EFFECT OF GIBBERELLIC ACID, CHELATED IRON COCONUT LIQUID IN SOME FLOWERING GROWTH TRAITS AND THE VOLATILE OIL YIELD FOR Jasminum sambac (L.) Ait PLANT.

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ABSTRACT

The study was conducted during the two growth seasons (2015-2016 and 2016-2017) at the production nursery (Saran) belonging to the Research Station, College of Agriculture, University of Basrah, Qarmat Ali city. The study aimed to investigate the effect of spraying Gibberellic Acid (GA3), chelated Iron and Coconut liquid on some flowering growth indicators and volatile oil yield of Jasminum sambac (L.) Ait. The study included 27 factorial treatments, It included combinations of three factors, namely, Gibberellic acid with three concentrations of (0, 150, 300 mg. L^{-1}), the chelated Iron with three concentrations of (0, 50, 100 mg. L^{-1}) and Coconut liquid with three concentrations of (0, 15, 30%). The Complete Randomized Block Design was used, with three replicates for each treatment. Thus, the number of experimental units is 81 experimental units, with a rate of 6 plants per experimental unit. So, the number of plants used in the experiment is 486 plants. The averages were Compared according to the Revised Least Significant Difference (R.L.S.D.) Test at probability level of 0.05. The following are the main results:

1- Spraying plants with Gibberellic acid at a concentration of (300 mg. L^{-1}) led to a significant increase in the number of flowers and total flower yield and the volatile oil yield and the fresh weight for flowers, in the first season and when spraying it with a concentration of (150 or 300 mg. L^{-1}) led to a significant increase in the percentage of volatile oil for the two seasons of study, and fresh weight for flowers in the second season.
2- Jasminum sambac (L.) Ait plant responded to spraying with chelated iron, spraying it with a concentration of (100 mg. L^{-1}) led to a significant increase in the number of flowers, the fresh weight of the flowers, total flower yield, the percentage of volatile oil and the volatile oil yield for the two study seasons.
3- The spraying of plants with coconuts at a concentration of 30% had a significant effect on the number of flowers, total flowers yield and volatile oil yield for the two study seasons, When spraying it with a concentration of (15% or 30%) led to a significant increase in the percentage of volatile oil for the two study seasons.
4- Bi-interactions and triple interactions had a significant effect for most flowering growth indicators and volatile oil yield for the two study seasons.

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تأثير حامض الجبرليك والحديد المخلبي وسائل جوز الهند في بعض صفات النمو الزهري وحاصل الزيت العطري الطيار لنبات الرازقي . *Jasminum sambac* (L.) Ait .

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الخلاصة

أجريت الدراسة خلال موسمي النمو 2015-2016 و2016-2017 في الظلة القماشية التابعة لمحطة أبحاث كلية الزراعة –جامعة البصرة –موقع كرمة علي . استهدفت الدراسة معرفة تأثير الرش بحامض الجبرليك والحديد المخلبي وسائل جوز الهند في بعض

مؤشرات النمو الزهري وحاصل الزيت العطري الطيار لنبات الرازقي ***Jasminum sambac*** (L.) Aiton تضمنت الدراسة 27 معاملة عامليه شملت توليفات من ثلاث عوامل هي حامض الجبرليك بثلاث تراكيز (0 و 150 و300) ملغم. لتر$^{-1}$ والحديد المخلبي بثلاث تراكيز (0 و 50 و 100) ملغم. لتر$^{-1}$ وسائل جوز الهند بثلاث تراكيز (0 و 15 و30)% استعمل تصميم القطاعات العشوائية الكاملة بتجربة عامليه بثلاث عوامل وبثلاث مكررات لكل عامل وبهذا تكون عدد الوحدات التجريبية 81 وحدة تجريبية وبواقع 6 نباتات لكل وحدة تجريبية وبهذا يكون عدد النباتات المستخدمة بالتجربة 486 نبات . قورنت المتوسطات حسب اختبار اقل فرق معنوي معدل عند مستوى احتمالية 0.05 وفيما يلي اهم النتائج التي تم التوصل اليها: أدى رش النباتات بحامض الجبرليك بتركيز 300 ملغم. لتر$^{-1}$ الى زيادة معنوية في عدد الازهار و حاصل الازهار الكلي وحاصل الزيت العطري الطيار والوزن الطري للأزهار، في الموسم الأول وعند رشه بتركيز 150 او 300 ملغم. لتر$^{-1}$ أدى الى زيادة معنوية في النسبة المئوية للزيت الطيار لموسمي الدراسه، والوزن الطري للأزهار في الموسم الثاني . استجاب نبات الرازقي للرش بالحديد المخلبي فقد أدى رشه بتركيز 100 ملغم. لتر$^{-1}$ الى زيادة معنوية في عدد الازهار والوزن الطري للأزهار وحاصل الازهار الكلي والنسبة المئوية للزيت العطري الطيار وحاصل الزيت العطري الطيار لموسمي الدراسه، كان لرش النباتات بسائل جوز الهند بتركيز 30% تأثير معنوي في عدد الازهار وحاصل الازهار الكلي وحاصل الزيت العطري الطيار ولموسمي الدراسة وعند رشه بتركيز 15% او 30% أدى الى زيادة معنوية في النسبة المئوية للزيت العطري الطيار ولموسمي الدراسة . كان للتداخلات الثنائية والثلاثية تأثير معنوي لمعظم مؤشرات النمو الزهري وحاصل الزيت العطري الطيار ولموسمي الدراسة .

***بحث مستل من رسالة دكتوراه للباحث الاول**

1. INTRODUCTION

Jasminum sambac (L.) Ait follows the oleaceae family. The Jasminum genus contains about 300 species distributed in Asia, Africa, Europe and the region of Pacific Ocean [1]. The original habitat of the jasmine plant is the Mediterranean region, the Levant, North Africa, India and China. The interest with jasmine plant is attributed to its many benefits in the medical, aromatic and cosmetic fields. Its flowers contain a lot of essential oil, which is called jasmine oil, which contains almost 100 ingredients according to the environment in which it grows. The compounds responsible for the fragrance include benzyl acetate, benzyl alcohol and linalool [2]. Jasmine oil is considered one of the most expensive oils to be used in the manufacture of cosmetics, perfumes, soap and pharmaceutical industry [3]. The effect of spraying of Gibberellic acid is not limited to vegetative parts, but is also effective in influencing flowering. The research shows that the Gibberellic acid has an impact in the flowering of most plants, but the extent of their effect varies depending on the adding method and its quantity, as well as the influence of some external factors such as temperature and light and the development stage of the plant [4]. The [5] showed When she added the chelated iron to the Gardenia plant at concentrations of (40, 60, 80, 100 mg. flowerpot^{-1}) led to a significant increase in the number of flowers for the plant and the number of petals for flowers, especially when added at the concentration of (80, 100 mg.flowerpot^{-1}). The experiment aims to study the extent of the response of the Jasmine plant to spraying with both the Gibberellic acid, the chelated iron and the coconut liquid in some flowering growth indicators and volatile oil yield.

2. MATERIALS AND METHODS

The study was conducted at the production nursery (Saran) belonging to the Research Station, College of Agriculture, University of Basrah, Qarmat Ali city, and for two consecutive seasons from 1/11/2015 to 1/11/2017. The study included 27 factorial treatments, It included combinations of three factors, namely, Gibberellic acid with three concentrations of (0, 150, 300 mg. L^{-1}), the chelated Iron with three concentrations of (0, 50, 100 mg. L^{-1}) and Coconut liquid with three concentrations of (0, 15, 30%). The aqueous solutions were prepared for it and were sprayed on the plant three times between one spray and another is one month. The Complete Randomized Block Design was used, with three replicates for each treatment. Thus, the number of experimental units is 81 experimental units,

with a rate of 6 plants per experimental unit. So, the number of plants used in the experiment is 486 plants. The experimental measurements included the number of flowers (flower.plant^{-1}), fresh weight for flowers (g) and flowers yield (flower), which is calculated according to the following equation: fresh weight for flowers × total number of flowers for the plant, and the percentage of the volatile oil which extracted by organic solvents method (Hussein, 1979), it was estimated according [6] to the following equation:

$$\text{The volatile oil (g)} = \frac{\text{The weight of the oil sample (g)}}{\text{Sample weight (g)}} \times 100$$

The volatile oil yield, which was calculated according to the following equation:

The volatile oil yield (g) = the percentage of volatile oil × total plant flowers.

3. RESULT AND DISCUSSION

The number of Flowers (flower.plant^{-1})

Table (1) shows the plants that treated with Gibberellic acid at a concentration of (300 mg. L^{-1}) was significantly excelled in the number of their flowers for the two study seasons, which amounted of (23.12, 22.88 flower. plant^{-1}), respectively, compared to the plants the control treatment that amounted of (19.39, 19.28 flower. plant^{-1}), respectively. As for the treating plants with chelated iron, the plants treated with (100 mg. L^{-1}) of chelated iron was significantly excelled in the number of flowers and for the two study seasons, which amounted of (22.38, 21.93 flower. plant^{-1}), respectively, compared to the plants of the control treatment that amounted of (20.40, 20.52 flower. plant^{-1}), respectively. As for spraying with coconut liquid, the plants treated with 30% coconut liquid was significantly excelled in the number of flowers and for the two study seasons, which amounted of (23.49, 22.88 flower. plant^{-1}), respectively, compared to the plants of the control treatment that amounted of (19.39, 19.18 flower. plant^{-1}), respectively. The significant increase in the number of flowers for the plants when spraying it with coconut liquid may be explained by its significant effect in increasing the number of primary and secondary branches and thus increasing the number of flowers. Table (1) shows the significant effect for the plants treated with Gibberellic acid at a concentration of (300 mg. L^{-1}) and the chelated iron at a concentration of (100-mg.L^{-1}) gave the highest number of flowers and for the two study seasons amounted of (24.06, 23.64 flower. plant^{-1}), respectively, compared to the plants of the control treatment which amounted of (19.86, 18.79 flower. plant^{-1}), respectively. The bi-interaction between the spraying treatment with Gibberellic acid and the coconut liquid had a significant effect on the number of flowers, where the bi-interaction between the plants treated with Gibberellic acid at a concentration of (300 mg. L^{-1}) and the spraying with coconuts liquid at a concentration of 30% was significantly excelled in the increase the number of flowers and for the two study seasons, which amounted of (23.74, 24.02 flower.plant^{-1}), respectively, compared to the lowest number of flowers for the plants of the control treatment, which amounted of (17.43, 16.93 flower.plant^{-1}). As for the effect of the bi-interaction between the two spraying factors with the chelated iron and the coconut liquid was significant in the trait of the number of flowers, where the plants treated with chelated iron at a concentration of (100 mg.L^{-1}) and the coconut liquid at a concentration of 30% gave the highest number of flowers amounted of (24.36, 23.59 flower.plant^{-1}) for the two study seasons, respectively, compared to the lowest number of flowers fromed by the control treatment plants amounted of (18.41 flower.plant^{-1}) for the first season and plants treated with chelated iron at a concentration of (50 mg.L^{-1}) only amounted of (18.56 flower.plant^{-1}) for the second season. As for the triple interaction, it had a significant effect in this trait, where the plants treated with the Gibberellic acid at the concentration of (300 mg.L^{-1}), the chelated iron at the concentration of (100 mg.L^{-1}) and the Coconut liquid at the

concentration of 30% by forming it the highest number of flowers amounted of (24.67 flower.plant^{-1}) compared to the lowest number of flowers recorded by plants that did not treating with any of the three solutions, which amounted to (16.44 flower.plant^{-1}).

Table 1: Effect of the Spraying with Gibberellic Acid, chelated iron and the Coconut liquid and their interactions in the number of Flowers (flower.plant^{-1}) for the jasmine Plant for both Study Seasons (2015-2016, 2016-2017).

Gibberellic Acid (mg.L^{-1})	Chelated Iron (mg.L^{-1})	First season				Second season			
		Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)	Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)
		0	**15**	**30**		**0**	**15**	**30**	
0	0	17.40	19.50	22.67	19.86	16.44	18.25	21.67	18.79
	50	17.22	20.67	22.75	20.21	16.67	19.25	20.66	18.86
	100	17.66	19.87	23.90	20.48	17.67	20.55	22.34	20.19
150	0	18.16	19.00	22.67	19.94	17.77	19.75	21.76	19.76
	50	19.78	21.66	23.67	21.70	18.36	20.67	22.72	20.58
	100	20.60	22.76	24.50	22.62	20.65	20.45	24.75	21.95
300	0	19.66	21.75	22.80	21.40	21.67	22.66	24.75	23.03
	50	21.16	22.67	23.75	22.53	20.66	23.75	23.63	22.68
	100	22.90	24.60	24.67	24.06	22.76	24.50	23.67	23.64
R.L.S.D 0.05		**1.322**			**0.763**	**1.297**			**0.749**
Average effect of Coconut liquid		19.39	21.39	23.49		19.18	21.09	22.88	
R.L.S.D 0.05		**0.440**				**0.432**			
Effect of interaction Gibberellic acid and coconut liquid					**Average effect of Gibberellic acid**	**Effect of interaction Gibberellic acid and coconut liquid**			**Average effect of Gibberellic acid**
0		17.43	20.01	23.11	20.18	16.93	19.35	21.56	19.28
150		19.51	20.14	23.61	21.11	18.93	20.29	23.08	20.76
300		21.24	23.01	23.74	22.66	21.69	23.64	24.02	23.12
R.L.S.D 0.05		**0.763**			**0.440**	**0.749**			**0.432**
Effect of interaction Chelated Iron and coconut liquid					**Average effect of Chelated Iron**	**Effect of interaction Chelated Iron and coconut liquid**			**Average effect of Chelated Iron**
0		18.41	20.08	22.71	20.40	18.63	20.22	22.73	20.52
50		19.39	21.67	23.39	21.48	18.56	21.22	22.34	20.71
100		20.39	22.41	24.36	22.38	20.36	21.83	23.59	21.93
R.L.S.D 0.05		**0.763**			**0.440**	**0.749**			**0.432**

The fresh weight of flowers (g)

Table (2) indicates the superiority of the plants treated with Gibberellic acid at a concentration of (300 mg.L^{-1}) in fresh weight of the flowers, which amounted to (2.22 g) compared to the plants of control treatment, which amounted to (1.99 g). As for the second season, the plants that treated with Gibberellic acid at the concentration of (150 or 300 mg.L^{-1}) has significantly excelled in the fresh weight of the flowers, which amounted to (2.13, 2.11 g),

respectively, compared to the plants of control treatment, which amounted to (1.98 g). The spraying of Gibberellic acid may be explained by the activation of cell division and its expansion by increasing the decomposed starch by increasing the elasticity of the wall and thus expanding the cells by increasing the cell's Osmosis content, thereby increasing their absorption of water [7]. As for plants treated with Chelated iron, the same table showed a significant superiority for the plants treated with (100 $mg.L^{-1}$) Chelated iron which the average fresh weight of their flowers amounted of (2.26 g) compared to the plants of the control treatments which recorded (1.97 g) in the first season, In the second season, there was a significant superiority of plants treated with Chelated iron with a concentration of (100 $mg.L^{-1}$) in fresh weight of their flowers, which amounted of (2.19 g) compared to the control plants, which recorded (1.95 g). As for the spraying with coconut liquid, the results showed the same table to the absence of a significant effect in this and both seasons of the study. Table (2) shows the significant effect for the interaction between the two study factors (the spraying with Gibberellic acid and Chelated iron) in the fresh weight of flowers. The plants of the first season that treated with Gibberellic acid at a concentration of (300 $mg.L^{-1}$) and Chelated iron with a concentration of (50 $mg.L^{-1}$) gave the highest fresh weight for its flowers amounted of (2.29 g), compared to the lowest fresh weight for the flowers of the control plants which amounted of (1.84 g), In the second season, the plants were treated with Gibberellic acid at concentration of (150 $gm.L^{-1}$) and the Chelated iron at concentration of (100 $mg.L^{-1}$) gave the highest fresh weight for the flowers, which amounted to (2.24 g) compared to the plants of the control treatment which amounted of (1.88 g). As for the bi-interaction between the spraying with the Gibberellic acid and coconut liquid had a significant effect in this trait, The plants of the first season and the treating with Gibberellic acid at concentration of (300 $mg.L^{-1}$) and the Coconut liquid with a concentration of 30% characterized by the highest fresh weight for the flowers amounted of (2.26 g) compared to the plants of the control treatment which amounted of (1.91 g), In the second season, the plants were treated with Gibberellic acid at concentration of (150 $gm.L^{-1}$) and the coconut liquid at concentration of (30%) gave the highest fresh weight for the flowers, which amounted to (2.22 g) compared to the plants of the control treatment which amounted of (1.97 g). The bi-interaction between the spraying with Chelated iron and coconut liquid had a significant effect in this trait. The plants that were sprayed with Chelated iron at a concentration of (100 $mg.L^{-1}$) and the Coconut liquid with a concentration of 30% gave the highest fresh weight for the flowers amounted of (2.29 g) compared to the plants of the control treatment which gave the lowest fresh weight for the flowes amounted of (1.89 g) during the first season. The plants that were sprayed with Chelated iron at a concentration of (100 $mg.L^{-1}$) and did not spray with the Coconut liquid with a concentration gave the highest fresh weight for the flowers amounted of (2.26 g) compared to 1.88 g for plants that did not spray any of the solutions. Table (2) shows the signifcant effect of the triple interaction in the fresh weight for the flowers, where the plants treated with (300 $mg.L^{-1}$) of Gibberellic acid and (50 $mg.L^{-1}$) of Chelated iron only and the plants treated with Chelated iron at a concentration of (100 $mg.L^{-1}$) an the Coconut liquid with a concentration of only 30% characterized by recording it the highest fresh weight for the flowers amounted of (2.32 g) compared to the lowest fresh weight of flowers recorded by the control plants, which amountedof (1.82 g) in the first season, In the second season, the same table showed that the plants treated with (150 $mg.L^{-1}$) of Gibberellic acid, (100 $mg.L^{-1}$) of Chelated iron and 30% of Coconut Liquid was excelled from the rest of the plants by giving it the highest fresh weight for its flowers amounted of (2.30 g) compared to plants not treated with any of the three solutions, which amounted of (1.83 g).

Table 2: Effect of the Spraying with Gibberellic Acid, chelated iron and the Coconut liquid and their interactions in the fresh weight for the Flowers (g) for the jasmine Plant for both Study Seasons (2015-2016, 2016-2017).

Gibberellic Acid (mg.L^{-1})	Chelated Iron (mg.L^{-1})	First season				Second season			
		Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)	Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)
		0	**15**	**30**		**0**	**15**	**30**	
0	0	1.82	1.87	1.83	1.84	1.83	1.96	1.86	1.88
	50	1.78	1.85	2.07	1.90	1.84	1.92	1.96	1.91
	100	2.13	2.26	2.32	2.24	2.25	2.15	2.08	2.16
150	0	1.87	1.99	2.06	1.97	1.87	1.95	2.09	1.97
	50	2.20	2.25	2.27	2.24	2.09	2.21	2.27	2.19
	100	2.23	2.27	2.28	2.26	2.27	2.15	2.30	2.24
300	0	1.97	2.06	2.25	2.09	1.95	2.02	2.06	2.01
	50	2.32	2.31	2.25	2.29	2.06	2.22	2.17	2.15
	100	2.27	2.30	2.28	2.28	2.26	2.07	2.15	2.16
R.L.S.D 0.05		**0.647**			**0.373**	**0.201**			**0.116**
Average effect of Coconut liquid		2.07	2.13	2.18		2.05	2.07	2.10	
R.L.S.D 0.05		**NS**				**NS**			
Effect of interaction Gibberellic acid and coconut liquid					**Average effect of Gibberellic acid**	**Effect of interaction Gibberellic acid and coconut liquid**			**Average effect of Gibberellic acid**
0		1.91	1.99	2.07	1.99	1.97	2.01	1.97	1.98
150		2.10	2.17	2.20	2.16	2.08	2.10	2.22	2.13
300		2.19	2.22	2.26	2.22	2.09	2.10	2.13	2.11
R.L.S.D 0.05		**0.373**			**0.215**	**0.116**			**0.067**
Effect of interaction Chelated Iron and coconut liquid					**Average effect of Chelated Iron**	**Effect of interaction Chelated Iron and coconut liquid**			**Average effect of Chelated Iron**
0		1.89	1.97	2.05	1.97	1.88	1.98	2.00	1.95
50		2.10	2.14	2.20	2.15	2.00	2.12	2.13	2.08
100		2.21	2.28	2.29	2.26	2.26	2.12	2.18	2.19
R.L.S.D 0.05		**0.373**			**0.215**	**0.116**			**0.067**

Total yield of flowers (g)

Table (3) indicates the superiority of plants treated with Gibberellic acid at a concentration of (300 mg.L^{-1}) in the flowers yield and for both study seasons, which amounted to (50.52, 48.73 g) significantly compared to the plants of the control which recorded (40.42, 38.31g). The significant increase in total flowers yield due to spraying with Gibberellic acid was attributed to its positive role in increasing the number of primary and secondary branches, respectively, and increasing the efficiency of photosynthesis. These led to an increase in the number of the formed flowers as shown in Table (1). As for the spraying of plants with Chelated Iron, the table showed the superiority of plants treated with Chelated iron at a concentration of (100 mg. L^{-1}) significantly in the flowers yield and

for both study seasons, which amounted of (50.69, 47.97 g) compared to the control treatment which recorded (40.36, 40.27 g), As for the plants treated with coconut liquid, the plants treated with 30% of coconut liquid was significantly excelled in the flowers yield and for both study seasons, which amounted of (51.29, 48.28 g) respectively, compared to the control plants which amounted of (40.35, 39.59 g). The reason may be explained by the significant effect of coconut liquid in increasing the number of flowers as shown in Table (1), thus increasing the total yield of flowers. The results of Table (3) showed the effect of the interaction between the two study factors of spraying with (Gibberellic acid and Chelated Iron) in the total yield of flowers, where the plants treated with Gibberellic acid at a concentration of (300 $mg.L^{-1}$) and the Chelated Iron at concentration of (100 $mg.L^{-1}$) were characterized by giving it the highest total yield of flowers for both study seasons amounted of (54.94, 51.02 g), respectively, compared to the lowest total yield of flowers for the control plants, which amounted to (36.57, 35.39 g), respectively. The bi-interaction for the two study factors, spraying with Gibberellic acid and coconut liquid had a significant effect in this trait, where the plants treated with Gibberellic acid at a concentration of (300 $mg.L^{-1}$) and Coconut liquid with a concentration of 30% gave the highest total yield of flowers amounted of (53.69 g) compared to (33.3 g) resulted from the control plants during the first season, In the second season was the excellence for the plants that sprayed with a Gibberellic acid at a concentration of (150 $mg.L^{-1}$) and the Coconut liquid with a concentration of 30% by giving it the highest yield of flowers amounted of (51.39 g) compared to (33.56 g) for the control plants. As for the effect of the bi-interaction between the two spraying factors with Chelated Iron and coconut liquid was also significant in this trait. The plants treated with the Chelated iron at concentrated of (100 $mg.L^{-1}$) and Coconut liquid with a concentration of 30% gave the highest yield of flowers for both study seasons amounted of (55.85, 51.44 g), respectively, compared to (34.79, 35.19 g) for the control plants. Table (3) indicates that the triple interaction has a significant effect on the yield of flowers, where the plants treated with (300 $mg.L^{-1}$) of Gibberellic acid, (100 mg. L^{-1}) of Chelated iron and 15% coconut liquid recorded the highest yield of flowers amounted of 56.58 g compared to the lowest yield of flowers for plants treated with Chelated iron with a concentration of (50 $mg.L^{-1}$) only which amounted of (30.65 g) in the first season, In the second season, the plants treated with (150 mg. L^{-1}) of Gibberellic acid, (100 mg. L^{-1}) of Chelated iron and 30% of Coconut Liquid has excelled by giving it the highest yield of flowers amounted of 56.97 g compared to (30.08 g) for the control plants.

Table 3: Effect of the Spraying with Gibberellic Acid, chelated iron and the Coconut liquid and their interactions in the total yield of flowers (g) for the jasmine Plant for both Study Seasons (2015-2016, 2016-2017).

Gibberellic Acid ($mg.L^{-1}$)	Chelated Iron ($mg.L^{-1}$)	First season				Second season			
		Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)	Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)
		0	**15**	**30**		**0**	**15**	**30**	
0	0	1.82	1.87	1.83	1.84	1.83	1.96	1.86	1.88
	50	1.78	1.85	2.07	1.90	1.84	1.92	1.96	1.91
	100	2.13	2.26	2.32	2.24	2.25	2.15	2.08	2.16
150	0	1.87	1.99	2.06	1.97	1.87	1.95	2.09	1.97
	50	2.20	2.25	2.27	2.24	2.09	2.21	2.27	2.19
	100	2.23	2.27	2.28	2.26	2.27	2.15	2.30	2.24
300	0	1.97	2.06	2.25	2.09	1.95	2.02	2.06	2.01
	50	2.32	2.31	2.25	2.29	2.06	2.22	2.17	2.15
	100	2.27	2.30	2.28	2.28	2.26	2.07	2.15	2.16
R.L.S.D 0.05		**1.172**			**0.677**	**1.733**			**1.000**
Average effect of Coconut liquid		40.35	45.73	51.29		39.59	43.86	48.28	
R.L.S.D 0.05		**0.391**				**0.578**			
Effect of interaction Gibberellic acid and coconut liquid					**Average effect of Gibberellic acid**	**Effect of interaction Gibberellic acid and coconut liquid**			**Average effect of Gibberellic acid**
0		33.31	39.87	48.09	40.42	33.56	38.96	42.42	38.31
150		41.14	46.07	52.10	46.44	39.79	42.88	51.39	44.69
300		46.60	51.25	53.69	50.52	45.42	49.74	51.04	48.73
R.L.S.D 0.05		0.677			0.391	1.000			0.578
Effect of interaction Chelated Iron and coconut liquid					**Average effect of Chelated Iron**	**Effect of interaction Chelated Iron and coconut liquid**			**Average effect of Chelated Iron**
0		34.79	39.69	46.61	40.36	35.19	40.02	45.61	40.27
50		41.09	46.45	51.42	46.32	37.56	45.11	47.80	43.49
100		45.18	51.05	55.85	50.69	46.02	46.45	51.44	47.97
R.L.S.D 0.05		**0.677**			**0.391**	**1.000**			**0.578**

The percentage of volatile oil (%)

Table (4) indicates the superiority of plants treated with Gibberellic acid at a concentration of (150 $mg.L^{-1}$) in the percentage of volatile oil and for both study seasons, which amounted to (0.629, 0.640 %) and (0.638, 0.654%) respectively, significantly compared to the control plants which amounted of (40.42, 38.31g). This may be due to the role of gibberellic acid in the genes production in the cell chromosomes, thus stimulating mDNA and after formation Some enzymes, which represent primary products, are composed of byproducts, such as volatile oil [8]. This result agrees with

the result of [9] on the Pelargonium graveolens plant. As for the spraying with Chelated iron in this trait has had a significant effect where the plants treated with Chelated iron at a concentration of (100 mg.L^{-1}) for the first season was significant in the percentage of its volatile oil, which amounted of (0.644%) compared to the control plants, where the percentage of its volatile oil amounted of (0.604, 0.613%). During the second season, there was no significant difference between the plants that sprayed with Chelated iron with a concentration of (50 or 100 mg.L^{-1}), in the percentage of its volatile oil amounted of (639, 0.652 %), respectively. However, it was significantly excelled in this trait on the control plants which gave 0.611%. The effect of the spraying with coconut liquid at a concentration of (15% or 30%) was significantly excelled for both seasons by giving it the highest percentage of volatile oil which amounted of (0.628, 0.639%, 0.630, 0.644 %), respectively on the percentage of volatile oil for the control plants which amounted of (0.604, 0.620%). The bi-interaction between the two study factors (the spraying with Gibberellic acid and Chelated Iron) had a significant effect on this trait, where the plants treated with Gibberellic acid at a concentration of (300 mg.L^{-1}) and the Chelated Iron at concentration of (100 mg.L^{-1}) were characterized by giving it the highest percentage of volatile oil for both study seasons amounted of (0.668, 0.671 %), respectively, compared to the lowest percentage of volatile oil in the plants that sprayed with (50 mg.L^{-1}) of Chelated Iron and did not spraying with the Gibberellic acid for the first season which amounted to 0.557% and plants that did not spraying with any of the solutions for the second season, which amounted to 0.597%. The bi-interaction between the spraying with the Gibberellic acid and the coconut liquid had a significant effect in this trait, where the plants that sprayed with the Gibberellic acid at a concentration of (300 mg.L^{-1}) and Coconut liquid with a concentration of 30% recorded the highest percentage of volatile oil and for both study seasons, which amounted of (0.667, 0.661), respectively, compared to the lowest percentage of volatile oil recorded by the plants that were sprayed with coconut liquid at a concentration of 30% for the first season which amounted of 0.591% and the control plants for the second season, which amounted to 0.581%. As for the effect of the bi-interaction between the spraying with the Chelated iron and the coconut liquid, it was significant in this trait, the plants that sprayed with Chelated iron at a concentration of (100 mg. L^{-1}) and Coconut liquid at a concentration of 15% for the first season and the plants that sprayed with Chelated iron at a concentration of (100 mg. L^{-1}) and Coconut liquid at a concentration of 30% in the second season recorded the highest percentage of volatile oil, which amounted of (0.666, 0.660%), respectively, compared to the lowest percentage of volatile oil recorded by the control plants and for both study seasons which amounted of (0.571, 0.591 %), respectively. The triple interaction between the three study factors spraying with the Gibberellic acid and the coconut liquid had a significant effect in this trait, where the plants that sprayed with the Gibberellic acid at a concentration of (150 mg. L^{-1}), Chelated iron at a concentration of (100 mg. L^{-1}) and Coconut liquid at a concentration of 30% recorded the highest percentage of volatile oil and for the first seasons of the study, which amounted of (0.678 %), respectively, compared to the lowest percentage of volatile oil recorded by the plants that sprayed with (300 mg.L^{-1}) of Gibberellic acid, and did not spraying with Chelated iron and coconut liquid, which amounted to 0.525, In the second season, the plants that sprayed with Gibberellic acid at a concentration of (300 mg.L^{-1}), the Chelated iron at a concentration of (100 mg. L^{-1}) and Coconut liquid with a concentration of 15% recorded the highest percentage of volatile oil amounted of 0.674% compared to 0.574% recorded by the control plants.

Table 4: Effect of the Spraying with Gibberellic Acid, chelated iron and the Coconut liquid and their interactions in the percentage of volatile oil (%) for the jasmine Plant for both Study Seasons (2015-2016, 2016-2017).

Gibberellic Acid ($mg.L^{-1}$)	Chelated Iron ($mg.L^{-1}$)	First season				Second season			
		Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)	Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)
		0	**15**	**30**		**0**	**15**	**30**	
0	0	0.592	0.615	0.636	0.614	0.574	0.621	0.597	0.597
	50	0.580	0.533	0.558	0.557	0.583	0.594	0.635	0.604
	100	0.605	0.663	0.578	0.615	0.587	0.632	0.651	0.623
150	0	0.597	0.654	0.658	0.636	0.590	0.622	0.617	0.610
	50	0.609	0.633	0.562	0.601	0.650	0.647	0.652	0.650
	100	0.605	0.662	0.678	0.648	0.661	0.664	0.658	0.661
300	0	0.525	0.586	0.662	0.591	0.610	0.623	0.647	0.627
	50	0.654	0.637	0.670	0.654	0.654	0.671	0.667	0.664
	100	0.665	0.672	0.668	0.668	0.668	0.674	0.670	0.671
R.L.S.D 0.05		**0.043**			**0.024**	**0.044**			**0.023**
Average effect of Coconut liquid		0.604	0.628	0.630		0.620	0.639	0.644	
R.L.S.D 0.05		**0.016**				**0.018**			
Effect of interaction Gibberellic acid and coconut liquid					**Average effect of Gibberellic acid**	**Effect of interaction Gibberellic acid and coconut liquid**			**Average effect of Gibberellic acid**
0		0.592	0.603	0.591	0.595	0.581	0.616	0.628	0.608
150		0.604	0.650	0.632	0.629	0.634	0.644	0.642	0.640
300		0.615	0.632	0.667	0.638	0.644	0.656	0.661	0.654
R.L.S.D 0.05		**0.024**			**0.016**	**0.023**			**0.018**
Effect of interaction Chelated Iron and coconut liquid					**Average effect of Chelated Iron**	**Effect of interaction Chelated Iron and coconut liquid**			**Average effect of Chelated Iron**
0		0.571	0.618	0.651	0.613	0.591	0.622	0.620	0.611
50		0.614	0.601	0.597	0.604	0.629	0.637	0.651	0.639
100		0.625	0.666	0.641	0.644	0.639	0.657	0.660	0.652
R.L.S.D 0.05		**0.024**			**0.016**	**0.023**			**0.018**

Volatile oil yield (g)

Table (5) indicates the superiority of plants treated with Gibberellic acid at a concentration of (300 $mg.L^{-1}$) in the volatile oil yield and for both study seasons, which amounted to (0.325, 0.319 g), respectively, compared to the control plants which amounted of (0.241, 0.234 g), respectively. It may be attributed to the fact that the Gibberellic acid led to a significant increase in the percentage of volatile oil, in the number of primary and secondary branches, thus a significant increase in the total yield of flowers for the plant and all this leads to increase in the plant yield from the volatile oil,

in addition to the role of Gibberellic acid in elongation of cells and its expansion, including oily glands, and this is agreed with [10] on the plant Chrysanthemum [11] on the Pelargonium graveolens plant. As for the spraying with Chelated iron, where the plants treated with Chelated iron at a concentration of (100 mg.L^{-1}) for both seasons, was significantly excelled in the volatile oil yield, which amounted of (0.327, 0.314 g) compared to the control plants, where the percentage of its volatile oil amounted of (0.249, 0.247 g), respectively. As for the treatment of plants with coconut liquid, the same table showed the superiority of the plants treated with coconut liquid at a concentration of 30% in Volatile oil yield, which amounted of (0.347, 0.312 g) significantly and for both study seasons on the control plants which amounted of (0.245, 0.248 g), respectively. The significant increase in the oil yield when sprayed with coconut liquid may be explained by its significant effect on increasing the total yield of flowers for the plant as shown in Table (5). As for the bi-interaction between spraying with the Gibberellic acid and Chelated iron had a significant effect, the plants treated with Gibberellic acid at a concentration of (300 mg. L^{-1}) and the Chelated iron at a concentration of (100 mg. L^{-1}) recorded the highest Volatile oil yield and for both study season s, which amounted to (0.367, 0.342 g) compared to the lowest Volatile oil yield recorded by plants treated with (50 mg. L^{-1}) of Chelated iron, which was not treated with Gibberellic acid, which amounted to (0.215 g) for the first season and the control plants, which amounted to (0.212 g) for the second season. As for the bi-interaction between the spraying with the Gibberellic acid and the coconut liquid had a significant effect where the plants treated with (300 mg. L^{-1}) Gibberellic acid and 30% of coconut liquid gave the highest Volatile oil yield and for both study seasons, which amounted to (0.358, 0.338 g), respectively, compared to the control plants, which gave the lowest Volatile oil yield amounted of (0.198, 0.195 g), respectively. The bi-interaction between the spraying with Chelated iron and coconut liquid had a significant effect on the Volatile oil yield and for both study seasons, where the plants treated with (100 mg. L-1) of Chelated iron, and 30% of coconut liquid was significantly excelled, which recorded the highest Volatile oil yield amounted of (0.358, 0.340 g), respectively, compared with the lowest of the Volatile oil yield, which amounted of (0.198, 0.209), respectively. The results of the table show the significant effect of the triple interaction between the three study factors in the Volatile oil yield, where the plants treated with the Gibberellic acid at a concentration of (300 mg. L^{-1}), Chelated iron at a concentration of (100 mg. L^{-1}) and the Coconut liquid at a concentration of 15% recorded the highest Volatile oil yield amounted of (0.380 g) compared to the lowest Volatile oil yield formed by the plants treated with (50 mg. L^{-1}) of Chelated iron only amounted of (0.178 g) in the first season, In the second season, the plants were treated with (150 mg. L^{-1}) of Gibberellic acid, (100 mg. L^{-1}) of Chelated iron and 30% coconut liquid which recorded the highest Volatile oil yield amounted of (0.375 g) compared to the lowest Volatile oil yield gave it the control plants, which amounted to 0.173 g.

Table 5: Effect of the Spraying with Gibberellic Acid, chelated iron and the Coconut liquid and their interactions in the Volatile oil yield (g) for the jasmine Plant for both Study Seasons (2015-2016, 2016-2017).

Gibberellic Acid ($mg.L^{-1}$)	Chelated Iron ($mg.L^{-1}$)	First season				Second season			
		Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)	Coconut liquid			Interaction (Gibberellic Acid × Chelated Iron)
		0	**15**	**30**		**0**	**15**	**30**	
0	0	0.187	0.224	0.269	0.227	0.173	0.222	0.241	0.212
	50	0.178	0.203	0.263	0.215	0.180	0.219	0.257	0.219
	100	0.228	0.298	0.320	0.282	0.233	0.279	0.303	0.272
150	0	0.203	0.247	0.306	0.252	0.196	0.240	0.281	0.239
	50	0.265	0.308	0.302	0.292	0.249	0.296	0.337	0.294
	100	0.278	0.342	0.379	0.333	0.310	0.295	0.375	0.327
300	0	0.203	0.263	0.340	0.269	0.258	0.285	0.330	0.291
	50	0.231	0.336	0.358	0.338	0.278	0.347	0.342	0.322
	100	0.346	0.380	0.376	0.367	0.344	0.342	0.341	0.342
R.L.S.D 0.05		**0.063**			**0.036**	**0.043**			**0.023**
Average effect of Coconut liquid		0.245	0.303	0.347		0.248	0.281	0.312	
R.L.S.D 0.05		**0.021**				**0.018**			
Effect of interaction Gibberellic acid and coconut liquid					**Average effect of Gibberellic acid**	**Effect of interaction Gibberellic acid and coconut liquid**			**Average effect of Gibberellic acid**
0		0.198	0.242	0.284	0.241	0.195	0.240	0.267	0.234
150		0.249	0.299	0.329	0.292	0.252	0.277	0.331	0.287
300		0.290	0.326	0.358	0.325	0.293	0.325	0.338	0.319
R.L.S.D 0.05		**0.036**			**0.021**	**0.023**			**0.018**
Effect of interaction Chelated Iron and coconut liquid					**Average effect of Chelated Iron**	**Effect of interaction Chelated Iron and coconut liquid**			**Average effect of Chelated Iron**
0		0.198	0.245	0.305	0.249	0.209	0.249	0.284	0.247
50		0.255	0.282	0.308	0.282	0.236	0.287	0.312	0.278
100		0.284	0.340	0.358	0.327	0.296	0.305	0.340	0.314
R.L.S.D 0.05		**0.036**			**0.021**	**0.023**			**0.018**

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