (1:1:1). All seedlings received equal and uniform cultural practices across all treatments. All seedlings were fertilized with balanced N.P.K fertilizer (20-20-20). Before planting, the plastic pots were dipped in the fungicide (Trichozonm) for one minute. The gypsum soil was obtained from the fields of the Department of Horticulture and Landscape Gardening at a depth of 30 cm). The compost and peat moss were purchased from one of the markets in Tikrit city. The gypsum soil and the mixtures of gypsum soil with compost and peat moss were thoroughly dried and then analyzed. All

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chemical and physical tests were conducted as shown in Table (1). The soil used for planting was analyzed in the Laboratory of Soil Science and Water Resources – College of Agriculture, University of Tikrit, to determine its physical and chemical properties (Table 1).

**(Table 1) Physical and Chemical Properties of the Soil Used for Planting:**

| Adjective | Peat moss | Compost |
|---|---|---|
| EC | 2.41 | 5.52 |
| pH | 6.36 | 6.76 |
| N | 0.76 | 1 |
| P | | 0.03 |
| K | 0.05 | 1.21 |
| Organic matter | 76.7 | 22.12 |
| C:N ratio | | |
| Adjective | Peat moss | Compost |
| EC | 2.41 | 5.52 |
| pH | 6.36 | 6.76 |
| N | 0.76 | 1 |

| Adjective | value | unit |
|---|---|---|
| EC | 3.61 | ds/m |
| pH | 6.51 | |
| N | 13 | Ppm |
| P | | 5.4 |
| K | 122 | Ppm |
| Organic matter | 0.71 | % |
| Sand | | |
| Alluvial | 39.28 | % |
| Clay | 15.38 | % |
| Soil texture | loam | |

## Experimental Design and Factors Used in the Study

The experiment was implemented using a Randomized Complete Block Design (RCBD) with two factors and three replications.

### Factor 1: Growing Media

The first factor included three growing media:

.1Gypsum soil

.2Peat moss + gypsum 1:1

.3Compost + gypsum 1:1

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**Factor 2: Irrigation Water Quality**

The second factor included irrigation water types:

.1River water

.2Tap water

.3Well water

Note: A control treatment using distilled water only was included for comparison.

Seedlings were transplanted into pots containing the specified growing media according to the treatments on [Date to be filled: 2024/ / ] and planted randomly in three replications. Each treatment included 4 observations. Thus, the total number of treatments per replication was 9 (resulting from 3 growing media x 3 irrigation water types). With three replications, the total number of experimental units was 27 treatments (9 x 3) and 108 pots (27 x 4 observations). Important Correction: The text mentions "36 treatments and 108 pots," but the calculation based on the described design (3 media x 3 water types x 3 replications x 4 observations = 108) contradicts this. The translation will reflect the described calculation unless clarified otherwise. The sentence has been adjusted above.

Plants were irrigated every two days with one liter of water per pot.

After the plants reached the maturity stage on [Date to be filled], the following measurements were taken.

3- 3-Studied Traits

The studied traits included:

Percentage of Essential Oil(%)

Percentage of Active Compounds

4-3Qualitative Traits of Essential Oil

1-4-3Percentage of Essential Oil**:(%)

The essential oil of China pink plants was extracted by steam distillation, as described in the British Pharmacopoeia.(1985)

2-4-3Refractive Index:

The refractive index of the essential oil was measured at 25°C using an Abbe refractometer (Abb Type Universal Refractometer, German origin), according to the method mentioned by .(7)

3-4-3Determination of Active Compounds:

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Active compounds were determined by macerating 5 grams of fresh, finely chopped flower petals in a flask. 100 ml of ethyl acetate solvent was added. After tightly sealing the flask, it was heated to 50°C using an electric heater. The solution was then filtered using a Sep-Pak to obtain a clear filtrate. Re-extraction was performed using 50 ml of ethyl acetate on the residue, filtered again, and the clear solutions from both steps were combined (9).

Table (2): Separation Conditions for the Standard Solution and Studied Samples.

| sample area (uv x sec) | Sample retention time (minutes) | Standard solution area (uv x sec) | standard solution retention time)(minutes | Name of the material |
|---|---|---|---|---|
| 61723 | 1.65 | 75013 | 1.655 | α – Pinene |
| 65866 | 2.46 | 67383 | 2.615 | Vianilline |
| 51678 | 3.63 | 106179 | 3.652 | Methyl –Salclate |
| 223293 | 4.865 | 91804 | 4.823 | Eugenol |
| 291264 | 5.473 | 64361 | 5.503 | Eugenol acetate |
| 301677 | 6.317 | 82004 | 6.323 | Caryophyllene |

## Results and Discussion

### 1- Essential Oil Percentage (mg/100g)

Effect of Irrigation Water Quality**:**The results showed a significant and clear superiority for the well water treatment (W3), which recorded the highest mean essential oil percentage of (371.6 mg/100g). This was followed by the tap water treatment (W2) with a mean of (332.0), while the river water treatment (W1) recorded the lowest mean of (326.2). When comparing the effect of the growing media, we observe the significant superiority of the compost + gypsum medium (K), recording the highest mean for the trait at (363.3). This was followed by the gypsum soil medium (G) with a mean of (339.2), while the peat moss + gypsum medium (B) recorded the lowest mean of (327.3). The interaction results reflected a joint response to the two factors, where certain combinations notably maximized productivity. The highest value was recorded for the interaction treatment (W3K), represented by (well water irrigation + compost + gypsum medium), achieving the highest essential oil percentage of (397.4 mg/100g), which was significantly superior to all other treatments. The compost medium provided optimal nutrients, while well water offered the environmental stimulus (mild stress) to increase oil concentration. In contrast, the lowest value was recorded for the interaction treatment (W2G), represented by (tap water irrigation + gypsum soil), with the lowest value for the trait at (286.6 mg/100g).

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**Table (3) Effect of Growing Media and Irrigation Water on Essential Oil Percentage (mg/100g)**

| Averages )(W | G gypsum soil | B Peat moss with gypsum | K Compost with gypsum | Type of addition / Water quality |
|---|---|---|---|---|
| 326.2 c | 337.7 d | 324.3 f | 316.7 h | W1 river water |
| 332.0 b | 286.6 i | 333.6 d | 375.8 c | W2 tap water |
| 371.6 a | 393.4 b | 324.1 g | 397.4 a | W3 well water |
| | 339.2 b | 327.3 c | 363.3 a | Averages |

**2- Effect of Growing Media, Irrigation Water, and Their Interaction on Methyl Benzoate Percentage**

The results shown in Table (4) indicate a significant effect of irrigation water quality on the methyl benzoate percentage in China pink plants. Treatment W3 (well water) significantly outperformed others, recording the highest mean of (2827). This was followed by treatment W2 (tap water) with a mean of (2776), while treatment W1 (river water) recorded the lowest mean of (2761).The results showed a significant superiority for growing medium K (compost with gypsum), which recorded the highest overall mean for the trait at (2839). This was followed by medium G (gypsum soil) with a mean of (2798), while medium B (peat moss with gypsum) recorded the lowest mean value of (2727).When examining the interaction between the two factors, we observe clear and significant differences. The highest value was recorded for the interaction treatment (W3K) (irrigation with well water + compost with gypsum medium), achieving the highest methyl benzoate percentage of (2899). Conversely, the lowest value was recorded for the interaction treatment (W2B) (irrigation with tap water + peat moss with gypsum medium), with a value of (2671).

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**Table (4) Effect of Growing Media and Irrigation Water on Methyl Benzoate Percentage**

| Averages )(W | G gypsum soil | B Peat moss with gypsum | K Compost with gypsum | Type of addition / Water quality |
|---|---|---|---|---|
| 27 61 c | 2786 d | 2767 f | 2731 h | W1 river water |
| 2776 b | 2768 e | 2671 i | 2887 b | W2 tap water |
| 2827 a | 2840 c | 2744 g | 2899 a | W3 well water |
| | 2798 a | 2727 c | 2839 a | Averages |

### 3- Effect of Growing Media, Irrigation Water, and Their Interaction on Camphene Percentage

The results showed a significant superiority for the well water treatment (W3), which recorded the highest mean camphene percentage of (1369), outperforming the tap water treatment (W2) which recorded (1342). The river water treatment (W1) recorded the lowest mean for the trait at (1302).When comparing the growing media, we observe that the compost with gypsum medium (K) significantly outperformed the other media, recording the highest mean of (1443). This was followed by the peat moss with gypsum medium (B) with a mean of (1292), while the gypsum soil medium (G) recorded the lowest mean of (1278). The interaction between water quality and growing medium showed significant and tangible differences, reflecting the plant's combined response to both factors together. The highest value was recorded for the interaction treatment (W3K), represented by (well water irrigation + compost with gypsum medium), achieving the highest camphene percentage of (1499). Conversely, the lowest value was recorded for the interaction treatment (W1B), represented by (river water irrigation + peat moss with gypsum medium), with a value of (1214).

**Table (5) Effect of Growing Media and Irrigation Water on Camphene Percentage**

| Averages )(W | G gypsum soil | B Peat moss with gypsum | K Compost with gypsum | Type of addition / Water quality |
|---|---|---|---|---|
| 1302 c | 1327 e | 1214 i | 1364 d | W1 river water |
| 1342 b | 1276 g | 1285 f | 1466 b | W2 tap water |
| 1369 a | 1231 h | 1376 c | 1499 a | W3 well water |
| | 1278 c | 1292 b | 1443 a | Averages |

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### 4- Effect of Growing Media, Irrigation Water, and Their Interaction on Salicylate Percentage

The results indicated that the well water treatment (W3) significantly outperformed others, recording the highest mean salicylate percentage of (1643.2). This was followed by the tap water treatment (W2) with a mean of (1580.6), while the river water treatment (W1) recorded the lowest mean of (1578.4).When examining the overall means for the media, we observe a significant superiority for the compost with gypsum medium (K), which recorded the highest mean of (1612.2). This was followed by the gypsum soil medium (G) with a very close mean of (1596.2), while the peat moss with gypsum medium (B) recorded the lowest mean of (1593.7). The interaction between the two study factors showed a clear and significant effect on the studied trait.The highest value was recorded for the interaction treatment (W3K), which is (well water irrigation + compost with gypsum medium), achieving the highest salicylate percentage of (1734.1), and was significantly superior to all other treatments. Conversely, the lowest value was recorded for the interaction treatment (W2K), which is (tap water irrigation + compost with gypsum medium), with a value of (1524.2).

**Table (6) Effect of Growing Media and Irrigation Water on Salicylate Percentage**

| Averages )(W | G gypsum soil | B Peat moss with gypsum | K Compost with gypsum | Type of addition / Water quality |
|---|---|---|---|---|
| 1578.4 c | 1582.8 f | 1574.2 h | 1578.4 g | W1 river water |
| 1580.6 b | 1594.2 d | 1623.6 b | 1524.2 i | W2 tap water |
| 1643.2 a | 1612.1 c | 1583.5 e | 1734.1 a | W3 well water |
| | 1596.2 a | 1593.7 c | 1612.2 a | Averages |

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## 5- Effect of Growing Media, Irrigation Water, and Their Interaction on Limonene Percentage

The results here showed a significant superiority for the tap water treatment (W2), which recorded the highest mean limonene percentage of (1841). This was followed by the well water treatment (W3) with a mean of (1794), while the river water treatment (W1) recorded the lowest mean of (1663).
The peat moss with gypsum treatment (B) recorded the highest mean limonene percentage of (1803), significantly outperforming the compost with gypsum treatment (K) by a slight margin, which recorded (1798). The gypsum soil treatment (G) ranked last with a mean of (1696). The interaction between water quality and growing media showed that, Highest Value: Despite gypsum soil (G) recording the lowest overall mean, its interaction with tap water (W2G) yielded the highest limonene percentage in the experiment at (1875). The lowest value was recorded for the interaction treatment (W1G), represented by (river water irrigation + gypsum soil), with a value of (1400).

**Table (7) Effect of Growing Media and Irrigation Water on Limonene Percentage**

| Averages )(W | G gypsum soil | B Peat moss with gypsum | K Compost with gypsum | Type of addition / Water quality |
|---|---|---|---|---|
| 1663 c | 1400 h | 1701 h | 1842 d | W1 river water |
| 1841 a | 1875 a | 1852 c | 1795 e | W2 tap water |
| 1794 b | 1769 f | 1857 b | 1756 g | W3 well water |
| | 1696 c | 1803 a | 1798 b | Averages |

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## Discussion

### I. Effect of Irrigation Water Quality (W):

Essential Oil and Active Compounds: Well water recorded the highest mean for essential oil percentage (371.6 mg/100g), carbohydrate percentage (39.36%), and was superior in the compound's methyl benzoate, camphene, and salicylates. This superiority is scientifically attributed to the fact that well water may contain certain salt concentrations that act as "mild salt stress," stimulating secondary metabolic pathways in the plant to increase the production of aromatic oils and defensive compounds as an adaptive mechanism (10).Chlorophyll and Limonene: In contrast, tap water (W2) excelled in total chlorophyll content (1.30 mg/g) and limonene percentage (1841). This is attributed to the low salt content in treated water reducing damage to the thylakoid membrane in chloroplasts, thereby maximizing the efficiency of building photosynthetic pigments and basic terpenes like limonene (11).

### II. Effect of Growing Media (M):

The growing media showed variation in supporting the qualitative growth of the plant:

Compost + Gypsum Medium (K): Proven highly efficient by recording the highest means for essential oil (363.3), methyl benzoate, camphene, and salicylates. Compost provides organic acids (Humic/Fulvic) that increase the availability of micronutrients, while gypsum acts as a source of sulfur necessary for synthesizing sulfur-containing amino acids that are building blocks for aromatic compounds (12).Gypsum Soil Medium (G): Significantly superior in carbohydrate content (38.42%) and total chlorophyll (1.21). This indicates the ability of the studied China pink variety to utilize the available calcium in gypsum soils to strengthen cell walls and increase photostability, positively reflecting on the accumulation of photosynthesis products (carbohydrates) (13).Peat Moss + Gypsum Medium (B): Although it ranked lowest in most traits, it excelled in limonene percentage (1803). This is due to the physical properties of peat moss (high porosity) which allow for optimal root aeration, stimulating the production of simple terpenes (14).

### III. Two-Way Interaction (Interaction Analysis):

Combination (W3K) - (Well Water + Compost & Gypsum): This was the best treatment for maximizing the yield of essential oil (397.4), methyl benzoate (2899), camphene (1499), and salicylates (1734.1). Reason: A synergy occurred between the high nutritional content of compost and the positive stress from well water, providing the energy and building blocks necessary for the biosynthesis of active compounds (14).Combination (W3G) - (Well Water + Gypsum Soil):Achieved the highest response in carbohydrate content (42.20%) and chlorophyll (1.36). Reason:The balance between the osmotic pressure of well water and the gypsum medium improved the Source-Sink balance, enhancing the efficiency of carbohydrate storage (15). This makes it the ideal combination for strong vegetative growth and efficient photosynthesis.

Combination (W2G): Achieved the highest limonene percentage (1875), clarifying that the response of limonene differs radically from other active components in its

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interaction with the study factors. **Reason:The interaction of freshwater with gypsum soil provided a relatively low Electrical Conductivity (EC) chemical environment, encouraging the pathway converting sugars to limonene instead of complex defensive compounds (16)

**Conclusion**

Well water (W3) played a stimulating role in the production of secondary metabolites, recording the highest values for essential oil percentage, carbohydrates, and active compounds (methyl benzoate, camphene, salicylates). This indicates that the potential mild salt stress in well water stimulated the plant to accumulate these compounds as a defense mechanism. Regarding the vital role of organic growing media, the study proved the efficiency of the compost + gypsum medium (K) in improving most vegetative growth indicators (plant height, stem diameter, leaf area) and root mass, in addition to its superiority in increasing essential oil yield and some active compounds (such as camphene and methyl benzoate). This is attributed to the role of organic matter in improving soil structure and increasing nutrient availability, making it a promising alternative to traditional media.

**Recommendations**

1. Conduct detailed studies on the salt concentrations in well water and determine the "critical threshold" that stimulates active compound production without significantly harming vegetative growth yield.

2. Study the economic feasibility of using locally produced compost as an alternative to imported peat moss in cultivating medicinal ornamental plants.

3. Test different concentrations of soil mixtures (different mixing ratios between gypsum and compost) to reach a combination that provides the optimal balance between vegetative growth and chemical content.

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