# Assessing Soil Phosphorus Availability in Andic Soils from Tenerife (Canary Islands)


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## Introduction

Canarias Explosivos, S.A. (CESA) is the leading company of the Canary Islands in fertilizer distribution. Founded in 1945, today CESA has warehouses in every island of the Archipelago, where all kinds of products for agriculture, coming from the principal internacional companies, are sold. CESA has an Agronomical Service to advise its clients, offering analytical services and fertilizing recommendations in its 'Laboratorio de Diagnóstico Agrícola I+D'.

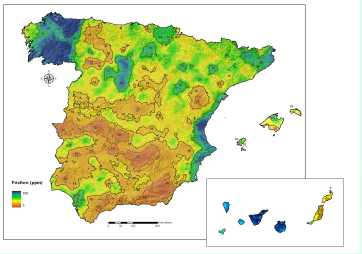
*From left to right: central warehouse in Tenerife, vineyard in the experimental plot in Grand Canary, and some views of the Laboratory and its staff.*

CESA's Laboratory was created in 1999. We carry out agricultural analysis: soil, water, nutritive solutions, drainages, leaves, fertilizers, compost, compost tea, slurry, growth media, sap... Our experience includes more than 11,000 samples (130,000 determinations) from the Canaries, Morocco, Senegal, Cape Verde and the Iberian Peninsula.

Apart from our routine analyses, the Laboratory has as its main research line the study and development of alternative analysis methods appropriate for soils derived from volcanic ash.

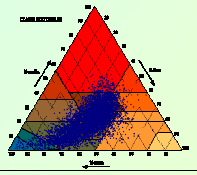
Andic soils usually show problems for the determination of nutrient availability because of their special physical and chemical characteristics. Soil Phosphorus availability is one of the problematic topics, but cation interchange capacity, salinity or boron management are also troublesome in variable charge soils.

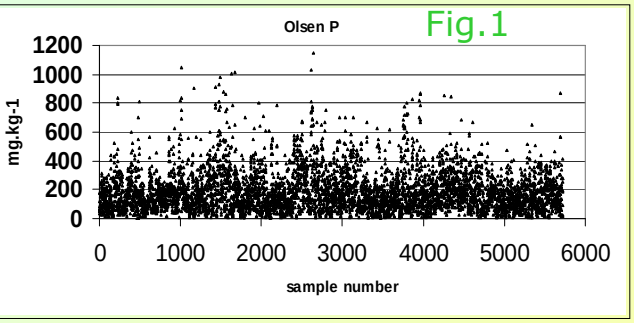
## Is there a P overfertilization in the Canary Islands?



In 2009, the Spanish 'Ministerio de Medio Ambiente y Medio Rural y Marino' published in the book "Metales Pesados, Materia Orgánica y otros Parámetros de los suelos Agrícolas y Pastos de España" this map of Olsen P (left). In the text it is said that contents greater than 32, 48 and 66 ppm are "very high" for sandy, loam and clayish soils, respectively. Our recommendation for banana crops is a figure between 80-110 ppm. This clash of criteria could create problems as fertilizing regulation increases in the EU due to environmental concerns.

Content of Olsen P according to our 11-year work on Canarian fields is presented in Fig. 1. The mean value is 190 ppm, but the median is 160. Samples' texture is shown below on the USDA triangle: by far, most soils are sandy loam, loam or clay loam.

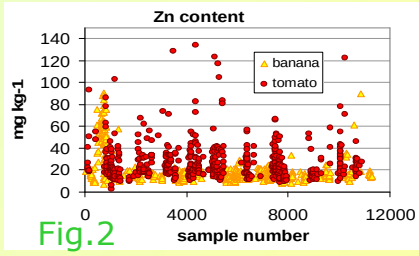





### The clues:

- Soils derived from volcanic materials show a very high affinity for P due to amorphous or short-range-ordered aluminosilicates (allophane, imogolite), Fe and Al oxy-hydroxides, and Al(Fe)-humus complexes.
- Assessing soil P availability is problematic because Olsen extraction yields values much higher than those reported in standard tables.
- Alternative extractions, such as anion exchange membranes and water extraction, are well known but still not considered in Spanish Official Methods. Contrary to other countries where andic soils are found, in the Canaries Olsen extraction remains widely used. This creates a generalised confusion that has lasted for decades.

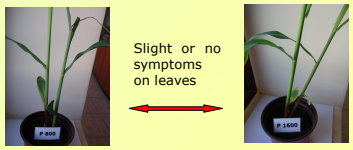
Actually, there are no signs of a wide overfertilization... In Fig. 2 we present zinc foliar content in banana and tomato leaves analysed in our Laboratory. Mean values are not below recommended levels, as would be expected in case of high available P levels. CESA's experience on the field shows that halting application of P fertilizers results in decreasing yields, as happens when agriculturists go into organic farming.

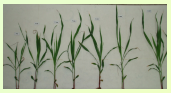



In this paper we show the unusual affinity of andic soils by means of a sorption curve. The soil chosen for our work is a typical organomineral A horizon at high altitude (950 m.a.s.l.), under pine forest, very rich in organic matter (13%), acid (pH 5,8), very light (d=0,5 g·cm$^{-3}$). It is the kind of soil that for centuries has been carried down to lower, warmer, zones of Tenerife to create artificial soils ("sorribas"). A sample was taken, air-dried, sieved through 2 mm and 500 g portions of which were equilibrated during 2 weeks with solutions containing increasing concentrations of P, resulting in amounts of supplied P from 50 to 1600 mg·kg$^{-1}$. Then the soils were analysed for available P by Olsen classical extraction and water extraction (1:10). Extraction and determination according to procedures described in L'Analyse du sol (Institute de Recherche pour le Développement). The sorption curve in Fig.3 shows a very strong P retention, with a maximum capacity around 2000 mg P kg$^{-1}$, obtained from the Langmuir linear regression. Thus, the quantity of fertilizer required to produce an appropriate concentration of P in soil solution is above standard, official recommendations. The Olsen P figures obtained, shown in Fig.4, range up to 128 mg·kg$^{-1}$, not necessarily meaning adecuate levels. To prove this we finally carried out a simple pot test with maize, growing plants in the portions of andic soil supplied with 0, 50, 100, 200, 400, 800 and 1600 mgP·kg$^{-1}$, and studying their development after 4 weeks. As we can see in the photos, only the 800 and 1600 treatments gave enough available P to ensure a healthy growth. There was only a slight increase in root length and foliar development, due to the soil buffering effect. In the other treatments different degrees of deficiency symptoms appeared (stunted plants, purplish spots on older leaves). This experiment confirmed the validity of empirically obtained values around 100 mg·kg$^{-1}$ of Olsen P as suitable for most crops.

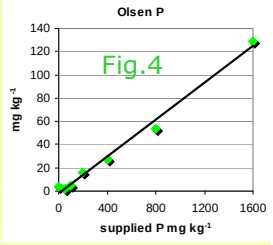
Purple spots on stem and lower leaves (labels show supplied P mg·Kg$^{-1}$)

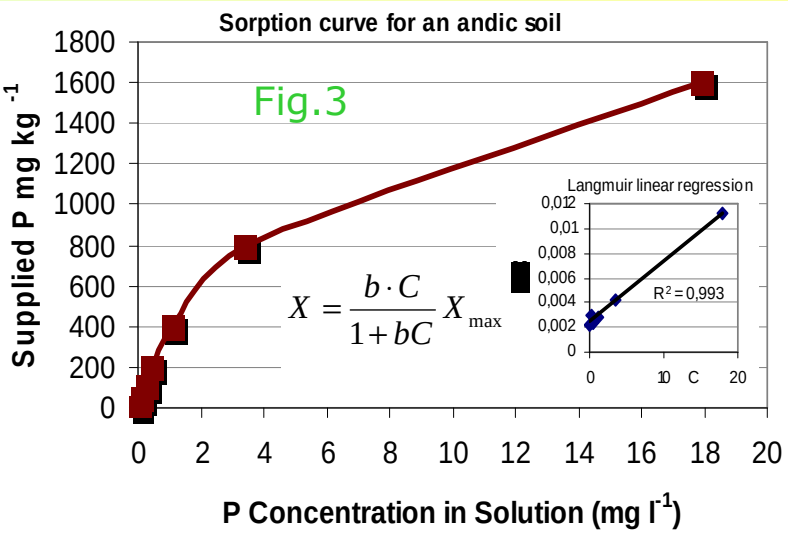

Slight or no symptoms on leaves



Root and leaf development




### Conclusions

- Our purpose was to show the disparity of views between Spanish Official Methods and the reality of soils with andic characteristics found in the Canary Islands.
- Alternative methods have been suggested for these kinds of soils. In the Canaries, anion exchange membranes and water extraction have been introduced, but only the last one has potential interest. Membranes have some limitations and are not suitable for routine analysis (required equilibration time).
- Further research must be done on water extraction to calibrate it with plant response. Our Laboratory intends to follow this research line and look for cooperation with public instances and La Laguna University.

Selected bibliography: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✓ Miguel Ángel Negrín Medina. Especiación de fósforo en suelos ándicos de las Islas Canarias. Tesis doctoral. ISBN 84-7756-666-6