The Influence of Land Conversion on Carbon Mineralization and CO₂ Emissions from Vineyards and Adjacent Oak Woodlands in the Napa Valley

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Problem:

Oak woodlands and oak woodland grandchildren in the Napa Valley have been historically converted to orchards and then to vineyards. Vineyard systems that underwent conversion in the city urban core have been less than two decades ago. Oak woodlands in the vicinity of the vineyards have undergone conversion, and the consequences of such disturbance on vineyard productivity are currently unknown.

Objectives:

- Separate the fluxes in the principal components responsible for CO₂ emissions - root and microbial respiration.

Approach:

- Field components
  - Vineyard (Figure 2) and adjacent oak sites (Figure 1) located on the same soil parent material (El Dorado Hill). Oak woodland soils were sampled at 10, 25, 40, 60, 100 and 150 cm in depth and sampled for CO₂ concentrations and CO₂ at the surface. The field were mixed every morning to establish a consistent water table.
  - Laboratory component
    - Field soil samples from the vineyard and oak sites were stored in the lab, mixed to 3 cm, mixed on a monthly basis, and placed on a quartz oscillator for 12 hours at 20°C. The release was collected in a sealed vessel containing 0% CO₂, water, and a small amount of CO₂ to ensure a consistent CO₂ concentration.

Results:

- Field Measurements of soil CO₂ emissions have shown that the oak sites may have much greater rates of CO₂ production than the vineyard soils. The vineyard soils also show an increase in CO₂ production between May and a warming trend. The vineyard soils had lower CO₂ emissions following winter, when the vineyard is dormant (Figure 3).
- Carbon dioxide emissions in the upper 5 cm of the oak site indicate that the vineyard and oak woodland soils probably have different effluxes due to differences in wood production and microbial activity. The upper 5 cm of the oak site has a higher rate of CO₂ emissions, a critical factor concerning the quantity of dissolved CO₂ in vineyard soils (Figure 4).
- Oak soil CO₂ is substantially higher in the vineyard soil and in areas with oak trees present compared to adjacent vineyard sites (Figure 5). Carbon dioxide emissions from the vineyard soils are higher in the upper 5 cm, while the oak site has a lower rate of CO₂ emissions, a critical factor concerning the quantity of dissolved CO₂ in vineyard soils (Figure 6).

Discussion and Future Goals:

Our results point to the need for further research on the quantification of root production in vineyards and adjacent oak woodlands. More accurate data on root production and movement of organic and inorganic carbon through ground water pathways is needed. To that end, we have studied the effects of land conversion on root production and movement of organic and inorganic carbon through ground water pathways. The results of our study show that vineyard systems have a higher rate of CO₂ production than oak woodland soils, and that the vineyard soils have a lower rate of CO₂ emissions following winter, when the vineyard is dormant (Figure 7).

References