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Effect of sulfur addition and foliar spray of Super Docson nutrient solution on some vegetative growth and yield properties of two grape cultivars.

ABSTRACT

The study was conducted during the two growing seasons (2019 and 2020) on grape vines (Halawani and Kamali varieties) in the vine yard of the Department of Horticulture and Landscape Design- College of Agriculture- Tikrit University. The vines cultivated in 2016. The experiment was conducted with three factors, the first, is the varieties (Halawani and Kamali), the second is agricultural Sulfur (S) with three levels, (S₀, S₁: 250 g. vine⁻¹, and S₂: 500 gm. vine⁻¹) and the third factor is the spraying of “Super Docson” nutrient solution with three concentrations (P₀ : spraying with distilled water, P₁ : 1.2 ml. L⁻¹ , P₂ : 2.4 ml. L⁻¹). The spraying was done in Early morning to until complete wetness. The experiment was carried out with the split plot system in Randomized Complete Block Design (RCBD). The varieties took the main plots, while the sulfur and nutrient treatments were randomly distributed on the sub plots, by three replications and the results showed That, the Halawani variety was excellence on Kamali in most studied traits, and which included (leaf area of vine(m².vine⁻¹) , main branch length(cm), leaf chlorophyll content, vine yield(kg) and total yield(tons.ha⁻¹). And the results showed excellence at concentrate 2.4 ml. L⁻¹ for nutrient and at level 500 g for sulfur in most studied traits.

This paper is a part of PhD for the first author.

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Introduction

The grape *Vitis vinifera* L. is an important horticultural crop, whether in Iraq or the world. Its cultivation is very old in Iraq since the emergence of the first civilizations, due to the suitability of environmental conditions. Grape cultivation was known among the Sumerians, and grape trees were found in the hanging gardens of Babylon. Grapes are mentioned eleven times in the Holy Quran. The area between the southern Black Sea and the Caspian Sea in Central Asia is the origin of the European grape (*Vitis vinifera* L.), from which all grape varieties originated before the discovery of the North American continent, and then its cultivation spread to the East and the West (Al-Saedi, 2000).

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There are many problems that affect the delay in growing fruits in Iraq, and among these problems is fertilization, which is one of the important agricultural applications. The fertilizers added to the soil may not be ready for absorption by the plant, and may be used by the soil organisms or washed out as a result of continuous irrigation. The foliar spray application is a modern and effective method to compensate for the lack of nutrients (Paparozzi & Tukey, 1979). Some studies have confirmed that adding fertilizers that give an adequate level as possible of ready-made mineral elements leads to increased production and improves the quality of grapes, as well as one of the problems that delay the cultivation of fruits in Iraq is the high pH of the soil, which works to hold the elements and make them unavailable for the plant, to eliminate this problem, nutrients are used (Krishnamoorthy, 1981).

Sulfur is one of the seventeen essential elements for plant growth (Havlin *et al.*, 2005), as it is usually called the fourth nutrient in terms of rank, after nitrogen, phosphorous and potassium (Lamond, 2002). It is included in the formation of amino acids (Methionine, Cystine and Cysteine), and sulfur is included in the formation of Lipid acids, as well as in the formation of CoASH and vitamins Biotin and Thiamine, these compounds are important due to their roles in Metabolic reactions in plants (Al-Tamimi *et al.*, 2018). Al-Taafi *et al.* (2005) showed that adding foamy sulfur in the grape orchard of the Halawani variety with four levels (0, 750, 1000 and 1250) g. vine⁻¹, led to a significant effect on the quantitative and the qualitative characteristics of yield, and the best results were when adding 750 g S. vine⁻¹ in the second season. Al-Hadithi *et al.* (2012) added sulfur to the soil of pear seedlings Cocia Cv. in three levels (0, 50 and 100 g. vine⁻¹), they found that the treatment (100 g. vine⁻¹) gave the highest height of seedlings as it was (64.55 and 83.42 cm) for both seasons respectively, and gave the highest content of chlorophyll in the leaves, reaching (41.93 and 43.98 SPAD) for both seasons respectively.

The study of micronutrients have an effective role in increasing production and improving its quality as well as keeping plants from contracting various diseases resulting from their deficiency and improving the quality of the yield (Jawad *et al.* 1988). Hashem (2014) indicated that the foliar spraying with the nutrient solution (MICRO NATE) at four levels (0, 12.5, 15 and 17.5 g. L⁻¹) on a French variety grape vines showed that, spraying with the nutrient solution at a concentration of 17.5 g. L⁻¹ was superior in all studied characteristics.

This study aimed to know the effect of agricultural sulfur and Commercial product “Super Docson” nutrient and their interaction effects on vegetative and yield characteristics of Halawani and Kamali grape Cvs.

Materials and methods

This study was conducted during the two growing seasons (2019 and 2020) on grape vines Halawani and Kamali varieties in the vine yard of the Department of Horticulture and Landscape Design/ College of Agriculture/ Tikrit University. The vines were cultivated in (2016) and trained of Pergola method, with 2 x 4 meters apart, and 2 meters high above soil surface. A factorial experiment was conducted with three factors, the first factor is the varieties Halawani (V₁) and Kamali (V₂), while the second factor is the addition of agricultural sulfur S to the soil, with three levels, the first is S₀ (not adding agricultural sulfur to the soil), the second S₁ (adding agricultural sulfur to the soil in an amount of 250 g. vine⁻¹), and the third S₂ (add agricultural sulfur in an amount of 500 g. vine⁻¹). The third factor is a foliar spraying with three concentrations of Super Docson nutrient: the first concentration P₀ (spraying with distilled water only without the nutrient), and the second concentration P₁ (spraying with Super Docson nutrient at a concentration of 1.2 ml. L⁻¹ water), and the third concentration P₂ (spraying with the nutrient Super Docson at a concentration of 2.4 ml. L⁻¹ water). The foliar spray was done three times in a growing season, the first before the flower clusters opened, the second spray when the berry reached a chickpea seed volume and the third a month after the first spray. The spraying was carried out on the morning early until runoff. Note that diffuser Tween20 has been added.

The vines were controlled to prevent fungal infections by both the fungicide Topsin and Rival on 1/4. The herbal control was also carried out with Grastop 24% of the grapevine for the areas far from the vines, while the areas close to the vines were mechanically fought.

The experiment was performed in a split plots system according to the Randomized Complete Block Design (RCBD), with three replicates. The varieties were put in main plots, while the sulfur and nutrient solution treatments distributed randomly in the subplots, so the experiment contained 54 experimental units, each experimental unit is one vine, and the experiment was repeated for the seasons 2019 and 2020.

Twenty seven similarly grown vines of Halawani and Kamali varieties were selected. Five canes of 12 eyes length and five regenerative spurs were left for each vine. A decomposing sheep manure was added (five kg. vine⁻¹) in December 2018, and DAP fertilizer NP type (Saudi SABIC) in a ratio of 46:18 was applied at a rate of 250 grams of vine⁻¹, and urea fertilizer was added on two batches, the first at the beginning of the opening of the vegetative buds and the second at the beginning of flowering, with an amount of 75 grams of vine⁻¹ for each batch for all the studied vines. The characteristics were studied: leaves area of vine (m². vine⁻¹), leaf area per cluster (cm²), length of the main branch (cm), leaf content of relative chlorophyll, vine yield (kg) and the total yield (tons. ha⁻¹). The collected data were statistically analyzed using the statistical analysis system (SAS), according to the experimental design and the averages were compared according to the Duncan Multiple Range Test at a probability level of 0.05 (Al-Rawi and Khalaf Allah, 2000).

Table (1) Some physical and chemical characteristics of the orchard soil (before planting)*

physical and chemical characteristics of the orchard soil (before planting)The treat	The value	The unit	The treat	The unit	The value
Sand	459	g. Kg ⁻¹	Bulk density	Mica gram. m ⁻³	1.34
Silt	308		PH		7.61
Clay	233		Dissolved ions		
Soil texture	S –C – L				
Electrical conductivity	2.33	dicey Siemens. m ₁ ⁻¹	Calcium	mmol. L ⁻¹	12.84
Positive ion exchange capacity	15.21	Centimole. Kg ⁻¹	magnesium		4.70
Organic matter	7.01	g. kg ⁻¹ soil	Potassium		0.41
Carbonate minerals	209		Sodium		1.33
Gypsum	49.28		Chloride		2.77
Available Potassium	110.88	ml. kg ⁻¹	Sulfates		11.09
Available nitrogen	21.14		Carbonates		Nil
Available phosphorous	4.89		Bicarbonate		2.09

* The soil model was analyzed in the Soil and Water Resources department.

Results and discussion

The leaves, area of the vine ($\text{m}^2 \cdot \text{vine}^{-1}$)

Tables 2a and 2b show the presence of significant effects of the three study factors (varieties, sulfur, and the nutrient Super Docson) and their interactions in the characteristic of the leaf area of the vine, as Halawani variety surpassed the Kamali variety significantly during the 2019 season only, as the averages of the two varieties reached 15.31 and $14.69 \text{ m}^2 \cdot \text{vine}^{-1}$ in 2019, 14.57 and $14.27 \text{ m}^2 \cdot \text{vine}^{-1}$ in 2020 season respectively, and for the effect of adding sulfur to the soil, it is noticed that the level $500 \text{ g} \cdot \text{vine}^{-1}$ exceeded significant with averages of 16.74 and $15.87 \text{ m}^2 \cdot \text{vine}^{-1}$ in 2019 and 2020 seasons respectively, and for the effect of the nutrient Super Docson, it is evident that the high concentration of $2.4 \text{ ml} \cdot \text{L}^{-1}$ was superior to the highest averages, reaching 15.38 and $14.97 \text{ m}^2 \cdot \text{vine}^{-1}$ in 2019 and 2020 seasons respectively.

For the bilateral interaction between the variety and sulfur, it is noticed that the interaction treatment of two varieties “Halawani and Kamali” and sulfur level of $500 \text{ g} \cdot \text{vine}^{-1}$ was superior significantly Compared to the averages of the remainder of the interactions, reaching 16.86 and $16.62 \text{ m}^2 \cdot \text{vine}^{-1}$ for the 2019 season, 15.75 and $15.98 \text{ m}^2 \cdot \text{vine}^{-1}$ for the 2020 season respectively. As for the effect of the interaction between the variety and the super Docson nutrient concentration, it is noticed from the same table for the 2019 season that the average interaction between the Halawani variety and the concentration is $2.4 \text{ ml} \cdot \text{L}^{-1}$ without a significant difference from the interaction between the variety as a Kamali at the concentration of $2.4 \text{ ml} \cdot \text{L}^{-1}$ and the Halawani variety at a concentration of $1.2 \text{ ml} \cdot \text{L}^{-1}$, with a significant difference from the averages of the rest of the interactions, with an average of $15.84 \text{ m}^2 \cdot \text{vine}^{-1}$, as for the 2020 season, the average interaction between the variety Kamali and the concentration at $2.4 \text{ ml} \cdot \text{L}^{-1}$ is observed without a significant difference than the averages of the interaction between the Halawani variety and the concentrations 2.4 and $1.2 \text{ ml} \cdot \text{L}^{-1}$ were significantly different from the averages of the rest of the interactions with an average of $15.06 \text{ m}^2 \cdot \text{vine}^{-1}$, and for the interaction between the averages of the effect of the levels of sulfur and the concentrations of the nutrient Super Docson, the averages of the interaction between the level of $500 \text{ g} \cdot \text{vine}^{-1}$ sulfur and concentration $2.4 \text{ ml} \cdot \text{L}^{-1}$ nutrient were superior, which amounted to 17.48 and $16.65 \text{ m}^2 \cdot \text{vine}^{-1}$ for the two seasons respectively, with significant differences from the averages of the rest of the interactions except for the interaction between the level of $500 \text{ g} \cdot \text{vine}^{-1}$ sulfur and the concentration $1.2 \text{ ml} \cdot \text{L}^{-1}$ nutrient during the two seasons. For the triple interaction between the variety, sulfur and nutrient Super Docson, it is noted that the triple interaction averages of the two varieties Kamali and Halawani were superior to the level of $500 \text{ g} \cdot \text{vine}^{-1}$ sulfur and the concentration of $2.4 \text{ ml} \cdot \text{L}^{-1}$ with averages of 17.65 and $17.31 \text{ m}^2 \cdot \text{vine}^{-1}$ for the season 2019, 16.99 and $16.31 \text{ m}^2 \cdot \text{vine}^{-1}$ for the season 2020 for the two varieties respectively, significantly superiority the averages of the rest of the interactions, except for the interactions of the Halawani variety with the level of $500 \text{ g} \cdot \text{vine}^{-1}$ sulfur at the concentrations of 1.2 and $0 \text{ ml} \cdot \text{L}^{-1}$ for the nutrient during the 2019 season and the interactions of the two varieties with the level of $500 \text{ g} \cdot \text{vine}^{-1}$ sulfur at a concentration of $1.2 \text{ ml} \cdot \text{L}^{-1}$ for the nutrient during the two seasons.

Table (2a): Effect of variety, sulfur, and nutrient and their interactions on leaves area of vine ($\text{m}^2 \cdot \text{vine}^{-1}$) in 2019 .

Variety (V)	Sulfur (S) ($\text{g} \cdot \text{vine}^{-1}$)	Super Docson nutrient ($\text{ml} \cdot \text{L}^{-1}$)			Effect of V \times S	
		0.00 (P ₀)	1.2 (P ₁)	2.4 (P ₂)		
Halawani (V ₁)	0.00 (S ₀)	13.31 ijk	14.06 f-j	14.70 e-i	14.02 c	
	250 (S ₁)	14.50 e-i	15.14 c-g	15.51 c-f	15.05 b	
	500 (S ₂)	16.30 a-d	16.98 ab	17.31 a	16.86 a	
Kamali (V ₂)	0.00 (S ₀)	12.13 k	12.60 jk	13.56 h-k	12.76 d	
	250 (S ₁)	13.83 g-j	14.83 d-h	15.36 c-f	14.67 b	
	500 (S ₂)	15.78 b-e	16.44 abc	17.65 a	16.62 a	
Effect of V \times P	Halawani	14.70 c	15.39 ab	15.84 a	Effect of variety	15.31 a
	Kamali	13.91 c	14.62 cb	15.52 a		14.69 b
Effect of S \times P	0.00 (S ₀)	12.72 g	13.33 g	14.13 e	Effect of sulfur	13.39 c
	250 (S ₁)	14.16 ef	14.90 e	14.43 cd		14.86 b
	500 (S ₂)	16.04 bc	16.71 ab	17.48 a		16.74 a
Effect of nutrient (P)		14.31 c	15.01 b	15.38 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at ($P \leq 0.05$).

Table (2b): Effect of variety, sulfur and nutrient and their interactions on leaves' area of vine ($\text{m}^2 \cdot \text{vine}^{-1}$) in 2020 .

Variety (V)	Sulfur (S) ($\text{g} \cdot \text{vine}^{-1}$)	Super Docson nutrient ($\text{ml} \cdot \text{L}^{-1}$)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V ₁)	0.00 (S ₀)	13.00 fg	13.46 ef	13.83 def	13.43 c	
	250 (S ₁)	14.10 c.f	14.98bcd	14.51 cde	14.53 b	
	500 (S ₂)	14.96 bcd	15.98 ab	16.31 a	15.75 a	
Kamali (V ₂)	0.00 (S ₀)	12.07 g	12.16 g	13.06f g	12.43 d	
	250 (S ₁)	13.83 def	14.26 cde	15.13 bc	14.41 b	
	500 (S ₂)	15.00 bcd	15.96 ab	16.99 a	15.98 a	
Effect of V \times P	Halawani	14.02 b	14.81 a	14.88 a	Effect of variety	14.57 a
	Kamali	13.63 b	14.13 b	15.06 a		14.27 a
Effect of S \times P	0.00 (S ₀)	12.53 f	12.81 ef	13.45 de	Effect of sulfur	12.93 c
	250 (S ₁)	13.96 cd	14.62 bc	14.82 b		14.47 b
	500 (S ₂)	14.98 b	15.97 a	16.65 a		15.87 a
Effect of nutrient (P)		13.82c	14.47 b	14.97 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at ($P \leq 0.05$).

Leaf Area per Cluster (cm^2)

Tables (3a and 3b) show that the study factors (Varieties, Sulfur, and Super Docson Nutrient) and their interactions had a significant effect on the leaf area per cluster, as it is noticed that the Kamali variety significantly exceeded the Halawani variety with averages of 6310.4 and 5251.89 cm^2 for the cluster during the two seasons respectively. The effect of adding sulfur to the soil at the level 500 $\text{g} \cdot \text{vine}^{-1}$ had a significant effect with averages of 6857.1 and 5859.22 cm^2 for the two seasons respectively, while the super Docson nutrient of 2.4 mL^{-1} exceeded the remain treatments by giving it the highest averages, reaching 6616.6 and 5357.17 cm^2 for the two seasons respectively.

The same table shows that the bilateral interaction between Halawani variety with the sulfur level 500 g. vine⁻¹ gave the highest value of leaves area per cluster, it was reached 6964.1 and 5957.56 cm² for the two seasons respectively. As for the effect of the interaction between the variety and the super docson nutrient concentration, the interaction between Kamali variety with the concentration 2.4 ml. L⁻¹ of nutrient was showed the superiority significantly of the rest of the interaction treatments, reaching 6644 and 5535.81 cm² for the two seasons, respectively. For the interaction between sulfur and super docson nutrient levels, the mean interaction between 500 g. vine⁻¹ sulfur and 2.4 ml. L⁻¹ was significantly higher than the over averages, as 7244.5 and 5925.17 cm² of cluster leaf area were achieved for the two seasons respectively.

For the triple interaction, the average interaction between the two varieties, Halawani and Kamali, was found to be superior to the level of 500 g. vine⁻¹ sulfur and the concentration of 2.4 ml. L⁻¹ with averages of 7275 and 7214 cm². Cluster⁻¹ respectively during the season 2019, while during the season 2020, the average interaction the Halawani variety with level 500 g. vine⁻¹ sulfur at a concentration of 2.4 ml. L⁻¹ of the nutrient significantly was achieved exceed the averages of the rest of the interactions, as it reached a value of 6076.33 cm² for the cluster

Table (3a): Effect of variety, sulfur, and nutrient and their interactions on the leaf area per cluster (cm²) in 2019 growing season.

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	4874.00 l	5805.00 i	6113.00 h	5597.4 f	
	250 (S1)	6222.00 f	4968.00 b	6380.00 e	5856.8 c	
	500 (S2)	6910.00 c	6707.00 d	7275.00 a	6964.1 a	
Kamali (V2)	0.00 (S0)	5614.00 j	5237.00 k	6247.00 f	5699.2 e	
	250 (S1)	6834.00 c	6141.00 h	6471.00 e	6481.9 d	
	500 (S2)	6651.00 d	6385.00 e	7214.00 a	6750.1 b	
Effect of V × P	Halawani	6002.0 e	5826.7 c	6589.3 b	Effect of variety	6139.4 b
	Kamali	6366.0 d	5921.2 f	6644.0 a		6310.4 a
Effect of S × P	0.00 (S0)	5244.1 h	5520.9 g	6179.9 f	Effect of sulfur	5648.3 c
	250 (S1)	6527.9 d	5554.7 c	6425.4 e		6169.3 b
	500 (S2)	6780.5 b	6546.3 cd	7244.5 a		6857.1 a
Effect of nutrient (P)		6184.2 c	5874.0 b	6616.6 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at (Pr≤0.05).

Table (3b): Effect of variety, sulfur, and nutrient and their interactions on the leaf area per cluster (cm²) in 2020 growing season.

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	4530.67 k	4719.50 j	4887.93 i	4712.70 f	
	250 (S1)	4779.67 j	4696.00 j	4947.15 i	4807.61 e	
	500 (S2)	5831.33 c	5965.00 b	6076.33 a	5957.56 a	
Kamali (V2)	0.00 (S0)	5265.55 g	4341.33 l	5039.52 h	4882.14 d	
	250 (S1)	5545.53 e	4374.33 l	5418.05 f	5112.89 b	
	500 (S2)	5796.33 c	5712.33 d	5774 cd	5760.89 b	
Effect of V × P	Halawani	5047.22 e	5126.83 c	5303.81 c	Effect of variety	5159.29 b
	Kamali	4809.33 f	5401.52 b	5535.81 a		5251.89 a
Effect of S × P	0.00 (S0)	4898.11 e	4530.42 f	4963.73 d	Effect of sulfur	4797.42 c
	250 (S1)	5162.60 c	4535.17 f	5182.60 c		4960.12 b
	500 (S2)	5813.83 b	5838.67 b	5925.17 a		5859.22 a
Effect of nutrient (P)		5291.51 b	4968.08 c	5357.17 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at ($P \leq 0.05$).

Main branch length (cm²)

Tables (4a and 4b) indicate the presence of significant effects of the study factors (variety, sulfur, and the nutrient Super Docson) and their interactions in the characteristic of the length of the main branch of the grapevine, as the results showed that the Halawani variety significantly exceeded the Kamali variety during the two seasons of the study with averages of (311.29 and 275.11 cm) during the season 2019 and 2020 respectively, and the effect of adding sulfur to the soil is noted for the significant superiority at the level of addition of 500 g. vine⁻¹ with averages of 343.78 and 307.27 cm during the seasons 2019 and 2020 respectively, while the Super Docson nutrient is shown to be superior to the concentrations 2.4 and 1.2 ml. L⁻¹ during the season 2019, by achieving the highest averages in significance, reaching 316 and 315.56 cm for the two concentrations, respectively, but during the season 2020, the concentration exceeded 2.4 ml- L⁻¹ significantly, by an average of 292 cm.

For the interaction between variety and sulfur, it is noted that the averages of interaction treatment for Halawani variety and Kamali variety for the first growing season with a sulfur level of 500 g. vine⁻¹ are observed the average interaction between the Halawani variety and the concentration was 2.4 ml. L⁻¹, with an average of 330.89 cm, without significant differences in the averages of the other interactions except for the average control (concentration 0), as for the 2020 season, the average interaction between the Halawani variety and the concentration 2.4 ml. L⁻¹ was significantly over the averages of the other interactions, and it reached 300.66 cm, and for the interaction between the averages of the effect of sulfur levels and the concentrations of the super Docson nutrient, the interaction averages between the level of 500 g. vine⁻¹ sulfur and the concentration of 2.4 ml. L⁻¹ nutrient, which reached 373 and 343.33 cm, for the two seasons respectively Significant differences from the averages of the rest of the interactions except for the interaction between the concentration of 1.2 ml. L⁻¹ nutrient and the levels 500 and 250 g. vine⁻¹ sulfur during the 2019 season.

For the triple interaction between the variety, sulfur and the nutrient, it is noticed that the averages of the triple interaction of the variety Halawani with the level of 500 g. vine⁻¹ sulfur and the concentration of 2.4 ml. L⁻¹ with averages of 396 and 356.66 cm for the seasons 2019 and 2020, respectively, is significantly superior to the averages of the rest of the interactions except the interaction of the two varieties with the level of 500 g. vine⁻¹ sulfur at the concentrations of 2.4 and 1.2 ml. L⁻¹ of the nutrient during the 2019 season.

Table (4a): Effect of variety, sulfur and nutrient and their interactions on main branch length (cm) for the 2019 season

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	243.33 def	288.33cde	266.67cde	266.11 c	
	250 (S1)	243.33 def	353.33 ab	330.00 b	308.89 b	
	500 (S2)	336.67 ab	344.00 ab	396.00 a	358.89 a	
Kamali (V2)	0.00 (S0)	200.00 f	240.00def	226.67 f	225.56 d	
	250 (S1)	246.67 def	316.67 bc	326.67 bc	296.67 c	
	500 (S2)	295.00bcd	341.00 ab	350.00 ab	328.67 ab	
Effect of V × P	Halawani	274.44 bc	328.56 a	330.89 a	Effect of variety	311.29 a
	Kamali	247.22 c	302.56 ab	301.11 ab		283.63 b
Effect of S × P	0.00 (S0)	221.67 d	269.17 c	246.67 c	Effect of sulfur	245.83 c
	250 (S1)	245.00 cd	235.00 ab	328.33 b		302.78 b
	500 (S2)	315.83 b	342.50 ab	373.00 a		343.78 a
Effect of nutrient (P)		260.83 b	315.56 a	316.00 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at ($P \leq 0.05$).

Table (4b): Effect of variety, sulfur, and nutrient and their interactions on main branch length (cm) for the 2020 season

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	220.00 jk	256.66 gh	243.33 hi	240.00 e	
	250 (S1)	229.00 ij	280.00 ef	302.00 cd	270.33 d	
	500 (S2)	286.00 de	302.33 cd	356.66 a	315.00 a	
Kamali (V2)	0.00 (S0)	181.66 l	203.33 k	210.00 k	198.33 f	
	250 (S1)	243.33 hi	296.00cde	310.00 c	283.11 c	
	500 (S2)	266.00 fg	302.66 cd	330.00 b	299.55 b	
Effect of V × P	Halawani	245.00 d	279.66 b	300.66 a	Effect of variety	275.11 a
	Kamali	230.33 e	267.33 c	283.33 b		260.33 b
Effect of S × P	0.00 (S0)	200.83 e	230.00 d	226.66 d	Effect of sulfur	219.16 c
	250 (S1)	236.16 d	288.00 c	306.00 b		276.72 b
	500 (S2)	276.00 c	302.50 b	343.33 a		307.27 a
Effect of nutrient (P)		237.66 c	273.50 b	292.00 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at ($P \leq 0.05$).

Leaf content of relative chlorophyll (SPAD):

Tables (5a and 5b) showed that the Halawani variety had significantly surpassed the Kamali variety by averages of 35.31 and 34.42 SPAD during the seasons 2019 and 2020, respectively. The sulfur addition was observed to exceed the level of the addition of 500 g. vine⁻¹ was significant, with averages of 32.68 and 31.79 SPAD during the two seasons respectively, and for the effect of the nutrient Super Docson, it was evident that the higher concentration 2.4 ml. L⁻¹ was higher by achieving the highest means, which amounted to 32.39 and 31.66 SPAD during the two seasons respectively.

For the interaction between the varieties and sulfur, the interaction treatment Halawani and 500 gS. vine⁻¹ was shown significantly over the averages of the rest of the interactions, reaching 37.05 and 35.82 SPAD for the two seasons respectively. The interaction treatment Halawani and 2.4 ml L⁻¹ of Super Docson nutrient observed the superiority of the averages reaching 36.64 and 35.74 SPAD for the two seasons respectively, with a significant superiority over the averages of the rest of the interactions except for the interaction of the Halawani variety with a concentration of 1.2 ml. L⁻¹. For the interaction between sulfur and super docson nutrient, the interaction treatment between 500 gS vine⁻¹ sulfur and 2.4 ml. L⁻¹ was significantly higher than the remaining averages, as it achieved 35.60 and 34.20 SPAD for the two seasons, respectively.

The triple interaction between study factors showed that the superiority of the averages of the triple interaction of the Halawani variety with the level of 500 g. vine⁻¹ sulfur and the concentration of 2.4 ml. L⁻¹ with averages of 39.23 and 37.16 SPAD for the seasons 2019 and 2020 respectively, in addition to the superiority of the average interaction between the variety Halawani with the level is 500 g. vine⁻¹ sulfur and the concentration is 1.2 ml. L⁻¹ is significant during the 2020 season with an average of 36.20 SPAD.

Table (5a): Effect of variety, sulfur and nutrient and their interactions on leaf chlorophyll content (SPAD) in 2019 season

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	32.10 d	33.83 d	34.66 bc	33.53 c	
	250 (S1)	34.30 cd	35.70b c	36.03 bc	35.34 b	
	500 (S2)	35.00 bc	36.93 b	39.23 a	37.05 a	
Kamali (V2)	0.00 (S0)	21.46 i	23.50 hi	24.83 gh	23.26 f	
	250 (S1)	22.43 i	26.76 g	27.63 ef	25.61 e	
	500 (S2)	23.30 i	29.70 e	31.96 d	28.32 d	
Effect of V × P	Halawani	33.80 b	35.48 a	36.64 a	Effect of variety	35.31 a
	Kamali	22.40 e	26.65 d	28.14 c		25.73 b
Effect of S × P	0.00 (S0)	26.78 f	28.66 e	29.75 de	Effect of sulfur	28.40 c
	250 (S1)	28.36 e	31.23 d	31.83 cd		30.47 b
	500 (S2)	29.15 e	33.31 b	35.60 a		32.68 a
Effect of nutrient (P)		28.10 c	31.07 b	32.39 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at (Pr≤0.05).

Table (5b): Effect of variety, sulfur and nutrient and their interactions on leaf chlorophyll content (SPAD) in 2020 season

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	31.73 f	32.16 f	34.36 de	32.75 c	
	250 (S1)	33.43 e	34.93 cd	35.70 bc	34.68 b	
	500 (S2)	34.10 de	36.20a b	37.16 a	35.82 a	
Kamali (V2)	0.00 (S0)	21.16 k	23.00 j	24.53 i	22.90 f	
	250 (S1)	22.50 j	26.16 h	27.01 h	25.22 e	
	500 (S2)	23.03 j	29.03 g	31.23 f	27.76 d	
Effect of V × P	Halawani	33.08 c	34.43 b	35.74 a	Effect of variety	34.42 a
	Kamali	22.23 f	26.06 e	27.59 d		25.29 b
Effect of S × P	0.00 (S0)	26.45 h	27.58 g	29.45 e	Effect of sulfur	27.82 c
	250 (S1)	27.96 gf	30.55 d	31.35 c		29.59 b
	500 (S2)	28.56 f	32.61 b	34.20 a		31.79 a
Effect of nutrient (P)		27.66 c	30.25 b	31.66 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at ($Pr \leq 0.05$).

The results were appeared in Tables (2a and 2b), (3a and 3b), (4a and 4b) and (5a and 5b), which showed significant effects of varieties, sulfur, and super Docson nutrient and the different interactions between them in the characteristics of leaf area, leaves area per cluster, main branch length and leaf content of chlorophyll. Respect to the varieties effect, may be interpreted in that the variation in the amount of the total leaf area of the vine and that allocated to the cluster provided by the variety may be due to the difference in the genetic structure of those varieties and their behavior in the distribution and concentration of the leaf area on the different parts of the plant, and these results indicate the existence of a complementary and positive relationship in growth between the main food processing center in the plant (leaf) and the plant's structure and source of strength (main branch and chlorophyll) (Al-Jubouri, 2013) and (Al-Douri, 2014).

The effect of sulfur in increasing the leaf area is due to its positive role in increasing the division and elongation of cells as well as its role in the formation of chlorophyll (Al-Taafi, 2005) and (Al-Araji, 2013).

As for the effect of the nutrient Super Docson, which includes a group of micro-nutrients, the increase in its effectiveness can be attributed to the increase in its concentration to the provision of good leaf nutrition, the increase in the biological representation of chlorophyll, the increase in the number of leaves, vine growth strength. (Alleviation, 2004) (Vasconcelos and Castagnoli, 2001).

It was also evident that the foliar spray with the Super Docson Nutrient showed a high superiority with a significant increase in the parameters of the two concentrations 1.2 and 2.4 ml. L⁻¹ compared to the control treatment, and these increases can be attributed to the roles of the micro-elements added by the spray solutions in many physiological processes as an increase in the content of Chlorophyll in leaves is necessary to raise the efficiency of the photosynthesis process, the formation of the amino acid Tryptophan, which is necessary for elongation of cells, (Mengel And Kirkby, 2000).

Yield of vine (kg vine⁻¹)

Tables (6a and 6b) show that the study factors of varieties, sulfur and super Docson nutrient and their interactions had a significant effect on the yield characteristic of the grapevine, as for the effect of the varieties, it showed that the Halawani variety had significantly superior to the Kamali variety by averages of 10.49 and 9.79 kg. vine⁻¹ for 2019 and 2020, respectively, the effect of adding sulfur during the 2019 season shows that the additive level 500 g. vine⁻¹ was exceeded significant, with an average of 11.51 kg. vine⁻¹, and the level 250 g. vine⁻¹, with an average of 10.09 kg. vine⁻¹, while during the 2020 season, the level of addition 500 gm. vine⁻¹ exceeded with an average of 10.63 kg. vine⁻¹, and for the effect of the nutrient Super Docson, the superiority of the two concentrations 2.4 and 1.2 ml. L⁻¹ was evident during the 2019 season by achieving the highest significant averages, reaching 11.48 and 10.52 kg, respectively. During the 2020 season, the concentration 2.4 ml. L⁻¹ exceeded significantly, with an average of 10.93 kg. vine⁻¹.

For the interaction between the variety and sulfur, it is noticed that the average interaction treatment for the variety Halawani exceeded the sulfur level of 500 g. vine⁻¹ significantly over the averages of the rest of the interactions, reaching 12.34 and 10.95 kg. vine⁻¹ for the two seasons respectively, as for the effect of the interaction between the variety and the super docson nutrient concentration interaction averages of the Halawani variety with a concentration of 2.4 ml. L⁻¹ of the nutrient significantly exceeded the averages of the rest of the interactions, reaching 12.49 and 11.84 kg. vine⁻¹ for the two seasons respectively, and for the interaction between the averages of the effect of sulfur levels and the concentrations of the super docson nutrient during the 2019 season, the superiority was observed. The average interaction between the level of 500 g. vine⁻¹ sulfur and the two concentrations 1.2 and 2.4 ml. L⁻¹ nutrient was a significant, reaching 13.03 and 12.81 kg. vine⁻¹ for the two concentrations, respectively, during the 2020 season, the average interaction between the level exceeded 500 g. vine⁻¹ sulfur and concentration of 2.4 ml. L⁻¹ significant nutrient with a value of 12.15 kg. vine⁻¹.

For the triple interaction between the variety, sulfur and the super docson nutrient, it shows the superiority of the triple interaction averages of the Halawani variety with the level of 500 g. vine⁻¹ sulfur and the concentration of 1.2 ml. L⁻¹ by 14.56 kg. vine⁻¹ during the season 2019, while during the season 2020, the averages of the interaction between the variety were achieved. Halawani with levels 500 and 250 g. vine⁻¹ sulfur at a concentration of 2.4 ml. L⁻¹ of the nutrient significantly exceed the averages of the rest of the interactions with values of 13.27 and 12.71 kg. vine⁻¹.

Table (6a): Effect of variety, sulfur and nutrient and their interactions on vine yield (kg) for the 2019 season

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	7.90 d	7.70 d	10.37 cd	8.26 b	
	250 (S1)	7.84 d	10.64 a-d	12.94 abc	10.48 ab	
	500 (S2)	8.33 d	14.56 a	14.15 ab	12.34 a	
Kamali (V2)	0.00 (S0)	7.36 d	8.97 cd	9.09 cd	8.47 b	
	250 (S1)	8.47 d	9.47 cd	10.88 a-d	9.70 b	
	500 (S2)	9.09 cd	11.49 a-d	11.47 a-d	10.69 ab	
Effect of V × P	Halawani	8.02 c	10.97 ab	12.49 a	Effect of variety	10.49 a
	Kamali	8.31 c	10.07 bc	10.48 ab		9.62 b
Effect of S × P	0.00 (S0)	7.63 c	8.33 c	9.73 bc	Effect of sulfur	8.56 b
	250 (S1)	8.15 c	10.18 bc	11.91 ab		10.09 a
	500 (S2)	8.71 c	13.03 a	12.81 a		11.51 a
Effect of nutrient (P)		8.16 b	10.52 a	11.48 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at ($Pr \leq 0.05$).

Table (6b): Effect of variety, sulfur and nutrient and their interactions on vine yield (kg) for the 2020 season

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	7.41 gh	7.77 gh	9.53 de	8.24 d	
	250 (S1)	7.38 gh	10.46 bcd	12.71 a	10.18 b	
	500 (S2)	8.19 fg	11.38 b	13.27 a	10.95 a	
Kamali (V2)	0.00 (S0)	6.92 h	8.81 ef	8.85 ef	8.19 d	
	250 (S1)	7.49 gh	5.59 de	10.16 cd	9.08 c	
	500 (S2)	8.76 ef	11.17 cb	11.04 cb	10.32 b	
Effect of V × P	Halawani	7.66 c	9.87 b	11.84 a	Effect of variety	9.79 a
	Kamali	7.72 c	9.85 b	10.02 b		9.20 b
Effect of S × P	0.00 (S0)	7.16 f	8.29 e	9.19 d	Effect of sulfur	8.22 c
	250 (S1)	7.44 f	10.02 c	11.44 b		9.63 b
	500 (S2)	8.47 e	11.27 b	12.15 a		10.63 a
Effect of nutrient (P)		7.69 c	9.86 b	10.93 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at ($Pr \leq 0.05$).

Total yield (tons. ha⁻¹)

Tables (7a and 7b) appeared

that the Halawani variety has exceeded the Kamali variety significantly with total yield average of 13.29 and 12.24 tons. ha⁻¹ during the 2019 and 2020 seasons respectively. the two level of sulfur addition exceeded significantly the control treatment with averages of 14.39 and 13.29 tons. ha⁻¹ for the two seasons respectively.

the nutrient Super Docson, the concentration of 2.4 and 1.2 ml L⁻¹ achieved the highest averages, which amounted to 14.36 and 13.66 tons. ha⁻¹ respectively for the two seasons respectively. For the interaction between the variety and sulfur, it is noticed that the interaction treatment between Halawani or Kamali and 500 g S vine⁻¹ exceeded significantly the rest of the interactions, reaching 15.43 and 13.68 tons. ha⁻¹ for the two seasons respectively, as for the effect of the interaction between the variety and the super docson nutrient concentration shows the superiority of the average interaction for the Halawani variety with a concentration of 2.4 ml. L⁻¹ of the nutrient significantly over the averages of the rest of the interactions, reaching 15.61 and 14.80 tons. ha⁻¹ for the two seasons respectively, and for the averages of the interaction between the effect of sulfur levels and the concentrations of the super docson nutrient during the 2019 season, the interaction averages between the level of 500 g. vine⁻¹ sulfur and the two concentrations 1.2 and 2.4 ml. L⁻¹ were significant nutrient in addition to the level of 250 g. vine⁻¹ sulfur and the concentration was 2.4 ml. L⁻¹ nutrient with values of 16.28, 16.01 and 14.89 tons. ha⁻¹ respectively, but during the 2020 season, the average interaction between the level of 500 g. vine⁻¹ sulfur and the concentration of 2.4 ml. L⁻¹ nutrient was a significant with a value of 15.19 tons. ha⁻¹.

For the triple interaction between the variety, sulfur and super docson nutrient, it shows the superiority of the triple interaction averages of the Halawani variety with the level of 500 g. vine⁻¹ sulfur and the concentration of 1.2 ml. L⁻¹ by 18.20 tons. ha⁻¹ during the season 2019, while during the season 2020 it achieved the average interaction between the variety Halawani with the level 500

gm. vine⁻¹ sulfur at a concentration of 2.4 ml. L⁻¹ of the nutrient significantly exceed the averages of the rest of the interactions, as it recorded 16.59 tons. ha⁻¹.

Table (7a): Effect of variety, sulfur and nutrient and their interactions on total yield (tons. ha⁻¹) for the 2019 season

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	9.87 d	10.13 d	12.96 cd	11.10 b	
	250 (S1)	9.80 d	13.31 a-d	16.18 abc	13.10 ab	
	500 (S2)	10.41 d	18.20 a	17.68 ab	15.43 a	
Kamali (V2)	0.00 (S0)	9.20 d	11.21 cd	11.36 cd	10.59 b	
	250 (S1)	10.59 d	12.18 cd	13.60 a-d	12.12 b	
	500 (S2)	11.36 cd	14.37 a-d	14.34 a-d	13.36 ab	
Effect of V × P	Halawani	10.03 d	14.35 ab	15.61 a	Effect of variety	13.29 a
	Kamali	10.38 cd	12.58 bcd	13.10 abc		12.02 b
Effect of S × P	0.00 (S0)	9.54 d	10.78 d	12.16 cd	Effect of sulfur	10.83 b
	250 (S1)	10.19d	12.74b cd	14.89 abc		12.61 a
	500 (S2)	10.88 d	16.28 a	16.01 ab		14.39 a
Effect of nutrient (P)		10.20 b	13.41 a	14.36 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at (Pr≤0.05).

Table (7b): Effect of variety, sulfur and nutrient and their interactions on total yield (tons. ha⁻¹) for the 2020 season

Variety (V)	Sulfur (S) (g.vine ⁻¹)	Super Docson nutrient (ml. L ⁻¹)			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani (V1)	0.00 (S0)	9.27 hi	9.72 gh	11.92 e	10.30 d	
	250 (S1)	9.23 hi	13.07 cd	15.89 a	12.73 b	
	500 (S2)	10.24 fg	14.23 b	16.59 a	13.68 a	
Kamali (V2)	0.00 (S0)	8.65 i	11.01 f	11.06 f	10.24 d	
	250 (S1)	9.37 hi	11.99 e	12.71d e	11.35 c	
		10.95 f	13.96 b	13.80b c	12.90 b	
Effect of V × P	Halawani	9.58 c	12.34 b	14.80 a	Effect of variety	12.24 a
	Kamali	9.65 c	12.32 b	12.52 b		11.50 b
Effect of S × P	0.00 (S0)	8.96 f	10.37 e	11.49 d	Effect of sulfur	10.27 c
	250 (S1)	9.30 f	12.53 c	14.30 b		12.04 b
	500 (S2)	10.59 e	14.09 b	15.19 a		13.29 a
Effect of nutrient (P)		9.62 c	12.33 b	13.66 a		

The values in front of them are the same or similar letters, there are no significant differences between them according to the Duncan Mutable Range test at (Pr≤0.05).

The results appearing in Tables (6a and 6b) and (7a and 7b), which showed significant effects of varieties, sulfur, super docson nutrient, and the different interactions between them in the vine yield and total yield characteristics, can be interpreted for the varieties in that the variation in the yield and its components has been revised. It is one of the complex genetic characteristics that are controlled by many genetic factors, as the number of clusters is affected by the number of fertile branches of the variety and the relationship between them is direct, and the number of clusters varies from year to year for the same variety, as well as the increase in the number of clusters, the increase in the leaf area works on increasing their weight, and this is through increasing the share of

each cluster of foodstuffs processed in the leaves and reducing competition between clusters, as clusters are the strongest consumers of photosynthesis products (Al-Saeedi, 2010) and (Abu Nuqtah and Batha, 2010).

The positive role of adding sulfur to the soil may be attributed to increasing the available nutrients, including nitrogen, phosphorous, potassium, and some micro-nutrients such as iron, manganese, zinc and copper, which have a role in increasing the formation of cytokinein, which is responsible for increasing plant branches, increasing the fertilization process, and providing fruits with nutrients resulting from the photosynthesis process. This is consistent with the findings of Al-Fahdawi (2008) and Kazem (2016).

As for the effect of the nutrient Super Docson, which includes a group of micronutrients, the increase in its effectiveness can be attributed to the increase in its concentration to provide good nutrition for the leaves, increase the bio-representation of chlorophyll, number of leaves and leaf area, increase the strength of the growth of the vines and thus increase the total yield and its component qualities, as well as the elements micronutrients, such as boron, activate the process of photosynthesis and contribute to the representation of sugars in leaves and their transfer to flowering and fruiting clusters, which ensures good feeding of clusters, which increases the share of each cluster of flowers and thus reduces competition between clusters for nutrients and hormones manufactured in leaf, leading to the development of the largest number of clusters (Al-Saeedi, 2003) and (Messenger, 2008).

Recommendation

1. showed results significant for halwani variety in most studied traits.
2. sulfur level of 500 g. vine⁻¹ was superior significantly in all studied traits .
3. the results showed excellence at concentrate 2.4 ml. L⁻¹ for nutrient in all studied traits.

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الخلاصة

اجريت هذه الدراسة خلال موسمي النمو (2019 و 2020) على كرمات العنب صنف حلواني وكمالي في بستان العنب التابع لقسم البستنة وهندسة الحدائق كلية الزراعة/ جامعة تكريت والمزروعة عام (2016) والمربات بطريق التربية على القمريات وبمسافات زراعة 4×2 متر وارتفاع 2 متر. تم اجراء تجربة عاملية بثلاثة عوامل العامل الأول هو الأصناف حلواني (V₁) وكمالي (V₂)، اما العامل الثاني فهو إضافة الكبريت الزراعي (S) الى التربة، بثلاثة مستويات هي S₀ (عدم إضافة الكبريت الزراعي الى التربة)، S₁ (إضافة الكبريت الزراعي الى التربة بكمية 250 غم. كرمة⁻¹)، S₂ (إضافة الكبريت الزراعي بكمية 500 غم. كرمة⁻¹). والعامل الثالث الرش بالمغذي Super Docson بثلاثة تراكيز هي P₀ (الرش بالماء المقطر فقط بدون مغذي)، P₁ (الرش بالمغذي Super Docson بتركيز 1.2 مل.لتر⁻¹ ماء)، P₂ (الرش بالمغذي Super Docson بتركيز 2.4 مل. لتر⁻¹ ماء)، نفذت التجربة بنظام الألواح المنشقة وفق تصميم القطاعات العشوائية الكاملة (RCBD) حيث أخذت الأصناف الألواح الرئيسية Main Plot، فيما وزعت معاملات الكبريت والمغذي على الألواح الثانوية Sub Plot، بثلاثة مكررات وبينت النتائج: ان الصنف حلواني قد تفوق على الصنف كمالي في أغلب الصفات المدروسة والتي تضمنت (طول الفرع الرئيسي، محتوى الاوراق من الكلوروفيل، حاصل الكرمة الواحدة والحاصل الكلي ولكلا الموسمين). كما اظهر التركيز 2.4 مل.لتر⁻¹ ماء للمغذي والمستوى 500 غم للكبريت تفوقا واضحا في اغلب الصفات المدروسة.