Unraveling metabolically active fungal-bacterial diversity in commercial organic vineyard soils

Carmen Biel[1], Miriam Guivernau[2], Marc Viñas[2], Xavier Aranda[3], Robert Savé[3] and Felicidad de Herralde[3]

[1]IRTA, Sustainable Plant Protection Program, Cabrils, (carmen.biel@irta.cat)
[2]IRTA, Integral Management of Organic Waste Program, Torre Marimon, Caldes de Montbui,
[3]IRTA, Fruit Production Program, Torre Marimon, Caldes de Montbui
SPAIN

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OBJECTIVES

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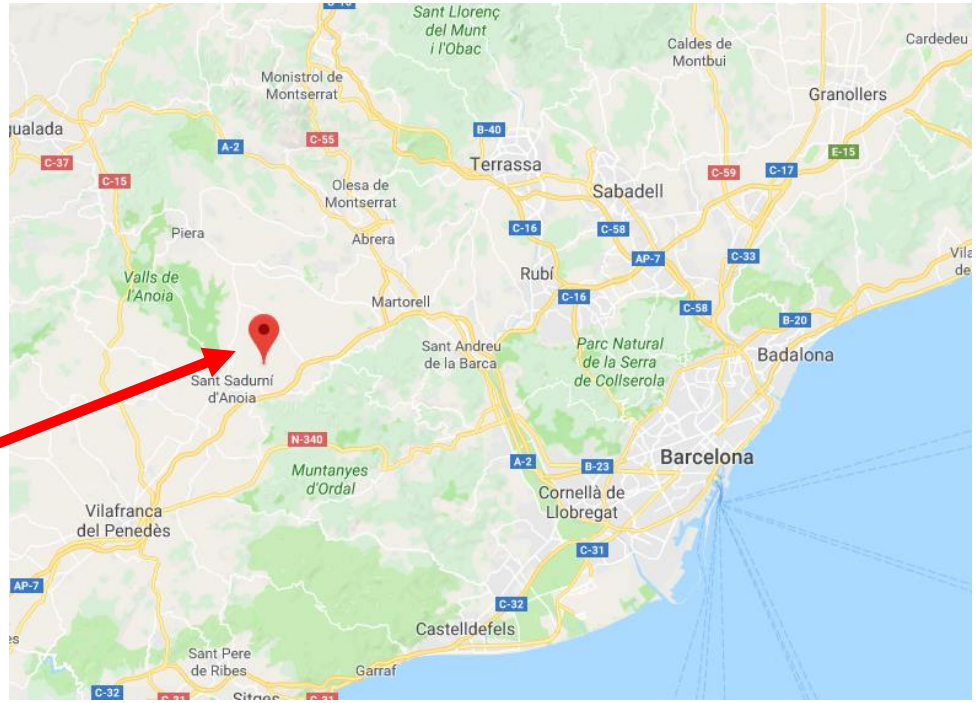
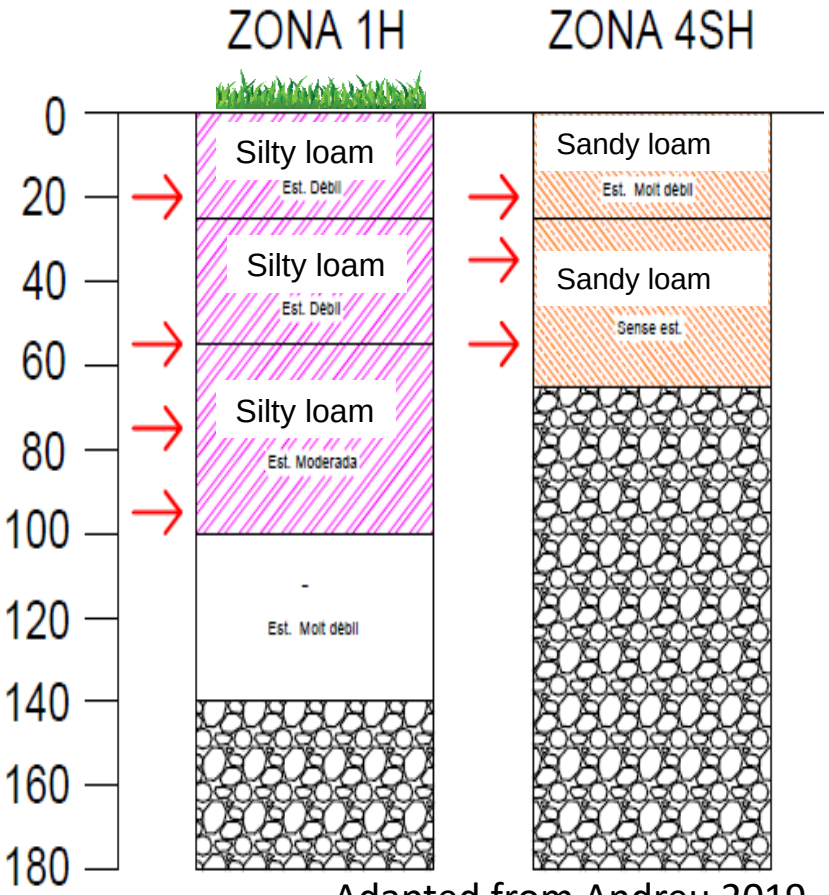
To assess the impact of phenology (pre-bloom and post-harvest periods) on the diversity of metabolically active soil-rhizosphere microbiota in a commercial vineyard in Sant Sadurní d'Anoia, a typical cava and wine producing region (Penedès DO, Catalonia, Spain).



Location of Catalonia (dark green)
Plot coordinates: 41°49'N 1°28'E

METHODOLOGY

- *Vitis vinifera* variety 'Macabeu', grafted onto 41-B (*V. berlandieri x V. vinifera*), 20 years old.
- Total Surface 6 ha, vine spacing: 1,0 x 2,6 m.
- Organic and rainfed farming.
- Fertilizer: 20 tones (composted cow manure)/ha every 4 years.
- Permanent cover crop and **silt loam** soil in Zone 1 and tillage and **sandy loam** soil in Zone 4.



Adapted from Andreu 2019

Mediterranean climate (SMC)

Temperature

Summer: 23–24 ºC

Winter: 6–8 ºC

Rainfall

- Annual 550 mm
- Maximum rate in fall and minimum rate in summer

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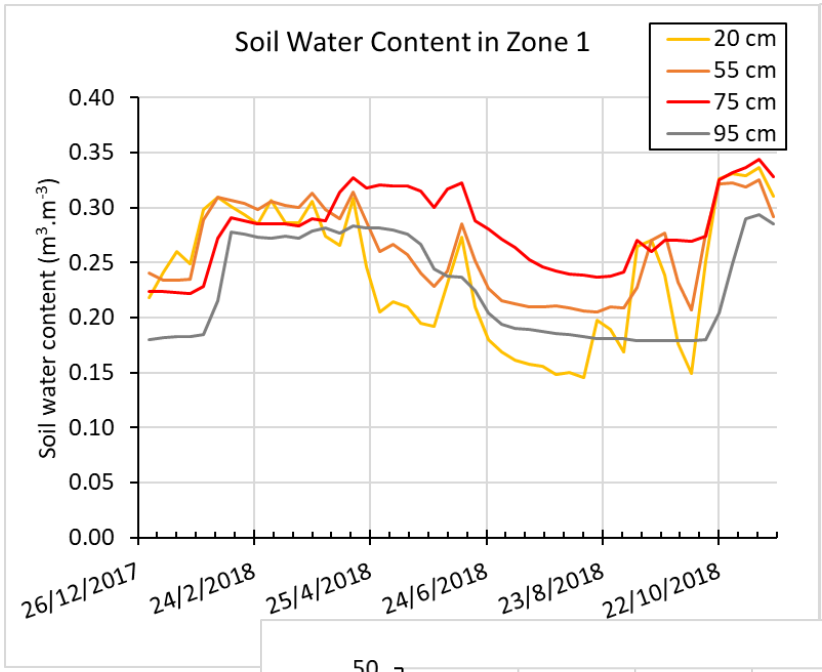
RESULTS

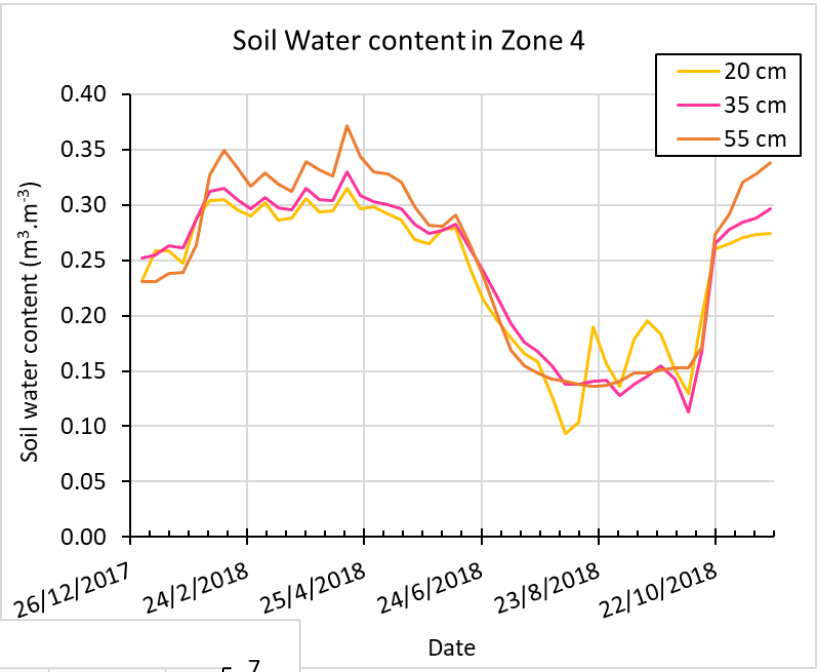
Soil water content

Measured with FDR proves (model 10HS, (Decagon) at diferent soil depths

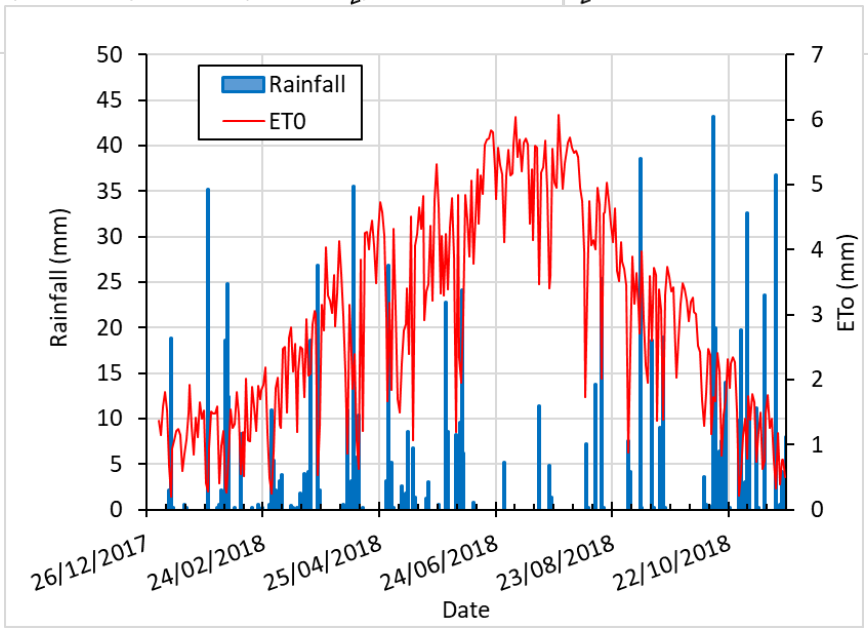
Silt loam soil, CRAD = 165 mm



Sandy loam soil, CRAD = 36 mm



Rainfall and ETo



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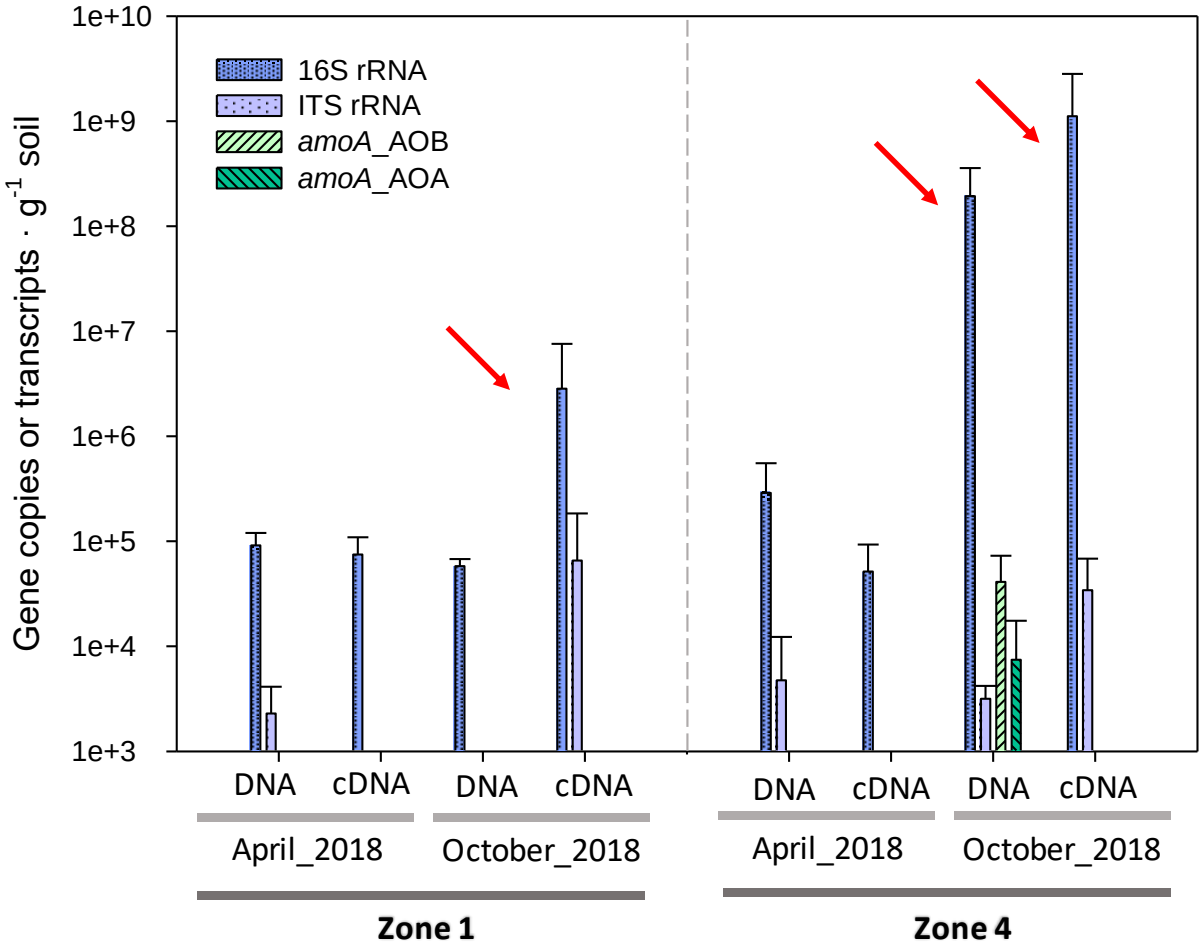
RESULTS

Microbial assessment: Quantitative PCR



April 2018: Pre-harvest

October 2018: Post-harvest

In **post-harvest period, bacterial and fungal population were more enriched and active**, specially in zone 4.

In zone 1, active bacterial population increased 2 orders of magnitude.
In zone 4, metabolically active bacteria increased 5 orders of magnitude.

The harvest and climate conditions promoted this activity.

Bacteria and Archaea Ammonia Oxidizers (AOB and AOA), were detected in, **post-harvest period.**

***Nitrospirales* presence and activity** (MiSeq data), could hamper ammonia-oxidizers activity.

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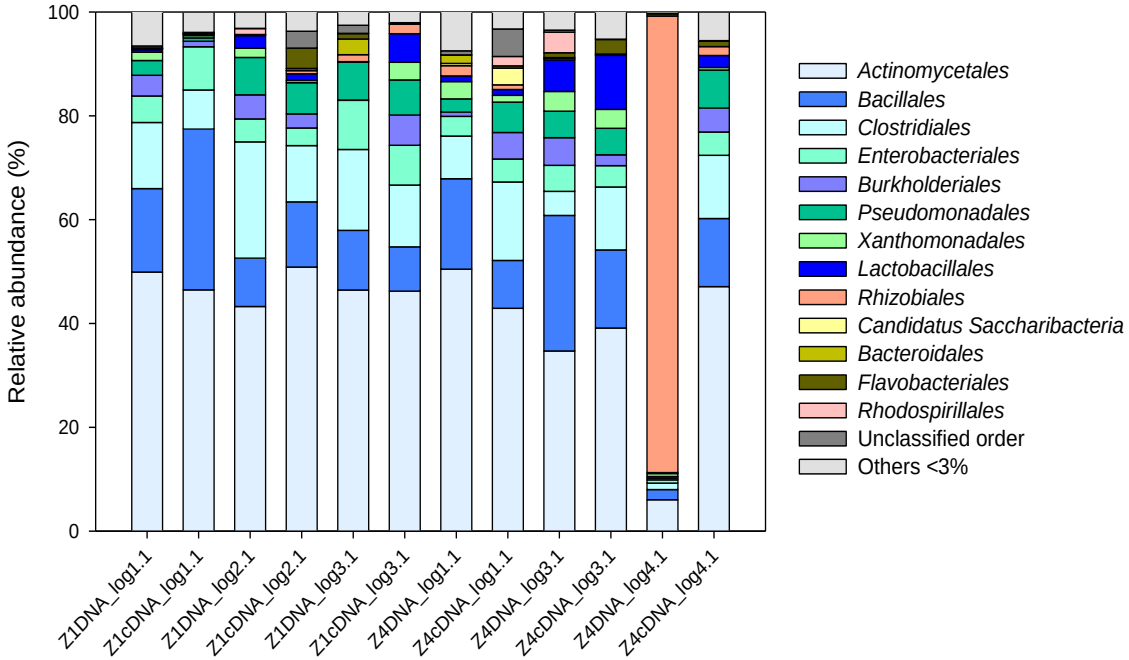
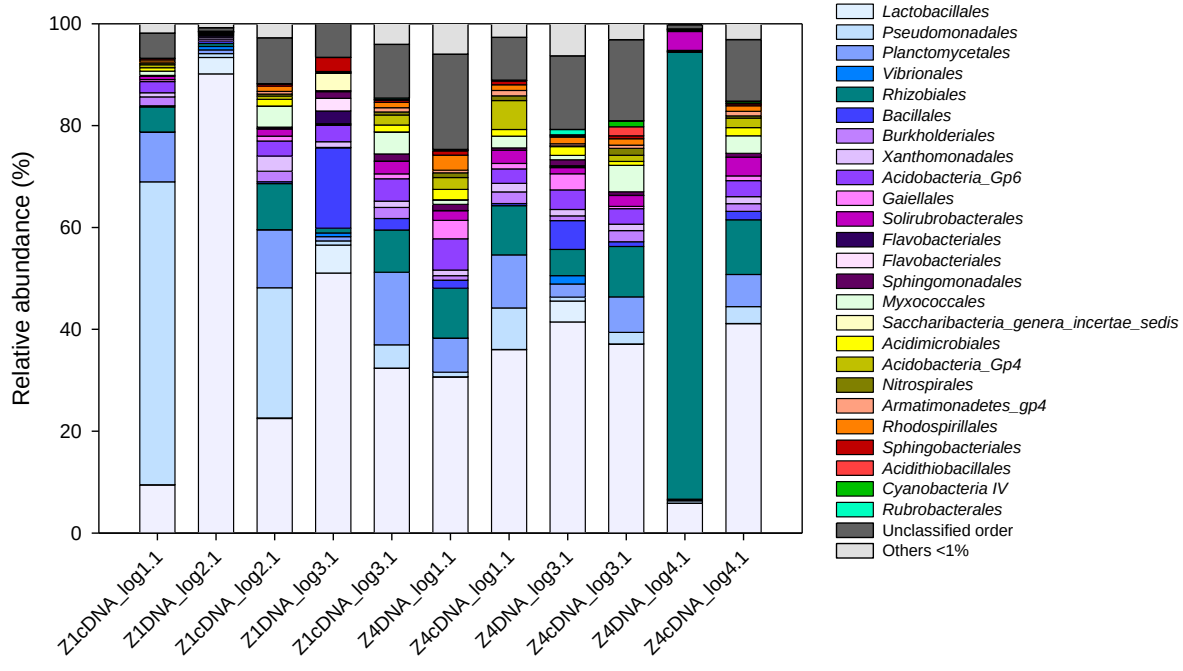
Bacteria (MiSeq 16S-V1-V3)

Bacterial Diversity

April 2018: Pre-harvest

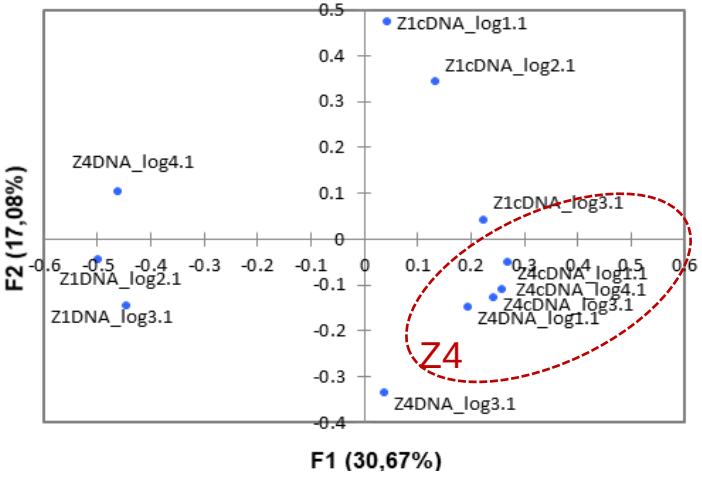


October 2018: Pos-harvest

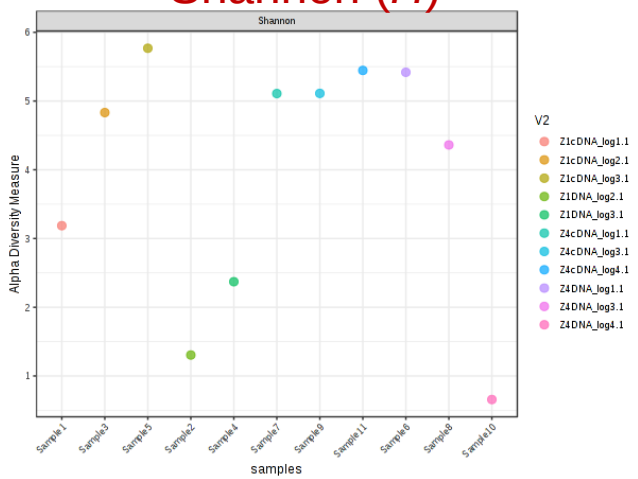


Bacterial Diversity: POST-HARVEST

PCoA



Shannon (*H*)



- Total and functional bacterial diversity in Z4 is more homogeneous in postharvest period than Z1 zone.
- ***Actinobacteria*** (mainly by *Actinomycetales* order), ***Proteobacteria*** (mainly by *Rhizobiales* and *Pseudomonadales* orders) were the most predominant phylotypes.
- ***Clostridiales*** (*Firmicutes* phylum) phylotypes were completely replaced during post-harvest season.

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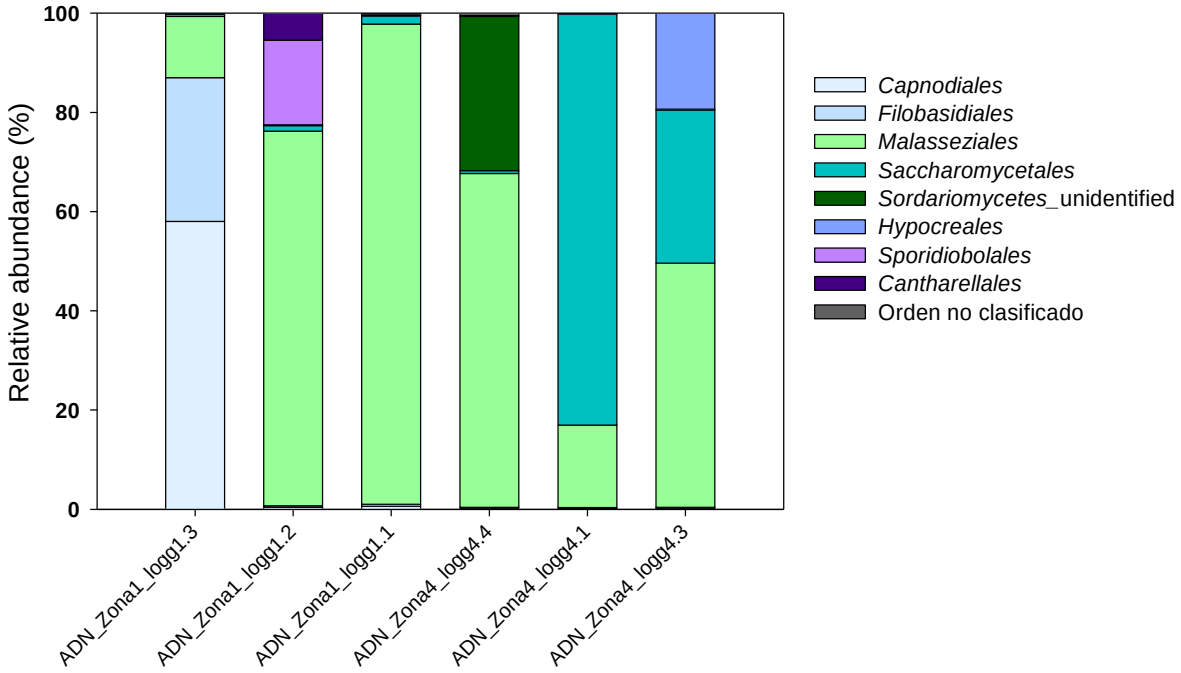
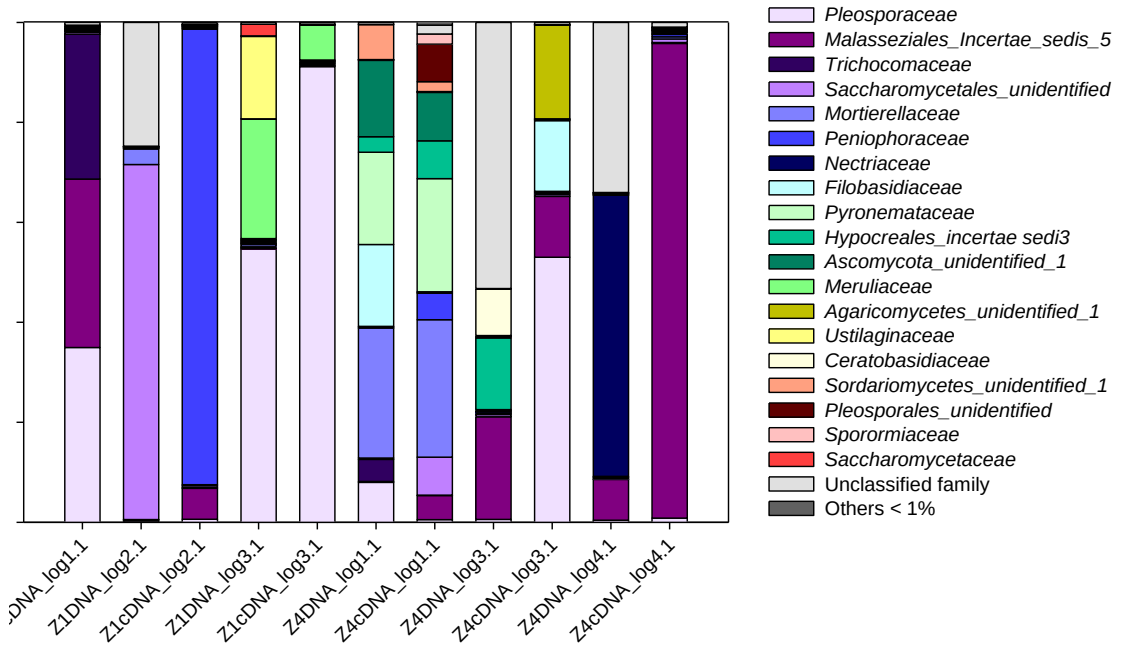
Fungi (MiSeq ITS1 rRNA)

Fungal Diversity

April 2018: Pre-harvest

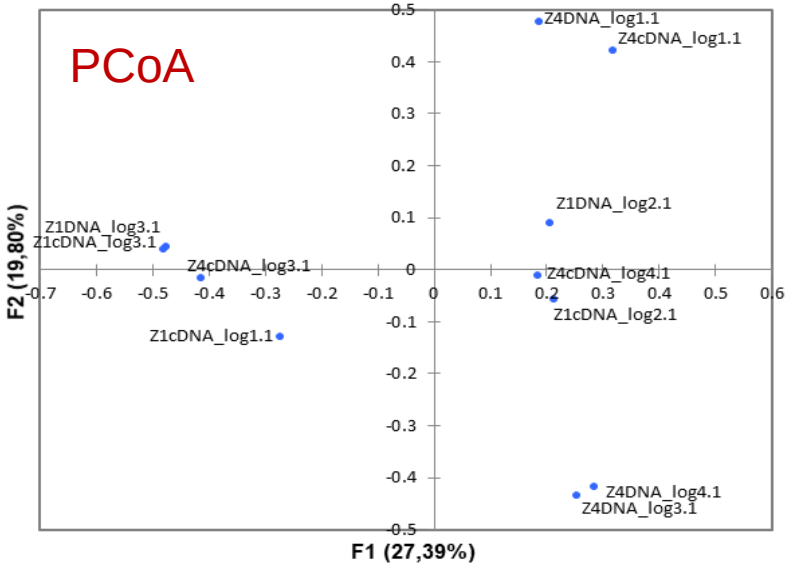


October 2018: Pos-harvest



Fungal Diversity: POST-HARVEST

PCoA



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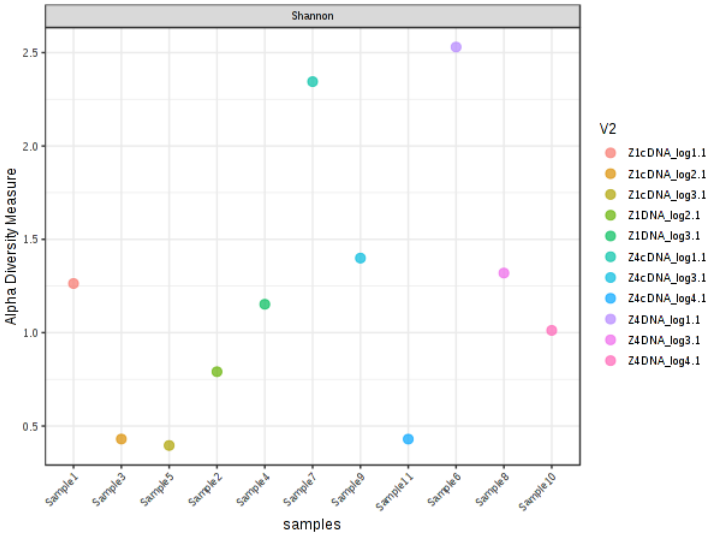

- **Alpha Fungal diversity was lower** than bacterial diversity in both plots.
- Fungal alpha and beta diversity was **smaller and less uniform** in both periods than bacterial diversity

Ascomycota, Basidiomycota and ***Zygomycota*** *were the most predominant* phyla.

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CONCLUSIONS

• Soil bacterial and fungal communities were more metabolically active during post-harvest than pre-harvest season season in both zones.

• No metabolically-active fungal community was detectable in pre-harvest period. Fungal populations were less diverse than bacterial diversity.

• Both environmental conditions and the mechanical harvest may promote microbial growth due to sugar availability in soil (-30 cm) linked to rainy periods. The vineyard, in post-harvest period, could be more exposed to phytopathogens, so this could be an interesting period to control these communities and consequently the potential infection for the next productivity period.

• High throughput sequencing analysis (16S/ITS MISeq) revealed that the microbial diversity was specific both for each plot each plant and time period.

• The diversity of bacterial and fungal populations increased during post-harvest season.

• Simultaneous RNA/DNA-based molecular biology tools could improve the knowledge of metabolically active microbial populations in soils at different seasons and phenological stages of rainfed vineyard.

• These can be important in order to study and evaluate the potential and real emissions of greenhouse gases from vines in Mediterranean conditions under climate change.

• This information must be used to accomplish the compromises developed in COP 21 and COP 22, related to mitigation strategies.

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