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## Effect of sulfur and the nutrient Super Docson Fertilization on the leaves content of the mineral elements of two grape varieties, *Vitis vinifera* L.

### ABSTRACT

The study was conducted during the two growing seasons (2019 and 2020) on grape vines in the Lubnianian Halawani and Kamali varieties in the orchard of grapes cultivated in 2016 in the Department of Horticulture and Landscape Design - College of Agriculture- University of Tikrit,. An experiment was including three factors, the first was considering the varieties (Halawani and Kamali), and the second factor was the addition of Agricultural Sulfur (S) to the soil, at three levels, S0 (no sulfur added), S1 (250 g. Grapevine-1), S2 (500 gm. Grapevine-1). The third factor was spraying the leaves with Super Docson nutrient at three different concentrations: P0 (spraying with distilled water), P1 (spraying with the Super Docson nutrient with three concentrations: P0 (spraying with distilled water), P1 (at a concentration of 1.2 ml. L-1 water), and P2 (at a concentration of 2.4 ml. L-1 water), and the Super Docson nutrient sprays which contains the diffuser (Tween 20) was applied in early morning and until complete wetness A factorial experiment was carried out with the split plot system according to the Randomized Complete Block Design (RCBD), where the varieties took the main plates, while the sulfur and nutrient treatments and their interactions were randomly distributed on the sub plot by three replications and the results showed: The Halawani variety superiority in most of the studied traits at the level (250 g. Vine-1) and the concentration (1.2 ml. L-1), except for the concentration of the element phosphorus in the leaves, where the Kamali variety was superior in this characteristic as perfection at the same level and concentration. The double interaction between sulfur and nutrient exceeded the level (250 g. Vine-1) and the concentration (1.2 ml. L-1) in most of the studied traits and for both seasons. As for the triple interaction between the variety, sulfur and nutrient, the Halawani variety was superior at the level (250 g. Vine-1) and concentration (1.2 ml. L-1) in most of the studied traits for both seasons.

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## INTRODUCTION

The grape *Vitis vinifera* L is an important horticultural crop all over the world including Iraq, and 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, and 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 area agreed upon by most botanists that it is the origin of the European grape *Vitis vinifera* L.,

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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-Saeedi, 2000).

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 operations, and the fertilizers added to the soil may not be ready for absorption by the plant, and may be used by the revival of the soil or washed out as a result of continuous irrigation. The method of fertilization by spraying the shoots of trees is a modern and effective method to compensate the lack of nutrients (Paparozzi & Tukey, 1979). Research and 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 uncomfortable for the plant to eliminate this problem, nutrients are used, including sulfur (Krishnamoorthy, 1981).

Pepper and Miller (1978) emphasized that symptoms of sulfur deficiency in soils and plants are found in many areas of the world. Sulfur is added to the soil either to meet the plants need of this element in soils that suffer from its deficiency and because it is a necessary element for plant growth, or it is added with the aim of reducing the degree of soil reaction (pH) to reclaim and increase its fertility to increase the productivity of the various crops grown, as it is added before a period to give time Sufficient for sulfur oxidation to show affects the pH of soil and increases its acidity (Al-Naimi, 1999).

The study of micronutrients effect on plants is of great importance in agricultural production, as it was found through experiments that the 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). Foliar fertilization is one of the important signs of modern agricultural development methods, as research and experiments have proven the possibility of supplying plants, fruit trees and other crops with the elements, which Hadi and Khalil (2015) pointed out that spraying with five types of nutrients is (algarain algae extract 6 ml. L<sup>-1</sup>, boron 3 ml, iron 3 ml, gibberellin 150 mg. L<sup>-1</sup> and the comparison treatment without spray) on the grape vines of the Halawani variety at the age of six years gave a significant increase in the leaves content of NPK.

This study aimed to know the effect of agricultural Sulfur and nutrient Super Docson on the growth and fruiting of both varieties (Halawani and Kamali) and their effect on the leaf content of nutrients.

### **Materials and methods**

This study was conducted during the two growing seasons (2019 and 2020) on grape vines Halawani and Kamali varieties in the grape orchard cultivated in 2016 and located at the Department of Horticulture and Garden Engineering of the college of Agriculture / Tikrit University and the breeders by the Pergola method, with planting distances of 2 x 4 meters, 2 meters high above soil surface specifications in Table (1). A factorial experiment was conducted with three factors, the first factor was the varieties Halawani (V<sub>1</sub>) and Kamali (V<sub>2</sub>), while the second factor was the addition of agricultural sulfur S to the soil, at three different levels, S<sub>0</sub> (not adding agricultural sulfur to the soil), S<sub>1</sub> (adding agricultural sulfur to the soil in an amount of 250 g. vine<sup>-1</sup>), S<sub>2</sub> (add agricultural sulfur in an amount of 500 g. Vine<sup>-1</sup>). The third factor was the application of nutrient sprays (Super Docson), as the vines were sprayed three different periods, first, before the flower clusters opened, the second spray when the grains reached the size of a chickpea seed and the third spray a month after the first spray, at three different concentrations: P<sub>0</sub> (spraying with

distilled water only without the nutrient), P<sub>1</sub> (spraying with Super Docson nutrient at a concentration of 1.2 ml. L<sup>-1</sup> water), P<sub>2</sub> (spraying with the nutrient Super Docson at a concentration of 2.4 ml. L<sup>-1</sup> water). The spraying was carried out early in the morning until complete wet. Note that diffuser Tween20 was also added

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

The treat	The value	The unit	The treat	The unit	The value
Sand	459	g. Kg <sup>-1</sup>	Bulk density	Mica gram. m <sup>-3</sup>	1.34
Silt	308		PH		7.61
Clay	233		Dissolved ions		
Soil texture	S – C – L				
Electrical conductivity	2.33	dacey Siemens. m <sup>-1</sup>	Calcium	mmol. L <sup>-1</sup>	12.84
Positive ion exchange capacity	15.21	Centimole. Kg <sup>-1</sup>	magnesium		4.70
Organic matter	7.01	g. kg <sup>-1</sup> soil	Potassium		0.41
Carbonate minerals	209		Sodium		1.33
Gypsum	49.28		Chloride		2.77
Available Potassium	110.88	ml. kg <sup>-1</sup>	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.

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.

A factorial experiment was designed with the split plots system according to the Randomized Complete Block Design (RCBD) with three factors (varieties, sulfur, and Super Docson nutrient). The items took the main plots, while the sulfur and nutrient coefficients and their interaction were distributed randomly on the subplots, so we had eighteen treatments, it resulted from the different interactions of the study factors, and it was distributed into three replicates to include the experiment 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 were selected for the Halawani variety and 27 grape vines for the Kamali variety (one vine for each experimental unit), five stems of 12 eyes length and five regenerative spurs were left for each vine, and the decomposing organic fertilizer (decomposing sheep manure) was added in December 2018 With the addition of DAP fertilizer NP type (Saudi SABIC) in a ratio of 46:18, at a rate of 250 grams of vine<sup>-1</sup>, 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<sup>-1</sup> for each batch for all the studied vines. The concentration of the element nitrogen%, phosphorous%, potassium%, sulfur%, magnesium%, and calcium% were studied, and the data were collected using Microsoft office excel program, and then statistically analyzed using the statistical analysis system (SAS), according to the experimental design used (split plots system according to the Randomized Complete Block Design), as the averages were compared according to the Duncan Multiple Range Test at a probability level of 0.05 to find out the significant differences between the mean of the parameters as reported by Al-Rawi and Khalaf Allah (2000).

## Results and Discussion

### Nitrogen concentration (%) in leaves

Tables (2a and 2b) show that the study factors of the varieties, sulfur and nutrient Super Docson and their interactions had a significant effect on the percentage of nitrogen concentration in the leaves of the plant. As for the effect of sulfur addition, the level of addition exceeded 250 g.

**Table (2a): Effect of variety, sulfur, and nutrient and their interactions on nitrogen concentration (%) for the 2019 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	1.49 g	1.64b cd	1.60 cde	1.58 a	
	250	1.54 efg	1.66 bc	1.53 efg	1.58 a	
	500	1.52 g	1.57 def	1.55 efg	1.55 a	
Kamali	0	1.28 i	1.66 b	1.58 def	1.50 b	
	250	1.38 h	1.76 a	1.54 efg	1.56 a	
	500	1.34 h	1.69 b	1.40 h	1.48 b	
Effect of variety and nutrient interaction	Halawani	1.52 d	1.62 b	1.56 c	Effect of variety	1.57 a
	Kamali	1.33 e	1.70 a	1.51 d		1.52 b
Effect of sulfur and nutrient interaction	0	1.38 f	1.65 b	1.59 c	Effect of sulfur	1.54 b
	250	1.46 e	1.71 a	1.54 d		1.57 a
	500	1.43 e	1.63 b	1.47 e		1.51 c
Effect of nutrient		1.42 c	1.66 a	1.53 b		

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 (2b): Effect of variety, sulfur, and nutrient and their interactions on nitrogen concentration (%) for the 2020 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	1.43 k	1.61 d	1.57 e	1.54 a	
	250	1.49 i	1.62 c	1.51 h	1.54 a	
	500	1.46 j	1.56 f	1.53 g	1.51 b	
Kamali	0	1.25 o	1.64 b	1.58 e	1.49 c	
	250	1.35 m	1.67 a	1.53 g	1.51 b	
	500	1.33 n	1.64 b	1.37 l	1.45 d	
Effect of variety and nutrient interaction	Halawani	1.46 e	1.60 b	1.54 c	Effect of variety	1.53 a
	Kamali	1.31 f	1.65 a	1.49 d		1.48 b
Effect of sulfur and nutrient interaction	0	1.34 i	1.63 b	1.57 d	Effect of sulfur	1.51 b
	250	1.42 g	1.64 a	1.52 e		1.53 a
	500	1.39 h	1.60 c	1.45 f		1.48 c
Effect of nutrient		1.38 c	1.67 a	1.52 b		

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).

vine<sup>-1</sup> was significant with averages of 1.57 and 1.53% for the two seasons respectively, and for the effect of the super Docson nutrient, the concentration of 1.2 ml. L<sup>-1</sup> was evident by achieving

the best averages significantly, which amounted to 1.66 and 1.67% for the two seasons respectively. As for the interaction between the variety and sulfur, during the 2019 season, the interactions of the Halawani variety with the sulfur levels 0 and 250 g. vine<sup>-1</sup> were significant, with an average of 1.58% each, followed by the average interaction of the variety Kamali with the sulfur level of 250 g. vine<sup>-1</sup> and the variety Halawani with the sulfur level 500. g. vine<sup>-1</sup>, which amounted to 1.56 and 1.55% for each, respectively, while during the 2020 season, the interactions of the Halawani variety with sulfur levels 0 and 250 g. vine<sup>-1</sup> were significantly superior with an average was 1.54% for each, as for the effect of the interaction between the variety. The nutrient super Docson concentration exceeded the interaction for the Kamali variety with the concentration of 1.2 ml. L<sup>-1</sup> for the nutrient in achieving the best means, which were 1.70 and 1.65% for the two seasons respectively, and the interaction between the averages of the effect of sulfur levels and the concentrations of the super Docson nutrient shows the superiority of the interaction between the level 250 g. vine<sup>-1</sup> sulfur and concentration of 1.2 ml. L<sup>-1</sup> was a significant nutrient in achieving the best averages, which amounted to 1.71 and 1.64% for the seasons 2019 and 2020, respectively. For the triple interaction between variety, sulfur and nutrient, it is noticed that the variety Kamali was superior with the level of 250 g, vine<sup>-1</sup> sulfur and the concentration of 1.2 ml. L<sup>-1</sup> in achieving the best significant averages of 1.76 and 1.67% during the seasons 2019 and 2020, respectively.

#### Phosphorous concentration (%) in leaves

From Tables (3 a and b), the varieties, sulfur, and Super Docson nutrient and their interactions had a significant effect on the percentage of phosphorus concentration in plant leaves, as it shows the superiority of the Kamali variety significantly compared to the Halawani variety in the percentage of phosphorus concentration with averages of 0.300 and 0.285% during the two seasons of the study 2019 and 2020,

**Table (3a): Effect of variety, sulfur, and nutrient and their interactions on phosphorus concentration (%) for the 2019 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	0.100 h	0.120 gh	0.110 gh	0.110 e	
	250	0.111 gh	0.135 e	0.147 e	0.131 d	
	500	0.105 h	0.140 ef	0.130 efg	0.125 d	
Kamali	0	0.256 d	0.276 d	0.258 d	0.263 c	
	250	0.266 d	0.362 a	0.377 a	0.335 a	
	500	0.269 d	0.342 b	0.297 c	0.302 b	
Effect of variety and nutrient interaction	Halawani	0.105 e	0.132 d	0.129 d	Effect of variety	0.122 b
	Kamali	0.263 c	0.327 a	0.311 b		0.300 a
Effect of sulfur and nutrient interaction	0	0.178 e	0.198 d	0.184 de	Effect of sulfur	0.186 c
	250	0.188 de	0.249 ab	0.262 a		0.233 a
	500	0.187 de	0.241 b	0.213 c		0.214 b
Effect of nutrient		0.184c	0.229 a	0.220 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).

as for the effect of adding sulfur, the level of addition was shown to exceed 250 g. vine<sup>-1</sup> was significant, with averages of 0.233 and 0.266% for the two seasons respectively, and for the effect of the nutrient Super Docson, it was evident that the concentration of 1.2 ml. L<sup>-1</sup> was superior to achieving the best averages significantly, which amounted to 0.229 and 0.218% for the two

seasons respectively. As for the interaction between the variety and the sulfur superiority of the Kamali variety with the level of 250 g. vine<sup>-1</sup> is significant with averages of 0.335 and 0.326% for the two seasons respectively, as for the effect of the interaction between the variety and the concentration of the nutrient Super Docson, the superiority of the interaction for the variety Kamali with a concentration of 1.2 ml. L<sup>-1</sup> for the nutrient in achieving the best means significantly, which amounted to 0.327 and 0.310% for the two seasons respectively, and for the interaction between the averages of the effect of sulfur levels and the concentrations of the nutrient Super Docson, the superiority of the interaction between the level of 250 g. vine<sup>-1</sup> sulfur and the concentration of 2.4 ml. L<sup>-1</sup> achieving the best averages of 0.262 and 0.256% for the seasons 2019 and 2020, respectively. For the triple interaction between variety, sulfur and nutrient, the variety Kamali surpassed with the level of 250 g. vine<sup>-1</sup> sulfur and the concentration of 2.4 ml. L<sup>-1</sup> in achieving the best significant averages of 0.377 and 0.368% during the seasons 2019 and 2020, respectively.

**Table (3b): Effect of variety, sulfur and nutrient and their interactions on phosphorus concentration (%) for the season 2020**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	0.092 m	0.109 k	0.099 l	0.100 f	
	250	0.102 l	0.130 j	0.144 h	0.125 d	
	500	0.100 l	0.136 i	0.128 j	0.121 e	
Kamali	0	0.229 g	0.253 e	0.240 f	0.241 c	
	250	0.256 e	0.355 b	0.368 a	0.326 a	
	500	0.253 e	0.323 c	0.290 d	0.288 b	
Effect of variety and nutrient interaction	Halawani	0.098 e	0.125 d	0.123 d	Effect of variety	0.115 b
	Kamali	0.246 c	0.310 a	0.299 b		0.285 a
Effect of sulfur and nutrient interaction	0	0.161 h	0.181 e	0.169 g	Effect of sulfur	0.170 c
	250	0.179 fe	0.242 b	0.256 a		0.226 a
	500	0.176 f	0.229 c	0.209 d		0.205 b
Effect of nutrient		0.172 c	0.218 a	0.211 b		

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).

### Potassium concentration (%) in leaves

Tables (4a and 4b) show that the study factors of the varieties, sulfur and super Docson nutrient and their interactions had a significant effect on the percentage of the potassium element concentration in the leaves of the plant for the two seasons of the study, as for the effect of sulfur addition, the level of addition exceeded 250 g. vine<sup>-1</sup> and the level of 500 g. vine<sup>-1</sup> during the 2019 season were significant, with averages of 1.38 and 1.33% for the two seasons respectively, and for the effect of the nutrient Super Docson, the concentration of 1.2 ml. L<sup>-1</sup> by achieving the best averages, which amounted to 1.46 and 1.38% for the two seasons, respectively. As for the interaction between the variety and the sulfur, the Halawani variety with the level was 250 gm. vine<sup>-1</sup> was significant with averages of 1.51 and 1.45% for the two seasons respectively, followed by the average interaction of the Halawani variety with the level of 500 g. vine<sup>-1</sup> during the 2019 season, which reached 1.49% without significant difference from the superior average, as for the effect of the interaction between the variety and the concentration of the nutrient Super Docson, superiority the Halawani variety with a concentration of 1.2 ml. L<sup>-1</sup> of the nutrient was shown in achieving the best averages significantly, which amounted to 1.58 and 1.49% 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, the interaction between the level of 500 g. vine<sup>-1</sup> sulfur and concentration of 1.2 ml. L<sup>-1</sup> nutrient was a significant during the 2019 season, and the interaction between the level of 250 g. vine<sup>-1</sup> sulfur and the concentration of 1.2 ml. L<sup>-1</sup> nutrient was a significant during the 2020 season with averages of 1.53 and 1.45% each, respectively. For the triple interaction between the variety, sulfur and nutrient, the triple interaction of the Halawani variety with the level of 500 g. vine<sup>-1</sup> sulfur and the concentration of 1.2 ml. L<sup>-1</sup> nutrient showed the superiority of the better significant average, which reached 1.66% during the 2019 season, while during the 2020 season the triple interaction for the variety Halawani with the level of 250g. vine<sup>-1</sup> sulfur and the concentration of 1.2 ml. L<sup>-1</sup> nutrient exceeded in achieving the highest mean average of 1.55%.

**Table (4a): Effect of variety, sulfur, and nutrient and their interactions on potassium concentration (%) for season 2019**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	1.34 g	1.46 d	1.34 g	1.38 b	
	250	1.36 g	1.62 c	1.55 c	1.51 a	
	500	1.35 g	1.66 a	1.48 d	1.49 a	
Kamali	0	1.09 k	1.22 i	1.28 h	1.20 d	
	250	1.14 j	1.38 e	1.23 i	1.25 c	
	500	1.13 j	1.40 e	1.25 i	1.26 c	
Effect of variety and nutrient interaction	Halawani	1.35 c	1.58 a	1.45 b	Effect of variety	1.46 a
	Kamali	1.12 e	1.33 c	1.26 d		1.24 b
Effect of sulfur and nutrient interaction	0	1.21 g	1.34 d	1.31 e	Effect of sulfur	1.29 b
	250	1.25 f	1.50 b	1.39 c		1.38 a
	500	1.24 f	1.53 a	1.36 d		1.38 a
Effect of nutrient		1.23 c	1.46 a	1.35 b		

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 (4b): Effect of variety, sulfur and nutrient and their interactions on potassium concentration (%) for the 2020 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	1.22 k	1.37 e	1.27 i	1.29 c	
	250	1.30 h	1.55 a	1.50 c	1.45 a	
	500	1.30 h	1.54 b	1.38 d	1.41 b	
Kamali	0	1.04 p	1.17 m	1.23 k	1.15 f	
	250	1.12 n	1.34 f	1.20 l	1.22 e	
	500	1.11 o	1.33 g	1.24 j	1.22 d	
Effect of variety and nutrient interaction	Halawani	1.27 d	1.49 a	1.39 b	Effect of variety	1.38 a
	Kamali	1.09 f	1.28 c	1.22 e		1.20 b
Effect of sulfur and nutrient interaction	0	1.35 i	1.27 e	1.25 f	Effect of sulfur	1.22 c
	250	1.21 g	1.45 a	1.35 c		1.33 a
	500	1.20 h	1.44 b	1.31 d		1.32 b
Effect of nutrient		1.18 c	1.38 a	1.30 b		

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 ( $Pr \leq 0.05$ ).

### Sulfur concentration (%) in leaves

Tables (5a and 5b) show the presence of significant effects for each of the varieties, sulfur, and the nutrient Super Docson and their interactions in the concentration of the sulfur element in the leaves of the plant. The Halawani variety was significantly superior during the two seasons of the study in the concentration of sulfur with averages of 0.300 and 0.288% for the two seasons respectively.

**Table (5a): Effect of variety, sulfur, and nutrient and their interactions on sulfur concentration (%) during the 2019 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	0.237 k	0.261 i	0.259 i	0.252 e	
	250	0.321 d	0.367 a	0.346 b	0.345 a	
	500	0.288 g	0.315 e	0.309 f	0.304 c	
Kamali	0	0.232 k	0.253 j	0.251 j	0.245 f	
	250	0.319 de	0.363 a	0.336 c	0.339 b	
	500	0.279 h	0.309 f	0.307 f	0.299 d	
Effect of variety and nutrient interaction	Halawani	0.282 e	0.314 a	0.304 c	Effect of variety	0.300 a
	Kamali	0.277 f	0.309 b	0.298 d		0.294 b
Effect of sulfur and nutrient interaction	0	0.235 h	0.257 g	0.255 g	Effect of sulfur	0.249 c
	250	0.320 c	0.365 a	0.341 b		0.342 a
	500	0.284 f	0.312 d	0.308 e		0.301 b
Effect of nutrient		0.279 c	0.311 a	0.301 b		

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 (5b): Effect of variety, sulfur, and nutrient and their interactions on sulfur concentration (ppm) during the 2020 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	0.225 k	0.255 j	0.259 ij	0.246 e	
	250	0.308 d	0.345 a	0.320 c	0.303 a	
	500	0.275 h	0.309 d	0.295 fg	0.291 b	
Kamali	0	0.225 k	0.252 j	0.255 j	0.262 e	
	250	0.295 fg	0.331 b	0.304 de	0.294 b	
	500	0.265 i	0.298 ef	0.291 g	0.283 c	
Effect of variety and nutrient interaction	Halawani	0.269 d	0.303 a	0.291 b	Effect of variety	0.288 a
	Kamali	0.262 e	0.294 b	0.283 c		0.280 b
Effect of sulfur and nutrient interaction	0	0.225 g	0.254 f	0.257 f	Effect of sulfur	0.245 c
	250	0.302 c	0.338 a	0.312 b		0.317 a
	500	0.270 e	0.304 c	0.293 d		0.289 b
Effect of nutrient		0.266 c	0.298 a	0.287 b		

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 sulfur level of 250 g. vine<sup>-1</sup> was exceeded significant, with averages of 0.342 and 0.317% for the two seasons respectively, and for the effect of the nutrient Super Docson, it was evident that the concentration of 1.2 ml. L<sup>-1</sup> was superior to achieving the best averages significantly, reaching 0.311 and 0.298% for the two seasons respectively. For the interaction between the variety and the sulfur is observed superiority the Halawani variety with the 250 g. vine<sup>-1</sup> level with averages of 0.345 and 0.303% for the two seasons respectively, as for the effect of the interaction between the variety and the super Docson nutrient concentration, the interaction of the Halawani variety with a concentration of 1.2 ml. L<sup>-1</sup> for the nutrient in achieving the best means significantly, which amounted to 0.314 and 0.303% for the two seasons respectively, and for the interaction between the average effects of the sulfur levels and the concentrations of the nutrient Super Docson, the superiority of the interaction between the level of 250 g. vine<sup>-1</sup> sulfur and the concentration of 1.2 ml. L<sup>-1</sup> nutrient was significant with averages of 0.365 and 0.338% for the two seasons, respectively. The triple interaction between the variety, sulfur and the nutrient shows the superiority of the interaction of the variety Halawani with the level of 250 g. vine<sup>-1</sup> sulfur and the concentration of 1.2 ml. L<sup>-1</sup> in achieving the best averages significantly of 0.367 and 0.345% for the two seasons respectively, in addition to the average interaction of the variety Kamali with The level 250 g, vine<sup>-1</sup> sulfur, and the concentration 1.2 ml. L<sup>-1</sup>, which was 0.363% for the 2019 growing season.

#### Magnesium element concentration (%) in leaves

Tables (6a and 6b) show the presence of significant effects of the study factors of varieties, sulfur and the nutrient Super Docson, and their interactions in the concentration of the magnesium element in the plant, as it is noted that the Halawani variety was significantly superior to the variety in terms of magnesium concentration with averages of 0.418 and 0.400% during the two seasons of the study.

**Table (6a): Effect of variety, sulfur and nutrient and their interactions on magnesium concentration (%) during the 2019 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	0.313 c	0.383 b	0.393 b	0.363 c	
	250	0.376 b	0.493 a	0.490 a	0.453 a	
	500	0.380 b	0.476 a	0.463 a	0.440 a	
Kamali	0	0.293 c	0.363 b	0.373 b	0.343 c	
	250	0.356 b	0.473 a	0.463 a	0.431 ab	
	500	0.366 b	0.500 a	0.463 a	0.443 ab	
Effect of variety and nutrient interaction	Halawani	0.356 b	0.451 a	0.448 a	Effect of variety	0.418 a
	Kamali	0.338 b	0.445 a	0.433 a		0.405 b
Effect of sulfur and nutrient interaction	0	0.303 c	0.373 b	0.383 b	Effect of sulfur	0.353 b
	250	0.366 b	0.483 a	0.476 a		0.442 a
	500	0.373 b	0.488 a	0.463 a		0.441 a
Effect of nutrient		0.347 b	0.448 a	0.441 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 ( $Pr \leq 0.05$ ).

For sulfur addition, the levels 250 and 500 g. vine<sup>-1</sup> were exceeded significant, with averages of 0.442 and 0.441% during the 2019 season, and 0.422 and 0.425% during the 2020 season for the two concentrations respectively, and for the effect of the nutrient Super Docson, the concentration of 1.2 ml. L<sup>-1</sup> by achieving the best averages and significant differences from the control treatments only, reaching 0.448 and 0.429% for the two seasons respectively. For the interaction between the variety and sulfur, is shown the

superiority of the Halawani variety with the level of 250 g. vine<sup>-1</sup> sulfur at averages of 0.453 and 0.433% for the two seasons respectively, with significant and insignificant differences from the averages of the rest of the interactions. As for the effect of the interaction between the variety and the concentration of the super Docson nutrient, the Halawani variety was superior with the concentration of 1.2 ml. L<sup>-1</sup> for the nutrient in achieving the best average, which reached 0.451% during the 2019 season, and the Halawani variety with a concentration of 2.4 ml. L<sup>-1</sup> for the nutrient in achieving the best average, which reached 0.434% during the 2020 season, with significant differences from the control factors only for the two seasons. For the interaction between the levels of sulfur and the concentrations of the super Docson nutrient, it is noted that the interaction between the level of 500 g. vine<sup>-1</sup> sulfur and the concentration of 1.2 ml. L<sup>-1</sup> nutrient was exceeded as a significant with averages of 0.488 and 0.471% for the two seasons respectively. For the triple interaction between variety, sulfur and nutrient, it is noticed that the variety Halawani with the level of 500 g. vine<sup>-1</sup> sulfur and the concentration of 1.2 ml. L<sup>-1</sup> in achieving the best averages which were 0.500 and 0.483% for the two seasons respectively.

**Table (6b): Effect of variety, sulfur, and nutrient and their interactions on magnesium concentration (%) during the 2020 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	0.296 fg	0.360 de	0.383 d	0.346 c	
	250	0.360 de	0.460 abc	0.480 ab	0.433 a	
	500	0.366 d	0.460 abc	0.440 c	0.422 ab	
Kamali	0	0.266 g	0.356 de	0.353 de	0.325 d	
	250	0.326 ef	0.456 abc	0.453 abc	0.412 b	
	500	0.356 de	0.483 a	0.446 bc	0.428 ab	
Effect of variety and nutrient interaction	Halawani	0.341 b	0.426 a	0.434 a	Effect of variety	0.400 a
	Kamali	0.316 c	0.432 a	0.417 a		0.388 b
Effect of sulfur and nutrient interaction	0	0.281 e	0.358 cd	0.368 c	Effect of sulfur	0.336 b
	250	0.343 d	0.458 ab	0.466 ab		0.422 a
	500	0.361 cd	0.471 a	0.443 b		0.425 a
Effect of nutrient		0.328 b	0.429 a	0.426 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).

### Calcium concentration (%) in leaves

Tables (7a and 7b) show the presence of significant effects of the study factors, the varieties, sulfur and the nutrient Super Docson, and their interactions in the concentration of the calcium element in the plant leaves, showing the significant superiority of the Halawani variety compared to the Kamali variety in the concentration of calcium with averages of 1.95 and 1.70% during the two seasons of the study. The addition of sulfur has exceeded the level of 500 g. vine<sup>-1</sup> was significant, with averages of 1.99 and 1.74% for the two seasons respectively, and for the effect of the nutrient Super Docson, it was evident that the concentration of 2.4 ml. L<sup>-1</sup> was superior to achieving the best averages significantly, reaching 2.02 and 1.80% for the two seasons respectively. For the interaction between the variety and the sulfur, the superiority of the Halawani variety with the level of 500 g. vine<sup>-1</sup> appears with averages of 2.11 and 1.81% for the two seasons respectively, as for the effect of the interaction between the variety and the concentration of the nutrient Super Docson, the superiority of the Halawani variety is noted with the concentrations of 1.2 and 2.4 ml. L<sup>-1</sup> for the nutrient in achieving the best averages significantly, which amounted to 2.10% for each of them for the year 2019 and gave the same interaction 1.84% for the year 2020, and for the interaction

between the averages of the effect of sulfur levels and the concentrations of the super Docson nutrient, the interaction between the level of 500 g. vine<sup>-1</sup> sulfur and the concentration 2.4 ml. L<sup>-1</sup> nutrient was significantly with averages of 2.41 and 2.17% for the two seasons, respectively. For the triple interaction between variety, sulfur and nutrient, the superiority of the triple interactions between the variety Halawani with the level of 500 g. vine<sup>-1</sup> sulfur and the concentration of 2.4 ml. L<sup>-1</sup> in achieving the best significant averages of 2.58 and 2.25% for the two seasons respectively, as well as the variety Kamali for the growing season 2019.

**Table (7A): Effect of variety, sulfur and nutrient and their interactions on calcium concentration (%) during the 2019 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	1.53 hi	11.78 g	1.86 e	1.72 e	
	250	1.71 g	2.51 a	1.86 e	2.03 b	
	500	1.72 g	2.02 d	2.58 a	2.11 a	
Kamali	0	1.26 j	1.51 i	1.72 fg	1.50 f	
	250	1.47 i	2.10 c	1.86 e	1.81 d	
	500	1.60 h	1.79 ef	2.23 a	1.87 c	
Effect of variety and nutrient interaction	Halawani	1.65 d	2.10 a	2.10 a	Effect of variety	1.95 a
	Kamali	1.44 e	1.80 c	1.94 b		1.73 b
Effect of sulfur and nutrient interaction	0	1.39 g	1.65 e	1.79 d	Effect of sulfur	1.61 c
	250	1.59 f	2.31 b	1.86 c		1.92 b
	500	1.66 e	1.91 c	2.41 a		1.99 a
Effect of nutrient		1.55 c	1.95 b	2.02 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 calcium concentration (%) during the 2020 season**

Variety	Sulfur (g.vine <sup>-1</sup> )	Super Docson nutrient (ml. L <sup>-1</sup> )			Effect of variety and sulfur interaction	
		0	1.2	2.4		
Halawani	0	1.43 g	1.60 f	1.68 e	1.57 d	
	250	1.44 g	2.11 b	1.58 f	1.71 b	
	500	1.39 g	1.81 d	2.25 a	1.81 a	
Kamali	0	1.13 i	1.39 g	1.62 ef	1.38 e	
	250	1.29 h	1.87 c	1.57 f	1.58 d	
	500	1.32 h	1.57 f	2.10 b	1.66 c	
Effect of variety and nutrient interaction	Halawani	1.42 d	1.84 a	1.84 a	Effect of variety	1.70 a
	Kamali	1.25 e	1.61 c	1.76 b		1.54 b
Effect of sulfur and nutrient interaction	0	1.28 g	1.49 e	1.65 c	Effect of sulfur	1.47 c
	250	1.36 f	1.99 b	1.58 d		1.64 b
	500	1.35 f	1.69 c	2.17 a		1.74 a
Effect of nutrient		1.33 c	1.72 b	1.80 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 of tables (2a and 2b) to (7a and 7b) showed significant effects for the varieties, sulfur and the nutrient Super Docson, and the different interactions between them on the

characteristic concentrations of major nutrients (nitrogen, phosphorous, potassium, sulfur, magnesium and calcium). For the varieties, the Halawani variety was superior regarding all tested elements, except for phosphorus concentration, and these results may be attributed to the variation in the genetic structure of the studied varieties and their behavior in the distribution and storage of the nutrient compounds entering the plant, and it may also be attributed to the ability of the varieties to absorb the nutrients and accumulate them in the leaves, and it may also be related to the increase in the concentrations of nutrients by increasing the paper space (Al-Hwaizi, 2008 and Al-Douri, 2014).

As for sulfur addition which caused a decrease in the degree of soil reaction through its oxidation and conversion to sulfuric acid, and then increasing the availability of the nutrients in the soil and then increasing their absorption by the roots, which led to an increase in their concentrations in the plant, and sulfur also increases the availability of some elements by reducing the rate of chemical equilibrium and its sedimentation, these results are consistent as previously stated by Atewi and Ahmed (2007) and Al-Bayati (2006) that adding sulfur to the soil has led to an increase in the availability of iron, zinc, copper and manganese elements in the soil and its absorption by the plant. The study is a clear evidence of the active role of the group of elements in the nutrient Super Docson in activating the absorption of macronutrients and micronutrients in the plant, as the role of micronutrients in the formation of amino acids, carbohydrates and energy compounds and increasing the respiration and photosynthesis processes in the plant has been supported by a number of researchers.

The role of the nutrient Super Docson in increasing the concentrations of nutrients within the plant may be attributed to its role in protein representation as in magnesium (Tandon, 1991), as it leads to an increase in the representation of chlorophyll in the leaves, which results in an increase in photosynthesis products and nutrients such as nitrogen (Delcroix, 1979), that green plants produce their food through the process of photosynthesis, as this process requires large quantities of nutrients, and the accumulation of these elements in the tissues of plants indicates their activity and their increased ability to absorb the elements to enter the process of photosynthesis and cell division and elongation (Zeiger and Taiz, 2006).

Also, increasing the number of clusters in the vine and the weight of the cluster, and then increasing the resulting yield have an important role in improving the development of roots and their absorption of nutrients, vegetative growth and leaf area, which leads to the need for nitrogen and phosphorous as well as other nutrients, which all lead to an increase in the metabolism of the vine. Nitrogen has a role in photosynthesis, improving energy transport, and increasing the accumulation of nutrients in the pellets, including nitrogenous substances (Wojcik, 2004) (not matching as written in the list of references). While phosphorus increases the speed of branch growth, numbers and weights due to the entry of some additional shoots in the activity, especially side (Champagnol, 1978), which increases the growth of the vine and potassium leads to an increase in the number of fruitful branches to provide adequate food and thus increase the shoots and strength of the vines because the increase in the vegetative total increases the consumption of potassium in the physiological processes in the grapevine (Al-Atrushi, 2009), as potassium regulates many metabolic processes and is necessary for growth and reproduction, and that the optimal amount of potassium prevents the falling off of the grains and increases the number of clogging grains (Botta *et al.*, 1995) because potassium increases fruiting precedes the transformation (Ribereau-Gayon and Peynaud, 1971) as a result of its activation of flowering and nodes being a catalyst in the fertilization process for its role in increasing the proportion of carbohydrates (Al-

Saeedi, 2000). Also, magnesium participates in the process of photosynthesis and facilitates the transfer of carbohydrates to the grains, and it also contributes to ripening, such as potassium, and the correct balance of these nutrients mentioned above is a determining factor for the transfer of sugars into the grains, which all play nearly similar roles (Al-Qaisi, 2015). (not exist in the list of references)

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### تأثير الكبريت والمغذي super Docson على محتوى الأوراق من العناصر المعدنية لصفين من العنب *Vitis vinifera*

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#### الخلاصة

اجريت هذه الدراسة خلال موسمي النمو (2019 و2020) على كرمات العنب صنف حلواني لبناني وكمالي في بستان العنب التابع لقسم البستنة وهندسة الحدائق كلية الزراعة/ جامعة تكريت والمزروعة عام (2016) والمربات بطريق التربية على القمريرات وبمسافات زراعة 4×2 متر وارتفاع 2 متر. وتم اجراء تجربة عاملية بثلاثة عوامل العامل الأول هو الأصناف حلواني V1 وكمالي V2، اما العامل الثاني فهو إضافة الكبريت الزراعي S الى التربة، بثلاث مستويات، ( S0 عدم اضافة 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 بثلاث تراكيز ( P0الرش بالماء المقطر فقط بدون مغذي)، ( P1الرش بالمغذي Super Docson بتركيز 1.2 مل.لتر-1 ماء)، ( P2الرش بالمغذي Super Docson بتركيز 2.4 مل. لتر-1 ماء)، وتم الرش في الصباح الباكر وحتى البلل التام. علما انه تم اضافة مادة ناشرة Tween20نفذت تجربة عاملية بنظام الألواح المنشقة وفق تصميم القطاعات العشوائية الكاملة ( RCBD)أخذت الأصناف الألواح الرئيسية Main Plot، فيما وزعت معاملات الكبريت والمغذي وتداخلاتها عشوائياً على الألواح الثانوية Sub Plot، بثلاث مكررات وبينت النتائج: الى ان الصنف الحلواني قد تفوق في اغلب الصفات المدروسة عند المستوى (250 غم. كرمة-1) والتركيز (1.2 مل. لتر-1) ماعدا صفة تركيز عنصر الفسفور في الأوراق حيث تفوق في هذه الصفة الصنف كمالي عند نفس المستوى والتركيز. أما التداخل الثنائي بين الصنف والكبريت فقد تفوق الصنف حلواني عند المستوى (250 غم. كرمة-1) في اغلب الصفات المدروسة ولكلا الموسمين. أما التداخل الثنائي بين الصنف والمغذي فقد تفوق الصنف حلواني عند التركيز (1.2 مل. لتر-1) في اغلب الصفات المدروسة ولكلا الموسمين ماعدا صفة تركيز عنصر الفسفور في الأوراق حيث تفوق في هذه الصفة الصنف كمالي عند نفس المستوى والتركيز. كذلك بالنسبة للتداخل الثنائي بين الكبريت والمغذي حيث تفوق المستوى (250 غم. كرمة-1) والتركيز (1.2 مل. لتر-1) في اغلب الصفات المدروسة ولكلا الموسمين. أما التداخل الثلاثي بين الصنف والكبريت والمغذي فقد تفوق الصنف حلواني عند المستوى (250 غم. كرمة-1) والتركيز (1.2 مل. لتر-1) في

#### الكلمات المفتاحية:

سماد ورقي ، كبريت ، مغذيات

اغلب الصفات المدروسة ولكلا الموسمين.