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*Article*

# The Effect of Biofertilization and Irrigation Water Type on the Growth of Two Varieties of Geranium Plants

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**Abstract:** A global experiment was conducted in a private nursery for the purpose of studying the effect of fertilization and biofertilization methods on the vegetative and flowering growth of two varieties of geranium plants. Three factors were used in the experiment, such as the first factor using two varieties of geranium (the white and the red variety), the second factor represented the use of 3 concentrations of Biohealth biofertilizer (0.0, 5.00 and 10.00 mg $L^{-1}$), while the third factor was the use of four types of irrigation water (tap, distill, well water and drainage water). Completely Randomized Design (C.R.D.), with three replicates for each treatment, each treatment contained three experimental units, with 3 pots for each experimental unit. Least Significant Difference (L.S.D.) was applied at the 0.05 level in data analysis. The results of the experiment showed that there were no significant differences between the two varieties on roots number and plant height, while it differed significantly in all other characteristics. Concentration was superior to all of the studied traits except for root length and plant height. Irrigation with distilled water produced a significant improvement in all characteristics except for root length, which was superior to the method of irrigation with well water.

**Keywords:** geranium plant, biofertilization, river water, drainage water

## 1. Introduction

Geranium (*Pelargonium grandiflorum* L.) belongs to the family Geraniceae, it is an evergreen herbaceous plant native to South Africa, characterized by its rapid growth [1]. It reaches a height of 20-40 cm, with many branches. The stems and branches are covered with very fine hair, it is best grown in shady, moist places [2]. It is either a plant with upright growth or an ink and fleshy branches with leaves of different shapes. Colors vary according to species and varieties, most of which are round in shape with serrated edges that tend to be red [3].

The flowers are either singly or in large pink inflorescences that appear almost throughout the year. Geranium plants are of high economic value, they are often used as potted plants and to decorate balconies, windows, and ponds [4]. It is also characterized by its medical and pharmaceutical importance, its leaf powder is used to protect against stinging insect bites, its leaves are also used in the treatment of rheumatic diseases [5].

Specialists found that the collateral damage caused by chemical fertilizers called for researchers, to think about environmentally safe alternatives, such as using biofertilizers to increase agricultural production, especially in nutrient-poor soils. Biofertilizers are defined as biomass resulting from the multiplication of microorganisms, which is added to the soil for the purpose of exploiting its vital activity to supply plants with part of their

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various nutritional needs, especially if this is combined with the quality of water used to irrigate plants after the great scarcity of irrigation water [6].

The study aimed to determine the effect of biological fertilization and water quality on the growth and flowering of two varieties of geranium plants.

## 2. Materials and Methods

The research was carried out in one of the private nurseries from March and August for the 2020 season, to study the effect of biological fertilization and irrigation water quality on root, vegetative and flower growth. Two varieties of geraniums, Alba, with white flowers, and Jersey, with large, compound red flowers.

The seeds were planted on 3/12/2020, in cork dishes (mesh) filled with peat moss agricultural medium (Table 1), after 40 days have passed from the date of planting, germination, and reaching the stage of the appearance of 3-4 true leaves on the seedlings. They were spread and planted in plastic pots with a diameter of 30 cm, it was filled with agricultural medium (river soil + peat moss) in a ratio of 1:1, one plant per pot under greenhouse conditions [7], after 15 days of separation and transportation, the plants were treated with Biohealth fertilizer on 5/15/2020. Adding soil to the growing medium in three additions, with a time difference of 21 days between each addition and the next.

The experiment was designed according to a Completely Randomized Design (C.R.D.). Three replicates for each treatment, and each replicate contained three experimental units, with three pots for each experimental unit. The data were analyzed using the least significant difference at the 5% probability level [8]. The first factor represented the cultivation of two types of geranium plants. The second factor was the use of three concentrations of Biohealth fertilizer (0.0, 5.0 and 10.0 mg $L^{-1}$). The third factor represented the use of four types of irrigation water (tap, distill, well and drainage water taken from one of the farms near the nursery).

**Table 1**. Physical and chemical characteristics of the peat moss used in the experiment

| Nitrate (N) | Ammonium | pH | E.C | N.P.K 12-14-24 | $P_2O_2$ (%) | $K_2O$ (%) | MgO (%) | Moisturizing media |
|---|---|---|---|---|---|---|---|---|
| 70 gm $kg^{-1}$ | 50 gm $kg^{-1}$ | 6.2 | 2-4 | 1000 mg $kg^{-1}$ | 140 | 240 | 28 | 175 ml $L^{-1}$ |

Produced by the Danish company Prindstrup

**The studied characteristics included the following:**

First: Root traits: They were measured at the end of the experiment and included:

1. Roots number (root $plant^{-1}$).
2. Root length (cm): It was measured using a metric ruler for one plant from each replicate in each treatment.

Second: Vegetative characteristics: It has been included

1. Plant height (cm): It was measured using a metric ruler when the flowers were fully opened and from the area in contact with the soil of the pot to the highest peak of the plant [4].
2. Leaves Number of (leaf $plant^{-1}$): It was measured after the plant reached the full flowering stage, specifically on 2/8/2020, at a rate of 3 leaves from the plant in each pot, in one replicate, and randomly, then the average number of one leaf was extracted.
3. Vegetative branches number (branch $plant^{-1}$).

Third: Floral traits: They were measured after the plants had fully flowered, specifically after the middle of July, when the plant began to flower and continued until the end of the month. The studied characteristics included the following:

1. The inflorescence flowers number in one (inflorescence plant$^{-1}$).
2. The flower number (flower plant$^{-1}$).

## 3. Results

### First/ Root traits

### Roots number (root plant$^{-1}$)

Table 2 indicated that there were no significant differences between the two varieties in the roots number. The Alba variety was the highest mean (10.39 roots plant$^{-1}$), compared to Jersey variety (10.25 roots plant$^{-1}$). As for the Biohealth fertilizer, significant differences were found in the same characteristic, the concentration of 10 mg L$^{-1}$ was significant superiority compare with the comparison treatment, which recorded the lowest mean (9.83 roots plant$^{-1}$), it did not differ significantly with the concentration treatment of 5 mg L$^{-1}$ (10.33 roots plant$^{-1}$). As for the type of irrigation water, irrigation with distilled water was significant superiority in this characteristic (13.11 roots plant$^{-1}$), this was superior to the two types of irrigation using well water and irrigation, without significant differences with irrigation treatment with tap water. The lowest rate was recorded when treated with irrigation with well water (7.39 roots plant$^{-1}$).

**Table 2**. Effect of fertilization method and irrigation water quality on the roots number for two varieties of geranium

| variety | Biohealth | Water type | | | | variety× |
|---|---|---|---|---|---|---|
| | Mg L$^{-1}$ | tap | distill | well | drainage | Biohealth |
| **Alba** | **0.00** | 11.67 | 12.33 | 6.67 | 7.33 | 9.50 |
| | **5.00** | 12.67 | 13.33 | 7.00 | 8.00 | 10.25 |
| | **10.00** | 13.67 | 14.33 | 8.33 | 9.33 | 11.42 |
| **Jersey** | **0.00** | 12.33 | 12.67 | 7.33 | 8.33 | 10.17 |
| | **5.00** | 13.33 | 12.67 | 7.00 | 8.67 | 10.42 |
| | **10.00** | 11.00 | 13.00 | 8.00 | 8.33 | 10.17 |
| **L.S.D$_{0.05}$ = 1.876** | | | | | | 0.938 |
| **variety× Biohealth** | | | | | | variety |
| **Alba** | | 12.67 | 13.33 | 7.33 | 8.22 | 10.39 |
| **Jersey** | | 12.22 | 12.89 | 7.44 | 8.44 | 10.25 |
| **L.S.D$_{0.05}$ = 1.083** | | | | | | N.S |
| **Biohealth× Water type** | | | | | | Biohealth |
| **0.00** | | 11.33 | 12.83 | 7.33 | 7.83 | 9.83 |
| **5.00** | | 13.00 | 13.00 | 7.00 | 8.33 | 10.33 |
| **10.00** | | 13.00 | 13.50 | 7.83 | 8.83 | 10.79 |
| **L.S.D0.05 = 1.326** | | | | | | 0.663 |
| **Water type** | | 12.44 | 13.11 | 7.39 | 8.33 | |
| **L.S.D$_{0.05}$** | | 0.766 | | | | |

The interaction of the variety with the biofertilizer Biohealth had a significant response on the same characteristic. The interaction (Alba variety × concentration of 10 mg

$L^{-1}$) was the highest mean (11.42 roots $plant^{-1}$), while the interaction (Alba variety × without treatment with Biohealth) recorded the lowest mean (9.50 roots $plant^{-1}$). A significant increase was also recorded resulting from the interaction of the variety with the quality of irrigation water. The interaction between (Alba variety × irrigation with distilled water) was the highest mean (13.33 roots $plant^{-1}$), while the lowest mean (7.33 roots $plant^{-1}$), was achieved when treated with the interaction (Alba cultivar × watered with well water).

The interaction of biological fertilization and irrigation water quality also achieved a significant effect when treated with the interaction (10 mg $L^{-1}$ × irrigation with distilled water), was the highest mean (13.50 roots $plant^{-1}$), compared with the interaction treatment (5 mg $L^{-1}$ × irrigation with well water), which gave mean of 7.00 roots $plant^{-1}$. The results of the table also showed that there was a significant increase in the roots number formed due to the triple interaction of factors for the experiment. The interaction (Alba variety × concentration of 10 mg $L^{-1}$ × watering with distilled water) gave a significant effect with the highest mean (14.33 roots $plant^{-1}$). The lowest rate was 6.67 roots $plant^{-1}$, which was achieved with the triple interaction treatment (Alba variety × without treatment with Biohealth × irrigation with well water).

**Root length (cm)**

Table 3 showed that there were significant differences between the two varieties in root length. The Jersey variety was significantly superior and achieved the highest rate of 20.39 cm, Alba variety recorded 19.06 cm. Biohealth fertilizer did not have a significant effect on this trait. As for the quality of irrigation water, irrigation with well water achieved significant superiority in this quality, it recorded an average of 21.00 cm, thus superior to the two types of irrigation with tap and distilled water, without having any significant differences with the treatment of irrigation with tap water. The lowest rate was recorded when irrigated with tap water at a rate of 17.78 cm.

The bilateral interaction between the variety and Biohealth produced a significant response in same trait. The interaction (Jersey variety × concentration of 5 mg $L^{-1}$) was the highest mean (21.08 cm), while the interaction (Alba variety × without treatment with Biohealth) recorded the lowest mean (18.58 cm). The results of the same table showed that there was a significant increase resulting from the interaction of the variety with the quality of irrigation water, the interaction between (Jersey variety × irrigation with well water) was the highest mean (21.56 cm), while the lowest mean (16.67 cm) was achieved when treated with the interaction (Alba variety × watered with tap water).

Significant differences were found when Biohealth and irrigation water quality interacted. The interaction treatment (10 mg $L^{-1}$ × irrigation with well water) achieved significant superiority, recording the highest mean (21.50 cm), comparison with the interaction treatment (0.0 mg $L^{-1}$ × irrigation with tap water), which gave the lowest mean (17.33 cm). The results of the same table also indicated that there was a significant increase in the above characteristic caused by the triple interaction of the factors combined. The interaction (Jersey variety ×concentration of 5 mg $L^{-1}$ × irrigation with well water) gave a significant effect, recording the highest mean (22.67 cm). The lowest rate was 16.00 cm, which was achieved when treated with the triple interaction (Alba variety × without treatment with fertilizer × irrigation with tap water).

**Table 3**. Effect of fertilization method and irrigation water quality on root length (cm) of two varieties of geranium

| variety | Biohealth | Water type | | | | variety× |
|---|---|---|---|---|---|---|
| | Mg $L^{-1}$ | tap | distill | well | drainage | Biohealth |
| **Alba** | **0.00** | 16.00 | 17.67 | 20.33 | 20.33 | 18.58 |
| | **5.00** | 16.67 | 18.33 | 20.67 | 21.00 | 19.17 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **10.00** | 17.33 | 19.67 | 20.33 | 20.33 | 19.42 |
| **Jersey** | **0.00** | 19.00 | 19.67 | 20.67 | 20.33 | 19.92 |
| | **5.00** | 19.00 | 20.67 | 22.67 | 22.00 | 21.08 |
| | **10.00** | 18.67 | 20.67 | 21.33 | 20.00 | 20.17 |
| | | **L.S.D$_{0.05}$ = 2.960** | | | | 1.480 |
| | | **variety× Biohealth** | | | | variety |
| **Alba** | | 16.67 | 18.56 | 20.44 | 20.56 | 19.06 |
| **Jersey** | | 18.89 | 20.33 | 21.56 | 20.78 | 20.39 |
| | | **L.S.D$_{0.05}$ = 1.709** | | | | 0.854 |
| | | **Biohealth× Water type** | | | | Biohealth |
| **0.00** | | 17.33 | 19.17 | 20.83 | 20.17 | 19.38 |
| **5.00** | | 17.83 | 19.00 | 20.67 | 20.67 | 19.54 |
| **10.00** | | 18.17 | 20.17 | 21.50 | 21.17 | 20.25 |
| | | **L.S.D0.05 = 2.093** | | | | N.S |
| **Water type** | | 17.78 | 19.44 | 21.00 | 20.67 | |
| **L.S.D$_{0.05}$** | | | 1.208 | | | |

**Second: Vegetative characteristics**

**Plant height (cm)**

Table 4 shows that there were no significant differences between the two varieties and the Biohealth biological fertilizer in plant height, as for the quality of irrigation water, irrigation with distilled water achieved significant superiority in this characteristic, recording mean of 59.17 cm, thus surpassing all types of irrigation. The lowest rate was recorded when treating irrigation with well water at a rate of 33.06 cm.

The binary interaction between the variety and Biohealth did not give a significant response in the same characteristic, while the results of the same table showed that there was a significant increase resulting from the interaction of the variety with the quality of irrigation water, the interaction (the two types × irrigation with distilled water) was the highest mean of 59.11 and 59.2 cm for both, while the lowest mean of 32.78 cm was achieved when treated with the interaction (Alba variety × irrigation with well water).

Significant differences were found when interacting with Biohealth fertilizer and irrigation water quality, the interaction treatment (10 mg $L^{-1}$ × irrigation with distilled water) achieved significant superiority, recording the highest mean (59.50 cm), compare with the interaction treatment (5.0 mg $L^{-1}$ × irrigation with well water), which gave the lowest mean (31.83 cm). The results of the same table also indicated that there was a significant increase in the same characteristic caused by the three-way interaction of the experimental factors. The interaction (Jersey variety × concentration of 5 mg $L^{-1}$ × irrigation with distilled water) gave a significant effect on this characteristic, as the highest mean (60.00 cm). The lowest rate was 31.67 cm, which was achieved with the triple interaction treatment (Alba variety × concentration of 5 mg $L^{-1}$ × irrigation with well water).

**Table 4**. Effect of fertilization method and irrigation water quality on plant height (cm) for two varieties of geranium

| **variety** | **Biohealth** | **Water type** | | | | **variety× Biohealth** |
|---|---|---|---|---|---|---|
| | **Mg $L^{-1}$** | **tap** | **distill** | **well** | **drainage** | |
| **Alba** | **0.00** | 50.00 | 58.33 | 34.00 | 37.67 | 45.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **5.00** | 48.67 | 59.33 | 31.67 | 38.67 | 44.58 |
| | **10.00** | 50.33 | 59.67 | 32.67 | 40.67 | 45.83 |
| **Jersey** | **0.00** | 48.67 | 58.33 | 32.00 | 37.00 | 44.00 |
| | **5.00** | 43.33 | 60.00 | 34.00 | 40.00 | 44.33 |
| | **10.00** | 50.00 | 59.33 | 34.00 | 37.00 | 45.08 |
| | | **L.S.D$_{0.05}$ = 4.864** | | | | N.S |
| | | **variety× Biohealth** | | | | variety |
| **Alba** | | 49.67 | 59.11 | 32.78 | 39.00 | 45.14 |
| **Jersey** | | 47.33 | 59.22 | 33.33 | 38.00 | 44.47 |
| | | **L.S.D$_{0.05}$ = 2.808** | | | | N.S |
| | | **Biohealth× Water type** | | | | Biohealth |
| **0.00** | | 46.67 | 59.17 | 34.00 | 38.83 | 44.67 |
| **5.00** | | 48.67 | 58.83 | 31.83 | 37.83 | 44.29 |
| **10.00** | | 50.17 | 59.50 | 33.33 | 38.83 | 45.46 |
| | | **L.S.D0.05 = 3.439** | | | | N.S |
| **Water type** | | 48.50 | 59.17 | 33.06 | 38.50 | |
| **L.S.D$_{0.05}$** | | | | 1.986 | | |

**Leaves number (leaf plant$^{-1}$)**

Table (5) shows that there are significant differences between the two varieties in the number of leaves. The Alba variety gave the highest mean (38.81 leaves plant$^{-1}$), compared to the Jersey variety (37.17 leaves plant$^{-1}$). As for the treatment with Biohealth, it resulted in a significant increase, with the concentration of 10 mg L$^{-1}$ recording the highest mean (40.17 leaves plant$^{-1}$), compared to 36.08 leaves plant$^{-1}$ for the comparison treatment. As for the quality of irrigation water, irrigation with distilled water achieved significant superiority in this characteristic, recording n mean of 46.39 leaves plant$^{-1}$, thus surpassing all types of irrigation. The lowest rate was recorded when treating irrigation with well water (33.28 leaves plant$^{-1}$).

The binary interaction between the variety and Biohealth recorded a significant response in the same trait. The interaction (Alba variety × concentration 10 mg L$^{-1}$) recorded a significant superiority with the highest mean (41.17 leaves plant$^{-1}$), compared to 35.08 leaves plant$^{-1}$ for the interaction treatment (Jersey variety × without treatment with Biohealth), while the results of the same table showed that there was a significant increase resulting from the interaction of the variety with the quality of irrigation water, the interaction (Alba variety × irrigation with distilled water) achieved the highest mean (47.67 leaves plant$^{-1}$), while the intervention treatment (Jersey variety × irrigation with well water) achieved the lowest mean of 32.67 leaves plant$^{-1}$.

Significant differences were found when Biohealth and irrigation water quality interacted. The interaction treatment (10 mg L$^{-1}$ × irrigation with distilled water) achieved significant superiority, recording the highest mean (50.00 leaves plant$^{-1}$), compared with the intervention treatment (0.0 mg L$^{-1}$ × irrigation with well water), which gave the lowest mean (31.33 leaves plant$^{-1}$). The results of the same table also indicated that there was a significant increase in the same characteristic caused by the triple interaction of the experimental factors. The interaction (Alba variety × concentration 10 mg L$^{-1}$ × irrigation with distilled water) gave a significant effect on this trait. The highest rate was 50.67 leaves plant$^{-1}$, while the lowest mean was 30.67 leaves plant$^{-1}$, which was achieved with the two triple-interaction treatments (Jersey variety × without treatment with fertilizer × irrigation with well water and drainage).

**Table 5**. Effect of fertilization method and irrigation water quality on the leaves number of two varieties of geranium

| variety | Biohealth | Water type | | | | variety× |
|---|---|---|---|---|---|---|
| | Mg $L^{-1}$ | tap | distill | well | drainage | Biohealth |
| **Alba** | **0.00** | 38.67 | 45.33 | 32.00 | 32.33 | 37.08 |
| | **5.00** | 38.67 | 47.00 | 33.33 | 33.67 | 38.17 |
| | **10.00** | 41.67 | 50.67 | 36.33 | 36.00 | 41.17 |
| **Jersey** | **0.00** | 37.00 | 42.00 | 30.67 | 30.67 | 35.08 |
| | **5.00** | 37.33 | 44.00 | 33.00 | 34.67 | 37.25 |
| | **10.00** | 38.00 | 49.33 | 34.33 | 35.00 | 39.17 |
| **L.S.D$_{0.05}$ = 4.021** | | | | | | 2.011 |
| **variety× Biohealth** | | | | | | variety |
| **Alba** | | 39.67 | 47.67 | 33.89 | 34.00 | 38.81 |
| **Jersey** | | 37.44 | 45.11 | 32.67 | 33.44 | 37.17 |
| **L.S.D$_{0.05}$ = 2.322** | | | | | | 1.161 |
| **Biohealth× Water type** | | | | | | Biohealth |
| **0.00** | | 37.83 | 43.67 | 31.33 | 31.50 | 36.08 |
| **5.00** | | 38.00 | 45.50 | 33.17 | 34.17 | 37.71 |
| **10.00** | | 39.83 | 50.00 | 35.33 | 35.50 | 40.17 |
| **L.S.D0.05 = 2.843** | | | | | | 1.422 |
| **Water type** | | 38.56 | 46.39 | 33.28 | 33.72 | |
| **L.S.D$_{0.05}$** | | 1.642 | | | | |

**Vegetative branches number (branch $plant^{-1}$)**

Table 6 indicates that the variety has a significant effect on the number of vegetative branches. The Alba variety was the highest mean (5.472 branch $plant^{-1}$), thus significantly superior to the Jersey variety, which gave mea of 4.972 branch $plant^{-1}$. As for the effect of Biohealth, the results of the same table showed that there were significant differences between the concentrations used according to the experimental conditions, the concentration treatment of 10 mg $L^{-1}$ was the highest rate of 5.792 branch $plant^{-1}$. It was superior to the two concentration treatments of 5 mg $L^{-1}$ and the comparison treatment, which recorded the lowest mean (4.583 branch $plant^{-1}$). The quality of irrigation water had a significant effect on the aforementioned characteristic, so the irrigation treatment with distilled water recorded the highest mean (6.889 branch $plant^{-1}$), this exceeds all other treatments, while the irrigation treatment with well water recorded the lowest mean (3.667 branch $plant^{-1}$).

As for the interaction of the variety and Biohealth, the interaction of the Alba variety with a concentration of 10 mg $L^{-1}$ recorded the highest mean (6.250 branch $plant^{-1}$), compared to the interaction treatment (Jersey variety × without fertilizer treatment), which recorded the lowest mean (4.500 branch $plant^{-1}$). The interaction of the variety with the quality of irrigation water had a significant effect on the same trait. The interaction (Alba variety × irrigation with distilled water) recorded the highest mean (7.222 branch $plant^{-1}$), this exceeds all treatments, while the interaction (Jersey variety × with irrigation with well water) recorded the lowest mean (3.333 branch $plant^{-1}$). As for the interaction of Biohealth and the quality of irrigation water, the highest mean of interaction (10 mg $L^{-1}$ × with irrigation with distilled water) was recorded at 7.667 branch $plant^{-1}$, this surpasses all other treatments compared to the intervention treatment (0.0 mg $L^{-1}$ × irrigation with well water), with the

lowest mean of 3.167 branch plant$^{-1}$. The same table showed that the triple interaction has a significant effect on the vegetative branches number. The intervention (Alba variety × concentration of 10 mg L$^{-1}$ × watering with distilled water) recorded a significant superiority over all treatments according to the conditions of the experiment by recording the highest mean of 8.333 branch plant$^{-1}$, on the other hand, the interaction (Jersey variety × without treatment with Biohealth × irrigation with well water) gave the lowest mean of 3.000 branch plant$^{-1}$.

**Table 6**. Effect of fertilization method and irrigation water quality on the number vegetative branches of two varieties of geranium

| variety | Biohealth | Water type | | | | variety× |
|---|---|---|---|---|---|---|
| | Mg L$^{-1}$ | tap | distill | well | drainage | Biohealth |
| **Alba** | **0.00** | 5.000 | 6.333 | 3.333 | 4.000 | 4.667 |
| | **5.00** | 6.333 | 7.000 | 4.000 | 4.667 | 5.500 |
| | **10.00** | 6.667 | 8.333 | 4.667 | 5.333 | 6.250 |
| **Jersey** | **0.00** | 5.333 | 6.000 | 3.000 | 3.667 | 4.500 |
| | **5.00** | 6.667 | 6.667 | 3.333 | 3.667 | 5.083 |
| | **10.00** | 6.000 | 7.000 | 3.667 | 4.667 | 5.333 |
| | | **L.S.D$_{0.05}$ = 1.077** | | | | 0.539 |
| | | **variety× Biohealth** | | | | variety |
| **Alba** | | 6.000 | 7.222 | 4.000 | 4.667 | 5.472 |
| **Jersey** | | 6.000 | 6.556 | 3.333 | 4.000 | 4.972 |
| | | **L.S.D$_{0.05}$ = 0.622** | | | | 0.311 |
| | | **Biohealth× Water type** | | | | Biohealth |
| **0.00** | | 5.167 | 6.167 | 3.167 | 3.833 | 4.583 |
| **5.00** | | 6.500 | 6.833 | 3.667 | 4.167 | 5.292 |
| **10.00** | | 6.333 | 7.667 | 4.167 | 5.000 | 5.792 |
| | | **L.S.D0.05 = 0.762** | | | | 1.422 |
| **Water type** | | 6.000 | 6.889 | 3.667 | 4.333 | |
| **L.S.D$_{0.05}$** | | | 0.440 | | | |

**Third: Floral characteristics**

**Flower inflorescences number (inflorescences flower$^{-1}$)**

Table 7 showed that there were significant differences between the two varieties on the flower inflorescences number. The Alba variety gave the highest mean (2.139 inflorescences plant$^{-1}$), compared to the Jersey variety, which recorded 1.583 inflorescences flower$^{-1}$. Treatment with Biohealth resulted in a significant increase, with the concentration of 5 mg L$^{-1}$ recording the highest mean (1.958 inflorescences plant$^{-1}$) compared to 1.792 inflorescences flower$^{-1}$ for the comparison treatment. As for the quality of irrigation water, irrigation with distilled water achieved significant superiority in this characteristic, achieving mean of 2.722 inflorescences plant$^{-1}$, this surpasses all types of irrigation, but the lowest rate was recorded when irrigated with well water, with mean of 1.111 inflorescences plant$^{-1}$.

The binary interaction between the variety and Biohealth recorded a significant response in the same characteristic. The interaction (Alba variety × concentration 10 mg L$^{-1}$) recorded a significant superiority with the highest mean (2.250 inflorescences flower$^{-1}$). In

exchange for 1.500 inflorescences plant$^{-1}$for the interaction treatment (Jersey variety × without treatment with Biohealth), while the results of the same table showed a significant increase resulting from the interaction of the variety with the quality of irrigation water, the interaction (Alba variety × watering with distilled water) achieved the highest mean of 3.000 inflorescences plant$^{-1}$, while the interaction treatment (Jersey variety × irrigation with well water) achieved the lowest rate of 1.000 inflorescences plant$^{-1}$.

Significant differences were found when the Biohealth and irrigation water quality interacted. The intervention treatment (5 mg L$^{-1}$ × irrigation with distilled water) achieved significant superiority, recording the highest mean of 3.167 inflorescences plant$^{-1}$, compared with the interaction treatment (5 mg L$^{-1}$ × watering with tap water), which gave the lowest mean of 1.500 inflorescences plant$^{-1}$. The results of the same table also indicated that there was a significant increase in the above characteristic caused by the triple interaction of the experimental factors. The interaction (Jersey variety × concentration 10 mg L$^{-1}$ × watering with distilled water) had a significant effect on the number of flower inflorescences, as the highest mean was recorded at 3.000 inflorescences plant$^{-1}$, as for the lowest rate, it was 1.000 inflorescences plant$^{-1}$, which was achieved with the triple interaction treatments (the Alba variety × without treatment with fertilizer and irrigation with well water, and the Jersey variety without treatment with fertilizer × irrigation with well water), and the two treatments (the Jersey variety × the concentration of 5 mg L$^{-1}$ × irrigation with well water and irrigation) and the treatment (the variety Jersey × concentration 10 mg L$^{-1}$ × irrigation with well water).

**Table 7**. Effect of fertilization method and irrigation water quality on the flower inflorescences number of two geranium varieties

| variety | Biohealth | Water type | | | | variety× |
|---|---|---|---|---|---|---|
| | Mg L$^{-1}$ | tap | distill | well | drainage | Biohealth |
| **Alba** | **0.00** | 2.667 | 3.333 | 1.000 | 1.333 | 2.083 |
| | **5.00** | 2.667 | 2.333 | 1.333 | 1.667 | 2.083 |
| | **10.00** | 2.667 | 2.333 | 1.333 | 2.000 | 2.250 |
| **Jersey** | **0.00** | 1.667 | 2.000 | 1.000 | 1.333 | 1.500 |
| | **5.00** | 2.000 | 2.333 | 1.000 | 1.000 | 1.583 |
| | **10.00** | 1.333 | 3.000 | 1.000 | 1.333 | 1.667 |
| | | **L.S.D$_{0.05}$ = 0.441** | | | | 0.221 |
| | | **variety× Biohealth** | | | | variety |
| **Alba** | | 2.667 | 3.000 | 1.222 | 1.667 | 2.139 |
| **Jersey** | | 1.667 | 2.444 | 1.000 | 1.222 | 1.583 |
| | | **L.S.D$_{0.05}$ = 0.255** | | | | 0.127 |
| | | **Biohealth× Water type** | | | | Biohealth |
| **0.00** | | 2.167 | 2.167 | 1.167 | 1.667 | 1.792 |
| **5.00** | | 2.000 | 3.167 | 1.167 | 1.500 | 1.958 |
| **10.00** | | 2.333 | 2.833 | 1.000 | 1.167 | 1.833 |
| | | **L.S.D0.05 = 0.312** | | | | 0.160 |
| **Water type** | | 2.167 | 2.722 | 1.111 | 1.444 | |
| **L.S.D$_{0.05}$** | | 0.180 | | | | |

**Flowers number (flower plant$^{-1}$)**

Table 8 show that there were significant differences between the two varieties in the number of flowers. The Jersey variety gave the highest mean of 15.28 flower plant$^{-1}$, compared to the Alba variety (12.03 flower plant$^{-1}$). Treatment with the Biohealth fertilizer did not cause a significant increase in the aforementioned trait. In contrast to the quality of irrigation water, irrigation with distilled water achieved significant superiority in this characteristic by recording the highest mean (18.56 flower plant$^{-1}$), this exceeds all types of irrigation, but the lowest mean was recorded when treating irrigation with well water, with a rate of 10.11 flower plant$^{-1}$.

The results of the same table indicated the presence of a significant effect caused by the bilateral interaction between the variety and the biological fertilizer. The interaction (Jersey variety × concentration 10 mg L$^{-1}$) recorded a significant superiority with the highest mean (15.75 flower plant$^{-1}$), compared to 11.83 flower plant$^{-1}$ for the interaction treatment (Alba cultivar × without treatment with Biohealth).

The interaction of the variety with the quality of irrigation water also achieved a significant effect when treated (Jersey variety × watered with distilled water), recording the highest mean (21.89 flower plant$^{-1}$), while the interaction treatment (Alba cultivar × watering with well water) achieved the lowest mean (8.67 flower plant$^{-1}$). Significant differences were found when the biological fertilizer and irrigation water quality interacted. The interaction treatment (5 mg L$^{-1}$ × irrigation with distilled water) achieved significant superiority, recording the highest mean (19.17 flower plant$^{-1}$), cmpared with the interaction treatment (0.0 mg L$^{-1}$ × watering with tap water), which gave the lowest mean (9.33 flower plant$^{-1}$). The results of the same table also indicated that there was a significant increase in the above trait caused by the triple interaction of the experimental factors. The interaction (Jersey variety × without treatment with fertilizer × watering with distilled water) gave a significant effect on the number of flowers, the highest mean was 22.67 flower plant$^{-1}$, while the lowest × was 8.33 flower plant$^{-1}$)], which was achieved with the two triple interaction treatments (Alba variety × concentrations 5 and 10 mg L$^{-1}$ × irrigation with well water).

**Table 8**. Effect of fertilization method and irrigation water quality on the flowers number for two varieties of geranium

| variety | Biohealth | Water type | | | | variety× |
|---|---|---|---|---|---|---|
| | Mg L$^{-1}$ | tap | distill | well | drainage | Biohealth |
| Alba | 0.00 | 12.67 | 14.33 | 9.33 | 11.00 | 11.83 |
| | 5.00 | 14.33 | 15.67 | 8.33 | 9.67 | 12.00 |
| | 10.00 | 13.67 | 15.67 | 8.33 | 11.33 | 12.25 |
| Jersey | 0.00 | 13.67 | 22.67 | 11.67 | 12.00 | 15.00 |
| | 5.00 | 14.67 | 21.33 | 10.33 | 14.00 | 15.08 |
| | 10.00 | 13.00 | 21.67 | 12.67 | 15.67 | 15.75 |
| L.S.D$_{0.05}$ 1.506 | | | | | | 0.753 |
| variety× Biohealth | | | | | | variety |
| Alba | | 13.56 | 15.22 | 8.67 | 10.67 | 12.03 |
| Jersey | | 13.78 | 21.89 | 11.56 | 13.89 | 15.28 |
| L.S.D$_{0.05}$ = 0.870 | | | | | | 0.435 |
| Biohealth× Water type | | | | | | Biohealth |
| 0.00 | | 14.50 | 18.50 | 9.33 | 11.83 | 13.54 |
| 5.00 | | 13.67 | 19.17 | 10.00 | 11.67 | 13.62 |
| 10.00 | | 12.83 | 18.00 | 11.00 | 13.33 | 13.79 |

| | | | | | |
|---|---|---|---|---|---|
| | **L.S.D0.05 = 1.065** | | | | N.S |
| **Water type** | 13.67 | 18.56 | 10.11 | 12.28 | |
| **L.S.D$_{0.05}$** | | | 0.615 | | |

## 4. Discussion

The significant difference resulting from the difference in the two varieties may be due to the genotype, which distinguishes each variety from the other and thus the difference in its genetic characteristics [3]. The reason for the significant superiority may be attributed to the contribution of the biological fertilizer represented by the addition of Biohealth extract, provide the necessary nutrients by containing many fungal species and Trichoderma fungi. Microorganisms work to fix the important nitrogen element in building amino acids and proteins, which the plant needs, in addition to its role in causing physical and chemical changes in the soil, contributes to improving its tissue and fertility, microorganisms also contribute to the secretion of many important enzymes and growth regulators such as auxins, gibberellins, vitamins and hormones, increase the growth of the root and vegetative systems of plants, it is positively reflected in increased plant growth and development.

Biofertilizers also play an important role in increasing soil stability by increasing soil concentrations, as a result, it secretes binders and multiple sugars that help retain nutrients, prevents its leakage away from root absorption areas by acting like protein bridges. The superiority of the studied characteristics may also be due to the role of the quality of irrigation water used in the research experiment, irrigation with distilled water produced a noticeable improvement in most characteristics, it may be because it is free of harmful compounds and salts and contains most of the nutrients in appropriate proportions [3].

On the contrary, there is a decrease in vegetative and flowering growth, the negative effect caused by irrigation with well water and drainage may be attributed to its osmotic effect, because it contains high levels of harmful salt compounds, which subsequently causes an increase in the osmotic pressure of the soil solution resulting from an increase in the percentage of dissolved salts in the growing medium, causes a deficit in the absorption and readiness of water by the plant [5], root membranes prevent or repel the entry of some ions by increasing the salinity of the water or the growing medium in them, as well as its effect through ionic toxicity, caused by dissolved salts, which affect the hormonal and nutritional balance of the plant [9].

## 5. Conclusion

The findings of this study revealed that the variety of geranium and the type of irrigation water significantly affect the growth and flowering characteristics of geranium plants, with distilled water producing superior results in most traits except for root length. The use of Biohealth biofertilizer significantly enhanced the number of roots and leaves, as well as the number of vegetative branches and flower inflorescences, demonstrating the beneficial role of biofertilizers in improving plant growth. These results underscore the importance of selecting appropriate irrigation water and biofertilization methods to optimize plant health and productivity. Further research is recommended to explore the long-term impacts of these treatments and to investigate the underlying mechanisms by which biofertilizers and water quality interact to influence plant development. This study has important implications for horticultural practices, particularly in regions with limited water quality, highlighting the potential for biofertilizers to mitigate the adverse effects of poor water quality.

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