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EFFECT OF SPRAYING ZINC, COPPER AND IRON ON LEAF NUTRIENT, FRUIT SET AND SOME FRUIT QUALITY OF PISTACHIO TREES (*Pistacia vera* L.) CV. HALEBI

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ABSTRACT

This study was conducted at a private orchard in the Ekmale village of Duhok Governorate, Kurdistan Region, Iraq during growing season (2020) to evaluate the effect of foliar sprays of three concentrations of zinc (0, 750, and 1500 mg.L^{-1}), three concentrations of copper (0, 100, and 200 mg.L^{-1}) and three concentrations of iron (0, 150, and 300 mg.L^{-1}) on leaf nutrient, fruit set, as well as yield and quality of 18-years old " Halebi " pistachio trees. The nutrition solutions were sprayed on trees at two times (bud swell stage and green tip stage). Based on the obtained results, fruit set percentage, yield, and leaf nutrient were significantly affected by foliar application of a zinc, copper and iron each alone. In combination, the triple interactions among 1500mg.L^{-1} zinc plus 200mg.L^{-1} copper and 300mg.L^{-1} iron was the most affected one which exceed significantly on the control treatment, Moreover, nutrient treatment had a significant effect on the percentage of blankness. In general, these results show that Zn, Cu and Fe fertilizers is necessary for obtaining better yield and fruit quality in " Halebi " pistachio trees.

INTRODUCTION

Pistachio (*Pistacia vera* L.), is a subtropical, dioecious, drought-tolerant species, which well-adjusted to arid and semi-arid regions (Javanshah *et al*., 2005; Einali and Valizadeh, 2017). Although, the soil in which pistachio grown is often poor and related with high calcium carbonate content and alkaline pH and restricted accessibility of some nutrients causing suffering of pistachio trees from many minerals' deficiencies (Tavalli and Rahemi, 2007). Hence, addition of fertilizers to complement the natural soil fertility is important for modern crop production, and accurate management of nutrient elements is essential for a sustainable agriculture production.

Lately as a result of some deficiency in micro elements in some pistachio area of production, low fruit set can be seen in many orchards (Mozafari 2005). One reason of low fruit set can be deficiency of zinc, copper, iron (Gursoz *et al*., 2010) and some other elements, as fruit set is an important component of yield (Rosati *et* al., 2010). Micro-nutrients such as iron, zinc and copper are fundamental for different biological functions that might be ascribed to tree yield and fruit quality (Shoeib and El sayed 2003).

Zinc (Zn) is regarded as fundamental in plants because of its worth in the activity of many enzymes, and it helps with cell division, photosynthesis, and the synthesis of tryptophan and proteins (Wang *et al*., 2016). Moreover, foliar applications of Zn have been effectively used to increase tree vigor, fruit set, and yield in walnut (Keshavarz *et al*,.2011). Furthermore, spraying of Zinc significantly increased yield in various pistachio cultivars through increasing fruit set. Also, enhanced physical and chemical fruit properties as well as leaf content of Zn and Mn, (Gursoz *et al*., 2010).

Copper (Cu) assume a significant part in the metabolism of plants and furthermore has a function in many cellular processes and is a basic ligand for the activities of specific enzymes which are important in cell growth and differentiation. Various studies have demonstrated that mineral foliar applications, particularly of zinc and copper, are gainful as for yield, fruit quality, nutritional status, and fruit set. Research has verified that this is the situation with fruit crops, as pistachio (Kallsen *et al*. 2000; Kizilgoz, *et al*., 2010).

Iron (Fe) is necessary for the synthesis and upkeep of chlorophyll in plants. It is an essential component of many enzymes and assume an imperative function in nucleic acid and

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chloroplast metabolism. So, deficiency of this element decreased the photosynthesis which causes huge losing in fruit yield (Chaturvedi *et al*., 2005). In addition, iron deficiency is a usual disorder influencing plants in many regions of the world, and is predominantly connected with high pH, calcareous soils. Plant Fe deficiency has economic significance, as crop quality and yields can be severely become compromised, and the use of costly restorative techniques is regularly required (Alvarez-Fernandez *et al*. 2004). Research found by (Najad 2004) showed that pistachio fruit quality increased with foliar Fe fertilization.

Therefore, the aims of this study were to determine the effect of foliar spraying of zinc, copper and iron on leaf nutrient, fruit set and yield of " Halebi " pistachio trees.

MATERIALS AND METHODS

The experiment was carried out on pistachio trees (cv. Halebi) 18 years of age, in (2020) in Ekmale private orchard. The position of this area is (36.92◦) north and (43.046◦) east at an elevation of (845) meters above sea level. This orchard considered as rainfed orchard. The experiment was designed as a 3 × 3 × 3 factorial experiment in a Randomized Complete Block Design (RCBD). Zinc treatment, was supplied from zinc sulfate source in three level (0, 750, and 1500 $mg.L^{-1}$), copper was supplied from copper sulfate source in three level (0, 100, and 200 $mg.L^{-1}$) and iron was supplied from iron sulfate source in three level (0, 150, and 300 $mg.L^{-1}$).

The nutrition solutions were sprayed on trees at two times (bud swell stage and green tip stage). The experiment consisted of 27 treatments with three replications and one tree for each experimental unit (81trees). Trees were hand sprayed to the point of runoff with treatment solution and Tween 20 was used as a surfactant. All the data were tabulated and statistically analyzed with computer using SAS program. The differences between various treatment means were tested with Duncan Multiple Range test at 5% level (SAS, 2015). For fruit set, four branches (from different direction of each tree) were randomly selected for each treatment. Flowers on the labeled shoots were counted at the (middle of April). For the primary fruit set%, fruit on the shoots were counted at the time of post-bloom (early of May), and fruit set percentage was calculated according to the following equation:

Primary fruit set (%) = [No. of fruit (post bloom) / Total no. of flower] × 100

Final fruit set% was estimated by dividing the number of fruit determined after harvesting by the total number of flowers:

Final fruit set (%) = [No. of fruit after harvesting / Total no. of flower] × 100

For yield and yield component, all pistachio clusters were removed from the labeled branches of the tree by hand, when the fruit reached the stage of physiological maturity, signaled by a reddish hull (end of August), fresh yield per shoot for each treatment was determined by means of weighing clusters. In addition, the number of blank nuts was determined from samples of 100 nuts taken randomly and evaluated as a percentage (Soliemanzadeh, 2012).

To determine the mineral concentration of the leaves, dry matter of the leaves was used in the chemical analysis 0.5g from each experimental unit was digested with diacid H2SO4.The previously dried samples were used to determine leaf zinc, copper and iron content. 0.5g of leaf dry matter from each experimental unit was digested by using (10ml) concentrated sulphuric acid (diacid H_2SO_4) and 5ml hydrogen peroxide ($HClO_4$) and the Inductively Coupled Plasma (ICP-OES 7000) was used (Bhargava and Raghupathi, 1993).

RESULTS AND DISCUSSIONS

1- Leaf Nutrient

1- Zinc content in leaves ($mg.kg^{-1}$)

Table (1) explained that the spraying Halebi pistachio trees with 1500$mg.L^{-1}$ zinc, 200$mg.L^{-1}$ copper with 300$mg.L^{-1}$ iron significantly increased zinc content in leaves which gave the highest value (14.90, 14.59 and 14.26 $mg.kg^{-1}$) respectively.

Results indicated that the triple interaction of 1500$mg.L^{-1}$ zinc, 200$mg.L^{-1}$ copper with 300$mg.L^{-1}$ iron gave the highest value (16.37 $mg.kg^{-1}$) compared to lowest value (10.46 $mg.kg^{-1}$) from the interaction of 0$mg.L^{-1}$ zinc, 0$mg.L^{-1}$ copper and 0$mg.L^{-1}$ iron

Table (1): Effect of Foliar Spraying of Zinc, Copper and Iron and their interactions on **zinc content in leaves (mg.kg^{-1})** of pistachio cv. " Halebi "

Zinc mg.L-1	Copper mg.L-1	Iron mg.L-1			Zinc × Copper	Means of Zinc
		0	150	300		
0	0.0	10.46p	11.60o	12.46l-n	11.51e	12.56c
	100	12.34m-o	12.50l-n	12.70k-n	12.51d	
	200	13.24i-ll	13.54g-j	14.23c-g	13.67c	
750	0	12.18no	13.14i-m	13.37h-k	12.90d	13.65b
	100	12.91j-n	13.71f-j	14.15c-g	13.59c	
	200	13.95d-i	14.38b-g	15.10b	14.48b	
1500	0	13.82e-i	14.47b-e	14.95bc	14.41b	14.90a
	100	14.28b-g	14.76b-d	14.97bc	14.67b	
	200	14.58b-e	15.87a	16.37a	15.61a	
Means of Iron		13.08c	13.78b	14.26a		
Zinc × Iron	0	12.01f	12.55e	13.13d		
	750	13.01d	13.75c	14.21b	Means of Copper	
	1500	14.23b	15.03a	15.43a		
Copper× Iron	0	12.15f	13.07e	13.59cd	12.94c	
	100	13.18de	13.66c	13.94c	13.59b	
	200	13.92c	14.60b	15.24a	14.59a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range tests at 5% level.

The results of the present study are in conformity with those of (Zhang and Brown 1999b; Tsipouridis *et al*. 2005; Kizilgoz *et al*., 2010; Ojeda-Barrios *et al*., 2014) on Pistachio trees. They detailed that foliar zinc application in different either form or concentrations enhanced zinc uptake which in turn was reflected in increasing leaf zinc concentration. Furthermore, Ghaderi, *et al*., (2003) reported that the foliar application of zinc was enhanced the nutritional status of 'Shahroodi' almond trees.

2- Copper content in leaves (mg.kg^{-1})

Data as shown in table (2) clear that zinc and iron, at second and third levels significantly increased copper content in leaves, compared with the control, while copper significantly increased copper content in leaves at third level at concentration 200mg.L^{-1} which were (13.29 mg.kg^{-1}).

Referring to the triple interactions, the highest copper content in leaves, (15.03 mg.kg^{-1}) was obtained from the interactions of zinc (1500mg.L^{-1}) plus copper (200mg.L^{-1}) and iron (300mg.L^{-1}), while the lowest copper content in leaves was obtained from the control (9.26 mg.kg^{-1}).

Table (2): Effect of Foliar Spraying of Zinc, Copper and Iron and their interactions on **copper content in leaves (mg.kg^{-1})** of pistachio cv. " Halebi "

Zinc mg.L-1	Copper mg.L-1	Iron mg.L-1			Zinc × Copper	Means of Zinc
		0	150	300		
0	0.0	9.26h	12.29c-g	12.13d-g	11.23e	12.04b
	100	11.49g	12.63b-f	12.66b-f	12.26d	
	200	11.89e-g	12.93b-e	13.06b-e	12.63cd	
750	0	12.06d-g	12.69b-f	13.09b-d	12.62cd	13.00a
	100	12.23c-g	13.33bc	13.59b	13.05bc	
	200	12.79b-f	13.53b	13.66b	13.33b	

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1500	0	11.73fg	12.79b-f	12.96b-e	12.49cd	13.13a
	100	13.06b-e	12.93b-e	12.99b-e	12.99bc	
	200	13.09b-d	13.59b	15.03a	13.91a	
Means of Iron		11.96b	12.97a	13.24a		
Zinc × Iron	0	10.88d	12.62bc	12.62bc		
	750	12.36c	13.18ab	13.45a	Means of Copper	
	1500	12.63bc	13.10ab	13.66a		
Copper × Iron	0	11.02e	12.59cd	12.73cd	12.11c	
	100	12.26d	12.96bc	13.08bc	12.77b	
	200	12.59cd	13.35b	13.92a	13.29a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range tests at 5% level.

The above results demonstrated positive effect of zinc, copper and iron foliar sprays on leaves copper concentration, the results are in agreements with Kallsen *et al*. (1998) they detailed that Copper spray significantly increased copper concentration of the leaf compared to control. However, foliar spray of iron (300 mg L-1) significantly increased the Fe concentration in pistachio leaves. Kallsen *et al*. (2000) also revealed that pistachio trees treated with zinc and copper increased leaves zinc and copper concentrations.

3- Iron content in leaves (mg.kg^{-1})

It is obvious from table (3) that foliar application of zinc and copper at second and third levels had a significant effect on iron content in leaves. While, iron application had no significant effect on leaves iron content when compared with control.

Referring to the interactions of the three studied factors, Results displayed that there were significant differences between the interactions of the three studied factors on leaves iron concentration. The interaction treatment of 1500mg.L^{-1} zinc plus 200mg.L^{-1}copper and 150mg.L^{-1}iron besides, 1500mg.L^{-1} zinc plus 200mg.L^{-1}copper and 300mg.L^{-1}iron gave the highest value. The highest leaves iron content was (59.82 mg.kg^{-1}) while the lowest value (49.45 mg.kg^{-1}) was recorded from untreated treatment.

Table (3): Effect of Foliar Spraying of Zinc, Copper and Iron and their interactions on **iron content in leaves** (mg.kg^{-1}) of pistachio cv. " Halebi "

Zinc mg.L-1	Copper mg.L-1	Iron mg.L-1			Zinc × Copper	Means of Zinc
		0	150	300		
0	0.0	49.45d	51.12cd	52.53b-d	51.04c	54.46b
	100	54.20a-d	54.96a-d	55.29a-c	54.82b	
	200	56.86a-c	57.23ab	58.50ab	57.53ab	
750	0	56.20a-c	56.86a-c	57.74ab	56.93ab	57.60a
	100	56.56a-c	57.37ab	57.90ab	57.28ab	
	200	58.44ab	58.66ab	58.70ab	58.60a	
1500	0	55.87a-c	56.53a-c	57.13a-c	56.51ab	57.90a
	100	57.54ab	58.34ab	58.58ab	58.15a	
	200	58.63ab	58.70ab	59.82a	59.05a	
Means of Iron		55.97a	56.64a	57.36a		
Zinc × Iron	0	53.50c	54.44bc	55.44a-c		
	750	57.07ab	57.63ab	58.11a	Means of Copper	
	1500	57.35ab	57.86ab	58.51a		
Copper × Iron	0	53.84c	54.84bc	55.80a-c	54.83b	
	100	56.10a-c	56.89a-c	57.26ab	56.75a	
	200	57.98ab	58.20ab	59.01a	58.39a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range tests at 5% level.

The findings of Norozi, *et al*., (2019) demonstrated that zinc foliar application, alone or in combination, increased leaf concentrations of Zn, Fe K, P, Mg, and Mn. In pistachio, it was noticed that there is an antagonistic influence between Zn and Fe, Mn and Cu, because the concentration of Fe was considerably higher in Zn-deficient trees, application of Zn decreased concentrations of Fe (Shahriaripour and Tajabadipour, 2010).

2-Fruit set

1-Primary fruit set%

Data as shown in (Table4) cleared that all treatment significantly increased Primary fruit set in comparison with control. Highest Primary fruit set was obtained from the trees received Zn (39.49 %), Cu (39.20 %) and Fe (39.52 %) each alone, while the lowest primary fruit set was obtained from the control.

The same table also points the significant effect of interaction among the three studied factors, the maximum value (49.32%) was obtained from combination of 1500 mg.L^{-1}zinc x 200 mg.L^{-1} copper and 300 mg.L^{-1} iron compared to lowest value (25.45%) was obtained from 0mg.L^{-1}zinc x 0 mg.L^{-1} copper and 0 mg.L^{-1} iron.

Table (4): Effect of Foliar Spraying of Zinc, Copper and Iron and their interactions on **primary fruit set%** of pistachio cv. " Halebi "

Zinc mg.L^{-1}	Copper mg.L^{-1}	Iron mg.L^{-1}			Zinc × Copper	Means of Zinc
		0	**150**	**300**		
0	**0.0**	**25.45k**	**30.71h-k**	**34.87e-i**	**30.34e**	**31.81c**
	100	**28.40jk**	**31.09g-k**	**36.24d-g**	**31.91e**	
	200	**29.38i-k**	**32.30f-j**	**37.90c-f**	**33.19de**	
750	**0**	**34.62e-i**	**35.27e-i**	**35.95e-g**	**35.28cd**	**37.25b**
	100	**36.05d-g**	**37.06c-g**	**37.11c-g**	**36.74bc**	
	200	**37.70c-f**	**38.28c-f**	**43.17bc**	**39.72b**	
1500	**0**	**31.17g-k**	**36.27d-g**	**39.30c-e**	**35.58cd**	**39.49a**
	100	**34.16g-j**	**38.52c-f**	**41.87b-d**	**38.19bc**	
	200	**39.31c-e**	**45.43ab**	**49.32a**	**44.69a**	
Means of Iron		**32.92c**	**36.10b**	**39.52a**		
Zinc × Iron	**0**	**27.74f**	**31.37e**	**36.33cd**		
	750	**36.13cd**	**36.87cb-d**	**38.74bc**		
					Means of Copper	
	1500	**34.88d**	**40.08b**	**43.50a**		
Copper × Iron	**0**	**30.42e**	**34.08cd**	**36.71bc**	**33.74c**	
	100	**32.87de**	**35.56b-d**	**38.41b**	**35.61b**	
	200	**35.46b-d**	**38.67b**	**43.46a**	**39.20a**	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range tests at 5% level.

The present results are in agreement with the finding obtained by (Baninasab, *et al*., 2007; Ranjbar Kabotarkhani *et al*. 2009) they concluded that zinc and copper treatments increased primary fruit set in pistachio trees.

2-Final fruit set%

Table (5) illustrated that the spraying Halebi pistachio trees with 1500 mg.L^{-1}zinc, 200 mg.L^{-1} copper and 300 mg.L^{-1} iron significantly increased the percentage of final fruit set which gave the highest value (22.81% , 22.28% and 21.48%) respectively.

In respect, the interaction of the three study factors, the interaction of 1500 mg.L^{-1}zinc, 200 mg.L^{-1}, copper and 300 mg.L^{-1} iron gave the highest value (27.32%) compared to lowest value (14.36%) from untreated (control) trees

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Table (5): Effect of Foliar Spraying of Zinc, Copper and Iron and their interactions on **Final fruit set%** of pistachio cv. " Halebi "

Zinc mg.L-1	Copper mg.L-1	Iron mg.L-1			Zinc × Copper	Means of Zinc
		0	150	300		
0	0.0	14.36k	15.61i-k	17.75g-k	15.91g	17.84c
	100	16.53h-k	17.45g-k	19.41f-h	17.79f	
	200	18.21g-j	20.51d-g	20.79c-g	19.83c-e	
750	0	15.54jk	19.30f-i	19.30f-i	18.05ef	19.92b
	100	19.64f-h	20.18e-h	21.19c-g	20.34cd	
	200	20.60c-g	21.10c-g	22.45b-f	21.38c	
1500	0	16.48h-k	19.47f-h	21.22c-g	19.05d-f	22.81a
	100	23.11b-f	24.20a—d	23.94a-e	23.75b	
	200	24.32a-c	25.24ab	27.32a	25.63a	
Means of Iron		18.76c	20.34b	21.48a		
Zinc × Iron	0	16.37f	17.86ef	19.31c-e		
	750	18.60de	20.19cd	20.98c		
	1500	21.30bc	22.97ab	24.16a	Means of Copper	
Copper× Iron	0	15.46f	18.13e	19.42de	17.67c	
	100	19.76c-e	20.61b-d	21.51bc	20.63b	
	200	21.05b-d	22.28ab	23.52a	22.28a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range tests at 5% level.

The presented results could be supported by (Soliemanzadeh *et al*., 2013) They investigate that foliar application of iron, zinc and copper on fruit quantity and quality of pistachio trees in different concentrations, increased the first and final fruit set as compared with control. The effect of Zn and Fe on fruit set was supported by Abd El Motty *et al*. (2006), they reported foliar application of Zn and Fe increased primary and final fruit set in citrus trees. Baybordi and Malakouti (2009) revealed that foliar application of Zn increased the final fruit set of pistachio trees. In addition, Zn-deficiecy lead to the number of nuts per cluster dramatically decreased and most of them can be blanks (Beede *et al*. 2005).

3- Yield per shoot (g)

As shown in table (6) all treatment significantly increased yield per shoot. So increasing the levels of zinc up to (1500 mg.L^{-1}) , copper to (200 mg.L^{-1}) and iron to (300 mg.L^{-1}) lead to significant increase in yield which were (127.08g, 114.18g, 113.75g) respectively.

In respect with the interactions of the three studied factors, the maximum value was (144.21g) at the interactions of third level of each treatment, whereas the minimum value was happened (63.35g) with untreated trees.

Table (6): Effect of Foliar Spraying of Zinc, Copper and Iron and their interactions on **Yield/ shoot (g)** of pistachio cv. " Halebi "

Zinc mg.L-1	Copper mg.L-1	Iron mg.L-1			Zinc × Copper	Means of Zinc
		0	150	300		
0	0.0	63.35l	71.87k	88.30ij	74.51g	84.54c
	100	81.86j	89.89ij	90.80ij	87.51f	
	200	88.79ij	91.77i	94.27hi	91.61f	
750	0	96.48hi	101.41gh	111.60f	103.16e	109.16b
	100	100.61gh	109.15fg	115.58ef	108.45d	
	200	102.69gh	117.99d-f	126.89b-d	115.86c	
1500	0	116.13ef	121.82c-e	122.71b-e	120.22c	127.08a
	100	125.78b-d	122.61b-e	129.42bc	125.94b	
	200	129.78bc	131.26ab	144.21a	135.08a	
Means of Iron		100.61c	106.42b	113.75a		
Zinc × Iron	0	78.00h	84.51g	91.13f	Means of Copper	
	750	99.93e	109.52d	118.03c		
	1500	123.90b	125.23b	132.11a		
Copper × Iron	0	91.99f	98.37e	107.54cd	99.30c	
	100	102.75de	107.22cd	111.93bc	107.30b	
	200	107.09c	113.67b	121.79a	114.18a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range tests at 5% level.

Combination among all the micronutrients application significantly increase yield of the pistachio trees may be because of the important roles of zinc in growth promoting substances (Shivanandam *et al*., 2007), cupper for the activities of certain enzymes which are beneficial in cell growth (Kallsen *et al*. 2000) and iron in electron transport chain (Meshcheryakov and Alekhina (1971)). Our results demonstrated that the combination among micronutrients significantly increased final fruit set and thus fruit yield, Sotomayor *et al*. (2000), and Pandit, *et al*., (2008) they revealed that the combination among studied treatments significantly increase final fruit set in trees. This increase in fruit set and yield might be attributed to the best possible development of pollen tube, adequate levels of nutrients in pollen grain, also an increase in duration of pollination time. It was revealed that foliar application of zinc sulfate (1 and 2 g L-1) increased yield of pistachio (Kizilgoz *et al*. 2010). Also Soliemanzadeh *et al.* (2014) reported that the foliar application of zinc and copper on pistachio trees at high levels, significantly increased primary and final fruit set, yield and yield quality when compared with control. Kizilgoz, *et al*.,(2010) investigate that an increased fruit yield of pistachio trees from zinc application as a result of increased leaves zinc content.

4- Blank Nuts %

Obtained results in table (7) showed that all of the treatments decreased the percentage of blank nuts, as compared with untreated trees in control treatment. High concentration of zinc 1500mg.L^{-1}, 200mg.L^{-1} copper and 300mg.L^{-1} iron each alone reduced the percentage of blank nuts which were (10.92%, 10.73%, 9.76%) respectively.

Regarding to the triple interactions, the interactions of 1500mg.L^{-1} zinc, 200mg.L^{-1} copper with 300mg.L^{-1} iron appeared to be the most operative which were (9.76%).

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Table (7): Effect of Foliar Spraying of Zinc, Copper and Iron and their interactions on **Blank nuts%** of pistachio cv. " Halebi "

Zinc mg.L-1	Copper mg.L-1	Iron mg.L-1			Zinc × Copper	Means of Zinc
		0	150	300		
0	0.0	13.12a	13.04ab	12.77a-c	12.98a	12.19a
	100	12.68a-d	12.05a-f	11.72c-g	12.15b	
	200	11.66c-g	11.44e-h	11.25e-h	11.45cd	
750	0	12.72a-d	12.18a-e	12.00b-f	12.30b	11.51b
	100	11.68c-g	11.57d-g	11.35e-h	11.53cd	
	200	11.01f-h	10.62g-i	10.50hi	10.71e	
1500	0	11.85c-f	11.72c-g	11.65c-g	11.74bc	10.92c
	100	11.42	10.94f-h	10.57g-i	10.98de	
	200	10.57g-i	9.77i	9.76i	10.03f	
Means of Iron		11.86a	11.48b	11.28b		
Zinc × Iron	0	12.49a	12.17ab	11.91a-c	Means of Copper	
	750	11.80b-d	11.46cd	11.28de		
	1500	11.28de	10.81ef	10.66f		
Copper× Iron	0	12.56a	12.31ab	12.14ab	12.34a	
	100	11.93bc	11.52cd	11.21d	11.55b	
	200	11.08de	10.61e	10.50e	10.73c	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range tests at 5% level.

In this study, micro nutrient treatments had a significant effect on the percentage of blankness, the results are in conformity with Norozi, *et al*., (2019) they found that nutrient treatments had significant effects on the percentage of blankness.

CONCLUSION

Foliar application of Zinc, Copper and Iron as foliar spray in bud swell stage and green tip stage significantly influenced leaf nutrients, fruit yield and the percentage of blankness of pistachio trees. It can be concluded that in the calcareous soils, foliar spray of Zinc, Copper and Iron fertilizers is essential for obtaining better fruit yield and quality in pistachio.

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