The importance of moisture in soil and its impact on the emission of BVOCs

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INTRODUCTION

- Climate change has significantly impacted global agriculture, exacerbating challenges faced by farmers worldwide [1].
- Allegedly, soil biogenic volatile organic compounds (BVOCs) are primarily attributed to microbial metabolic activities [2].
- It is claimed that soil drought diminishes BVOCs emissions due to purported reductions in microbial activity and decomposition processes [3].
- This study investigates reduced rainfall's effects on Cypriot vineyard soils' aromatic profile and elemental composition.
- Through controlled experiments simulating rainfall reduction, this research aims to discern the potential repercussions of soil moisture depletion on vineyard soil characteristics.

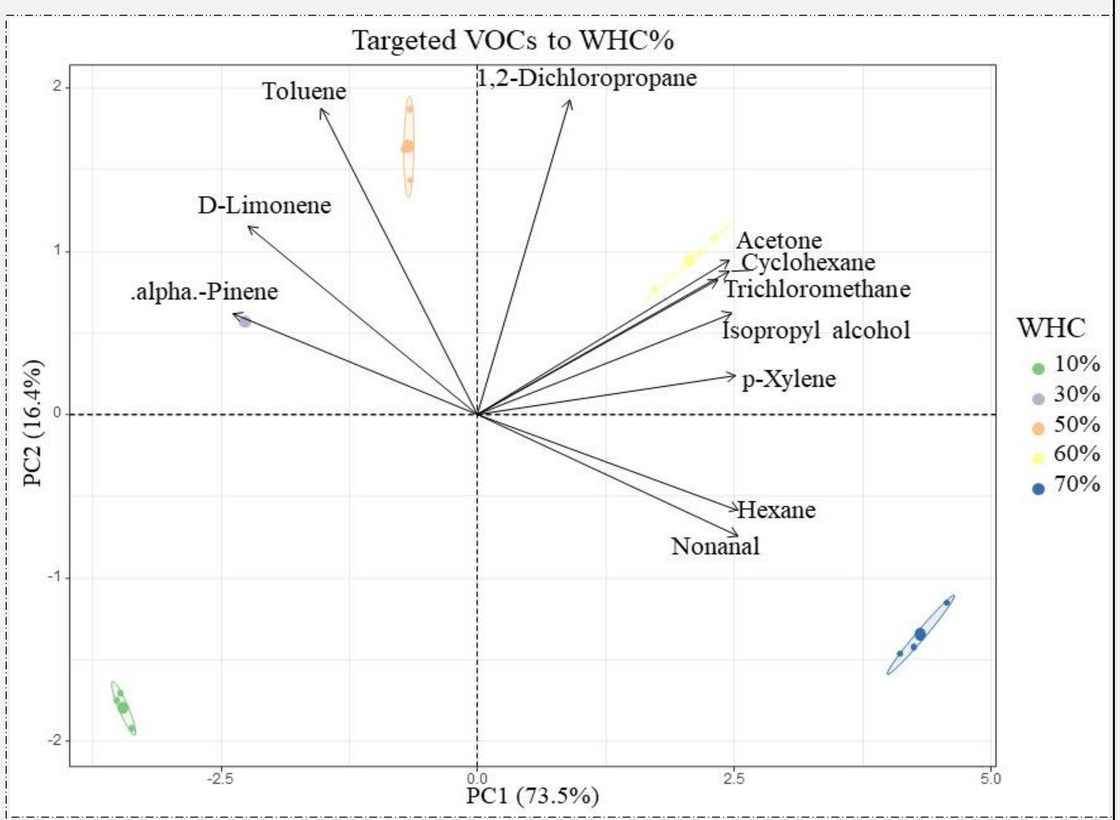
EXPERIMENTAL PART

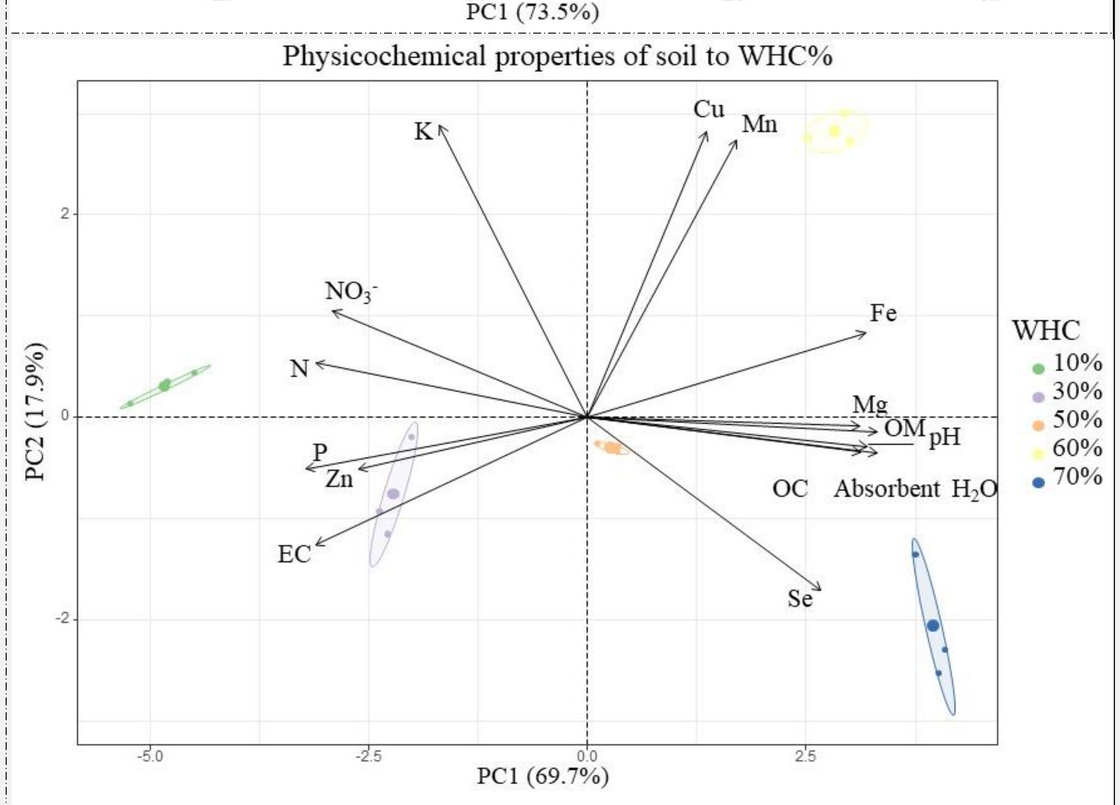
PAL HS-SPME-GC-MS system

- **Water-holding capacity (WHC) Assessment:**
  - Soil samples were collected from a vineyard in the village of Soultanina variety, located in Limassol, Cyprus.
  - Simulated drought stress on soil was achieved by varying soil water-holding capacity (WHC) percentages, mimicking climate change effects:
    - Drought stress conditions were simulated at 10% WHC.
    - Control conditions were maintained at 30%-70% WHC, representing typical rainfall levels.
- **BVOCs Analysis:**
  - Analysis of soil BVOCs was performed using headspace solid-phase microextraction coupled with gas chromatography-mass spectrometry (HS-SPME-GC-MS).
- **Determination of Soil Nutrient Concentrations:**
  - Concentrations of NO_3^-- nitrate (UV/Vis spectrophotometer), as well as macro-elements (Phosphorus - P, Potassium - K, Nitrogen - N, Magnesium - Mg) and micro-elements (Copper - Cu, Zinc - Zn, Manganese - Mn, Selenium - Se, Iron - Fe) were determined using atomic absorption spectrometry (AAS), Kjeldahl method, and flame photometer.
  - Soil samples with different WHC percentages were analyzed to assess nutrient availability under varying soil moisture conditions.
- **Additional Soil Parameters:**
  - pH and electrical conductivity (EC) were measured to evaluate soil acidity and salinity levels.
  - Organic matter (OM) and organic carbon (OC) content were determined to assess soil fertility and carbon sequestration potential.
- **Statistical Analysis:**
  - Data processing was performed using RStudio 4.3.3, employing Principal Component Analysis (PCA) plots to elucidate relationships between variables and treatments.

RESULTS

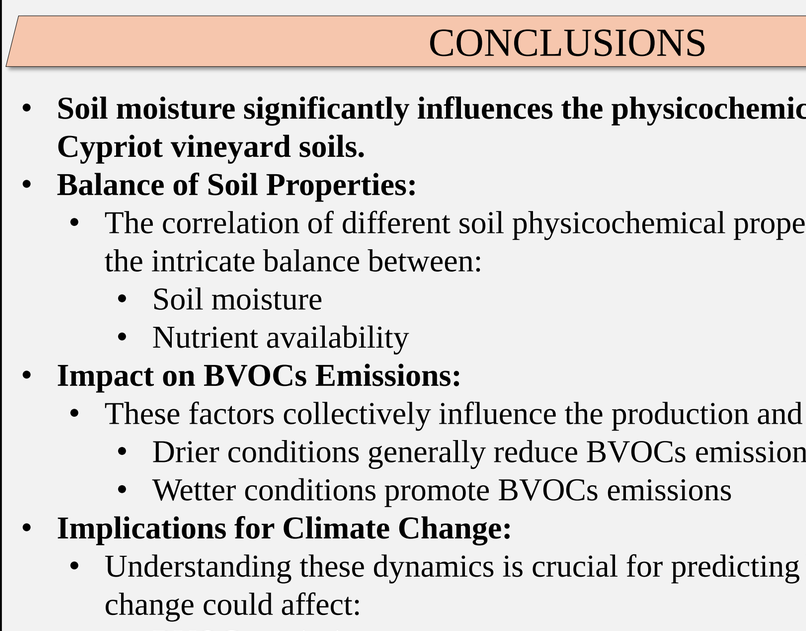
- **a-Pinene and d-Limonene:**
  - Decrease with increased WHC%
  - Higher emissions under drier conditions due to stress responses in vineyard soil microorganisms
  - Correlated with higher NO_3^-, N, P, K, Zn, and EC at low WHC%
- **Hexane, Acetone, Isopropyl Alcohol, Cyclohexane:**
  - Increase with increased WHC%
  - Enhanced microbial activity and decomposition in moister vineyard soils
  - Correlated with higher Cu, Mn, Fe, Mg, OM, pH, OC, and EC at higher WHC%
- **Toluene and p-Xylene:**
  - Increase until 50% WHC, then decrease until 70% WHC
  - Optimal microbial activity in vineyard soils at moderate WHC levels
  - Correlated with balanced nutrient and physicochemical properties at moderate WHC%
- **1,2-Dichloropropane and Trichloromethane:**
  - No significant effect of WHC%
  - Stable production in vineyard soils unaffected by soil moisture variations
- **Impact of Long-term Drought on Vineyard Soil Functions:**
  - Reduced microbial activity: Lower soil moisture diminishes microbial metabolism in vineyard soils
  - Decreased nutrient cycling: Slowed processes reduce nutrient availability for vines
  - Altered BVOCs emissions: Shift in types and amounts due to stress responses in vineyard soils
  - Soil carbon sequestration: Reduced decomposition and altered carbon dynamics in vineyard soils

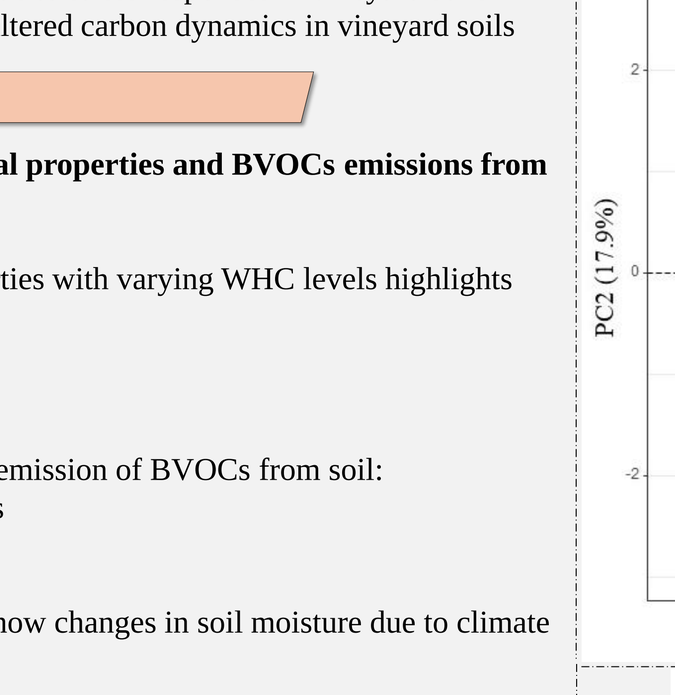




CONCLUSIONS

- **Soil moisture significantly influences the physicochemical properties and BVOCs emissions from Cypriot vineyard soils.**
- **Balance of Soil Properties:**
  - The correlation of different soil physicochemical properties with varying WHC levels highlights the intricate balance between:
    - Soil moisture
    - Nutrient availability
- **Impact on BVOCs Emissions:**
  - These factors collectively influence the production and emission of BVOCs from soil:
    - Drier conditions generally reduce BVOCs emissions
    - Wetter conditions promote BVOCs emissions
- **Implications for Climate Change:**
  - Understanding these dynamics is crucial for predicting how changes in soil moisture due to climate change could affect:
    - BVOCs emissions
    - Atmospheric chemistry
    - Ecosystem health





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