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Effect of spraying zinc and copper on chemical fruits quality of Manfalouty pomegranate

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Abstract

Effects of foliar spray of zinc and copper on the chemical fruit properties of pomegranate were studied during 2020 and 2021 seasons in a private orchard at Al-Badari, Assiut, Egypt. Zinc and copper were sprayed one time/ month, starting from April till October at the rate of 1, 1.5, 2 and 2.5% for each microelement under Randomized complete blocks design. Zn and Cu spray positively affected the TSS, acidity, TSS/acid ratio, total reducing, non-reducing sugars and vitamin C. According to the results, spraying zinc and copper significantly improved the chemical fruit quality of Manfalouty pomegranates.

Keywords: pomegranate, foliar spray, zinc, copper, fruit quality, micronutrients.

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1. Introduction

Pomegranate (*Punica granatum* L.) belonging to the punicaceae family, is one of the favorite table fruits grown in tropical and sub-tropical regions. This plant is native of Iran and is extensively cultivated in the Mediterranean region since ages (Sheikh and Manjula, 2006). The edible part of the fruit is the seeds having a fleshy covering and called arils, which are eaten fresh or used for making juice, jam and paste. In addition, the fruit is also valued for its pharmaceutical properties. The fruit peel, and the tree stem and root bark and leaves are good source of secondary metabolites such as tannins, dyes and alkaloids (Mirdehghan and Rahemi, 2007). The incidence of micronutrient deficiencies in fruit crops has increased markedly in recent years due to intensive cropping, losses of micronutrients through leaching, decreased proportions of farm manure application compared to chemical fertilizers, increased purity of chemical fertilizers, soil erosion and use of marginal lands (with high pH and EC) for crop production (Zia *et al.*, 2006). The climate change by weather warming and drying might be another important reason for the disorders. Zinc (Zn) is an essential trace element for plants, being involved in many enzymatic reactions and is necessary for their good growth and development. Zinc is also involved in regulating the protein and carbohydrate metabolism (Swietlik, 2010). Zn availability to plants is reduced in high pH soils. Two main theories are offered to account for high Zn deficiency incidence on calcareous soils. First, the solubility of Zn in these soils to be decreased up to 100-fold per unit increase in pH, and the second theory which is based on the adsorption of this element by calcium carbonate ($CaCO_3$); the carbonate found in such soils forms an insoluble complex with Zn added as zinc sulfate (Rasouli-Sadeghiani *et al*., 2002). Zinc deficiency is commonly observed in pomegranate orchards of Iran (Daryashenas and Dehghani, 2006; Taghavi, 2000). Zinc uptake rate was faster in mango trees when zinc sulfate was foliar applied as compared with its soil application (Bahadur *et al.*, 1998). However, the foliar or soil application of zinc sulfate showed no effect on yield and fruit quality of mango, except for TSS in the juice of fruit. The use of fertilizers by spraying on the leaves is a modern method, where considered spraying of vegetable parts of the plant with dilute solutions for these nutrients and for several times of the important and successful methods of treating a nutrient deficiency, especially the micronutrient. Copper, where it has an effective role in the biological processes in the plant by activating a number of enzymes, including the oxidizing enzymes of the polyphenol oxidase, as well as the process of transferring electrons in photosynthesis, where studies showed that about 70% of the total copper in the leaves is found in the chloroplasts, and this confirms its role in the process of photosynthesis. Copper has long been used with other materials as a mixture to treat fungal diseases (Abu *et al*., 1988; Al-Sahaf, 1989). Balakrishnan *et al.* (1996) reported that foliar application of 0.25% each of zinc sulfate, manganese sulfate and iron sulfate combined with 0.15% boric acid significantly increased juice content of pomegranate fruit. Hasani *et al.* (2012) spraying Zn had positive significant effects on the yield, the aril/peel ratio, TSS, weight of 100 arils, juice content of arils, anthocyanin index, fruit diameter and leaf area. Zn effects were also significant for TSS, TSS/TA ratio, juice content of arils and leaf area (Hasani *et al.*, 2012). On the other hand, Hussein and Hasan (2020) reviewed that spraying wonderful cultivar thrice with copper gave the highest percentages in many vegetative and chemical traits. Therefore, the present study was executed to estimate the effect of spraying Zn and Cu on chemical fruit quality of Manfalouty pomegranate.

2. Materials and methods

2.1 Experimental site and treatments description

The current experiment was conducted during two progressive seasons of 2020 and 2021 on twelve years-old Manfalouty pomegranate trees in a private orchard at Al-Badari, Assiut, Egypt. Micronutrients treatments were as follows: T_0 Control (water only), T_1 (spraying zinc at 1%), T_2 (spraying zinc at 1.5%), T_3 (spraying zinc at 2%), T_4 (spraying zinc at 2.5%), T_5 (spraying copper at 1%), T_6 (spraying copper at 1.5%), T_7 (spraying copper at 2%) and T_8 (spraying copper at 2.5%). The trees were sprayed by using a Knapsack sprayer (20 L), total volume of 5 L was sufficient for each tree at maximum growth. A surfactant liquid soap at 0.5 ml/l was added to the spraying solutions. The spraying compounds were applied one time/ month, starting from April till October at four concentrations of 1, 1.5, 2 and 2.5% for each microelement. Randomized complete block design was set up in the three replicates, each replicate consisted of 3 trees. The horticultural practices such as irrigation, soil management and fertilization have been implemented as proposed.

2.2 Measurements

Total soluble solids (TSS %) by using a hand refractometer (ATAGO N-IE). Total acidity (T.A) (expressed as % tartaric acid) was determined by titration of NaOH at 0.1N using phenolphthalein as an indicator. The NaOH was adjusted by using a known volume of oxalic acid 0.1 M according to AOAC (1990). The total acidity was expressed as tartaric acid according to the following equation:

$$\text{Acidity } (\%) = (\text{NaOH volume used in titration} \times \text{NaOH molarity} \times \text{equivalent weight of citric acid}) \,/\, (1000 \times \text{sample volume}) \times 100$$

Where: equivalent weight of tartaric acid

= 75, NaOH molarity = 0.1M, Sample vol = 5 ml.

TSS / acid ratio was determined. Vitamin C (Ascorbic acid) was determined by the method described by A.O.A.C. (1990). Dye solution of 2, 6-dichlorophenol indophenol (0.025%) was prepared by dissolving 50 mg of it in 150 ml hot water containing 42 mg sodium bicarbonate and then filled to 200 ml with distilled water and stored at 3°C. Dye molarity was determined by using 100 mg Ascorbic acid filled to 100 ml in volumetric flask with Conservation solution (15 g oxalic acid + 40 ml acetic acid 10% filled to 500 ml by distilled water). The titration with DCPI on 2 ml of conservation solution was made to adjust the dye molarity and then the titration with adjusted dye on 10 ml pomegranate juice was executed to determine the vitamin C content. Vitamin C (%) was calculated according to the following equation:

$$\text{Vitamin C (\%)} = \frac{\text{Dye volume used in titration} \times \text{dyemolarity}}{\text{Sample volume}} \times 100$$

Reducing sugars (%) were determined according to Lane and Eynon procedure outlined in AOAC (1990).

2.3 Statistical analysis

Experiment was setup as Randomized complete blocks design (RCBD) with three replications for each treatment and one tree per each. The analysis of variance (ANOVA) was applied using Proc Mixed of SAS package version 9.2 (SAS, 2008) and means were compared by using the revised L.S.D. test at 0.05% level of the probability (Steel and Torrie, 1981).

3. Results and discussion

3.1 TSS

Data in Table (1) showed that fruit TSS significantly increased with spraying Zn and Cu at 2.5% for each and they recorded the highest values 16.333 and 16.733% for Zn and 15.933 and 16.133% for Cu) compared to the control, which recorded the lowest values 13.076, 12.733% during the two studied seasons, respectively. This was in concomitant with those found by Balakrishnan *et al*. (1996) in Ganesh pomegranate.

3.2 Titratable acidity

Data presented in Table (1) showed that, titratable acidity significantly decreased with spraying Zn and Cu at 1% for each and they recorded the lowest values of 0.884, 0.849% for Zn and 0.893, 0.871% for Cu compared to the control, which recorded the highest values of 1.089 and 1.115% during the two studied seasons, respectively. Zn and Cu sprays decreased titratable acidity, although they were not significant. On the contrary, it has been reported that the foliar application by zinc sulfate (2000 to 4000 ppm) increased titratable acidity of 'Manfaluty' pomegranate fruit (El-Khawaga, 2007). The variation in the results may be attributed to time of application of Zn and variable responses of different cultivars of pomegranate to zinc application or the environment conditions.

Table (1): Influence of spraying Zinc and Copper on chemical fruit quality of Manfalouty pomegranate during 2020 and 2021 seasons.

Treatments	TSS (%)		Acidity (%)		TSS/acid ratio		Total sugars (%)		Reducing sugars (%)		Non-educing sugars (%)		Vitamin C (%)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Control	3.067	2.733	1.089	1.115	11.999	11.420	11.008	10.727	10.208	9.948	0.799	0.779	0.950	0.926
Zn 1%	3.400	3.667	0.884	0.849	15.158	16.098	11.288	11.513	10.469	10.677	0.820	0.836	0.975	0.994
Zn 1.5%	5.000	5.067	0.911	0.898	16.465	16.778	12.636	12.693	11.719	11.771	0.918	0.922	1.091	1.096
Zn 2%	5.600	6.000	1.004	1.000	15.538	16.000	13.142	13.479	12.188	12.500	0.954	0.979	1.135	1.164
Zn 2.5%	6.333	6.733	1.018	1.013	16.044	16.518	13.760	14.097	12.760	13.073	0.999	1.024	1.190	1.217
Cu 1%	3.267	3.467	0.893	0.871	14.857	15.462	11.176	11.345	10.365	10.521	0.811	0.824	0.965	0.979
Cu 1.5%	4.667	5.000	1.000	0.978	14.667	15.337	12.356	12.636	11.458	11.719	0.897	0.918	1.067	1.091
Cu 2%	5.200	5.267	1.062	1.040	14.313	14.680	12.805	12.861	11.875	11.927	0.930	0.934	1.106	1.110
Cu 2.5%	5.933	6.133	1.076	1.067	14.808	15.120	13.423	13.591	12.448	12.604	0.975	0.987	1.159	1.173
L.S.D at 0.05%	0.151	0.348	0.012	0.022	0.007	0.006	0.127	0.293	0.118	0.272	0.009	0.021	0.011	0.025

3.3 TSS/acid ratio

Also, the effects of Zn and Cu spray at 2.5% have significant increment for TSS/TA ratio, where recorded treatments the highest values of 16.044 and 16.518% for Zn and 14.808 and 15.120% for Cu compared to the control, which recorded the lowest values of 11.999 and 11.420 %, during the two studied seasons, respectively (Table 1).

3.4 Total sugars

At the same way data in Table (1) indicated that, total sugars significantly increased with spraying Zn and Cu at 2.5% for each, recorded the superior treatments highest values of 13.760 and 14.097% for Zn and 13.423 and 13.591% for Cu compared to the control, which recorded the lowest values of 11.008 and 10.727% during the two studied seasons, respectively.

3.5 Reducing sugars

Data in Table (1) showed that reducing sugars significantly increased with spraying Zn and Cu at 2.5% for each and they recorded the highest values of 12.760 and 13.073% for Zn and 12.448 and 12.604% for Cu compared to the control, which recorded the lowest values of 10.208 and 9.948%, during the two studied seasons, respectively.

3.6 Non-reducing sugars

Moreover, non-reducing sugars take the same path, where significantly increased with spraying Zn and Cu at 2.5% for each and they recorded the highest values of 0.9990 and 1.024% for Zn and 0.975 and 0.987 % for Cu compared to the control which, recorded the lowest values of 0.799%, during the two studied seasons, respectively.

3.7 Vitamin C

According to vitamin C, there was a significant increment with spraying Zn and Cu at 2.5% for each and they recorded the highest values of 1.190 and 1.217% for Zn and 1.159 and 1.173% for Cu compared to the control, which recorded the lowest values of 0.950 and 0.926%, during the two studied seasons, respectively, as shows in Table (1).

4. Conclusion

It could be concluded that application of Za and Cu at 2.5% for each improved the chemical fruit some quality characters like TSS, acidity, TSS/TA ratio, sugars and Vitamin C of pomegranate.

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