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IMPACT OF FOLIAR APPLICATION OF CHELATED ZINC ON THE SEASONAL CHANGES OF GROWTH AND DEVELOPMENT OF GRAPE BERRIES (VITIS VINIFERA L.)

Nabil M. Ameen ABDULLAH ALIMAM [1]

University of Mosul, Iraq

Abstract

A Field experiment was conducted A Field experiment was conducted in 2019 in the growing season, to study the effect of foliar application of zinc-chelated "Zn-EDTA" at concentrations 0,50,100 and 200 mg.l-1 on the seasonal dynamic of the growth and development of some physical and chemical characteristic in berries of Halwani Lebanon grape cultivar, grown on a calcareous soil in Mosul region- Iraq. The results revealed that the foliar application of 100 mgZn.l-1 caused a significant increase of berry weight, TSS, Glucose and Fructose in berries. While spraying with 200 mgZn.l-1 caused a significant decrease in the TA and Malic acid in juice berries compared to the control. Additionally, berry weight, TSS, Glucose and Fructose were increased from the beginning of berry growth to véraison and ripening stages. Total acidity was increased from berry set to 14 June and decrease towards the end of the maturity of berries on September 6th during growth season. While Tartaric and Malic acids were increased from berry set to véraison. Whereas, decrease towards the maturity of berries. On the other hand, the interaction between zinc levels and times on growth and development of berries were also discussed.

Keywords: Zinc, Spraying, Seasonal Changes, Grape Berry.

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[1] nabemo56@uomosul.edu.iq, https://orcid.org/0000-0002-2613-8900

Introduction

Grape (*Vitis vinifera* L.) is considered as one of the most popular, favorite fruits and remain the most economically important fruit crop in the world (Keller, 2020 and Mohamed, 2020). In Iraq grape is considered as one of the main fruits which ranks the second after date palm. Many field experiments have shown significant effects of nutrient uptake when spraying their solutions on the vegetative part of the plant (Ali, *et al.* 2014). Halwani Lebanon is considered one of the most important grape cultivars grown successfully in Iraq. Seasonal changes occurred in many physical and chemical characteristics of the grapes during growth and development from beery set to maturity. Among micronutrients, Zinc is one of the essential micronutrients of plants, and Zn deficiency is common in many crops. Zinc is required for the activity of different enzymes, including carbonic anhydrase, alcohol dehydrogenase, superoxide dismutase, isomerases, transphosphorylases, RNA and DNA polymerases, cell division, maintenance of membrane structure and photosynthesis and also acts as a regulatory cofactor in protein synthesis and quality (Singh and Ram, 1983; Marschner, 2012).

Zn deficiency is widespread in plants and human beings in many countries due to the calcareous nature of soils, high pH, low OM, salt stress, continual droughts, high temperature, high bicarbonates in irrigation water (Malakouti, 2007). Zn also plays a part in the plant nitrogen metabolism. Zn is essential for the formation of indole acetic acid (IAA) from tryptophan, one of the necessary ingredients for the synthesis of IAA. This growth factor (IAA) would be indirectly affected by Zn concentrations. Zn also affects the metabolic reactions of gibberellic acid, whereby such reactions are disturbed under Zn deficiency conditions (Marschner, 2012).

The objectives of this experiment were to:

1- Investigate the effect of foliar application of Zn-EDTA on berry weight and its some bio-chemicals composition in grape berry juice.
2- To study the effect of seasonal changes (every two weekly intervals) of berry weight and its some bio-chemical composition of berry growth and development during the growing seasons.

MATERIALS AND METHODS:

The present investigation a factorial experiment split in time (Roger and Hasted, 2003) was carried out during 2019 growing season, on 20-year the growing seasons on 20-year old vines (*Vitis vinifera* L.) of Halwani Lebanon grapevines cultivar grown at private orchard located at 36.19 N, 43.09 E and at latitude of 222.6m above mean sea level in the city of Mosul, Nineveh governorate, Iraq. The vines were planted at 2.25m × 3m a part. Full description of the tested soil is given in table 1 according to (Page *et al*, 1982). The vines trained to the cane system were chosen as uniform in vigor as possible for this study. The experimental vines were pruned in mid- February (Alimam and Altalib, 1995), left four canes (each with 12 buds) and six spurs (each with 2 buds) per vine. The chosen vines were divided into a different treatment, including the control. Foliar application of Zn-EDTA at four concentrations (0,50,100 and 200 $mg.l^{-1}$) was carried out three times per season, the first time before the start of bloom at April 20, the second time after berry set on May 20, and the third time, 30 days later using Tween-20 as a wetting agent at 0.1% was added to the spraying solution of Halwani Lebanon cultivar.

Table (1) Analysis of the tested soil according to (Page *et al*, 1982)

Depth (cm)	Clay (%)	Silt (%)	Sand(%)	O.M.(%)	$CaCo_3$(%)	HCO3 (meq/l)	Soil pH
0-25	22.3	55.6	22.1	1.36	18.3	2.26	7.63
25-50	19.2	58.4	22.4	0.96	19.6	2.62	7.74
50-75	18.8	59.1	22.1	0.64	19.9	2.69	7.79
Depth (cm)	Available		K (meq/l)	p (ppm)	Total N (%)	CEC (meq/l)	EC (ds/m)
	Zn (ppm)	Fe (ppm)					
0-25	1.00	1.83	0.211	4.0	0.08	23.60	1.20
25-50	1.10	1.70	0.216	3.7	0.08	23.63	1.22
50-75	0.92	1.69	0.214	3.0	0.04	23.50	1.24

And study the seasonal changes of the berry weight, Total Soluble Solids (TSS), Glucose, Fructose, Total Acidity (TA), Tartaric acid and Malic acid during the growth phases of berries. Grape berries of Halwani Lebanon cultivar were sampled eight times from May 29th to Septeber 6th by every two weeks intervals separately.

Grape berries were sampled at 8 times from berry set on May 29th throughout fruit ripening on Sept. 6th. TSS determined with hand refract meter, quantity determination of glucose and fructose as Plummer,1974 using Enthrone, the per cent absorbance was then read at 620 nm by Spectrophotometer with the reagent blank set at zero absorbency. Total Acidity determined against NaOH 0.1N as tartaric acid (Rangana,1986). Quantity determination of Tartaric acid determined by the spectrophotometer at 520nm (Zoecklein, 1980) using Sodium meta vanadate material. Quantity determination of Malic acid as (Jakobs,1958) by using Calcium acetate.

RESULT AND DISCUSSION:

Berry weight: Data in Fig.1 obviously showed that the berry weight of Halwani Lebanon grape was positively affected in response to foliar application of Zinc-chelated "Zn-EDTA" during the growing season. The highest value of berry weight was obtained by spraying with 200 mg.l^{-1} of zinc (4.61g) compared with the control (4.3g).

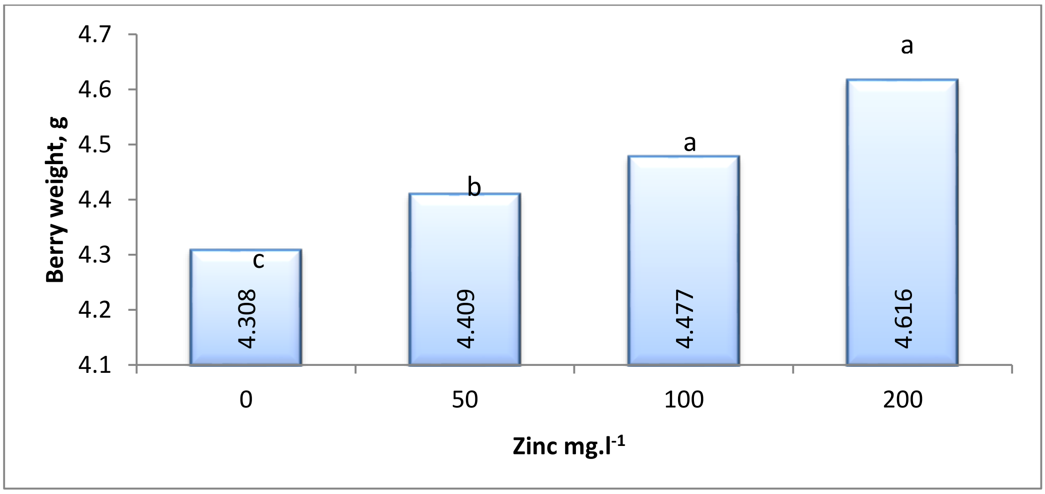

Fig.1 Effect of Zn-EDTA levels on berry weight

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

Spraying with Zinc caused a significant increase in the percentage of pollen vitality, pollen grains germination, length of pollen tube, setting of berries, ovules fertilization and the number of seeds in the berry, in addition to, the increase of chlorophyll content of leaves, and leaf area per cluster (Al-Imam, 1998) and increase photosynthesis sufficiency, and its product is used for cell division and expansion, which has been positively reflected in the increasing the berry weight. In general, micronutrient values in (table 1) were under the critical range in calcareous soil of orchard soils of vines. This indicates that the grapevines grown in this orchard, might respond to Zn-fertilization, whereas a negative correlation between micronutrients with both pH and carbonate forms was appeared. These relations indicated the significant effects of pH and carbonate forms upon the distribution of available micronutrients in calcareous soils (Seddyk, *et al.*, 1995). The soils of Nineveh orchards were characterized as calcareous with high $CaCo_3$ content and high pH values that results in decreasing the available amount of some nutrients especially micronutrients whose deficiency symptoms appear on grapevines.

The results in Fig.2 clearly showed that significant changes in grape berries were sampled during the growing season and increased dramatically from berry set on May 29th (0.293g) throughout maturity on Sept.6th (7.81g).

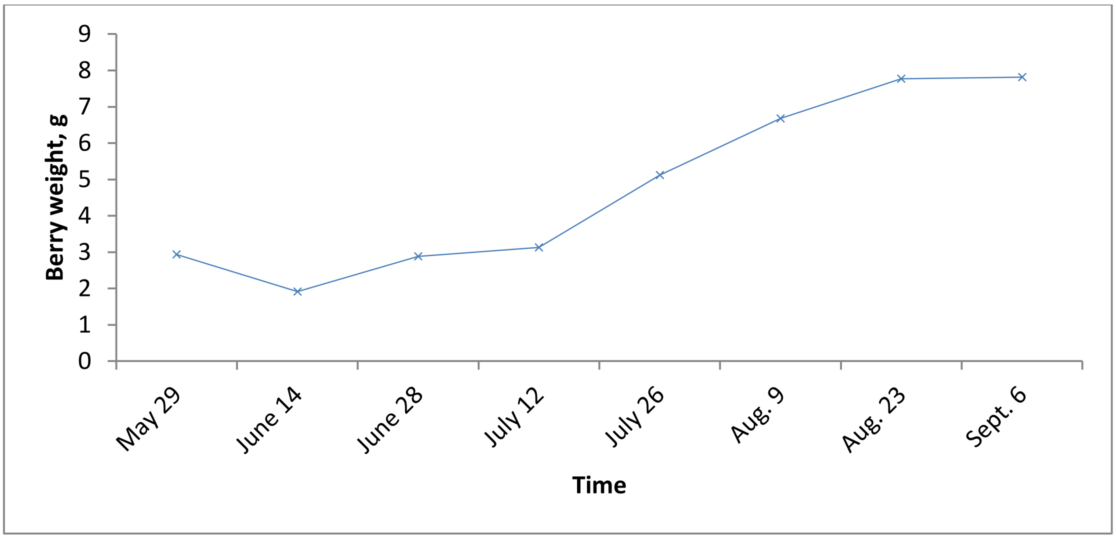

Fig.2 Changes in berry weight measured during the growth and development of cv. Halwani Lebanon grape berries.

In the first phase of berry grape growth the fertilization results in immediate and rapid cell division in more than approximately 200,000 cells at a thesis to a maximum of 600,000 at berry véraison, which is distinguished by a large change in gene expression (Davies and Robinson, 2005). The results of the investigation in Table 2 revealed that the combination of zinc concentrations with sampling dates of berries, had a clear effect on berry weight, especially foliar sprays with 100 mg.l^{-1} of zinc and their combinations with a final sampling date of Sept.6th caused a significant increase of berry weight (7.98g). The growth and development of the grapevine berries are usually divided into three major and quite distinct phases. The first-phase show in Table 2 a period of rapid growth and display a very active metabolism and rapid cell division, which starts after fruit set on May 29th (0.293g) to June 28th (2.88g). In these 4 weeks there was a significant increase of berry weight. In the second phase-period was a slow and slight increase in berry weight from June 28th (2.88g) to July

12th (3.13g) at véraison. The French word véraison used to describe the change in berry skin color (Conde *et al.*, 2007), indicates the beginning of ripening. After véraison, berries resume fast growth again from July 26 (5.11g) to fruit maturity on Sept.6 (7.81g) of berry weight. The berries starts to accumulate water and carbohydrates especially sugars and other color levels bred to increase fruit size and weight. The most dramatic changes in the grape berry composition occur during this ripening phase (Winkler et al. 1974; Monselise and Raton, 1986 and Conde et al., 2007). In addition to the development of fruit tissue represents the final phase of floral development and involves both cell division and cell expansion (O' Neill, 1997). Foliar sprays is most effective, when soil nutrient availability is low, topsoil dry and root activity during the reproductive stage is decreased (Wojcik, 2004). Data of soil analysis listed in table 1, revealed that the soil of the experimental orchard contained high pH, percentage of $CaCO_3$ and low organic matter.

Table (2) Effect of Zn-EDTA concentrations and their Interaction effect of seasonal times on berry weight of cv. Halwani Lebanon grape.

Times	Zn – EDTA Concentrations $mg.l^{-1}$				Mean of Times
	0	50	100	200	
May 29	2.70 i	3.05 i	3.10 i	2.88 i	2.933 g
June 14	1.902 h	1.951 h	2.031 h	1.781 h	1.916 f
June 28	2.853 g	2.879 g	2.903 g	2.911 g	2.886 e
July 12	2.971 g	2.904 g	3.663 f	2.999 g	3.134 d
July 26	4.996 e	5.011 e	5.309 e	5.157 e	5.118 c
Aug. 9	6.501 d	6.632 d	6.804 d	6.77d	6.677 b
Aug. 23	7.460 c	7.781 abc	7.920 abc	7.913abc	7.768 a
Sept. 6	7.509 bc	7.813 abc	7.987 a	7.969 ab	7.819 a
Mean of Zn	4.308 c	4.409 bc	4.477 ab	4.616 a	

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

The predominantly calcareous of high pH soils could limit the availability of micronutrient, including Fe, Mn, Cu and Zn, since they tend to precipitate in soil solution in a carbonate-dominated environment (Epstein and Bloom, 2005). Foliar fertilization might be due to the beneficial effect of zinc increase, zinc availability and quicker direct uptake of Zn^{++} iron (Zn-EDTA) by vine leaves resulting in better absorption and translocation of N, P, K, Fe and Zn (Al-Imam, 2014). These mineral statues affected on physiological performances photosynthesis activity and its products and ultimately fruit quality.

Total Soluble Solids in berry juice (TSS): Fig.3 showed that foliar the application of 100 mg.l^{-1} of zinc caused a significant increase in TSS of berry juice (9.01 %) compared with other treatments. The sugars of the vinifera grape are primarily glucose and fructose, generally accounting for 90% or more of the carbohydrates and from 12 to 27% or more of the weight of the mature berry.

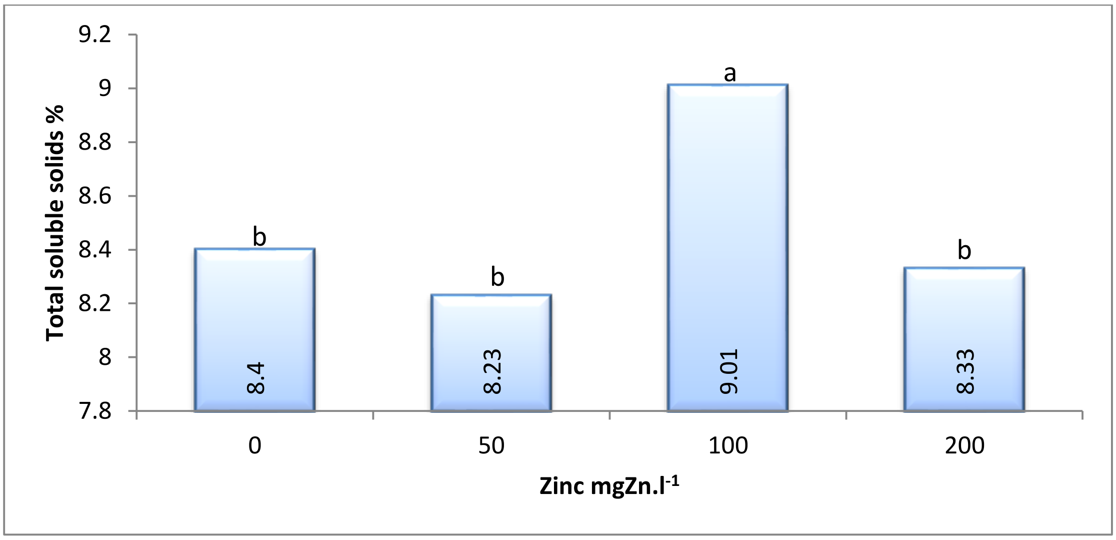

Fig.3 Effect of Zn-EDTA levels on Total Soluble Solids percentage

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

The trend lines of the samples of berries were taken for eight times every two weeks intervals from berry set on May 29th to fruit ripening on Sept.6th of TSS were presented in graphic form in Fig.4 in the berry juice.

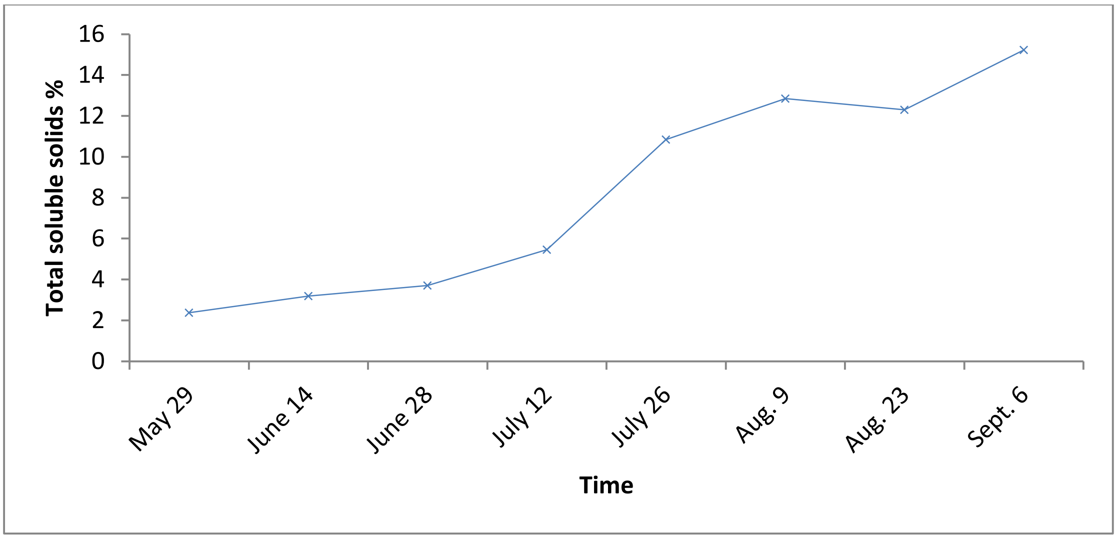

Fig.4 Changes in Total Soluble Solids percentage during the growth and development of cv. Halwani Lebanon grape berries.

There was a slow rise in TSS from May 29 samples (2.38 %) to July 12 samples (3.7 %). After July 12 the increase in TSS was very rapid in berries especially at July 26th trend continued up to maturity (15.23 %) which were significantly superior to all sample dates in the season.

The analysis of variance of TSS (Table 3) showed highly significant zinc levels × sampling dates interaction. During the first period of rapid growth of the berries the percentage of sugar present is low. During the second stage of growth and development of berries the sugars increase rapidly. During early summer the vines are growing rapidly, most of the sugars are then being used in the growth of the vine and in the increase of berry weight and size. The carbohydrate (Sugar and Starch) that begin to accumulate in the leaves and woody parts of the vine are translocate to the berries, where there is a rapid buildup of sugars. Another possible source of the sugars in grape berries is from transformation of organic acids from malic and tartaric acids (Winkler *et al.*, 1974; Conde *et al.*, 2007; Greasy and Greasy, 2009).

Table 3: Effect of Zn-EDTA concentrations and their Interaction effect of seasonal times on total soluble solid percentage (TSS) of cv. Halwani Lebanon grape.

Times	Zn – EDTA Concentrations mg.l^{-1}				Mean of Times
	0	50	100	200	
29 May	2.60 nop	2.40 op	2.50 nop	2.00 p	2.38 h
14 June	3.20 mn	3.00 mno	3.30 mn	3.23 mn	3.18 g
28 June	3.50 m	3.30 mn	4.30 kl	3.70 lm	3.7 f
12 July	5.00 jk	7.00 i	5.50 j	4.30 kl	5.45 e
26 July	11.20 g	9.10 h	12.20 ef	10.90 g	10.85 d
9 Aug.	12.70 ef	12.00 f	13.90 d	12.80 e	12.85 c
23 Aug.	14.00 d	14.20 cd	14.80 bc	14.20 cd	14.3 b
6 Sept.	15.00 ab	14.80 bc	15.60 a	15.50 ab	15.23 a
Mean of Zn	8.4 b	8.23 b	9.01 a	8.33 b	

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

The summer season in Iraq is hot and the heat summation is rapid, the grapes ripen faster. The amount of TSS content of berries at different zinc levels were significantly increased during the berry growth season. A significantly greater content of TSS in berries was recorded on Sept.6th collected from spraying the vines with 100 mg.l^{-1} of zinc (15.6 %) in the season, while the lowest amount of TSS recorded on May 29th from all the four zinc levels.

Glucose in berry juice: The major carbohydrate compounds of the grape berry are glucose and fructose. During ripening glucose and fructose accumulate in roughly equal amounts in the vacuole (Ageorges *et al.*, 2000). The results in Fig.5 showed that spraying the grapevines with 50 mg.l^{-1} of zinc caused a significant increase in the glucose content of berry juice as compared with other treatments.

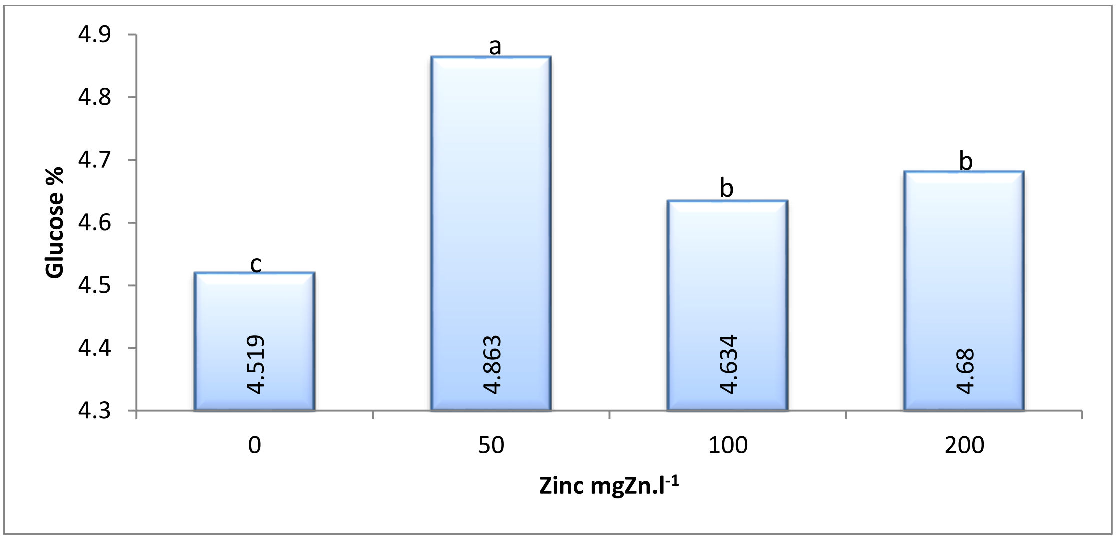

Fig.5 Effect of Zn-EDTA levels on Glucose percentage

Means with the same letter are not significantly different at p=0.05 according to Dancan's test.

The seasonal changes in glucose percentage in berries by times from berry set May 29th to maturity on Sept.6th, it is shown in figure 6 that the glucose concentration in the first weeks after fruit set was low especially from May 29th to June 28 collected. After that glucose amount was significantly increased gradually to maturity.

While the fructose amount increased rapidly after Aug.9th to maturity (Fig.8). The ratio of glucose to fructose in the grape, changes considerably between fruit set until fruit maturity.

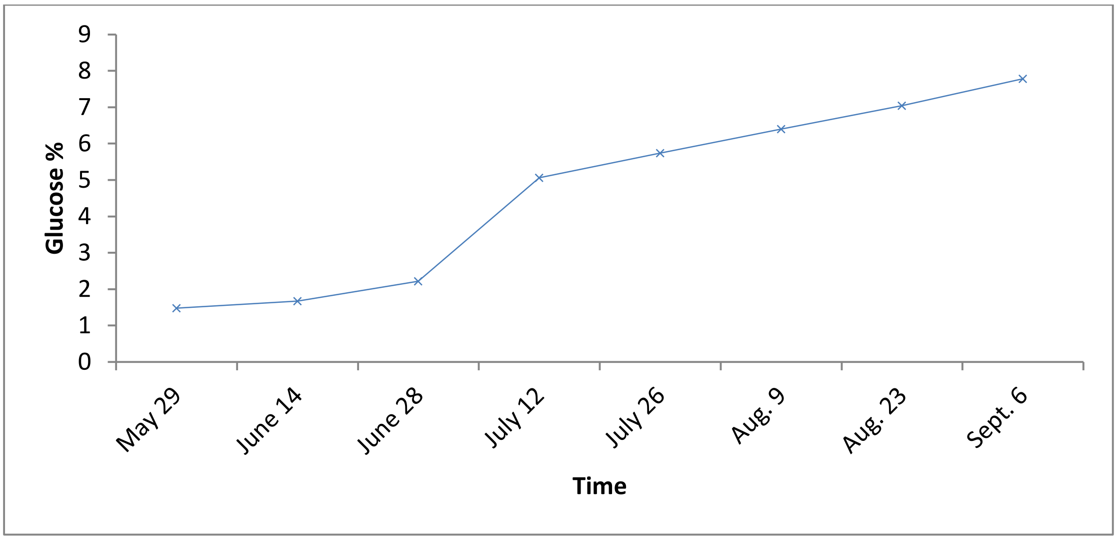

Fig.6 Changes in Glucose percentage during the growth and development of cv. Halwani Lebanon grape berries.

The analysis of variance of glucose showed in Table 4, the effect of interaction between zinc levels × sampling dates that the highest value of glucose into the vines which sprayed at foliar application of 200 mg.l^{-1} zinc on Sept.6th at maturity (7.88%) which significantly superior to other combination treatments.

Table (4) : Effect of Zn-EDTA concentrations and their Interaction effect of seasonal times on Glucose percentage of cv. Halwani Lebanon grape.

Times	Zn – EDTA Concentrations mg.l^{-1}				Mean of Times
	0	50	100	200	
29 May	1.43 o	1.45 o	1.48 no	1.56 mno	1.48 h
14 June	1.58 mno	1.83 lmn	1.63 mno	1.64 mno	1.67 g
28 June	1.90 lm	2.90 k	2.00 l	2.06 l	2.22 f
12 July	4.90 j	5.20 j	5.01 j	5.12 j	5.06 e
26 July	5.61 i	5.97 gh	5.69 hi	5.70 hi	5.74 d
9 Aug.	6.23 gf	6.69 ed	6.30 gf	6.38 ef	6.40 c
23 Aug.	6.98 cd	7.00 cd	7.09 c	7.10 c	7.04 b
6 Sept.	7.52 b	7.86 a	7.87 a	7.88 a	7.78 a
Mean of Zn	4.519 c	4.863 a	4.634 b	4.680 b	

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

Fructose in berry juice: The results in Fig.7 showed that spraying the grapevines with 200 mg.l^{-1} of zinc caused a significant increase in the fructose content of berry juice as compared with other treatments.

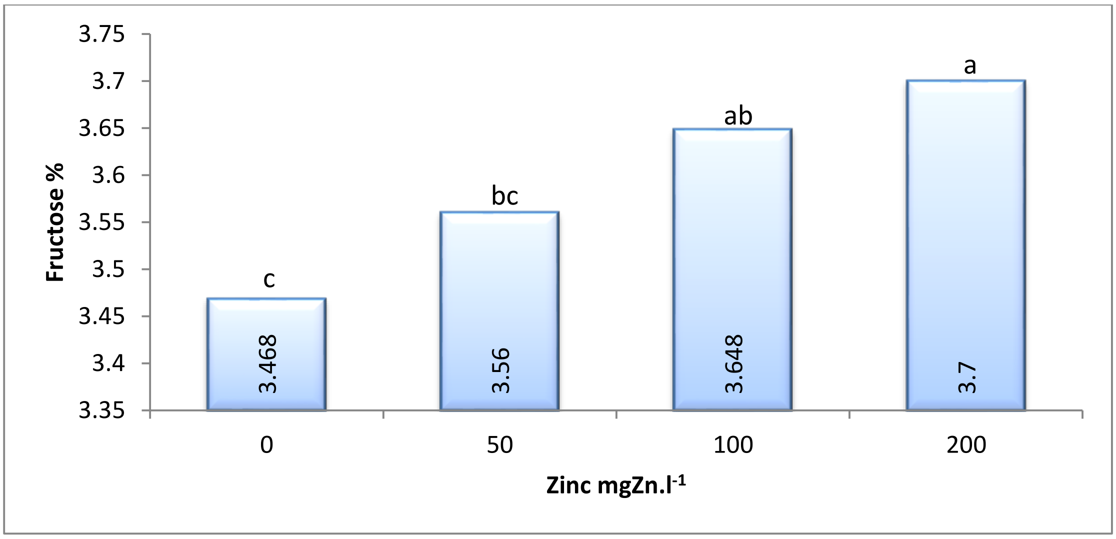

Fig.7 Effect of Zn-EDTA levels on Fructose percentage

Means with the same letter are not significantly different at p=0.05 according to Dancan's test

Fig.8 clearly show that the seasonal changes in fructose percentage in berries by the time from berry set May 29th (0.93 %) to maturity (7.30 %) on Sept.6th.

The fructose amount increased rapidly after July.26th (3.35%) to maturity (7.30%) (Fig.8). The ratio of glucose to fructose in the grape, changes considerably between fruit set until fruit maturity.

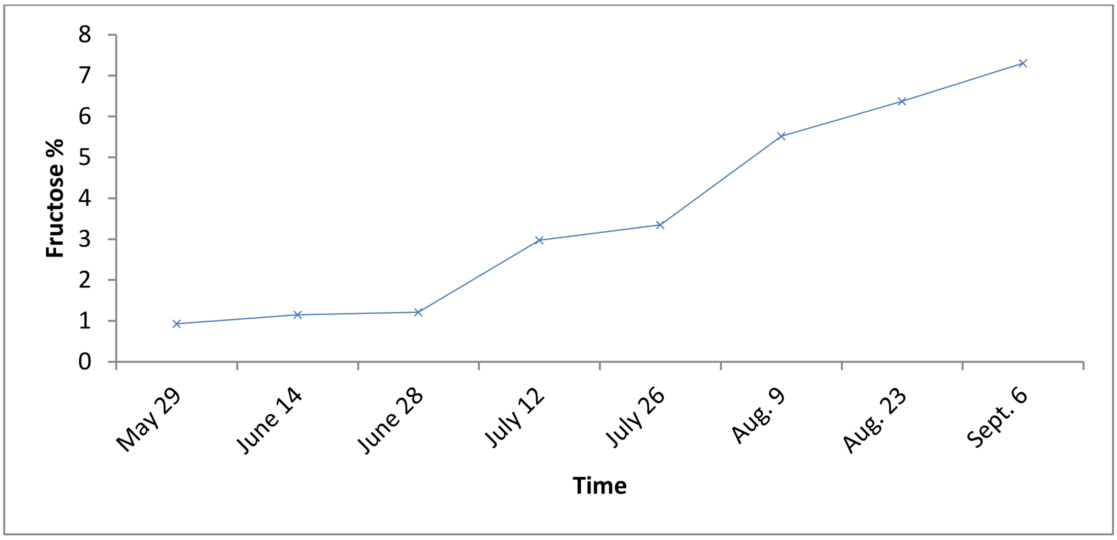

Fig.8 Changes in Fructose percentage during the growth and development of cv. Halwani Lebanon grape berries.

The analysis of variance of fructose (Table 5) showed the effect of interaction of zinc levels × sampling dates. It was shown that the highest value of fructose (Table 5) showed at the vines sprayed with 200 $mg.l^{-1}$ zinc on Sept. 6th (7.40 %) at maturity were significantly superior to other combination treatments.

Table 5: Effect of Zn-EDTA concentrations and their Interaction effect of seasonal times on Fructose percentage of cv. Halwani Lebanon grape.

Times	Zn – EDTA Concentrations $mg.l^{-1}$				Mean of Times
	0	50	100	200	
29 May	0.92 h	0.93 h	0.94 h	0.94 h	0.93 g
14 June	1.10 h	1.11 h	1.19 h	1.18 h	1.15 f
28 June	1.20 h	1.20 h	1.21 h	1.22 h	1.21 f
12 July	2.90 g	2.98 fg	2.99 fg	2.99 fg	2.97 e
26 July	3.20 fg	3.28 ef	3.30 ef	3.60 e	3.35 d
9 Aug.	5.19 d	5.28 d	5.77 c	5.84 c	5.52 c
23 Aug.	6.28 b	6.39 b	6.40 b	6.43 b	6.37 b
6 Sept.	7.10 a	7.31 a	7.38 a	7.40 a	7.30 a
Mean of Zn	3.486 c	3.560 bc	3.648 ab	3.700 a	

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

Total Acidity (TA) in berry juice: Fig.9 clearly show that spraying with 200 $mg.l^{-1}$ of zinc chelated caused a significant decrease in total acidity (TA) as tartaric acid with the increase of zinc concentration in the spraying solutions.

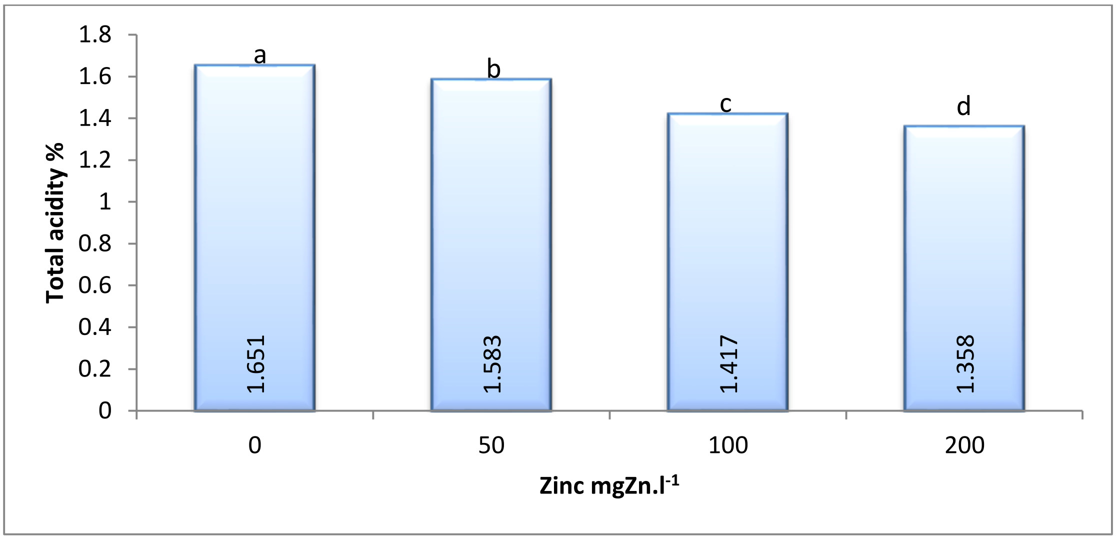

Fig.9 Effect of Zn-EDTA levels on total acidity percentage

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

The total acidity of berries of Halwani Lebanon grape increased fast from berry set on May 29th to June 28th. After these sampling dates the TA decreased slowly until July 26. After that, there was a sharp decrease in TA until Sept.6th at maturity (Fig.10).

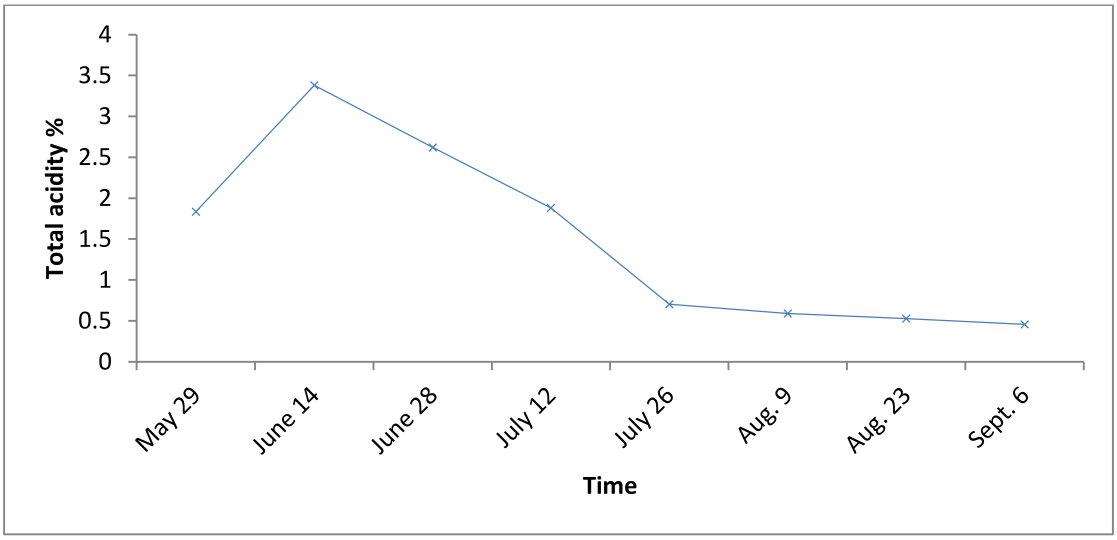

Fig.10 Changes in Total Acidity percentage during the growth and development of cv. Halwani Lebanon grape berries.

The changes in total acidity in grape berries was evident from means of zinc levels × sampling dates interaction (Table 6) and there was a significant increase in TA for 0 mg.l^{-1} zinc on June 14th (3.65%). After these sampling dates the TA decreased through Sept.6th at maturity (0.47 %).

Tartaric acid was synthesized most rapidly by young developing leaves and immature fruits in the first phase of berry growth. These explain the higher amounts of total acidity found early in the seasons in immature fruits (Kilewer, 1968). Malic acid is rapidly lost during warm temperatures and during ripening, while tartaric acid salts are more stable. The decrease in acid concentration is due to an increase in membrane permeability allowing more acid to be metabolized. A reduction in the amount of acids translocate from the leaves, and the formation of salts, mainly potassium salts. A reduced synthesis of acid, the berries, finally, have a dilution effect, due to the rapid increase in berry volume during ripening (Monselise and Rato, 1986).

Table 6: Effect of Zn-EDTA concentrations and their Interaction effect of seasonal times on total acidity percentage of cv. Halwani Lebanon grape.

Times	Zn – EDTA Concentrations $mg.l^{-1}$				Mean of Times
	0	50	100	200	
29 May	2.26 ef	2.18 f	1.65 h	1.25 i	1.835 c
14 June	3.65 a	3.45 b	3.42 b	3.00 c	3.380 a
28 June	2.78 d	2.63 d	2.70 d	2.38 e	2.623 b
12 July	2.10 fg	2.10 fg	1.32 i	2.00 g	1.881 c
26 July	0.74 j	0.71 jkl	0.67 jkl	0.67 jkl	0.703 d
9 Aug.	0.61 j-m	0.59 j-m	0.58 j-m	0.57 j-m	0.588 ef
23 Aug.	0.55 klm	0.53 klm	0.51 lm	0.52 lm	0.527e
6 Sept.	0.52 lm	0.47 m	0.46 m	0.47 m	0.480 f
Mean of Zn	1.651 a	1.583 b	1.417 c	1.358 d	

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

Tartaric acid in berry juice: The results indicated that foliar application with 200 $mg.l^{-1}$ of zinc showed a significant increase in tartaric acid in berry juice (0.574 %) as compared with the 50 and 100 $mg.l^{-1}$ of zinc treatments (Fig.11).

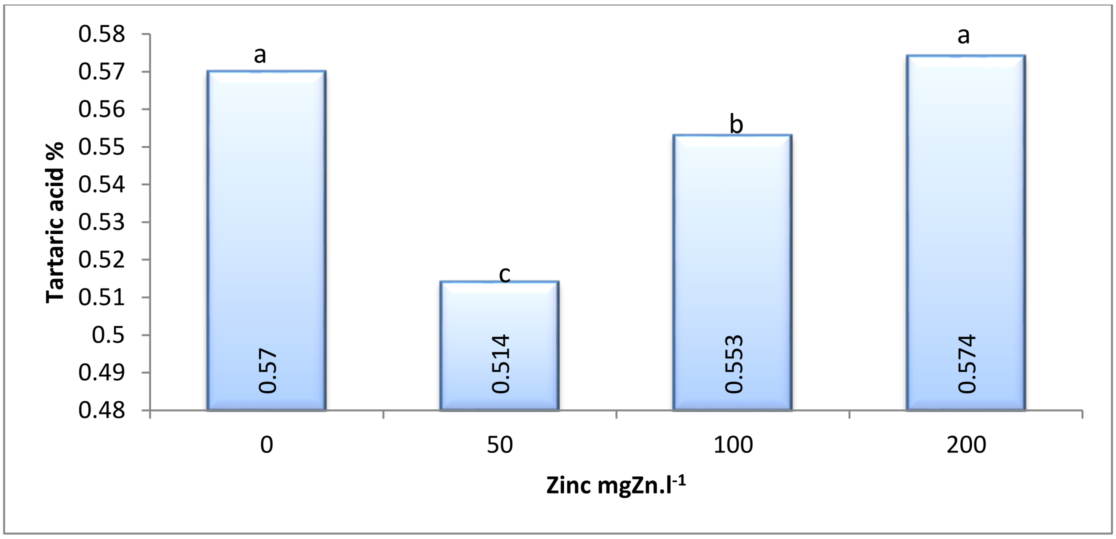

Fig.11 Effect of Zn-EDTA levels on Tartaric acid

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

Seasonal changes of tartaric acid were found in Fig.12 to increase up on June 28th of berry development (0.92 %)during green berry stage . From July 12th there was a continuous decrease in the rate of tartaric acid till maturity on Sept.6th during the season.

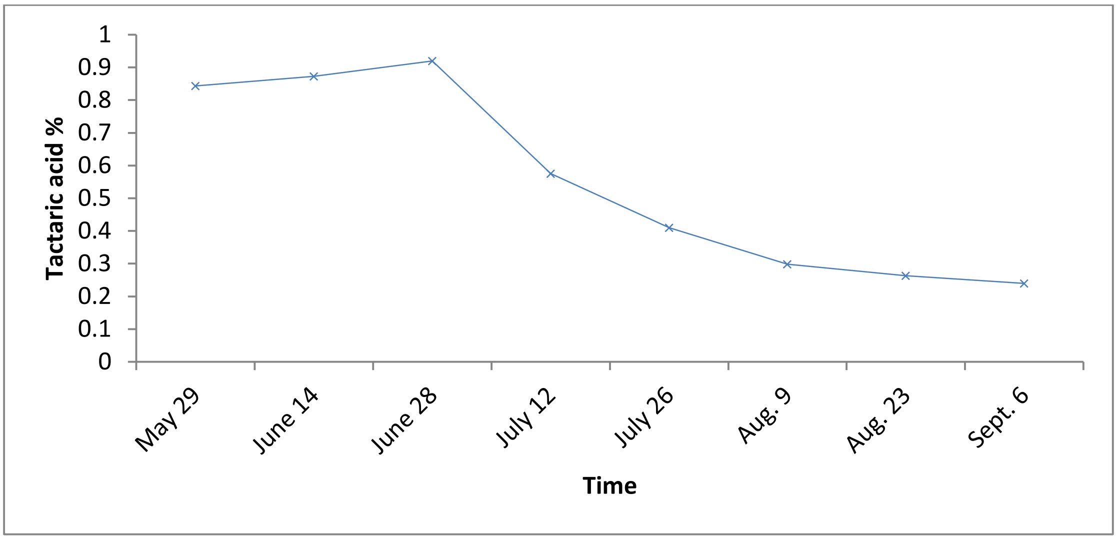

Fig.12 Changes in Tartaric acid percentage during the growth and development of cv. Halwani Lebanon grape berries.

The analysis of variance between zinc levels × sampling dates was evident from means of the combination in Table 7 and were significant differences between zinc levels in tartaric acid for all sampling dates especially, the berries sampled of June 28th (1.04 %) which were sprayed with 200 mg.l^{-1} of zinc had a significantly greater amount of tartaric acid in the season. The lower amount of tartaric acid (0.23%) was recorded on Sept.6th which was sprayed with 200 mg.l^{-1} zinc.

Table (7) Interaction effect of Fe-EDTA and seasonal times of Tartaric acid percentage in berry juice of cv. Halwani Lebanon grape.

Times	Zn – EDTA Concentrations mg.l^{-1}				Mean of Times
	0	50	100	200	
29 May	0.74 h	0.76 gh	0.92 d	0.95bcd	0.843 c
14 June	0.77 gh	0.82 f	0.93 cd	0.97 bc	0.873 b
28 June	0.80 fg	0.86 e	0.98 b	1.04 a	0.9.200 a
12 July	0.73 h	0.57 i	0.50 j	0.50 j	0.575 d
26 July	0.59 i	0.35 kl	0.34 kl	0.36 k	0.410 e
9 Aug.	0.33 klm	0.29 mno	0.28 nop	0.29 mno	0.298 f
23 Aug.	0.31 lmn	0.24 pq	0.25 opq	0.25 opq	0.263 g
6 Sept.	0.29 mno	0.22 q	0.22 q	0.23q	0.240 h
Mean of Zn	0.570 a	0.514 c	0.553 b	0.574 a	

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

Malic acid in berry juice: The data in Fig.13 indicated that spraying with 0 mge.l^{-1} of zinc significantly increased the malic acid in berry juice (0.169 %) as compared with other treatments of zinc levels.

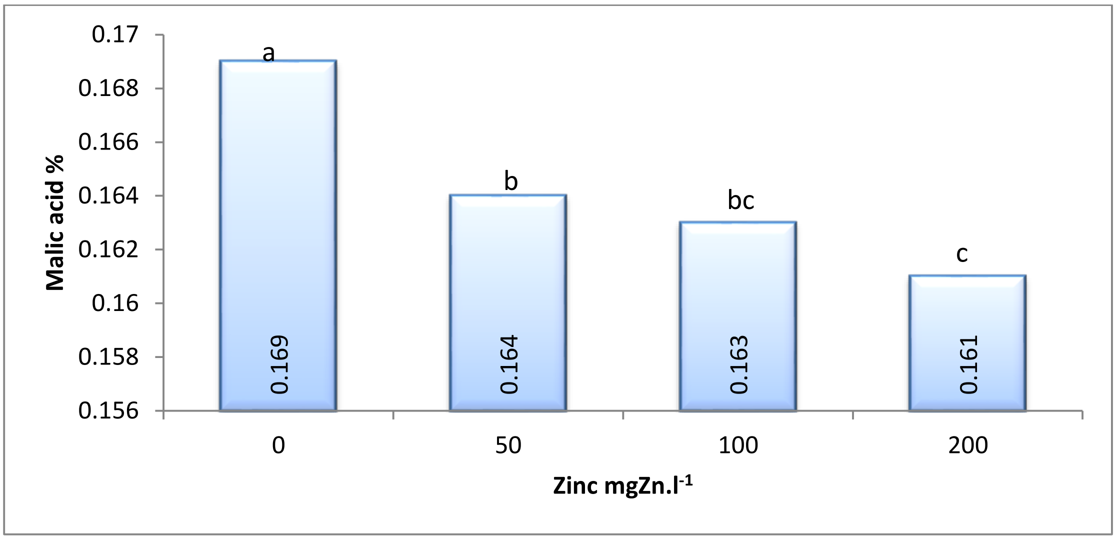

Fig.13 Effect of Zn-EDTA levels on Malic acid

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

Fig.14 clearly showed that malic acid gradually increased until about the July 12th (0.251 %) at véraison, and then started to decrease at maturity Sept.6th. Malic acid decreases more rapidly than tartaric acid during ripening.

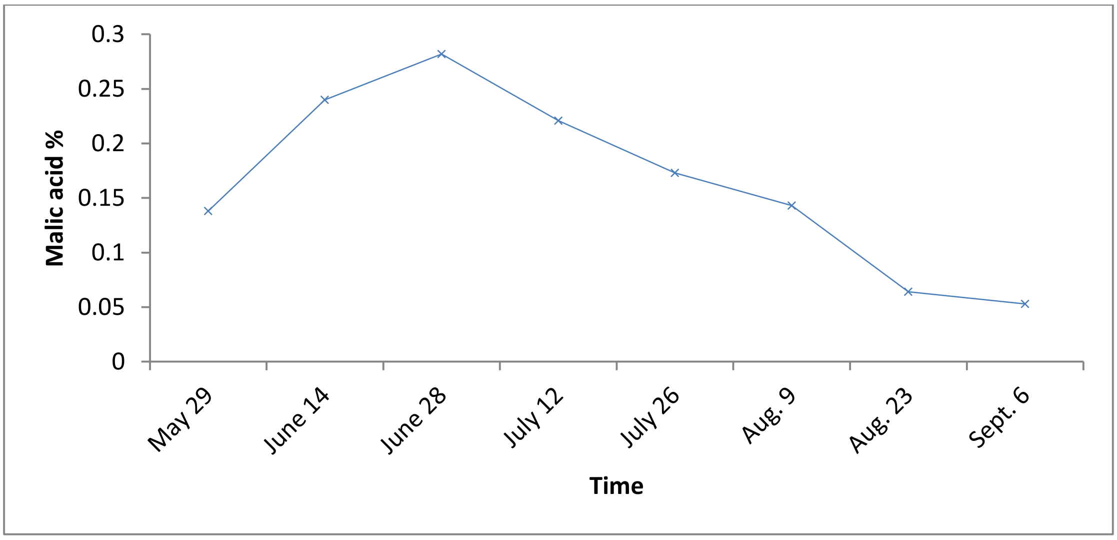

Fig.14 Changes in Malic acid percentage during the growth and development of cv. Halwani Lebanon grape berries.

The analysis of variance (Table 8) showed a significant interaction between zinc levels × sampling dates for data on malic acid in berry juice. The highest value of malic acid shown in the vines sprayed with 200 mg.l^{-1} of zinc on June 28 in the season (0.292 %). The lower amount of malic acid in the berry juice was obtained at maturity on Sept.6 and sprayed with

200 mg.l-1 of zinc (0.04 %). Grape berries are characterized by large amount of tartaric acid together with malic acid. The two organic acid account for more than 90% of the total acidity of the grape berry (Monselies and Raton, 1986).

Table (8) Interaction effect of Fe-EDTA and seasonal times of Malic acid percentage in berry juice of cv. Halwani Lebanon grape.

Times	Zn – EDTA Concentrations mg.l-1				Mean of Times
	0	50	100	200	
29 May	0.130 l	0.135 kl	0.140 jk	0.145 j	0.138 f
14 June	0.205 f	0.225 e	0.260 d	0.270 c	0.240 b
28 June	0.26 d	0.283 b	0.290 a	0.292 a	0.282 a
12 July	0.265 cd	0.220 e	0.200 f	0.200 f	0.221 c
26 July	0.18 g	0.180 g	0.170 h	0.160 i	0.173 d
9 Aug.	0.159 i	0.142 j	0.140 jk	0.130 l	0.143 e
23 Aug.	0.078 m	0.067 n	0.060 o	0.050 p	0.064 g
6 Sept.	0.072 n	0.060 o	0.040 q	0.040 q	0.053 h
Mean of Zn	0.169 a	0.164 b	0.163 bc	0.161 c	

Means with the same letter are not significantly different at p=0.05 according to Duncan's test.

CONCLUSIONS:

Foliar application of zinc level increased grapevine berry weight, TSS, Glucose, Fructose, Tartaric acid in berry juice. Berry weight and its bio-chemical products were changed according to the physiological seasonal growing stage. Highly increased in berry weight, TSS, Glucose and Fructose from berry set to fruit maturity. Highly concentrations of total acidity, tartaric acid and malic acid to vréraison and decreased in mature berries stage especially at ripening.

References:

Agaeorges A., Issaly A., Picard S., Delrot S. and Romieu S. (2000). Identification and functional expression in yeast of a grape berry sucrose carrier. Plant Physio. Biochem., 38:177-185.

Ali, A., S. Perveen, S. N. M. Shah, Z. Zhang, F. Wahid, M. Shah, S. Bibi,and A. Majid.(2014). Effect of foliar application of micronutrients on fruit quality of peach. American Journal of Plant Sciences, 5, 1258- 1264.

Al-Imam N.M.A. and Altalib, S.S. (1995). Effect of pruning time on yield and quality of grape cv. Dais Anze, Mesopotamia J. of Agric. 27(1): 20-24.

Al-Imam, N.M.A. (1998). Study on the effect of foliar application of iron, zinc and NPR fertilization on the growth and yield of Halwani Lebanon and Kamali grape cultivars (*Vitis vinifera* L.), Ph.D. Thesis, College of Agriculture and Forestry, University of Mosul, Iraq.

Al-Imam, N.M.A. (2014). Effect of foliar application of iron on seasonal changes of minerals composition in petioles and berry of Halwani Lebanon and Kamali grape cultivars (*Vitis vinifera* L.), J. of Agric. Science and Technology, A, 4:404-413.

Conde C., Silva P., Fontes N., Alberto C.P., Rui M., Travares, M.J., Sousa, A.A., Serge D. and Hernani G. (2007). Biochemical changes throughout grape berry development and fruit and wine quality. Food (1):1-22 Global Science Books.

Davies C. and Robinson S. (2000). Differential Indicates a dramatic change in mRNA profiles during grape berry ripening. Cloning and characterization of cDNAs encoding putative cell wall and stress response proteins. Plant Physiol.122: 803-812.

Epstein E. and Bloom A.J. (2005). Mineral nutrition of plants: Principle and perspectives, 2^{nd}. Ed., Sinauer, Sunderland Massachusetts.

O'Neills (1997). Pollination regulation of flower development. Annu. Rev. Plant Physiol. Pant Mol. Biol. 48:547-574.

Greasy G.L. and Greasy L.L. (2009) Grapes, in: Crop production science of horticulture series (16), MPG Books Group.

Jakobs M.B. (1958). The chemical analysis of food and food product. D.Van Nostrand Company, INC. Princeton, New Jersey.

Keller,M. (2020).The Science of Crapevines. Academic Press is as imprint of Elservier.Third Edition. London. U.K.

Kliewer W, Lider L (1968). Influence of cluster exposure to the sun on the composition of Thompson Seedless fruit. American Journal of Enology and Viticulture 19:175-184.

Malakouti, M. J. (2007). Zinc is a neglected element in the life cycle of plants: A review. Middle Eastern and Russian Journal of Plant Science and Biotechnology 1:1-12.

Marschner, H., 2012. Mineral nutrition of higher plants. Academic Press Limited Harcourt Brace and

company, Publishers, London, PP.347 – 364.

Mohamed, A.A. (2020). Impact of foliar application of nanomicronutrient fertilizers on some quantitative and qualitative traits of" Thompson seedless" grapevine. *Middle East J. Appl. Sci., 10(3): 435-441.*

Monselise S.P. and Raton B. (1986). Handbook of fruit set and development. Vol. IV by CRC Press, Inc., Florida, USA.

Page A.L, Miller R.H. and Keeney D.R. (1982). Methods of soil analysis, Amer. Soc. Inc. Publican, Wisconsin, USA.

Plummer D.T. (1974). An introduction to practical biochemistry. McGraw-Hill book company (UK) limited. England.

Ranganna S. (1986). Handbook of analysis and quality control for fruit and vegetable products. Toto McGraw-Hill publishing company limited, New Delhi.

Roger Mead, R. N. C. and A. M. Hasted (2003). Statistical methods in agriculture and experimental biology chapman. 3ed Edi: Hall, A CRC Press Co., Washington, D. C.

Seddyk E.A.S., Dawood, M.A. and Jamal, M.A. (1995). Distribution of available micronutrients, Fe, Mn, Zn and Cu in some calcareous soils of northern Iraq. Proc. 5th. "Micronutrients and Application of Foliar Fertilizers in the Arab Rejion", 16-21 Dec., 1989, Cairo-Ismailia, Egypt. pp.23-31.

Singh, R. S. and S. Ram, 1983. Studies on the use of Palm growth substances for fruit retention in mango cv. Dashehair. Indian Hort., 40: 180-194.

Winkler A.J., Cook, J.A., Kilewer, W.M. and Lider L.A. (1974). General Viticulture. Univ. Califo. Press. London.

Wojcik P. (2004). Uptake of mineral nutrient from foliar fertilization. J. of Fruit and Ornamental Plant Research 12:201-208.

Zoecklein B.W., Fugelsang K.C., Nury F.S. (1980). Wine analysis and production. Department of Agriculture Industry and Education-Enology. California State University, FRESON. USA. Pp.332.