How does Using Sheep to Manage Vineyard Cover Crops affect Soil Health and Greenhouse Gas Emissions?

Noelymar Gonzalez-Maldonado

Dr. Cristina Lazcano,\textsuperscript{1} Tsz Fai Wong,\textsuperscript{2} Mia Falcone,\textsuperscript{2} Erika Yao,\textsuperscript{1} Anthony Alameda,\textsuperscript{1} Dr. Charlotte Decock\textsuperscript{2}

University of California Davis\textsuperscript{1}, California Polytechnic University\textsuperscript{2}

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Soils = Life
Soil Organisms

Soil Processes
- Decomposition
- Nutrient Cycling
- Soil Structure
- Biological population regulation
- Plant growth

Soil Ecosystem Services
- Food, Fuel, Fibers
- Antibiotics
- Construction materials
- C Sequestration
- Waste decomposition
- Water purification
- Foundation human infrastructure and culture
Labile C & N from SOM as Soil Health Indicators

Soil Organic Matter & Soil Health
- Sensitive to soil management
- Rapid Nutrient Cycling
- Soil Aggregates
- Carbon Sequestration
Soil Management can impact Soil Health

Intensive Tillage & Uncovered Soils
- Soil Erosion
- Gas emissions
- Soil Organic matter
- Soil Biodiversity
- Overall Soil Quality
Soil Management can impact Soil Health

- CA vineyard soils are highly susceptible to erosion
- Soil Conservation Practices for Soil Health
  - Cover Crops
  - No-Till & Reduced Tillage
Cover Crops need to be managed correctly

Herbicide

- Effective
- Non-targeted effects on soil biota and human health
Cover Crops need to be managed correctly

**Tilling**

+ effective, quick incorporation of the organic matter, infiltration?
  - destroys structure, compaction, C loss
  - Labor & fuel intensive
Cover Crops need to be managed correctly

Grazing

+ effective, N addition, stimulates cover crop growth, stimulates soil biota?
- compaction, only in dormant season, source of greenhouse gases (\(\text{CH}_4\) and \(\text{N}_2\text{O}\))
## Cover Crops need to be managed correctly

### Herbicide
- Effective
- Non-targeted effects on soil biota and human health

### Tilling
- Effective, quick incorporation of the organic matter, infiltration?
- Destroys structure, compaction, C loss
- Labor & fuel intensive

### Grazing
- Effective, N addition, stimulates cover crop growth, stimulates soil biota?
- Compaction, only in dormant season, source of greenhouse gases (CH$_4$ and N$_2$O)
Problems

- The effects of grazing cover crops in tilled vs not-tilled in soil health are not well understood.
- It is thought that increased cover cropping, no-till and sheep grazing could impact soil greenhouse gas emissions.
Research Questions

1. How can different cover crop termination strategies affect soil health indicators such as carbon and nitrogen?

2. What is the impact of different tillage intensities and grazing activity in greenhouse gas emissions from soils?
Hypotheses

1) Soils that were grazed and not tilled will result in higher labile carbon and nitrogen

2) Soils that were grazed and tilled will result in higher greenhouse gas emissions
Methods

Carbon:
- Active C (POXC)
- Mineralizable Carbon (Min C)
- Microbial Biomass Carbon (MBC)

Nitrogen:
- Soil Nitrate (NO$_3^-$)

Greenhouse Gasses:
- Carbon Dioxide (CO$_2$)
- Nitrous Oxide (N$_2$O)
- Methane (CH$_4$)

Data Analysis: Analysis of Variance
Experimental Design

• Tablas Creek Vineyard in Paso Robles, CA
• Syrah Grape, Cover Crop mix
• Biodynamic Management
• Established in 2018

• Tillage:  
  ○ Till
  ○ No-Till
• Grazing  
  ○ Grazed
  ○ Non-Grazed
Sampling

- Gas samples: gas chambers
- Time: February 2020
- Soil Depth:
  - 0-15 cm
  - 15-30 cm
- Location
  - Vine Row
  - Tractor Row
Results: No significant increase in Active Carbon and Microbial Biomass Carbon

Hypothesis 1: Soils that were grazed and not tilled will result in higher labile carbon and nitrogen

- Grazing and No-Tillage had no negative effects on Active C and MBC.
Results: Mineralizable C

Hypothesis 1:
Soils that were grazed and not tilled will result in higher labile carbon and nitrogen

- In general, Higher Min C in Grazed soils
- Inconsistent trends among tillage treatments
Results: Nitrate overall higher in Non-Grazed

Hypothesis 1: Soils that were grazed and not tilled will result in higher labile carbon and nitrogen

- Slightly lower nitrate in Grazed plots
- No-Till mean values were less variable
Grape Yields

- No negative effects of Grazing
- No-Till had higher yields
Preliminary Results: Greenhouse Gas Emissions

Hypothesis 2:
Soils that were grazed and tilled will result in higher greenhouse gas emissions

Inconsistent
Possible Implications

- Soil Health indicators minimum responses to treatments
- Higher C and N values in the top depth were expected
- High SOM soil + Biodynamic Vineyard
- Tillage and Grazing might increase CO2 and CH4 emissions
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References:

Questions / Suggestions?

Noely Gonzalez-Maldonado, M.S.
ngonzalezmaldonado@ucdavis.edu
@noelymarg & @WomenAgScience

Dr. Cristina Lazcano:
clazcano@ucdavis.edu