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# Orchard`s soil characterization and nutrient mobilization to Rocha pear (*Pyrus communis* L.) fruits

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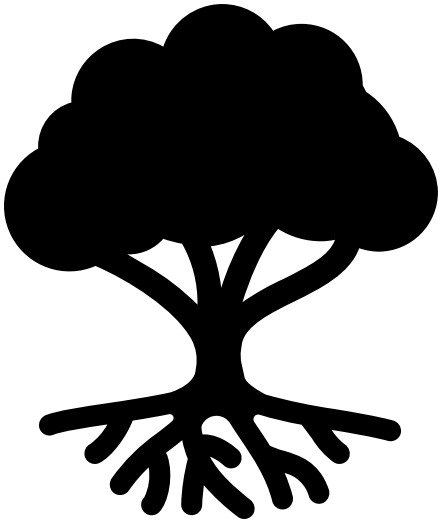
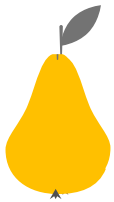


*Pyrus communis* L.



- Fruit
  - Mineral analysis
- Soil
  - Humidity
  - Organic matter
  - pH
  - Electrical conductivity
  - Colorimetric parameters
  - Mineral analysis

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**Abstract:** Soil is a limited resource, being vital for plant production during the agricultural phase, and consequently a fundamental component of the agro-industrial sector. In a near future where efficiency in food production will be crucial to feed a growing population, agronomic strategies to ensure food quality needs to be tested and optimized with field trials. Taking this into consideration, in 2018, as part of the execution of a fortification workflow of Rocha pears (*Pyrus communis* L.), a field characterization was carried out before the beginning of foliar spraying, to identify possible limitations to the increase of calcium in fruits. Thus, in March, soil samples were collected from an orchard (i.e., a parcel with 500 $m^2$) located in the West region of Portugal, where this variety is largely produced. During sample analysis, humidity, organic matter, pH, electrical conductivity, colorimetric parameters by CIELab system (with and without organic matter) and mineral analysis by X-ray fluorescence (of soils and fruits at harvest) were assessed. Humidity values indicated an even irrigation on the orchard. Additionally, it was found that organic matter values influenced soil color. Electrical conductivity and pH values were within the recommended range for pomeids. Additionally, higher values of Ca and P prevailed in soils, while K and S contents remained higher in fruits. In conclusion, no major limitations were identified, and field characterization before Ca fortification workflow was useful to assess the orchard`s conditions and possible limitations to nutrient absorption by trees.

**Keywords:** Chemical and physical parameters; Colorimetric analysis; analysis; Orchard; Soil analysis

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# Introduction

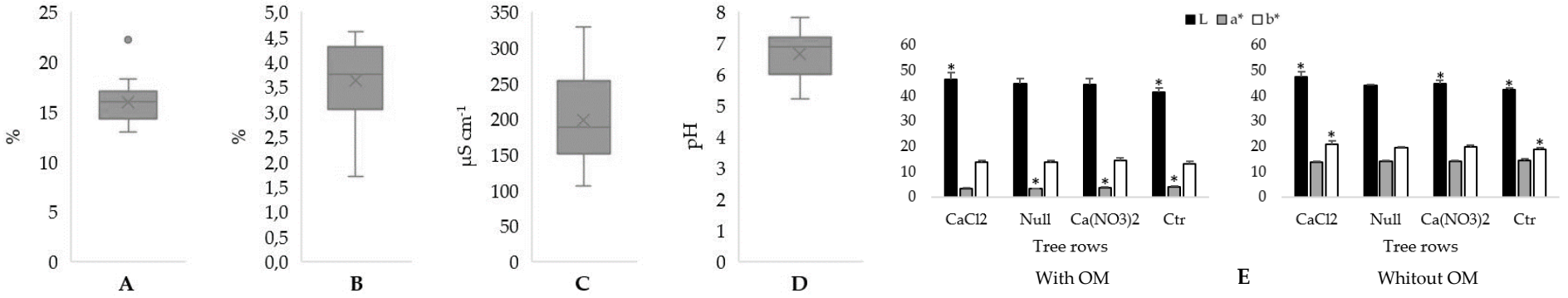
Food is a necessity granted to consumers by agroindustries. However, in meads of an expected increase of global population, and likely limitation of water and land resources, maximizing efficiency and reducing waste becomes crucial to achieve sustainability (FAO, 2017; FAO, 2021).

Agricultural land takes up 38% of the global land surface, from which two thirds are meant for livestock, and the remaining third is used as cropland (10% destined for permanent crops such as fruit trees) (FAO, 2021).

Calcium (Ca) is the third most important element present in soils, but sometimes its compounds can be unavailable for plant absorption due to its insolubility (D`Imperio, 2016). Furthermore, besides Ca availability in soils, other factors such as competition with other cations, transpiration and root growth influence Ca absorption by plants (Bonomelli et al., 2019).

Currently in Portugal, over 11 300 ha are destined to pear production (INE, 2021). This study hence focused on the physic-chemical assessment of an orchard of pears prior to the execution of a fortification workflow with Ca, to identify limiting factors to potential Ca increases in fruits, further considering mobilization of nutrients from soils to control fruits.

# Results and Discussion




- **Humidity (A)**: For this agricultural parcel, there was a variation of 5.3% between samples suggesting an adequate drainage system. This can be due to the drop-to-drop irrigation system performed in the orchard, which is advised, to assure nutrient assimilation from soils and consequent healthy development of fruits (DGADR, 2021).
- **Organic matter (B)**: Our values were on average in accordance with another study (Mendes, 2017), where OM values of 8 different Rocha pear orchards located in the West region of Portugal, varied between 2.46 % to 4.68 %, with only one sample from our parcel being outside this range.
- **Electrical Conductivity (C)**: The EC values from this field were inferior to 600 µS $cm^{-1}$, being in accordance with the recommended value for orchards with these trees (pomeids) (DGADR, 2021).
- **pH (D)**: Overall, pH values were between 6 – 8 (except 3 values) which is an adequate interval for agricultural practices (Läuchli and Grattan, 2012) since most nutrients are easily absorbed by vegetation.
- **Color (E)**: This indicates that OM contributes to the color of soils, being in accordance with other authors (Margesin and Schinner, 2005) as previously mentioned, and its presence caused a decrease of a* and b* parameters, while L was not majorly affected.

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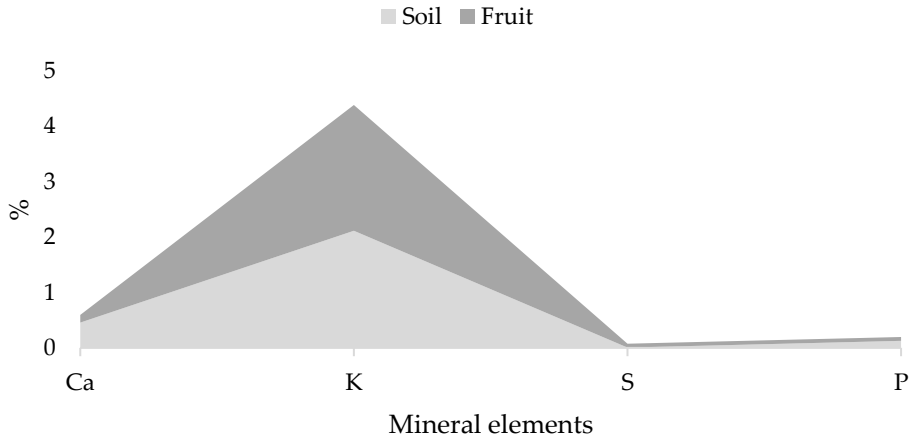
# Results and Discussion

Regarding mineral content of soils and fruits at harvest (without any foliar sprays), Ca and P were superior in soils, while K and S presented higher values in fruits.




Plants development and growth can be related to 17 elements, that can be acquired from soils, and P, K, Ca and S are required in larger quantities (Kumar, 2021). When considering these four elements, and their usual content in soils, literature (El-Ramady et al., 2014) indicates a prevalence of K (0.2 - 3%) and Ca (0.2 - 1.5%) in comparison to P and S (0.01 - 0.1%), with our soil values being in accordance with these proportions.

For plants, the adequate proportion of elements should pass by K > Ca > P > S (Taiz and Zeiger, 2002), and regarding mineral content in pear fruits, K is present in larger quantities in comparison to P and Ca (PortFIR, 2021), with the same tendency occurring for our data. These results can not only be related to absorption and translocation processes, and hence mobility in plants, but also physiological functions of these minerals.

# Conclusions

Considering this parcel`s characteristics, no major limitations were identified, deeming it adequate for the implementation of a foliar spray workflow. The results further showed, no constraints to nutrient absorption due to the presence of an adequate irrigation system, no necessity of additional energy spent by trees during nutrient absorption from soil, and pH values adequate for nutrients availability. The mineral values from the soil and fruit were in accordance with literature, and availability, interactions, transport and physiological functions contribute to their proportions.

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