EFFECT OF FOLIAR APPLICATION OF MICRONUTRIENTS AND CANOPY MANAGEMENT ON YIELD AND QUALITY OF GRAPEVINE (*Vitis vinfera* L) cv. MIRANE

Sh. M. M. Al-Atrushy
Assist. Prof.
Dep. of Hort. Coll. of Agric., University of Duhok, Iraq
dr.shawkat.atrushy@gmail.com

ABSTRACT

A field experiment was carried out at the private vineyard located at Bara-Bhar village, Duhok Governorate, Kurdistan region, Iraq, during the seasons of 2016 and 2017 to investigate the effect of three concentrations of micronutrients (0, 50 and 100 mg.L^{-1}) and determine the optimum bud loads per vine for "Mirane" grapevines. Twelve years old uniform vines were chosen and pruned to four different levels of buds load, namely 36, 44, 48 and 64 buds.vine^{-1}. The factorial experiment within randomized complete block design, with three replication was used. The results showed that the application of micronutrients especially at high concentration significantly increased leaf area, total chlorophyll content, number of clusters. Vine-1, cluster's weight and yield per vine, as well as weight and size of 100 berries, chemical parameters TSS, total sugar and juice percentage, juice density and β- carotene in addition to increase mineral content in leaves petiole (Fe, Zn and Mn), whereas the same concentration decreased total acidity and phenols percentage. On the other hand, buds load had significant effect on some characteristics of grapevine. The higher values of leaf area, total chlorophyll, cluster's weight, weight and size of 100 berries, TSS and total sugars percentage were obtained when the vine was pruned to 36 buds.vine^{-1}. The higher values of number of clusters, yield per vine total phenols and total acidity percentage were obtained when the vine was pruned to 64 bud.vine^{-1}. Highest value of juice percentage was obtained when the vine pruned to 48 buds.vine^{-1}.

Key words: grape, mirane, micronutrients, buds load, fruit quality.

تاثير الرش بالمغذ يات الصغرى وادارة المجموع الخضري على كمية ونوعية حاصل العنب (*Vitis vinfera* L) صنف ميراني

شوكت مصطفى محمد الاتروشي
استاذ مساعد
قسم البستنة/كلية الزراعة/ جامعة دهوك

المستخلص

اجريت التجربة في مزرعة عنب اهلية تقع في قرية برى–بهار، محافظة دهوك،اقليم كردستان العراق، خلال موسمي النمو 2016 – 2017 لدراسة تاثير ثلاث تراكيز من المغذيات الصغرى (صفر، 50 و 100 ملغم.لتر$^{-1}$) ولتحديد امثل حمل لكرمة العنب صنف ميراني. اختيرت كرمات بعمر 12 سنة وتم تقليمها الى اربع مستويات حمل البراعم هي 36، 44، 48 و64 برعم لكل كرمة وحسب تصميم القطاعات العشوائية الكاملة. اظهرت النتائج بان اضافة المغذي خاصة بالتركيز العالي ادى الى زيادة معنوية في مساحة الورقة ومحتوى الكلوروفيل الكلي وعدد العناقيد لكل كرمة ووزن العنقود وحاصل الكرمة الواحدة، كذلك وزن وحجم 100 حبة ونسبة المواد الصلبة الذائبة الكلية ونسبة السكريات الكلية ونسبة وكثافة العصير وبيتا كلروتين) بالاضافة الى زيادة محتوى الورقة في اعناق الاوراق (حديد وزنك والمنغيز)، في حين نفس التراكيز قللت معنويا نسبة الحموضة الكلية ونسبة الفينولات في عصير الحبات. من جهة اخرى حمل البراعم كان له تاثير معنوي على بعض الصفات، حيث ان اعلى القيم لمساحة الورقة والكلوروفيل الكلي ووزن العنقود ووزن وحجم مئة حبة ونسبة المواد الصلبة الذائبة الكلية ونسبة السكريات الكلية ظهرت عند تقليم الكرمة الى36 برعم. كرمة$^{-1}$ ، بينما اعلى القيم لعدد العناقيد والحاصل للكرمة الواحدة والنسبة المئوية للحموضة الكلية والفينولات الكلية نتجت عند تقليم الكرمة الى 64 برعم.كرمة$^{-1}$، اعلى قيمة للنسبة المئوية للعصير ظهرت عند التقليم الى 48 برعم.كرمة$^{-1}$.

الكلمات المفتاحية: العنب، ميراني، مغذيات صغرى،حمل البراعم، نوعية الثمار

***Received:5/8/2018, Accepted:8/1/2019**

INTRODUCTION

There are more than 70 varieties of grapes grown in Kurdistan including dessert grapes, varieties that are dried to give currants and varieties that can be used for the production of juice and wine, Although the land suitable for growing grapes is there, yet unfortunately Iraq heavily dependent on neighboring countries for grapes and their products (7, 15, 4). Mirane is one of the local varieties cultivated deployed in Dohuk, it's one of the table grapes, flowers are functionally female and there are a big differences between the farmers on how to pruning, (8) mentioned that the basal eyes are fertile. Quality of table grapes is usually considered as a combination of appearance (average size of clusters as uniformly large size berry, perfect berries, without shot berry) with the characteristic color and texture of the variety (21), flavor characteristics, sugar concentration, Acidity (20). The primary goal of pruning is to limitation the amount of one-year old wood on each grapevine without encouraging the plant to produce so many grape clusters that it lacks the energy and nutrients to fully ripen them. Left to its own devices, a grapevine grows to a dense mass of mostly older wood with relatively little "fruiting wood" each year. The dense growth leads to poor air circulation, which encourages fungal diseases. Expect to remove 70 to 90 percent of the previous year's growth each winter (11). There are many factors which can effect on the yield and quality of grape such as pruning, crop load, thinning, girdling, topping and pinching, the use of plant growth regulators and correct nutrition (27). Pruning is considered the most important practice through which grape production can be increased and cluster quality improved. The basal 3-4 buds of the some cultivar are less fruitful, so testing the length of canes is important for production normal crop (17). There are two types of grape pruning—cane pruning and spur pruning. Mature plants should be pruned yearly to remove all growth except new one-year-old fruiting canes and renewal spurs. Bud load is the most important factor affecting yield and cluster quality as well as vine vigor of grapevine (31, 8). (17) Studied pruned six different levels of bud load, namely 78, 91, 104, 117, 130 and 143 buds/ vine. Number of buds was fixed at 13 buds per cane. Data indicated that 104 or 117 buds.vine^{-1} were more suitable for Cirimson seedless grapevines to produce good yield and fruit quality. Nutrition is a critical management tool for grape growers. The use of nutrition in the vineyard can influence leaf area, chlorophyll content, fruit set, fruit quality and the quality of the end product. Nutrition in the vineyard is often determined on a vineyard-to-vineyard basis due to vineyard variation, though much can be learnt and applied from basic knowledge of site-specific soils (e.g. texture, pH, etc.), the role of specific nutrients in the plant, variety and rootstock characteristics (33). Iron (Fe) is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions. Hence, iron has many essential roles in plant growth and development including chlorophyll synthesis, thylakoid synthesis and chloroplast development (24, 1). Zinc (Zn) is one of the essential elements for plants (12). Zn is required for the synthesis of Auxins, chlorophyll, and starch and metabolism carbohydrate (23, 35). Manganese (Mn) is involved in photosynthesis and metabolism of nitrogen and carbohydrate (16). (1) studied the effect of foliar application with some micronutrients (Fe, Zn, Mn and B) on physical and chemical properties of (Bez El Naka) grapevine cultivar during two successive seasons (2014 and 2015). The result obtained proved that all parameters such as cluster weight, berries weight, juice volume, and total chlorophyll content, TSS, acidity and total phenols were improved all treatments as compared with control. The objective of this study is to determine the optimum micronutrient concentration and buds load.vine^{-1} for Mirane seeded grape and to study the effect of bud load combine with micronutrients concentration on cluster quality, yield.vine^{-1} and physical and chemical properties of this cultivar.

MATERIALS AND METHODS

A field experiment was carried out at a private vineyard located near Zauita town during two growing season (2016 and 2017). Healthy and similar vigor Mirane cultivar vines of 12 years old grown on clay soil under drip irrigation system were chosen, the vines were planted at 2.5 x 3m apart. Vines were trained according to the ‘T’ trails system. During the first week of March, all vines were pruned to investigate the effect of different buds load and fruiting unit’s length and foliar application of mixture of micronutrient on vegetative growth, yield and quality of grape. The experiment was study conducted as follows: four buds load.vine^{-1} were carried out as 36, 44, 48 and 64 buds per vine and adjusted number of buds.cane^{-1} was 4 and 6 buds. Consequently the number of bearing units per an individual vine ranged from 6 and 8 canes per vine with 6 and 8 renewal spurs respectively. So the buds load.vine^{-1} was carried out as follow:

1- 6 cane x 4 buds per cane + 6 renewal spur x 2 per spur = 36 buds

2- 8 cane x 4 buds per cane + 6 renewal spur x 2 per spur = 44 buds

3- 6 cane x 6 buds per cane + 6 renewal spur x 2 per spur = 48 buds

4- 8 cane x 6 buds per cane + 8 renewal spur x 2 per spur = 64 buds

All vines received the standard agricultural practices used in the vineyard including fertilizer application, irrigation and pest control except for the tested different treatments through the two studied seasons Micronutrients (Fe, Zn and Mn) were foliar applied at a concentration of 50 and 100 mg.L^{-1} in a chelated form in two different concentrations in addition to control:-

1- First 50 mg.L^{-1} (Fe, Zn and Mn) in a chelated form (Fe-EDTA, Zn-EDTA and Mn-EDTA,)

2- Second 100 mg.L^{-1} (Fe, Zn and Mn) in a chelated form (Fe-EDTA, Zn-EDTA and Mn-EDTA).

All treatments were foliar applied at the same day and twice a year, the first one was achieved at 1 May (two weeks before full bloom) the second was carried out after 5 weeks of the first spraying. Detergent Powder as a wetting agent at 1-2 g.L^{-1} was added to all micronutrients solutions. Foliar were applied in the morning (6-9 Am.) using a hand pressure sprayer. Potential effects of Micronutrients concentration and buds load were evaluated in terms of the change in leaf area, chlorophyll, number of clusters, cluster’s weight and yield^{-1} vine, as well as physical (weight and size of 100 berries) and chemical parameters (TSS, total sugar, total acidity, juice percentage, juice density, total phenols and β- carotene). A factorial experiment within randomized complete block design with two factors was followed in the experiment. Every treatment consisted of one vine per replicate with three replications, so the number of vines used was 36 vines. All the results were analyzed statistically by using SAS programs (2003). Duncan’s multiple range test (DMRT) at 5% level of portability was used to compare the treatments means according to (6).

RESULTS AND DISCUSSION

Vegetative growth

Results in Table (1) shows that leaf area and total chlorophyll content were increased significantly as micronutrient concentration was increased and the treatment of 100 mg. L^{-1} gave the highest values (178.68 and 177.68 cm^2; 52.40 and 52.76) in the two seasons, leaf area and total chlorophyll content, whereas, a lower significantly leaf area and total chlorophyll content (160.76 and 157.76 cm^2; 42.71and 45.36) in both seasons, respectively. The same Table also shows that the leaf area and total chlorophyll content were significantly increased by decreasing bud load. Moreover, the highest leaf area and total chlorophyll content were obtained by those vine pruned to 36 buds per vine (175.97 and 177.97 cm^2) and (53.80 and 52.76 SPAD) in the two seasons, respectively whereas the lowest leaf area and total chlorophyll content were obtained by those vine pruned to 64 buds per vine which recorded (165.19 and 163.19 cm^2) and (45.80 and 45.66 SPAD) in the two seasons, respectively. the interaction between foliar application of micronutrient and buds load significantly increased leaf area and total chlorophyll content (Table 1), the highest leaf area (179.86 and 177.96 cm^2) for both season were resulted from the interaction of 100 mg.L^{-1} micronutrient + 44 buds.vine^{-1} respectively while the lowest value (147.82 and148.82 cm^2) for two season obtained from the interaction of the control + 64 buds.vine^{-1} respectively, whereas, the highest total chlorophyll content (56.52 and 55.39 SPAD) for both season was appeared respectively when the vine sprayed by 100 mg. l^{-1} and pruned to 36 bud compared to the lowest total chlorophyll content (39.36 and 38.57 SPAD) for both season respectively for the control and when the vine was pruned to 64 bud.

Table 1. Effect of canopy management and foliar application of micronutrients on some vegetative parameters of grapevine cv. Mirane

Treatments			Leaf area (cm2)		Total chlorophyll (SPAD)	
			2016	2017	2016	2017
Micronutrient ($mg.L^{-1}$)		0	160.76 b	157.76 c	42.71 c	45.36 b
		50	174.81 a	170.81 b	48.55 b	46.60 b
		100	178.68 a	177.68 a	52.40 a	51.93 a
Buds load ($Buds.vine^{-1}$)		36	175.97 a	177.97 a	53.80 a	52.76 a
		44	174.01 a	171.01 b	47.23 b	48.29 ab
		48	170.49 ab	170.49 b	44.71 b	47.15 b
		64	165.19 b	163.19 c	45.80 b	45.66 b
Micronutrient (0)	Buds	36	173.51 a	171.51 ab	50.27 a-d	49.36 ab
		44	163.17 bc	159.17 bc	44.03 cde	43.15 bc
		48	158.52 cd	162.52 cd	41.17 de	50.35 ab
		64	147.82 d	148.82 d	39.36 e	38.57 c
Micronutrient (50 $mg.L^{-1}$)	Buds	36	176.83 a	174.83 a	54.61 ab	53.52 ab
		44	179.00 a	177.40 a	45.05 b-e	44.15 bc
		48	173.51 ab	171.51 ab	44.12 cde	43.23 bc
		64	169.91 abc	168.91 abc	46.42 b-e	45.49 abc
Micronutrient (100 $mg.L^{-1}$)	Buds	36	177.58 a	176.58 a	56.52 a	55.39 a
		44	179.86 a	177.96 a	52.61 abc	51.56 ab
		48	179.44 a	177.44 a	48.84 a-e	47.86 abc
		64	177.85 a	175.85 a	51.61 abc	52.91 ab

Mean in each column followed by the same letters are not significantly different at P≤ 0.05 according to Duncan's multiple range test

Yield and its components

Results in Table (2) shows the number of clusters.vine^{-1} were increased significantly as foliar application of micronutrient was increased. It is clear that treatment of 100 mg. L^{-1} predicted the highest number of clusters.vine^{-1} 35.68 and 39.26 in the two seasons, respectively compare to the control which gave a lowest significantly number of clusters (27.08 and 29.79) in both seasons, respectively. Also the same Table show that cluster's weight were significantly increased by increasing concentration of micronutrient, since the highest weight of cluster (611.96 and 621.96 g) in the two seasons, respectively was obtained by application of 100 mg.L^{-1} compared to the lowest weight of cluster (554.75and 534.75 g) in the two seasons, respectively was obtained for the control. From the same Table, the yield.vine^{-1} was significantly increased by increasing micronutrient concentration. Likewise, the highest yield.vine^{-1} was obtained by application of 100 mg.L^{-1} of micronutrient (21.80 and 24.40 kg.vine^{-1}) in the two seasons, respectively. This increment in vine yield may be attributed to the increase in both numbers of clusters per vine and cluster's weight (Table 2). Results in Table (2) also indicate that numbers of clusters.vine^{-1} were increased significantly as bud load was increased. It is obvious that treatment of 64 buds.vine^{-1} produced the highest number of clusters.vine^{-1} (35.78 and 40.46) in two seasons, respectively, whereas, leaving 36 buds.vine^{-1} produce a lower significantly number of cluster (25.82 and 28.41) in both seasons, respectively. On the other hand, cluster's weight were significantly decreased by increasing bud load, since the highest weight of cluster (616.66 and 611.66 g) in the two seasons, respectively were obtained by leaving 36 buds per vine compared to the lowest weight of cluster (515.07 and 535.16 g) in the two seasons, respectively obtained by leaving 64 buds.vine^{-1}. From the same Table, show that the yield.vine^{-1} was significantly increased by increasing bud load. Moreover, the highest yield.vine^{-1} was obtained by those vine pruned to 64 buds per vine 18.43 and 21.85 kg.vine^{-1} in the two seasons, respectively. This increment in vine yield may be attributed to increase in both number of clusters.vine^{-1} and their weight. Results in Table 2 show that the interaction between foliar application of micronutrient and buds load significantly increased number of clusters.vine^{-1}, cluster weight and yield, the highest value (43.09 and 47.40 clusters.vine^{-1}; 21.80 and24.40 kg.vine^{-1}) respectively for both season were resulted from the interaction of 100 mg.L^{-1} micronutrient + 64 buds.vine^{-1}. While the lowest value (210.85 and 23.84 clusters per vine and 13.20 and14.51 kg.vine^{-1}) of number of clusters and yield per vine respectively obtained from the control, whereas, the highest cluster's

Table 2. Effect of canopy management and foliar application of micronutrients on some yield parameters of grape cv. Mirane

Treatments			Parameters					
			No. of clusters		Cluster we. (g)		yield (Kg.vine^{-1})	
			2016	2017	2016	2017	2016	2017
Micronutrient (mg.L^{-1})		0	27.08 c	29.79 c	554.75 b	534.75 c	14.90 c	15.93 c
		50	30.34 b	33.38 b	582.31 ab	582.31 b	17.53 b	19.94 b
		100	35.68 a	39.26 a	611.96 a	621.96 a	21.80 a	24.40 a
Buds load Buds.vine^{-1}		36	25.82 c	28.41 c	616.66 a	611.66 a	16.02 c	17.61 b
		44	28.77 c	31.65 c	587.33 b	610.33 ab	16.90 b	19.27 ab
		48	33.78 ab	36.05 b	542.98 b	572.98 b	18.90 ab	20.78 a
		48	35.78 a	40.46 a	515.07 c	535.16 b	18.43 a	21.85 a
Micronutrient (100 mg.L^{-1})	Buds	36	21.67 e	23.84 e	607.70 a	617.71 a	13.20 d	14.51 d
		44	26.67 de	29.33 de	587.62 a	596.52 a	15.67 cd	17.23 cd
		48	28.35 d	31.18 d	540.66 ab	548.62 ab	15.37 cd	16.90 cd
		64	31.64 cd	34.80 cd	483.03 b	492.13 b	15.35 cd	16.88 cd
Micronutrient (100 mg.L^{-1})	Buds	36	26.76 de	29.44 de	621.59 a	632.49 a	16.67 cd	18.33 cd
		44	27.68 de	30.44 de	616.17 a	623.19 a	17.03 cd	18.73 cd
		48	31.33 cd	34.46 cd	559.93 ab	567.83 ab	17.52 cd	19.27 cd
		64	35.61 bc	39.17 bc	531.57 ab	541.67 ab	18.90 c	20.79 c
Micronutrient (100 mg.L^{-1})	Buds	34	29.04 d	31.94 d	620.70a	631.60 a	18.18 c	19.99 c
		44	31.97 cd	35.17 cd	618.20 a	627.24 a	19.87 bc	21.85 bc
		48	38.65 ab	42.51 ab	618.36 a	628.38 a	23.81 ab	26.18 ab
		64	43.09 a	47.40 a	590.60 a	599.63 a	25.34 a	27.87 a

Mean in each column followed by the same letters are not significantly different at P≤ 0.05 according to Duncan's multiple range test.

weight (621.59 and632.49 g) for both season was appeared respectively when the vine was pruned to 36 bud and sprayed by 100 mg.L^{-1} compared to the lowest cluster's weight (483.03 and492.13 g) respectively for both season when the vine was pruned to 64 bud and control.

Physical parameters

Data of table (3) shows that weight and size of 100 berries and TSS were increased significantly as micronutrient concentration was increased. It is obvious that treatment of 100 mg. l^{-1} gave the highest values (412.62 and 408.16 g; 434.33 and 430.12 cm^3; 19.09and20.19 %) in the two seasons, respectively of weight and size of 100 berries and TSS respectively, whereas, a lower significantly weight and size of 100 berries and TSS (383.88 and 378.37 g; 404.08 and 383.88cm^3; 16.00and17.10 %) in both seasons, respectively to 0 mg.$^{L-1}$. Table (3) shows that the weight and size of 100 berries and TSS were significantly increased by decreasing bud load. furthermore, the highest weight and size of 100 berries and TSS were obtained by those vine pruned to 36 buds.vine^{-1} (425.39 and 421.14 g; 447.78 and 425.39 cm^3; 18.31and19.51 %) in the two seasons, respectively whereas the lowest weight and size of 100 berries and TSS were obtained by those vine pruned to 64 buds per vine which recorded (384.33 and 367.15 g); (404.56 and 390.99 cm^3) and (16.72 and 16.56 %) in the both seasons, respectively

Table 3. Effect of canopy management and foliar application of micronutrients on some physical parameters of grape cv. Mirane

Treatments			We of 100 berries (g) 2016	We of 100 berries (g) 2017	Size of 100 berries(cm^3) 2016	Size of 100 berries(cm^3) 2017	TSS (%) 2016	TSS (%) 2017
Micronutrient (mg.L-1)		0	383.88 b	378.37 b	404.08 b	383.88 c	16.00 c	17.10 c
		50	400.71 ab	395.30 ab	429.17 ab	404.38 b	17.16 b	18.17 b
		100	412.62 a	408.16 a	434.33 a	430.12 a	19.09 a	20.19 a
Buds load Buds.vine-1		36	425.39 a	421.14 a	447.78 a	425.39 a	18.31 a	19.51 a
		44	414.81 ab	400.76 a	426.11 ab	405.92 ab	18.43 a	17.42 b
		48	391.08 b	389.39 ab	411.67 b	402.19 ab	16.20 b	16.27 b
		64	384.33 b	367.15 b	404.56 b	390.99 b	16.72 b	16.56 b
Micronutrient	Buds	36	415.78 abc	411.63 abc	437.67 abc	415.78 abc	17.59 bc	18.57 bc
		44	388.55 abc	384.66 abc	409.00 abc	388.55 abc	16.52 cd	17.42 cd
		48	369.55 bc	365.85 bc	389.00 bc	369.55 bc	15.16 d	16.26 d
		64	361.63 c	351.35 c	380.67c	361.63 c	14.73 d	14.03 d
Micronutrient	Buds	36	420.22 ab	416.01 ab	442.33 ab	420.22 abc	18.10 abc	19.12 abc
		44	399.00 abc	395.01 abc	420.00 abc	399.00 abc	18.87 abc	19.77 ab
		48	400.90 abc	396.89 abc	422.00 abc	400.90 abc	15.38 d	16.28 d
		64	410.72 abc	373.28 abc	432.33 abc	397.38 abc	16.28 cd	17.38 cd
Micronutrient	Buds	36	440.17 a	435.77 a	463.33 a	440.17 a	19.24 ab	20.14 ab
		44	426.87 ab	422.60 ab	449.33 ab	430.20 ab	19.90 a	20.91 a
		48	402.80 abc	405.44 abc	424.00 abc	436.13 a	18.06 abc	19.16 bc
		64	380.63 bc	376.83 abc	400.67 bc	413.97 abc	19.16 ab	20.11 ab

Mean in each column followed by the same letters are not significantly different at P≤ 0.05 according to Duncan's multiple range test.

For the interaction, the highest weight and size of 100 berries were obtained by the interaction between spraying of 100 mg.L^{-1} and vine pruned to 36 buds.vine^{-1} which recorded (440.17 and 435.77 g; 463.33 and 440.17 cm^3), while the highest TSS (19.90 and 20.91) was obtained from the interaction between spraying of 100 mg. L^{-1} and vine pruned to 44 buds.vine^{-1}.

Chemical parameters

Table (4) shows total sugar and juice percentage were increased significantly as foliar application of micronutrient was increased. It is noticeable that treatment of 100 mg. l^{-1} produced the highest total sugar and juice percentage (22.78 and 23.06; 70.33 and 67.23 %) in the two seasons, respectively compared to the control which produced a lower significantly total sugar and juice percentage (16.91 and 18.60; 57.61 and 55.56) in both seasons, respectively. There are no clear differences on the number of clusters that had been obtained by application of 50 mg. L^{-1} and control. Also the same Table shows that total acidity percentage was significantly decreased by increasing concentration of micronutrient, since the lower total acidity percentage (0.443 and 0.494) in the two seasons, respectively was obtained by application of 100 mg. L^{-1} compared to the highest total acidity percentage (0.712 and 0.681) in the two seasons, respectively was obtained by the control. Data of Table (4) indicate that there are no clear differences in total sugar percentage that had been obtained by increasing buds load from 34 buds to 64 buds per vine in first season, but there is a significantly decreased in total sugar percentage as bud load were increased in the second season. On the other hand it is clear that treatment of 64 buds per vine gave the highest Total acidity percentage which recorded (0.707 and 0.687)in the two seasons, respectively, whereas, leaving 34 buds per vine gave a lower significantly total acidity percentage (0.482 and 0.466) in both seasons, respectively. Concerning the juice percentage same table shows that the highest juice percentage was obtained when the vine was pruned to 48 buds.vine^{-1} in the first season, but, there are no clear differences on the juice percentage that had been obtained in the second season by increasing buds load.vine^{-1}. Table 4 show that the interaction between foliar application of micronutrient and buds load significantly affected on total sugar; total acidity and juice percentage, the highest values of total sugar; total acidity and juice percentage

(23.20 and 25.52; 0.964 and0.933 ; 73.37 and69.70 %) respectively for both season were resulted from the interaction of 100 mg.L^{-1} micronutrient + 48 buds.vine^{-1}; 0mg.l^{-1} + 64 buds.vine^{-1} and100 mg.L^{-1} + 64 buds.vine^{-1} , while the lowest value (15.99 and 17.59; 0.411 and 0.396 and 50.64 and 50.26 %) of total sugar; total acidity and juice percentage respectively were obtained from the interaction of 0mg.l^{-1} + 64 buds.vine^{-1}; 100 mg.L^{-1} + 64 buds.vine^{-1} and 0mg.L^{-1} + 36 buds.vine^{-1} (first season); + 64 buds.vine^{-1} (second season) respectively for both season.

Table 4. Effect of canopy management and foliar application of micronutrients on some chemical parameters of grape cv. Mirane

Treatments			Total sugar (%) 2016	Total sugar (%) 2017	Total acidity (%) 2016	Total acidity (%) 2017	Juice (%) 2016	Juice (%) 2017
Micronutrient (mg.L^{-1})		0	16.91 b	18.60 b	0.71 a	0.68 a	57.61 c	55.56 b
		50	18.10 b	20.50 ab	0.59 a	0.57 ab	61.76 b	58.67 b
		100	22.78 a	23.06 a	0.44 b	0.49 b	70.33 a	67.23 a
Buds load Buds.vine^{-1}		36	20.04 a	22.82 a	0.48 b	0.46 b	60.64 b	61.49 a
		44	19.29 a	21.22 ab	0.52 b	0.50 b	63.73 ab	60.54 a
		48	19.05 a	20.95 ab	0.62 ab	0.55 b	65.19 a	61.93 a
		64	18.68 a	20.55 b	0.70 a	0.68 a	63.37 ab	57.98 a
Micronutrient	Buds	36	18.76 b	20.64 ab	0.50 bc	0.485 bc	50.64 g	54.78 cd
		44	16.61 b	18.27 c	0.70 abc	0.679 abc	59.31 ef	56.34 bcd
		48	16.26 b	17.89 c	0.66 bc	0.639 bc	64.08 cde	60.87 abc
		64	15.99 b	17.59 c	0.96 a	0.933 a	56.41 fg	50.26 d
Micronutrient	Buds	36	19.09 b	23.34 ab	0.46 bc	0.445 bc	62.15 c-f	62.37 abc
		44	18.74 b	20.61 ab	0.42 c	0.404 c	64.54 b-e	61.31 abc
		48	17.68 b	19.45 c	0.75 ab	0.731 ab	60.01 def	57.01 bcd
		64	16.90 b	18.59 c	0.74 ab	0.719 ab	60.33 def	53.98 cd
Micronutrient	Buds	36	22.26 a	24.49 a	0.49bc	0.477 bc	69.12c ab	67.33 a
		44	22.52 a	24.78 a	0.43 c	0.420 c	67.34 a-d	63.97 ab
		48	23.20 a	25.52 a	0.43 c	0.420 c	71.50 ab	67.92 a
		64	23.16 a	25.47 a	0.41 c	0.396 c	73.37 a	69.70 a

Mean in each column followed by the same letters are not significantly different at P≤ 0.05 according to Duncan's multiple range test.

Table (5) indicates that juice density was increased significantly as micronutrient concentration was increased. It is obvious that treatment of 100 mg. L^{-1} gave the highest values recorded (1.140 and 1.231 OD) in the two seasons, respectively, whereas, a lower significantly juice density (1.017 and 1.098 OD) in both seasons, respectively. Moreover, there are no clear differences in juice density that had been obtained by increasing bus load in both seasons of studying. The same Table also shows that the total phenols percentage was significantly decreased from1.474 and1.462 % at control to 1.315 and1.314 by application of 100 mg. L^{-1} in the two seasons, respectively while there are no clear differences between control and application of 50 mg. L^{-1}. Whereas, the total phenols percentage were significantly increased by increasing buds load, the highest total phenols were obtained by those vine pruned to 64 buds.vine^{-1} (1.523 and 1.472 %) in the two seasons, respectively whereas the lowest total phenols were obtained by those vine pruned to 36 buds per vine (1.271 and 1.298 %) in the two seasons, respectively. Concerning the B-carotene content, data in same Table shows that B-carotene content was increased significantly as micronutrient concentration was increased. It is noticeable that treatment of 100 mg.L^{-1} gave the highest values recorded (27.98 and 27.04 mg.kg^{-1}) in the two seasons, respectively, whereas, a lower significantly carotene content (21.39 and 20.18 mg.kg^{-1}) in both seasons, respectively at control. Moreover, there are no clear differences in carotene content that had been obtained by increasing bus load in both seasons of studying. Table (5) shows that the interaction between foliar application of micronutrient and buds load significantly affected juice density; total phenols percentage and B-carotene content, the highest juice density; total phenols percentage and B-carotene content (1.273 and 1.375 OD; 1.648 and 1.618 %; 30.56 and 28.15 mg.kg^{-1}) respectively for both season were resulted from the interaction of 100 mg.L^{-1} micronutrient + 64 buds.vine^{-1}; 0 mg.L^{-1} + 64 buds.vine^{-1}; 100 mg.L^{-1} micronutrient + 64 buds.vine^{-1} (1saeson) 100 mg.L^{-1} micronutrient + 48 buds.vine^{-1} (2 season) respectively. Although the lowest values of juice density; total phenols percentage and B-carotene content (0.915 and0.988 OD; 1.199 and1.240 %; 18.29 and18.11 mg.kg^{-1}) respectively for two season obtained from the interaction of the control + 64 buds.vine^{-1}, 100 mg.L^{-1} + 36 buds.vine^{-1}; 0 mg.L^{-1} micronutrient + 44 buds.vine^{-1}.

Table 5. Effect of canopy management and foliar application of micronutrients on some chemical parameters of grape cv. Mirane

Treatments			Juice density (OD) 2016	Juice density (OD) 2017	Total phenols 2016	Total phenols 2017	B-carotene (mg.kg^{-1}) 2016	B-carotene (mg.kg^{-1}) 2017
Micronutrient (mg.L^{-1})		0	1.017 b	1.098 c	1.474 a	1.462 a	21.39 b	20.18 c
		50	1.100 ab	1.158 b	1.408 ab	1.377 ab	23.69 b	23.95 b
		100	1.140 a	1.231 a	1.315 b	1.314 b	27.98 a	27.04 a
Buds load Buds.vine^{-1}		36	1.037 a	1.120 a	1.271 b	1.298 b	24.22 a	23.98 a
		44	1.096 a	1.184 a	1.373 ab	1.356 ab	23.25 a	23.02 a
		48	1.114 a	1.203 a	1.429 ab	1.412 ab	24.16 a	23.91 a
		64	1.095 a	1.183 a	1.523 a	1.472 a	25.79 a	25.31 a
Micronutrient (mg.L^{-1})	Buds	36	0.920 bc	0.993 b	1.329 abc	1.335 b	22.92 bcd	22.69 abc
		44	1.110 abc	1.198 ab	1.451 abc	1.422 ab	18.29 d	18.11 c
		48	1.123 abc	1.212 ab	1.469 abc	1.474 ab	21.74 cd	21.53 bc
		64	0.915 c	0.988 b	1.648 a	1.618 a	22.61 bcd	22.39 abc
Micronutrient (mg.L^{-1})	Buds	36	1.070 abc	1.156 ab	1.286 bc	1.318 b	24.30 bc	24.06 ab
		44	1.082 abc	1.169 ab	1.363 abc	1.335 b	23.97 bcd	23.73 abc
		48	1.150 ab	1.242 ab	1.451 abc	1.422ab	22.29 cd	22.07 bc
		64	1.099 abc	1.186 ab	1.531 ab	1.433 ab	24.21 bc	25.97 ab
Micronutrient (mg.L^{-1})	Buds	36	1.121 abc	1.211 ab	1.199 c	1.240 b	25.44 abc	25.19 ab
		44	1.096 abc	1.184 ab	1.306 bc	1.311 b	27.50 abc	27.23 ab
		48	1.070 abc	1.155 ab	1.366 bc	1.339 b	28.43 ab	28.15 a
		64	1.273 a	1.375 a	1.389 abc	1.365 ab	30.56 a	27.58 ab

Mean in each column followed by the same letters are not significantly different at P≤ 0.05 according to Duncan's multiple range test

Mineral content

Table (6) shows that Fe, Zn and Mn content of leaf petiole of grapevine were significantly increased as micronutrient concentration was increased. It is observable that treatment of 100 mg.L^{-1} gave the highest values recorded (145.73 and 147.04 %; 25.19 and 26.37 mg.Kg^{-1}; 46.30 and45.89 mg.Kg^{-1}dry weight) in the two seasons, respectively of Fe, Zn and Mn content respectively, whereas, a lower significantly Fe, Zn and Mn content (130.02 and 131.19 %; 19.67 and 21.44 mg.Kg^{-1}; 37.67 and 38.01 mg.Kg^{-1}) in both seasons, respectively. Moreover, there are no clear differences between 50 mg. l^{-1} and other treatment. Same Tables also shows that buds load had no clear effect on Fe, Zn and Mn concentration of leaf petiole of grapevine in the two seasons of study. For the interaction, it's comprehensible from Table 6 that the interaction between treatments undertaken in this study had no clear effect on the Fe percentage in leave petiole, whereas, had significantly effect on Zn and Mn content in leave petiole, It is clear that the highest Zn and Mn content in leave petiole were obtained when the vines were sprayed by 100 mg.L^{-1} and pruned to 64 buds.vine^{-1} for Zn content and same concentration of micronutrient and pruned to 48 buds.vine^{-1} for Mn content which recorded (27.50and29.98; 48.03 and 48.47 mg.Kg^{-1}) in the two seasons, respectively, compare to the lower values (19.02 and 20.73; 32.92 and 33.22 mg.Kg^{-1}) in the two seasons, respectively for Zn and Mn respectively

Table 6. effect of canopy management and foliar application of micronutrients on Fe, Zn and Mn content of leaf petiole of grapevine cv. Mirane

Treatments			Fe (%) 2016	Fe (%) 2017	Zn ($mg.Kg^{-1}$) 2016	Zn ($mg.Kg^{-1}$) 2017	Mn ($mg.Kg^{-1}$) 2016	Mn ($mg.Kg^{-1}$) 2017
Micronutrient		0	130.02 b	131.19 b	19.67 b	21.44 b	37.67 b	38.01 b
		50	140.32 ab	139.91 ab	21.32 b	22.82 b	41.60 ab	41.14 ab
($mg.L^{-1}$)		100	145.73 a	147.04 a	25.19 a	26.37 a	46.30 a	45.89 a
Buds load		36	139.11 a	138.14 a	21.80 a	23.43 a	42.73 a	43.12 a
		44	137.07 a	138.30 a	21.93 a	22.79 a	40.56 a	40.93 a
($Buds.vine^{-1}$)		48	138.27 a	139.51 a	21.74 a	23.70 a	41.59 a	41.97 a
		64	140.31 a	141.57 a	22.77 a	24.26 a	42.54 a	40.70 a
Micronutrient	Buds	36	127.53 a	128.68 a	20.63 cd	22.49 c	41.26 ab	41.63 ab
($mg.L^{-1}$)		44	126.40 a	127.54 a	19.46 d	21.21 c	32.92 b	33.22 b
		48	130.47 a	131.64 a	19.57 d	21.33 c	39.14 ab	39.49 ab
		64	135.67 a	136.89 a	19.02 d	20.73 c	37.37ab	37.70 ab
Micronutrient	Buds	36	146.47 a	141.12 a	21.87 bcd	23.84 bc	41.94 ab	42.32 ab
($mg.L^{-1}$)		44	135.80 a	137.02 a	21.57 bcd	23.51 bc	40.74 ab	41.11 ab
		48	133.73 a	134.94 a	20.06 d	21.87 c	40.12 ab	40.48 ab
		64	145.27 a	146.57 a	21.79 bcd	22.08 c	43.58 ab	40.64 ab
Micronutrient	Buds	36	143.33 a	144.62 a	22.90 bcd	23.96 bc	45.00 ab	45.41 ab
($mg.L^{-1}$)		44	149.00 a	150.34 a	24.75 abc	23.64 bc	48.03 a	48.47 a
		48	150.60 a	151.96 a	25.59 ab	27.89 ab	45.51 a	45.92 a
		64	140.00 a	141.26 a	27.50 a	29.98 a	46.67 a	43.75 ab

Mean in each column followed by the same letters are not significantly different at P≤ 0.05 according to Duncan's multiple range test

It's clear from table that leaf area and total chlorophyll of grapevine cv. Mirane were increased by increasing micronutrient concentration; these may be to the role of Fe, Zn and Mn, since the Iron forms are essential for both enzymes and chlorophyll synthesis, accordingly, reducing iron in plants causes' leaf chlorosis, deficiency in vegetative growth, decreases net photosynthetic rate and chlorophyll content of plants. Zn spray application increased chlorophyll content of plants, leaf area, net photosynthetic rate and vegetative growth (25, 10). Mn is a main component of chlorophyll, its contents in chlorophyll is about 15 to 20 % of the total Mn constitution in plants, also consider as a structural component in ribosome granules, stabilizing them in the composition necessary, so foliar spray of Mn increased the translocation of synthesized materials of the photosynthesis from the leaf to the grape fruit (22). Increasing buds load decreased leaf area and total chlorophyll content, these may be attributed to that fewer leaves in vine when leaving a number of 36 buds load per vine (Table 1), which reduces competition for nutrients, as well as increased penetration of light into the vine, as the increase in lighting leads to an increase in the process of photosynthesis and then increase the surface area and chlorophyll of the leaf (38, 2, 30, 3). Recording the effect of micronutrient concentration on improving yield and it's components, may be returns to the role of Fe, Zn and Mn, in increasing leaf area and chlorophyll content (Table 1) which may increase berry set, a number of berry in cluster and cell size or cell number resulting hence competition of photosynthetic substance between berries on a cluster (14), also, increasing chlorophyll content in the leaf which is associated with high production of photosynthesis in a plant (29). Generally, to get the best price of table grapes in domestic and export markets, there are some Characteristics for the cluster of grapes such as large berries, compactness cluster, firmness berries and sweetness (1). For the effect of buds load on yield and it's components, it's clear from Table (2) that increasing buds load significantly increased number of cluster and yield per vine, these may attributed to increase in number of buds per vine and to increase the number of shoots per vine (3), on the other hand increasing buds load significantly reduced cluster weight, the decrease in cluster weight can be attributed to an increase in the number of clusters (Table 2), the greater the number of clusters on the vine, the smaller the weight of the cluster (9, 5, 30) due to the increase in competition among them on food manufactured in leaves. Increased berry Wight and size of 100berries by application of micronutrient was explained by increasing chlorophyll content in the leaf (Table 1) which is associated with high production of photosythate in a plant (29). The result of the increases in weight and size of 100 berries by reducing buds load may due the increases in the leaf area and chlorophyll content (table 1) which lead to increases the portion of each cluster when leaving 36 or 44 buds per vine compared with leaving 64 buds.vine^{-1}, which increases the amount of food processed in the leaves and increase the share of each cluster of these materials and collected it in the berries (36), collection of sugars in berries (26,28,3). Foliar application of these micronutrient improved chemical characteristics (table 4 and 5), the reason may be attributed to its an important role in photosynthesis and related enzymes which are resulted in decreasing acidity and increasing the sugar and its effect on sugar metabolism and accumulation of carbohydrates (1). Total phenol in both investigated seasons decreased with application of nutrients and decreasing of buds load compared with the control. Usage of a high rate of micronutrients was more effective than the lower rate. So results proved that, the micronutrients improved quality of fruits including total phenol otherwise, Increasing buds load increased total phenols percentage; this is due to the increased number of leaves on the vine which may increase the total phenols. As well as the high leaves area of the vine at high buds load may produce higher polyphenols (37), also, there is an inverse relationship between the ratio of sugars and the amount of phenols in berries juice and climate differences affect the content of polyphenols and by varieties (18). The results in Table 5 reveal that, high concentration showed the significant values of carotene compared with the control, Some researches proved that application of micronutrients, may facilitate absorption and utilization of mineral nutrients and transport of assimilates. These would also participate towards increasing the capacity of the treated plants for biomass production as it reflected in increasing fresh and dry weight of plants. Therefore, the application of nutrients had increased *β-carotene* (13). Thus, TSS can accumulate very rapidly with use suitable nutrition like Fe, Zn and Mn, enhancing translocation of sugars from leaves to the fruit which can be postulated that it hastens maturity (19, 20). Data in Table 6 shows that application of micronutrients significantly increased Fe, Zn and Mn content in leave petioles, this may be due to the element's readiness as a result of spraying of this element is absorbed and transferred to leaves (32), and to increase the productivity of leaves from food to increase its area and chlorophyll content (Table 1), which improves the process of photosynthesis (34, 3).

REFERENCES

1. Abdel-Salam, M. M. 2016. Effect of Foliar Application of Salicylic Acid and Micronutrients on the Berries Quality of “Bez El Naka” Local Grape Cultivar. Middle East Journal of Applied. 6(1):178-188

2. Abdul-Qader, Sh. M. 2006. Effect of Training System, Canopy Management and Dates on the Yield and Quality of Grapevines cv. ‘Taifi’ (*Vitis vinifera* L.) Under non Irrigated Condition. M.Sc. Thesis, College of Agric. Univ. of Duhok, Iraq. pp: 40-55.

3. Al-Atrushy, Sh. M. 2009. Effect of Eyes Number and Foliar Spray of Potassium and Copper on the Vegetative Growth, Productivity and Quality of Grape (*Vitis vinifera* L.) cv. Zark under Non-Irrigated Condition. Ph. D. Dissertation. The Council of the College of Agriculture and Forestry, University of Mosul. Iraq (in Arabic). pp:33-45.

4. Al-Atrushy, Sh. M. 2018. Grape Production. Duhok University press. Kurdistan region. Iraq. pp:1-6

5. Al-Hawezi, Sh. M. 2008. Effect of Shoots Shortening and Foliar Sprays of Manganese Sulphate on Growth and Yield of Five Grapevine Cultivars (*Vitis vinifera* L.). PhD. Thèses, Coll. of Agric. and Forestry, Univ. of Mosul. pp: 25-34

6. Al-Rawi, K. M. and A. Khalafalla. 2000. Analysis of Experimental Agriculture Design. Dar Al-Kutub for Printing and Publishing. Mosul Univ. Iraq (in Arabic). pp:488

7. Alsaidi, I. H. 2000. Grape Production. Mosul university press.
8. Alsaidi, I.H. 2014. Grape Classification. Dar Al-Wathah Publisher, Jordan
9. Al-Tuhafi, S. A. A. 2004. Effect of Foam Sulfate and Foliar Spray by Micronutrients Solution in the Productivity and Vegetative Characteristics of Kamali and Halwani Grapevine (*Vitis vinifera* L.). PhD Dissertation, College of Agric. Univ. of Baghdad, Iraq (In Arabic). pp:32-43
10. Alvarez-Fernandez, A., J. Abadía, and A. Abadía. 2006. Iron Deficiency, Fruit Yield and Fruit Quality. Iron Nutrition in Plants and Rhizospheric Microorganisms, Springer Netherlands. pp: 85-101
11. Bernadine, C. S. 2011. Growing Table Grapes. Oregon state Univ. Extension service. P: 21
12. Bybordi, A. and A. Shabanov. 2010. Effects of the Foliar Application of magnesium and zinc on the yield and quality of three grape cultivars grown in the calcareous soils of Iran. Sci. Biol., 2(1): 81-86
13. Chandra, A., A. Anand, A. Dubey. 2007. Effect of Salicylic Acid on Morphological and Biochemical Attributes in Cowpea. J. Environ. Biol., 28:193-196
14. Ebadi A.; atashkar D. and M. babalar 2001. Effect of Boron on pollination and fertilization in seedless grapevine cvs white Seedless and Askari. Iranian Journal Agriculture Sciences. 32(2): 457-465.
15. Elam, M. 2011. Kurdistan: Grape Varieties Part 1: Kurdistan: Food Security, Food Safety, Agriculture, Water and Livestock.pp: 9
16. El-Sheikh, M.H., S.A.A. Khafgy, and S.S. Zaied. 2007. Effect of foliar application with some micronutrients on leaf Mmineral content, yield and fruit quality of florida prince desert red peach trees. Journal of Agricultural and Biological Science. 3: 309-315.
17. Fawzi M. I. F.; Shahin M. F. M. and E. A. Kandil 2010. Effect of bud load on bud behavior, yield, cluster characteristics and some biochemical contents of the cane of crimson seedless grapevines
18. Ferrandion, A., S. Guidoni, and F. Mannini. 2005. Grape quality parameters and polyphenolic content of different Barbera and Nebbiolo (*Vitis vinifera* L.)
19. Hanson, E. J., 1991. Movement of Boron out of Tree Fruit Leaves. Hort. Sci., 26: 271-273
20. Jonathan, M., 2012. Impact of Marine Extracts Application on cv. Syrah Grape Yield Components, Harvest Juice Quality Parameter and Nutrient Uptake. M.Sc. Thesis. Polytechnic State University, California.
21. Kamiloglu, O. 2011. Influence of some cultural practices on yield, fruit quality and individual anthocyanins of table grape cv. Horoz Karasi. J. Anim. Plant Sci. 21. pp: 240–245.
22. Malakouti, M.J. and H. Rezaei, 2001. The Roles of Sulphur, Calcium and Magnesium on the Improvement of Yield and Quality of Agricultural Products. Ministry of Agriculture. Tehran, Iran.
23. Marschner H. 1995. Mineral Nutrition of Higher Plants. 2nd ed. Academic Press. New York.
24. Mousavi, S.R., 2011. Zinc in crop production and interaction with phosphorus. australian Journal of Basic and Applied Sciences, 5: 1503-1509
25. Pestana, M., M. David, A. deVarennes, J. Abadı´a, and E.A. Faria. 2001. Responses of newhall' orange tree stoir on deficiency inhydroponics: effects on leaf chlorophyll, photosynthetic efficiency and root ferricchelate reductase activity. Journal of Plant Nutrtion, 24: 1609-1620
26. Philip,T. and J.R. Kuykendhall .1973. Changes in titratable acidity, brix and potassium content, malate and tartrate duringberry development of 'thompson seedless' grapes. J. Food Sci. 38:874-876
27. Prabhu P.C, and P. Singaram 2001. Effect of micronutrients on growth and yield of grapes cv. muscat. Madras Agriculture Journal. 88(1-3). Pp: 45-49.
28. Rabeh ,M.R.M.; A.M. Higazy; S.A. Ahmed; A.M. Allam and A.H. Omer. 1994. Physiological studies on nutrition in grape (*Vitis vinifera* L.).III. fruit quality and yield. Menofiya J. Agric. Res. 19 No. 6 (2): 3323-3343.
29. Rana, R.S. and H.C. Sharma, 1979. Effect of iron sprays on growth, yield and quality of grapes. Punjab Hort. J. 19(1-2): 31-34
30. Rasool, H. A. 2008. Effect of Pruning Levels, Boron and Zinc on Quantity and

Quality of Yield for Two Varieties of Grape. PhD. Dissertation, Agric. Col. Sulaimania Univ. Iraq (in Arabic). P:31
31. Rubio, J.A.; M. V. Albuquerque; J. l. peixy and J. yuste. 2002. La Mejora Varietal De Lavid, Sus Consescuencias Y Beneficios. Vida Rural, pp: 62-66
32. Selim, S.M.; M.M. Hassan and E.M. Badawy. 1993. Effects of soil media on the growth and flowering of carnation. Zagazig J. Agri. Res., 20 (1B) 317-331.
33. Shange, S. 2006. Grapevine nutrition literature review. Cooperative Research Centre for Viticulture (CRCV).pp: 1-45
34. Singh, B. 2002. Effects of macro and micro nutrient spray on fruit yield and quality of grapes (*Visit Vinifera* L.) Cv. Perlette. Acta. Hort, 594: 197-202
35. Song, C.Z.; M.Y. Liu ; J.F Meng .; M. Chi .; Z.M Xi . and Z.W. Zhang . 2015. Promoting effect of foliage sprayed zinc sulfate on accumulation of sugar and phenolics In berries of *Vitis Vinifera* cv. merlot growing on zinc deficient soil. Molecules. 2; 20(2):2536-54
36. Tomar, N.S. and W.S. Brar. 1982. Training-cum-pruning trial on grapes: yield, bunch-berry development and quality of 'thompson seedless'. J. Res. 19 (4): Valouiko, G. G. (1978). Vignoble et vin d'URSS. Ann. Tech. Agric. 27(1):71-79.
37. Tomasi, D.; A. Pitacco, A. Calo and R. Flamini. 2000. Effects of Berry Temperature and Yield-Leaf Surface on the Anthocyanin Content and Profile in cv. Carbenet Sauvignon. Grapevine Physiol. Techn. Heraklion, Greece. 6th inter. Symp. 37.
38. Vasconcelos, M.C. and S. Castagnoli. 2001. Leaf canopy stricture and vine performance. Amer. J. Enol. Vitic. 51(4):1-14.