Effect of removing growing tips, foliar spraying with boron and biofertilization on the productivity of grapes Vitis vinifera L. Taifi variety

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ABSTRACT

This study was conducted in the vineyard of the Pribahar area, located before Zawita district, Dohuk Governorate, Kurdistan Region/Iraq. During the growing season of 2023, on 16-year-old Taif grape vines planted at 2×3 m spacings using the T-shaped cultivation method to study the effect of removing (pinching) the growing tips at three times (without pinching, one week before flowering, and two weeks after set), and foliar spraying with regular boron using boric acid at two concentrations (50, 100 mg L-1) and two concentrations of nano-boron fertilizer (20, 30 mg L-1) in addition to the control treatment (0 mg L-1). And fertilization with the bio-fertilizer Fungi Mycorrizhal at two levels (0, 50 gm vine-1), with a study of the interaction between the three factors with the aim of improving fruit set and increasing the amount of the crop. The results can be summarized as follows: The results show that removing the growing tips after set caused a significant increase in the number of clusters, cluster weight, number of berries in the cluster, weight of 100 berries, and total yield of the vine. The results show that foliar spraying of nano-boron caused a significant increase, especially at a concentration of 20 mg L-1, in the percentage of set, cluster weight, number of berries in the cluster, weight of 100 berries, and total yield of the vine. While foliar spraying of nano-boron at a concentration of 30 mg L-1 caused a significant increase in the number of clusters. It is noted from the results of the triple interaction between the studied factors that removing the growing tips (pinching) after set and foliar spraying with boric acid at a concentration of 100 mg L-1 with addition of 50 g vine-1 of mycorrhizal biofertilizer led to a significant increase in the number of clusters and total yield of the vine. While the triple interaction of the studied factors by removing the growing tips (pinching) before flowering and foliar spraying with boric acid (ordinary boron) at a concentration of 50 mg L-1 with the addition of 50 gm grape-1 of mycorrhizal biofertilizer caused a significant increase in the percentage of set, number of clusters, number of berries in the cluster, and weight and size of 100 berries.

INTRODUCTION

Grapes Vitis vinifera L. occupy the top position among all types of fruits worldwide and its cultivation is considered one of the oldest known to mankind. It is believed that its cultivation began in Central Asia in the region between the southern Black Sea and the Caspian Sea. Grape cultivation is widely spread in subtropical and temperate regions (Grassi and DeLorenzis, 2021). Iraq is considered one of the oldest places famous for grape cultivation, It was noted that grape cultivation dates back to the Assyrian era before 2440 BC. (Al-Saeedi, 2000). Grapes are one of the most important fruit crops in the world from an economic point of view. and have a high nutritional value, which makes them a high source of energy, in addition to being necessary for building bones and nerves in the body and many vitamins (Keller, 2020). Summer pruning includes several forms in grape farms, such as removing buds, branches

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or leaves when they are green or grassy. This type of pruning is carried out when the vine is active or continuing to grow. Summer pruning includes several forms in grape farms, such as removing buds, branches or leaves when they are green or grassy. Summer pruning has many uses, including directing new growths by some operations such as removing buds, pinching to increase the shading of the clusters and stimulate the growth of side branches and make the vine open Which increases the exposure of the berries to air and light. The process of removing the growing tops of the fruitful branches is one of the methods used to improve the quantity of the crop by increasing and improving the percentage of set if it is carried out before flowering and providing good nutritional conditions for the flowers by diverting the path of the nutrients manufactured in the leaves towards the flowers instead of their path towards the growing tops. and Carrying out this process after flowering helps in the development and growth of the berries and increasing their size and improving their quality (Al-Mu'adidi, 1999, and Al-Sa'idi, 2000). Boron is an important micronutrient for plants. The soil content of total boron ranges from 20-200 mg kg-1 soil and is absorbed in the form of boric acid (H3BO3). It is an immobile element in the plant, and therefore symptoms of its deficiency appear on new growths of fruit trees growing in particular in sandy and calcareous soils. Boron is an important micronutrient for plants. Boron plays an important role in the vital processes in plants, especially in the growth of pollen on the stigmas of fruit tree flowers, the success of the pollination and fertilization process, the occurrence of set and Flowering, And it has a great relationship with plant hormones, the division and increase in the size of plant cells, in addition to its physiological role in the formation and transfer of sugars, the representation of proteins and nucleic acids, and it works to increase dry matter in plant tissues. Boron also enters into the composition of plant cell membranes andIt helps to increase it thickness., in addition to the role of boron in the process of respireation in plants and stimulates the formation of vitamin C and the vitamin B complex group, and its role in the process of forming RNA (Al-Shadhili, 1999, Jundia, 2003, and Al-Moaini, 2024). Nanotechnology is considered one of the emerging technologies in applied technological sciences. In fact, nanotechnology works to modify the shape of the basic derived elements, as it works to change the molecular and atomic properties of mineral elements, and it has unconventional properties in various agricultural applications, as it is characterized by the small size of its molecules compared to the size of regular molecules. Nanofertilizers are characterized by their high solubility in water, in addition to the possibility of adding them as fertilizers to the soil or spraying on the vegetative group of the plant (Sabir et al., 2014). Nanotechnology is now widely used in various agricultural and horticultural crops to increase vegetative growth,pollination and flower fertility, which leads to an increase and improvement in the quantity and quality of agricultural crops (Zahzog et al., 2017 and Zahedi et al., 2019). Mycorrhizal fungi invest in the soil to provide the root system with large amounts of water and nutrients because the mycorrhizal fungi threads are in contact with the plant roots and go deep into the soil, which makes the plant able to explore and invest a larger volume of soil in order to obtain water and nutrients, where the mycorrhizal fungi threads contain polyphenol oxidase enzymes that decompose

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the soil organic matter with a high carbon/nitrogen ratio. Mycorrhizal fungi form poorly soluble forms of phosphorus and increase the absorption of other nutrients such as copper, zinc, manganese, and molybdenum, which participates in biological nitrogen fixation. The root hairs of grapevines can absorb phosphorus through arbuscular mycorrhizae (Mengel et al., 2001). The study aims to improve the fruit set and quantitative characteristics of the yeild of Taifi grape variety.

MATERIALS AND METHODS

The experiment was conducted in one of the vineyards of the Taifi variety in the village of Bari Bahar near the city of Zawiya. This area is located between latitude 36052"08"81N and longitude 43005"49"34E and an elevation of 745 above sea level (Guest, 1966), in Dohuk Governorate - Kurdistan Region - Iraq, during the growing season 2023 on 16-year-old grape vines. variety (Taiefi). Winter pruning was carried out in mid-February by leaving six fruitful Canes on each vine, each containing 8 eyes, and leaving 6 spurs with a length of two buds/spurs. Different soil samples were taken at a depth of 0-50 cm before the experiment was carried out, and some physical and chemical properties were analyzed, as shown in Table (1.(

Factors studied and experimental design:

The experiment contained three factors in addition to the interaction between these three factors as shown below:

First factor: Summer pruning levels (removal of the growing tips of the fruitful branches): The growing tips were pinched at three levels : -

-1Without pinching.

-2Pinching before flowering.

-3Pinching after setting.

Second Factor: Foliar spraying with regular boron (using boric acid) and nano, at five concentrations:

-1control treatment (spraying the vines with distilled water only.(

-2Foliar spraying with regular boron at a concentration of 50 mg L-1.

-3Foliar spraying with regular boron at a concentration of 100 mg L-1.

-4Foliar spraying with nano boron at a concentration of 20 mg L-1.

-5Foliar spraying with nano boron at a concentration of 30 mg L-1.

Foliar fertilization with regular and nano boron solutions was carried out by spraying the vegetative group of the vines until completely wet, at a rate of two sprays, the first spraying before flowering on 4/15/2023 and the second two weeks after the set.

Table 1. Chemical and physical properties of the grapes farm soil in the village of Bribahar/Duhok.

Physical properties of soil samples					
Sand (g Kg^{-1})	Silt (g Kg^{-1})	Clay (g Kg^{-1})	O.M. (g Kg^{-1})		Texture
657.1	118.9	165.2	295.8		Clay sandy
Chemical properties of soil samples					
EC ($doc.m^{-1}$)	pH	Ca^{++} (Meq L^{-1})	Mg^{++} (Meq L^{-1})	Ci^{-} (Meq L^{-1})	$aHCO^{3}$ (Meq L^{-1})
0.60	8.5	3	1.2	2.5	6
NPK available					
N (ppm)		P (ppm)		K (ppm)	
0.0399		17.657		20	

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third factor: Biofertilization with mycorrhizal fungi:

-1Without fertilization.

-2Fertilization with 50 gm vine-1.

Biofertilizer (mycorrhizal) was added to the soil in the middle of March using mycorrhizal inoculum with an inoculum density of 50 spores gm-1.

The experiment was carried out using the Split-plot system in the Randomized Complete Block Design (RCBD), where boron was placed in the main plot and biofertilization with mycorrhizal fungus in the secondary plots, while summer pruning occupied the secondary plots with three replicates and using one vine in each experimental unit. The experiment included 30 factorial treatments (3×5×2×3×1), so the number of vines became 90 vines only (Al-Rawi and Khalaf Allah, 1980.(

Results and Discussion

Setting percentage:(%)

The results of the treatments in Table (2) showed no significant differences between the levels of fertilization with mycorrhizae and the levels of pinching in the setting percentage. While the treatment of spraying with nano-boron at a concentration of 20 mg L-1 recorded the highest setting percentage, which amounted to 9.44%, while the control treatment recorded the lowest values for this trait, which amounted to 7.98%. The results of the triple interaction between the studied factors indicate that the interaction treatment between fertilization of 50 gm vine-1 with mycorrhizae and spraying with regular boron at a concentration of 50 mg L-1 and pinching before flowering gave the highest setting percentage of 11.65%, while the lowest value of 7.17% was recorded in the treatment of fertilization of 50 gm vine-1 with mycorrhizae and spraying with regular boron at a concentration of 100 mg L-1 and without pinching.

Number of clusters (clusters vine-1 :(

The results in Table (3) indicate that there are no significant differences between the mycorrhizal treatments in the number of clusters trait. As for the effects of spraying with boron, the highest value in the number of clusters trait was recorded for the spraying treatment with nanoboron at concentrations of 20 and 30 mg L-1, where it reached 28.55 and

Table (2): The effect of bio-fertilization with mycorrhizae and spraying with regular and nano boron and pinching on the percentage of berries set (%) of grape vines of Taifi variety.

Mycorrhizae	boron	pinching treatments			Mycorrhizae × boron	Effect of Mycorrhizae
		Non pinching	Pinching Before flowering	Pinching after setting		
0 g vine^{-1}	0	7.69 b	8.53 ab	7.30 b	7.84 b	8.43 a
	50	8.15 b	8.95 ab	9.27 a b	8.79 a b	
	100	7.38 b	9.00 ab	9.53 a b	8.64 a b	
	20	7.93 b	8.42 ab	9.14 a b	8.51 a b	
	30	8.37 a b	8.53 ab	8.24 a b	8.38 a b	

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50 g vine^{-1}	**0**	7.47 b	8.47 ab	8.42 a b	8.12 b	8.61 a
	50	8.75 a b	11.65 a	10.50 a b	10.09 a	
	100	7.17 b	7.78 b	8.38 a b	7.78 b	
	20	7.44 b	8.26 ab	10.50 a b	8.73 a b	
	30	9.85 a b	7.73 b	7.46 b	8.34 a b	
Mycorrhizae × pinching	**0**	7.90 a	8.70 a	8.69 a	**Effect of boron**	
	50	8.14 a	8.78 a	8.93 a		
Boron × pinching	**0**	7.58 bc	8.50 abc	7.86 bc	7.98 b	
	50	7.69 bc	8.36 abc	9.82 ab	8.62 ab	
	100	9.11 abc	8.13 abc	7.84 bc	8.36 ab	
	20	8.45 abc	10.30 a	9.57 a bc	9.44a	
	30	7.28 c	8.39 abc	8.95 a bc	8.21 ab	
Effect of Pinching		8.02 a	8.74 a	8.81 a		

Means with the same letter are not significantly different according to Duncan's multiple ranges test at 5% level.

29.1clusters vine-1, respectively, and the lowest value for the control treatment, where it reached 18.69 clusters vine-1, while the pinching after flowering treatment recorded a significant increase in the number of clusters, where it reached 25.91 grape clusters-1, while the lowest values were for the non-pinching treatment reached 23.53 clusters vine-1. The results of the triple interaction between the studied factors showed significant differences between the treatments, as the treatment of fertilizing 50 gm vine-1 with mycorrhizal fungi with spraying with regular boron at a concentration of 100 mg L-1 and pinching after the set was superior to the other treatment, and the highest values for the number of clusters were recorded, reaching 36.36 clusters vine-1, while the lowest values were recorded, reaching 13.03 clusters vine-1 in the control treatment.

Table 3. The effect of bio-fertilization with mycorrhizae and spraying with regular and nano boron and pinching on number of clusters (cluster vine-1) of grape vines of Taifi variety.

Mycorrhizae	**Boron**	**pinching treatments**			**Mycorrhizae × boron**	**Effect of Mycorrhizae**
		Non pinching	**Pinching Before flowering**	**Pinching after setting**		
0 g vine^{-1}	**0**	13.03 n	18.99 j kl	21.38 h k	17.80 d	23.54 a
	50	24.79 e j	28.75 bf	24.32 ej	25.95 b	
	100	26.18 e j	28.99 cf	32.46 abc	29.21 a	
	20	30.42 be	17.32 mn	18.18 l mn	21.97 c	

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	30	22.81 hk	22.47 ks	22.96 gk	22.94 c	
50 g vine^{-1}	**0**	17.56 mn	20.23 hl	20.95 hk	19.58 cd	24.76 a
	50	32.26 ad	25.42 eh	35.76 ab	31.15 a	
	100	26.66 dh	24.04 gk	36.36 a	29.02 a	
	20	21.28 hl	20.74 hm	20.99 ms	22.59 c	
	30	20.37 il	23.10 f l	20.99 hl	21.49 c	
Mycorrhizae × pinching	**0**	23.44 b	23.31 b	23.86 b	**Effect of boron**	
	50	23.62 b	22.71 b	27.96 a		
Boron × pinching	**0**	15.29 g	19.61 f	21.16 f	18.69 c	
	50	25.85 cde	19.03 f	21.97 ef	22.28 b	
	100	21.59 f	22.79 def	21.98 ef	22.12 b	
	20	28.52 bc	27.09 bc	30.04 b	28.55 a	
	30	26.42 bcd	26.52 bcd	34.41 a	29.11 a	
Effect of Pinching		23.53 b	23.01 b	25.91 a		

Means with the same letter are not significantly different according to Duncan's multiple ranges test at 5% level.

Cluster weight (g:(

The results of Table (4) that there are no significant differences between the mycorrhizal treatments in the cluster weight trait. As for the effects of spraying with regular and nano boron, the treatment of spraying with nano boron at a concentration of 20 mg L-1 recorded a significant increase with the highest value and reached 619.07 g, and the lowest value for the treatment without spraying with boron and reached 447.77 g. The pinching treatments also caused a significant increase in the cluster weight, as the pinching treatment before flowering and after setting gave the highest cluster weight of 523.47 g and 554.51 g, respectively, while the lowest values of cluster weight were recorded in the control treatment, which reached 423.52 g. The results of the triple interaction show that there are significant differences between the treatments, as the fertilization treatment of 50 gm vine-1 with mycorrhizae, interacted with spraying with regular boron at a concentration of 50 mg L-1 and pinching before flowering, outperformed and recorded the highest values of the average cluster weight, which reached 812.7 g, while the lowest values of 256.0 g were recorded in the interaction treatment between not fertilizing with mycorrhizae an spraying with regular boron at a concentration of 100 mg L-1 and not pinching.

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Table (4): The effect of bio-fertilization with mycorrhizae and spraying with regular and nano boron and pinching on cluster weight (g) of grape vines of Taifi variety.

Mycorrhizae	boron	pinching treatments			Mycorrhizae × boron	Effect of Mycorrhizae
		Non pinching	Pinching Before flowering	Pinching after setting		
0 g vine^{-1}	0	354.9 de	470.3 be	535.7 bcd	453.65 b	478.92 a
	50	456.5 be	638.4 abc	587.3 ad	560.72ab	
	100	256.0 e	502.1 be	623.2 ad	460.42 b	
	20	384.9 cde	542.2 bcd	536.9 bcd	487.99 b	
	30	406.5 be	457.7 be	431.2 be	431.80 b	
50 g vine^{-1}	0	410.1 be	440.4 be	475.2 be	441.88 b	522.08 a
	50	590.3 ad	812.7 a	629.3 ad	677.42 a	
	100	393.8 be	456.5 be	592.1 ad	480.93 b	
	20	435.4 be	506.2 be	662.6 ab	534.75 b	
	30	546.8 bcd	407.9 be	471.7 be	475.45 b	
Mycorrhizae × Pinching	0	371.76 b	522.12 a	542.87 a	Effect of boron	
	50	475.29 a	524.81 a	566.16 a		
Boron × Pinching	0	382.51 cd	455.35 b cd	505.44 b cd	447.77 b	
	50	410.17 cd	524.19 b c	599.75 a b	511.37 b	
	100	476.63 b cd	432.80 b cd	451.46 b cd	453.63 b	
	20	523.41 bc	725.53 a	608.27 ab	619.07 a	
	30	324.90 d	479.47 bcd	607.65 ab	470.67 b	
Effect of Pinching		423.52 b	523.47 a	554.51 a		

Means with the same letter are not significantly different according to Duncan's multiple ranges test at 5% level.

Number of berries in the cluster (grain cluster-1:(

It is noted from the data in Table (5) that there were no significant differences in the number of berries in the cluster for mycorrhizal fertilization. while Spraying with nano-boron at a concentration of 20 mg L-1 led to a significant increase in the number of berries, which reached 141.02 berries cluster-1 compared to 122.37 berries cluster-1 in the the control treatment. as the pinching treatments before flowering and after setting achieved a significant increase in the average number of berries in the cluster, which reached 131.00 and 135.67 berries cluster-1, respectively, compared to 120.46 berries cluster-1 in the control treatment. It is noted from the results of the triple interaction that the fertilization treatment of 50 gm vine-1 with mycorrhizae, with spraying with regular boron at a concentration of 50 mg L-1, and the pinching before flowering recorded the highest values in the average number of berries, reaching 170.56 berries cluster-1 compared to 94.37 berries cluster-1 in the control treatment.

Weight of 100 berries (g:(

The results of Table (6) showed no significant differences between the mycorrhizal treatments in the trait of weight of 100 berries. As for the effects of spraying with regular and nano boron, the spraying treatment with a

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concentration of 20 mg L-1 of nano boron

Table (5): The effect of bio-fertilization with mycorrhizae and spraying with regular and nano boron and pinching on Number of berries (berry cluster-1) of grape vines of Taifi variety.

Mycorrhizae	boron	pinching treatments			Mycorrhizae × boron	Effect of Mycorrhizae
		Non pinching	Pinching Before flowerng	Pinching after setting		
0 g vine^{-1}	0	94.37 g	123.26 cf	126.78 bf	114.80 d	126.44 a
	50	123.44 cf	153.59 ab	136.87 bf	137.96 ab	
	100	113.07 fg	127.55 cf	142.78 be	129.44 ad	
	20	118.07 efg	127.55 bf	135.45 bf	127.02 bcd	
	30	121.84 cg	121.90 cg	125.18 cf	122.97 bcd	
50 g vine^{-1}	0	120.41 cg	121.50 cg	147.90 abc	129.93 ad	131.65 a
	50	134.58 bf	170.56 a	127.11 bf	144.08 a	
	100	112.74 fg	115.46 efg	139.13 bf	122.44 cd	
	20	119.43 dg	129.04 bf	154.25 ab	134.23 abc	
	30	146.70 ad	114.74 efg	121.33 cf	127.59 bcd	
Mycorrhizae × pinching	0	114.15 b	131.75 a	133.14 a	Effect of boron	
	50	126.77 a	130.26 a	137.94 a		
Boron × pinching	0	107.39 f	122.38 cf	137.34 bcd	122.37 b	
	50	118.74 d ef	128.29 be	144.85 b	130.63 b	
	100	134.27 bcd	118.32 def	123.97 cf	125.28 b	
	20	129.00 be	162.07 a	131.98 be	141.02 a	
	30	112.90 ef	123.97 cf	112.90 ef	125.94 b	
Effect of Pinching		120.46 b	131.00 a	135.67 a		

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recorded a significant increase in the weight of 100 berries, which amounted to 408.72 g, and the spraying treatment with a concentration of 100 mg L-1 of regular boron recorded the lowest values for this trait, which amounted to 356.61 g, while the pinching treatment after the set caused a significant increase in the

weight of 100 berries, which amounted to 401.57 g, while the lowest values were recorded in the control treatment, which amounted to 352.93 g. The results of the triple interaction showed the superiority of the fertilization treatment of 50 gm of mycorrhizae, with spraying with regular boron at a concentration of 50 mg L-1 and pinching before flowering, which recorded the highest values in the weight of 100 berries, while the lowest values were recorded int the treatment of not fertilizing with mycorrhizae and spraying with nano-boron at a concentration of 20 mg L-1 and not pinching

Table 6. The effect of bio-fertilization with mycorrhizae and spraying with regular and nano boron and pinching on weight of 100 berries (g) of grape vines of Taifi variety

Mycorrhizae	boron	pinching treatments			Mycorrhizae × boron	Effect of Mycorrhizae
		Non pinching	Pinching Before flowering	Pinching after setting		
0g vine^{-1}	0	342.67 b	371.00 ab	415.67 ab	376.44 ab	374.51 a
	50	363.33 ab	404.00 ab	424.67 ab	397.33 ab	
	100	340.00 b	366.33 ab	429.33 ab	378.56 ab	
	20	319.33 b	414.00 ab	386.00 ab	373.11 ab	
	30	329.67 b	371.00 ab	340.67 b	347.11 b	
50 g vine^{-1}	0	328.67 b	369.67 ab	438.00 ab	378.78 ab	388.24 a
	50	429.33 ab	473.33 a	357.67 ab	420.11 a	
	100	345.33 b	392.33 ab	429.33 ab	389.11 ab	
	20	358.00 ab	384.33 ab	419.00 ab	387.11 ab	
	30	373.00 ab	350.33 b	375.00 ab	366.11 ab	
Mycorrhizae × pinching	0	339.00 b	385.27 ab	399.27 a	Effect of boron	
	50	366.87 ab	394.00 a	403.87 a		
Boron × pinching	0	335.67 c	370.33 abc	426.83 a b	377.61 ab	
	50	338.67 c	399.17 abc	402.50 abc	380.11 ab	
	100	351.33 bc	360.67 abc	357.83 abc	356.61 b	
	20	396.33 abc	438.67 a	391.17 abc	408.72 a	
	30	342.67 c	379.33 abc	429.50 ab	383.83 ab	
Effect of Pinching		352.93 b	389.63 a	401.57 a		

Means with the same letter are not significantly different according to Duncan's multiple ranges test at 5% level.

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Total vine yield (kg :(

The results of Table (7) indicate that the vines treated with mycorrhizal fungi did not differ significantly in the total yield. As for the treatments of spraying with regular and nano boron, the highest values in the total yield of the vines were recorded in the treatment of spraying with nano boron at concentrations of 20 and 30 mg L-1 and reached 16.57 kg and 14.50 kg, respectively, while the lowest values were in the control treatment. As for the pinching treatments, the results indicate the superiority of the pinching treatment after set in the total yield, which reached 14.34 kg compared to the non-pinching treatment, which reached 10.01 kg.The data of the triple interaction between the studied factors that fertilization with 50 gm vine-1 with mycorrhizae, spraying with regular boron 100 mg L-1, and pinching after set recorded the highest values for the total vine yield, amounting to 21.62 kg , while the lowest value was recorded in the control treatment amounting to 4.45 kg.

pinching the growing tips of the fruitful branches regulates vegetative growth, keeps the branches erect, and facilitates the penetration of air and light into the vine, thus improving the nutritional conditions of the flower and fruit clusters during the different growth stages, because the Custom materials that to the growing tips will be used by the flower and fruit clusters, i.e. eliminating competition for carbohydrates and other nutrients between the tops of the main branches and between the flowers, and the ovaries develop, thus increasing the number of clusters, the number of berries in the cluster, the weight and size of one hundred berries, and increasing the total yield of the vine, especially when pinching after the set, in addition to the role of pinching the branches, which can work to increase the transfer of photosynthesis products from carbohydrates from the rapid growth areas of the bud tips to the clusters and reduce competition between them, which enhances the quantitative characteristics of the clusters and the berries (Al-Muadhidi, 1999 on the Kamali grape variety, and Roberto, 2017 on the Thompson Seedless grape variety, and Khamis et al., 2017 and Bassiouni, 2020 On the Flame Seedless grape variety). The increase and improvement of the quantitative characteristics of the yield is attributed to the positive effect of the process of pinching the growing tips in increasing the leaf area of the vine and activating the photosynthesis process inside the vine canopy by improving light penetration and temperature, which in turn increases the weight of the cluster and the yield of a single vine by increasing the leaf area and the length of the cluster, which works to increase the physiological and light efficiency, which leads to the transfer of most of the carbohydrate materials to the clusters, which leads to improving and increasing the yield (Farag and Abd El-All, 2019, Farag et al., 2020, Awad and Khalil, 2022.(

The increase in the weight of the cluster, especially when the foliar spraying with nano-boron at a concentration of 20 mg/L, may be attributed to the increase in the leaf area of the vine and the increase in the Biosynthesis of chlorophyll in the leaves, which led to an increase in its nutritional products by increasing the efficiency of the photosynthesis process in the leaves and increasing the Biothynthesis of hormones and their transfer to the clusters, as the share of each cluster of these nutrients increased and their accumulation in the berries and their weights increased (Al-Tahhafi, 2004, Rasool, 2008,

and Al-Qaisi, 2015). As for the number of berries in the cluster, it achieved a significant increase, especially when spraying with a concentration of 20 g/l of nano-boron, which is attributed to the physiological role of boron in reducing the fall of flowers and newly set berries, due to the role of boron in activating the formation of sugars and their transfer to the flowers and the presence of boron in high concentrations in special parts of the flower such as the stamen containing pollen berries, the stigma and the ovary. This shows the important role of boron in encouraging the germination of pollen berries and increasing the number of pollen tubes reaching the ovary, in addition to producing and regulating the growth of the pollen tube on the stigma and pollen berries, and its very important physiological role in the growth of pollen on the stigmas of flowers by

Table 7. The effect of bio-fertilization with mycorrhizae and spraying with regular and nano boron and pinching on total yield (kg) of grape vines of Taifi variety.

Mycorrhizae	boron	pinching treatments			Mycorrhizae × boron	Effect of Mycorrhizae
		Non Pinching	Pinching Before flowering	Pinching after setting		
0 g vine^{-1}	0	4.45 i	8.32 ghi	11.98 dh	8.25 d	11.37 a
	50	10.07 fi	18.11 ad	14.32 bf	14.17 b	
	100	10.21 fi	13.59 cg	14.32 bg	14.68 b	
	20	11.52 di	9.45 ghi	9.43 ghi	10.14 bc	
	30	9.12	10.38 ei	9.35 ghi	9.62 cd	
50 g vine^{-1}	0	5.94 i	9.16 ghi	13.24 cg	9.45 cd	12.86 a
	50	19.03 abc	20.74 ab	17.16 ae	18.98 a	
	100	10.07 fi	11.25 ei	21.62 a	14.32 b	
	20	8.73 g h i	10.54 ei	16.88 af	12.05 bc	
	30	10.96 e i	8.36 ghi	9.21 ghi	9.51 cd	
Mycorrhizae × pinching	0	9.08 c	11.97 b	13.06 ab	Effect of boron	
	50	10.95 b c	12.01 b	15.62 a		
Boron × pinching	0	5.20 f	8.74 ef	12.61 cde	8.85 b	
	50	10.12 de	9.99 d e-	13.15 cde	11.09 b	
	100	10.04 de	9.37 ef	9.28 ef	9.56 b	
	20	14.55 cd	19.42 ab	15.74 bc	16.57 a	
	30	10.14 de	12.42 cde	20.93 a	14.50 a	
Effect of Pinching		10.01 c	11.99 b	14.34 a		

Means with the same letter are not significantly different according to Duncan's multiple ranges test at 5% level.

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helping the pollen grain absorb water and thus the pollen grain explodes at the ovules so that fertilization can occur, thus ensuring the success of the pollination and fertilization process, which leads to an increase in the percentage of setting in the cluster and an increase in the number of berries and the weight of the cluster, In addition to the vital role of boron in increasing the leaf area of the vine and the cluster and increasing the representation of chlorophyll in the leaves, which leads to increasing the efficiency of the photosynthesis rate and thus improving the nutrition of flowers and newly set berries by providing soluble sugars and energy compounds necessary for the growth process and their transfer to the berries, which is easier with the presence of boron and increasing cell division in the berries and increasing the germination of pollen berries and the construction and transfer of sugars and the movement of plant hormones and improving the absorption of water and nutrients, which also leads to an increase in the weight and size of the berries (Galet, 1983, Al-Shazly, 1999, Al-Saeedi, 2003, Jundia, 2003, Mangel et al., 2002, Hopknis Huner, 2004, Desouky, 2009, Al-Douri, 2012, Mohamed, 2018). The increase in the total yield of the vine when spraying with nano-boron at a concentration of 20 mg/L is attributed to the increase in the leaf area of the vine and the cluster, the increase in the number of clusters, and the increase in the weight of the cluster. In addition to the role of boron in improving and encouraging the characteristics of vegetative growth, chlorophyll formation, increasing the absorption of nutrients, and increasing the number of setting in the berries, which led to an increase in the yield (Mohamed and Qaoud, 2019 and Kok and Bal, 2019.(

Reference

.1Al-Douri, Ihsan Fadhel Saleh. (2012). Response of pomegranate trees, Salimi variety (Punica granatum L). to organic fertilization, NPK, and foliar spraying with boron and ascorbic acid. College of Agriculture and Forestry - University of Mosul.

.2Al-Moaini, Abdul Majeed Turki Hammadi (2024). Soil fertility and fertilization under arid and semi-arid conditions. Majdi Office. Mosul. Iraq.

.3Al-Mu'adidi, Ali Farouk Qasim. (1999). Effect of the timing of removing the growing tips of the main branches and spraying with ethephon on the productivity and quality of Kamali grapes (Vitis vinifera L.). College of Agriculture and Forestry - University of Mosul.

.4Al-Qaisi, Nazim Aliwi Musa. (2015). Effect of foliar spraying with boron and magnesium on the yield and some quantitative and qualitative characteristics of grapes (Vitis vinifera L.) Kamali and Halwani. PhD thesis. College of Agriculture and Forestry - University of Mosul. Iraq.

.5Al-Rawi, Khasha Mahmoud and Abdul Aziz Mohammed kHalaf Allah. (1980). Design and analysis of agricultural experiments. Ministry of Higher Education and Scientific Research. University of Mosul.

.6Al-Saeedi, Ibrahim Hassan Mohammed. (2000). Grape production. Dar Al-Kotob for Printing and Publishing. University of Mosul. Iraq.

.7Al-Saeedi, Ibrahim Hassan Mohammed. (2003). Effect of boron spraying on yield and quality of Abbasi grape variety (Vitis vinifera L). Tikrit Journal of Agricultural Sciences, 3 (5): 17-29.

ISSN 2072-3857

.8Al-Shadhili, Saeed. (1999). Technology of nutrition, fertilization and irrigation of fruit trees in desert lands. Academic Library. First edition.

.9Al-Tahhafi, Sami Ali Abdul Hamid. (2004). Effect of foaming sulfur and spraying with microelements solution on the vegetative and productive characteristics of Kamali and Halwani grape varieties (Vitis vinifera L). PhD thesis. College of Agriculture. University of Baghdad. Iraq.

.10Awad, Thaer Khalil and Awad Nazik Haqi. (2022). Response of grapes, Kamali variety, to fertilization, summer pruning and foliar spraying with growth stimulants. Iraqi Journal of Soil Sciences, Volume (22): Issue (Special.(

.11Bassiony, S. S. (2020). Effect of Bud Load Levels and Summer Pruning on Vine Vigor and Productivity of "Flame Seedless" (Vitis vinifera, L.) Grapevines. J. of Plant Production, Mansoura Univ., Vol. 11 (4):301 – 310.

.12Desouky, I. M; L.F. Haggag, M. M. M. Abd El-Migeed, Y.F.M. Kishk and E.S. El-Hady (2009). Effect of boron and calcium nutrients sprays on fruit set, oil content and oil quality of some olive oil cultvars. World J.Agric. Sci., 5 (2): 180-185 .

.13Farag, A.R.A. and A.E.A. Abd El-All. (2019). Effect of summer pruning and magnesium spray on the microclimate and berry quality of flame seedless grapevines and carbohydrate export. Egypt. J. of Appl. Sci., 34 (11): 272-289.

.14Farag, G. Samir; Abdelgawad, S. Ahmed and Khaled H. Arafat. (2020). The Influence of Summer Pruning and Alternative Fungicides on Yield Quality and Powdery Mildew Progression of Black Monukka Grapevine. American-Eurasian J. Agric. & Environ. Sci., 20(5):391-398.

.15Galet, P. (1983). Precis de viticulture, 4ed. Imprimerie. Dehan, Montpellier. France.

.16Grassi F, and DeLorenzis G. (2021). Back to the Origins: Background and Perspectives of Grapevine Domestication. Int J Mol Sci. 22(9): 4518.

.17Guest, E. (1966). Flora of Iraq. Vol. (1). Ministry of Agric. Republic of Iraq.

.18Hopkins, W. G. & N. P. A. Huner (2004). Introduction of plant physiology. 3rd Edition. John Wiley & Sons, Inc. U.S.A.

.19Jundia, Hassan. (2003). Physiology of fruit trees. Arab House for Printing and Distribution. First edition.

.20Keller, M. (2020).The science of grapevines.Third edition academic. Press in an imprint to Elsevier. Inc.UK.

.21Khamis, M. A.; A. A. R. Atawia, H. E. M. El-Badawy and A. A. M. Abd El-Samea (2017). Effect of buds load on growth, yield and fruit quality of Superior grapevines. Middle East J. Agric. Res., 6(1):152-160.

.22Kok, D and E. Bal. (2020). Physical and Biochemical Properties of cv. Michele Palieri Table Grape (V. vinifera L.) in Relation to Various Doses of Foliar Applications of Oak and Boron. Erwerbs-Obstbau https://doi.org/10.1007/s10341-019-00432-6 .

.23Mengel, K.; E. A. Kerkby.; H. Kosegarten and T. Apple. (2002). Principle of plant Nutrition, 5th ed. International potash Intitute, Bem, Switzerland.

.24Mohamed, H. M. A. (2018). Response of superior grapevines grown under minia region conditions to spraying wheat seed sprout extract and nano-boron. Fayoum J. Agric. Res. & Dev., Vol. 32, No.2.

.25Mohamed, M. A. A and E. M. Qaoud. (2019). Using Boron, Magnesium and some Amino Acids to Improve Yield and Fruit Quality of Roomy Red Grapevines.

ISSN 2072-3857

Hortscience Journal of Suez Canal University, Volume 8 (1): 79-86.

.26Rasool, Hama Taher Saeed. (2008). Effect of pruning level and feeding with boron and zinc on the quantity and quality of the yield of three grape varieties. PhD thesis. College of Agriculture. University of Sulaimani. Iraq.

.27Roberto, S. R.; C. H. Mashima, R. C. Colombo, and R. T. Souza (2017). Berry-cluster thinning to reduce compactness of 'Black Star' table grapes. Ciência Rural, Santa Maria, 47 (4):1-7.

.28Sabir, S.; M. Arshad and S. K. Chaudhari. (2014). Zinc Oxide Nanopparticles fer Fevolutionizing agriculture: synthesis and application. The scientific world journal. published online 2014 Nov.11. doi: 10.1155/2014/925494. Pp.1-16.

.29SAS, Copyright 2017, Institute Inc. Cary, NC. 27513, USA.

.30Zahedi. S. M., Karimi and J. A. Teixeira da silva. (2019). the use of nanotechnology to increase guality and yield of fruit crops. J. Sci. food Agric., (1002). 10004.

.31Zahzog, O. A; M. G. Mohamed and N.K, Hafaz. (2017). Effect of Nanochitosan on Vegetative Growth, Fruiting and Resistance ofMalformation of Mango. Tends in Horticultural Research.

ISSN 2072-3857