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EFFECT OF SPRAYING DIFFERENT CONCENTRATIONS OF FE AND CU ON SOME VEGETATIVE CHARACTERISTICS SEEDLING GROWTH OF LOCAL APRICOT *PRUNUS ARMENIACA* L.

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Abstract

The experiment was conducted at a lath house affiliated to the Department of horticulture and landscape, College of Agriculture, University of Karbala from15\3\2019 to 30\6\ 2019 to investigate the effect of spraying various concentrations of Fe and Cu on the seedling growth of the local cultivar apricot. The experiment carried out relying on the Randomized Complete Block Design (R.C.B.D) as a factorial experiment of three replicates and two factors involving Fe at three concentrations 0, 30 and 60 mg.l^{-1} and Cu at three concentrations 0, 20 and 40 mg.l^{-1}. The seedlings sprayed twice with an interval period of a week between them started on 15/3/2019. Measuring taken, data analyzed, the averages compared according to the least significant difference (L.S.D) at the probability 0.05. The most important concluded results were:

1. The treatment of 60 mg.l^{-1} of Fe was significantly superior to the other concentration in all vegetative growth traits (plant height, stem diameter, number of leaves, leaf area, leaf chlorophyll content, relative leaf moisture, iron concentration in the leaves, and shoot dry weight) that gave the highest averages (89.89 cm, 6.46 mm, 154.80 leavs.seedling^{-1}, 4246.33 cm^2, 47.16 SPAD, 72.91%, 64.50 mg.l^{-1} and 14.20 g.seedling^{-1} respectively).

2. Cu treatment of 40 mg.l^{-1} achieved significant superiority in all vegetative traits (plant height, stem diameter, number of leaves, leaf area, leaf chlorophyll content, relative leaf moisture, iron concentration in the leaves, and shoot dry weight) that gave the highest averages (85.67 cm, 5.90 mm, 143.80 leaves.seedlingl-1, 3452.33 cm^2, 45.21 SPAD, 67.77 %, 62.11 mg.l^{-1} and 13.03g.seedling^{-1}).

3. The interaction between the two factors significantly affected the most traits (seedling height, stem diameter, leaf area, relative leaf moisture, and shoot dry weight) that gave 94.00 cm, 6.93 mm, 5296.00 cm^2, 77.78% and 16.48 g.seedling^{-1} respectively on average, while the interaction effect on other traits (number of leaves, total leaf chlorophyll content, and iron concentration in the leaves) was not significant.

Key words: Apricot, seedlings, foliar application, vegetative Characteristics

Introduction

Apricot *Prunus armeniaca* belongs to Rosaceae family (Hassan, 2002). Apricot trees history back five thousands years ago in China (Janick, 2005). Other references refer that apricot native country is North China where was cultivated 4000 years ago (Al-Douri & Al-Rawi, 2000). The wild species extend from Japan to Afghanistan. The Romans called it called Arminian apple that is why some scientists believe apricot origin is Armenia (Al-Douri & Al-Rawi, 2000 and Punia, 2007). The word, Apricot, as an origin returns to the Greek word AL-Praecox meaning the early fruit (Janick, 2005).

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Apricot is an excellent source of sugars and contains a valuable collection of ingredients minerals and vitamins, their effect is moisturizer, stomach cooler, blood tonic, thirst reducer and crumbly.

Worms repellent (Al-Dujwi, 1997 and Moseley, 2000). Generally, fertilization processes are considered one of the factors affecting the growth of fruit trees, it was necessary to use various means, including Foliar Nutrition with microelements such as Fe and Cu, as the microelements are exposed to sedimentation and the formation of complex compounds that are not ready for absorption by plant roots, especially Alkaline soil prevailing in middle and southern Iraq, this reduces their readiness and impedes their absorption by the plant, so it has become essential using various fertilization means such as relying on foliar fertilization for micronutrient involving Fe and Cu (Taiz & Zeiger, 2010). It is worth noting that Fe has a role in building chlorophyll even though it does not enter into its structure as it enters the process of forming RNA and thus helps cells to form proteins in the walls of cells. (Focus, 2003). 80% of the leaf iron is in chloroplasts (Taiz & Zeiger, 2010). Iron deficiency causes direct effects in the photosynthesis process and leads a decrease in yield (Alam & Raza , 2001). Also, Cu has an important role in the process of the transfer of electrons in light reactions in the process of photosynthesis and has an important role in the stability of chlorophyll and other colored substances in plant tissues as it enters in the synthesis of many enzymes, including enzymes Phenolase, Laccase, Ascorbic oxidase, and Cytochrome oxidase (Al-Sahaf, 1989). Kabota (2005) referred that spraying 200 mg.l^{-1} of ferrous sulfate on seedlings increased the length, diameter, dry weight of the roots significantly compared to the control. AL-Kabe, (2006) found that spraying 0.5 and 1 g.l^{-1} of ferrous sulfate on orange seedlings grafted on one-year- old bitter orange increased the length, diameter, dry weight of the roots significantly compared to the control treatment. Khudhair (2012) reported that when spraying the two concentrations 10 and 20 mg.l^{-1} of chelated Fe (Fe 6%) on apricot seedlings, the treatment of 20mg.l^{-1} was significantly superior in the seedling height, stem diameter, leaf chlorophyll content, and shoot dry weight compared to the control treatment. Khudair, & Al-Musawi (2014) referred that spraying chelated Fe on one-year-old olive seedlings, cultivar Khistawi, in concentrations of 50 and 100 mg.l^{-1} increased the seedling height, stem diameter, total leaf chlorophyll content, and iron concentration in the leaves compared with untreated seedlings . Because of limited research in Iraq on the use of spraying Fe and Cu in growth of apricot seedlings, The aim of this experiment was conducted of knowing its role in improving the growth of apricot seedlings.

Materials and Methods

The experiment was conducted at a lath house affiliated to the Department of horticulture and landscape, College of Agriculture, University of Karbala from 15\3\2019 to 30\6\ 2019 to study the effect of spraying with different concentrations of Fe and Cu on the growth of apricot seedlings, a local variety. Fifty-four one- year old seedlings of homogeneous in size and growth were chosen. The seedlings had been grown in polyethylene bags sized 1.25 kg containing loamy soil and on 5/3/2019 they were transferred into bags sized 2kg table 1. A factorial experiment 3×3 carried out within the design of (RCBD) involving two factors Fe and Cu with three concentrations for each. The treatments were replicated three times where each replicate included 8 seedlings namely 2 for each treatment. Hand sprinkler of one litter capacity was used for spraying where 1cm^3 of the diffuser was added to each concentration for reducing the surface tension of water molecules and reaching the fully wet of the vegetative parts. Seedlings sprayed with Fe as chelated Fe-EDTA 6% at three concentrations 0, 30 and 60 mg.l^{-1} during the early morning whereas the Cu sprayed as sulfate, $CuSo_4.5H_2O$ (24.8 % Cu) at three concentrations 0. 20 and 40 mg.l^{-1} in the evening and only distilled water used for the control treatment. The spraying performed twice with an interval period of 7 days starting on 15/3/ 2019. The seedlings were sprayed a day after irrigation to increase the plant efficiency for absorbing the sprayed materials as moisture plays an important role in guard cell turgor and opening stomata; furthermore, pre-spraying irrigation help to dilute the solvents inside the leaf cell that increases penetrating the ion of the spray solution into the leaf cells (Al-Sahaf, 1989). All service practices of irrigation and weeding of bags and between replicates for all treatments were done evenly at the end of June 2019, measurements were recorded that included.

1. Seeding height (cm): was measured with a measuring tape from the soil surface (bag soil) to the top of the seedling.

2. Stem diameter (mm): was measured for the main stem at 6 cm above the soil surface with a Vernier.

3. Number of leaves (leaves.seedling^{-1}): were calculated per seedling.

4. Leaf area (cm^2): was calculated based on the weight method, of the fresh weight, according to (Dvornic, 1965). Three fresh leaves from each fully expanded plant were taken and weighted separately, then the leaves averages weight was calculated. Next, one piece for each leaf with an area of 1 cm 2 was cut and their average fresh weight was recorded, later, the leaf area was calculated according to the following equation:

Leaf area (cm^2) =

$$\frac{average\, weight\, of\, the\, leaves\,(g)}{average\, weight\, of\, the\, leaf\,\, piece\,(g)}$$

Seedling leaf area (cm^2) =

leaf area (cm^2)×number of leaves

5. Leaf chlorophyll content (SPAD): was estimated with chlorophyll meter type SPAD - 502. The average values for four leaves were calculated from each

experimental unit and measured as SPAD units according to (Jemison & Williams , 2006).

6. Relative leaf moisture content (%): was estimated according to Siddique *et al*., (2000) where 20 fresh leaves from each seedling were weighted with a sensitive balance of 0.0001. Then the leaves were submerged in distilled water for one day at room temperature (23-25°C) under low light to saturate the leaves with distilled water and recorded its saturated turgor weight, after that the leaves were dried with an oven at temperature 70°C until the weight stability. The weight was recorded and the relative leaf moisture content was calculated according to the following formula:

relative leaf moisture content (%) =

$$\frac{leaf\ fresh\,weight - leaf\ dry\ weight}{turgor\ weight - leaf\ dry\ weight} \times 100$$

7. Iron concentration in the leaves: was estimated with an Atomic absorption device according to the method of (Katyal & sharma, 1980).

8. Shoot dry weight (g): was calculated as an average dry weight of leaves, stem, and branches by putting them inside perforated paper bags and dried in electric oven at temprature70°C until the weight stability and then weighted with an electric sensitive balance.

At the end of the experiment, the data analyzed according to the design of R.C.B.D and the results and averages were compared according to the LSD test, at the probability level 0.05 (AL-Rawi & Khalaf Allah 2000).

Table 1: some physical and chemical characteristics of the soil used in the experiment.

Soil characteristics	
Soil texture	**Sandy loam**
Sand	871g.kg.-1
Silt	41 g.kg.-1
Clay	88 g.kg.-1
pH	7.8
E.C	1.25
N	28.70 g.kg.-1
P	0.46 g.kg.-1
K	35.00 g.kg.-1

Results and Discussion

Seedling height

Results in table 2 illustrate that the seedling height significantly increased when the seedlings treated with 60 mg.l^{-1} producing 89.89 cm height compared to the control treatment that produced seedlings of 74 cm height. The increase in the seedling height may be due to the role of iron in the biological activities as a cofactor participates in the synthesis of chlorophyll, cytochrome, and the protein a chloroplast, it increases the efficiency of carbon assimilation and then increases the growth rate as it helps to construct the cell wall proteins as well as, it has a role in the cell division process (Al-Sahaf, 1989). These results were consistent with those found by Kabota (2005), AL-Kabe, (2006), Khudhair (2012)and Khudair, & Al-Musawi (2014). The table also referred to a significant effect of the cooper on the seedling height. The concentration of 40 mg.l^{-1} gave the highest seedling height averaged 85.87 cm while the control treatment gave the lowest seedling height averaged 79.00 cm. The reason behind the seedling height increase may be to the copper role in activating several enzymes including Phenolase, Ascorpic acid oxidase and Cytochrom oxidase consequently it increased the plant growth (Al-Sahaf, 1989). The bilateral interaction between iron and copper affected the trait significantly. The treatment of 60 mg.l^{-1} iron with 40 mg.l^{-1} copper produced the highest seedling height averaged 94.00 cm compared with untreated seedlings giving the lowest seedling height averaged 71.33 cm.

Table 2: Seedling height (cm).

Copper (mg.l^{-1}) Iron (mg.l^{-1})	**0**	**20**	**40**	**mean**
0	71.33	74.33	76.67	74.11
30	79.33	83.00	86.33	82.89
60	86.33	94.00	94.00	89.89
mean	79.00	82.22	85.67	
L.S.D	Iron	Copper	Interaction	
0.05	0.522	0.522	0.905	

Stem diameter

Table 3 shows that the Fe treatment affected the stem diameter mean where the treatment of 60mg.l^{-1} recorded the highest average of the stem diameter reached 6.46 cm while the seedling of the control treatment recorded the lowest stem diameter reached 4.89 cm. The reason of the effect may be due to the iron participates in several biological processes within a plant such as synthesis of amino acids, proteins, and enzymes enhancing the cell division and elongation thus increasing the plant tissues resulting in increasing the calcium layer activity that the stem diameter is increased as a results of its division (Al-Sahaf, 1989). These results are consistent with those found by Kabota (2005), AL-Kabe, (2006), Khudhair (2012)and Khudhair & Al-Musawi (2014). It also observed in table 3 significant differences in the stem diameter affected by the different Cu concentrations. The seedlings treated by 40 mg.l^{-1}

produced the highest stem diameter of 50.90 cm compared to the control that produced a stem of 5.30 cm in diameter. The stem diameter increase may be attributed to the copper activating effect on the vegetative growth involving the plant height table 2 in addition to its effect on the electron translocation during the light reaction as well as it participates in constructing several enzymes such Phenolase, Ascorpic acid oxidase, and Cytochrom oxidase (Al-Sahaf, 1989). The table also refers to a significant effect of the interaction between the factors on the stem diameter. The treatment of the interaction between 60mg.l^{-1} Fe and 40mg.l^{-1} Cu gave the highest stem diameter averaged 6.93 cm compared with untreated seedlings that gave average of stem diameter 4.81 cm.

Table 3: Stem diameter (mm).

Copper (mg.l^{-1}) Iron (mg.l^{-1})	0	20	40	mean
0	4.81	4.86	5.00	4.89
30	5.30	5.49	5.78	5.52
60	5.78	6.68	6.93	6.46
mean	5.30	5.68	5.90	
L.S.D	Iron	Copper	Interaction	
0.05	0.047	0.047	0.082	

Number of leaves (leaves. seedling^{-1})

Table 4 demonstrates the significant effect of spraying Fe on the number of leaves per seedling. The treatment of spraying 60 mg.l^{-1} produced the highest number of leaves averaged 154.8 leaves.seedling^{-1} while untreated seedlings produced the lowest number of leaves averaged 106.90 leaves.seedling^{-1}. Cu also affected the number of leaves significantly. The seedling treated with 40 mg.l^{-1} achieved the highest average of the trait (143.00 leaves.seedling^{-1}) compared to the lowest number of leaves (120.00 leaves.seedling^{-1}) recorded by the control treatment. The effect of the study factors on increasing the number of leaves may be attributed to the role of Fe and Cu in involving in biological processes going on inside which increases the plant activity of performing the carbon assimilation resulting in increasing the number of leaves (Popov, 1978 and Devlin *et al.*, 1993). The bilateral interaction between Fe and Cu did not affect the trait significantly.

Table 4: Number of leaves (leaves. seedling^{-1}).

Copper (mg.l^{-1}) Iron (mg.l^{-1})	0	20	40	mean
0	95.30	106.70	118.70	106.90
30	125.00	132.70	139.70	132.47
60	139.70	151.70	173.00	154.80
mean	120.00	130.37	143.80	
L.S.D	Iron	Copper	Interaction	
0.05	5.570	5.570	N.S.	

Leaf area

Results listed in table 5 showed significant differences among Fe concentrations in the leaf area. The concentration of 60 mg.l^{-1} produced the highest average of the leaf area reached 4246.33cm^2.seedling^{-1} compared to the lowest leaf area (1392.33 cm^2.seedling^{-1}) produced by the control treatment. The increase in the leaf area may be due to the important iron role within the plant where 80% of the total iron content is found in the chloroplasts indicating the iron necessity for the carbon assimilation as well as the important role played by which in forming cytochromes necessary for the photosynthesis and respiration (Taiz & Zeiger, 2010). These results are consistent with the findings of AL-Kabe, (2006). The results referred to by the table also illustrated a significant effect of Cu on leaf area the treatment of 40 mg.l^{-1} Cu was superior recording the leaf area averaged 3452.33 cm^2.seedling^{-1}, while the control treatment the lowest leaf area reached 2178.33 cm^2.seedling^{-1}. The cause of increasing the leaf area may be due to Cu important role in the electron transmission process during the light reaction related to the carbon assimilation process; moreover, Cu participates in constructing several enzymes including Lactase, Phenolase, Ascorbic acid, oxidase, and Cytochrom oxidase (Al-Sahaf, 1989). Concerning the interaction between Fe and Cu concentrations, it affected significantly on the leaf area. The treatment of 60 mg.l^{-1} with 40mg.l^{-1} gave the highest leaf area averaged 5296.00 cm^2.seedling^{-1} while untreated seedlings gave the lowest leaf area averaged 1094.00 cm^2.seedling^{-1}.

Table 5: Leaf area (cm^2).

Copper (mg.l^{-1}) Iron (mg.l^{-1})	0	20	40	mean
0	1094.00	1357.00	1726.00	1392.33
30	2087.00	2563.00	3335.00	2661.67
60	3354.00	4089.00	5296.00	4246.33
mean	2178.33	2669.67	3452.33	
L.S.D	Iron	Copper	Interaction	
0.05	136.500	136.500	236.400	

Total chlorophyll content in leaves (SPAD)

Table 6 refers that the chlorophyll content in the leaves was increased significantly to 47.16 SPAD affected by the treatment of spraying 60mg.l^{-1} Fe compared to the control treatment that produced a low chlorophyll content in the leaves averaged 40.34 SPAD. This is due to Fe role in increasing the chlorophyll and protein contents in the chloroplast leading to enhancing the photosynthesis; despite it does not participate in constructing the chlorophyll molecule, as well as Fe helps to cell wall protein formation (Focus, 2003). It found that 80% of the total Fe is located in the chloroplast (Taiz & Zeiger, 2010). These results are in agreement with those found by AL-Kabe, (2006), Khudhair (2012) and Khudair & Al-Musawi (2014). Spraying Cu also affected the content of the chlorophyll in the leaves significantly. The highest values averaged 45.21 SPAD was obtained from spraying 40mg.l^{-1} Cu on the seedling compared to 42.42 SPAD recorded by the control treatment. This increased chlorophyll content in the leaves may be due to Cu role in electron translocation during the light reactions as well as Cu participates in constructing many enzymes including Lactase, Ascorbic acid, oxidase and Cytochrom oxidase (Al-Sahaf, 1989). The interaction between Fe and Cu did not affect the total chlorophyll content in the leaves significantly.

Table 6: Leaf chlorophyll content (SPAD).

Copper (mg.l^{-1}) Iron (mg.l^{-1})	0	20	40	mean
0	38.74	40.67	41.60	40.34
30	42.70	44.37	45.40	44.16
60	45.83	47.03	48.63	47.16
mean	42.42	44.02	45.21	
L.S.D	Iron	Copper	Interaction	
0.05	0.482	0.482	N.S.	

Relative moisture content in leaves (%)

It is evident in Table that Fe significantly affected the relative moisture content in the apricot leaves. The treatment of 60mg.l^{-1} was superior in the trait recording the highest relative moisture content averaged 72.91% while the lowest average of the trait (45.05%) recorded by the control treatment. Cu also affected significantly the content of the relative moisture in the leaves where the highest average of the relative moisture content (67.77%) obtained from the treatment of 40mg.l^{-1} compared to the control treatment characterized by the lowest relative moisture content (60.41%). The table also demonstrates a significant effect of the interaction between the two factors represented by the treatment of 60 mg.l^{-1} with 40 mg.l^{-1} that gave the highest content of the relative moisture reached 77.78% while the control treatment gave the lowest relative moisture content (51.54%).

Table 7: Relative leaf moisture content (%).

Copper (mg.l^{-1}) Iron (mg.l^{-1})	0	20	40	mean
0	51.54	53.72	56.89	54.05
30	61.05	63.58	68.64	64.42
60	68.64	72.30	77.78	72.91
mean	60.41	63.20	67.77	
L.S.D	Iron	Copper	Interaction	
0.05	0.835	0.835	1.446	

Iron concentration in leaves

Results in table 8 refers that spraying Fe affected the trait significantly. Treatment of 60 mg.l^{-1} increased the iron concentration in the leaves to 64.50 mg.l^{-1} compared to the control treatment of seedlings where the iron concentration in leaves was only 54.79 mg.l^{-1}. The increment of the iron concentrations in the leaves attributed to effect of the added Fe on the vegetative growth and consequently increasing the absorption of Fe to meet the plant need as it participates in the processes of chlorophyll synthesis and in increasing number of grana in the chloroplast; furthermore, it contributes to protein construction (Guller and Krucka, 1993). These were consistent with those found by Kabota (2005), AL-Kabe, (2006) and Khudhair & Al-Musawi (2014). The table referred also to a significant effect of Cu on the trait. The concentration of 40mg.l^{-1} gave the highest iron concentration in the leaves averaged 62.11 mg.l^{-1} while the Cu untreated seedlings gave the lowest iron concentration averaged 57.24mg.l^{-1}. The effect of the bilateral interaction between the two factors did not reach the significance rank.

Table 8: Iron concentration in the leaves (mg.l^{-1}).

Copper (mg.l^{-1}) Iron (mg.l^{-1})	0	20	40	mean
0	52.40	54.54	57.42	54.79
30	57.82	60.18	61.38	59.79
60	61.51	64.46	67.53	64.50
mean	57.24	59.73	62.11	
L.S.D	Iron	Copper	Interaction	
0.05	0.780	0.780	N.S.	

Shoot system dry weight (g.seedling^{-1})

Table 9 shows significant differences among the effect of Fe concentrations on the dry weight of the seedling shoot system compared to the control treatment. Treating the seedlings with 60mg.l^{-1} produced the highest average of the dry weight (14.20 g.seedling^{-1}) while

Table 9: Shoot dry weight (g.seedling^{-1}).

Copper (mg.l^{-1}) Iron (mg.l^{-1})	0	20	40	mean
0	8.98	9.59	10.29	9.62
30	10.71	11.70	12.31	11.57
60	12.35	13.76	16.48	14.20
mean	10.68	11.68	13.03	
L.S.D	Iron	Copper	Interaction	
0.05	0.475	0.475	0.823	

untreated seedlings produced the lowest dry weight (9.62 g.seedling^{-1}) these results go in line with the results obtained by Kabota (2005), AL-Kabe, (2006), Khudhair (2012). It also found a significant effect of C u on the trait. The seedlings treated by 40mg.l^{-1} Cu maximized the shoot dry weight to 13.03g.seedling^{-1} on average, whereas the control treatment minimized the average to 10.68g.seedling^{-1}. The reason behind Fe and Cu role in the plant growth may be due to their contribution to the biological activities such as the light reaction that increases the plant efficiency for absorbing nutrients leading to increasing the growth indicators including the seedling height, stem diameter, number of leaves, and leaf area tables 2, 3, 4 and 5 which are positively coincide with the increase in the shoot system size table 9. The interaction between the two factors showed a significant effect on the shoot dry weight. The treatment of 60mgl^{-1} Fe with 40mg.l^{-1} Cu produced the highest average of the trait (16.48 g.seedling^{-1}) compared to the untreated seedlings that produced the lowest average of shoot dry weight (8.98 g.seedling^{-1}).

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