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Improvement of Fruit Yield and Quality by Iron Chelates Addition

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ARTICLE INFO	ABSTRACT
<p>Article No.: 1202131008 DOI: 10.15580/GJAS.2014.4.1202131008</p> <hr/> <p>Submitted: 02/12/2013 Accepted: 27/05/2014 Published: 04/06/2014</p> <hr/> <p>*Corresponding Author Gharbi Hajji Hasna E-mail: hasnagharbi2010@gmail.com Phone: +00216 95306380</p> <hr/> <p>Keywords: <i>Prunus persica</i>, peaches, yield, fruit quality</p>	<p>A field study was carried out to evaluate the effects of supplying iron chelates on fruit yield and quality of two peach varieties (<i>Elegant lady</i> and <i>Carnival</i>) in Tunisian area. Results showed that EDDHA-Fe improved fruit quality parameters for both varieties and 20 and 40 g/tree doses enhanced significantly the total sugar rate (°Brix) of juice in the <i>Elegant Lady</i> variety. However, iron chelates increased the weight of five fruits and firmness by 20, 40 and 60 g/trees the both varieties. Fruit diameter and growth of peaches were improved by the EDDHA-Fe addition. Nevertheless, no significant differences were observed between the different treatments.</p>

ABBREVIATION: DAFB: Days After Full Bloom

1. INTRODUCTION

The major of Mediterranean areas have calcareous soil with high pH (Marra et al., 2013) and peach trees (*Prunus persica* L. Batsch) are very susceptible to lime induced chlorosis when growing in these grounds (Callot et al., 1982; Pestana et al., 2002).

Therefore, many active lime tolerant genotypes are used as peach rootstocks. However, genotypes currently available are too vigorous and less attractive (Donnini et al., 2009) and the ordinary peach rootstocks tends to develop lime-induced Fe chlorosis and to reduce the cropping efficiency (Marra et al., 2013). In fact, both fruit yield and quality could be decreased and losses could be marked (Alvarez-Fernández et al., 2007; Abadia et al., 2011).

The iron chelates addition is stilling the most effective solution for iron assimilation enhancement and Fe chlorosis correction (Nadal et al., 2013). Further iron chelates represent a source of Fe and thus widely used to control the problem (Sánchez-alcalá et al., 2012). Many forms of iron chelates are commercialized: leaves sprayers, trunk implants or soil

applied chelates. The applied soil chelates are the most common and effective for the iron deficiency correction in plants (Hernández-Apaolaza et al., 1997) and the EDDHA-Fe (ferric ethylenediamine-N, N'-bis (hydroxylphenyl acetate) is considered as the most used and the most stable in calcareous soils (Alvarez-Fernández et al., 2005).

The current experiment was planned with the following objective: studying the efficacy of EDDHA-Fe at supplying iron to *Elegant Lady* and *Carnival* peach varieties on yield and fruit quality.

2. MATERIALS AND METHODS

2.1 Experimental location

The test orchard was established at 2006-2007 in the region of M'hammdia (delegation of Ben Arous located in the North of Tunisia). Physical and chemical characteristics of the studied soils (Soil I and soil II are respectively corresponding to the *Elegant Lady* the *Carnival* varieties) are represented on the Table 1.

Table 1: Soil characterization of the two studied orchards

	Soil I			Soil II		
	0-20 cm	20-40 cm	40-60 cm	0-20 cm	20-40 cm	40-60 cm
% Argile	47,62	47,17	42,02	49,75	59,17	46,30
% Silt	49,70	50,00	54,93	48,45	37,98	50,64
% Sand	2,68	2,83	3,05	1,80	2,85	3,06
pH	8	7,9	8	8,00	8,00	7,90
CE (milli-simens/cm)	2,20	4,8	5,5	1,40	3,10	4,90
Total lime (%)	25,37	30,10	31,39	26,23	26,66	25,37
Active lime (%)	10,5	7	8,5	11,00	13,50	10,50
C _{org} (%)	0,88	0,92	0,8	0,36	0,76	1,04
OM (%)	1,52	1,59	1,38	0,62	1,31	1,79
N _{total} (‰)	2,91	2,35	1,96	2,80	2,24	1,96
C/N _{total}	30,26	39,17	40,84	12,88	33,95	53,09

2.2 Plant material and iron chelates application

In this experimentation, two ten years old varieties of peach were considered: *Elegant Lady* (seasonal variety) and *Carnival* (latest variety). All peach trees were grafted on the GF677 rootstock and were made to received all necessary treatments and irrigation.

Three blocs and four iron chelates treatments (T0, T1, T2 and T3) corresponding to 0, 20, 40 and 60 g/plant were applied in soil, near dripper. The considered iron chelate was a commercial water soluble granules of EDDHA-Fe (séquestrène) containing 7% of soluble Fe, 6.2% of chelated Fe (3.4% of Fe chelated with a [o,o]-EDDHA, 2.2% of Fe chelated with [o,p]-EDDHA. Three replications were considered for each treatment and represented as an elementary unit with four lines and four plants/lines. Each treatment was divided to five applications. The first application was in full bloom (FB) (100% flowers). The others were between fruit set and fruit harvest because of high roots activity in this period witch

coincides with spring flow and the last application was ten days before harvest.

2.3 Fruits quality determination

The fruit diameter monitoring was realized once per 15 days using a caliper.

Fruit quality parameters: weight of five fruits, flesh firmness, weight and volume of juice, total sugar rate and titratable acidity and pH were carefully measured after harvest and transport to the laboratory. Five peaches were weighted and mean of three replicates was calculated. The flesh firmness was determined by a penetrometre. After that the volume of peaches juice was weighted and the total sugar rate was established by a refractometre. pH and titratable acidity were calculated using a pH- meter and titration of the malic acid respectively.

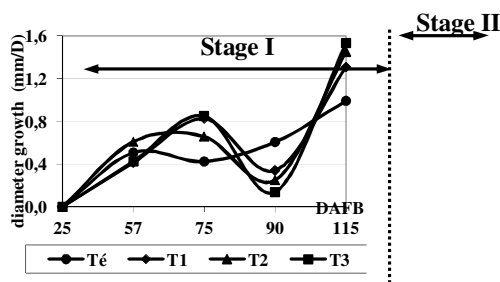
2.4 Data analysis

All data were statistically analyzed using the STATITCF software (version5) except the parameters of quality which were analyzed with the SAS software. A 95% interval of confidence was considered for all analysis. Unless otherwise indicated the term "significant" refers to significance level lower than 0.05.

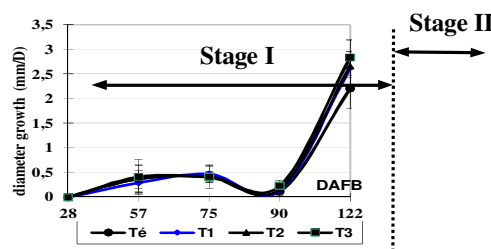
3. RESULTS

3.1 The EDDHA-Fe chelates effects on peach fruits growth

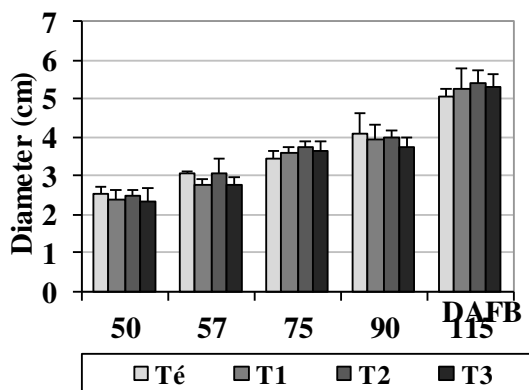
Monitoring the peaches diameter showed that peaches growth rate could be drawn on sigmoid curve for both studied varieties (Graph.1 and Graph.2).



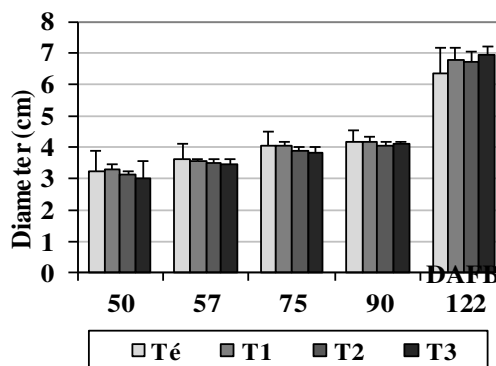
Graph.1 : Curve growth rate of *Elegant Lady* peaches



Graph.2 : Curve growth rate of *Carnival* peaches



Graph.3: Fruit diameter of *Elegant Lady* peaches



Graph.4: Fruit diameter of *Carnival* peaches

Stage I: from 25 to 57 DAFB (days after full bloom) and from 28 to 75 DAFB for *Elegant Lady* and *Carnival* respectively. Iron chelates supplying at 20 g/tree and 60 g/tree improved fruit growing for *Elegant Lady* variety but no statistically significance were observed between treatments for both varieties.

Stage II: From 58 to 115 DAFB and from 76 to 122 DAFB for *Elegant Lady* and *Carnival* respectively. In addition, results showed that fruits diameters were improved by iron chelates application for the two varieties (Graph.3 and Graph.4). At harvest, the average diameter of the *Elegant Lady* peaches reached 5.43 cm, 5.30 cm and 5.08 cm for peach trees have been supplied with T2, T3 treatments and the

reference no treated respectively. For the *Carnival* variety, peaches diameter reached 7.17 cm, 6.93 cm, 6.72 cm and 6.34 cm for the T1, T3, T2 treatments and the no treated trees respectively for *Carnival*. However, no significant differences were showed for both varieties.

3.2 EDDHA-Fe chelates effects on peaches quality parameters

According to the Table 2 and the Table 3 the applied soil chelates improved significantly the total sugar rate in *Elegant Lady* peaches and decreased significantly the peaches acidity for *Carnival* peaches. In fact, iron chelates increases the weight of five fruits 34.3%, 33%

and 27.33% by 60, 40 and 20 g/tree doses respectively in the *Elegant Lady* variety and 9.3% and 2.5% with 20 and 40 g/tree respectively in *Carnival* variety. In addition, the flesh firmness of *Elegant Lady* and *Carnival* peaches was better with T2 and T3 and with T1 and T3 respectively. The weight and the volume of juice of the *Elegant Lady* peaches were also enhanced by iron chelates addition but no significant effect was showed. Then, the Total soluble solids was highly improved in the *Elegant Lady* peaches which

have receiving the 20 and 60 g/tree doses. The acidity of juice was significantly decreased in the *Carnival* peaches by 20 and 40 g of iron chelates addition. In addition, no significant effects of treatments on the pH of juice were observed. These results confirm those demonstrated by Alvarez-Fernández et al. (2007) who demonstrated that iron chelates in EDDHA-Fe form improved fruit quality parameters in citrus but they haven't found any significant differences between treated and no treated fruit trees.

Table 2: Physical and chemical characteristics of the *Elegant Lady* peaches

Doses of iron chelates (g/plant)	0	20	40	60
Weight of Five peaches (g)	632.39	870.28	943.43	962.68
Flesh firmness (Kg/0.5cm ²)	3.93	3.83	4.09	4.11
Weight of juice of five peaches(g)	164.64	249.58	285.68	272.18
Volume of juice of five peaches (ml)	140.30	200.14	300.12	300.10
Total soluble solids (°brix)	11.07 ^d	13.73 ^a	12.50 ^c	13.10 ^b
pH	3.77	4.20	4.37	4.20
Acidity (%)	0.13 ^b	0.16 ^a	0.15 ^a	0.13 ^b

Means followed by different letters along the line are significantly different at 95% interval of confidence.

Table 3: Physical and chemical characteristics of the *Carnival* peaches

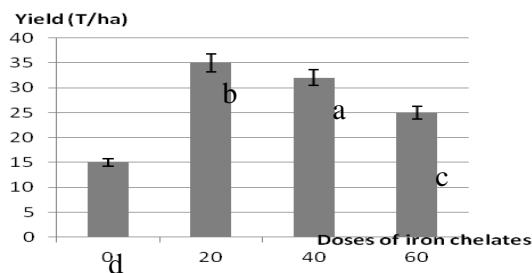
Doses of iron chelates (g/plant)	0	20	40	60
Mean weight of five peaches (g)	1018.21 ^{ab}	1112.65 ^a	1042.82 ^{ab}	961.52 ^b
Flesh firmness (Kg/0.5cm ²)	2.15	2.75	2.15	2.98
Weight of juice of five peaches(g)	385.24	368.34	424.38	314.20
Volume of juice (ml)	350	360	300	400
Total soluble solids (°brix)	13.50 ^a	12 ^c	13 ^b	10.33 ^d
pH	3.70	3.80	3.90	3.80
Acidity (%)	0.16 ^a	0.13 ^b	0.12 ^c	0.13 ^b

Means followed by different letters along the line are significantly different at 95% interval of confidence.

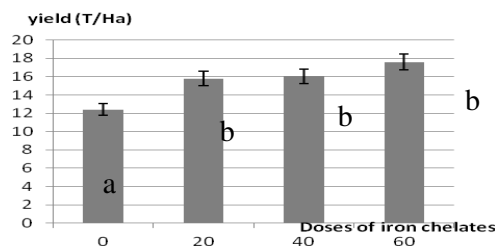
3.3 EDDHA-Fe chelates effect on peaches yield production

Supplying the Fe (III) at the EDDHA-Fe form increased significantly yield for both seasonal and latest varieties. In fact, yield represented a significant increase with 233%, 213% and 166% by 20g, 40g and 60g of iron chelates addition for the *Elegant Lady*

variety) in comparison the yield of control peach trees and 20g/plant was the most effective dose. In addition, the yield production was improved 28% and 30% by application of doses 20 g and 40 g and 60 g/tree respectively and a significant difference was observed between different treatments and the reference no treated for the *Carnival* variety (Graph 5 and Graph 6).



Graph.5: The effect of iron chelates on yield of the *Elegant Lady* variety



Graph.6: The effect of iron chelates on yield of the *Carnival* variety

4. DISCUSSION

The curve growth rate of all treatments peaches showed two major stages which represents cellular division and nutriment storage and fruit maturity phases respectively. These results confirm those represented by Génard *et al.* (1991) who exhibited that peaches growth is determinate according to a descriptive growth model with 2 phases. The supplement of EDDHA-Fe improved fruits growth rate at the second phase with the 60 and 40 g/plant doses on *Elegant lady* variety but there were no significant differences inter-treatments. In fact, iron proteins represents an important metabolic process in plants especially photosynthesis, respiration, nitrogen metabolism and sulfur metabolism, (Briat et Vert, 2004)

Concerning the peaches diameter, the lack of significance could be attributed to his phenotypic character managed by the genome and excess on iron chelates addition EDDHA-Fe form (60 g/tree) have no effect on fruit growth diameter for *Carnival* variety. Yield losses were corrected by EDDHA-Fe application for both varieties.

5. CONCLUSION

Results showed that iron chelates in EDDHA-Fe form may be recommended for peach trees in order to correct iron deficiency and to improve yield productivity of peach trees in Mediterranean regions characterized by calcareous soil with high pH and high active loam rate.

Studies must be concentrated on stage II of the peaches growth and especially for seasonal variety to evaluate biochemical and physiological responses of fruits to iron chelates at that period.

More attention must be attributed to doses of application because excessive use of chelates can't be effective on peach productivity but it can cause residues in soil and fruits which contribute to environment and human contamination.

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