Effect of spraying with organic and liquid fertilizer on vegetative and flowering growth and active components of Calendula officinalis L.

Wajeeha Musa Issa
Aljamieuh of Basra - College of Agriculture – Dept. of Horticulture and Landscape
Wajeehahalfaragh@gmail.com

Abstract

The experiment was conducted in the agricultural season 2022-2023 in the fabric shade of the College of Agriculture - Aljamieuh of Basrah, as the experiment aimed to study the effect of spraying with organic fertilizer and Aljamieuh fertilizer on the vegetative and Flowering growth of Calendula officinal is plant. The experiment included 9 factorial treatments in which two factors interacted: foliar spraying with organic fertilizer at three concentrations of zero, 4, 6 g. L-1 and spraying with Aljamieuh fertilizer at concentrations of zero, 5, 10 mg. L-1, and the spraying was in three batches with an interval of 15 days between each batch.Spraying with organic fertilizer at a concentration of 6 mg. L-1 led to a significant increase in plant height, number of lateral branches, number of leaves, percentage of dry matter of the vegetative group, number of flowers, flower diameter and percentage of dry matter in flowers, while this concentration caused a significant delay in flowering. Spraying plants with organic fertilizer at a concentration of 4 mg.L-1 led to a significant increase in the number of petals. Spraying with Aljamieuh fertilizer at the highest concentration of 10 mg.L-1 led to a significant increase in plant height, number of lateral branches, number of leaves, percentage of dry matter of the vegetative group, number of flowers, number of petals, flower diameter, and percentage of dry matter in flowers, while this concentration caused a significant delay in flowering. The bilateral interactions had a significant effect on all the traits under experiment.

The highest number of active compounds was recorded in plants treated with organic fertilizer, which amounted to 41 compounds, while the treatment with liquid fertilizer recorded the number of active chemical compounds 37 compounds compared to the control treatment, which had 35 compounds.

Key word: spraying, organic and liquid, fertilizer and flowering

Introduction

Calendula officinalis L. is a medium-height plant belonging to the Asteraceae family. It is contains many medically active compounds. The roots are white-yellow to light brown in color, about 20 cm long and 7 mm thick, and carry many root branches (Al-Mayah et al., 2016). The stem is long and strong, reaching 30 cm. The leaves are simple, spoon-shaped, and oblong, 15-20 cm long, dark green in color. The flowers are a compound inflorescence with a main axis ending in a round disc, on the outer edges of which there are a number of yellow or orange ray flowers. The original habitat is the Mediterranean basin and it grows wild in southern and central Europe, North Africa, and Canada, and is cultivated in most parts of the Arab world. Its flowers were used to treat joint diseases and as an antidote to poisons. It was grown in homes to repel flies and was used in garden and

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flower bed landscaping due to the cultivar of colors of its flowers. (Hamad and Juma, 2000.(

Recent research has focused on plant extracts and seaweeds as a safe alternative to industrial growth regulators due to its natural components, as it does not leave a negative effect on humans and the environment, and its benefit in increasing the plant's resistance to diseases and stimulating the plant's growth and development (Al-Dajwi, 2002). One of the modern techniques that have recently become widespread as a biostimulant for physiological functions in plants is spraying with foliar organic fertilizer with seaweed extracts, as it is characterized by its effectiveness as a fertilizer in many garden crops because it contains stimulants and plant hormones necessary for growth, which in turn causes an increase in the strength of plant growth and an increase in the absorption of nutrients and resistance to freezing and diseases, which is reflected in the increase in plant production and improvement of its quality (Daoud et al.,2013). Most of them consist of important compounds such as vitamins, minerals and amino acids, as they contain protein between (4-25) % of the dry weight (Al-Miyah and Al-Hameem,1991). Abdel Fattah et al. (2019) showed the effect of compost fertilization on some growth and productivity measurements of the yellow cultivar of Calendula officinalis , as it was noted that treatment with NPK chemical fertilizer gave the highest vegetative and chemical measurements, and gave values close to plants treated with compost. Essaa (2023) studied the effect of spraying with humic acid and active yeast suspension on the vegetative and Flowering growth of Calendula officinalis L. Spraying with humic acid at a concentration of 4 mg. L-1 led to a significant increase in plant height, number of lateral branches, percentage of dry matter of the vegetative group, number of flowers, number of petals, flower diameter, flower stalk length, and percentage of dry matter in flowers, while this concentration caused a significant delay in flowering. Spraying with active yeast suspension at the highest concentration of 6 mg. L-1 led to a significant increase in plant height, number of lateral branches, number of leaves, number of flowers, number of petals, flower diameter, and percentage of dry matter in flowers, while this concentration caused a significant delay in flowering. The study of Ismail et al. (2023) showed the effect of some safe natural and bio fertilizers on the growth and productivity of Calendula officinal is plant, as the results confirmed that treatment with biological fertilizer gave the best results for vegetative, chemical and crop growth during the two growing seasons.

Materials and methods

Study location and implementation

The experiment was conducted in the cloth shade (covered with Saran cloth) of the College of Agriculture/Aljamieuh of Basra, Karma Ali site for the agricultural season 2022-2023.

It included planting Calendula officinalis L. seeds brought from one of the agricultural equipment and seed shops in Baghdad. The seeds were planted on 10/15/2018 in 205-cell cork plates filled with a growing medium consisting of German peat moss only, produced by Kekila Company at a concentration of 4%. After the seeds were fully germinated, i.e. three days after planting, and after two to three pairs of leaves were formed, they were separated into pots with a diameter of 10 cm after filling them with a culture medium prepared from a mixture of agricultural soil that was sterilized with formaldehyde at a concentration of 4%

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according to the method of Al-Saeed and Al-Douri (1982) and peat moss at a ratio of 1:2 (Hassan, 2009) respectively, with one plant per pot.

Experimental design and statistical analysis

The experiment was implemented according to the Randomized Complete Block Design (R.C.B.D) with a factorial experiment, which included 9 factorial treatments, which are combinations between spraying with organic fertilizer at three concentrations (0, 4, 6) mg. L-1 Table (1), and liquid Aljamieuh fertilizer at three concentrations (0, 5, 10) mg. 1 L-1 Table (2) and with three replicates for each treatment, thus the number of experimental units is 27 experimental units, then the results were analyzed using analysis of variance and the Revised Least Significant Differences Test (R.L.S.D) was chosen by comparing the averages at a probability level of 0.05 (Al-Rawi and Khalaf Allah, 2000.(

Experimental treatments

The experiment included studying the effect of two factors and their bi- interactions

First: Spraying plants with organic fertilizer at three concentrations:

0-1non-treatment (control.(

4-2mg. L-1.

6-3mg. L-1

Second: Spraying plants with liquid Aljamieuh fertilizer at three concentrations:

0-1non-treatment (control.(

5-2mg. L-1.

10-1mg. L-1

Table (1) Components of ALGIDEX organic fertilizer

Quantity	Components	No.	Quantity	components	No.
160	Manganese	8	37.5 $g.L^{-1}$	Organic Matter	1
10	Cobalt	9	12.5	Proteins	2
120	Molybdenum	10	67$mg.L^{-1}$	Nitrogen	3
540	Magnesium	11	67 $mg.L^{-1}$	Phosphorus	4
150	Boron	12	67 $mg.L^{-1}$	Potassium	5
100	Calcium	13	550 $mg.L^{-1}$	Iron	6
60	Copper	14	450 $mg.L^{-1}$	Zinc	7

Table (2) Some components of Aljamieuh fertilizer

Percentage	Components	No.
%5	Nitrogen	1
%5	Phosphorus	2
%7	Potassium	3
0.5%	Magnesium	4
0.5%	Potassium Humate	5

Aqueous solutions of both organic fertilizer and liquid Aljamieuh fertilizer were prepared at the required concentrations and a few drops of Tween-20 were added to each of them. Then the plants were treated by spraying on the leaves using a hand sprayer until completely wet, at a rate of three sprays during the growing season as follows:

1- The first spray after ten days of rotation.

2- The second spray after 15 days from the first spray.

3- The third spray after 15 days from the second spray.

Service operations

All agricultural operations followed in growing Calendula officinal is plants were

carried out completely and for all experimental units whenever necessary, including irrigation, weeding and weeding.

Experimental measurements

Vegetative growth indicators: All experimental measurements of vegetative growth indicators were taken when the plant reached the stage of full flowering on all experimental plants and included the following characteristics.

Plant height (cm): The height of each plant in the experimental unit was measured from the soil surface to the top of the plant using a measuring tape and its average was recorded.

Number of lateral branches. Plant-1: The number of lateral branches of each plant in the experimental unit was calculated and its average was recorded.

Number of leaves. Plant-1: The total number of leaves was calculated for each plant in the experimental unit and its average was recorded

Percentage of dry matter of the vegetative growth (%): After taking the fresh weight of the vegetative growth of the plants after separating it from the root mass, it was then placed in paper bags in an electric oven at a temperature of 70°C for 48 hours until the weight was fixed, then its weight was recorded and the percentage of dry matter was calculated according to the following equation:

Dry weight of the vegetative growth (g)

Percentage of dry matter of the vegetative growth % = × 100

Fresh weight of the vegetative growth (g)

Flowering growth indicators

Date of first bud appearance (day): The number of days required from planting the seeds until the first flower bud appears for each plant in the experimental unit was calculated and its average was recorded.

Date of first color appearance (day): The number of days required from planting the seeds until the first color of the flower bud appears for each plant in the experimental unit was calculated and its average was recorded.

Date of first flower opening (day): The number of days required from planting the seeds until the first flower opens for each plant of the experimental unit was calculated and its average was recorded.

Number of flowers. Plant-1: The number of flowers opened in each plant of the experimental unit was calculated and its average was recorded.

Flower diameter (cm): The diameter of the flowers formed in each plant of the experimental unit taken at full opening and crosswise was measured by Vernea and its average was recorded.

Number of petals. Flower-1: The number of petals for five flowers for each plant of the experimental unit was calculated and its average was recorded.

Flower stem length (cm): The length of the flower stem of each plant of the experimental unit was measured from the point of contact of the flower stem with the stem to the base of the flower for each plant of the experimental unit and its average was recorded.

Percentage of dry matter in flowers (%)

Three flowers were taken randomly from each plant of the experimental unit and their fresh weight was recorded. They were placed in paper bags in an electric oven at 70°C for 48 hours until the weight was fixed. Then their weight was recorded and the percentage of dry matter was calculated according to the following equation:

Percentage of dry matter of flowers % = (Dry weight of flowers (g))/(Fresh weight of flowers (g)) × 100

Results and discussion

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Table (3) that spraying plants with organic fertilizer had a significant effect on the height of Calendula officinal is plant at a concentration of 6 mg/L, as it gave the highest plant height of (44.12) cm, compared to the control plants, which reached 10.42 cm. The reason is due to the nitrogen content of the organic fertilizer, which plays a role in protein synthesis. It is noted from the same table that the spraying treatments with Aljamieuh liquid fertilizer achieved a significant increase in the plant height at a concentration of 10 mg/L, as it gave the highest plant height of (12.64) cm, compared to the control treatment, which gave the lowest height of (9.38) cm. This increase may be attributed to the Aljamieuh liquid fertilizer containing potassium (Table 2), which is an osmotic regulator that plays an effective role in the process of opening and closing the stomata, which is reflected in the increase in water and nutrient absorption that works to activate the photosynthesis process and increase its products and its effect on cell elongation and division, which leads to an increase in plant height (Devlin and Witham, 1998). The same table shows that the two-way interaction between organic fertilizer and Aljamieuh fertilizer had a significant effect on this trait, as plants sprayed with organic fertilizer at a concentration of 6 mg.L-1 and Aljamieuh fertilizer at a concentration of 10 mg.L-1 gave the highest height of 13.50 cm compared to the lowest height of 9.00 cm resulting from the control plants.

Table (3). Effect of spraying with organic fertilizer and Aljamieuh fertilizer in mg.L-1 on the height of Calendula officinalis plant (cm)

Organic fertilizer effect average	Aljamieuh fertilizer concentration			Organic fertilizer concentration
	10	5	0	
10.42	12.10	10.17	9.00	0
11.36	12.33	11.73	10.00	4
12.44	13.50	13.33	10.50	6
2.66 1.53				L.S.D
	12.64	11.74	9.83	Aljamieuh fertilizer effect average
		1.53		L.S.D

Table (4) shows that spraying organic fertilizer had a significant effect on the number of lateral branches of Calendula officinalis plant at a concentration of 10 mg/L, as it gave the highest number of lateral branches of the plant, reaching (6.89) branches, compared to control treatment, which reached 5.00 branches. The reason for the increase in lateral branches when using organic fertilizer may be due to its containing nitrogen, which stimulates the plant to produce tokinins that have a clear effect in stimulating new lateral growths of the side buds (Al-Ani, 1987). This is consistent with what Al-Samarrai and Hassan (2012) found on the Jaafari plant. It is noted from the same table that spraying treatments with liquid Aljamieuh fertilizer achieved a significant increase in the number of lateral branches of the plant at a concentration of 10 mg/L, as it gave the largest number, reaching (6.67) branches, compared to control treatment, which gave the lowest number of branches, reaching (5.00) branches. This increase may be due to the content of the Aljamieuh liquid fertilizer of essential nutrients (Table 2) that are important for plant growth and added as a spray on the leaves, which are the center of many vital

activities, especially phosphorus and nitrogen, which enter into the composition of proteins, enzyme cofactors and nucleic acids that stimulate the formation of cytokinins, which in turn encourage rapid cell division and construction, which is reflected in improving the characteristics of vegetative growth. The same table shows that the two-way interaction between organic fertilizer and Aljamieuh fertilizer had a significant effect on this trait, where the plants sprayed with organic fertilizer at a concentration of 6 mg.L-1 and Aljamieuh fertilizer at a concentration of 10 mg.L-1 gave the largest number of lateral branches of the plant, reaching 7.33 branches, compared to the smallest number, reaching 3.67 branches, resulting from the control plants

Table (4). The effect of spraying with organic fertilizer and Aljamieuh fertilizer mg.L-1 on the number of lateral branches of Calendula officinalis plant (branch.plant-1)

Organic fertilizer effect average	Aljamieuh fertilizer concentration			Organic fertilizer concentration
	10	5	0	
5.00	6.00	5.33	3.67	0
5.78	6.67	6.00	4.67	4
6.89	7.33	6.67	6.67	6
1.86 1.07				L.S.D
	6.67	6.00	5.00	معدل تأثير سماد الجامعة
		1.07		L.S.D

It is noted from Table (5) that spraying organic fertilizer had a significant effect on the number of leaves of Calendula officinal is plant at a concentration of 10 mg/L, as it gave the highest number of leaves per plant, reaching 65.30 leaves, compared to the control plants, which reached 40.00 leaves. This may be due to the organic fertilizer content of seaweed extract and nutrients such as nitrogen, phosphorus and potassium, as well as some growth regulators and polyamines that lead to improving vegetative growth, which is reflected in the phenotypic traits, including an increase in the number of leaves (Al-Sahaf, 1989). This is consistent with what Al-Asadi (2016) found on the freesia plant. It is noted from the same table the significant effect of spraying with liquid Aljamieuh fertilizer on the number of leaves per plant, where the number of leaves increased in plants sprayed with liquid Aljamieuh fertilizer at a concentration of 5 mg/L and 10 mg. The number of leaves per plant was not significantly different between the two treatments, as it reached 62.80 and 60.90 leaves, respectively, compared to control treatment, which gave the lowest number of 35.00 leaves. This increase may be due to the content of the Aljamieuh liquid fertilizer on potassium humate, which has a physiological effect completely similar to the effect of cytokinin, which affects the encouragement of plant growth. The same table shows that the two-way interaction between organic fertilizer and Aljamieuh fertilizer had a significant effect on this trait, as the plants sprayed with organic fertilizer at a concentration of 6 mg.L-1 and Aljamieuh fertilizer at a concentration of 10 mg.L-1 gave the largest number of leaves per plant, reaching 82.30 leaves, compared to the lowest number of 29.00 leaves, which resulted from control treatment .

It is noted from Table (6) that the plants sprayed with organic fertilizer at a concentration of 6 mg/L showed a significant superiority in the percentage of dry matter of the vegetative growth of Calendula officinalis

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plant, as it reached 9.83% compared to the control plants, which reached 8.65%. This may be due to the organic fertilizer content of seaweed extract, which works to provide part of the plant's nitrogen needs and contributes to building protein inside it through its content of free amino acids. It also helps to improve the efficiency of photosynthesis processes inside the leaf (Abdul Hafeez, 2011). This is consistent with what was found by (Kadhim, 2012) on the geranium plant. It is noted from the same table that the plants sprayed with Aljamieuh liquid fertilizer at a concentration of 10 mg/L were superior in this characteristic, as it reached 9.95%, compared to the control treatment, which gave the lowest percentage of 8.37%. This increase may be attributed to Aljamieuh liquid fertilizer content of potassium, which plays an important role in accelerating the transfer of all manufactured materials to storage sites. The same table shows that the two-way interaction between organic fertilizer and Aljamieuh fertilizer was significant in this trait if the plants sprayed with organic fertilizer at a concentration of 6 mg.L and Aljamieuh fertilizer at a concentration of 10 mg.L gave the highest percentage of 11.68% compared to the lowest percentage of J 7.36 produced by control treatment .

It is noted from Table (7) that spraying plants with organic fertilizer at a concentration of 6 mg/L led to a significant delay in the flowering date, which reached 101.6 (days after planting) compared to the control plants, which reached 112.1 (days after planting). The reason for this may be due to the role of natural extracts from algae and seaweeds, which provide the plant with natural stimulants, such as cytokinins, auxins, gibberellins, amino acids, and proteins, which led to encouraging growth and thus early flowering (Al-Ani 1987). It is noted from the same table that spraying plants with Aljamieuh fertilizer at a concentration of 10 mg/L led to a significant delay in the flowering date, which reached 103.00 (days after planting) compared to the control plants, which reached 109.2 (days after planting). The reason is due to equipping the plants with the necessary elements for their growth, which was reflected in improving the growth of the vegetative group and thus increasing photosynthesis, which led to early flowering. It is noted from the same table that the two-way interaction between the experimental factors had a significant effect on this trait, as the plants sprayed with organic fertilizer at a concentration of 6 mg.L-1 and Aljamieuh fertilizer at a concentration of 10 mg.L were early in the flowering date, which reached 98.00 (days after planting) compared to the control plants, which reached 123.3 (days after planting .(

It is noted from Table (8) that spraying plants with organic fertilizer at a concentration of 6 mg/L led to a significant increase in the number of flowers, which reached 13.33 (flowers/plant), compared to the control plants, which reached 5.44 (flowers/plant). The reason for the increase in the number of flowers in the plant is due to the components of the organic fertilizer from the herbal extract and what it contains of nutrients, including iron and manganese and their role in the process of photosynthesis and energy-rich compounds, thus increasing the production of nutrients within the plant, which leads to encouraging plant growth and increasing the number of flowers (Al-Samarrai and Hassan, 2012). It is noted from the same table that spraying plants with Aljamieuh fertilizer at a concentration of 10 mg/L led to a significant increase in the number of flowers

(flowers/plant). The reason is that spraying Aljamieuh fertilizer provides plants with the necessary elements for their growth, which was reflected in improving the growth of the vegetative group and thus increasing photosynthesis, which led to an increase in the number of flowers. It is noted from the same table that the two-way interaction between the experimental factors had a significant effect on this trait, as the number of flowers increased in plants sprayed with organic fertilizer at a concentration of 6 mg.L and Aljamieuh fertilizer at a concentration of 10 mg.L-1, reaching 16.67 (flowers. plants) compared to control plants, which reached 1.67 (flowers. plants.(

Table (5). The effect of spraying with organic fertilizer and Aljamieuh fertilizer in mg.L-1 on the number of leaves of Calendula officinalis plant (leaf.plant-1)

Organic fertilizer effect average	Aljamieuh fertilizer concentration			Organic fertilizer concentration
	10	5	0	
40.00	42.70	48.3	29.00	0
53.30	57.70	67.30	35.00	4
65.30	82.30	72.70	41.00	6
15.97 9.22				L.S.D
	60.90	62.80	35.00	معدل تأثير سماد الجامعة
		9.22		L.S.D

Table (6). The effect of spraying with organic fertilizer and Aljamieuh fertilizer mg.L-1 on the percentage of dry matter of the green mass of Calendula officinalis plant (%)

Organic fertilizer effect average	Aljamieuh fertilizer concentration			Organic fertilizer concentration
	10	5	0	
8.65	8.46	10.14	7.36	0
9.14	9.72	8.98	8.72	4
9.83	11.68	8.78	9.04	6
1.83 1.06				L.S.D
	9.95	9.30	8.37	معدل تأثير سماد الجامعة
		1.06		L.S.D

Table (7). The effect of spraying with organic fertilizer and Aljamieuh fertilizer mg.L-1 on the date of the first flower opening of Calendula officinalis plant (day)

Organic fertilizer effect average	Aljamieuh fertilizer concentration			Organic fertilizer concentration
	10	5	0	
112.1	105.7	107.3	123.3	0
105.7	106.3	107.3	103.3	4
101.6	98.00	106.3	101.0	6
2.16 1.13				L.S.D
	103.00	107.0	109.2	معدل تأثير سماد الجامعة
		2.16		L.S.D

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Table (8). The effect of spraying with organic fertilizer and Aljamieuh fertilizer in mg.L-1 on the number of flowers of Calendula officinalis plant (flowers. plants-1)

Organic fertilizer effect average	Aljamieuh fertilizer concentration			Organic fertilizer concentration
	10	5	0	
5.44	10.67	4.00	1.67	0
10.00	14.33	8.33	7.33	4
13.33	16.67	12.33	11.00	6
6.55 3.78				L.S.D
	13.89	8.22	6.67	معدل تأثير سماد الجامعة
		3.78		L.S.D

Table (9) shows that spraying plants with organic fertilizer at a concentration of 4 mg/L led to a significant increase in the number of petals, which reached 315 (petals/plant), compared to the control plants, which reached 209 (petals/plant). The reason for the increase in the number of petals in the plant is due to the organic fertilizer content of nutrients, including iron and manganese, and their role in the photosynthesis process and the entry of nitrogen and phosphorus into energy-rich compounds, thus increasing the production of nutrients within the plant that stimulate growth. It is noted from the same table that spraying plants with Aljamieuh fertilizer at a concentration of 10 mg/L led to a significant increase in the number of petals (petals/plant). The reason may be due to the fact that spraying Aljamieuh fertilizer provides plants with the necessary elements for growth, which led to improving the growth of the vegetative and root system, thus increasing the amount of carbohydrate materials accumulated in plant tissues, which in turn pushes plants to good Flowering growth (Al-Jalabi, 2001). It is noted from the same table that the two-way interaction between the experimental factors had a significant effect on this trait, as the number of petals in the flowers of the plants sprayed with organic fertilizer at a concentration of 6 mg.L-1 and Aljamieuh fertilizer at a concentration of 10 mg.L-1 increased to 352 (petals. plant) compared to the control plants, which reached 168 (petals. plant .(

It is noted from Table (10) that spraying the plants with organic fertilizer at a concentration of 6 mg/L led to a significant increase in flower diameter, which reached 7.50 cm, compared to the control plants, which reached 6.95 cm. The reason for the increase in flower diameter is due to the role of natural extracts and seaweeds in providing natural stimulants such as amino acids, proteins and cytokinins, which encourage cell division and elongation, which is reflected in increased growth represented by an increase in flower diameter (Al-Ani, 1987). It is noted from the same table that spraying the plants with Aljamieuh fertilizer at a concentration of 10 mg/L led to a significant increase in flower diameter of 7.70 cm compared to the control plants of 6.83 cm. The reason may be that spraying Aljamieuh fertilizer provides plants with the necessary elements for growth, which led to improving the growth of the vegetative and root system, and thus increasing the amount of carbohydrates accumulated in plant tissues, which in turn pushes plants to good Flowering growth (Al-Jalabi, 2001). It is noted from the same table that the two-way interaction between the experimental factors had a significant effect on this trait, as the flower

diameter of the plants sprayed with organic fertilizer at a concentration of 6 mg.L-1 and Aljamieuh fertilizer at a concentration of 10 mg.L-1 increased to 7.67 cm compared to the control plants, which reached 6.03 cm.

Table (11) showed that spraying plants with organic fertilizer at a concentration of 6 mg/L led to a significant increase in the percentage of dry matter of flowers, which reached 14.80%, compared to the control plants, which reached 12.50%. The reason for the increase in flower diameter may be due to the role of the organic fertilizer content of the necessary compounds to encourage growth and manufacture carbohydrates and their accumulation in flowers, as they are a center of attraction and attraction for nutrients (Al-Sahaf, 1989). It is noted from the same table that spraying the plants with the Aljamieuh fertilizer at a concentration of 10 mg.L-1 led to a significant increase in the percentage of dry matter of the flowers, which reached 15.71% compared to control treatment, which reached 12.28%. The reason may be that spraying the Aljamieuh fertilizer provides the plants with the necessary elements for growth, which led to improving the growth of the vegetative and root system, and thus increasing the amount of carbohydrate materials accumulated in the plant tissues (Al-Jalabi, 2001). It is noted from the same table that the two-way interaction between the experimental factors had a significant effect on this trait, as the percentage of dry matter of the flowers increased for the plants that were sprayed with organic fertilizer at a concentration of 6 mg.L-1 and Aljamieuh fertilizer at a concentration of 10 mg.L-1, reaching 18.61% compared to control treatment, which reached 11.17%.

The effect of different treatments on the active chemicals in Calendula officinalis plant

Table (12) and Figure (1) show the effect of spraying with organic fertilizer and liquid fertilizer on the active chemical compounds in Calendula officinalis plant extract, as the highest number of compounds was recorded in the plants treated with organic fertilizer, which amounted to 41 compounds, while the treatment with liquid fertilizer recorded the number of active chemical compounds of 37 compounds compared to the control treatment, which had 35 compounds.

The resulting chemical compounds also differed in their concentration rate, some of which had a high concentration and others decreased, and some of them disappeared from two treatments compared to the control, and new compounds appeared in the treatments to which Calendula officinalis plant was exposed (Table 12). The reason for this may be that organic fertilizers that nourish plants increase the activity of plant growth as well as the plant's absorption of water, thus increasing the efficiency of the photosynthesis process, which leads to the production of new secondary compounds or increasing the concentrations of the compounds present in it.

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Table (9). The effect of spraying with organic fertilizer and Aljamieuh fertilizer at mg.L-1 on the number of petals of Calendula officinalis plant (petal. plant-1)

Organic fertilizer effect average	Aljamieuh fertilizer concentration			Organic fertilizer concentration
	10	5	0	
209	269	191	168	0
315	352	290	302	4
244	229	231	273	6
126.6 73.1				L.S.D
	284	237	248	معدل تأثير سماد الجامعة
		73.1		L.S.D

Table (10): The effect of spraying with organic fertilizer and Aljamieuh fertilizer at mg.L-1 on the flower diameter of Calendula officinalis plant (cm)

Organic fertilizer effect average	Aljamieuh fertilizer concentration			Organic fertilizer concentration
	10	5	0	
6.95	7.50	7.33	6.03	0
7.48	7.93	7.67	6.83	4
7.50	7.67	7.00	7.63	6
1.243 0.717				L.S.D
	7.70	7.00	6.83	معدل تأثير سماد الجامعة
		0.717		L.S.D

Table (11). The effect of spraying with organic fertilizer and Aljamieuh fertilizer mg.L-1 on the percentage of dry matter of the flowers of Calendula officinalis plant (%)

Organic fertilizer effect average	Aljamieuh fertilizer concentration			Organic fertilizer concentration
	10	5	0	
12.50	13.66	12.68	11.17	0
13.02	14.86	12.76	11.45	4
14.80	18.61	11.53	14.24	6
2.63 1.52				L.S.D
	15.71	12.32	12.28	معدل تأثير سماد الجامعة
		1.52		L.S.D

Table (12): The effect of different treatments on the active chemicals in Calendula officinal is plant.

Liquid	**Organic**	**control**	**Chemical compounds**
21.066	-	33.683	.beta.-Sitosterol
-	16.562	21.762	1,2-Benzenediol, 3,5-bis(1,1-dimethylethyl)-
16.445	17.292	16.651	1,2-Bis(trimethylsilyl)benzene
14.121	15.136		1,3-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
5.952	5.568	5.497	1,4-Butanediamine
9.536	9.021	9.075	1-Heptadecanamine
8.256	6.854	5.366	1-Hexanamine
8.712	8.611	7.795	1-Octanamine
7.733	-	5.882	2,6-Dimethyldecane

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Liquid	Organic	control	Chemical compounds
16.255	18.621		2'-Hydroxy-5'-methylacetophenone, TMS derivative
10.436	-	8.431	2-Isopropoxyethyl propionate
7.430	-	6.912	3,4-Furandiol, tetrahydro-, cis-
7.203	7.541	-	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-
6.907	6.835	6.476	5-Hydroxymethylfurfural
13.228	13.085	11.507	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-
20.158	19.660	18.439	Arsenous acid, tris(trimethylsilyl) ester
6.091	7.234		Benzaldehyde
21.829	22.488	21.725	Benzo[h]quinoline, 2,4-dimethyl-
6.832	5.647	5.473	Butane, 1,1-diethoxy-
5.834	5.651	4.771	Butane, 1,1-diethoxy-3-methyl-
10.558	12.071		Cycloheptasiloxane, tetradecamethyl-
20.156	-	19.377	Cyclohexanehexanoic acid, .epsilon.-oxo-
12.144	12.951	11.743	Cyclononasiloxane, octadecamethyl-
-	14.055	13.305	Dichloroacetic acid, heptadecyl ester
10.704	-	12.556	Diethyl-di(prop-2-enyl)-silane
-	6.981	6.514	Diglycolamine
6.531	6.425	6.357	Ethyl hydrogen succinate
11.632	11.495	10.120	Hexadecane
12.477	12.461	12.415	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester
18.401	18.129	16.756	Hexasiloxane, tetradecamethyl-
11.906	10.585		l-Gala-l-ido-octose
-	9.491	8.878	N,N-Dimethylsuccinamic acid
14.175	14.372		N-[3-[N-Aziridyl]propylidene]-3-dimethylaminopropylamine
11.265	11.265	11.265	Neophytadiene
11.766	11.766	11.766	n-Hexadecanoic acid
9.103	7.553		Nonadecane
-	8.491	7.733	Nonane
8.295	7.931		Nonane, 5-butyl-
-	10.119	9.836	Octane, 2-methyl-
-	9.331	10.494	Pentanoic acid, 1-methylethyl ester
10.721	11.054		Phenol, 2,5-bis(1,1-dimethylethyl)-
18.605	18.605	18.605	Stigmasterol
-	6.004	4.194	Styrene
-	11.738	11.187	Sulfurous acid, pentadecyl 2-propyl ester
7.498	7.552	6.498	Tridecane
6.259	7.658		Urethane
37	41	35	Total

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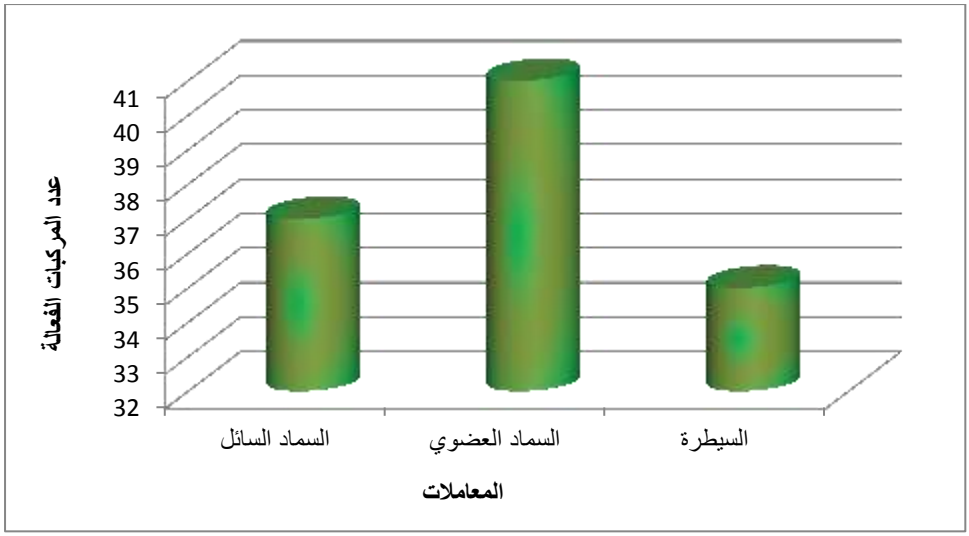

Figure (1): Effect of organic fertilizer and liquid fertilizer on the active chemical compounds in the extract of Calendula officinalis plant

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