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Dynamics of biogene elements concentration in leaf and fruit of picholine olive variety in conditions of Ulcinjsko polje

Dinamika sadržaja biogenih elemenata u listu i plodu masline sorte Picholine u uvjetima Ulcinjskog polja

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ABSTRACT

In conditions of Ulcinjsko polje, during the period 1987-1991, growth intensity of one-year old olive shoots and fruit growth in Picholine variety were investigated. Related to that, the dynamics of mineral nutrition (N, P, K, Ca and Mg) was followed in leaves and fruits in the period from middle of July to the middle of October. Results showed that nutrient status during vegetation period was within optimal values for olive. Decreasing dynamics during vegetative period was in N (from 2.22% to 1.67%). Slight increasing dynamic was showed in K (1.15% to 1.32%), Ca (0.91% to 1.22%) and Mg (0.17% to 0.21%), while P had a relatively stable content in olive leaves (0.19%).

Nutrient status in the fruit showed different tendencies. Decreasing dynamics showed N (0.81 to 0.59%), Ca (260 to 229 ppm) and Mg (228 to 191 ppm). Slight increment showed P (0.13 do 015%) and K (1.44 do 1.51 %).

Key words: olive, Picholine, mineral nutrition, leaf, fruit, shoot growth

SAŽETAK

U uvjetima Ulcinjskog polja u razdoblju od 1987. do 1991. istraživani su intezotet rasta jednogodišnjih izdanaka masline I rast ploda sorte Picholine. U vezi s time praćena je dinamika (N,P,K,Ca I Mg) u lišću I plodovima u razdoblju od sredine srpnja do sredine listopada. Rezultati su pokazali da je stanje hraniva u vrijeme vegetacije bilo u rasponu optimalnih vrijednosti za maslinu. Dinamika opadanja u razdoblju vegetacije bila je za N (od 2,22% do 1,33%). Dinamika neznatnog povećanja pokazala se u K (1,15% do 1,32%), Ca (0,91% do 1,33%) I Mg (0,17% do 0,21%) dok je P imao relativno stabilan sadržaj u lišću masline (0,19%). Stanje hraniva u plodu pokazalo je različite tendencije. Dinamiku opadanja pokazali su N (0,82 do 0,59%), Ca (260 do 229 ppm) I Mg (228 do 191 ppm). Lagano povećanje pokazali su P (0,13 do 0,15%) i K (1,44 do 1,51%).

Ključne riječi: maslina, Picholine, mineralno hranivo, list, plod, rast izdanaka

INTRODUCTION

Although the olive is able to grow on very poor soil conditions with relatively low content of nutrients, for regular and high production olive has demands for basic nutrients as well as other fruit species.

The most important biological processes in olive happen during the period characterised by lack of water. Water and nutrients supply highly influence all physiological processes and vegetative growth in current year, also climatic conditions and feed of plants, which is one of the fundamental conditions for the next year flowering and productivity.

Picholine, a variety with regular and high production (Lazović, 2000), was used as a model for investigation of physiological parameters: shoot and fruit growth, and dynamics of concentration in leaf and fruit of the most important minerals presented in this paper. The aim of this study was to learn about the supply and dynamics of mineral elements in olive during the vegetative period in conditions of southern part of Montenegro coastal area. Having in mind that this kind of research on olive nutritive physiology is the first in our ecological conditions, we present the data with the purpose of supporting further work to this very important part of olive growing and agriculture in general.

MATERIAL AND METHODS

Investigation into mineral elements concentration dynamics in leaf and fruits of the olive variety Picholine during a five years period (1987-1991), from July to October, in experimental plot in Ulcinjsko polje was done. The orchard was planted in the period 1980-82 with density 7x5m. Uniform trees were chosen for research. The experiment was organized in a block system with 5 repetition where one three was repetition. From each three the sample of 100 leaves and 15 fruits was taken every 15 days for mineral nutrients status analyses. In the laboratory the volume of the fruit sample was measured and dynamics of fruit growth determined (Miljkovic, 1984).

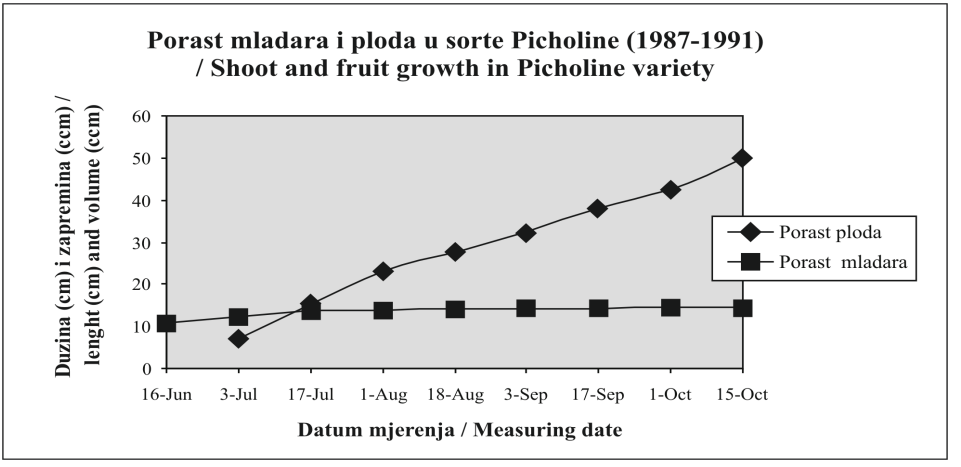
From the samples 1g of plant material was used for analyses on the concentration of main mineral elements, N, P, K, Ca and Mg. Nitrogen was determined by the method of Kjeldahl. For other elements the material was prepared in the oven at 600^{o}C for 12h then dissolved in 0.1N HCl. Total P was determined colorimetrically while K, Ca and Mg on AAS (Pye Unicam) (Saric et al. 1986)

The data obtained were statistically processed by analysis of variance. Separation of means was carried out using LSD test range 0.05% (Hadzivukovic, 1991).

REZULTS AND DISCUSSION

Shoots and fruit growth

Climate, vegetative growth and olive productivity are closely related. Morettini (1950) observed that shoot growth ritmus had maximum in June and July and could be prolonged until August, when it reduced because of the fruit growth, while Bignami (1994) noted that fruit increment drastically reduced after fruit set. Such tendency in shoot and fruit growth was expressed in our investigations on Picholine variety (graph.1). The highest shoot growth was recorded until July, when the fruits were still small, and almost stagnated in later period observed. However, the length of shoots at the end of the period observed was on average 14.63 cm and in accordance with findings of Bignami et al. (1994) for some Italian varieties. Miljkovic (2006) presented for Picholine in conditions of Istria very intensive shoot growth of about 25 cm for the period observed. We suppose that different climate and somewhat later vegetation as well as water supply influenced such intensive shoot growth in the period of the highest temperatures. In our investigation about 75% of shoot growth performed until middle of June or about 93% until middle of July, until beginning of measuring or in the first phase of measuring (Lazovic, 2003).

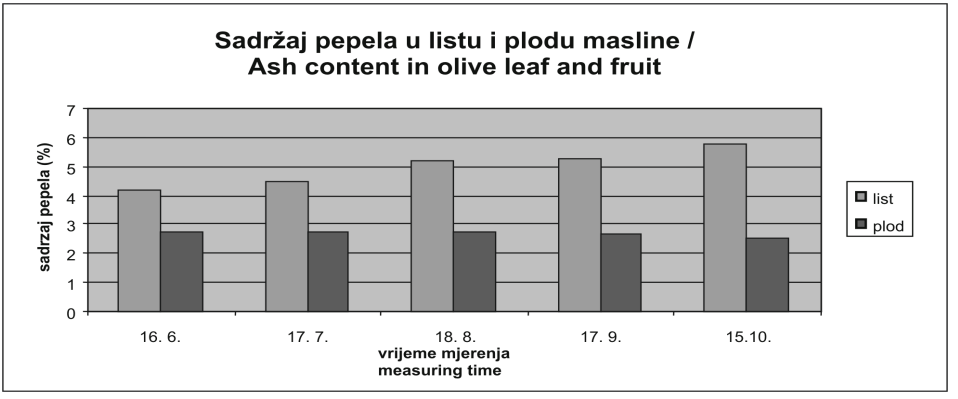


Graph.1. Shoot and fruit growth of Picholine variety in conditions of Ulcinjsko polje (1987-91)

Fruit growth, measured from the beginning of July, was intensive during whole the observing period, 42.8 ccm. (graph. 1). Miljkovic (2006) recorded for Picholine the volume of 1.8 ccm in the middle of November as a maximum of fruit growth. The influence of climate on late flowering and the beginning of measuring period in the middle of August was also observed. In conditions of Ulcinjsko polje Picholine variety at the end of the period observed, the middle of October, was harvested for conservation as green.

Mineral element dynamics in leaves

On the basis of four years results the ash content in olive leaves (graph.2), measured in monthly intervals had a slight increment. We presume that even in further period, because of leaf aging to the end of active vegetation period, the ash content would have the same trend.



Graph. 2. Ash content in leaf and fruit of Picholine variety

In table 1 and on graphs 3 and 4 average concentration of mineral elements in leaf of Picholine variety is presented.

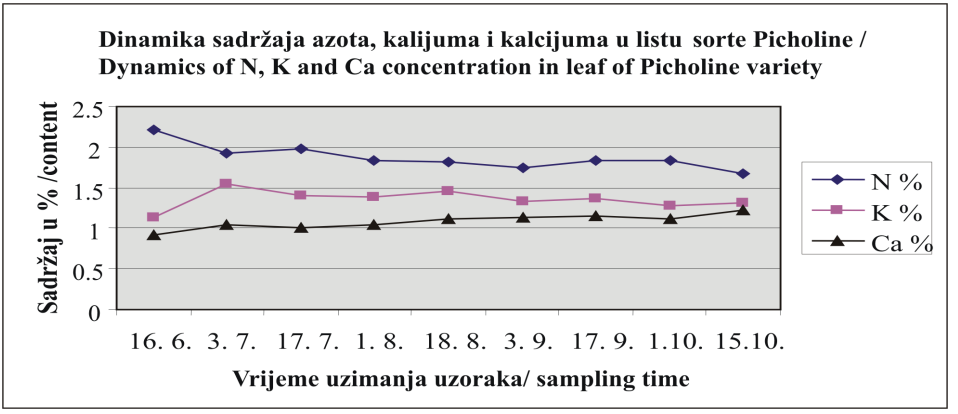
Table 1. Dynamics of N, P, K, Ca and Mg concentration in leaf of Picholine variety
Tablica 1. Dinamika N,P,K,Ca I Mg u lišću sorte Picholine

Koncentr. Concentr.	Vrijeme praćenja / Period of observation									LSD 0,05%
	16. 6.	3. 7.	17. 7.	1. 8.	18. 8.	3. 9.	17. 9.	1. 10.	15. 10.	
N (%)	2,22^{a}	1,93^{b}	1,97^{b}	1,83^{bc}	1,83^{bc}	1,81^{bc}	1,83^{bc}	1,83^{bc}	1,67^{c}	0,217
P (%)	0,19^{abc}	0,21^{a}	0,20^{ab}	0,18^{bc}	0,18^{bc}	0,17^{c}	0,18^{bc}	0,17^{c}	0,19^{bc}	0,025
K (%)	1,15^{c}	1,54^{a}	1,42^{ab}	1,39^{abc}	1,45^{ab}	1,34^{abc}	1,36^{abc}	1,28^{bc}	1,32^{abc}	0,246
Ca (%)	0,91^{d}	1,03^{bc}	1,00^{cd}	1,06^{bc}	1,11^{abc}	1,13^{ab}	1,15^{ab}	1,13^{bc}	1,22^{a}	0,124
Mg (%)	0,17^{c}	0,17^{c}	0,18^{bc}	0,19^{b}	0,19^{ab}	0,19^{ab}	0,18^{b}	0,19^{b}	0,21^{a}	0,016

Predominant element in leaf was N followed by K and Ca. Decreasing dynamics in N concentration during vegetation was noted. The highest concentration was at the beginning of the measuring period, 2.22%, decreasing to the end of the period observed, 1.67%.

Concentration of nitrogen in leaf in ecological conditions of Ulcinjsko polje is above the concentration that Picholine variety had in conditions of Istria (Miljkovic, 2006) where, contrary to our results and observations of Ulger et al. (2004), the concentration increased toward the end of the period observed, from 1.49 to 1.80%. In the same conditions of Istria Leccino variety had nitrogen concentration from 2 to 2.4%, and in Ulcinjsko polje other varieties had much lower concentrations (Lazovic, 2001) measured in August but above the satisfactory limit of 1.5% given by Escobar et al. (1999), while Žutica in Bar had about 2% N in leaf (Lazovic, 2001). High concentrations were also recorded in different Italian olive varieties, from 1.88 do 2.25% N (Tittarelli i sar., 2006), as well as in Greek varieties and in olive orchards measured at the beginning of March, from 1.90 do 2.10% (Vemmos i sar., 2006).

Potassium concentration increased at the beginning of the measuring period by 0.4%, slightly decreased during further period of vegetation reaching 1.32% at the end of measuring which was above the concentration for this variety in conditions of Istria (Miljkovic, 2006), as well as in various varieties in Ulcinjsko polje (Lazovic, 2001), and much above the data given for different Italian and Greek olive varieties and orchards (Tittarelli et al., 2006; Dimasi et al., 1997; Vemmos et al., 2006). Similar decreasing tendency of K in leaf was recorded by Escobar et al. (1999) but with concentrations lower than of the satisfactory limit in 'on' and 'off' years.

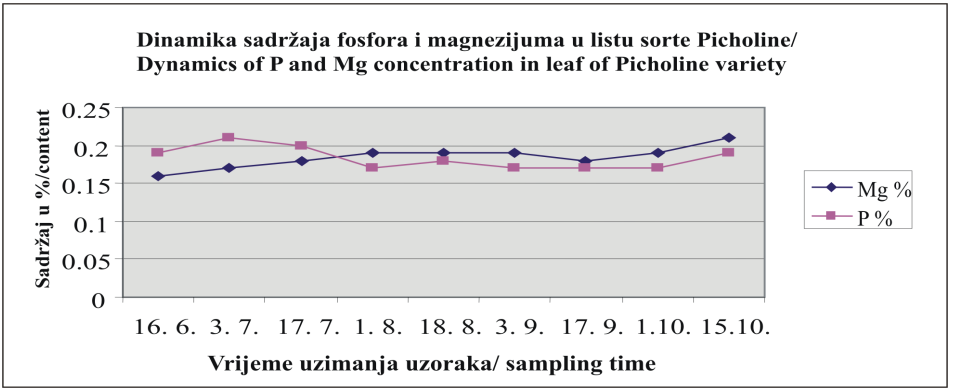


Graph. 3. Dynamics of N, K and Ca concentration in leaf of Picholine variety

Permanent slight increment from the beginning to the end of measuring was noted in Ca concentration, 0.91 to 1.22 %, which is in accordance with literature data on permanent increment of this element (Miljkovic, 2006, Escobar et al., 1999). Concentration of Ca in our experiment was lower than the observations for different Italian and Greek olive varieties (Tittarelli et al., 2006; Dimasi et al., 1997; Vemmos et al., 2006), which can be a result of soil properties.

Concentration of P in leaf was the highest at the beginning of July, 0.21% while the lowest at the beginning of August, 0.17%, and stagnated until mid October, similar to the observation of Miljkovic (2006), when it reached the concentration of 0.19% as well as at the beginning of the measuring period. These results are in accordance with literature data where concentration of P was above the satisfactory limit of 0.1% (Escobar et al. 1999, Lazovic, 2001), and above observations for Italian and Greek olive varieties (Tittarelli et al., 2006; Vemmos et al., 2006).

Regarding the concentration of Mg, this element had intensive increment in leaf during June and July followed by stagnation and decrease to mid September, and then increase to the end of measuring reaching 0.21%. It can be noted that concentration of Mg was pretty much above data given by Escobar et al. (1999) and satisfactory limit of 0.1%, especially in comparison with concentration in 'on' year when it was under the satisfactory limit, suggesting the highest needs of olive for Mg in productive years. Such need was not noticed in our investigations and our conditions in different varieties, even the Mg content in leaf of most productive variety Zutica was above 0.3% measured in August (Lazovic, 2001). Moreover, we noticed the difference from the results obtained in conditions of Istria (Miljkovic, 2006) where Mg concentration in



Graph. 4. Dynamics of P and Mg concentration in Leaf of Picholine variety.

leaves decreased during the period of vegetation almost to the satisfactory limit. Concentration of Mg in Picholine leaf was a little higher than data given for Italian varieties (Tittarelli et al., 2006), and lower than data on the content of this element in Greek varieties and orchards recorded at the beginning of March (Vemmos i sar. 2006).

Statistically significant differences were recorded in dynamics of all investigated elements (table 1).

Generally speaking, the total results on concentration of individual mineral elements in olive leaf in conditions of Ulcinjsko polje showed good supply of minerals, supposing good base for shoot and fruit growth. This also suggests the conclusion that mineral nutrition could not be a reason for relatively weak shoot growth (graph. 1), and also prove the importance of precipitation in condition of this climate or needs for irrigation that should be investigated (Lazovic, 2003).

DYNAMICS OF MINERAL ELEMENTS CONCENTRATION IN FRUIT

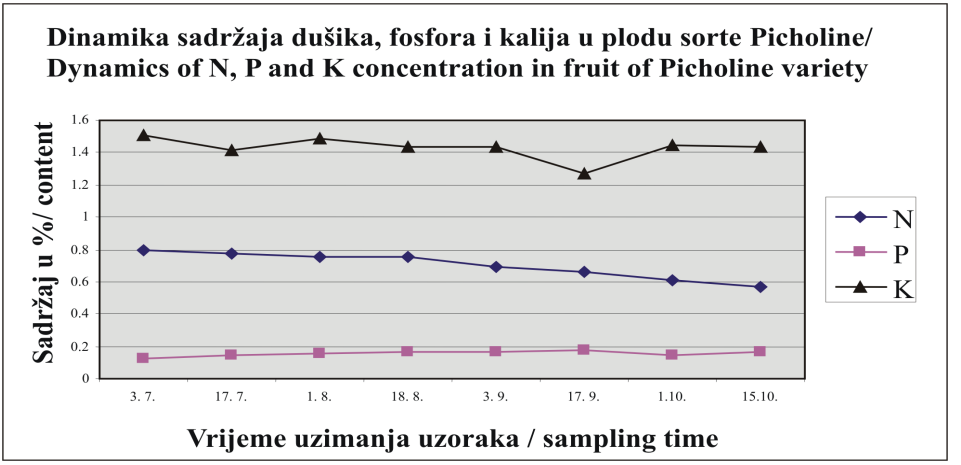
The ash content (graph. 2) in fruit of Picholine variety was contrary to the dynamics in leaf, or it had permanent decreasing tendency during measuring period, from 2.77 to 2.53%. Compared to leaf, the ash content in fruit was lower by about 33% at the beginning up to 56% at the end of measuring period.

Regarding the mineral elements presented in table 2 and on graph no 5, the highest concentration in fruit was of K, followed by N and P.

Table 2. Dynamics of N, P, K, Ca and Mg concentration in fruit of Picholine variety

Sadržaj	Vrijeme praćenja /period of observation								LSD
Content	3. 7.	17. 7.	1. 8.	18. 8.	3. 9.	17. 9.	1. 10.	15. 10.	0,05%
N %	0,81^{a}	0,77^{a}	0,75^{ab}	0,75^{a}	0,69^{abc}	0,67^{abc}	0,62^{bc}	0,59^{c}	0,143
P %	0,14^{a}	0,14^{a}	0,15^{a}	0,14^{a}	0,14^{a}	0,15^{a}	0,13^{a}	0,15^{a}	0,018
K %	1,51^{a}	1,41^{a}	1,49^{a}	1,43^{a}	1,44^{a}	1,28^{b}	1,45^{a}	1,44^{a}	0,125
Ca ppm	260^{a}	254^{abc}	249^{abcd}	258^{ab}	231^{cd}	250^{abcc}	235^{bcd}	229^{d}	24,30
Mg ppm	160^{b}	228^{a}	205^{a}	212^{a}	205^{a}	209^{a}	213^{a}	191^{ab}	45,23

The potassium concentration, except the minimum noted by mid September that significantly differed, was in slight decrease during the period of observation, from 1.51 to 1.44%, and the content was double much as recorded by Ulgera et al. (2004) for concentration of K in fruit of Memecik variety. However is consider that there is a positive correlation in composition of mineral elements in olive leaf and fruit (Jordao et al., 1989), the K content in fruit comparing to that in leaf was almost the same to the middle of August and then increased on account of the leaf concentration.



Graph. 5. N, P and K content in fruit of Picholine variety

Nitrogen concentration, similar to the tendency in leaf, decreased, slow at the beginning of September and later more intensively, and with 0.81 to 0.59% was much lower compared to the leaf content but on the level of observation of Ulgera et al. (2004).

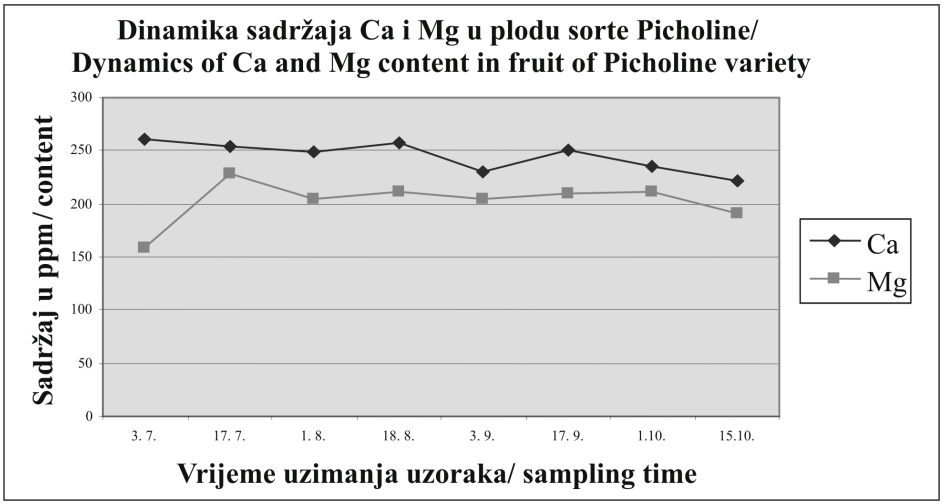
Concentration of P was relatively low with maximum of 0.15% at the beginning of August, while the minimum, 0.13%, was recorded at the beginning of October. Phosphorus concentration in fruit is somewhat lower than in leaf but in accordance with that observed by Ulgera et al. (2004).

The highest concentration of Ca was at the beginning of measuring (graph. 6), then decreased to the minimum concentration recorded at the beginning of September and at the end of measuring period.

Mg concentration was the lowest at the beginning of July (160 ppm), then increased to more than 200 ppm and with small oscillations stayed constant to the end of measuring, when new minimum of 191 ppm was showed.

Concentration of Ca and Mg was significantly lower than the concentration in leaf and also lower than the data given by Ulgera et al. (2004) that show the same content in fruit and leaf in the same period, but in accordance with the results for different olive varieties in conditions of Ulcinjsko polje (Lazovic, 2001).

Statistically significant differences were not observed in dynamics of P concentration, while in Mg significant difference was obtained in concentration at the beginning of measuring. Similar differences were recorded in dynamics of Ca and N concentration, especially in fruit ripening period.



Graph. 6. Ca and Mg content in fruit of Picholine variety

Concentration of some mineral elements in fruit is also important, because the fruit is used for consumption, and from that aspect the knowledge on nutritive quality of some olive varieties is important (Nosti Vega et al., 1984). Moreover, the fruit is exported from the orchard and consequently a specific quantity of nutrient from soil is also exported, and depending on their concentration in fruit the amount of nutrients that should be returned to the soil is planned (Poli, 1986).

CONCLUSIONS

On the basis of the results presented in this paper it can be concluded that:

- The biggest shoot growth in Picholine variety in ecological conditions of Ulcinjsko polje was performed to the mid of July while the fruits ware still small, latter growth was rather stagnate. Fruit growth was intensive during the whole period of measuring with the average volume of 42.8 ccm.
- Results on concentration of mineral elements in leaf prove the good supply of nutrients, supposing good base for the shoot and fruit growth. The most present mineral in leaf was N (2.21% to 1.67%), then K (1.14% to 1.32%) and Ca (0.91% to 1.22%).
- In fruit of Picholine variety the most concentrated element was K (1.51 to 1.44%), followed by N (0.81 to 0.59%) and P (0.13 to 0.15%), while the

concentrations of Ca and Mg were from 260 to 229 ppm and from 160 to 191 ppm respectively.

Based on the mineral elements content in leaf and fruit and their export with the yield, the quantity of nutrients that should be returned to the plants and soil for assuring the normal growth and production is calculated. These analyses show to be the most secure indicator of the plant supply and needs for nutrients and should be regularly performed in olive orchards in Montenergo.

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