Proceedings VI World Avocado Congress (Actas VI Congreso Mundial del Aguacate) 2007.
Viña Del Mar, Chile. 12 – 16 Nov. 2007. ISBN No 978-956-17-0413-8.

DETERMINATION OF THE NUTRIENT ABSORPTION CURVE, USING EXTRACTOMETRIC SONDA AND FOLIAR ANALYSIS IN HASS AVOCADO (*Persea americana* Mill)

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In the last years, fertigation has been incorporated as an important tool for fruit orchard management. By understanding the concept of fertigation as a way of providing nutrients to the crop according to requirements, an investigation was made during three seasons in 3 good productivity avocado orchards, located in the zone of Ovalle, Region of Coquimbo, Chile. Soil solution extraction was carried out at three different depths, along with a foliar sample for analysis. This was done with the objective of determining the concentration level for each nutrient contained in the soil solution, from where avocado tree absorbs. The concentration in which nitrate leaching in fertigation management is produced, was also determined. The foliar sample was used to find out if the disappearance of nutrient in soil solution from the 3 depths occurred because of plant absorption or because of organic matter absorption and fixation in the soil, in the case of cations; as well as interaction of nutrients with irrigation water, mainly with bicarbonates present in water. Besides, the foliar curve for each nutrient was determined during the crop cycle.

DETERMINACIÓN DE LA CURVA DE ABSORCIÓN DE NUTRIENTES, MEDIANTE SONDAS EXTRACTÓMETRAS Y ANÁLISIS FOLIARES EN PALTO (*Persea americana* Mill) CV HASS.

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En los últimos años la técnica de fertirriego se ha incorporado como una herramienta importante en el manejo de los huertos frutales. Al entender el concepto de fertirriego como una forma de aportar nutrientes en base a la demanda del cultivo, se realizó una investigación durante 3 temporadas en 3 huertos de paltos de buena productividad ubicados en la zona de Ovalle, Cuarta Región. Se utilizó la técnica de extracción de solución de suelo a tres profundidades; y junto con esto, se tomó muestra foliar para su análisis. El objetivo de esto fue determinar el nivel de concentración de cada nutriente en la solución de suelo, en la cual el palto absorbe. Además se determinó la concentración en la cual se produce lixiviado de nitratos en el manejo de la fertirrigación. La muestra foliar se utilizó para descartar si la desaparición del nutriente de la solución de suelo en las 3 profundidades se debió a absorción por parte de la planta o por absorción en el suelo y fijación por la materia orgánica para el caso de los cationes, e interacción de los nutrientes con el agua de riego, principalmente bicarbonatos presentes en ésta. Además junto

con esto, se determinó la curva foliar para cada nutriente durante el ciclo de cultivo.

INTRODUCTION

The process talks about to the control of the absorption and assimilation of elements for the plant, being based for it on the study of the ion dynamics throughout the profile to rootzone, as well as its relation with the chemical composition of different vegetal organs (leaf, sap, fruit, etc.). With this it is persecuted to assure an optimal nutritional and hydric advantage on the part of the plant, diminishing the possible environmental impacts caused by excesses of fertilizers. The continuous evaluation of the ion dynamics in the profile is carried out by means of the analysis and study of the ground solutions extracted with extractometers to several depths of the profile to rootzone. If to the ion dynamics one adds his relation with the chemical composition of the evolution of nutrients in leaves and fruits, it is possible to be known:

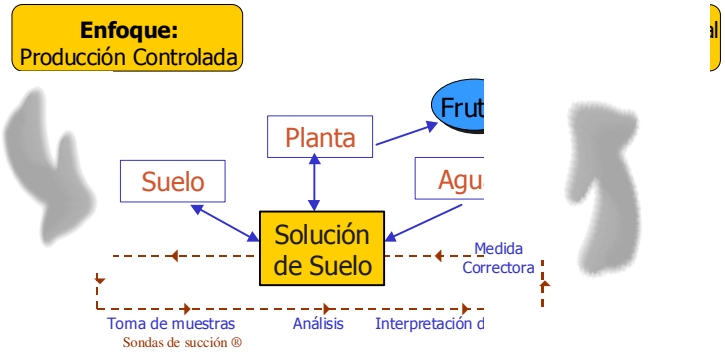
• The necessities of the plant at every moment and throughout the cycle (nutrients, water, etc.).
• The fertilizing solution more adapted to phenology.
• Helping and the chemical forms of elements more adapted to use in each soil to assure the best availability nutrients.
• The form to avoid nutritional antagonisms.
• What the plant does not take for leached.

This procedure of nutricional control allows:

1. To quickly evaluate and with the minimum risk the efficiency of any performance technical-chemistry related to this system.
2. To diminish possible environmental, economic, physiological impacts.
3. To harness the final quality of the product and the productivity. Interpretation and diagnose: From the analysis of ground solutions the following information is obtained:

• The form of the availability of each chemical element.
• In global form the existence of synergies and antagonisms and the information on hydric gradient.
• Dynamics and movement of ions, as these are absorbed, to what extent and forms ionic, atmosphere redox, ionic precipitation existence, mobilizations, interchanges.

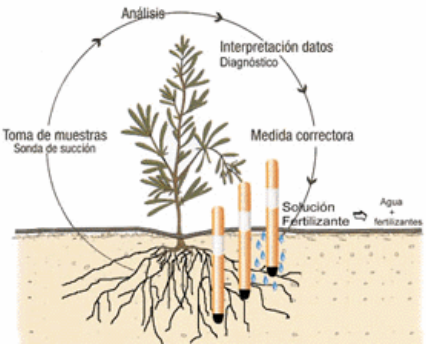
From the analysis of the fertilizing solution (SFR) it will be known: • Quality and composition of different fertilizers.
• Precipitated or obstructions in the irrigation system. From foliar analyses information is obtained about the capacity of the tree to absorb and to use the nutrients contributed in the fertilizing solution and by the ground.



MATERIALS AND METHOD

Location of the test: The work was made in the zone of Ovalle, located in the Fourth region in Chile, between the months of August until April. Four orchards of the zone were used, one was Pedregal, in the high Ovalle, With trees of 3 years, a distance of plantation of 6x3 with a surface of 12 hectares. Paloma Estates, in the zone of Sotaquí, 10 years with a distance of plantation of 7x6, with surface of 80 hectare. Agricola Cantarrana, with trees of 3 years with a distance of 6x4. Cerrillos de Tamaya, zone of Punitaqui, with 6 years, a distance of plantation of 6x4. Drip irrigation with two rows and drip inserted each 50cm. with a volume of 4 lt hr-1.

Extractometer: The extractometer (Agriquem ®) consists of a material that is used for the extraction as solution as ground to three depths 20.40 and 60 cm. where they are located, in the zone of the bulb to radicular and under the emitter. They consist of a tube of PVC that in its inferior part has a porous capsule of ceramics, place by where they are absorbed or penetrates the ground solution towards its interior. Later from that extractometer, the samples will be extracted to be sent to laboratory for their analysis.
Foliar analysis is made as a methodology of control on the nutricional state of the plant. The taking of these samples is a complement of the taking of samples of the soundings. Fertilizing solution: It consists of applying to the fertilizers more water of irrigation contributed to the irrigation system.

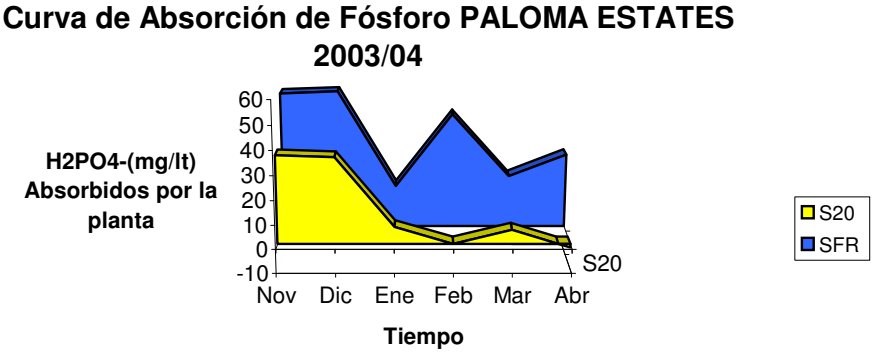


Therefore every 20 days volume the sample that consisted of the ground solution of each sounding, fertilizing solution in real time of irrigation, shows to foliar and water analysis. Altogether 8 times in the season.

RESULTS

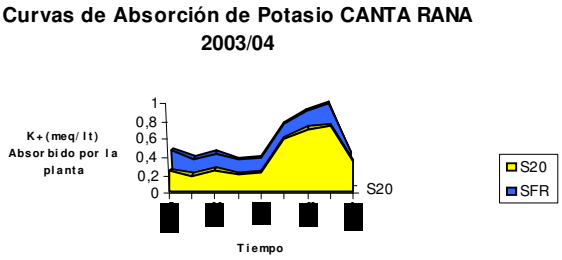
NITRATES is one of the form in which is available nitrogen for the plants, and this it is dissolved in the soil solution. The graphical show that the amounts of Nitrate are absorbed from August to December, reaching the Maxima absorption in the month of February with amounts of 1.71 (meq L-1.) In January, the absorption of the element stops, due to an increase in the contribution of water of irrigation therefore the concentration of the low nutrient, and therefore the low absorption of the element causing that the absorption of the element is null. Due to its negative load the power of adsorption of grounds is very under reason why the nitrate salts are very soluble and increase the possibilities that take place leachings of the anion. The leachings caused by an excess of irrigation are corroborated since when making a next sampling by the end of the month when this handling has been corrected, the amounts of nitrate begin to be absorbed and in greater amounts to the 60 cm. when the values of absorption reach the 1,12 (meq L-1). Navarro (2000) it indicates, that although nitric nitrogen, descends in the ground by leaching, inversely also can raise by capillarity in the periods of drought.

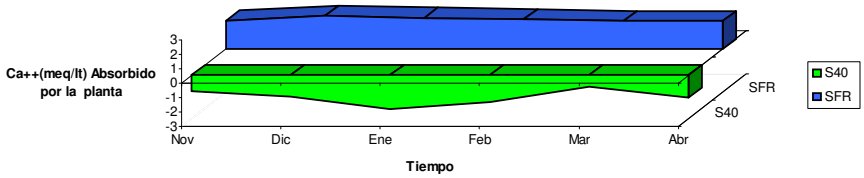
PHOSPHORUS

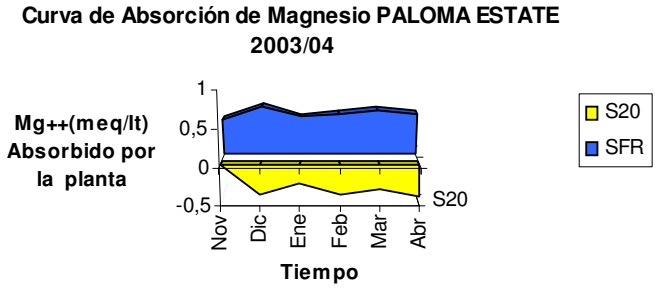


Navarro (2000) it indicates, that the element so that it can be assimilated, is necessary that one is like H2PO4-. The same author indicates that the Phosphorus is available in greater amounts with pH between 6 and 7. The analyses of soil solution show that pH Fluctuated between 6 up to 8.8 that already is high, which produces insolubilitation, forming precipitated like calcic phosphate. The Phosphorus for being a little movile element, does not undergo leaching (Navarro, 2000). When was apply phosphates fertilizers were not applied neutralizing bicarbonates of the irrigation water with. It was see that the absorption of the ion phosphate begins to happen from 15 ppm in the fertilizing solution, being observed positive answer the absorption until with 100 ppm.

POTASSIUM, CALCIUM AND MAGNESIUM

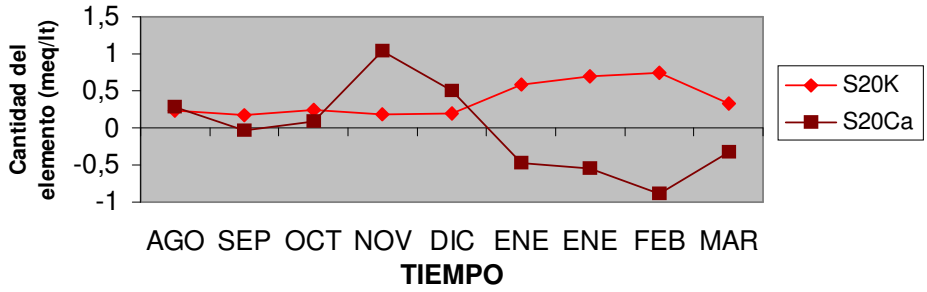




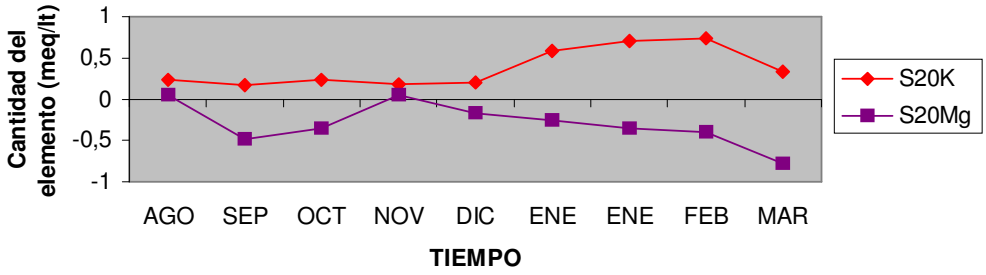


The potassium when comparing the graph of soil solution with the phenology curves of the culture, show us that the absorption is related to the vegetative growth and the flowering and fruit set. In the months of November and December the absorption is being 20-40cm. of depth to the 60 cm. no longer this being absorbed what sample that the element is leaching, or in opposite form is taking place antagonisms with other elements, existing competition to enter the plant. During the months of January March the absorption levels increase considerably since a fall of fruits appears and begins the second flash of vegetative growth where the Potassium begins to be required and it is, that at level to foliar the levels happens to be high. In the fields in study was observed a strong antagonism between potassium, calcium and magnesium in which the bivalent cations absorption was negative.

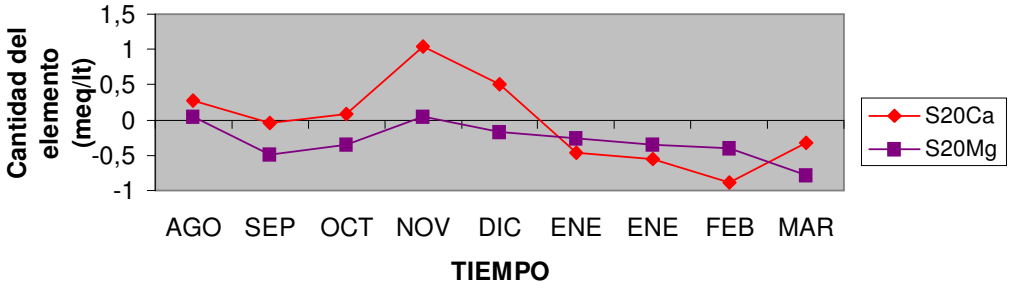
Curvas de antagonismos entre Potasio/Calcio
CAMARICO 2003/04



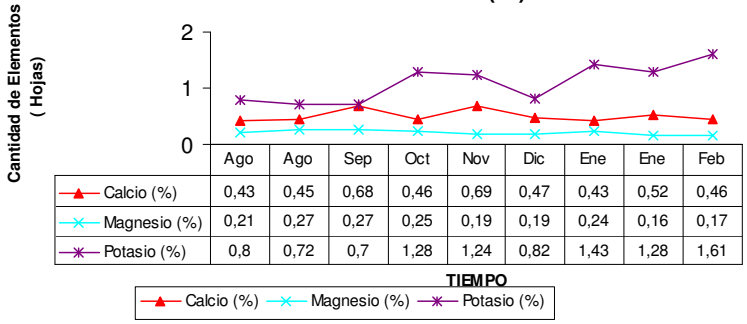
Curva de antagonismo entre Potasio/Magnesio
CAMARICO 2003/04



Curva de antagonismo entre Calcio/Magnesio
CAMARICO 2003/04



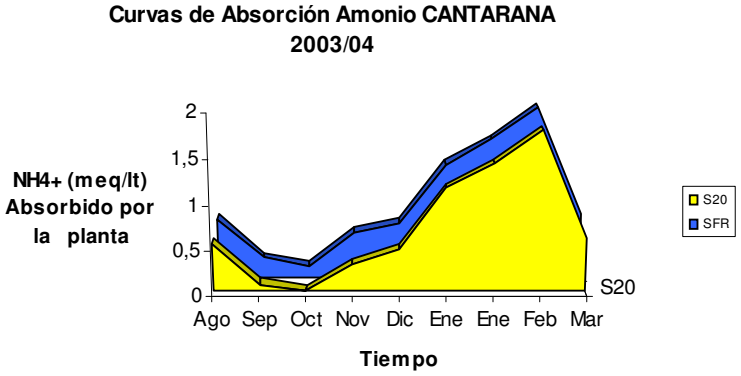
Curvas de Análisis Foliares (%)



	Ago	Ago	Sep	Oct	Nov	Dic	Ene	Ene	Feb
Calcio (%)	0,43	0,45	0,68	0,46	0,69	0,47	0,43	0,52	0,46
Magnesio (%)	0,21	0,27	0,27	0,25	0,19	0,19	0,24	0,16	0,17
Potasio (%)	0,8	0,72	0,7	1,28	1,24	0,82	1,43	1,28	1,61

In the foliar analysis It was observed deficiency of calcium and magnesium, not that potassium. Calcium the Maxima absorption is during the month of November arriving at a top of 1 meq L-1. Absortion in the 20 cm. of depth. Another moment of high absorption is reflected during the month of September with 0,83 (meq L-1), to the 40 cm. of depth. During this period the vegetative growth of spring appears and in addition flowering and materializes, which increases the flow transpiration and increases the absorption of the element. In general, the calcium absorptions are low, being null in the months of January, February and March which indicates leaching and antagonisms on the part of Potassium since the absorption levels are elevated, on the contrary the levels of Calcium absorption are diminished.

AMMONIUM

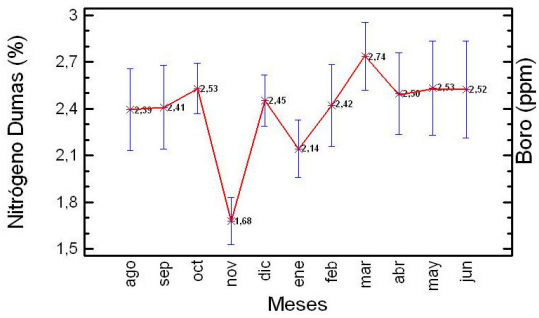


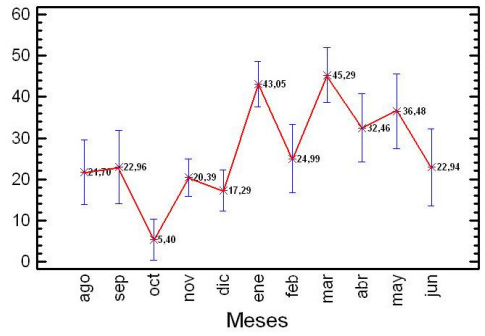
Another form in which Nitrogen is absorbed is like Ammonium ion (NH4+), great part of this ion this adsorbed on the surfaces of clays. The graphs show that the Ammonium is absorbed, during the months of August and September, with pH between 6 and 8 what it makes available. This fraction of nitrogen predominates in conditions of lack of I oxygen in the soil solution, and the opposite situation predominates the nitric fraction. During the month of October the availability is smaller, small amounts are available, but it is not absorbed, being able to be retained by clays. Soon an increase in the availability and the absorption of the ion begins ammonium. The ammonium disappear in the soil solution in February, in amounts of 1.80 meq L-1. It was not determine the amount of ammonium adsorbed by the soil.

Micro nutrients in this study were applied to foliar therefore did not determine them in the soil solution of these.

FOLIAR DYNAMICS

With the successive sampling of several seasons of nutricional pursuit dynamics can be constructed to foliar for each nutrient.


Nitrógeno Dumas (%)
3
2,7
2,4
2,1
1,8
1,5
2,39
2,41
2,53
1,68
2,45
2,14
2,42
2,74
2,50
2,53
2,52
ago
sep
oct
nov
dic
ene
feb
mar
abr
may
jun
Meses


Boro (ppm)
60
50
40
30
20
10
0
21,70
22,96
5,40
20,39
17,29
43,05
24,99
45,29
32,46
36,48
22,94
ago
sep
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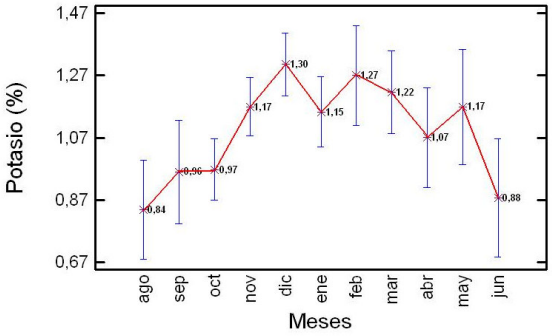
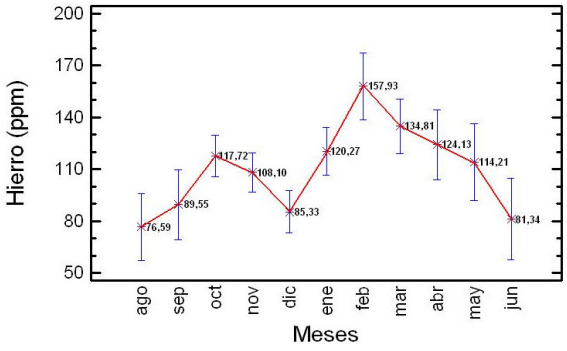
may
jun
Meses


Potasio (%)
1,47
1,27
1,07
0,87
0,67
0,84
0,96
0,97
1,17
1,30
1,15
1,27
1,22
1,07
1,17
0,88
ago
sep
oct
nov
dic
ene
feb
mar
abr
may
jun
Meses


Hierro (ppm)
200
170
140
110
80
50
76,59
89,55
117,72
108,10
85,33
120,27
157,93
134,81
124,13
114,21
81,34
ago
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mar
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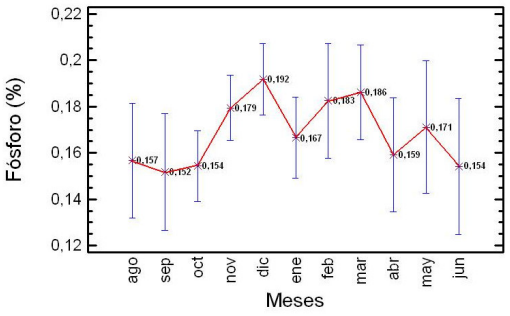
may
jun
Meses


Fósforo (%)
0,22
0,2
0,18
0,16
0,14
0,12
0,157
0,152
0,154
0,179
0,192
0,167
0,183
0,186
0,159
0,171
0,154
ago
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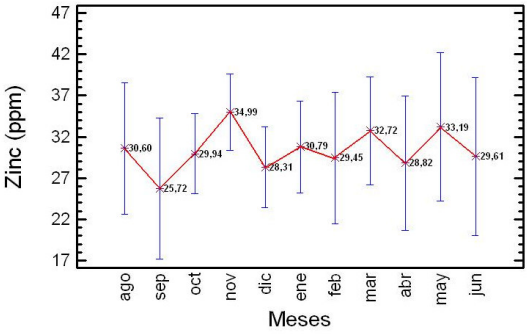
may
jun
Meses


Zinc (ppm)
47
42
37
32
27
22
17
30,60
25,72
29,94
34,99
28,31
30,79
29,45
32,72
28,82
33,19
29,61
ago
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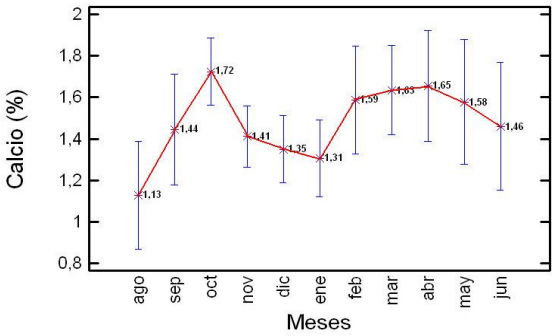
may
jun
Meses


Calcio (%)
2
1,8
1,6
1,4
1,2
1
0,8
1,13
1,44
1,72
1,41
1,35
1,31
1,59
1,63
1,65
1,58
1,46
ago
sep
oct
nov
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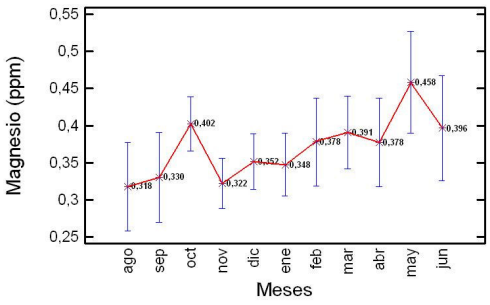
ene
feb
mar
abr
may
jun
Meses


Magnesio (ppm)
0,55
0,5
0,45
0,4
0,35
0,3
0,25
0,318
0,330
0,402
0,322
0,352
0,348
0,378
0,391
0,378
0,458
0,396
ago
sep
oct
nov
dic
ene
feb
mar
abr
may
jun
Meses

LEACHING

By means of the use of extractometers in the leached handling of fertigation it is possible to determine the intensity of nutrients. In the present work was considered the washing of the nitric form of nitrogen. The avocado responds to nitrate absorption between 1 to 2 meq L-1. In the orchards, the analyzed estates fertilizations in nitrate concentration took place between 0.5 to 3.5 meq L-1 therefore they are doses that must be fit to the nutritional requirement of the culture.

CONCLUSIONS

In the studied parcels it is possible to be determined that the concentrations in that the nutrients are absorbed by avocado are the following ones:
Nitrates 1 to 3 meq L-1.
The ammonium shows positive answer in the disappearance in the ground or by nitrificación, adsorption and/or absorption by the plant.
Minimum phosphate of 15 ppm seeing a positive answer the increase of concentration up to 100 ppm.
Potassium, calcium and magnesium greater answer with concentrations superior to 1 meq L-1, although the presence of the three at the same time in the irrigation bulb, generates ionic antagonism among them.

When analyzing the nitrate leached ones are observed that with concentrations greater to 2 meq L-1 begins to happen this process.

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