Orchard Soil Quality and Mulching

Ashley Thompson, Ph.D.
Oregon State University Extension Services
Wasco and Hood River Counties

What is Soil?

• Living
• Provides anchorage, water, and nutrients
• Defined by chemical, physical, and biological characteristics

Soil Composition
• 45% Minerals
• 25% Air
• 25% Water
• 5% Organic matter
  • 80% Humus
  • 10% Root Material
  • 10% Organisms
What Characteristics Make a “Quality Soil”? 

Physical

Quality Soil

Biological

Chemical

Physical Characteristics & Their Measurements

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Type and Texture</td>
<td>NRCS Web Soil Survey</td>
</tr>
<tr>
<td>Soil Structure</td>
<td>Bulk Density</td>
</tr>
<tr>
<td></td>
<td>Penetration</td>
</tr>
<tr>
<td></td>
<td>Aggregation</td>
</tr>
<tr>
<td></td>
<td>Rainfall Test</td>
</tr>
<tr>
<td></td>
<td>Pore Space</td>
</tr>
<tr>
<td>Water Infiltration</td>
<td>Ring Infiltration</td>
</tr>
<tr>
<td>Water Retention</td>
<td>Available Water Capacity</td>
</tr>
</tbody>
</table>

Lincoln, NE July 2017
Chemical Characteristics & Their Measurements

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Nutrients</td>
<td>Soil Test</td>
</tr>
<tr>
<td>Organic Matter</td>
<td>Soil Test</td>
</tr>
<tr>
<td>Cation Exchange Capacity</td>
<td>Soil Test</td>
</tr>
<tr>
<td>pH</td>
<td>Soil Test</td>
</tr>
<tr>
<td>Soil Salinity</td>
<td>Soil Test</td>
</tr>
</tbody>
</table>

The basics:
- Be consistent!
- Pre-plant + every 3-5 years
- Sample the same time every year
- Send samples to the same, trustworthy lab
- Read recommendations with critical eye

![How soil pH affects availability of plant nutrients](https://www.eperimmobiles.com/what-is-ph-3-to-14)
### Extractible Soil Mineral Nutrients

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>units</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Excessive</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>ppm</td>
<td>&lt;20</td>
<td>20-40</td>
<td>40-100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>K</td>
<td>ppm</td>
<td>&lt;150</td>
<td>150-250</td>
<td>250-800</td>
<td>&gt;800</td>
</tr>
<tr>
<td>Ca</td>
<td>ppm</td>
<td>&lt;1000</td>
<td>1000-2000</td>
<td>&gt;2000</td>
<td>&gt;&gt;2000</td>
</tr>
<tr>
<td>Mg</td>
<td>ppm</td>
<td>&lt;60</td>
<td>60-180</td>
<td>&gt;180</td>
<td>&gt;&gt;180</td>
</tr>
<tr>
<td>B</td>
<td>ppm</td>
<td>&lt;0.5</td>
<td>0.5-2</td>
<td>&gt;2</td>
<td>&gt;&gt;2</td>
</tr>
</tbody>
</table>

*Add fertilizer*  
*Consider adding fertilizer*  
*No fertilizer needed*

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### Biological Characteristics & Their Measurements

#### Characteristic | Test
---|---
Diversity | Molecular Tests  
| Fatty Acids |
Nutrient Cycling | Potentially Mineralizable  
| Nitrogen  
| Soil Active Carbon |
Pest and Disease Pressure | Root Pathogen Assessment  
| Nematode Assessment |
Activity | Microbial Respiration

**Inputs** (carbon, water, plant species...)

**Outputs** (plant growth, disease prevention, N...)

Putting it Together

Soil Texture

Soil Organic Matter

Energy For Microorganisms

Nutrient Retention

Nutrient Release from Organic Matter

pH Regulation

Water Retention

Enhanced Crop Growth

How Can We Promote Quality Soils?

- Orchard Floor Management Choices
  - Management of orchard soil to improve tree productivity and soil quality
  - Ideally easy to maintain
  - Orchard floor management decisions affect the entire orchard ecosystem
  - Management decisions complicated
- Make “healthy” choices to reduce drought and nutrient stress
  - Work to improve soil OM
  - Reduce “uncovered” soil
Typical Orchard Floor Management: The Weed Free Strip

Alternative Orchard Floor Management: Mulching

Using organic or inorganic materials to improve soil quality for long-term tree growth

Carbon-based Mulch
1. Compost
2. Woodchips
3. Straw
4. Newspaper
5. Manure
6. Cover crops

Inorganic Mulch
1. Geotextile fabrics
2. Plastic films
Why Carbon-based Mulch?

- Provide additional minerals
- Improve soil structure
- Increase nutrient and water holding capacity
- Increase water infiltration
- Increase soil microbial activity and function
- Buffer soil temperature
- Reduce erosion

Table 2. Summary of orchard floor management studies using wood chip mulch.

<table>
<thead>
<tr>
<th>Treatment description</th>
<th>Study length (yrs)</th>
<th>OM(^1)</th>
<th>Tree Growth(^2)</th>
<th>Yield</th>
<th>Notes</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woody Mulch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bark mulch</td>
<td>10</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>Yield increase documented in one of 2 years compared to black plastic mulch. OM increased by 80% and tree growth by 15%, yield increased in most but not all years.</td>
<td>Nilsen et al. 2014</td>
</tr>
<tr>
<td>Bark mulch</td>
<td>15</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>OM increased by 170%, tree growth increased most years; yield increases only after 5 years. Water infiltration rate was higher and temperatures were lower under mulch.</td>
<td>Yao et al. 2005</td>
</tr>
<tr>
<td>Bark mulch</td>
<td>15</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>Atucha, et al. 2011</td>
<td></td>
</tr>
<tr>
<td>Bark mulch</td>
<td>10</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>Granatstein &amp; Mullinix 2008</td>
<td></td>
</tr>
<tr>
<td>Bark mulch</td>
<td>10</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>Granatstein et al. 2014</td>
<td></td>
</tr>
<tr>
<td>Bark mulch</td>
<td>15</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>Yield increased for apple when summed over 3 years, but only for 1 of 3 years for pear compared to landscape fabric with flaming. Larger fruit size and higher soil water content in mulched plots.</td>
<td>Granatstein et al. 2010</td>
</tr>
<tr>
<td>Bark mulch</td>
<td>15</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>TerAvest et al. 2011; Hoagland et al. 2008</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) OM = organic matter. \(^2\) Tree growth rate measured by cross sectional area.

▲ = indicates an increase, ● = indicates no change.
Other Carbon-based Mulch Considerations

• Most data from apple/tart cherry studies
  • Sweet Cherry Studies: Neilsen et al., 2010
• Changes in yield/leaf mineral nutrition/soil quality are inconsistent
• Changes in soil quality depend on soil texture/organic matter

Questions

• How does mulch affect mature sweet cherry yield and quality?
  • Packout
  • Cherry Size
  • Flesh Firmness
• How does mulch affect soil quality?
  • Physical
  • Chemical
  • Biological factors
### Treatments & Design

#### Treatments

1. Control - weed free strip & standard nutrition program
2. Orchard mulch/compost & standard nutrition program
3. “Bio-intensive” - sap sampling & AEA foliar products with a weed free strip
4. “Bio-intensive” + Orchard mulch/compost

#### Design

- Skenna
- Randomized complete block design
- 4 blocks x 4 treatments x 4 replications
- Treatments applied to entire tree row
**Packout**

- **Weed Free Strip**:
  - lb/acre: 19500

- **Mulch**:
  - lb/acre: 23500

**Row Size**

- **Weed Free Strip**:
  - Row Size: 9.5

- **Mulch**:
  - Row Size: 9.0
**Fruit Firmness**

<table>
<thead>
<tr>
<th></th>
<th>Weed Free Strip</th>
<th>Mulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>340 g/mm</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>320 g/mm</td>
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</table>

**Sugars**

<table>
<thead>
<tr>
<th></th>
<th>Weed Free Strip</th>
<th>Mulch</th>
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<tbody>
<tr>
<td></td>
<td>16% Brix</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17% Brix</td>
<td></td>
</tr>
</tbody>
</table>
Take Aways

• After two years, mulch did not increase:
  • Yield
  • Packout
  • Fruit Size
  • Fruit Quality
  • Leaf Nitrogen
Weed Free Strip Mulch

Organic Matter

Cation Exchange Capacity

Weed Free Strip Mulch
**Active Carbon**

<table>
<thead>
<tr>
<th>Weed Free Strip</th>
<th>Mulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>100</td>
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<tr>
<td>150</td>
<td></td>
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<tr>
<td>200</td>
<td></td>
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<tr>
<td>250</td>
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<tr>
<td>300</td>
<td></td>
</tr>
<tr>
<td>350</td>
<td></td>
</tr>
<tr>
<td>400</td>
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</table>

**Water Infiltration**

<table>
<thead>
<tr>
<th>Weed Free Strip</th>
<th>Mulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>seconds</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>20</td>
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<td>40</td>
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<tr>
<td>120</td>
<td></td>
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<tr>
<td>140</td>
<td></td>
</tr>
<tr>
<td>160</td>
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</tbody>
</table>
Take Aways

- Mulching increased:
  - OM
  - Water infiltration

- Mulching did not increase:
  - Cation exchange capacity
  - Active carbon

Summary

- Orchard floor management can be used to improve overall soil health and soil moisture
- Adding organic matter to your soil may not immediately increase your bottom line
- Mulching may not increase your yield or quality—highly variable
- Choose an orchard management system that is easy for you to maintain and makes sense for your conditions
Don’t Treat Your Soil Like Dirt!

Ashley.Thompson@oregonstate.edu
541.296.5494

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Collaborators:
Lynn Long, David Granatstein,
and Mike Omeg

Technical Assistance:
Jim Dunlop, David Crawford,
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