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INFLUENCE OF SPRAYING WITH COPPER ELEMENT AND GROWTH REGULATOR (FLORATONE) ON GROWTH AND YIELD OF POMEGRANATE TREES (WONDERFUL CULTIVAR)

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Abstract

This experiment was conducted in the orchard development project of the Ministry of Agriculture in Babylon province, Al-Mahawil District for the period from 1/3/2019 to 11/11/2019, to study the effect of spraying concentrations of copper and fluoratone growth regulator with different dates and their interactions in the vegetative and fruiting and chemical traits in the growth and yield of trees. Pomegranate, *Punica granatum*, wonderful cultivar, 5 years age cultivated in 4 × 4 spaces and under the drip irrigation system. The trees were sprayed on 04/30/2019, and this represents the first date. As for the second date, the trees were sprayed 3 sprayings on 4/30/2019 and 5/30/2019 and the last spray on 30/6/2019. The spraying treatments were as follows (spraying with water only, 0.5 fluoraton gm. L^{-1}, 1 fluoraton g.L^{-1}, 1 copper g. L^{-1}, 1.5 copper, 1 copper +0.5 fluoraton g. L^{-1}), The experiment was conducted according to the Randomized Complete Block Design (RCBD) with two factors and the averages were compared according to the Duncan polynomial test at the probability level of 5%. The results of the experiment can be summarized as follows: The second date, which represents three sprayings, gave the highest percentages in many vegetative and chemical traits and the traits of the yield of pomegranate trees, which it excelled in the number of leaves and foliar area cm 2 and in the percentage of chlorophyll SPAD and the fruit size cm^3 and the yield amount was given (6674 leaves.$tree^{-1}$, 4.111 cm^2, 85.59 SPAD, 86.90 cm^3, 6.94 kg) respectively. The sprayings combination (1 copper + 0.5 fluoraton) g.L^{-1} excelled in most of the vegetable and chemical traits for pomegranate trees, where it excelled in the leaves number, the leaf area cm^2, the percentage of chlorophyll SPAD, reduced the percentage of fruit cracking %, the fruit size cm^3 and the amount of yield (7280 Leaf.$tree^{-1}$, 4,813 cm^2, 83.40 SPAD, 5.3%, 101.79 cm3, 7.640 kg) respectively.

Keywords **:** Copper element, Floratone, Wonderful cultivar

Introduction

Pomegranate *Lunica granatum* L. belongs to the punicaceae family, where its cultivation is spread in temperate regions and is in tropical and semi-tropical areas evergreen to partially deciduous. In cold areas, it is deciduous and the cultivation of pomegranate in Iraq succeeds well to suit its environmental conditions by providing protection for its fruits From the blight of the sun in summer, it is believed that its habitat is west of South Asia, Iran, Iraq, Yemen and the southern part of the Arabian Peninsula and the countries of the Mediterranean basin, then its cultivation has moved to European countries such as Spain, Italy and France and then to America (Mir *et al*., 2010). The use of fertilizers by spraying them on the leaves is a modern method by spraying the 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 ones, including 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 (Al-Sahaf, 1989 and Abu Dahi and Younis, 1988). Most of the Iraqi soil is characterized by a high content of calcium carbonate and with a reaction that tends to be basic. A part that is not a few of the macro and micronutrients when added to the soil directly may be exposed to the processes of loss, fixation and sedimentation, and the plant does not benefit from them, especially the micro-nutrients. This prompted researchers to find methods An alternative to adding it as a foliar spray (Al-Salmani *et al*., 1988) Growth regulators that encourage and inhibit growth are an important factor in plant growth and development. These growth regulators, encouraging, inhibiting or altering the biological processes in plants and many researchers emphasized the importance of these growth regulators in increasing plant growth and yield, Also, industrial Auxins are considered growth regulators that are related to many physiological activities that take place within the plant, including the product of Floratone, one of the commercial compounds containing industrial Auxin, which consists of Naphthalene acetic acid (NAA) and Naphthalene acetamide Naphthylacetamide (NAAm), It contributes to increasing the contract of flowering and fruit formation, which leads to increased production (Al-Hamdani, 2015), as well as its effect on other plant hormones to contribute to improving the vegetative and productive state of the plant, so the research aims to:

1. Study the effect of copper and the Floratone and their interaction on the vegetative and fruiting traits, and improve qualitative yield traits of pomegranate trees.
2. Study the effect of the copper and the growth regulator Floratone on the phenomenon of cracking (splitting) of the pomegranate fruit.

Materials and Methods

This experiment was conducted in the orchard development project belonged to the Ministry of Agriculture in the Babylon province, Al-Mahawil district during the agriculture season 2019 on pomegranate trees *Punica granatum* of Wonderful cultivar is 5 years of age

homogeneous in terms of size and growth, cultivated at a cultivation distance of 4 x 4 m and equipped with a drip irrigation system, to study the effect of dates and foliar spraying with several concentrations of copper and Floratone growth regulator on the growth and yield of pomegranate trees Wunderfle cultivar.

Study factors:

The experiment included two factors, as follows:

1- The first factor: spraying date and which it symbolized (D), and it includes two dates:

The first date: where trees were sprayed once with spraying on 30/4/2019 (after flowering and the beginning of the Fruit set) and which its symbolized (D1)

The second date includes three sprayings, where the trees were sprayed every month once with spraying treatments, starting from the date of 30/4/2019, and which its symbolized D2.

The second factor: spraying treatments on the vegetative growth and which it symbolized (B) and it includes:

B1: Only water spray

B2: Floratone (Table 1) at a concentration of 0.5 $g.L^{-1}$

B3: Floratone at a concentration of 1 g.L-1

B4: Copper fertilizer (Table 2) at a concentration of 1 $g.L^{-1}$

B5: Copper fertilizer at a concentration of 1.5 $g.L^{-1}$

B6 A mixture of (fluratone 0.5 $g.L^{-1}$ + copper 1 $g.L^{-1}$).

Table 1 : Shows the composition of the fluoraton growth regulator (Vapco Jordan)

The percentage per 1kg	Composition
4.5 g	Alpha Naphthyl Acetic Acid
12.5 g	Alpha Naphthyl Acetamide
35.0g	Adhesives and spreading

Table 2 : Shows the composition of the copper fertilizer Disper Cu Max (Eden Spain)

Concentration	Composition
14%	Total copper dissolved in water
14%	Complex copper with lignosulphonic acid and gluconic acid

Spray dates

Copper fertilizer and fluratone were sprayed and for those promised on 30/4/2019 after flowering and at the beginning of the flowers site stage once at the first date D1 and three sprayings for the second date D2, The second spraying, one month after the first spraying, on 30/3/ 2019 and the third on 30/6/ 2019.The solutions were sprayed on vegetative growth to the full degree of wetness of the tree and sprayed at sunset.

Experimental design

The pomegranate trees wonderful cultivars were selected of five-year-age and homogeneous as possible in size and strength of growth, A factorial experiment was conducted according to the randomized complete block design (RCBD) with three replicates and by one tree for the experimental unit (Al-Rawi and Khalaf Allah, 2000). Thus, the number of trees included in the experiment is 36 trees. The results were analyzed using a table of variance analysis and the averages were compared according to the Dunkin polynomial test under the probability level 5% (narrator and successor of God, 1980).

The study traits:

1. The increase in the number of leaves (leaf.tree^{-1})

In the second week of April, the number of leaves was measured for ten side branches of each branch (structural) marked and then extracted the average number of leaves for one side branch and then multiplied by the number of side branches of the main branch (Structural) one then in the number of the total structural branches of the tree and at the end of the experiment at the beginning of October, the same measurement was repeated and the difference between them taken

2. The leaf area (cm^2): At the end of September, (9) full-size leaves were collected from the middle of the branches of the current season (less than a year old).

It was measured using the method used by (2002) O'neal, M.E., Landis, D.A. and using the scanner device by Image software installed on the computer and then took the rate to calculate the leaf area

3. Chlorophyll leaf content (SPAD unit)

The percentage of chlorophyll was estimated using the SPAD-502 Chlorophyll Meter manufactured by the Japanese company Minolta, where it was calculated as an average of ten readings of full-size middle leaves of the branch with age less than a year in one tree and from all directions in the third week of September (Felixlon) And Nina, 2013 and league, 2012).

4 - Average fruit size (cm^3)

Five fruits were randomly selected from the total yield of one tree when harvested. It was calculated as the arithmetic mean of the size of the five fruits after each one was measured using a cylinder inserted using the water-displacement method to extract the average fruit size.

5 - The total yield of one tree (kg)

It was calculated by taking the weight of all the fruits on one tree when harvesting in the first week of October.

6- The percentage of Cracking fruits (%)

The number of Cracking fruits for each tree was calculated at harvest in the second week of October 12/12/2019. Its percentage to the total number of fruits at harvest was estimated according to the following formula:

Cracking fruits (%) =) number of Cracking fruits/number of remaining fruits at harvest (x 100)

Results and Discussion

The average increase in the number of leaves (leaf.tree^{-1})

The results in Table (3) indicate that two dates of sprayings were a significant effect on the trait of the average increase in the number of leaves. leaf.tree^{-1}, while the first date was given the average amounted to 5,838 leaves. leaf.tree^{-1}. As for spraying treatments, it significantly affected the number of leaves. The treatment fluratone 0.5 $g.L^{-1}$ B2 and fluratone 0.5 g .L^{-1} + copper 1 g. L^{-1} B6 gave the highest

value of the number of leaves amounted to 7436 and 7280 leaf.tree^{-1}, respectively, compared to the water-spray treatment that gave 5114 leaf.tree^{-1}. As for the interaction, the results indicated the excelled of D2B2 which reached 8710 leaf.tree^{-1} compared to the treatment of D2B4, D2B5, D1B3, D1B4, D1B1, D1B5 and D2B1 which gave the lowest increase in leaves of 5880, 5856, 5703, 5550, 5242, 5192 and 4987 sheets. Tree 1 straight.

Table 3 : Effect of date and spraying with copper and fluoratone and their interaction in the average increase in the number of leaves (leaf.tree^{-1}) for pomegranate Wonderful cultivar.

Average treatments (A)	D2	D1	Date (D) / Treatments (A)
5114 c	4987 c	5242 c	B1
7436 a	8710 a	6163 bc	B2
6467 b	7231 b	5703 c	B3
5715 bc	5880 c	5550 c	B4
5524 c	5856 c	5192 c	B5
7280 a	7380 b	7180 b	B6
	6674 a	5838 b	Average Date (B)

The numbers in a single column with similar letters, it did not differ significantly according to Duncan's polynomial test under the 5% probability level

The Leaf area (cm^2)

The results in Table (4) show that there were significant differences for the effect of the spraying date on the leaf area (cm^2), where the second date, which gave 4.111cm^2 excelled on the first date, reached 3.755 cm^2. Whereas, the same table showed a significant difference in spraying treatments, whereby the treatment of B5 (copper 1.5 g.L^{-1}) and B6 (fluoraton 0.5 g.L^{-1} + copper 1 g.L^{-1}) was excelled. Where it gave the highest value amounted to 4.907 cm^2 and 4,813 cm^2 respectively compared to the water spray treatment that recorded the lowest value amounted to 3.090 cm^2. As for the interaction, the treatment of D2B5 gave the highest value amounted to 5.263 cm^2, compared to the lowest value of the interaction treatments D1B1 which reached 2.920 cm^2.

Table 4 : Effect of date and spraying with copper and fluoratone and their interaction in the average increase in the Leaf area (cm^2)for pomegranate Wonderful cultivar.

Average treatments (A)	D2	D1	Date (D) / Treatments (A)
3.090 d	3.260 fg	2.920 g	B1
3.580 c	3.380 efg	3.780 def	B2
4.152 b	3.850 de	4.453 bc	B3
4.373 b	4.710 ab	4.037 bc	B4
4.907 a	5.263 a	4.550 bc	B5
4.813 a	4.730 ab	4.897 ab	B6
	4.111 a	3.755 b	Average Date (B)

The numbers in a single column with similar letters, it did not differ significantly according to Duncan's polynomial test under the 5% probability level

The percentage of chlorophyll in the leaf (SPAD unit)

The results in Table (5) showed that a significant difference in spray dates, where the second date D2 which gave 85.59 SPAD excelled the first date that gave 74.59 SPAD, while for spray treatments where the treatment copper gave 1.5 g.L^{-1}, the treatment B5 gave the highest average amounted to 87.46 SPAD and The lowest average was given to treatment spray B1 water spray which amounted to SPAD 61.83. As for the interaction, the treatments D2B5 gave the percentage of chlorophyll at SPAD 93.50, while the interaction D1B1 and D2B1 which reached 59.83 and 63.83 SPAD, respectively.

Table 5 : Effect of date and spraying with copper and fluoratone and their interaction in the average increase in the percentage of chlorophyll in the leaf (SPAD unit)for pomegranate Wonderful cultivar.

Average treatments (A)	D2	D1	Date (D) / Treatments (A)
61.83 b	63.83 e	59.83 e	B1
81.73 a	88.20 abc	75.27 d	B2
83.07 a	90.70 ab	75.43 d	B3
83.04 a	85.15 bc	80.93 cd	B4
87.46 a	93.50 a	81.42 cd	B5
83.40 a	92.13 ab	74.67 d	B6
	85.59 a	74.59 b	Average Date (B)

The numbers in a single column with similar letters, it did not differ significantly according to Duncan's polynomial test under the 5% probability level

Average fruit size (cm^3)

Table (6) indicates that there were significant differences in spraying dates, where the second date gave the highest size of fruit that reached amounted to 86.90 cm3, and the first date gave the lowest fruit size amounted to 66.40 cm^3. As for the spraying treatments, it is noted that the treatment of spraying with fluoratone was higher than the concentration of 0.5 $g.L^{-1}$ + copper 1 $g.L^{-1}$ B6 with an increase of 101.79 cm^3, which was significantly excelled to the rest of the spraying treatments relative to the treatment of spraying with water only B1, which amounted to 50.49 cm^3. As for the effect of the interaction between the date and the spraying treatments, we notice that through the same table, the treatment of D2B6 excelled the highest volume of fruit reaching amounted to 118.53 cm^3, while the interaction treatment D2B1 decreased to 47.90 cm^3.

Table 6 : Effect of date and spraying with copper and fluoratone and their interaction in the average increase in the Average fruit size (cm^3) for pomegranate Wonderful cultivar.

Average treatments (A)	D2	D1	Date (D) / Treatments (A)
50.49 c	47.90 c	53.08 cd	B1
78.28 ab	95.57 ab	61.00 bcd	B2
81.33 ab	86.13 abc	76.35 bcd	B3
70.67 bc	76.10 bcd	65.25 bc	B4
77.33ab	97.20 ab	57.47 cd	B5
101.79 a	118.53 a	85.05 abcd	B6
	86.90 a	66.40 b	Average Date (B)

The numbers in a single column with similar letters, it did not differ significantly according to Duncan's polynomial test under the 5% probability level

The total yield of one tree (kg)

Table 7 indicates that there were significant differences in spraying dates, where the second date D2 excelled on the first date D1, which gave the highest average of increase in the yield of the result reached amounted to 6.94 kg, while the first date gave 5.05 kg. As for spraying, it is noted that the treatment of spraying with fluoratone the concentration of 0.5 $g.L^{-1}$ + copper 1 $g.L^{-1}$B6 was given the higher value amounted to 7.640 kg, which significantly excelled on the rest spraying treatments, As the treatment with water spray only gave B1 the lowest quotient of 3.59 kg. As for the effect of the interaction between the date and the spraying treatment, we notice that the D2B6 treatment amounted to 8,583 kg, while the D2B1 interaction treatment decreased to 3.187 kg.

Table 7 : Effect of date and spraying with copper and fluoratone and their interaction in the average increase in the total yield of one tree (kg) for pomegranate Wonderful cultivar.

Average treatments (A)	D2	D1	Date (D) / Treatments (A)
3.59 c	3.187 e	3.995 de	B1
6.076 b	7.040 abc	5.112 cde	B2
6.457 c	7.170 abc	5.743 bcd	B3
6.099 b	7.764 ab	4.433 de	B4
6.29 b	7.903 ab	4.333 de	B5
7.640 a	8.583 a	6.696 abc	B6
	6.94 a	5.05 b	Average Date (B)

The numbers in a single column with similar letters, it did not differ significantly according to Duncan's polynomial test under the 5% probability level.

The percentage of Cracking fruits (%)

Table (8) indicates that no significant differences appeared in the spraying dates. As for spraying treatments, it is noted that the treatment of spraying with fluoratone at a concentration of 0.5 $g.L^{-1}$ + copper 1 $g.L^{-1}$B6 and the treatment with fluoraton at a concentration of 1 $g.L^{-1}$ separately B3 And the treatment of copper spray in the concentration of $g.L^{-1}$ B4 and the treatment of copper spraying in the concentration of $g.L^{-1}$ B51.5 all gave the lowest cracking average amounted to 5.3%, 5.5%, 11.4% and 12.3%, respectively, significantly excelled to the treatment with water spraying. Only B1 which gave the highest value amounted to 43.2%. As for the effect of the interaction between the date and the spraying treatments, we notice through the same table only that the treatments D2B3, D1B6, D2B6 and D1B3, which reached 4.2%, 4.7%, 6% and 6.8% respectively, gave the highest percentage of cracking 48.2%.

Table 8 : Effect of date and spraying with copper and fluoratone and their interaction in the average increase in the percentage of Cracking fruits (%)for pomegranate Wonderful cultivar.

Average treatments (A)	D2	D1	Date (D) / Treatments (A)
43.2 a	48.2 a	38.3 ab	B1
28.0 b	21.7	34.3 bc	B2
5.5 c	4.2 e	6.8 e	B3
11.4 c	10.8 de	12.0 de	B4
12.3 c	12.8 de	11.9 de	B5
5.3 c	6.0 e	4.7 e	B6
	17.3 a	18.0 a	Average Date (B)

The numbers in a single column with similar letters, it did not differ significantly according to Duncan's polynomial test under the 5% probability level

The excelled of the second date in many studied vegetative traits is due to the percentage of chlorophyll and leaf area due to the fact that the second date was repeated spraying in it three times, which provided the Auxin and the copper element on the different growth stages, which have an important role in many physiological activities within the plant. In increasing vegetative growth through its activity in the process of photosynthesis, Where it enters in the synthesis of proteins specific to the chloroplast, in which it participates in the electronic transport chain that links the chemical photosynthetic reaction systems to carbon representation. In adding to that it is involved in the synthesis of enzymes that assist in reactions that reduce the oxygen molecule, such as the enzyme Cytochrome Oxidase) and other enzymes involved in the processes of oxidation and reduction that occur in plant tissue cells and lead to biological processes such as respiration, protein and nitrate reduction in adding to being a catalyst in the formation of nucleic acids DNA and RNA in developing organs (Hassan *et al*., 1990). As a result of the treatment with fluoratone, the role of Auxin in it is restored by increasing the plasticity and elasticity of the plant cells, which leads to elongation and increase in size and help in the division of plant cells with an increase in their protein content and an increase in the flow of fluids into the cell, which leads to their rapid division, thus the plant grows accidentally by increasing the number of its cells in Its different tissues (Abdul, 1987). And also, the role of Auxin in elongating cells and helping to increase their division, which leads to encouraging growth and increasing the formation of leaf principles, which leads to an increase in the number of leaf buds and a reflection of their increase in the end up on an increase in the number of leaves (Moore, 1979) as it was found (Al-Fatly, 2011) to obtain an increase a significant number of leaves of apricot seedlings when treated with Auxin. This increase in the number of leaves reflected negatively on the leaf area (Table 8), where the increase in the number of leaves reduced the leaf area. These results differed from what Nijjar found (1985). The spraying of apple trees with copper sulfate resulted in a significant increase in the leaf area and the dry matter in the leaves compared with control trees.

(Hussein, 2015) in his study on the effect of spraying naphthalene, acetic acid on the growth of olive seedlings, Sourani and Khudheiry , cultivars a significant increase when spraying at a concentration of 500 mg. L^{-1} in the number of leaves, the leaf content of chlorophyll. (Al-Qadhi *et al*., 2017) found that when spraying olive seedlings, a cultivar of Bashiqa at the growth regulator NAA had three concentrations (0.1000, 2000) mgL^{-1} significant differences where the concentration excelled 1000 mg. L^{-1} on the control treatment in the traits of (number of leaves and leaf area) And chlorophyll in the leaves) with an increase of (14.04, 13.38, 16.86)%, respectively, compared to the control treatment. Also (Al-Enibi, 2008), spraying fig trees a black Diyala cultivar, with NAA at a concentration of 25, 50, and 75 $mg.L^{-1}$ in 1/6/2006 and 10/30/2006 led to a significant increase in the leaf area and the leaf content of chlorophyll.The decrease in the phenomenon of fruit cracking is due to the effect of copper in the cell walls, where (Al-Saadi *et al*., 2017) found an increase in the thickness of the cells of Potamogeton praelongous leaves when sprayed with copper at a concentration of 15 $mg.L^{-1}$ where they observed an increase in the thickness of the cells of the upper and lower epidermis of the shell and thickened it with an increased concentration Copper This confirms, in turn, the decrease in the phenomenon of cracked fruits (Table 8), preserved as a result of the increase in the thickness of the shell

Also, the result of the treatment with fluoratone was observed in the expansion of the fruit size (Table 6) by the effect of Auxin, which works on the elasticity and plasticity of cells and elongation and increases the size and helps in the division of plant cells (Abbas and Hasan, 2018). And the increase in the flow of fluids into the cell, which leads to its rapid division, as it is a source of withdrawal of nutrients and minerals, which reflected positively "in increasing the physiological and biological activities of the plant and the availability of manufactured foodstuffs that improved the qualitative and quantitative yield traits (Abdoul, 1987; Hasan, 2017). The positive effect on the qualities of the quantitative yield caused by adding copper to the pomegranate trees may be due to its positive action in increasing the leaf area and thus increasing the effectiveness of photosynthesis and other enzymatic processes that led to the increase of the material manufactured by the leaves and their transfer to the fruits and thus increase their growth and improve their quantitative traits (Al-Qawami *et al*., 2002; Metep and Hasan, 2020) The adding of this element also increased the content of leaves from chlorophyll (Table 5), which works to increase the physiological activities of the plant that is important in the process of carbohydrate and protein representation, which works to supply fruits with it and its reflection on tree traits and improving yield trait (Gobara, 1998; Hasan *et al.*, (2019) Copper is also included in the formation of the chloroplast, where it has a role in proving chlorophyll and protecting it from early demolition, as 70% of the total copper of the paper is found in the chloroplast. The role of copper in the formation of

carbohydrates, proteins and nitrate reduction within plant cells (Bergmann, 1992) and affects the process of photosynthesis of the plant as it enters the synthesis of a number of enzymes such as Tyrosinase, Cytochrome oxidase (Al-Naimi, 1999 and Emadi, 1991). These results were agreed with (Mohamed and Ahmed, 1991) that spraying copper on apple trees gave the best results in the fruits size as well as the amount of yield compared to the control treatment. 70 and 20) $mg.L^{-1}$ at an average of two sprayings showed significant differences in the fruits size and the number of leaves compared to the control trees. (Al-Rawi, 1999) found that spraying fig trees Aswad Diala cultivar with NAA at a concentration of 5,15.15 $mg.L^{-1}$ in 18/6/1996 and 1997 a significant increase in the fruits size and the highest average at the concentration was 20 $mg.L^{-1}$ as it reached 27.30 3 cm compared to 24.20 cm 3 in the control treatment when the fruits are maturity.

References

Abbas, M.A. and Hasan, A.M. (2018). Effect of spraying zinc, tryptophan and thiamin on growth and yield of grapevine cv. "khalili". Journal of Kerbala for Agricultural Sciences, 5(1): 30.

Abdul, K.S. (1987). Plant Growth Regulators. Ministry of Higher Education and Scientific Research, Salahuddin University, Iraq.

Abu, D.; Youssef, M. and Al-Younes, M.A. (1988). Plant Nutrition Manual, Dar Al-Kutub Printing and Publishing Directorate, University of Mosul.

Al-Araji, J.M.A. and Al-Hamdani, P.I.A. (2005). Effect of leaf fertilization with boron and copper on yield and qualitative characteristics of pear fruits (*Pyrus communis* L.) Ottoman variety. Damascus University Journal for Agricultural Sciences 1.

Al-Douri, I.F.S. (2012). Response of pomegranate trees Selemi (*Punica granatum* L.) to organic fertilization, NPK, boron leaf spray and ascorbic acid PhD thesis, College of Agriculture and Forestry, University of Mosul, Iraq.

Al-Dulaimi, R.M.H.; Al-Sahaf, F.H. and Al-Jubouri, M.Q. (2001). Response of pomegranate trees is a Salimi cultivar for spraying with nitrogen, potassium and calcium and the relationship of fruit pulp content of these elements with the phenomenon of pomegranate cracking, Iraqi Journal of Agricultural Sciences, 31(4): 76-65.

Al-Eneibi, R. and Majed, M. (2008). The effect of spraying NAA, calcium chloride and wax vapor - Gard on vegetative growth and the specific and storing traits of fig fruits (*Ficus carica* L.), Diyala black variety, Master Thesis. faculty of Agriculture, University of Kufa, Iraq.

Al-Hamdani, S.H.B. and Asaad, K.O. (2015). The effect of leaf spraying with fluoraton and the date of spraying on some traits of vegetative and flower growth of two cultivars of *Olea europaea* L., College of Agriculture, Tikrit University, Ministry of Higher Education and Scientific Research, Iraq.

Al-Naimi, S.N.A. (1999). Fertilizers and Soil Fertility, Dar Al-Kotub Press and Publishing Directorate, University of Mosul Ministry of Higher Education and Scientific Research. Iraq.

Al-Qadhi, R.A.; Suzan, A.H. and Al-Bayati, M.M. (2017). The effect of organic fertilization with Humic Acid and growth regulator NAFA on some growth traits of olive seedlings (*Olea europaea* L.) cultivar Bashiqi) 18(1): ISSN -1813-1646.

Al-Qawami, S.M.J.; Salman, A.M. and Salman, M.A. (2002). The effect of spraying with Fe, Zn, N, GA_3 on some physiological traits of fig fruits (*Ficus carica* L.) Diyala black cultivar. Iraqi Journal of Agricultural Sciences 33(4): 71-76.

Alrawi, K.M. and Abdel, A.M.K.A. (2000). Design and Analysis of Agricultural Experiments. Second Edition. University of Al Mosul. Ministry of Higher Education and Scientific Research. The Republic of Iraq.

Alrawi, K.M.; Khalaf, A. and Abdul, A. (1980). Design and analysis of agricultural experiments, Ministry of Higher Education and Scientific Research, Dar Al-Kutub Press for Printing and Publishing, University of Mosul, Iraq (466 pages). Second, Arab House for Publishing and Distribution, Egypt.

Al-Rawi, Uday Zain Al-Din Nagy (1999). Effect of NAA and GA3 treatment on the percentage of precipitation and fruit traits of the fig variety, Black Diyala. Master Thesis. College of Agriculture, University of Baghdad, Iraq.

Al-Saadi, Sahar Abdul-Abbas, Wad Mazzban Taher Al-Asadi, Alaa Nasser Hussein Al-Waheeb (2017). Study of the test of the praelongous Potamogeton plant's ability to accumulate some heavy elements and their effect on some physiological and anatomical traits. Journal. 7(2): 171-191.

Al-Sahaf, F.H. (1989). Applied Plant Nutrition, Ministry of Higher Education and Scientific Research, Iraq.

Al-Salman, M.A. (1988). Propagation of horticultural plants. Baghdad University. Ministry of Higher Education and Scientific Research, Iraq.

and Analytical Diagnosis, Jena; Stuttgart; New york: G. Fischer-P(204-282).

Bergmann, W. (1992). Nutritional Disorders of Plant Development Visual

El-Fatly, H.A.H. (2011). Response of apricot grafts Zaggenia cultivar to endole acetic acid and the effect of foliar spray (gromor) on the growth of apricot seedlings. Master Thesis. Technical College/Al-Musayyib. Board of Technical Education. Ministry of Higher Education and Scientific Research. Iraq.

Emadi, T.H. (1991). Micronutrients in agriculture. Dar Al-Hekma for Printing and Publishing. Ministry of Higher Education and Scientific Research. Baghdad University, Iraq.

Felixloh, J.G. and Nina, B. (2013). Use of the Minolta SPAD- 502 to determine chlorophyll concentration in *Ficus benjamina* L. and populous deltoid's Marsh leaf tissue. Hort. Science, 35(3): 423.

Gobara, A.A. (1998). Response of Le-conte pear trees to foliar application of some nutrients. Egyption Journal of Horticulture, 25(1): 55-70.

Hasan, A.M. (2017). Effect of Foliar Application Date of PRO-SOL Fertilizer and Some Plant Growth Promoters on Growth of Naval Orange Saplings. Journal of Kerbala University, 15(4): 36.

Hasan, A.M.; Ali, T.J.M. and Al-Taey, D.K.A. (2019). Effects of Winter Foliar Fertilizing and Plant Growth Promoters on Element and Carbohydrate Contents on the Shoot of Navel Orange Sapling. International Journal of Fruit Science, 1-10.

Hassan, Nouri Abd al-Qadir, Hassan Yousef al-Dulaimi and Latif Abdullah Al-Ithawi (1990). Soil fertility and fertilizer. Ministry of Higher Education and Scientific Research. University of Baghdad, Iraq.

Metep, S.S. and Hasan, A.M. (2020). Response of apricot trees for spraying by antioxidants compounds and foliar fertilizers. Ecology, Environment and Conservation, 26: 62-69.

Mir, M.; Sofi, M.A.; Sheikh, M.A.; Umer, M.I.; Rehman, U.M. and Rather, G.H. (2010). Agronomic and fruit characteristics of pomegranate.

Moore,T.C.1979.Biochemistry and physiology of plant hormones. Springer-Verlag, New York, U.S.A.

Nijjar, G.Gs. (1985). Nutrition of Fruit Trees P.52-137 Kalyani publishers New Delhi –Indian.

O'neal, M.E.; Landis, D.A. and Isaacs, R. (2002). An inexpensive, accurate method for measuring leaf area and defoliation through digital image analysis. Journal of Economic Entomology, 95(6): 1190-1194.