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USING FOLIAR APPLICATION OF Fe AND GA_3 TO IMPROVE GROWTH OF TWO OLIVE CV. (*Olea europaea*) TRANSPLANTS

Sarfaraz F. A. Al-Bamarny [a], * and Amira S. Abdulrahman [a]

[a] Dept. of Horticulture, college of Agriculture, University of Duhok, Iraq - (Sarfarazfatah@yahoo.com)

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ABSTRACT:
This investigation was carried out in the lath house of the nursery of Malta station/ Duhok. Kurdistan region, Iraq. During the growing season of 2017, to study the effect of the different concentrations of Fe (0, 10 and 20 mg L^{-1}) and GA_3 (0, 500 and 1000 mg L^{-1}) on vegetative growth, roots length and leaves nutrients content of one-year-old of two olive cultivars (Nebali and Bashike) transplantings. The results appeared that Nebali cultivar significantly dominated in stem length(cm), stem diameter (mm), branch length (cm), leaves number, root length (cm), N (%), K (%), P (%) and Fe (mg L^{-1}), Baeshike cultivar dominate in leaf area(cm2), stem length(cm), shoot root ratio, root length(cm) and K (%) were significantly increased with increase GA_3 to 1000 mg L^{-1}. Foliar application of GA_3 at 500 mg L^{-1} significantly increased branch length (cm) and P (%). When the transplants treated with 10 mg L^{-1} Fe significantly effect on the Fe % content but spray transplants with the Fe at 20 mg L^{-1} had significantly affected on stem diameter (mm), leaves number root length (cm) and N (%). Most of the interactions (cultivar × Fe and cultivar × GA_3) showed significant effects on the most studied characteristics.

KEYWORDS: Olive cultivars, Fe, GA_3, Growth characters.

1. INTRODUCTION

Olive (*Olea europaea* L.) has been known as ‘‘the fragrance of the soft gold’’ due to its high economic, social and cultural values. Nowadays, olive is the most extensively cultivated oleiferous tree species in the world, covering an area of 10 million of hectares (Yang *et al*., 2007).
Iron plays an important role in the activation of chlorophyll and in the synthesis of many heme proteins such as different cytochrome, which participate in different functions in the plant metabolism (Bhandari and Randhawa, 1985). Fe and Cu play key roles in several enzyme systems that contribute vital function in overall plant metabolisms (Romheld and Marschner, 1991). The olive tree requires small amounts of boron, iron zinc, manganese, copper and molybdenum. A deficiency in any of these elements can reduce growth and fruiting in the olive (Kailis and Harris, 2007). Iron is an essential micronutrient for almost all living organisms because of it plays critical role in metabolic processes such as DNA synthesis, respiration, and photosynthesis. Further, many metabolic pathways are activated by iron, and it is a prosthetic group constituent of many enzymes. An imbalance between the solubility of iron in soil and the demand for iron by the plant are the primary causes of iron chlorosis (Gyana and Sunita, 2015). Iron is the third most limiting nutrient for plant growth and metabolism, primarily due to the low solubility of the oxidized ferric form an aerobic environments (Zuo and Zhang, 2011 and Samaranayke *et al*., 2012). Iron is involved in chlorophyll synthesis, and it is essential for the maintenance of chloroplast structure and function (Schmidt, 1993). Typically, approximately 80% of iron is found in photosynthetic cells where it is essential for the biosynthesis of cytochromes and other heme molecules, including chlorophyll, the electron transport system, and the construction of Fe-S clusters (Hansch and Mendel, 2009). Iron plays many essential roles in plant growth and development, including chlorophyll synthesis, thylakoid synthesis and chloroplast development. Iron is required at several steps in the biosynthetic pathways (Marschner, 1995).
Iron deficiency is one of the major abiotic stresses affecting fruit tree crops in the Mediterranean area. One of the most obvious characteristics of the plants affected by Fe deficiency is that their leaves become chlorotic (Morales *et al*., 1994). El-Kassas *et al*., (1987) mentioned that mandarin seedlings when spraying by Fe at 250 mg L^{-1} led to increase of stem diameter. Shayal Alalam (2013) showed that the interaction between 2 ml.L^{-1} kelpak40 + 20 mg Fe.L^{-1} of loquat seedlings significantly dominated in leaves number, seedling leaves area and leaves dry weight percentage.
Gibberellins is the second group of plant hormones that were discovered after auxins, biologically effective in stimulating cell division or elongation or both, they also have a role in the phenomenon of genetic dwarfism of plants and their influence in the process of formation of flowers and parthenocarpic fruits and the removal of seed dormancy and buds (Al-Khafaji, 2014).
GAs stimulates stem elongation by promoting cell elongation and cell division (Taiz and Zeiger, 2002). Gibberellins, especially gibberellic acid (GA_3) play an important role in the growth and development of plants. Gibberellins are classified as diverse group of plant hormones that enhance some physiological or biochemical pathways in plants. The use of GA_3 for boosting the growth and vigor of various horticultural plants is very old known and well documented (Gul *et al*., 2006).
Gibberellins promote seed germination, stimulate stem elongation, leaf expansion, flowering, pollen and seed development and delay fruit ripening (Rosenvasser and Friedman, 2006). GA is responsible for cell elongation, rather than cell division (Francis and Sorrell, 2001). Al-Abbassy (2009) found that foliar spray with GA_3 at 100 mg L^{-1} caused

* Corresponding author

significant increase in height and diameter of the main stem, total chlorophyll in leaves and nitrogen and phosphorus percentage in apricot leaves. Hassan *et al*., (2010) recorded that, highest content of leaves N, K, Fe and Zn was in the plum trees treated with Aminofert at 0.25% + GA_3 at 20mg L^{-1}. Shayal Alalam (2009) noted that the peach trees when treated with 50 mg L^{-1} GA_3 caused significant increase in leaves P concentration, leaves number, trees leaf area and main stem diameter. Soest (2012) Found that the spray apple trees with gibberellic acid at 20mg L^{-1} gave the highest leaf N, P, K and chlorophyll content. Al-Mousawi, (2013) Found that foliar spray with Gibberellic acid at 500mg L^{-1} caused significant increase in length and diameter of the main stem, number of branches, leaves area, total chlorophyll in leaves and nitrogen, phosphorus, potassium and carbohydrates percentage in olive leaves. The main objective of this investigation, comparison between the response for two (*Olea europaea* L.) cultivars and improve the growth of both cultivars with add different concentration of Fe and GA_3.

2. MATERIALS AND METHODS

This investigation was carried out in lath house at the nursery of the Malta station/ Duhok, Kurdistan region, Iraq. The investigation conducted on two olive cv. (Nebali and Bashike) transplants grown in boxes during 2017 season. The olive transplants were one year old. The study included two factors, first spray with Fe or GA_3 were 5 treatments as follow:
1- Foliar sprays with distilled water only (control treatment for both Fe and GA_3).
2- Spray with10 mg L^{-1} Fe
3- Spray with Fe at 20 mg L^{-1}
4- Spray with GA_3 at 500 mg L^{-1}
5- Spray with GA_3 at 1000 mg L^{-1}
The second factor included two olive cultivates. Transplanting were sprayed with above concentration three times15 march, 15 April and 15 May 2017, with three levels of Fe (0, 10 and 20 mg L^{-1}), and three levels of GA_3 (0, 500 and 1000 mg L^{-1}), Foliar sprays were applied using a hand pressure sprayer.
The results were analyzed statistically and the comparison were made using Duncan'multiple range test at 5% probability (Al-Rawi and Khalaf-Allah, 1980). All the data were tabulated and statistically analyzed with computer using (SAS system, 2000).
The Measurements or parameters were:
1-Stem length (cm): It was measured at the end of investigation 10 November, 2017 using the measuring tape.
2- Stem diameter (mm): It was measured at 5cm above soil surface using hand Vernier.
3- Branches length per Transplant (cm): The length of branches was calculated at the end of investigation.
4- Leaves number: The Leaves number was calculated at the end of field measurements.
5 - Leaf area (cm^2): The average leaf area was determined by gravimetric method according to Drovnic *et al*., (1965).
6- Shoot / Root Ratio: This ratio was determined by weighting the shoots and roots of three transplants randomly chosen from each treatment (Goss, 1973).
7. Root length (cm): The root length was calculated at the end of field measurements.
8-Mineral Nutrient Contents of the Leaves:
a.) Macronutrient at content in plant includes the following elements (N.P.K).
1-Nitrogen (%): It was determined by the Microkjelhdahl method.
2-Phosphorus (%): It was determined by colorimetric method using Spectrophotometer pharmacia LKB method.
3- Potassium (%): It was determined by the Flame photometer.
b.) Micronutrient content Fe (mg L^{-1}): The concentration was determined using Atomic absorption Spectrophotometer.

3. RESULTS AND DISCUSSION

3.1 Interaction effect of cultivars and spraying with Fe and GA_3on some vegetative growth characters:

3.1.1 Stem Length (cm): Results in table (1) showed that transplants of Nebali cultivar had significantly higher stem length compared with the Baeshike cultivar. The transplants treated with 1000 mg L^{-1} GA_3 gave highest stem length, On the other hand the interaction between cultivars and concentration notice that the Baeshike transplants treated with 1000 mg L^{-1} GA_3 showed maximum stem length which had significant effect with all other interaction treatment Nebali cultivar sprayed with same concentration of GA_3. The increased in stem length with GA_3 treatment was due to the role of this hormone in increasing nutrient absorption, causing cell multiplication and cell elongation in the cambium tissue of intermodal region therefore increased length of the transplanting (Shanmugavelu, 1966). The results are also agreed with results of Harshavardhan and Rajasekhar (2012) for jackfruit and Vasantha *et al*., (2014) in tamarind. These results compatible with other studies performed by Steven, (1994) and Al-Kafaji and Muslat, (1995) who mentioned that the increase in growth of treated plants attributed to growth improvement of GA_3 treated plants to the influence of GA_3 on cell wall and cell cytoplasm. They found that GA_3 highly increased cell size and cell number which finally reflected on tissue size, and they referred that Osmotic of cell solution to the impact of GA_3 on mRNA transcriptions was responsible for enzyme synthesis, especially those involved in chlorophyll synthesis.

3.1.2 Stem Diameter (mm): Table 1 showed that the nebali cultivar has the highest value of stem diameter when the transplants sprayed with the Fe at 20 mg L^{-1} as compared with the other concentrations of Fe and GA_3. This result may be due to effect of iron fertilizer on accelerating metabolism reactions as well as stimulating enzymes (Yousefzadeh and Sabaghnia, 2016). Fe is a cofactor approximately for more than hundred enzymes that catalyze physiological processes (Brittenham, 1994).

3.1.3 Branch length (cm): The branches length was significantly influenced by cultivars. Nebali transplants branches length was longer than Baeshike cultivar. Transplant treated with 500 mg L^{-1} GA_3 gave a significant value (table 1), about the interaction between cultivar and concentration the Nebali cultivar treated with 500 mg L^{-1}. GA_3 recorded the highest significant value compared with other interaction treatments. El-Shenawy (2005) found that GA_3 or KNO_3 treatments either alone or combined with inflorescences thinning stimulated tree growth of mango cv. Kiett. The gibberellic acid may lead to increase side buds open in many plant species, which produce branches and leaves, as well as that GA_3 retards aging and fallen leaves, leading to increase the number of remaining leaves on the trees until the end of the season (Al-Khafaji, 2014).

3.1.4 Leaves number: No significant difference was noticed between the two cultivars. Foliar spray of 500 mg L^{-1} GA_3 significantly increased leaves number in comparison with the untreated transplants. The highest leaves number was recorded for Baeshike cultivar treated with 500 mgL^{-1} GA_3. It might be due to activity of GA_3 at the apical meristem resulting in more synthesis of nucleoprotein responsible for increasing leaf initiation and leaf area (Sen and Ghunti, 1976). It may be also due to GA_3 which induced vigorous growth by more number of branches which expose to sunshine by the plants to produce more number of leaves. This is in line with the results of Shaban (2010) in mango and Anjanaw *et al*., (2013) in papaya.

Table 1. Effects of Foliar Spray of Fe and GA_3 on some vegetative growth characters of two Olive cv. (*Olea europaea*) transplants.

Cultivar	Parameters: Stem length (cm)	Stem diameter (mm)	Branch length (cm)	Leaves number (leaf/ transplant)
Baeshike	63.47 b	9.20 b	35.27 b	319.73 a
Nebali	68.40 a	9.69 a	36.07 a	302.73 a
(mg L^{-1})	Concentration			
Control 0	49.33 d	6.52 d	25.50 d	166.00 d
Fe 10	63.17 c	10.19 b	37.83 b	236.67 c
Fe 20	67.67 b	11.75 a	38.33 b	393.17 a
GA3 500	66.50 b	8.39 d	40.67 a	422.83 a
GA31000	83.00 a	10.37 c	36.00 c	337.50 b
(mg L^{-1})	Cultivar × Concentration			
B* × Control 0	53.33 e	6.37 ed	24.67 e	190.33 ef
B* × Fe 10	63.33 c	9.38 c	37.67 c	258.00 d
B* × Fe 20	57.67 d	10.18 bc	41.67 b	348.33 bc
B* × GA3 500	58.67 d	9.38 c	34.00 d	447.00 a
B* × GA31000	84.33 a	10.31bc	38.33 c	355.00 bc
N** × Control 0	45.33 f	6.30e	26.33 e	141.67 f
N** × Fe 10	63.00 c	11 b	38.00 c	215.33 de
N** × Fe 20	77.67 b	13.32a	35.00 d	438.00 a
N** × GA3 500	74.33 b	7.39 d	47.33 a	398.67 ab
N**×GA31000	81.67 a	10.34 b	33.67 d	320.00 c

Means for each character separately (the same column) for both factors and their interactions having the same letter or letters are not different significantly according to Duncan's multiple range test at 5% level. B*: mean Baeshike; N**: mean Nebali

3.1.5 Leaf area (Cm^2): Table 2 notice that the transplants of Baeshike cultivar had significantly higher leaf area than transplants of Nebali cultivar. The transplant when treated with 1000 mg L^{-1}GA_3 significantly had a large leaf area. For the interaction between the cultivar and concentration recorded that Baeshike cultivars transplants that treated with the 1000 mg L $^{-1}$ GA_3 gave highest significant value in comparing with the other interaction treatments.

3.1.6 Shoot -root ratio: Table (2) showed that significant differences in shoot root ratio between the cultivars show that Baeshike cultivar significantly increased when compared with Nebali transplant. The transplants when treated with the 1000 mg L^{-1} GA_3 gave the higher value (14.82) when compared with other concentration. The Baeshike cultivar when treated with the 1000 mg L^{-1} GA_3 had superior average shoot root ratio compared with the other concentration. The increase of shoot root ratio was closely correlated with the change in activities of sugar metabolizing enzymes induced by GA application (Ramezani and Shekafandeh, 2009). The improvement occurred in shoot root ratio in transplanting due to supplying transplants with GA_3 could be attributed to its role in increasing cell elongation (Abd El-Moneim *et al*., 2007). Marschner (1986) indicated that application of GA_3 on higher plants caused elongation in the primary cells of young tissues and growth centers. The present results may be attributed to simulative influence of this bio-regulator on cell extension and cell division.

3.2 Interaction effect of cultivars and spraying with Fe and GA_3 on root length (cm): Baeshike cultivar significantly had higher root length compared with root length of Nebali transplant. The root length increased when sprayed with the GA_3 at 1000 mg L^{-1} and no significant with the transplanted treated with the 20 mg L^{-1} Fe and 500 mg L^{-1} GA_3. The interaction between the cultivars and concentrations showed that the Baeshike cultivar when treated with the 20 mg L^{-1} Fe gave the highest significant value in comparison with the other Interaction treatments. This could be due to the iron role as an important component of proteins in cells, events such as respiration and cell division (Zocchi *et al*., 2007).

Table 2. effects of foliar spray of Fe and GA_3 on some growth characters of two Olive cv. (*Olea europaea*) transplants.

Cultivar	Parameters: Leaf area (cm^2)	Shoot- root ratio	Root length (cm)
Baeshike	11.62 a	2.15 a	33.27 a
Nebali	9.65 b	1.87 b	28.60 b
(mg L^{-1})	Concentration		
Control 0	5.35 e	1.62 d	21.67 c
Fe 10	13.20 b	1.93 c	31.17 b
Fe 20	9.28 d	1.76 d	34.83 a
GA_3 500	10.52 c	2.29 b	33.33 ab
GA_3 1000	14.82 a	2.45 a	33.67 a
(mg L^{-1})	Cultivar × Concentration		
B × Control 0	4.40 f	1.68 ef	25.67 f
B × Fe 10	14.48 b	2.49 b	35.67 bc
B × Fe 20	9.90 d	1.66 ef	39.33 a
B × GA_3 500	12.19 c	2.08 c	34.33 b-d
B × $GA_3$1000	17.15 a	2.84 a	31.33 de
N** × Control 0	6.30 e	1.55 fg	17.67 g
N** × Fe 10	11.93 c	1.36 g	26.67 f
N **× Fe 20	8.67 d	1.86 de	30.33 e
N **× GA_3 500	8.85 d	2.49 b	32.33 c-e
N **× $GA_3$1000	12.49 b	2.06 cd	36.00 b

Means for each character separately (the same column) for both factors and their interactions having the same letter or letters are not different significantly according to Duncan's multiple range test at 5% level. B*: mean Baeshike; N**: mean Nebali.

3.3 Interaction effect of cultivars and spraying with Fe and GA_3 on nutrients elements:

Table 3 shows Nitrogen, Potassium and phosphor percentage in leaves was significantly influenced by cultivars. Nebali cultivar leaves had significantly more concentration of NPK than the leaves of Baeshike cultivar while there was no significant difference between the two cultivars in leaf iron content. The transplant when treated with the 20 mg L^{-1} Fe gave highest nitrogen value when compared with other concentration (1.6%), while when the transplants treated with 1000 mg L^{-1} GA_3 gave the highest value of potassium when compare with other concentrations. the transplants treated with at 500 mg L^{-1} GA_3 gave the highest percent of phosphor (0.103%) when compare to other treatments. On other hand the transplants when treated with the Fe at 10 mg L^{-1} gave the highest value of Fe content in leaves (143.53). The interaction between the cultivars and concentration notice that the Baeshike cultivar treated with GA_3 at 1000 mg L^{-1} gave the highest percentage of (N, K and P%) while the Nebali cultivar when treated with Fe at 10 mg L^{-1} gave the highest value (154.83 mg L^{-1}) when compared with the other concentrations. That's back to the role of gibberellic acid in the division and cell elongation (Gindia, 2003), which may lead to increased absorption of some nutrients from the soil, including nitrogen potassium concentrations in leaves. Generally, these results are in harmony with those reported by (Desouky, 2016) on olive trees, (Al-Abbassy, 2009 and Al-Hamadany, 2009) when they worked on apricot trees. However, Homo brass inolide, increased nitrogen fixation and enhance soluble protein content and photosynthesis (Clouse and Sasse, 1996).

Table 3. Effects of foliar spray of Fe and GA_3 on the leaves minerals content from elements (N,P and K%) and Fe (mg L^{-1}) of two Olive cv. (*Olea europaea*) transplants.

Cultivar	Parameters			
	Leaves N (%)	Leaves K (%)	Leaves P (%)	Leaves Fe (mg L^{-1})
Baeshike	1.30 b	1.01 b	0.090 b	120.94 a
Nebali	1.55 a	1.04 a	0.100 a	118.96 a
(mg L^{-1})	**Concentration**			
Control 0	1.34 d	0.80 c	0.081 c	90.38 e
Fe 10	1.27 e	1.01 b	0.086 c	143.53 a
Fe 20	1.60 a	1.06 b	0.093 b	135.53 b
GA_3 500	1.39 c	1.01 b	0.103 a	106.72 d
$GA_3$1000	1.53 b	1.23 a	0.093 ab	123.58 c
(mg L^{-1})	**Cultivar × Concentration**			
B* × Control 0	4.40 f	0.75 g	0.080 d	109.77 d
B* × Fe 10	14.48 b	0.94 e	0.083 cd	132.23 c
B* × Fe 20	9.90 d	1.10 b	0.090 cd	126.83 c
B *× GA_3 500	12.19 c	1.02 cd	0.093 bc	130.43 c
B *× $GA_3$1000	17.15 a	1.24 a	0.107 a	105.43 d
N** ×Control 0	6.30 e	0.86 f	0.083 cd	71.00 f
N **× Fe 10	11.93 c	1.08 bc	0.093 bc	154.83 a
N × Fe 20	8.67 d	1.03 cd	0.103 a	144.23 b
N** × GA_3 500	8.85 d	1.01 de	0.100 ab	83.00 e
N**× $GA_3$1000	12.49 c	1.22 a	0.100 ab	141.73 b

Means for each character separately (the same column) for both factors and their interactions having the same letter or letters are not different significantly according to Duncan's multiple range test at 5% level. B*: mean Baeshike; N**: mean Nebali

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