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

Carmen Biel\textsuperscript{1}, Miriam Guivernau\textsuperscript{2}, Marc Viñas\textsuperscript{2}, Xavier Aranda\textsuperscript{3}, Robert Savé\textsuperscript{3} and Felicidad de Herralde\textsuperscript{3}

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

SPAIN

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OBJECTIVES
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

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• *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.

Temperature
- Summer: 23–24 °C
- Winter: 6–8 °C

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

Mediterranean climate (SMC)

![Adapted from Andreu 2019](image-url)
Soil water content

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

Silt loam soil, CRAD = 165 mm

Sandy loam soil, CRAD = 36 mm

Rainfall and ETo
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.
April 2018: Pre-harvest

Bacterial Diversity: POST-HARVEST

October 2018: Pos-harvest

- 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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**Fungal Diversity**

April 2018: Pre-harvest

October 2018: Post-harvest

- **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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Soil bacterial and fungal communities were more metabolically active during post-harvest than pre-harvest 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.