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# Effect of Foliar Application with Manganese and Zinc on Pomegranate Growth, Yield and Fruit Quality

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**Abstract:** This study was carried out at a pomegranate orchard, Horticultural Station Al-mahaweel, in the province of Babylon during 2010 and 2011 growing seasons. It was aimed to investigate the influence of spraying manganese and zinc solutions on 12 years old trees of Salemy pomegranate cultivar. This study included two factors; manganese (Mn) and zinc (Zn) wich done in the last week of May and first week of June in both seasons. Manganese was applied with four levels *i.e.*, 0 ($Mn_0$), 20 ($Mn_{20}$), 40 ($Mn_{40}$) and 60 ($Mn_{60}$) mg/l. Whereas, Zinc was applied at 0 ($Zn_0$), 1.5 ($Zn_{1.5}$), 3% ($Zn_3$). Each treatment replicated three times with a factorial experiment using RCBD. The number of trees used was 36 trees. The obtained results showed that 60 mg/l manganese with 3% zinc recorded the highest leaf area (5.43 and 5.69 $cm^2$), chlorophyll content (56.12 and 56.26, SPAD unit), fruit set (49.34 and 50.55%) and the highest fruit weight (188.88 and 187.97 g) in the first and second seasons, respectively. Whereas, the lowest values of these parameters were recorded with control treatment. Also, $Mn_{60}$ with $Zn_3$ gave the lowest value of splitting fruit (15.67 and 15.60 %) in the first and second seasons, respectively. Finally, we recommended conducting these treatments annually and apply advanced study on the effect of these elements in the other dates on the pomegranate cvs.

**Key words:** Spraying · Elements · Mn · Zn · Pomegranate · Salemy

## INTRODUCTION

Pomegranate (*Punica granatum* L.), belonging to the Punicaceae family, is one of the favorite table fruits and growing in the tropical and sub-tropical regions. This plant is native of Iran and is extensively cultivated in the Mediterranean region since ages [1]. In the fact, pomegranate fruits have different industrial usage fields such as fruit juice, conserve, vinegar, citric acid and medicine, lead to its gaining popularity in the world markets [2]. The fruit peel, tree stem, root bark and leaves are good source of secondary metabolites such as tannins, dyes and alkaloids [3]. Many factors *i.e.*, climate, soil and irrigation, varieties, pruning, insects and nutrition statues influence the growth and production of fruit trees. Deficiencies of various micronutrients are related to soil types, plants and even to various cultivars. Most micronutrients are readily fixed in soil having alkaline pH. Plant roots are unable to absorb these nutrients adequately from the dry topsoil [4]. Foliar fertilization is particularly useful under conditions where the absorption of nutrients through the soil and this difficult situation to be present in the micro-nutrients such as manganese, zinc and iron. Since the micro-mineral elements is needed for plants in small amounts, so spraying them at the right time is correct way to save the plant requirements [5].

Zinc from the micro-nutrient deficiency, which causes an imbalance in plant growth through a number of enzymes to activate up to 300 enzyme which Peptidase, Protenase, Enolase, also need a plant in the formation of the amino acid Tryptophan, which consists of hormone indole acetic acid (IAA) is essential for cell elongation [6]. Similar to zinc, manganese also is a heavy metal micronutrient, the functions of which are fairly known. It is involved in the oxygen-evolving step of photosynthesis and membrane function, as well as serving as an important activator of numerous enzymes in the cell [7]. Soil application of Mn is problematic, since its efficiency depends on many soil factors, including soil pH. A suitable method for the correction and /or prevention of Mn deficiency in plants is the foliar application of ionic or chelated solution forms of this nutrient [8]. Many previous studies revealed that zinc and manganese spray affects the some characteristics growth

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and yield. El-Sheikh *et al*. [9] found that Florida Prince and Desert Red peach trees were sprayed once, twice and thrice a year with combinations of chelate at the rate of 0.7g/L Fe, 0.3 g/L Zn and 0.3 g/L Mn led in improving chlorophylls (a, b) content and increase in yield, fruit weight, fruit size and fruit firmness. Naiema [10] mentioned that the treatment of Le-Conte pear trees with 3.6 % chelated microelements (Zn, Fe and Mn) gave an increase in fruit weight, fruit size and yield. Hasani *et al*. [11] found that Malas e Torsh e Saveh pomegranate trees were sprayed with Zn and Mn had increased fruit set, yield as weight or number of fruits/tree, as well as, fruit characteristics (TSS, Flesh thickness, weight of 100 arils, leaf area).

The aim of this study was to assess the effect of foliar spray of zinc and manganese sulfates on some pomegranate growth and fruit traits. In addition, it was to study the effect of these elements on fruit cracking percentage of Salemy pomegranate trees.

## MATERIALS AND METHODS

This study was conducted in two successive seasons (2010 and 2011) in pomegranate orchard, Horticultural Station, Al mahaweel in the province of Babylon, to investigate the influence of manganese and zinc spray on 12 years old trees of "Salemy" pomegranate cultivar. Trees were cultivated at 4 X 4 m apart under basin irrigation system. Trees were healthy, similar in vigor and subjected to the same horticultural practices adapted in the region.

Trees has been sprayed with four levels of Manganese Sulphate (0, 20, 40 and 60 mg/l) and three levels of Zinc Sulphate (0, 1.5 and 3 %) and the interaction between them was tested. Each treatment contained three replicates (trees), in a factorial experiment in a completely randomized block design. All treatments were carried out in the last week of May and first week of June in both seasons. Two main branches, from two directions (East and West), of each tree were chosen and tagged in March during the two experimental seasons. The number of flowers and fruit setting were recorded on the selected branches. At the harvest time, fruit weight and number of splitting fruits percentage were estimated. Ten normal fruits were randomly taken from each tree to determine fruit quality traits. Fruit juice was extracted; and the total soluble solids were determined using hand refractometer. Fruit total acidity content (expressed as citric acid/100ml Juice according to AOAC [12] were calculated. Leaf area ($cm^2$), where tenth leaf from the middle position of shoots that randomly taken, were estimated by leaf area meter (Model Cl-202 USA made). Chlorophyll leaves content was determined, in October, using SPAD meter according to Felixloh and Nina method [13]. Leaves dry matter was also calculated as a percentage. The obtained results were subjected to analysis of variance according to Elsahookie and Wuhaib [14] and the means were compared using LSD at 5% level.

## RESULTS AND DISCUSSIONS

**Effect of Zinc and Manganese Spraying on Leaf Area ($cm^2$), Chlorophyll Percentage and Leaf Dry Weight:** The obtained results of both seasons (Table 1) revealed that spraying pomegranate trees with different rates of Zn resulted in significant increase in leaf area; chlorophyll percentage and leaf dry weight that particularly at 3% rate as compared to untreated ones. Pomegranate trees treated by 60 mg Mn/L substantially significantly increased leaf area and chlorophyll percentage. Results also indicated that the combination between manganese and zinc rates displayed that 60 mg $Mn.L^{-1}$ and 3% Zn appeared to the most potent treatment, as it gave the highest leaf area and chlorophyll percentage (5.43 and 5.69 $cm^2$, 56.12 and 56.26 SPAD unit for both seasons, respectively). These results are owing to the use of micronutrients that play an important role in the representation of critical auxins that increase cell division and increase the content chlorophyll in the leaf, which works to increase the leaf area. Also, due to that zinc helps in building the chlorophyll through its direct impact in the composition of amino acids and carbohydrates and energy compounds used in the construction chlorophyll. As well as, it's importance in building the necessary RNA in protein synthesis and stimulates the enzymes that participate in biological processes for the formation of chlorophyll [15].

These results are in agreement with founding of peach trees (9), pear trees (10) and apricot trees (16). They found that the leaf area and chlorophyll percentage was positively correlated with Mn and Zn spray in those trees.

**Effect of Zinc and Manganese on Fruit Set %, Fruit Weight (g) and Yield (kg/tree):** Data concerning the effect of treatments on fruit set (%), fruit weight (g) and yield (kg) during the two experimental seasons are listed in Table 2. The data cleared that, zinc and manganese spray significantly increased fruit set compared with the control at both seasons. Moreover, spraying zinc at 3% combined with manganese at 60 mg/L was more effective than the other treatments, which gives the highest fruit set of 49.34 and 50.69 % for both seasons, respectively. This result may be due to the use micronutrient elements

Table 1: Effect of spraying Zn and Mn on leaf area, Chlorophyll content and Leaf dry weight of "Salemy" pomegranate trees (2010 and 2011 seasons)

| | | Leaf area ($cm^2$) | | Chlorophyll content (SPAD) | | Leaf dry weight | |
|---|---|---|---|---|---|---|---|
| Zinc | Mn | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| 0 | 0 | 4.54 | 4.58 | 51.55 | 52.22 | 45.33 | 45.39 |
| | 20 | 4.59 | 4.64 | 51.90 | 52.29 | 45.38 | 45.42 |
| | 40 | 4.68 | 4.76 | 52.12 | 52.40 | 45.44 | 45.49 |
| | 60 | 4.82 | 4.85 | 52.44 | 52.67 | 45.50 | 45.55 |
| 1,5 | 0 | 4.61 | 4.73 | 52.10 | 52.34 | 45.80 | 45.91 |
| | 20 | 4.83 | 4.99 | 52.58 | 52.88 | 45.84 | 45.98 |
| | 40 | 4.98 | 5.19 | 52.99 | 53.16 | 45.93 | 46.13 |
| | 60 | 5.18 | 5.31 | 53.42 | 53.91 | 46.18 | 46.30 |
| 3 | 0 | 4.87 | 5.04 | 52.92 | 53.03 | 45.92 | 46.14 |
| | 20 | 5.11 | 5.22 | 53.73 | 54.44 | 46.18 | 46.30 |
| | 40 | 5.31 | 5.44 | 55.00 | 55.63 | 46.31 | 46.41 |
| | 60 | 5.43 | 5.69 | 56.12 | 56.26 | 46.43 | 46.60 |
| LSD at 5% level | Zn | 0.25 | 0.27 | 1.11 | 1.20 | 0.38 | 0.41 |
| | Mn | 0.29 | 0.32 | 1.28 | 1.39 | N.S | N.S |
| | Interaction | 0.50 | 0.54 | 2.22 | 2.40 | 0.78 | 0.82 |

Table 2: Effect of spraying Zn and Mn on fruit set, fruit weight and yield of Salemy pomegranate trees (2010 and 2011 seasons)

| | | Fruit set (%) | | Fruit weight (gm) | | Yield (Kg) | |
|---|---|---|---|---|---|---|---|
| Zinc | Mn | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| 0 | 0 | 41.23 | 43.25 | 200.12 | 200.34 | 23.24 | 23.56 |
| | 20 | 42.44 | 45.19 | 198.56 | 197.45 | 23.55 | 23.63 |
| | 40 | 44.00 | 45.47 | 195.77 | 195.67 | 23.70 | 23.81 |
| | 60 | 45.39 | 46.08 | 194.11 | 193.14 | 23.86 | 23.98 |
| 1,5 | 0 | 43.56 | 43.87 | 196.66 | 195.94 | 24.69 | 24.59 |
| | 20 | 45.23 | 45.89 | 194.34 | 193.67 | 24.99 | 24.95 |
| | 40 | 46.78 | 47.11 | 193.00 | 192.49 | 25.15 | 25.07 |
| | 60 | 48.06 | 48.80 | 191.23 | 191.03 | 25.49 | 25.40 |
| 3 | 0 | 45.66 | 46.34 | 193.33 | 192.17 | 25.88 | 25.71 |
| | 20 | 46.87 | 48.00 | 192.24 | 191.00 | 26.03 | 25.97 |
| | 40 | 47.90 | 49.45 | 190.30 | 189.34 | 26.49 | 26.56 |
| | 60 | 49.34 | 50.55 | 188.88 | 187.97 | 26.83 | 26.77 |
| LSD at 5% level | Zn | 1.34 | 1.47 | 1.55 | 1.62 | 1.17 | 1.20 |
| | Mn | 1.55 | 1.70 | 1.79 | 1.87 | N.S | N.S |
| | Interaction | 2.68 | 2.94 | 3.10 | 3.24 | 2.34 | 2.40 |

are needed in relatively very small quantities for adequate plant growth and fruit production. Results also indicated that, control treatment was the highest in fruit weight. Perhaps due to the role of these elements in increasing the number of perfect flowers and increase fruit set, leading to increased the number of fruits and therefore increase food competition [17]. Moreover, spraying zinc and manganese exhibited favorable effect on increasing yield (Kg) in the two experimental seasons. The highest yield value was recorded by spraying zinc at 3% combined with manganese at 60 mg/L.

In general, these results are in line with those obtained by El-Seginy *et al.* [18] and Abd-Ella and El-Sisi [19]. They reported that foliar spraying chelated mixture of Zn, Mn and Fe increased fruit set, fruit weight and as a result increased the yield. Also, El-Sheikh *et al*. [9] and Hassan *et al*. [20] found that foliar spraying chelated mixture of Zn, Mn and Fe increased the fruit set and total yield of Florida Prince and Desert Red Peach trees and Hollywood plum trees.

**Effect of Zinc and Manganese on Splitting Fruit, Total Soluble Solids (TSS) and Total Acidity (TA):** The present data in Table 3 showed that foliar application with zinc reduced the percentage of splitting fruits in Salemy pomegranate cultivars in both seasons. The minimum splitting value was observed by using the highest concentration of zinc (3%). In our experiment, each of Mn and Zn sprays had significant positive effects on TSS and the effect of Zn was more reasonable than Mn in

Table 3: Effect of spraying Zn and Mn on Splitting fruit, Total soluble solids(TSS) and Total acidity (TA) of Salemy pomegranate trees (2010 and 2011 seasons)

| | | Splitting fruit (%) | | TSS(%) | | TA | |
|---|---|---|---|---|---|---|---|
| Zinc | Mn | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| 0 | 0 | 22.67 | 22.16 | 11.78 | 11.67 | 1.55 | 1.58 |
| | 20 | 22.56 | 22.14 | 11.97 | 11.88 | 1.53 | 1.56 |
| | 40 | 22.34 | 22.00 | 12.09 | 12.00 | 1.47 | 1.52 |
| | 60 | 22.11 | 21.88 | 12.34 | 12.22 | 1.41 | 1.46 |
| 1,5 | 0 | 19.11 | 18.26 | 12.11 | 12.04 | 1.48 | 1.50 |
| | 20 | 18.77 | 18.12 | 12.44 | 12.41 | 1.48 | 1.47 |
| | 40 | 18.53 | 17.87 | 12.75 | 12.66 | 1.43 | 1.42 |
| | 60 | 18.41 | 17.81 | 12.99 | 12.91 | 1.39 | 1.40 |
| 3 | 0 | 16.16 | 15.99 | 12.86 | 12.80 | 1.44 | 1.45 |
| | 20 | 16.00 | 15.82 | 13.17 | 13.11 | 1.42 | 1.44 |
| | 40 | 15.82 | 15.77 | 13.56 | 13.43 | 1.38 | 1.40 |
| | 60 | 15.67 | 15.60 | 13.81 | 13.77 | 1.37 | 1.38 |
| LSD at 5% level | Zn | 1.39 | 1.52 | 0.44 | 0.50 | N.S | N.S |
| | Mn | N.S | N.S | 0.51 | 0.58 | N.S | N.S |
| | interaction | 2.78 | 3.04 | 0.88 | 1.00 | N.S | N.S |

increasing TSS, but their combination resulted in relatively higher TSS (Table 3). The cause for increasing the percentage of total soluble solids when spraying these elements, it may be due to the role of these elements in increasing activities of the vegetative growth as shown in Table 1, then absorb nutrients [21]. Also due to their role in the efficiency of the process of photosynthesis, there by increasing manufactured materials in the leaves and moving to the fruit increases the components and their properties. Values in Table 3 also show that total acidity was not affected by spraying zinc and manganese.

In general, these results are in line with those obtained by El-Khawaga [22] and Khorsandi *et al*. [23]. They reported that foliar spraying by Zn had increased TSS and reduce cracking of the fruit. Also, AlHawezi [24] found that foliar spraying of Mn increased TSS in grape berry. It has been reported that the highest TSS and not affected by the acidity was obtained by foliar application of zinc combined with manganese in pomegranate trees cv. Malas e Torsh e Saveh [11].

## REFERENCES


1. Sheikh, M.K. and N. Manjula, 2009. Effect of split application of N and K on growth and fruiting in 'Ganesh' pomegranate (*Punica granatum* L.). Acta Hort., 818: 213-217.
2. Aviram, M. and L. Dornfeld, 2001. Pomegranate juice consumption inhibits serum angiotensin converting enzyme activity and reduces systolic blood pressure. Atherosclerosis, 158: 195-198.
3. Mirdehghan, S.H. and M. Rahemi, 2007. Seasonal changes of mineral nutrient and phenolic in pomegranate (*Punica granatum* L.) Fruit. Sci. Hortic., 111: 120-127.
4. Foth, H.D and B.G. Ellis, 1996. Soil Fertility. Lewis Pub., pp: 119-129.
5. Kuepper, G., 2003. Foliar fertilization. ATTRA (Appropriate Technology Transfer for Rural areas), US Dept. Agric., pp: 1-10.
6. Barker, A.V. and D.J. Pilbeam, 2007. Handbook of Plant Nutrition. Taylor and Francis Group.
7. Wiedenhoeft, A.C., 2006. Micrunutrients. In Plant Nutrition, ed., W.G. Hapkins. Chelsea House Publications, pp: 14-36.
8. Papadakis, I.E., T.E. Sotiropoulos and I.N. Therios, 2007. Mobility of iron and manganese within two citrus genotypes after foliar application of iron sulfate and manganese sulfate. J. Plant Nutr., 30: 1385-1396.
9. El-Sheikh, M.H., S.A.A. Khafagy and N.S. Zaied, 2007. Effect of foliar spray of some micronutrients on leaf mineral concentration, fruit set, yield and fruit quality of Florida Prince and Desert Red peach trees. Res. J. Agric. Bio. Sci., 3(4): 309-315.

10. Naiema, M.S., 2008. Effect of foliar application of liquid organic fertilizer (Aminofert), some micro nutrients and gibberellins on leaf mineral content, fruit set, yield and fruit quality of Le Conte pear trees. Alex. J. Agric. Res., 53(1): 63-71.
11. Hasani, M., Z. Zamani, G. Savaghebi and R. Fatahi, 2012. Effects of zinc and manganese as foliar spray on pomegranate yield, fruit quality and leaf minerals. Journal of Soil Science and Plant Nutrition, 12(3): 471-480.
12. A.O.A.C., 1975. Official methods of analysis of the association of official analytical chemist. Springer-Verlag.
13. Felixloh, J.G. and B. Nina, 2000. Use of the Minolta SPAD- 502 to determine chlorophyll concentration in *Ficus benjamina* L. and populous deltoid's Marsh leaf tissue. HortScience, 35(3): 423.
14. Elsahookie, M.M. and K.M. Wuhaib, 1990. Design and Analysis of experiments. Dar Alhekma Printing and Publishing.
15. Havlin, J.L., J.D. Beaton, S.L. Tisdale and W.L. Nelson, 2005. Soil fertility and fertilizer. Upper Saddle River.
16. Al-Rawi, W., N.A. Jassim and M.E. Al-Hadethi, 2012. Effect of iron and zinc spray on yield, growth and content of the seeds of apricot amygdalin. Egyptian Journal of Applied Sciences, 27(4): 173-187.
17. Jomaa, F.F., 2008. Flowering habits study on pomegranate: effect of flower thinning and zinc spry on perfect flower percentage and yield of some local pomegranate cultivars. Al-Anbar J. Agri. Sci., 6(2): 198-210.
18. El-Seginy, A.M., M.S.M. Naiema, W.M. Abd El-Messeih and G.I. Eliwa, 2003. Effect of foliar spray of some micro-nutrients and gibberellins on leaf mineral content, fruit set, yield and fruit quality of Anna apple trees. Alex. J. Agric. Res., 48(3): 137-143.
19. Abd-Ella, E.E.K. and W.A.A.Z. El-Sisi, 2006. Effect of foliar application of gibberellic acid and micronutrients on leaf mineral content, fruit set, yield and fruit quality of Sultani fig trees. J. Agric. Res., Fac. Agric. Saba Basha, 11(3): 567-578.
20. Hassan, H.S.A., S.M.A. Sarrwy and E.A.M. Mostafa, 2010. Effect of foliar spraying with liquid organic fertilizer, some micronutrients and gibberellins on leaf mineral content, fruit set, yield and fruit quality of Hollywood plum trees. Agric. Biol. J. N. Am., 1(4): 638-643.
21. Al-Rawi, W., N.A. Jassim, M.E. Al-Hadethi and M.J. Al-Kasab, 2012. Effect of Foliar Application with manganese, zinc and calcium in leaf mineral content of Salemy pomegranate trees. Egyptian Journal of Applied Sciences, 27(10): 583-594.
22. El-Khawaga, A.S., 2007. Reduction in fruit cracking in Manfaluty pomegranate following a foliar application with paclobutrazol and zinc sulphate. J. Appl. Sci. Res., 3(9): 837-840.
23. Khorsandi, F., F. Alaei Yazdi and M.R. Vazifehshenas, 2009. Foliar zinc fertilization improves marketable fruit yield and quality attributes of pomegranate Int. J. Agr. Biol., 11(6): 766-770.
24. AlHawezi, S.M., 2008. Effect of shoots shortening and foliar sprays of manganese sulphate on growth and yield of five grapevine cultivars (*Vitis vinifera* L.). Ph. D. Thesis, Fac. Agric. Mosul Univ. Iraq.