Soil Health Management in Horticultural Crops

Common problems with soils in Horticultural Crop production ....

- Cracking and crusting at seeding
- Compaction and drainage problems
- Soil-borne diseases
- Declining crop vigor, yields and quality
- Grower headaches

Dr. Doug Waterer

Problems with horticulture soils

Tend to be more of an issue in vegetable crops as ...

- Need to establish crops early and annually = fighting soil conditions
- More emphasis on fast growth which depends on soil health
- Root crops make special demands on the soil for maximum yields and quality

Problems with horticulture soils ....

- May reflect problems with “original” soil texture, structure, chemistry or microbiology
- May reflect changes due to (mis)management

Soil Texture

Clay soil: very fine particles, very dense together, easily waterlogged; clumps when wet

Loam soil: mixture of different soil particles; drains well but retains water

Sandy soil: coarse particles well-separated, dries quickly, easily around
Problems with soil texture

- Difficult to modify texture
- Need to change equivalent of 1/3 of total soil volume before texture shows significant change = impractical
- Remember ... adding sand to clay is the recipe for concrete
- Recommendation
  - Its easier to switch locations, switch crops or switch production techniques than it is to fight problems with soil texture.

Basic Soil Structure

These portions you can change

Compaction

Compaction

- Interferes with root growth = weak plants
- Interferes with quality of root crops
- Interferes with drainage = root disease and drown outs
- Cause = traffic on compaction-prone soils

Compacted soil = less air space

Compaction

- Avoid it by ....
  - Not growing on fine textured soils (clays and loams)
  - Reducing + focusing traffic.
80% of all compaction occurs with the 1st pass of the vehicle.

Compaction

- Avoid it by 
  - minimizing traffic when soils are wet

Compaction

- Avoid it by 
  - reducing weight of vehicles
  - spread weight out by using wider tires or duals

Compaction

- Avoid ....
  - Repeated cultivation to the same depth
  - Repeated cropping to shallow rooted vegetables (onions, lettuce)

Compaction

- Remedy
  - Chisel, plough or deep rip = quick solution
  - Takes operator time and horsepower = weight!
  - If not done properly, can cause more problems than it solves.
Compaction

- Remedy
  - Natural processes = longer term solution.
  - Frost action + earthworm activity + root penetration.

Crusting

- Interferes with seed emergence
- Occurs in all soil textures
- Cause
  - impact of water (heavy rain or irrigation) causes soil structure to break down. As soil dries, crust forms.
  - soil structure is weak due to lack of organic matter

Managing Problems with Soil Structure

Answer = Organic Matter

On clay soils
- increases aeration
- improves tilth = fewer clods

On sandy soils
- increases moisture and nutrient holding
- increases soil strength = less erosion and crusting

Soil Organic Matter

- What is it?
  - Residues from previous crops and native plants.
  - Portion is stable (fully decomposed) = humus.
  - Portion is unstable = breaks down with time.

- What is it good for?
  - Humus provides soil strength, nutrient and water holding capacity.
  - Unstable portion = slow-release source of nutrients
  - Maintains balanced animal/microbial population in soil = well aerated, fertile soil with fewer diseases.
Soil Organic Matter

- 5% soil O.M. considered ideal
  - Sandy soils preferred in vegetable production start off with low O.M. content (1-3%)

- Soil O.M. content decreases due to:
  - Minimal return of crop residues in vegetable production
  - Frequent tillage + Irrigation + Application of fertilizers speed breakdown of O.M.

Estimated % cover remaining after harvest of various crops.

<table>
<thead>
<tr>
<th>Non-Fragile Crop Residue</th>
<th>% Cover</th>
<th>Fragile Crop Residue</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley/Wheat</td>
<td>70-90</td>
<td>Carrots</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Corn (grain)</td>
<td>75-85</td>
<td>Potatoes</td>
<td>10-20</td>
</tr>
<tr>
<td>Canola</td>
<td>60</td>
<td>Beans</td>
<td>30-40</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>70-80</td>
<td>Cabbage</td>
<td>50-60</td>
</tr>
<tr>
<td>Pasture/Hay Crops</td>
<td>80-90</td>
<td>Corn</td>
<td>50-70</td>
</tr>
</tbody>
</table>

Challenge

- Preserve/add soil O.M. in vegetable fields

Preserving soil O.M.

- Reduced irrigation or fertility? NO!
- Reduced tillage?
  - Common concept in field crops
  - Practical in vegetable crops??
  - Loss of weed control!
  - Creates cold + lumpy soils!
  - Can vegetable seeding equipment handle trash cover?!
Preserving soil O.M.

- Crop Rotations
  - Objective is to get as much O.M. into the soil as a.s.a.p.
  - Also useful for weed, disease and insect control

Field Crops in Vegetable Rotations

- Cereals
  - Cheap seed,
  - Good weed control,
  - Deep penetrating roots
  - High O.M. yields
  - Volunteers as weeds in the next vegetable crop
  - Volunteers controlled with herbicides

Field Crops in Vegetable Rotations

- Legumes
  - Field peas, clovers
  - Deep penetrating roots
  - N-Fixation
  - Not as effective for weed control
  - Watch for carry over of herbicides used in the pulse crop

Field Crops in Vegetable Rotations

- Mustard Family
  - Canola or Yellow mustard
  - Worth some $?
  - Disease control potential?
  - Host for a range of diseases and insects that attack vegetable crops
  - Volunteers in the next vegetable crop

Preserving soil O.M.

- Problems with Rotations with non-vegetable crops
  - Ties up land in non-$ crops
  - Additional land + equipment requirements

Green Manuring

Crop is grown strictly as a means to enhance soil health, not harvested.
Select green manure crops for maximum contribution to soil health at minimum cost.
Knock GM crop down at peak value.
Green Manuring

Cereal Crops
- fall rye is the standard
- excellent vigor, biomass production and weed control
- Watch for problems in establishing small seeded vegetable crops into rye trash

Pulses
- Faba bean produces most biomass and N but seed is $
- Field pea is ok
- Difficult to get vetches to catch quickly

Cover Cropping
- After harvest seed down land to cover crop
- Adds organic matter without interfering with growing season of $ crops
- Suppresses fall and spring weeds
- Captures nutrients left over from crop season
- Reduces soil erosion over winter
Crop residues (OM) from elsewhere = MANURE !!

- **Advantages**
  - Good source of O.M.
  - Quick
  - Adds nutrients

- **Disadvantages**
  - Access/cost ?
  - Weed seeds
  - Salinity
  - Nutrient imbalance

**Table 1. (Typical)**

<table>
<thead>
<tr>
<th></th>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Organic matter</th>
<th>Moisture content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FRESH MANURE</strong></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Cattle</td>
<td>0.5</td>
<td>0.3</td>
<td>18.7</td>
<td>81.3</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.9</td>
<td>0.5</td>
<td>30.7</td>
<td>64.8</td>
</tr>
<tr>
<td>Poultry</td>
<td>0.9</td>
<td>0.5</td>
<td>30.7</td>
<td>64.8</td>
</tr>
<tr>
<td>Horse</td>
<td>0.5</td>
<td>0.3</td>
<td>7.0</td>
<td>68.8</td>
</tr>
<tr>
<td>Swine</td>
<td>0.6</td>
<td>0.5</td>
<td>15.5</td>
<td>77.6</td>
</tr>
<tr>
<td><strong>TREATED DRIED MANURE</strong></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Cattle</td>
<td>2.0</td>
<td>1.5</td>
<td>69.9</td>
<td>7.9</td>
</tr>
<tr>
<td>Sheep</td>
<td>1.9</td>
<td>1.4</td>
<td>53.9</td>
<td>11.4</td>
</tr>
<tr>
<td>Poultry</td>
<td>4.5</td>
<td>2.7</td>
<td>58.6</td>
<td>9.2</td>
</tr>
</tbody>
</table>

**Manuring**

- > 10 T/a/year of steer manure required to maintain soil O.M. levels
  - Adds 200 #/a N ... with 35% available
  - Adds 80 #/a P2O5 ... with 50% "

**Manuring**

- Weeds seeds
  - 2 years of composting will reduce weed seed numbers in manure
  - poultry rations = few viable weed seeds + few survive digestion.
  - Are a few extra weed seeds a major issue ... relative to benefits?
**Manuring**

- **Salinity**
  - avoid heavy applications of manure just prior to salt sensitive crops
  - composting reduces salt load

- **Safety**
  - manure represents potential source of human pathogens
  - avoid application during the cropping season
  - ideally, compost prior to use
  - extra care required in crops eaten without cooking (or washing).

**Problems with Soil Chemistry**

**Managing soil salinity**

- Horticultural crops are more sensitive to salt damage than field crops.
- Vegetables, especially at the seedling stage are salt sensitive.
- Salts tend to build up in Hort fields due to:
  - irrigation
  - heavy fertilizer applications
  - manuring

**An ounce of Prevention …**

- Avoid soil types and topography that lead to salt build up
- Careful selection of water source
- Use irrigation techniques that minimize application of water
- Match fertilizer applications (timing and amount) to crop needs
- Use well-aged manure

**Managing soil salinity**

- Select crops for their tolerance of salinity
- Use transplants
- Attempt to flush salts from surface deep into the soil beyond the root zone
- Install sub-soil drainage system to carry flushed salts out of the field

**Nutrient Imbalances**

- Excess supplies of certain soil nutrients or imbalance in nutrient ratios
- May reflect native soil fertility or may created by management practices … especially manuring.
Problems with Soil Chemistry

Common Nutrient Imbalances

- Excess soil K (native) slows uptake of calcium
  - Solution …..

- Excess soil P (manuring) binds Zn
  - Solution …

Problems with Soil Health

Pathogens

- Wide range of soil-borne pathogens
- Mostly fungi
- Soil residence times range from weeks to decades

Problems with Soil Health

- Managing Pathogens
  - Prevention is better
  - Avoid soils with pathogen problems or a history of growing susceptible crops
  - Avoiding introducing the pathogen – via contaminated seed, soil, or equipment
  - Grow resistant crops and cultivars
  - Follow recommended rotations

Problems with Soil Health

- Managing Pathogens
  - Is there a Cure?
  - Seed or soil applied fungicides provide some degree of protection – but at considerable costs and risk
  - Fumigation of the soil will control a wide range of soil pathogens – but at considerable cost
  - Quit growing susceptible crops
  - Look for new “healthy” land

Problems with Soil Health

Mycorrhizal Fungi

- Advantages
  - Increase P use efficiency = lower costs
  - Improve plant health
  - Naturally occur in all soils
Mycorrhizal Fungi

• Problems
  – Damaged by excessive tillage
  – Suppressed by surplus P fertilizer
  – Suppressed by Brassicas
  – Killed by fumigants and some fungicides

Common problems with soils in Horticulture production

• Know the soil requirements of your selected crops and production system
• Know the strengths and limitations of your soil
• Match the crop and production system to the soils or you have
• Find another production site with the "right" type of soil.

Common problems with soils in Horticulture production

• Common production practices lead to degradation of soil structure, chemistry and/or microbiology
• Left unmanaged, these changes will affect viability of the farm

Solution
  Recognition of the problem ...
  – causes and effects.
  Avoidance is always better than the Cure
  Inventory management options.
  Problem solving takes time and commitment.

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or
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