

Changes in Tillage Regimes

Soil Carbon Case Study - Vineyards

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Tilling / Discing: Effects on the soil

- Common and impactful type of soil disturbance
- Often implemented annually
- Can limit buildup of SOC
- Increases CO₂ emissions in short-term after tillage occurs
- Destroys soil aggregates



Benefits of Tillage in Vineyards

- Breaks up impermeable soil surfaces
- Increases water infiltration and soil aeration rates in the short-term
- Improves weed control (especially if done before seeds set)
 - This may improve cover crop success
- May be used to improve land leveling



Detriments of Tillage in Vineyards

- Destroys soil aggregates leading to long-term degradation of soil structure
- May increase soil erosion if implemented before rains
- Disrupt rhizosphere ecosystems and microbial communities
 - Can result in lower accumulated SOM and SOC over time



Case Study: Changes in Soil Disturbance

- A vineyard study conducted by NRCS, Mendocino County RCD, and Norman Kobler looked at the combined effect
 - Cover crops
 - No-till practices
- Soil samples were taken 2.5 and 5.5 years after the trial began
- Significant differences in soil health measures were mostly found at the 5.5-year sampling point; emphasizing the **long-term** impact of soil carbon building practices

Trial - Investigators

Mendocino County RCD

- Linda McElwee
- Seth Myrick

USDA Natural Resources Conservation Service

- Erica Lundquist
- Katy Brantley
- Kristin Filipowich



Norman Kobler

Experimental Design

Treatments

- Five common cover crop systems
- Annual till, no-till with mowing, and alternate row tilling (every other row)

System name	Typical mixture components	Management operations
1. Green manure, plow down or biomass cover crop (GMCC)	Oats, triticale, barley, field peas, common vetch, and fava beans	Mow once in spring. Disk 3-4 times annually to incorporate cover crop and prepare fall seedbed. Annual seeding.
2. No-till re-seeding, permanent cover crop (NTCC)	Blando brome, Zorro fescue, rose clover, crimson clover, and subterranean clover	Tillage to prepare seedbed, fall planting. Once established, mow 4-5 times annually with no tillage.
3. Naturalized vegetation, no-till (NTNV)	Annual grasses, forbs, and legumes	Mow 4-5 times annually, no tillage.
4. Naturalized vegetation, tilled (TNV)	Annual grasses, forbs, and legumes	Mow once in spring. Disk 3-4 times annually.
5. Alternate row with cover crop (ARCC)	System 1 (GMCC) alternating every other row with system 2 (NTCC)	Same as systems 1 and 2. System in each row not changed during trial.



GMCC Left of vine row and NTCC right of vine row soon after cover crop incorporation and mowing (April 2018) – Image courtesy of Erica Lundquist

Data Collected

- Cover crop biomass
- Vine status
- Soil compaction
- Water Infiltration
- Soil bulk density
- **Soil Health Panel (OSU)**
 - Water content
 - Total Nitrogen
 - Stable aggregates
 - TOC
 - POX-C
 - C-mineralization



General Outcomes

- Neither cover cropping nor tillage treatments affected yield parameters
- Tillage for cover cropping did not increase overall soil compaction
 - Additional passes may have increased shallow-depth, soil compaction though
- Water stable aggregates were significantly higher in no-till treatments after 5.5 years but not at the 2.5-year sampling point

Soil and Carbon Outcomes

- Total C and N did not differ with cover crop treatments **during this study**. However, this site had been grown with cover for 22 years before this.
- Total Carbon was 20% lower in rows than middles attributed to the previous 22 years of cover cropping in *only vineyard row middles* (Long-term impacts)
- Total Carbon varied by tillage and type of cover in year 5.5
 - Highest = No-till with cover crop and green manure with cover crop (incorporated)
 - Lowest = Tilled with bare soil
- Any combination of cover crop and/or tillage practice can increase labile carbon by 25-35% when compared with tilled, bare soil

Conclusions

- Within 5 years, tillage and cover cropping has some impact on soil health parameters, but little effect on vine performance
- When compared with any tested tillage or cover cropping, bare soil with chemically controlled weeds had negative influences on soil function like water retention, nutrient cycling, and C-sequestration
- Total Carbon, Labile Carbon, and Mineralizable Carbon all increase in response to reduced tillage and cover cropping or green manure within the 5-year time frame used in this study

Summary

- Where water is available and sufficient, cover cropping and reduced till practices may help improve soil health and soil ~ carbon dynamics via:
 - Increased Soil Organic Matter (Total Carbon)
 - Higher mineralizable carbon rates and labile carbon
 - More water stable aggregates; reducing risk of soil erosion
 - Improved water infiltration rates
 - Increased potentially mineralizable nitrogen when compared with bare soil



Thank you



Special thanks to the organizations and individuals who provided data and images included in this presentation



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Sources

You can find this presentation at:

1. <https://ucanr.edu/sites/chenlab>
2. Speaker Presentations

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