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Response of fig trees to GA3 spraying and the organic fertilizer Super Fruit *Ficus carica* L

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Abstract

The study was conducted in a private orchard in Babil Governorate, Al-Kifl District, Bani Muslim area, in 2023. The aim was to investigate the effect of spraying with gibberellin at four concentrations (0, 10, 20, and 30 mg L⁻¹) and the organic fertilizer Super Fruit (0,1,2,3 ml.L⁻¹). The results showed that the 30 mg L⁻¹ concentration was superior in all studied traits (fruit weight, fruit size, fruit length, fruit diameter, yield per tree, total yield, percentage of soluble solids, and total acidity), with values of (43.72 g, 41.41 cm³, 4.76 cm, 5.38 cm, 40.12 kg, 6.25 t, 11.91%, and 0.46%). The 3 ml L⁻¹ concentration of the Super Fruit was also superior in all studied traits.

(Fruit weight, fruit size, fruit length, fruit diameter, yield per tree, total yield, percentage of soluble solids and total acidity) where it reached (46.07 g, 38.69 cm³, 5.05 cm, 5.48 cm, 41.93 kg, 6.53 tons, 11.77%, 0.88%) and the concentration of 3 ml L⁻¹. The interaction treatment between the concentration of 30 mg L⁻¹ of gibberellins and 3 ml L⁻¹ of super fruit was superior in all traits.

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1. Introduction

Figs (*Ficus carica* L.) are deciduous fruits belonging to the genus *Ficus*, which is part of the Moraceae family. This genus comprises 400 species and 700 varieties. It is believed to have originated in the Arabian Peninsula, and its cultivation has spread to North Africa and the Mediterranean countries. Turkey is the world's leading producer of figs, both in terms of the area under cultivation and the number of trees. Greece and California in the United States follow. The average annual global production of figs is 1,935,000 tons (Ferguson *et al.*, 1999) ^[11]. In Iraq, the number of fruit-bearing trees reached 477,235, with a total annual production of 9,867 tons. Salah al-Din Governorate ranks first, followed by Nineveh and then Wasit (Central Statistical Organization, 2023) ^[8]. Figs produce fruits that are consumed either fresh or dried. They are also used in many food industries. Fig fruits have high nutritional value due to their carbohydrate and protein content, as they contain 3.60% protein, 52.90% total sugars, and 1.30% fats, in addition to many vitamins and minerals, as they are rich in iron, sodium, calcium, and vitamins A and C. Al-Jumaili and Al-Dujaili, 1990) ^[3]

Foliar feeding is a technique for feeding plants by applying liquid fertilizers directly to the leaves. Plants are able to absorb essential nutrients through their leaves. Absorption occurs through the plant's stomata as well as its epidermis (Okur, 2018) ^[23]. There are many reasons for using foliar feeding, including avoiding fertilizers injected into the soil and absorbed by the roots. Other reasons include the negative effects of injected fertilizers on crop quality and human health, as well as environmental pollution, soil degradation, high costs, and the unavailability of many nutrients for absorption by the soil (Doberman & Firehurst, 2000).

From a physiological standpoint, relying solely on soil for plant nutrition can lead to nutrient deficiencies in the soil. This affects the plant's metabolic and physiological processes, as these deficiencies can cause physiological imbalances due to nutritional imbalances that may occur due to soil conditions, type, and fertilization methods.. (EL-Khawaga, 2007).

Organic fertilizers are natural solutions that are sprayed directly onto the leaves for rapid absorption by the plant, which treats acute nutritional deficiencies, stimulates growth, and increases branching and vegetative buds. Many organic fertilizers are available in agricultural product sales offices in the local market, and their content of nutrients and organic matter varies. One of these fertilizers is Super Fruit, which is specially manufactured for fig trees (Attia, 2020) ^[6].

The overuse of mineral fertilizers instead of organic fertilizers is primarily due to the low percentage of organic matter in the soil. This has led to renewed emphasis on the importance of adding organic fertilizers in agriculture, which are an essential and indispensable part of providing nutrients to growing plants, especially when using various chemical fertilizers is reduced. Organic matter is a good source of nutrients for plants, whether applied to the soil or sprayed on the leaves (Taha, 2007) ^[24], (Hartman, 2002) ^[14]. Harty and Vajranabhiyah (2020) ^[16] indicated that organic fertilizers contain growth hormones such as auxins, gibberellins, and cytokinins, as well as vitamins and amino acids that affect plant growth. Appireddy *et al.* (2022) ^[5] concluded that the application of organic fertilizers as a foliar spray leads to a significant increase in some vegetative and chemical characteristics of olive trees. Khehra and Bal (2014) ^[20] reported that the use of organic fertilizer led to a significant increase in vegetative growth characteristics and some chemical properties of lemon trees. Abd El-Naby *et al.* (2017) ^[1] reported that fertilizing fig trees with organic fertilizers resulted in significant differences in some physical characteristics of the fruit, as well as yield characteristics. Mohamed and Hussein (2016) studied the effect of nitrogen, phosphate, potassium, and organic fertilizers on some vegetative and chemical properties of the Black Sugar fig variety. The results showed significant differences in most of the physical and chemical properties of the fruit and yield.

Nitrogen is involved in the construction of many compounds that are essential for the growth and continuation of plant life. Nitrogen is involved in the construction of photosynthetic pigments, especially chlorophyll, and in the formation of energy compounds ATP, NADH₂, NADPH₂, purine and pyrimidine bases, and in the formation of cell membranes, mitochondria, and chloroplasts. Nitrogen is also involved in the formation of enzymes and participates in the formation of porphyrin groups involved in the biosynthesis of chlorophylls and plant hormones such as natural auxin (IAA). Nitrogen is involved in the construction of amino acids, proteins, and other secondary compounds that are formed in the leaves and are then transferred to other parts of the plant. As for phosphorus, it is involved in the composition of some organic compounds that are of great importance in vital activities. It is involved in the synthesis of nucleic acids, amino acids, and phospholipids, and in the formation of some energy-rich compounds such as ATP. Like nitrogen, phosphorus is a component of cell membranes, including the plasma membrane, mitochondria, chloroplasts, and vacuole membranes. Furthermore, phosphorus enhances vegetative

and floral growth in plants, increasing the number of branches and strengthening the root system. Potassium is the only positively charged ion required by all higher plants, despite not being part of any organic compound except organic acids, with which it combines to form organic salts. Potassium is a mobile element within the plant, and its primary direction of movement is towards meristematic tissues. It has been reported that potassium promotes root growth, contributes to cellulose synthesis, activates numerous enzymes, and aids in photosynthesis and protein synthesis (Al-Sahaf, 1989) ^[4].

Gibberellins are one of the plant growth regulators that are built up in different parts of the plant, especially in new parts such as meristematic tips, new leaves, roots and fruits. One of the most important types of gibberellins is gibberellic acid GA₃, with the chemical structure: C₁₉H₂₂O₆ and a molecular weight of 336.37. It is considered the most important growth regulator in agricultural production, as it has important effects, including seed germination, dormancy control, and increasing fruit size. It works to increase cell elongation and expansion. Gibberellins affect the distribution system of hemicellulose fibers in cell walls, reducing their rigidity and increasing their flexibility and elasticity, thus facilitating the process of cell expansion and elongation (Al-Asadi and Al-Khaikani, 2019; Hartmann *et al.*, 2002) ^[2, 15]. Hopkins and Hüner (2004) ^[17] demonstrated that gibberellins promote cell elongation and division, as well as stimulate a group of enzymes important in seed germination, seedling growth, and development. They also enhance the activity of enzymes involved in vital cellular processes, including α -amylase, protease, ribonuclease, and β -glucanase, and promote the synthesis of DNA, RNA, and proteins. Ghosh *et al.* (2018) ^[12] indicated that gibberellins play an important role in developing fruit cultivation and improving fruit quality. They also stimulate the growth of main stems, especially when applied to the entire plant, in many fruit crops, particularly in temperate regions, such as figs, apples, pears, peaches, cherries, and apricots. Brahmabhatt (2008) ^[7] sprayed gibberellin, boron, and zinc on fig trees, resulting in a significant increase in the percentage of fruit set (64.60%), fruit weight (27.22 g), fruit size (48.67 cm³), and fruit diameter (3.98 cm). Al-Hameedawi *et al.* (2014) demonstrated that pruning (50%) and spraying with olive oil and Grolfals tablets containing gibberellin at a concentration of 250 mg/L on Waziri fig trees for two seasons resulted in an increase in yield (23.50 and 24.76 kg/tree, respectively). In a study conducted by Thapleyal *et al.* (2016), spraying pear trees with gibberellin at a concentration of 50 ppm caused a significant increase in... The length of the fruit is (6.98 cm), the diameter of the fruit is (6.81 cm), the volume of the fruit is (171.16 cm³), and the weight of the fruit is (175.90 g). In a study conducted by Kurubar *et al.* (2017) ^[21] on fig trees to determine the effects of nine concentrations of gibberellic acid on growth and yield, the study showed that spraying at a concentration of 30 mg/L resulted in increased fruit weight, size, length, and diameter, as well as higher overall tree yield. In an experiment conducted by Gonzalez *et al.* (2018) ^[13] on the effect of spraying gibberellic acid on fig trees at a concentration of 0.5 ml/L, it resulted in increased fruit length (4.06 cm), fruit weight (101.37 g per five fruits), and fruit diameter (3.40 cm), as well as increased tree yield. Kheder (2019) ^[19] demonstrated that spraying mandarin trees with gibberellin (50 mg L⁻¹) and copper sulfate (25 mg L⁻¹) for

two seasons led to an increase in the percentage of soluble solids and total acidity.

The main objective of this study is to determine the response of fig trees to the Superfruit stimulant spray and gibberellin spray, and to study the effect of these factors on some physical and chemical characteristics and yield of fig fruits.

Materials and Methods

The study was conducted in a private orchard in Babil Governorate - Al-Kifl District - Bani Muslim area in 2023. Fig trees were planted at 4 x 4 spacing. The experiment was designed as a factorial experiment according to a Randomized Complete Block Design (RCBD) with three replicates and two factors. The first factor was the organic

fertilizer Super Fruit, produced by the Jordanian company Al-Mawsim Al-Akhdar, at four concentrations (0, 1, 2, 3) ml L⁻¹. The second factor was the growth regulator gibberellin at four concentrations (0, 10, 20, 30) mg L⁻¹ (Al-Rawi and Khalaf Allah, 2000). 48 well-grown fig trees Aswad Diala, varieties. as uniform in size as possible and 8 years old, were selected. Each tree represented an experimental unit. The trees were then marked with indicator signs according to the design used, and the service process was carried out according to the needs of the plant and throughout the duration of the study. Then, samples of the field soil were taken, and the soil properties were estimated before the treatments were carried out in order to measure some of its physical and chemical properties, according to the method of Page *et al.* (1982).

Table 1: Some physical and chemical properties of the soil used before starting the experiment.

Value	Unit of measurement	property	
83	gm. kg-1	Sand	Soil separators
107		Silver	
810		Clay	
is clay.		The texture	
7.38	---	pH 1 : 1	
104	Decismens. M-1	EC 1 : 1	
0.13	%	N	Elements
0.09		P	
0.06		K	

Tree spraying times

The first factor: gibberellin: It is sprayed three times during the season: the first spray on 1-4-2023, the second spray on 1-5-2023, and the third spray on 1-6-2023. The second factor: super fruit: It is sprayed three times during the season: the first spray on 5-4-2023, the second spray on 5-5-2023, and the third spray on 5-6-2023.

Spraying Method: Spray the trees according to the required schedule and concentration in the early morning using a 20 ml backpack sprayer, adding a few drops of liquid washing

solution to reduce surface tension.

The studied characteristics: Fruit weight, fruit size, fruit length, fruit diameter, yield per tree, total yield per dunam, percentage of soluble solids, and total acidity were measured.

Statistical Analysis: At the end of the study, the results were recorded, then the variance was analyzed and the factors and their interactions were tested using a computer and the ready-made statistical program Genstat. The differences between the means were compared according to the least significant difference (LSD) test at a probability level of 0.05.

Result

Table 2: Effect of GA3 and super fruit on fruit weight and size of fig trees

rate of GA3	fruit weight gm					rate of GA3	fruit size cm ³				
	Super Fruit				GA3		Super Fruit				GA3
	3	2	1	0		3	2	1	0		
37.73	43.16	40.55	34.11	33.12	0	33.17	33.11	33.11	33.15	33.33	0
40.00	45.12	42.33	37.45	35.10	10	34.94	35.70	35.50	34.45	34.11	10
41.50	46.88	44.55	38.15	36.42	20	37.05	40.18	36.88	36.61	34.55	20
43.72	49.15	45.11	40.50	40.13	30	41.41	45.77	42.57	40.18	37.14	30
	46.07	43.13	37.55	36.19	rate of Super Fruit		38.69	37.01	36.09	34.78	rate of Super Fruit
SuperFruit GA3 intraction 2.112 2.112 3.991					L.S.D	SuperFruit GA3 intraction 4.064 2.031 2.032					L.S.D

The data in Table 2 indicate significant differences when treating trees with GA3, as the concentration of 30 mg.L-1 outperformed the other concentrations, giving the highest values in the two characteristics of fruit weight and fruit size (43.72 and 41.41), surpassing the control treatment, which gave (33.17 and 37.73) respectively.

As can be seen from the data in Table 2, there are significant

differences when treating the trees with Super Fruit, as the 3 ml L-1 concentration outperformed the other concentrations, giving the highest values in the fruit weight and fruit size characteristics (46.07 and 38.69), surpassing the control treatment, which gave (36.19 and 43.78) respectively.

The results also showed that the interaction between the experimental factors had a significant effect, as the

interaction between GA3 and Super Fruit (30 mg.L-1 and 3 ml.L-1) was superior compared to the control treatment (0 mg.L-1 and 0 ml.L-1).

Table 3: Effect of GA3 and super fruit on the length and diameter fruit of fig trees

fruit length cm					fruit diameter cm						
rate of GA3	Super Fruit				GA3	rate of GA3	Super Fruit				GA3
	3	2	1	0			3	2	1	0	
4.41	4.58	4.49	4.36	4.22	0	5.26	5.41	5.32	5.21	5.12	0
4.57	5.11	4.51	4.40	4.27	10	5.31	5.45	5.37	5.25	5.17	10
4.66	5.20	4.65	4.44	4.35	20	5.34	5.51	5.40	5.29	5.19	20
4.76	5.33	4.77	4.50	4.47	30	5.38	5.55	5.42	5.33	5.23	30
	5.05	4.60	4.42	4.32	rate of Super Fruit		5.48	5.37	5.27	5.17	rate of Super Fruit
SuperFruit GA3 intraction <i>0.190 0.190 0.380</i>					L.S.D	SuperFruit GA3 intraction <i>0.091 0.091 0.182</i>					L.S.D

The significant differences can be seen in the table. 3 indicate significant differences when treating trees with GA3, as the concentration of 30 mg.L-1 outperformed the other concentrations, giving the highest values in the two characteristics of fruit length and fruit diameter (4.26 and 5.38), surpassing the control treatment, which gave (4.41 and 5.26) respectively.

As can be seen from the data in Table 3, there are significant differences when treating the trees with Super Fruit, as the 3 ml L-1 concentration outperformed the other concentrations,

giving the highest values in fruit length and fruit diameter characteristics (5.05 and 5.48), surpassing the control treatment, which gave (4.32 and 5.17) respectively.

Knowing the result of the interaction between the study factors in this table is very important. The results also showed that the interaction between the experimental factors had a significant effect, as the interaction between GA3 and Super Fruit (30 mg.L-1 and 3 ml.L-1) was superior compared to the control treatment (0 mg.L-1 and 0 ml.L-1).

Table 4: Effect of GA3 and super fruit on the yield per tree and the total yield per dunam for fig trees

yield per tree kg. tree					the total yield per donum t.d						
rate of GA3	Super Fruit				GA3	rate of GA3	Super Fruit				GA3
	3	2	1	0			3	2	1	0	
36.41	40.58	36.49	35.36	33.22	0	5.68	6.33	5.69	5.51	5.19	0
38.39	41.51	39.50	37.46	35.11	10	5.98	6.47	6.16	5.84	5.47	10
39.21	42.11	40.72	37.88	36.14	20	6.11	6.56	6.35	5.90	5.63	20
40.12	43.53	41.52	39.24	36.22	30	6.25	6.79	6.47	6.12	5.65	30
	41.93	39.55	37.48	35.17	rate of Super Fruit		6.53	6.16	5.84	5.48	rate of Super Fruit
SuperFruit GA3 intraction <i>2.082 2.081 4.161</i>					L.S.D	SuperFruit GA3 intraction <i>0.071 0.071 0.142</i>					L.S.D

Looking at the data in Table 4, we can conclude that there are significant differences between the treatments. with GA3, as the concentration of 30 mg.L-1 outperformed the other concentrations, giving the highest values in the two characteristics of yield per tree and the total yield per donum (40.12 and 6.25), surpassing the control treatment, which gave (36.41 and 5.68) respectively.

It can also be determined as can be seen from the data in Table 4, there are significant differences when treating the trees with Super Fruit, as the 3 ml L-1 concentration

outperformed the other concentrations, giving the highest values in the yield per tree and the total yield per donum (41.93 and 6.53), surpassing the control treatment, which gave (35.17 and 5.48) respectively.

The results also showed that the interaction between the experimental factors had a significant effect, as the interaction between GA3 and Super Fruit (30 mg.L-1 and 3 ml.L-1) was superior compared to the control treatment (0 mg.L-1 and 0 ml.L-1).

Table 5: Effect of GA3 and super fruit on the percentage of soluble solids and total acidity of fig fruits

percentage of soluble solids %					total acidity %						
rate of GA3	Super Fruit				GA3	rate of GA3	Super Fruit				GA3
	3	2	1	0			3	2	1	0	
11.38	11.51	11.49	11.31	11.22	0	0.26	0.37	0.33	0.24	0.10	0
11.42	11.55	11.51	11.38	11.26	10	0.31	0.41	0.37	0.29	0.18	10
11.61	11.85	11.70	11.52	11.40	20	0.38	0.50	0.47	0.34	0.22	20
11.91	12.20	11.99	11.79	11.67	30	0.46	0.60	0.55	0.40	0.29	30
	11.77	11.67	11.50	11.38	rate of Super Fruit		0.88	0.43	0.31	0.19	rate of Super Fruit
SuperFruit GA3 intraction <i>0.053 0.053 0.091</i>					L.S.D	SuperFruit GA3 intraction <i>0.231 0.231 0.462</i>					L.S.D

The data in Table 5 indicate significant differences when treating trees with GA3, as the concentration of 30 mg.L-1 outperformed the other concentrations, giving the highest values in the two characteristics of percentage of soluble solids and total acidity (11.91 and 0.46), surpassing the control treatment, which gave (11.38 and 0.26) respectively. As can be seen from the data in Table 5, there are significant differences when treating the trees with Super Fruit, as the 3 ml L-1 concentration outperformed the other concentrations, giving the highest values in percentage of soluble solids and total acidity (11.77 and 0.88), surpassing the control treatment, which gave (11.38 and 0.19) respectively.

The results also showed that the interaction between the experimental factors had a significant effect, as the interaction between GA3 and Super Fruit (30 mg.L-1 and 3 ml.L-1) was superior compared to the control treatment (0 mg.L-1 and 0 ml.L-1).

Discussion

The increase in the physical characteristics of the fruit (Tables 2 and 3) may be due to the role played by GA3, as they have important effects, including increasing the size of the fruits. They work to increase the elongation and expansion of the cells through their effect on the distribution system of hemicellulose fibers of the cell walls, thus reducing their rigidity and increasing their flexibility and elasticity, which facilitates the process of cell expansion and elongation. Consequently, this is reflected in the weight, size, length, and diameter of the fruits (Al-Asadi and Al-Khaikani, 2019)^[2] and (Hartmann *et al.*, 2002)^[15]. GA3 also stimulate a group of important enzymes in seed germination, seedling growth and development, and increase the stimulation of enzymes involved in cell vital processes, including α -amylase, protease, ribonuclease, and β -glucanase. They also promote the synthesis of DNA, RNA and protein (Hopkins and Hüner, 2004)^[17]. This leads to increased vegetative and fruit growth in the trees, which is reflected in the total yield (Table 4). This result is consistent with what was mentioned by: Thapliyal *et al.*, 2016), (Kurubar *et al.*, 2017)^[21] and (Gonzalez *et al.*, 2018)^[13]. As for the effect of GA3 on increasing the percentage of soluble solids and total acidity, this is due to the fact that gibberellin activates enzymes that break down starch into simple sugars such as glucose and fructose, which constitute the largest part of the soluble solids in the fruit. The reason for the increase in acidity in the fruit is that gibberellin delays the breakdown of citric acid, thus increasing acidity in the fruit. This result is consistent with what Kheder (2019)^[19] stated in his study on orange (mandarin) trees. Spraying organic matter on the foliage of a plant acts as a chelating agent, binding nutrients and facilitating their uptake by the leaves. This increases the efficiency of any foliar fertilizer, acting as an absorption enhancer, in addition to containing humic and fulvic acids, which are important for improving the plant's nutritional status. These findings are consistent with those of Appireddy *et al.* (2022)^[5] (Khehra and Bal, 2014)^[20]. The significant increase in the physical characteristics of fig fruits when trees are sprayed with the general stimulant Super fruit is due to the macronutrients contained in this stimulant. Nitrogen, in particular, is involved in the formation of many compounds essential for plant growth and survival. It is involved in the synthesis of photosynthetic pigments, especially chlorophyll, purine bases, and in the formation of energy compounds ATP,

NADH2, NADPH2, and biobases. Nitrogen is involved in the formation of cell membranes, mitochondria, and chloroplasts, as well as in the formation of enzymes. It is also involved in the synthesis of amino acids, proteins, and other secondary compounds that are formed in the leaves and then transported to the fruit, thus improving its physical characteristics, which in turn affects the yield. Phosphorus, on the other hand, is a component of some organic compounds that are crucial for vital processes. It is also a component of nucleic acids. Phosphorus is involved in the formation of amino acids and phospholipids, as well as in the formation of some energy-rich compounds (ATP). Additionally, phosphorus enhances the vigor of vegetative and flowering growth in plants, increasing the number of branches, which in turn promotes increased vegetative and fruiting. Potassium, on the other hand, is required by all higher plants, despite not being incorporated into any organic compounds like organic acids, with which it combines to form organic salts. Potassium is a mobile element within the plant, and its primary direction of movement is towards meristematic tissues. It also contributes to cellulose synthesis, activates numerous enzymes, and aids in photosynthesis and protein synthesis. This increases the amount of substances stored in fruits, resulting in an increase in fruit solids in the form of starch and an increase in total acidity (Table 5). The Super fruit stimulant also contains micronutrients that are of great importance to plant growth when sprayed on the leaves due to their rapid absorption. This provides a quick supply of micronutrients, including manganese and iron, which are important in the photosynthesis process. Consequently, photosynthesis increases, which is reflected in vegetative and fruit growth.

Conclusion

Figs are considered an important crop in Iraq and the world due to their high nutritional and medicinal value. They are a significant source of income for many farmers in Iraq. This study aims to determine the effect of gibberellin and superfruit on some physical, quantitative, and chemical characteristics of figs. The study will conclude with the completion of the experiment and the execution of statistical analysis. was conducted, it became clear that these factors had a significant effect on the studied characteristics. Therefore, it has become necessary to recommend to researchers and farmers in the field of fig cultivation the necessity of using these agents as a foliar spray, whether on fig trees or on other fruit trees. The same research approach can also be continued with other local varieties.

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