Response of the scion of the two apple cultivars (Sharabi and Anna) to Indole acetic acid (IAA) and the effect of spraying with copper and zinc sulfate on seedling growth

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Abstract

The study was conducted at the Horticulture and Forestry Station in Al Mahawil District / Babylon province in the season 2019. With three factors, the first factor was two cultivars of apple scion (Sharabi and Anna). The second factor is that the scion are dipping with IAA at a concentration of (0 and 30 mg / L). The third factor is spraying with ZnSo4 sulfate. 7H2o and CuSo4 copper sulfate. 5H2o and for four levels (0, 25 Zn, 25Cu, 25Zn + 25Cu mg / L).A factorial experiment was conducted according to The Randomized Complete Block Design (RCBD) with three replicates. The results were statistically analyzed using analysis of variance and the averages were compared using the least significant difference (LSD) under the probability level of 0.05. As the results showed that the percentage of successful scion was significantly excelled when treatment with Indole acetic acid IAA at a concentration of 30 mg / L amounted to 90.00% on the control treatment that gave 56.67%. It was found that the treatment of indole acetic acid IAA at a concentration of 30 mg / L had a significant effect on most of the studied traits compared to the control treatment. The results showed that there were no significant differences in the diameter of the main branch, the number of lateral branches, and the percentage of dry matter in the roots when treated with (IAA) at a concentration of 30 mg / L compared to the control treatment. The treatment with (Cu + Zn) concentration (25 + 25 mg / L) gave a significant effect on all the studied traits except for (percentage of phosphorus in the leaves) compared to the control treatment. The treatment with (Cu) concentration (25 mg / L) significantly excelled and gave the highest percentage of phosphorus in leaves compared to the untreated. It was also found that the graft cultivar Anna had the highest average leaf area compared to the Sharabi cultivar. As for the Sharabi cultivar, it was significantly excelled in the concentration of zinc in the leaves compared to the cultivar Anna. It was found that the interaction between cultivars and foliar fertilization and the interaction between treatment with auxin and foliar fertilization had a significant effect in increasing the average of all studied traits compared to control treatment, and the triple interaction also had a significant effect in increasing the average of all Studied traits.

Keywords: IAA, zinc ,copper sulfate, apple scion .

اســتجابة طعوم صنفي التفاح (شرابي و Anna) للانــدول حامــض الخليك وتأثير الرش بكبريتات الزنك والنحاس في نمو الشتلات.

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الخلاصة

نفذت الدراسة في محطة البستنة والغابات في قضاء المحاويل/محافظة بابل في الموسم 2011. بثلاثة عوامل فكان العامل الاول صنفين من طعوم التفاح (شرابي وAnna). والعامل الثاني تغطيس الطعوم بـــ IAA بتركيز(0 و30 mg/L). والعامل الثالث الرش بكبريتات الزنك ZnSo4 . 7H2o وبكبريتات النحاس CuSo4. 5H2o ولأربعة مستويات (0، 25 Zn ،25Cu ،25Zn+25Cu mg/L). نفذت تجربة عامليه بثلاثة عوامل وفقاً لتصميم القطاعات العشوائية الكاملة Randomized Complete Blocks Design (R.C.B.D) وكان عدد المعاملات 16 معاملة وبثلاثة مكررات وبواقع 5 شتلات لكل وحدة تجريبي وحللت النتائج إحصائياً باستخدام تحليل التباين وقورنت المتوسطات باستعمال اقل فرق معنوي (LSD) تحت مستوى احتمال 0.05. اذ اظهرت النتائج تفوق النسبة المئوية للطعوم الناجحة معنويا عند المعاملة باندول حامض الخليك IAA بتركيز30 mg/L بلغت 90.00% على معاملة المقارنة التي أعطت 56.67%. ووجد أنّ للمعاملة باندول حامض الخليك IAA بتركيز30 mg/L تأثيرا معنويا في اغلب الصفات المدروسة قياسا بغير المعاملة. وبينت النتائج بأنه لا توجد فروقات معنوية في قطر الفرع الرئيس وعدد التفرعات الجانبية والنسبة المئوية للمادة الجافة في الجذور عند المعاملة باندول حامض الخليك IAA بتركيز30 mg/L قياسا بغير المعاملة. واعطت معاملة التغذية الورقية الثنائية بالـ(Cu+Zn) تركيز (25+25 mg/L) تأثيرا معنويا في جميع الصفات المدروسة ما عدا (النسبة المئوية للفسفور في الأوراق) قياسا بغير المعاملة. وتفوقت المعاملة بالـ (Cu) تركيز (25 mg/L) معنويا وأعطت أعلى معدل في النسبة المئوية للفسفور في الأوراق قياسا بغير المعاملة. كما وجد أن صنف الطعم Anna اعلى معدل لمساحة الورقة قياسا بالصنف شرابي ،أما الصنف شرابي فقد تفوق معنويا في تركيز الزنك في الأوراق قياسا بالصنف Anna. وتبين أن للتداخل بين الأصناف والتسميد الورقي والتداخل بين المعاملة بالاوكسين والتسميد الورقي تأثيرا معنويا في زيادة معدل جميع الصفات المدروسة قياسا بغير المعاملة كما أنّ للتداخل الثلاثي ايضا تأثيرا معنويا في زيادة معدل جميع الصفات المدروسة.

الكلمات المفتاحية: IAA، كبريتات الزنك والنحاس، طعوم صنفين من التفاح.

Introduction

Apple (*Mallus pumila mill*) fruit trees belong to the Rosaceae family, and the northwestern Himalayan regions and the southern regions of the Caucasus are their original country(Youssef, 2002). Grafting is the common method for propagating commercial apple cultivars and it is either on Seedlings or vegetable rootstocks, and the seedlings rootstocks have good qualities, including being a strong growing, stable in the soil, resisting diseases and insects, free from viral diseases and compatible with most varieties, The graft cultivars differ in their responses to the effects of the grafted rootstocks on them in terms of the mutual influence between the rootstocks and the graft on the vegetative and root growth traits (Salman, 1988). IAA also has an important role in stimulating plant cell division and

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elongation, callus formation, and in the differentiation of callus tissue into Phloem and Xylem (Moore, 1979). Although, the presence of the necessary nutrients for the plant in quantities that satisfy its need in the soil, the ready-made ones are not sufficient to meet its needs, especially the micronutrients, which are often exposed to washing, sedimentation and fixation processes in the soil, especially in the basal soils. As is the case in central and southern Iraq, which is characterized by its content of lime and clay, in addition to its hot and dry climate. Therefore, foliar fertilization in such conditions is considered more efficient than ground fertilization because it absorbs the nutrients directly by the plant to contribute to the metabolic processes within its tissues such as photosynthesis and others. Improvement of seedling growth strength and disease resistance (Tisdale, 1985) and (Abu Dahi and Al-Younes 1988). Therefore, the research aims to know the response of both cultivars to the IAA in the success rate of Grafting and the role of foliar nutrition with micronutrients (Cu, Zn) in giving strong growth seedlings suitable for transport and planting them in a sustainable place.

Materials and methods

The research was conducted at the horticulture and forestry station in Al-Mahawil district / Babylon province for the period from 1/10/2018 to 9/15/2019, and the first two phases included a study of the effect of the scion treatment of two cultivars of apples (Syrup and Anna) on the growth regulator (IAA) and at two levels (30, 0) mg / L in the success rate of scion .The second stage is the effect of spraying the resulting seedlings with zinc sulfate concentration (25 mg/L), copper sulfate concentration (25 mg/L), and zinc sulfate and copper concentration (25 + 25 mg/L) in addition to the control treatment in distilled water.(240) apple seedlings were selected with nearly homogeneous seeds at the age of one year, cultivated on Furrow, and were used as rootstocks . The grafting process was conducted on 1/10/2010 and the graft branches selected from the middle of the branches of the mothers of apple trees took the local drink cultivar and the Anna cultivars cultivated in the same station and From the mature growth of the current year and the graft branches were treated with (IAA) by dipping them for a period of (10 minutes) , And it followed the Shield Budding method in the shape of the letter (T) and at a height of (25 cm) above the soil level. The percentage of successful scion were calculated in (2011-3-20), then on 1-4-2011). The seedlings grafted with zinc sulfate and copper sulfate were sprayed and the spraying process was conducted until complete wetness in the early morning (Al-Sahaf, 1989) using a hand sprayer a capacity of 2 liters and three sprayings

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during the growing season and the period between one spray and another one month.

Experiment factors

The first factor: it included the scion of two cultivars of apples, namely (Sharabi and Anna), which were flavored on the apple seedlings rootstocks.

The second factor: the treatment of apple scion with (IAA) concentration (0 and 30 mg / L).

The third factor: spraying with zinc and copper sulfate in four levels, as follows:

- Without spraying (0) control treatment.

spraying with a concentration of 25mg / L of $ZnSo_4$. $7H_2O$ pure.

spraying with a concentration of 25mg / L of $CuSo_4$. $5H_2O$ pure.

spraying at a concentration of 25 + 25mg / L of pure ZnCu.

Experimental design

A factorial experiment was followed (the cultivar of scion × IAA × Copper and zinc sulfate) 2 × 2 × 4 according to a randomized complete block design (RCBD) and with three replicates and the results were analyzed using an ANOVA table according to (Gnta SAS, 2007) program. The statistical differences between the treatments using the lowest significant difference (LSD) and the probability level (0.05) (Al-Sahuki and Waheeb, 1990).

Study traits

1- The percentage of successful scion (%).

2- Average length of the main vegetative branch (cm)

3- Average leaf area (cm^2)

4- leaves content of Chlorophyll (SPAD unit).

5- The percentage of dry matter in leaves (%).

6- Determination of the concentration of zinc component in the leaves in mg / kg.

7- Determination of the copper element concentration in the leaves in mg / kg.

Results and discussion:

The percentage of successful scion

Table (1) that the treatment of scion with IAA before grafting had a significant effect in increasing the success average of scion and it gave the highest success average of 90.00% compared to the control treatment that gave 56.67%. It is noted from the table that there is no significant effect of the cultivars on the percentage of successful scion . The results of the same table indicate the presence of significant interaction between cultivars and treatment with (IAA). Where the cultivar Anna was significantly better when treated with (IAA) in the percentage of successful scion , where it gave the highest average of (93.33%) compared to the control treatment of IAA, and the Sharabi cultivar, which gave the lowest average of (53.33%).The reason may be due to the catalytic role of indole acetic acid (IAA) in the formation of a strong fusion zone as a result of its encouragement and acceleration of cell division as well as its role in

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the differentiation of callus tissue into the elements of Xylem and phloem, which facilitates the connection of transport vessels between the graft and the rootstocks and thus the formation of a good fusion zone (Hartmann and Kester, 2003) or, it may be because auxin affects the process of mechanizing the cell walls, which is an important factor in the formation of a strong fusion zone (Roberts, 1976). As Kose and Gulery (2006) obtained a significant increase in the percentage of successful scion . which reached (100%) when the grape Grafting area was treated with (IAA).

Table 1. The effect of IAA on the percentage of successful scion for two cultivars of apple and the interaction between them.

The average of cultivars	The IAA effect		scion cultivars
	(30mg/L)	Control (0 mg/L)	
70.00	86.67	53.33	Sharabi
76.67	93.33	60.00	Anna
	90.00	56.67	The average of IAA
N.S	27.85		$L.S.D_{(0.05)}$
39.39			$L.S.D_{(0.05)}$ interaction

The average of main branch height (cm)

The results in Table (2) indicate that the treatment with (IAA) had a significant effect on the average of the main branch for seedlings and gave a significant increase in the average of the main branch height of (122.48 cm) compared to the control treatment that gave (103.41 cm) where it is noted from the same table that for Foliar fertilization with zinc sulfate and copper had a significant effect in increasing the average of the main branch. The double treatment with (Cu + Zn) significantly excelled and gave the highest average of 125.34 cm compared to the control treatment, which gave the lowest average of 103.10 cm. It is noticed that a significant difference occurred between (auxin and foliar fertilization), where the double treatment with (Cu + Zn with IAA) gave the highest average of the main branch height of 136.73 cm compared to the control treatment for foliar fertilization with IAA, which gave the lowest average of 89.40 cm . The table also showed that there is a significant difference in the interaction between (cultivars and foliar fertilization) where the cultivars Anna with double foliar fertilization (Cu + Zn) gave the highest average of the main branch height of 125.69 cm compared to the control treatment for Anna and the foliar fertilization which gave 98.76 cm. It is noticed from the same table that there is a significant difference for the interaction between (cultivars and auxin) as the Sharabi cultivars and the auxin

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treatment gave the highest average in the trait of the main branch height of 123.95 cm2 compared to the control interaction treatment for Anna and the IAA which gave the lowest average of 101.24 cm .There was also a significant difference in the triple interaction treatments between (cultivars, auxin, and foliar nutrition), where the treatment of cultivar Anna with the treatment of spraying with (Cu + Zn) and the (IAA) gave the highest average of 139.23 cm compared to the control treatment for the interaction of Anna with the IAA with foliar nutrition, which gave the lowest average was 81.11 cm2. The reason may be due to the effective role of (IAA) in stimulating cells to increase in size as well as activating it to produce amino and nucleic acids, especially (RNA). It also works to increase the elasticity and elasticity of cell walls to help them increase in size and thus fill them with water and food, and this thus positively affects the increase. main stem growth (Moore, 1979). Watanabe (2003) also found that the treatment of Trajan apple seedlings with NAA significantly increased the length of the main stem of the treated seedlings compared to the non-treatment. These results are consistent with Noori (2008) found that the treatment of peach scion with IAA led to a significant increase in the average length of the main branch for seedlings. Perhaps the reason is due to the great role played by the zinc element as a catalyst in building the amino acid Tryptophan, the initiator compound for building the plant hormone (IAA) necessary for cell expansion and elongation (Awad and Atawia, 1995), or the reason is due to the role of the copper element in increasing vegetative growth through its activity. In the process of photosynthesis, where it is included in the synthesis of proteins specific to chloroplasts (Bergmann, 1992). Gobara (1998) also showed that copper has an effective effect on increasing the concentration of auxin and its effect on cell growth and thus increasing plant size.

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Table 2. The effect of IAA and spraying with zinc sulfate and copper and the cultivar and the interaction between them on the average of the main branch height (cm)

Interaction Foliar fertilization × Auxin (IAA)	Foliar fertilization				Auxin (IAA)	scion cultivars
	Zn+Cu 25+25mg/L	Cu 25mg/L	Zn 25mg/L	Control		
105.58	115.73	106.00	102.92	97.70	Control	Sharabi
123.95	134.23	123.35	121.04	117.19	30mg/L	
101.24	112.16	102.74	108.96	81.11	Control	Anna
121.01	139.23	109.90	118.53	116.41	30mg/L	
	125.34	110.49	112.86	103.10	The average of Foliar fertilization	
12.27	21.77= triple interaction ، Foliar fertilization 10.88				L.S.D(0.05)	
The average of cultivars	Interaction Foliar fertilization × cultivars					
114.77	124.98	114.67	111.98	107.44	Sharabi	
111.13	125.69	106.32	113.74	98.76	Anna	
N.S	19.26				L.S.D(0.05)	
The average of Auxin (IAA)	Interaction Foliar fertilization × Auxin (IAA)					
103.41	113.94	104.37	105.94	89.40	Control	
122.48	136.73	116.62	119.78	116.80	30mg/L	

Average leaf area (cm^2)

Table (3) that the treatment of Indole Acetic Acid (IAA) had a significant effect on the average leaf area, where the treatment with (IAA) significantly excelled the average leaf area, which amounted to 28.45 cm2 compared to the control treatment that gave 23.91 cm^2. The results of the same table indicate that The foliar nutrition treatments significantly affected the average leaf area. The double treatment with (Cu Zn) significantly excelled and gave the highest average leaf area of 29.78 cm^2, while the control treatment gave the lowest average of 23.73 cm^2. It is also noticed from the table that the cultivar has an effect on the average leaf area. The cultivar Anna was significantly excelled and gave the highest average with leaf area of 28.55 cm^2, while the average leaf area of the Sharabi cultivar was the lowest average of 23.74 cm^2. It appears from the same table that there is a significant interaction between (auxin and foliar fertilizer). As the treatment with (Cu + Zn) with (IAA) was significantly excelled in the average leaf area, where it gave 32.27 cm^2 compared to

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the control treatment for the two factors, which gave the lowest average of 21.06 cm^2. The cultivar Anna had the highest average foliar area of 31.54 cm^2 when treated with (IAA) compared to control treatment, which gave the lowest average of 22.10 cm^2. Also, a significant interaction was observed between (cultivars and leaf-nutrition), as the cultivar, Anna gave the highest average leaf area of 32.25 cm^2 when treating with (Cu + Zn) compared to the control treatment, which gave the lowest average of 21.24 cm^2. The results also show that the triple interaction between (cultivars , auxin, and foliar fertilizer) had a significant effect on the average leaf area, where the cultivar Anna gave the highest average leaf area of 34.90 cm^2 when treating with (Cu + Zn with IAA) compared to the control treatment for the cultivar. Sharabi with IAA and foliar fertilizer gave the lowest average of 19.11 cm2. This increase is due to the role of auxins by increasing the elongation of the leaf cells and this is thus reflected in its area (Moore, 1979). Al-Fattli (2011) showed that the treatment of apricot scion with IAA led to a significant increase in leaf area. Ibrahim (2010) found that treating peaches with NAA had a significant effect in increasing leaf area. The increase in leaf area is due to good and direct nutrition of the leaves with the solution of these two components. EL-Shazly (2004) showed that spraying apple seedlings with zinc resulted in a significant increase in leaf area. It was supported by Shahin et al. (2010) that spraying the green of Anna apple with zinc resulted in a significant increase in leaf area. or it may be due to the role of the zinc element, where it helps in building the amino acid (Tryptophan), which is the starting compound for the synthesis of the natural hormone (IAA) that works to increase the size of cells, and the reason is due to the role of the copper element in the photosynthesis process and its entry into the synthesis of redox enzymes. Nitrates during atmospheric nitrogen fixation (Abu Dahi and Al-Younes, 1988) The nitrogen component had an effective effect on increasing the number and size of leaf cells and increasing the formation of chlorophyll, which led to an increase in the effectiveness of leaves in the process of photosynthesis and then vegetative growth (Grozov, 1974 ; Popov, 1978).

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Table 3. The effect of IAA and spraying with zinc sulfate and copper and the cultivar and the interaction between them on the average leaf area (cm^2)

Interaction Foliar fertilization × Auxin (IAA)	Foliar fertilization				Auxin (IAA)	scion cultivars
	Zn+Cu 25+25mg/L	Cu 25mg/L	Zn 25mg/L	Control		
22.10	25.00	21.72	22.58	19.11	Control	Sharabi
25.36	29.64	23.72	24.73	23.37	30mg/L	
25.73	29.59	24.56	25.75	23.01	Control	Anna
31.54	34.90	30.68	31.16	29.42	30mg/L	
	29.78	25.17	26.06	23.73	The average of Foliar fertilization	
2.73	triple interaction= 4.42 ، Foliar fertilization=2.21				$L.S.D_{(0.05)}$	
The average of cultivars	Interaction Foliar fertilization × cultivars					
23.73	27.32	22.72	23.66	21.24	Sharabi	
28.63	32.25	27.62	28.46	26.21	Anna	
1.56	4.18				$L.S.D_{(0.05)}$	
The average of Auxin (IAA)	Interaction Foliar fertilization × Auxin (IAA)					
23.91	27.30	23.14	24.17	21.06	Control	
28.45	32.27	27.20	27.95	26.40	30mg/L	
1.56	4.34				$L.S.D_{(0.05)}$	

Chlorophyll content in leaves (SPAD)

Table (4) shows that the treatment with Indole acetic acid (IAA) had a significant effect on the leaf content of chlorophyll, where the treatment with (IAA) significantly excelled and gave the highest average of leaf content of chlorophyll, reaching 39.43 SPAD compared to the control treatment, which gave the lowest average of leaf content of chlorophyll. It reached 34.91 SPAD. The table also indicates that there is a significant effect on the leaves content of chlorophyll in the treatment of foliar fertilization with (zinc and copper), where the treatment with (Cu + Zn) was significantly higher in this traits, which gave 41.32 SPAD, while the control treatment gave the lowest average of 32.01 SPAD. As for the cultivars, there are no significant differences between them in affecting this trait. The same table shows that there is a significant effect of the interaction between (auxin and foliar fertilizers), where the treatment of double nutrition with (Cu + Zn) with IAA was significantly excelled in giving the highest average of 43.75 SPAD, while the control treatment gave the lowest average of 29.72 SPAD. It is noticed from the same table that there

is a significant interaction between (cultivars and foliar nutrition) where the treatment of cultivar Anna was significantly excelled in the leaves content of chlorophyll and gave 41.90 SPAD when sprayed with double foliar nutrition with (Cu + Zn) compared to the control treatment for the cultivar syrup, which gave the lowest rate of 31. 02 SPAD.The same table indicates that there is a significant interaction between (cultivars and the IAA), where the cultivar Anna was significantly excelled in the leaf content of chlorophyll when treated with (IAA), which gave the highest average of 40.42 SPAD compared to the control treatment for the two factors, which gave the lowest average of 34.73 SPAD. The results of the table also show that there is a significant triple interaction between (varieties, auxin, and foliar nutrition), where the cultivars Anna was significantly excelled when treating the double nutrition with (Cu + Zn) with IAA), which gave the highest average of 44.57 SPAD compared to the control treatment of the Sharabi cultivar with the IAA. The foliar nutrition gave the lowest average of 29.39 SPAD. The reason may be due to the role of the growth regulator (IAA) in preventing the breakdown of these pigments by stopping or reducing the activity of the enzyme chlorophyll, in addition to the fact that these substances work to accumulate nutrients in the leaves and thus increase the inside of them to form bold chlorophyll (Muhammad and Yunus, 1991). Filotly (2011) found an increase in the leaves content of chlorophyll when apricot seedlings were treated with IAA. This may be due to the role of the zinc component to help build chlorophyll through its direct effect on the formation of amino acids, carbohydrates and energy compounds that are used in building chlorophyll as well as its importance in building RNA necessary for protein synthesis and stimulating enzymes that participate in the vital processes of forming chlorophyll (Abu Dahi and Al-Younes, 1988). In addition to the effect of the copper element in increasing the efficiency of the plant on the vitamin (C), which contributed directly or indirectly to building chlorophyll as well as its effect on preserving it from oxidation as an antioxidant factor (Oertli, 1987).This is what distinguishes the role of copper in fixing chlorophyll and protecting it from premature demolition. Mohamed et al. (2011) showed that spraying the pears with a solution of microelements (Fe + Zn + Mn) increased the chlorophyll content of the leaves.

Table 4. The effect of IAA and spraying with zinc sulfate and copper and the cultivar and the interaction between them on the Leaf chlorophyll content (SPAD)

Interaction Foliar fertilization × Auxin (IAA)	Foliar fertilization				Auxin (IAA)	scion cultivars
	Zn+Cu 25+25mg/L	Cu 25mg/L	Zn 25mg/L	Control		
34.73	38.53	34.22	36.77	29.39	Control	Sharabi
38.44	42.94	37.89	40.30	32.65	30mg/L	
35.09	39.24	33.84	37.23	30.06	Control	Anna
40.42	44.57	39.26	41.90	35.93	30mg/L	
	41.32	36.30	39.05	32.01	The average of Foliar fertilization	
3.44	triple interaction= 3.74 ،Foliar fertilization=1.87				L.S.D(0.05)	
The average of cultivars	Interaction Foliar fertilization × cultivars					
36.58	40.73	36.06	38.53	31.02	Sharabi	
37.75	41.90	36.55	39.56	32.99	Anna	
N.S	3.82				L.S.D(0.05)	
The average of Auxin (IAA)	Interaction Foliar fertilization × Auxin (IAA)					
34.91	38.88	34.03	37.00	29.72	Control	
39.43	43.75	38.58	41.10	34.30	30mg/L	
1.32	2.54				L.S.D(0.05)	

The percentage of dry matter in leaves

The results in Table (5) showed a significant increase in dry matter in leaves when treated with auxin (IAA) at a concentration of (30 mg / L), which reached 44.14% compared to the control treatment, which gave the lowest average of 37.83%. It is noted from the same table that there is no significant effect of the cultivars on these traits. It also emerged from the same table that there is a significant effect in the percentage of dry matter in the leaves when the interaction between (auxin and foliar nutrition), where the treatment of double nutrition with (Cu + Zn) with IAA) gave a significant increase in the dry matter in the leaves, which reached 47.30% compared to the control treatments, which gave the lowest average of 31.74%.The results of the same table indicate that there is a significant difference for the interaction between (cultivars and foliar nutrition), where the Anna cultivar was significantly excelled when treated with double foliar nutrition (Cu + Zn), which gave the highest percentage of 46.56% compared to the control treatment for two factors, which gave the lowest

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average of 36.99%. The same table also shows that there is a significant interaction between (varieties and auxin), where Anna apple cultivar gave the highest percentage of dry matter in the leaves, amounted to 45.11% when treated with IAA), compared to the control treatment for two factors, which gave the lowest average of 37.32%.The same table shows that there is a significant effect of the triple interaction between (cultivars, auxin, and foliar nutrition), where the Anna apple cultivars, with the double treatment with Cu + Zn (with IAA), gave the highest rate in the percentage of dry matter in the leaves, which was 48.08% compared to the interaction treatment Comparison of the three factors that gave the lowest average of 30.86%.The reason may be due to the role of the growth regulator (IAA) in increasing the efficiency of the photosynthesis process in plant leaves and then increasing the dry matter in the leaves as auxin increases the size of cells and encourages their division and differentiation, thus attracting processed nutrients and mineral elements and collecting them in the place of addition (Muhammad and Yunus , 1991) or due to the effective role of (IAA) in its positive effect on the average of the main branch height, leaf area and chlorophyll content, which was reflected in the good growth of the seedling and thus its reflection in the dry matter of the leaf, Tables (4,3,2). This is in agreement with Al-Fattli (2011). Treatment with growth regulators increased the dry weight of the leaves. It is evident from the table that the foliar nutrition had a significant effect on the percentage of dry matter in the leaves, where the treatment of double nutrition with (Cu + Zn) was significantly excelled, which gave the highest percentage of dry matter in the leaves, amounted to 45.67%, compared to the control treatment, which gave the lowest percentage of 37.37%. From the results it appears that there is a positive correlation between the two elements (Cu, Zn) while spraying them on apple seedlings and for both cultivars, and this is due to their effectiveness in improving the physiological condition of the seedlings, which positively affected the increase in the height of the main branch, leaf area and chlorophyll tables (2,3,4) Respectively, leading to an increase in the average dry weight of the plant (Kellr and Kolet, 1995). The treated plants have a reason for this for the role that these elements play in activating the vital activities, where zinc encourages the elongation of branches and increase the size of the leaves through its role in building amino acid (tryptophan), which is the starting compound for the manufacture of plant hormone (IAA) that affects the expansion and elongation of cells. It increased the activity of photosynthesis and the activity of growth regulators. Also, the copper element has a very effective role in increasing the

growth and then the accumulation of substances resulting from it in the plant through its role in encouraging the increase of dry matter in the leaves by (50%) as a result of the increase in the percentage of soluble carbohydrates, which increased the solids content in them (Salama, 2001). This is consistent with its pitfall (2005), when *Ziziphus mauritiana* seedlings sprayed apple variety with (Zn), the dry matter percentage in leaves obtained an increase of 28.76% compared to 20.53%

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Table 5. The effect of IAA and spraying with zinc sulfate and copper and the cultivar and the interaction between them on the percentage of dry matter in leaves (%)

Interaction Foliar fertilization × Auxin (IAA)	Foliar fertilization				Auxin (IAA)	scion cultivars
	Zn+Cu 25+25mg/L	Cu 25mg/L	Zn 25mg/L	Control		
38.33	43.04	38.42	39.23	32.63	Control	Sharabi
43.18	46.52	40.20	43.14	42.87	30mg/L	
37.32	45.04	36.17	37.23	30.86	Control	Anna
45.11	48.08	43.44	45.78	43.13	30mg/L	
	45.67	39.56	41.35	37.37	The average of Foliar fertilization	
5.02	triple interaction= 9.51 ، Foliar fertilization=4.75				L.S.D(0.05)	
The average of cultivars	Interaction Foliar fertilization × cultivars					
40.76	44.78	39.31	41.19	37.75	Sharabi	
41.22	46.56	39.81	41.50	36.99	Anna	
N.S	7.60				L.S.D(0.05)	
The average of Auxin (IAA)	Interaction Foliar fertilization × Auxin (IAA)					
37.83	44.04	37.29	38.23	31.74	Control	
44.14	47.30	41.82	44.46	43.00	30mg/L	
3.36	6.08				L.S.D(0.05)	

The zinc content in leaves (mg / kg)

Table (6) that the IAA had a significant effect on the concentration of zinc in the leaves, where the treatment with (IAA) significantly excelled and gave the highest average of 33.56 mg / kg, while the control treatment gave the lowest average of 25.23 mg / kg. It is noticed from the same table that the treatments of foliar nutrition have a significant effect on the concentration of zinc on leaves. The treatment of double nutrition with (Cu + Zn) significantly excelled the rest of the treatments, which gave

36.53 mg / kg compared to the control treatment, which gave the lowest average of 22.18 mg / kg. It was evident from the same table that there were significant differences between the cultivars, where the Sharabi cultivar was significantly excelled in giving the highest average of zinc concentration in the leaves of 30.22 mg / kg compared to Anna, which gave the lowest average of 28.58 mg / kg. The results of the table show that there are significant differences in the interaction between (auxin and foliar nutrition), where the treatment of double nutrition with Cu + Zn (with IAA) gave the highest average of zinc concentration in the leaves of 42.78 mg / kg compared to the control treatment for the two factors which gave the lowest average of 17.71 mg / kg. It is noticed from the same table that there is a significant interaction between (cultivars and foliar nutrition), where the Sharabi cultivar was significantly excelled to the double foliar nutrition with Cu + Zn) and gave the highest average of 37.92 mg / kg compared to the control treatment for Anna with the foliar nutrition which gave the lowest average. It reached 22.03 mg / kg. The same table shows that there is a double significant interaction between (cultivars and auxin), where the syrup cultivar, when treated with (IAA), gave the highest average in leaf content of zinc, which was 34.86 mg / kg compared to the control treatment for Anna cultivar with the IAA, which gave the lowest average of 24.89 Mg / kg. Significant differences also occurred in the triple interaction treatments between (cultivars, auxin, and foliar nutrition), where the syrup cultivar when treating the double foliar nutrition with Cu + Zn (with IAA) gave the highest average of zinc in leaves was 45.48 mg / kg compared to the control treatment for the Sharabi cultivar with IAA and foliar nutrition gave the lowest average of 16.96 mg / kg. The reason may be due to the effect of IAA in the formation of a strong bonding zone between graft and rootstocks when treated with it, and then the differentiation of callus tissues into Xylem and Phloem (Davies, 2004), which increases the transfer of the element to the active places in the plant, or due to the role of auxin in raising growth average by increasing cell division, which was reflected in raising the rates of most vegetative traits and an increase in plant activity in the absorption of nutrients from the soil, as well as high averages of food processing contribute to raising the content of leaves of this element (Attia and Jadoua, 1999). Amiri (2008) found a significant increase in the zinc content of leaves when spraying apple trees with Zn, compared to the control treatment.

Table 6.The effect of IAA and spraying with zinc sulfate and copper and the cultivar and the interaction between them on the zinc content in leaves (mg / kg)

Interaction Foliar fertilization × Auxin (IAA)	Foliar fertilization				Auxin (IAA)	scion cultivars
	Zn+Cu 25+25mgL	Cu 25mg/L	Zn 25mg/L	Control		
25.57	30.37	26.02	28.96	16.96	Control	Sharabi
34.86	45.48	31.15	35.12	27.71	30mg/L	
24.89	30.03	24.00	27.09	18.46	Control	Anna
32.26	40.27	30.12	33.09	25.59	30mg/L	
	36.53	27.82	31.06	22.18	The average of Foliar fertilization	
5.07	triple interaction= 4.01 ، Foliar fertilization=2.00				L.S.D(0.05)	
The average of cultivars	Interaction Foliar fertilization × cultivars					
30.22	37.92	28.59	32.04	22.33	Sharabi	
28.58	35.14	27.06	30.09	22.02	Anna	
1.42	6.37				L.S.D(0.05)	
The average of Auxin (IAA)	Interaction Foliar fertilization × Auxin (IAA)					
25.23	30.20	25.01	28.02	17.71	Control	
33.56	42.87	30.63	34.11	26.65	30mg/L	
1.42	2.96				L.S.D(0.05)	

The copper content in leaves (mg/kg)

Table (7) that the indole acetic acid (IAA) has a significant effect on the copper concentration in the leaves, where the treatment with (IAA) gave the highest average of copper concentration in the leaves, which was 17.25 mg/kg, while the control treatment gave the lowest average of 13.75 mg. / Kg. It appears from the same table that there are significant differences in the foliar nutrition treatments with zinc and copper. The treatment of double foliar nutrition with (Cu + Zn) gave the highest average for these traits, reaching 17.73 mg/kg, compared to the control treatment, which gave 12.23 mg/kg. The results of the same table also show that there is a significant interaction between (auxin and foliar nutrition), where the treatment of double foliar nutrition with Cu + Zn (with IAA) was significantly higher in the copper content of leaves, which amounted to 19.44 mg / kg, compared to the control treatment for the two factors that gave 8.96 mg/kg. And it appeared from the same table that there was a significant interaction between (cultivars and foliar nutrition) as the apple cultivars Anna when

treating the double foliar nutrition with (Cu + Zn), gave the highest average of copper concentration in the leaves, reaching 17.88 mg/kg compared to the control treatment for the Sharabi cultivars and the foliar nutrition the lowest average. It reached 12.07 mg / kg. A significant effect was also found in the interaction between (cultivars and auxin), The cultivar Anna, when treated with (IAA), gave the highest average concentration of copper in leaves, reaching 17.63 mg / kg, compared to the control treatment for Anna and IAA, which gave the lowest average of 13.53 mg/kg. The data of the same table indicate that there are significant differences in the triple interaction between (cultivars, auxin, and foliar nutrition), where the cultivar Anna, when treating the double foliar nutrition with Cu + Zn, with (IAA) gave the highest average copper concentration of 19.68 mg / kg compared to the control treatment. cultivar Anna with IAA and foliar nutrition gave the lowest average of 8.66 mg / kg.

Table 7. The effect of IAA and spraying with zinc sulfate and copper and the cultivar and the interaction between them on the copper content in leaves (mg/kg)

Interaction Foliar fertilization × Auxin (IAA)	Foliar fertilization				Auxin (IAA)	scion cultivars
	Zn+Cu 25+25mg/L	Cu 25mg/L	Zn 25mg/L	Control		
13.98	15.98	15.85	14.86	9.25	Control	Sharabi
16.88	19.20	17.24	16.20	14.89	30mg/L	
13.53	16.08	15.63	13.76	8.66	Control	Anna
17.63	19.68	18.40	16.31	16.15	30mg/L	
	17.73	16.78	15.28	12.23	The average of Foliar fertilization	
2.13	1.70				L.S.D(0.05)	
The average of cultivars	Interaction Foliar fertilization × cultivars					
15.43	17.59	16.55	15.53	12.07	Sharabi	
15.58	17.88	17.02	15.04	12.40	Anna	
N.S	triple interaction= 2.84 ، Foliar fertilization=0.85				L.S.D(0.05)	
The average of Auxin (IAA)	Interaction Foliar fertilization × Auxin (IAA)					
13.75	16.03	15.74	14.31	8.95	Control	
17.25	19.44	17.82	16.25	15.52	30mg/L	
0.60	1.17				L.S.D(0.05)	

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Conclusions

1- Treatment with (IAA) improved most of the traits of vegetative and root growth and the mineral content of leaves.

2- Foliar fertilization treatments with zinc and copper, especially in the combined form of (Zn + Cu), were the most effective in improving the traits of vegetative and root growth and increasing the concentration of mineral elements in the leaves.

4- The study factors were more effective in improving the vegetative growth traits compared to the individual effect of the factors.

References

Abu Dahi, Yousef Hamad. And Moayad Ahmed Al-Younes. 1988. Handbook of Plant Nutrition. Baghdad University. Ministry of Higher Education and Scientific Research. Iraq.

Al Sahuki, Medhat Majeed, Karima Waheeb, 1990. Applications in design and analysis of experiments. House of wisdom for printing and publishing. University of Al Mosul .

Al-Fattli, Hanaa Ahmad Hashem. 2011. Response of apricot seeds of Zaginia cultivar to indole acetic acid and the effect of foliar spraying with (gromor) on the growth of apricot seedlings. Master Thesis. Technical College / Musayyib. Board of Technical Education. Ministry of Higher Education and Scientific Research. Iraq.

Al-Sahhaf, Fadel Hussain 1989. Applied plant nutrition. Baghdad University. faculty of Agriculture. Iraq.

Amiri, M. E; F. Esmaeil and G. Ahmad. 2008. Influence of Foliar and Ground Fertilization on Yield, Fruit Quality, and Soil, Leaf and Fruit Mineral Nutrients in Apple. Journal of Plant Nutrition . Issue 3.pages 515-525.

Attia, Hatem Jabbar and Khudair Abbas Jadoua. 1999. Plant growth regulators theory and practice. Ministry of Higher Education and Scientific Research. Baghdad University.

Awad, M.M. and R.A. Atawia.1995.Effect of foliar sprays with som micronutrients on' Le-conte' pear trees.1 :Tree growth and leaf mineral content .Annals Agric.Sci. 40 (1) :359-367.

Bergmann, W. 1992.Nutritional Disorders of Plant Development Visual and Analytical Diagnosis,Jena;Stuttgart;New york:G.Fischer-P(204-282).

Davies,P.J.2004.Plant Hormones Biosynthesis,Signal Transduction. Action Kluwer Academic publishers. Dordrecht. Boston. London.

El –Shazly, S.M. and R.Dris.2004.Response of Anna apple trees to foliar sprays of chelated Iron,manganese and zinc.Jurnal of food,Agriculture and Environment,.2(3&4):126-130. www.world-food.net

Genta SAS.2007.SAS/STATUser Guide forPersonal Computers,SAS Institute Inc, Cary, N.C.USA .

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

Grozov, D.N. 1974 . The effect of nitrogen on Photosynthesis in apple trees . Sadovodstva Vinoyra darstvo Ivinodaiie Modavif (2) 16 – 18 . (C.F. Hort. Abst., 4 (10) , abst 1314 – 1974)

Hartmann,H.T.and D.E.Kester. 2003 . Plant Propagation: Principles and Practices.6rded.PrenticeHall,Inc.,Englewood Cliffs,New Jersey. USA.

Ibrahim, Z.R.2010. Effects of foliar application of NAA,KNO3 and Fe on vegetative growth yield and Fruit quality of peach. MSc thesis , University of Duhok.

Kabouta, Dalia Esmat Shaya. 2005. The effect of iron, zinc and nitrogen spraying on the growth of Sidr seedlings (Zizyphus mauritiana L.) apple variety. Master Thesis. faculty of Agriculture. Baghdad University. Iraq.

Kellr,M. and M. Kolet. 1995. Dry matter and leaf area partitioning bud and second season growth of limiting irradiance Vitis. 34:77-83.

Kose,C.and M.Gulery.2006.Effect of auxin and cytokinins on graft union of grapenvine (*Vistis vinifera*) .New Zealand journal of ceopand .Hor.Sci. Vol.34:145-150.

Mohamed, A. A. A; M. A. K. Zeinab; A. F. E. El-Rmah and M. A. El-Akabawy.2011. Response of Le-Conte Pear Trees growth under Egyptian codition to some Foliar applications and soil spraying with agar solution J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 2 (3): 327 - 340.

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

Muhammad, Abdul Azim Kazem and Muayad Muhammad Yunus. 1991. Fundamentals of plant physiology. faculty of Agriculture. Baghdad University. Ministry of Higher Education and Scientific Research. Iraq.

Nijjar, G.G. 1985.Nutrition oF Fruit Trees. Kylyani publishers New. P.52-137 . Delhi –Indian.

Noori,I.M.2008.Studies on seed germination seedling growth and budding of some stone fruits. (Prunus spp). ph. D. Dissertation. university of sulaimani.Iraq.

Oertli, J. J. 1987 .Exogenous application of vitamins as regulators for growth and development of plant. Preview. Z. Planzenr Nahr. Bodenk 150 : 375-391.

Popov,F.1978.Chlorophyll contect and photosynthetic productivity in apple trees in relation to soil. Mangement in apolmette orchard.Vopr. Intensifik. Plodovod. Kishinev Moldavian. SSR:44-46. (C.F.Hort. Abs. Vol. 49,No. 9. abst. 6544.).

Roberts, L.W. 1976. Cytodifferentiation in Plant– Xylogenesis As a Modle system. Cambridge University Press. London.

Salama, Z. A. 2001. Diagnosis of copper deficiency througt Growth, nutrient uptake and some biochemical reaction in Pisum sativium L..J. of Biological 4(11) :1299 - 1302. Pakistan.

Salman, Muhammad Abbas. 1988. Propagating horticultural plants. Ministry of Higher Education and Scientific Research. Baghdad University .

Shahin. M.F. M; M.I. F. Fawzi and E .A. Kandil. 2010. Influence of Foliar Application of some nutrient (fertifol misr) and Gibberellic acid on fruit set ,Yied, fruit ,Quality and leaf composition of Anna apple trees Growen in sandy Soil .Journal of Amercan science 6(12) pp:202-208.

Tisdale, S.L.,W.L.Nelson and J.D.Beaton. 1985.Soil fertility and Fertilizer.4th Fd.Macmillan public.Co.New.Yourk.PP:631-671.

Watanabe. M; W. S.Akira; K.Sadaoand S.Hidetugu.2003.Effect of plant growth regulators on shoot growth of a columnar type apple tree (crop production and cropping type in Japanese).Hort.Res. Japan. 2(2): 97-100. http://www.jstage.jst

Youssef, Youssef Hanna. 2002. Deciduous fruit production between theory and practice. Zahran House for Publishing and Distribution. Syria.