Article

Seasonal variation of the foliar concentration of nutrients in fig orchards under intensive production systems

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Abstract

In order to investigate the fluctuation in the foliar concentration of nutrients during the growing season, a study was carried out in four fig orchards with intensive production systems, in the Comarca Lagunera, Durango, Mexico. A soil characterization was carried out, as well as monthly sampling and analysis, from April to October, of N, P, K, Ca, Mg, Fe, Cu, Mn, Zn and Ni. With respect to the foliar concentration of nutrients, in most cases they did not show significant differences between orchards, within each sampling date. The foliar concentration of N, Mg and Zn was highest at the beginning of the cycle (April-May) and then decreased during the cycle. On the other hand, the concentration of P, Ca, Cu and Ni showed a lower concentration at the beginning than at the end of the cycle, while K, Fe and Mn did not obtain a definite trend during the season. All the nutrients were within the levels of sufficiency reported in the literature, with the exception of Ca and Mg which were lower, despite which they did not show symptoms of deficiency. It was concluded that this species shows large seasonal variations during the cycle, in most of the nutrients; therefore, it is recommended that the sampling of leaves for nutrimental diagnostic purposes be made in June, in the period between the end of the harvest of brevas and before fruit harvest, which was when there was less variability among orchards.

Keywords: *Ficus carica* L., foliar sampling, intensive production, sufficiency ranges.

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Introduction

The fig tree (*Ficus carica* L.) is native to Central Asia, from where it was taken to the Mediterranean and from there to the American continent (Pereira *et al*., 2015). The fig tree adapts to a wide variety of soils, it is tolerant to salinity and drought; its best yields are obtained in areas with dry and warm climate in summer and with cool and humid winter, making it a typical crop of arid zones (El-Shazly *et al*., 2014). Turkey and Egypt occupy the first and second place, with 300 000 and 168 000 t year^{-1}, respectively, while Mexico occupies the 19th place, with a production of 7 000 t year^{-1}, in an area of 1 340 ha located mainly in the states of Morelos and Baja California Sur, which gives a yield of 5.2 t ha^{-1} (FAO, 2018; SIAP, 2018).

In the Lagunera District of Durango there is a total of 22 hectares of fig trees, with technified production systems; they have pressurized irrigation, macro tunnel type plastic covers to prevent cold damage during winter, high densities of plantation (2 500 trees ha^{-1}) and annual pruning and green to keep the crown of the tree compact.

The fig tree is considered a marginal crop, with low nutritional requirements (CONABIO, 2018); however, studies such as that of Brown (1994) shows that foliar concentration of essential nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu), manganese (Mn) and zinc (Zn), present changes throughout the growth cycle; for example, in trees of high vigor, the concentration of N decreased from 2.3 to 1.5%, that of P from 0.14 to 0.09% and K from 1.4 to 0.7% from May to October (from flowering to postharvest), while the concentration of B increased from 65 to 125 and that of Mn from 80 to 150 mg kg^{-1} in the same period.

In pecan tree (*Carya illinoensis*, Wangenh, Koch), which is also a deciduous fruit species, the concentration of N, K, Ca, Mg, sulfur (S), boron (B) and Fe increased during the development of the leaves, while the concentration of Mg and Zn decreased during the formation of cotyledons (Kim and Wetzstein, 2005). The above, emphasizes the importance of knowing the variation in the concentration of nutrients in the orchards with technified systems of fig production in this region, the former as a support to define reference values of nutrients and times of foliar sampling.

The objective of the present work was to evaluate the fluctuation in the concentration of the essential nutrients N, P, K, Ca, Mg, Fe, Mn, Cu, Zn and nickel (Ni), during the annual growth cycle, in four orchards with technified systems of fig production. The hypothesis was that the concentration of nutrients does not differ significantly between orchards and therefore preliminary reference values can be generated from the data set of all orchards.

Materials and methods

Four orchards were selected in the municipality of Gomez Palacio, Durango, which were in their fourth year of growth; they were planted at the beginning of 2012 and began to produce in 2014. The orchards are: 1) Vergel-1, in macro tunnel with plastic cover in winter; 2) Vergel-2, without plastic cover; 3) Transportes, under greenhouse with plastic all year round; and 4) Dinamita, without plastic cover. The purpose of the chat cover is to prevent damage by cold in winter.

The four locations are between the coordinates 25° 65’ 48” and 25° 77’ 12” North latitude and between 103° 46’ 71” and 103° 50’ 11” West longitude.

The trees are planted at 2 x 2 m, for a density of 2 500 plants ha^{-1}, the crown of the trees is kept compact by annual pruning and pruning in green. They have a micro-sprinkler irrigation system and an average irrigation sheet of 95 cm was applied in the year. At the beginning of the cycle, 1 to 2 kg tree^{-1} of compost was applied based on dairy cattle manure and no conventional chemical fertilizers were applied. In each garden three tunnels were taken as repetitions and within each repetition six trees were selected as experimental unit, the trees were selected taking as criterion the average trunk circumference of 16 cm, measured at 20 cm above ground level.

To characterize some physical and chemical properties of the soil, in April 2015 a soil sample was taken in each of the selected trees by repetition the sample was taken within the drip area of the tree crown, at a distance of 30 cm of the trunk and alternating the position with respect to the trunk. Then, with the samples of each repetition, a composite sample was made; the sampling depths were 0-30, 30-60 and 60-90 cm.

The samples were taken to the Laboratory of Soil Analysis of the Experimental Field La Laguna, of the INIFAP, for its physical and chemical characterization. The analyzes were carried out in accordance with the protocols of NOM-O21-SEMARNAT-2000 (SEMARNAT, 2001). Although there are differences between orchards with respect to the percentages of sand and clay, the soil of the four orchards corresponds to the textural class of clay, with more than 45% of clay and less than 32% of sand in the three depths (Table 1).

Table 1. Physical-chemical characterization of the soil of the fig orchards selected in the study.

Orchard	Depth	Silt	Sand	Clay	pH	CE	MO	N inorg.	P Olsen	K
	(cm)	(%)	(%)	(%)		(mS cm^{-1})	(%)	(mg kg^{-1})		(Cmol$^{(+)}$ kg^{-1})
Dinamita	0-30	25.3	28.4	46.3	7.6	3	1.52	126.1	41.3	2.5
	30-60	24.9	28.7	46.5	7.8	2		80.4	26.1	2.4
	60-90	22.3	32.4	44.3	7.9	1.5		65.7	14.6	2.2
Transportes	0-30	20.9	20.4	58.7	7.8	2.2	1.3	62.5	6.4	2.1
	30-60	20.2	17.3	62.4	7.7	3.6		42.5	3	1.5
	60-90	20.8	21.7	55.4	7.6	3.2		51.5	4.5	1
Vergel-1	0-30	24.6	24.2	47.5	7.9	5.1	1.86	35.2	18.4	3.1
	30-60	26	23.9	49.7	7.8	5.6		33.6	6.4	3.2
	60-90	24	26.6	47.1	7.9	5		30.5	7.6	2.9
Vergel-2	0-30	27.4	24.7	48.4	7.9	3.8	1.5	24.7	8.6	2.4
	30-60	29	18.5	53	8.1	4.8		30.5	9	3.1
	60-90	28.1	22.7	45.9	8	5.2		22.6	6.4	4

Table 1. Physical-chemical characterization of the soil of the fig orchards selected in the study (continuation).

Orchard	Depth	Ca	Mg	Fe	Cu	Mn	Zn
	(cm)	Cmol$^{(+)}$ kg^{-1}		(mg kg^{-1})			
Dinamita	0-30	13.1	4.1	1.01	0.49	11.43	0.21
	30-60	16.3	4.3	0.69	0.07	8.52	0.18
	60-90	18	4.2	0.89	0.06	4.75	0.12
Transportes	0-30	15	5.2	0.95	0.28	7.54	0.15
	30-60	26.4	4.5	0.78	0.3	3.83	0.13
	60-90	8.6	3.8	0.65	0.27	1.86	0.11
Vergel 1	0-30	28.9	4.7	0.25	0.4	8.63	0.26
	30-60	13.5	4.8	0.46	0.38	2.19	0.13
	60-90	13.4	4.3	0.21	0.44	1.54	0.13
Vergel 2	0-30	19.9	4.2	0.56	0.34	4.99	0.21
	30-60	15	4.4	0.48	0.38	2.64	0.15
	60-90	10.6	4.5	0.41	0.36	0.68	0.12

The pH values are in the range of 7.6 and 8.1, which correspond to moderately alkaline soils, typical of calcareous soils of arid zones. With respect to salinity, the CE in the Huerta Vergel-1 was the highest, with values of 5.0 to 5.6 dS m^{-1}, which is why it is classified as saline soil. In the other orchards the CE fluctuated from 2.2 to 3.8 dS m^{-1} in the 0-30 cm layer (Table 1), values considered as moderately saline (SEMARNAT, 2000). Organic matter (OM) was only analyzed in the 0-30 cm stratum, considering that it is where the differences are manifested when applying compost.

OM values varied from 1.3 to 1.86% among orchards (Table 1); According to NOM-021-SEMARNAT-2000, values of 1.5% or less are classified low in OM, while above 1.5% are medium in OM. The concentration of inorganic N in the soil was higher in the Dinamita orchard, with an average of 90 mg kg^{-1}, throughout the profile (0-90 cm), followed by Transport, Vergel-1 and Vergel-2, with values of 52, 33 and 26 mg kg^{-1}, respectively; the values in Dinamita and Transport are classified as very high, while those in Vergel-1 and Vergel-2 are considered average values (SEMARNAT, 2000). With respect to P, the Dinamita orchard had the highest values, with 27.3 mg kg^{-1} on average from 0 to 90 cm, followed by Vergel-1, Vergel-2 and Transport with averages of 10.8, 8 and 4.6 mg kg^{-1}, respectively.

P values in soil greater than 11 mg kg^{-1} are considered high, while values lower than 5.5 mg kg^{-1} are considered low (SEMARNAT, 2000). The concentration of K was high (>0.6 Cmol$^{(+)}$ kg^{-1}) in all orchards and throughout the profile. The Ca had a high concentration (>10 Cmol$^{(+)}$ kg^{-1}) in all cases, except in the Transport garden at 60-90 cm, where it reached an average value of 8.6 Cmol(+) kg^{-1}. Similarly, the Mg had an average of 4.4 (±0.4) Cmol$^{(+)}$ kg^{-1}, also considered as high (SEMARNAT, 2000).

The concentrations of Fe and Zn in the entire profile of the four orchards were classified as deficient, with less than 2.5 Cmol$^{(+)}$ kg^{-1} of Fe and less than 0.5 Cmol$^{(+)}$ kg^{-1} of Zn (NOM-021-SEMARNAT-2000). The concentration of Cu is classified as adequate (>0.2 Cmol$^{(+)}$ kg^{-1}) in all cases, except for 30-90 cm in the Dinamita orchard, where it was deficient (<0.2 $Cmol^{(+)}$ kg^{-1}), in the case of Mn, the concentration was adequate (>1 $Cmol^{(+)}$ kg^{-1}) in all cases, except in Vergel-2 at 60-90 cm, which was deficient with less than 1 $Cmol^{(+)}$ kg^{-1} (NOM-021-SEMARNAT-2000).

Leaf samplings were carried out monthly in each of the trees selected in the four orchards, from April to October 2015. Three leaves were taken from each tree, from three different shoots, with the criterion of sampling the youngest leaf completely expanded in buds of the year, randomly selected within the tree, then a composite sample was obtained by combining the 18 leaves of the six trees of each repetition. The samples were washed with demineralized water twice and then dried to a constant weight in a forced air oven at 65 ºC, to subsequently grind them until a mesh of 0.5 mm was passed.

N was analyzed by the micro Kjeldhal method, P by the colorimetric method with molybdate-vanadate; K, Ca, Mg, Fe, Cu, Mn, Zn and sodium (Na) by acid digestion in microwave oven and analysis in atomic absorption (Perkin Elmer model AA-700). The analysis techniques were performed according to Kalra (1998). The analyzes were carried out in the Laboratory of Soil Analysis of the Experimental Field La Laguna, of the INIFAP. Analysis of variance was performed to detect differences between orchards, within each sampling date. The analysis of the information was carried out with the statistical analysis system SAS (version 9.0, SAS Institute, Cary, NC).

Results and discussion

Foliar concentration of macronutrients

The concentration of N in leaf was higher in April in the four orchards, without the differences between them being significant. In May and August the differences between orchards were significant (Table 2) in May, the orchards Dinamita and Transportes had lower values than Vergel-1 and Vergel-2, while, in August, Dinamita had higher values than Vergel-1 and Transportes (Figure 1).

Table 2. Probability values (*p*) of which the averages of the foliar concentration of each nutrient in the four orchards are statistically equal, according to the analysis of variance.

Nutriment	April	May	June	July	August	September	October
N	0.175	0.001 (0.374)	0.092	0.127	0.036 (0.335)	0.813	0.533
P	0.601	0.032 (0.022)	0.41	0.522	0.337	0.031 (0.112)	0.082
K	0.032 (0.185)	0.009 (0.592)	0.394	0.058	0.076	0.09	0.635
Ca	0.938	0.157	0.258	0.101	0.156	0.055	0.035 (0.574)
Mg	0.509	0.501	0.819	0.421	0.105	0.002 (0.036)	0.005 (0.073)
Fe	0.244	0.773	0.075	0.404	0.046 (104.66)	0.036 (121.2)	0.468

Nutriment	April	May	June	July	August	September	October
Cu	0.909	0.413	0.019 (2.431)	0.726	0.058	0.261	0.04 (48.95)
Mn	0.827	0.808	0.022 (20.196)	0.473	0.535	0.65	0.021 (12.681)
Zn	0.993	0.007 (5.52)	0.293	0.36	0.1	0.007 (4.558)	0.238
Ni	0.403	0.14	0.541	0.011 (1.415)	0.409	0.201	0.528

Where there are significant differences ($p \leq 0.05$), the Fisher significant minimum difference value (DMS) is written in parentheses, with a value of $\alpha = 0.05$.

The N concentration remained stable from May to October in the Dinamita orchards and Transportes, and from June to October in Vergel-1 and Vergel-2. In April, the average concentration (± standard deviation) of the four orchards was 3.54 ±0.33%, while from June to October the average was 2.54 ±0.23%. The decrease in the concentration of N in the first months coincides with the development of shoots and leaves; therefore, the lower concentration of N may be due to a dilution effect (Tehryung and Wetzstein, 2005). In addition, the decrease of N from May to June and from August to September may be due to the harvest of figs and fruits, respectively (Brown, 1994).

Depending on the species of plant, the stage of development and organ, the requirements of N for an optimal development can be between 2 to 5% (with dry base) of the plant (Marschner, 2012). The decreasing tendency of the concentration of N coincided with the results of Brown (1994), in fig trees in California, USA, although the concentrations indicated by this author were lower, from 2.3% in May (flowering) to 1.5% in October (post-harvest). On the other hand, despite the differences between orchards in the concentration of inorganic N in soil in the present study (Table 1), the N leaf did not vary significantly in most of the sampling dates and during June and July remained within of the sufficiency interval of 2 to 2.5% indicated by Jones *et al*. (1991), except the Dinamita orchard in July, which reached 3.1%, without the difference being significant; this may be due to the fact that the Dinamita orchard had the highest concentration of inorganic N in the soil profile (Table 1).

The P on the leaf was relatively low from April to June, with an average of 0.12 ±0.03% in May the differences between orchards were significant (Table 2), when the Transportes orchard had lower concentration of P than the others (Figure 1). As of July, the P concentration increased and remained stable until October, with an average of 5.7 ±0.09%. In September, the Vergel-2 orchard was significantly superior to the others (Figure 1).

The increase in the concentration of P from July coincides with the high harvest of fruits. High values of P in fig were recorded by Caetano *et al*. (2006), who found P values of 0.73% at the end of spring. For optimal growth of most plants, the P must be in the range of 0.3 to 0.5% during the vegetative growth stage (Marschner, 2012). According to Jones *et al*. (1991), the range of sufficiency of P in fig tree is from 0.1 to 0.3%, which coincides with the values recorded from April to June in all orchards, despite the differences in P in the soil (Table 1).

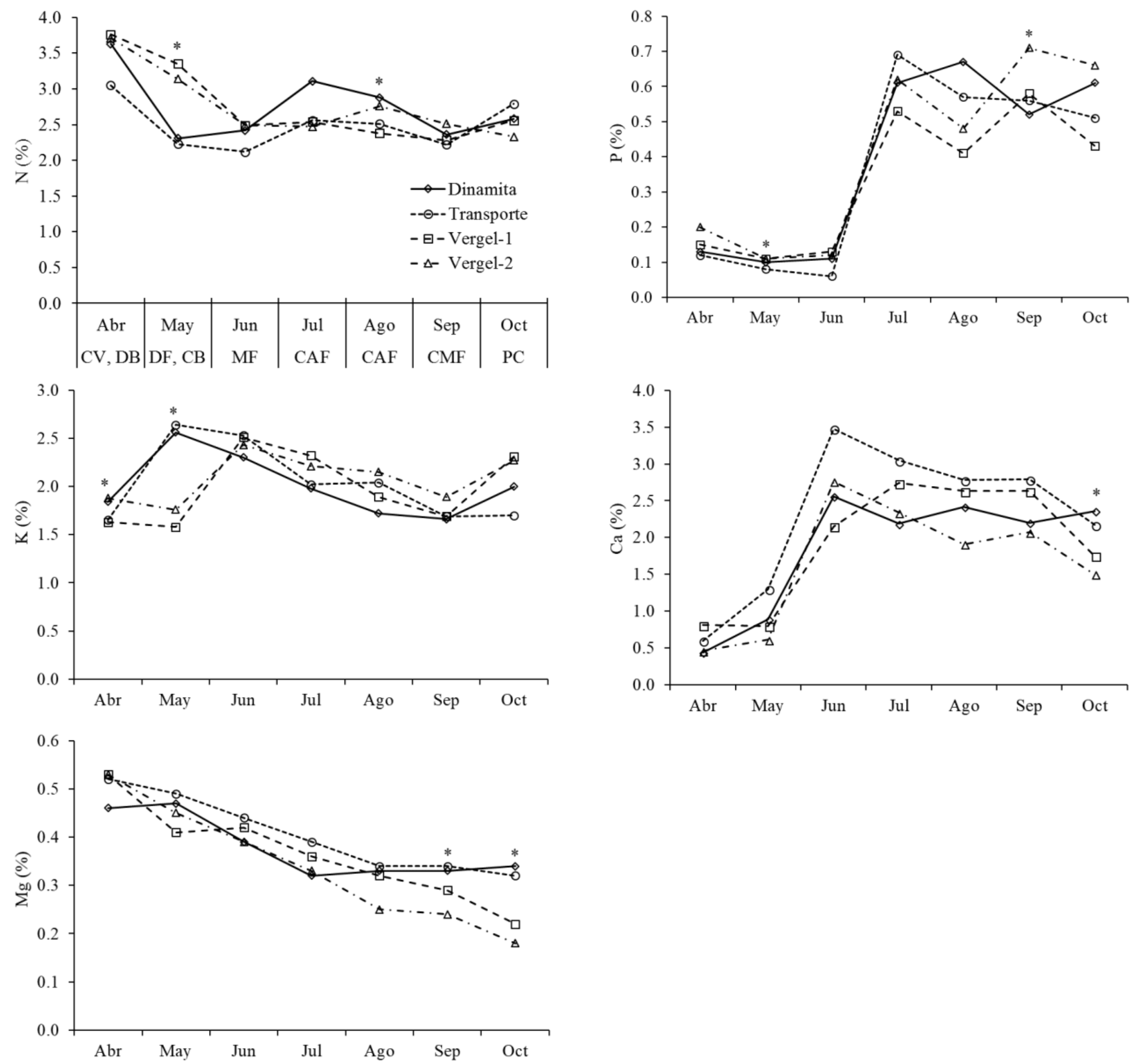

Figure 1. Seasonal variation of macroelements in the fig crop during the production cycle. CV= vegetative growth; DB= development of brevas; DF= fruit development; CB= harvest of brevas; MF= fruit ripening; CAF= high fruit harvest; CMF= average fruit harvest; PC= postharvest. *Indicates significant difference between orchards, within each sampling date, according to Fisher's minimum significant difference test (DMS), with a value of α= 0.05).

The concentration of K showed significant differences between orchards in April and May (Table 2). In April, the K was higher in Dinamita and Vergel-2, with an average of 1.86%, in May the K was highest in the Dinamita and Transportes orchard, which averaged 2.6%. As of June, the K concentration decreased from 2.44% until September, reaching an average similar to that of April, with 1.73% (Figure 1).

The previous values of leaf K in April and May had no relationship with the K in the soil, since the Dinamita orchard had soil values of K lower than Vergel-1 (Table 1) and higher values in the foliage. The decrease in leaf K values coincided with the fruit harvest period, while in October there was a slight increase in the concentration of K, when it is already the postharvest stage. According to Marschner (2012), the K, together with N, is the required mineral element in greater quantity, with an optimum interval between 2 to 5% in vegetative parts. However, Jones *et al*. (1991) indicate that the concentration of K sufficient for fig is >1%.

The pattern to decrease the concentration of K throughout the cycle coincides with Brown (1994), although this author obtained lower concentrations, between 1.4% in May and 0.7% in October. The concentration of K in the soil was high in all orchards (Table 1), typical of clay and alkaline soils (Aguado *et al*., 2002) as in the present study, which may explain the high concentration of foliar K. The values of Ca were low in April and May, with an average of 0.74%, and then increased to values between 2.15 and 3.48% in June. In this period there was the development and harvest of brevas, as well as the development of the fruits.

As of July, the concentration of Ca decreased to values between 1.5 and 2.36% in October, in this last month of sampling the differences between orchards were significant (Table 2), registering the highest values in Dinamita and Transportes (Figure 1). The concentration of Ca in leaf was not related to the Ca in the soil, since the Dinamita orchard had the second lowest value and Transportes had the highest value (Table 1). Brown (1994) indicates that part of the variability in the concentration of nutrients at the end of the cycle is explained by the remobilization of nutrients outside the leaves.

The low values in the present work (<2% of Ca) coincide with Caetano *et al*. (2006), who registered 1.45%. Jones *et al*. (1991), mention a concentration higher than 3% as sufficient for this crop, in samples taken in July and August, similar to what was identified by Brown (1994), with Ca values between 2.9 and 3% from May to September. With respect to the concentration of Mg, in April an average of 0.51% was obtained and thereafter low on average 0.04% each month, according to the linear regression model (Mg= -0.0409X + 0.658; r^2= 0.8) between the Mg concentration, average of the four orchards, and the number of month of sampling (data not shown).

All the above values are lower than the critical sufficiency value of 0.7%, indicated by Jones *et al*. (1991) and by Reuter and Robinson (1997); however, deficiency symptoms were not observed. Marschner (2012) indicated that the optimum concentration of Mg in plants in general is in the range of 0.15 to 0.35%. In fig trees in production, Caetano *et al*. (2006) analyzed fig leaf samples at the beginning of spring and found Mg values (0.59%) similar to those found in this work in the month of April.

Foliar concentrations of micronutrients

The foliar concentration of Fe did not show a tendency to decrease or increase during the production cycle. The Fe remained at concentrations between 100 and 500 mg kg^{-1}; however, in August and September the differences between orchards were significant (Table 2) in these months, Vergel-1 and Vergel-2 had the highest concentrations, with average values of 245 to 318 mg kg^{-1}, which were higher to those reported by Brown (1994); Caetano *et al*. (2006).

On the other hand, according to Marschner (2012), the levels of Fe found in the present study are within normal parameters for most plants, the author noted that a deficiency may be in the range of 50-150 mg kg^{-1}, while higher concentrations of 500 mg kg^{-1} can be toxic for some plants (Figure 2). The high concentration of Fe in leaves recorded in the present study may be due to the application of compost based manure (Nikoli and Matsi, 2011).

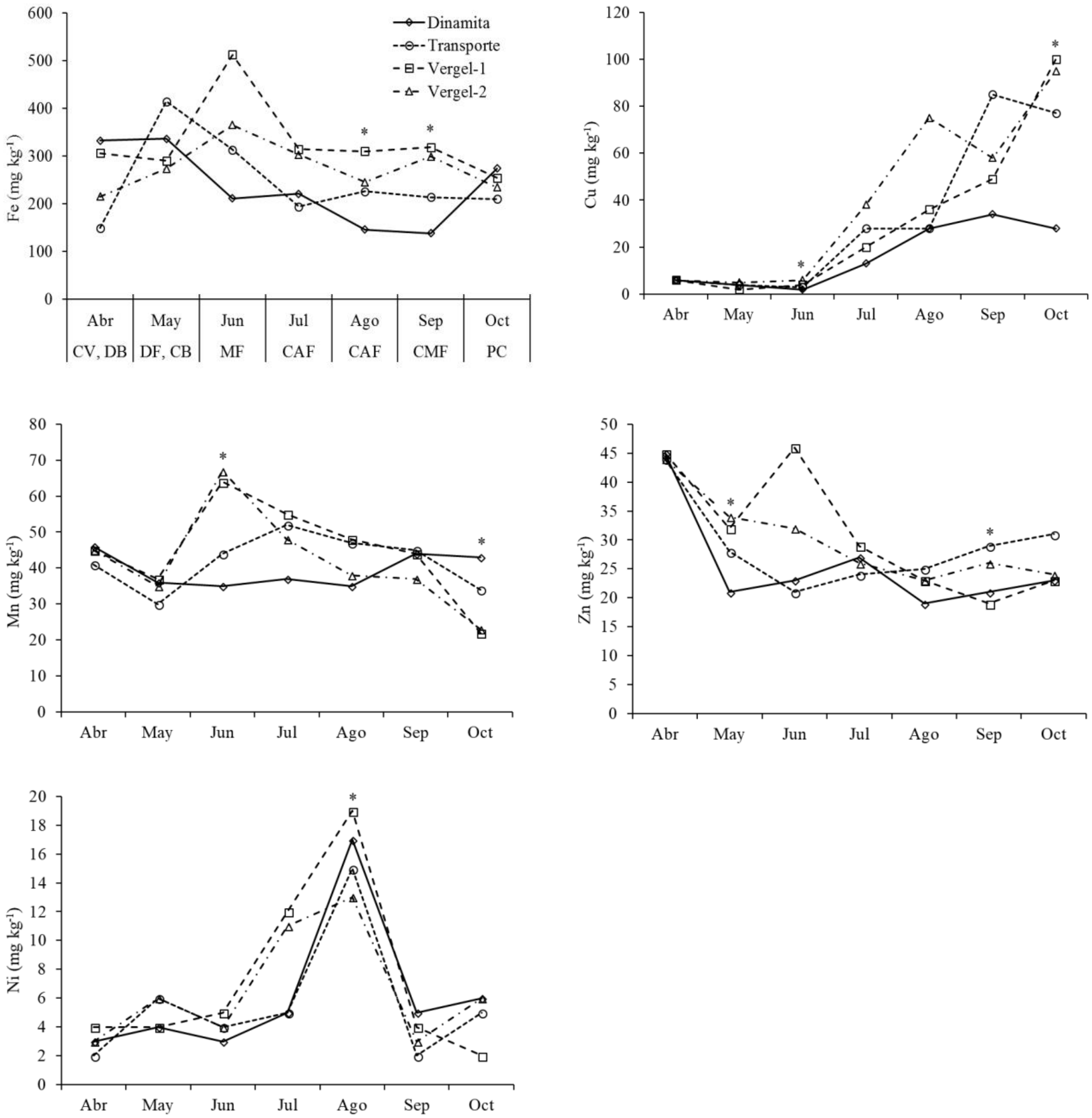

Figure 2. Seasonal variation of microelements in the fig crop during the production cycle. CV= vegetative growth; DB= development of brevas; DF= fruit development; CB= harvest of brevas; MF= fruit ripening; CAF= high fruit harvest; CMF= average fruit harvest; PC= postharvest. *Indicates significant difference between orchards, within each sampling date, according to Fisher's minimum significant difference test (DMS), with a value of $\alpha = 0.05$).

The concentration of Cu from April to June varied from 2 to 6 mg kg^{-1}, then gradually increased from July, reaching average values of 95 to 100 mg kg^{-1} in October. In October, the differences between orchards were significant (Table 2), where the lowest average concentration was registered in the Dinamita orchard (28 mg kg^{-1}). According to Marschner (2012) a deficiency of Cu could be between 1 and 5 mg kg^{-1}, and an effect due to toxicity in some plants could be detected at concentrations higher than 30 mg kg^{-1}, although there are species of natural vegetation that can have Cu concentrations up to 1 000 mg kg^{-1}.

However, Jones *et al*. (1991) determined for fig a sufficiency concentration >4 mg kg^{-1} Cu of July and August, without specifying a toxic critical level. Like Fe, the high concentration of Cu found in the present study may be due to the application of compost based manure (Nikoli and Matsi, 2011). The average concentration of Mn showed significant differences between orchards in June and October (Table 2). In June, Vergel-1 and Vergel-2 had the highest average values (64 and 67 mg kg^{-1}, respectively) while, in October, the Dinamita orchard had the highest average concentration (43 mg kg^{-1}).

These concentrations are low compared to that indicated by Brown (1994) and Caetano *et al*. (2006). Brown (1994), recorded values between 80 and 165 mg kg^{-1}, in different stages of the cycle and in trees with different vigor. In contrast, Jones *et al*. (1991) established a concentration >20 mg kg^{-1} as a profitability value in fig. The average concentration of Zn in April was 44.5 mg kg^{-1}, as of May the Zn dropped and remained in the average range of 30.5 mg kg^{-1} in June to 22.5 mg kg^{-1} in August. In May, the concentration of Zn in the Dinamita orchard was significantly lower than the others, while in September, Dinamita and Vergel-1 had lower concentrations of Zn, with respect to the other two orchards (Table 2).

The final concentrations of Zn are similar to the average reported by Caetano *et al*. (2006) on fig trees. Marschner (2012) noted that generally in plants, a deficiency of Zn could occur at concentrations below 15 to 20 mg kg^{-1}. However, Brown (1994) indicated a concentration between 9 and 12 mg kg^{-1} for fig trees with high production. The concentration of Ni in leaf was maintained between 2 and 6 mg kg^{-1} from April to June, then increased between 5 and 19 mg kg^{-1} in July and August, to then decrease to values between 2 and 6 mg kg^{-1}. According to Marschner (2012), in most plants, the concentration of Ni in the vegetative organs is in the range of 1 to 10 mg kg^{-1}. Wood *et al*. (2004) concluded that the visual symptom in pecan walnut known as ‘mouse ear’, was due to a deficiency of Ni, which can be severe at values less than 1 mg kg^{-1} (Figure 2). Also, in walnut, Smith *et al*. (2012) indicate a normal critical value of Ni ≥2.5 mg kg^{-1}.

In general, large seasonal variations were observed in most nutrients, over all minor elements. Brown (1994) showed this type of variation, for example, from 80 to 166 mg kg^{-1} of Fe between May and October, or 190 to 450 mg kg^{-1} of Mn in the same sampling months. According to this author, part of the variability at the end of the cycle is explained by the remobilization of nutrients outside the leaves. Considering that most of the nutrients did not observe significant differences between orchards, the monthly averages can serve as preliminary reference values for trees in production.

All the nutrients are within the sufficiency values reported by Jones *et al*. (1991) and Reuter and Robinson (1997), except for Ca and Mg, whose concentration was slightly lower than the sufficiency value, but no symptoms of deficiency were observed. Jones *et al*. (1991) have suggested that the best time to collect foliar samples in fig trees is between July and August, taking the youngest leaf completely expanded, in different buds. However, in those months the fig fruit harvest is generalized in this region, which could influence the nutrient content in the leaves. A suitable time for this region may be when the harvest of brevas ends and even before the fruit harvest begins, which in the present study occurred during June. In addition, in the present study, June was when there was less variation among orchards (Table 3).

Table 3. Average values per month (± standard deviation) of the concentration of nutrients in fig trees.

Month	April	May	June	July	August	September	October
N (%)	3.54 ±0.42	2.76 ±0.55	2.38 ±0.2	2.67 ±0.35	2.63 ±0.27	2.34 ±0.33	2.56 ±0.37
P (%)	0.16 ±0.05	0.1 ±0.02	0.11 ±0.05	0.61 ±0.13	0.53 ±0.19	0.59 ±0.09	0.55 ±0.12
K (%)	1.75 ±0.14	2.14 ±0.55	2.44 ±0.17	2.13 ±0.19	1.95 ±0.23	1.73 ±0.12	2.07 ±0.54
Ca (%)	0.58 ±0.65	0.9 ±0.35	2.74 ±0.8	2.58 ±0.47	2.44 ±0.54	2.42 ±0.4	1.94 ±0.42
Mg (%)	0.51 ±0.06	0.45 ±0.06	0.41 ±0.06	0.35 ±0.05	0.31 ±0.05	0.3 ±0.04	0.26 ±0.07
Fe (mg kg^{-1})	251 ±118	328 ±153	350 ±173	258 ±95	232 ±90	242 ±104	243 ±58
Cu (mg kg^{-1})	6.1 ±0.8	3.8 ±2.1	3.7 ±2	24.8 ±25.4	41.8 ±28.1	56.3 ±30.7	74.7 ±35.2
Mn (mg kg^{-1})	44.1 ±6.3	34.7 ±9.1	52.4 ±17.9	47.9 ±12.7	41.8 ±14.5	42.5 ±9.4	30.8 ±11
Zn (mg kg^{-1})	44.6 ±4.6	28.8 ±5.3	30.3 ±16.8	26.5 ±3.1	22.7 ±3	23.7 ±4.6	25.3 ±5.2
Ni (mg kg^{-1})	2.91 ±1.29	4.8 ±1.59	3.85 ±1.62	8.33 ±3.89	15.7 ±4.16	3.33 ±1.56	4.67 ±3.23

Conclusions

In most of the elements, a variation was observed throughout the cycle in its concentration in leaves; N, Mg and Zn obtained higher concentrations at the beginning, while P, Ca, Cu and Ni had the opposite, in the case of Fe and Mn, they did not show a definite trend. In general, no significant differences were observed between orchards, with respect to the concentration of nutrients, for each sampling date. All the nutrients were within the levels of sufficiency indicated in the literature with the exception of Ca and Mg; however, deficiency symptoms were not observed. t is advisable to take leaf samples during June as this month most items less variation was observed among orchards and is the time when there is no harvest brevas or figs.

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