Greener Journal of Agricultural Sciences
ISSN: 2276-7770; ICV: 6.15
Vol. 4 (5), pp. 205-210, June 2014

http://gjournals.org/GJAS

Research Article (DOI: http://dx.doi.org/10.15580/GJAS.2014.5.112713987)

Enhancement of Peach Leaves Mineral Contents in Response to Iron-Chelates Addition

Gharbi Hajji Hasna* and Sanaa Mustapha

Agronomic Institute of Agriculture, Laboratory of Soil and Environment Sciences, 43, Av. Charles Nicolle, 1082, Tunis, Tunisia.

ARTICLE INFO

Article No.: *112713987*
DOI: *10.15580/GJAS.2014.5.112713987*

Submitted: *27/11/2013*
Accepted: *18/06/2014*
Published: *26/06/2014*

****Corresponding Author***
Gharbi Hajji Hasna
E-mail: *hasnagharbi2010@gmail.com*
Phone: *+00216 95306380*

Keywords:
Prunus persica, iron chlorosis, foliar diagnosis.best dates for foliar diagnosis for Elegant Lady and Carnival respectively

ABSTRACT

Mineral peach leaves contents were investigated for three periods to assess the response of peach trees to iron chelates in EDDHA-Fe form addition. Two peach varieties: *Elegant Lady* and *Carnival* were considered and received four treatments of iron chelates (Tc, T1, T2 and T3 corresponding on 0, 20, 40 and 60 grams (g) of chelates/tree). Results showed that iron chelates improved significantly nitrogen assimilation by plants and T2 and T1 were the most effective for *Elegant Lady* and *Carnival* respectively. In addition, iron chelates decreased foliar potassium and magnesium which indicated an iron deficiency correction. However, iron mobilisation through leaves was improved at 60 and 90 Days After Full Bloom (DAFB) for *Elegant Lady*. So, 60 and 90 DAFB are recommended as the best dates for foliar diagnosis for *Elegant Lady* and *Carnival* respectively.

1. INTRODUCTION

Peach (*Prunus persica* L. batsch) is the third cultivated fruit tree in world (Mamouni, 2006). However, iron chlorosis resulting to iron deficiency at its active form in soil, is the major problem affecting peach nutrition in Mediterranean region with calcareous soil, high pH etc. . In fact, iron solubilisation depends on many soil factors (texture, pH, active lime, % of organic matter) (Guardia et *al.*, 1995; Hansen et *al.*, 2007; Rombolà and Tagliavini, 2007). In order to correct iron deficiency, farmers use available rootstocks (Ryser and Heller, 2006) and supply synthetic iron chelates. Thus, the soil application of iron chelates is considered as the most oil application of iron chelates and is considered the most common and the most effective method (Hernàndez-Apaolalza et *al.*, 1997). In addition, iron deficiency affects peach nutrition. In fact, iron has physiological functions in plants: respiration, nitrates reduction and photosynthesis (Perez and Mong, 1995). Ryser and Heller (2006) demonstrated that chlorophyll synthesis is the principal function of iron. In this way, we investigated to correct iron chlorosis on two peach trees. In this way, we investigate to show the mineral correction and evolution on leaves in response to iron chelates addition. Then, three dates for foliar diagnosis were considered (60, 90 and 120 Days After Full Bloom (DAFB)) to determine Nitrogen, Phosphor, Potassium, Calium, Magnesium and Iron (N, P, K, Ca, Mg and Fe) foliar contents.

2. MATERIAL AND METHODS

2.1 Field characteristics

Experience was conducted during the 2006 and 2007 companies in an irrigated orchard in the North of Tunisia. Experimental situ belongs in a semi-arid climate and is characterised by a calcareous soil with 12% of active lime, high pH value (=8) and a low rate of organic matter.

2.2 Plant material

Ten years old peach trees varieties *Elegant Lady* (seasonal variety) and *Carnival* (latest variety) grafted on the GF-677 rootstock and planted in a Tunisian calcareous soil were considered. For both varieties, the experience was a randomized block with three blocks (repetitions). For each block four treatments of iron chelates on the ethylenediamine-N, N'-bis (2-hydroxyphenylacetic acid-Fe (EDDHA-Fe) form (Tcontrol, T1, T2 and T3 corresponding to 0, 20, 40 and 60 g/tree respectively) were applied on the soil. For each repetition of the treatments four lines with four trees each (16 similar trees in total) were considered. Doses of iron chelates were applied on soil near root zone five times during the vegetative period. The first application was added at full bloom (100% flower) and the others were effected between fruit training stage and a week to ten days before harvest.

2.3 Foliar diagnosis and analysis

Leaves sampling were defected in three replicates at 60, 90 and 120 DAFB. Each sample represents 80 leaves. Leaves were selected then conducted to the laboratory, washed with distilled water, dried at 65°C until weight stabilisation and crushed. The collected dry matter was stored for ulterior uses. One g of dray matter (DM) was calcined at 450°C and the ash was extracted with Nitric Acid (1N) solution to determine P, K, Ca, Mg and Fe concentrations. Indeed, phosphorus was determined by a spectrophotometer according to the Olsen method as enounced by Pawels et al. (1992). Potassium and calcium were determined by a flame spectrophotometer (Pawels et *al.*, 1992). Magnesium and iron were determined by atomic spectrophotometer as enounced by (Pawels et *al.* (1992).

The rate of total nitrogen was calculated after digestion, distillation and acid titration of a 0.1g of dry matter according to the kjeldhal method enounced by (Pawels et *al.* (1992).

3. DATA ANALYSES

Results were statistically treated using the STATITCF software with the Fisher test “F” in a 95% confidence interval.

4. RESULTS AND DISCUSSION

4.1 Mineral Leaves Evolution for Elegant Lady Peach Trees

The evolution of elemental contents on leaves of *Elegant Lady* variety and corresponding to the different treatments is represented by Table1.

Table 1 : Total Nitrogen, Phosphorus, Potassium, Calcium, Magnesium and Iron levels evolution on leaves corresponding to *Elegant Lady* variety (Tcontrol= 0 grams, T1=20 grams, T2=40 grams and T3= 60 grams of iron chelates)

	DAFB	Treatments			
		Tcontrol	**T1**	**T2**	**T3**
totalN (mg/g)	**60**	3.02 ± 0.00 **bc**	3.20± 0.26 **b**	3.81± 0.13 **a**	3.15± 0.35 **b**
	90	2.83± 0.00 **bc**	3.00± 0.09 **bc**	3.12 ± 0.14 **b**	3.19 ± 0.23 **b**
	120	2.91± 0.00 **bc**	2.90± 0.04 **bc**	2.81± 0.14 **bc**	2.59± 0.28 **c**
P (mg/g)	**60**	0.20 ± 0.00	0.20 ± 0.05	0.22 ± 0.02	0.21± 0.01
	90	0.20 ± 0.00	0.19 ± 0.02	0.18 ± 0.02	0.18 ± 0.01
	120	0.18 ± 0.00	0.19 ± 0.01	0.19 ± 0.01	0.14 ± 0.01
K (mg/g)	**60**	2.4 ± 0.00 **d**	2.63 ± 0.06 **cd**	2.73 ± 0.31 **cd**	2.27 ± 0.47 **d**
	90	3.9 ± 0.00 **a**	3.1 ± 0.36 **bc**	3.37 ± 0.12 **ab**	3.47 ± 0.31 **ab**
	120	3.3 ± 0.00 **ab**	3.4 ± 0.1 **ab**	3.42 ± 0.24 **ab**	3.37 ± 0.31 **ab**
Ca (mg/g)	**60**	3.00 ± 0.00 **a**	2.27 ± 0.12 **c**	2.30 ± 0.10 **c**	2.70 ± 0.12 **b**
	90	1.60 ± 0.00 **d**	1.50 ± 0.20 **d**	1.50 ± 0.10 **d**	1.57 ± 0.15 **d**
	120	1.50 ± 0.00 **d**	1.37 ± 0.26 **d**	1.27 ± 0.12 **d**	1.37 ± 0.23 **d**
Mg (mg/g)	**60**	0.68 ± 0.00	0.58 ± 0.04	0.50 ± 0.07	0.62 ± 0.09
	90	0.56 ± 0.00	0.48 ± 0.03	0.50 ± 0.03	0.47 ± 0.04
	120	0.78 ± 0.00	0.60 ± 0.06	0.57 ± 0.03	0.65 ± 0.07
Fe (mg/kg)	**60**	236.30 ± 0.00 **a**	143.83 ± 11.54 **bc**	162.33 ± 43.33 **b**	147.37 ± 18.37 **bc**
	90	211.30 ± 0.00 **a**	124.53 ± 9.08 **bc**	106.93 ± 1.46 **c**	134.70 ± 23.22 **bc**
	120	164.20 ± 0.00 **b**	123.40 ± 1.87 **bc**	131.67 ± 16.25**bc**	140.93 ± 35.45 **bc**

Averages in the same row's table and which are not followed by the same letter are significantly different with at the risck of 5% (test of Newman and Keuls).

4.1.1 Nitrogen evolution

At 60 DAFB, chelates in EDDHA-Fe form contributed with roots on nitrogen assimilation through soil solution and leaves corresponding to treatment T2 (40 g/tree) showed the highest concentration of nitrogen in their tissues (3.81 %). In addition, between 90 and 120 DAFB, nitrogen mobilization from leaves to fruits was improved by EDDHA-Fe addition, and T2 and T3 (40 and 60 g/tree respectively) were the most effective at this period.

4.1.2 Phosphorus evolution

At 60 DAFB, T2 enhanced phosphor uptake by plants more than T3 and the respective concentrations were 0.22% and 0.20%. The lower phosphor concentration resulting from higher iron chelates doses could be attributed to the antagonist effect of iron on soluble phosphorus on soil solution as was demonstrated by Hansen et *al*. (2007). In fact, they showed that excess of micro-elements (Zn, Mn, Cu or Fe) inhibits the phosphorus's liberation.

4.1.3 Potassium evolution

Between 90 and 120 DAFB, foliar potassium concentration were very excessive but it decreased on leaves corresponding to treated trees more than on leaves corresponding to the no treated peach trees and T1 (20 g/tree) was the most effective treatment. Indeed, excess of potassium in leaves indicates an iron deficient situation which was corrected by iron supplement on EDDHA-Fe form. These results confirm those enounced by Larbi, (2003) and Mahmoudi et *al*. (2005) which proved that chlorotic leaves store potassium in their tissues as a response to an iron deficit.

4.1.4 Calcium evolution

Leaves calcium concentration were significantly decreased, between 60 and 90 DAFB, for both treated and no treated trees as a response of higher levels of potassium at this period. In fact, a negative interaction between potassium and calcium was observed by Larbi et al. (2003) and Garcia-Hernàndez et al. (2006) in iron deficient leaves. This is why K/Ca ratio increased for most treatments and during vegetative cycle. In fact, it passes from 0.7-1.3 to 2-2.3 at this period. Addition of 20 g/tree was most effective at the end and no significant differences were observed.

4.1.5 Magnesium evolution

Magnesium contents on leaves was lower in treated trees than no treated one through all foliar diagnosis dates and treatment T2 was the most effective at the end of the vegetative cycle because it caused a lower foliar magnesium level (0.57%). But no significant differences were observed. Nevertheless, higher levels of foliar magnesium contents observed in leaves corresponding at non treated peach trees (0.68% at 60DAFB and 0.78% at 120DAFB) indicate a chlorotics situation of these trees as was demonstrated by Pissaloux et al. (1995).

4.1.6 Iron evolution

At 60 and 90 DAFB, leaves corresponding to the reference peach trees represent a significant high iron concentration (236.3% and 211.3% respectively) which contrasts with the iron deficiency definition. This phenomenon named *iron paradox* was defined as physiological inactive iron storage on nervures of chlorotics leaves (Alvarado et *al*., 1995).

4.2 Mineral Leaves Evolution for Carnival Peach Trees

Evolution of mineral contents on leaves of *Carnival* variety and corresponding to different treatments are summarized on Table 2.

Table 2: Total Nitrogen, Phosphorus, Potassium, Calcium, Magnesium and Iron levels evolution on leaves corresponding to *Carnival* variety (Tcontrol= 0 grams, T1=20 grams, T2=40 grams and T3= 60 grams of iron chelates)

	JAPF	Traitements			
		Tcontrol	**T1**	**T2**	**T3**
totalN (mg/g)	**60**	3.25 ± 0.00 **bc**	3.76 ± 0.11 **a**	3.22 ± 0.06 **bcd**	3.48 ±0.42**ab**
	90	2.80 ± 0.00 **def**	2.98 ± 0.12 **cde**	3.04 ± 0.17 **cde**	3.03 ± 0.06 **cde**
	120	2.55 ± 0.00 **fg**	2.86 ± 0.10 **cdef**	2.74 ± 0.03 **ef**	2.37 ± 0.30 **g**
P (mg/g)	**60**	0.21 ± 0.00	0.21 ± 0.01	0.23 ± 0.01	0.21 ± 0.02
	90	0.22 ± 0.00	0.20 ± 0.02	0.23 ± 0.04	0.20 ± 0.02
	120	0.17 ± 0.00	0.16 ± 0.01	0.20 ± 0.03	0.21 ± 0,03
K (mg/g)	**60**	2.40 ± 0.00 **d**	2.73 ± 0.21 **c**	2.93 ± 0.12 **c**	2.87 ± 0.12 **c**
	90	3.50 ± 0.00 **ab**	3.83 ± 0.15 **a**	3.70 ± 0.17 **ab**	3.70 ± 0.26**ab**
	120	3.60 ± 0.00 **ab**	3.30 ± 0.35 **b**	3.30 ± 0.00 **b**	3.40 ± 0.00 **b**
Ca (mg/g)	**60**	3.80 ± 0.00 **a**	3.07 ± 0.23 **c**	3.07 ± 0.25 **c**	3.43 ± 0.21 **b**
	90	1.60 ± 0.00 **d**	1.70 ± 0.00 **d**	1.67 ± 0.06 **d**	1.63 ± 0.06 **d**
	120	1.80 ± 0.00 **d**	1.53 ± 0.06 **d**	1.63 ± 0.15 **d**	1.67 ± 0.06 **d**
Mg (mg/g)	**60**	0.63 ± 0.00	0.53 ± 0.03	0.56 ± 0.03	0.60 ± 0.02
	90	0.62 ± 0.00	0.51 ± 0.04	0.44 ± 0.02	0.52 ± 0.14
	120	0.70 ± 0.00	0.64 ± 0.03	0.61 ± 0.06	0.63 ± 0.01
Fe (mg/kg)	**60**	142.20 ± 0.00 **b**	141.93 ± 4.80 **b**	227.43 ± 65.26 **a**	139.70 ± 9.92 **b**
	90	106.60 ± 0.00 **b**	114.53 ± 15.93 **b**	98.77 ± 6.08 **b**	122.43 ± 17.84**b**
	120	128.04 ± 0.00 **b**	126.73 ± 20.48 **b**	129.33 ± 11.49 **b**	142.27 ± 28,95**b**

Averages in the same row's table and which are not followed by the same letter are significantly different with at the risck of 5% (test of Newman and Keuls).

4.2.1 Nitrogen evolution

At 60 DAFB, iron chelates addition improved Nitrogen assimilation and highest foliar concentration was 3.76% N for leaves corresponding to treatment T1. However, between 90 and 120 DAFB, treatment T3 (40 g/tree) was the most effective with 3.48% N (a value near the norm proposed by (Gautier, 1975) and it enhances nitrogen mobilization from leaves to others parts of the plant and especially fruits.

4.2.2 Phosphorus evolution

Leaves corresponding to treatment T1 showed an important decrease on phosphorus between 60 and 120 DAFB (from 0.21% P to 0.16% P). Nevertheless, no significant differences were observed between the different treatment with iron chelates and the control plants that are no treated.

4.2.3 Potassium evolution

Foliar potassium contents decreased between 90 and 120 DAFB by iron supplement and the best effect was observed in leaves corresponding to treatment T1 which caused a significant decrease at this period (from 3.83% K to 3.3% K) indicating a good mobilization of the element through plants. But no significant differences were observed at this period between all iron treatments.

4.2.4 Calcium evolution

At 60 DAFB, calcium levels were lower in leaves corresponding to iron treatments than in leaves corresponding to the reference. This variation may be attributed to calcium migration to fruits at this period knowing that soil was sufficient on calcium at this stage.

4.2.5 Magnesium evolution

There were no significant differences between all treatments for foliar magnesium concentration but leaves of non treated peach trees showed the highest level of magnesium.

4.2.6 Iron evolution

Iron assimilation and mobilization was improved by iron chelate application as soon as the case of the seasonal variety. This result confirm those demonstrated by Huang et *al*. (2012) which showed that Fe-EDDHA application significantly increased Fe nutrition in iron deficiency citrus trees. Actually, assimilation was better with T3 at 90 DAFB (122.43% Fe) and with T1 at 120 DAFB (126.73 % Fe) and no significant differences were distinguished. Yet, increase of foliar iron between 90 and 120 DAFB can be an analytic symptom of iron deficiency appearance at this time.

5. CONCLUSION

Results showed that iron-chelates on the EDDHA-Fe form improved significantly the assimilation of some elements such as N, K, Ca and Fe, through soil solution and their mobilization through peach tissues, for both varieties. Best results were observed on the *Elegant Lady* variety. This may be due to shortness of the vegetative cycle of the seasonal variety in comparison with the latest one which did not benefit from the first application. So, timing of the iron-chelates application was very approached for *Elegant Lady* than *Carnival* variety.

We noted that excess of iron did not contribute to mineral assimilation especially for the seasonal variety.

60 DAFB and 90 DAFB are recommended as the best time for foliar diagnosis for *Elegant Lady* and *Carnival* respectively.

Foliar diagnosis must not be considered for iron deficiency revealing because of *iron paradox phenomenon* and choice of foliar diagnosis date which depends on many factors such as climate variation.

REFERENCES

Alvarado JJ, Velenzuela JL, Sàbchez A and Romera L (1995). Iron nutrition in wild plants growing in two different soils 141-145. In J. Abadia (eds). Iron Nutrition in Soils and Plants. Kluwer Academic Publishers, printed in Netherlands.

Garcia-Hernàndez JL, Cepeda D, Valdez R, Bernardo MA, Alfredo F, Morales B, Francisco H, Ruiz E, Arnoldo FH and Ebrique TD (2006). Preliminary compositional nutrient diagnosis norms in *Aloa vera* L. grown on calcareous soil in an arid environment, Environmental and Experimental Botany. 58 :244-252.

Gautier M (1975). Sept années de contrôle de nutrition par diagnostic foliaire dans les vergers du Loir-et-Cher. L'arboriculture fruitière; N°257/258; 21-29.

Guardia MD, Felipe A, Alcantara AE, Fournier JM and Romera FJ (1995). Evaluation of experimental peach rootstocks grown in nutrient solutions for tolerance to iron stress. In: J. Abadia (eds), Iron Nutrition in Soils and plants. Kluwer Academic Publishers, Netherlands. 201-205.

Hansen NC, Hopkins BG, Ellsworth JW and Jolley VD (2007). Iron nutrition in field crops. In: Larry L. Barton and J. Abadia (eds). Iron Nutrition in plants and rhizospheric microorganisms, Springer. 23-59.

Huang H, Hu CX, Tan Q, Hu X, Sun X and Bi L (2012). Effects of Fe-EDDHA application on iron chlorosis of citrus trees and comparison of evaluations on nutrient balance with three approaches. Scientia Horticulturae. 146:137-142.

Hernàndez-Apaolaza L, Barak P and Lucena JJ (1997). Chromatographic determination of commercial Fe(III) chelates of ethylendiaminetetracetic acid, ethylenediaminedi (*o*-hydroxyphenylacetic) acid and ethylenediaminedi (*o*-hydroxy-*p*-methylphenylacetic) acid, Journal of chromatography 789:453-460.

Larbi A (2003). Clorosis férrica requestas de las plantas y méthdos de correction, High school of agronom ingeneer of Saragosse, Thesis, 359p.

Larbi A, Morales F, Abadia J and Abadia A (2003). Effects of branch solid Fe sulphate implants on xylem sap composition in field-grown peach and pear: changes in Fe, organic anions and pH, journal of plant physiology, 160: 1473-1481.

Mahmoudi H, Ksouri R, Gharsalli M and Lachâal M (2005). Differences in reponses to iron deficiency between two legumes: lentil (*Lens culinaris*) and chickpea (*Ciser arietiinum*), Journal of plant physiology; 1237-1245.

Mamouni A (2006). Le pêcher : une culture de diversification. Programme national de transfert de technologie en agriculture, Rabat, Bul.138.

Pawels J, Van RE, Verloo M and Mvondo AZE (1992). Méthodes d'analyse de sols et de plantes, équipement, gestion de stocks de verrerie et de produits chimiques, Manuel de laboratoire de pédologie, République du Cameroun, Royaume de Belgique.

Pérez C, Val J and Monge E (1995). Effects of iron deficiency on photosynthetic structures in peach (*Prunus persica* L.Batsch) leaves 183-189. In: J. Abadia (eds), Iron Nutrition in Soils and Plants, Kluwer Academic Publishers, Netherlands.

Pissaloux A, Morard P and Bertoui G (1995). Alkalinity-Bicarbonate-Calcium effects on chlorosis in White lupine in soiless culture. In: J. Abadia (eds), Iron Nutrition in Soils and Plants, Kluwer Academic Publishers, Netherlands. 127-133.

Rombolà AD and Tagliavini M (2007). Iron nutrition of fruit tree crops, in: L.L. Barton et J. Abadia (eds). Iron nutrition in plants and rhizospheric microorganisms. Springer.

Ryser and Heller (2006). La chlorose ferrique en arboriculture (web site).

Cite this Article: Gharbi HH, Sanaa M, 2014. Enhancement of Peach Leaves Mineral Contents in Response to Iron-Chelates Addition. Greener Journal of Agricultural Sciences. 4(5):205-210, http://dx.doi.org/10.15580/GJAS.2014.5.112713987.