

**Soil Savvy: A Key to Successful Western Gardens and Landscapes**

*Master Gardener  
Soil Knowledge Review  
March 6, 2021*

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**Soil Savvy :**

- Learn about and understanding the basic properties of your landscape soil
- Use that knowledge to develop best management practices that promote both soil and plant health.
- See CSU GardenNotes and Fact Sheets on soil properties.

2

**Four Handouts**

- Slides from the presentation
- Two handouts on soil testing
  - Table 1 Desirable range of soil properties (CSU-STL)
  - How to properly collect/process soil samples
- Examples of how to calculate how much fertilizer to add based on soil test recommendation

3

**Pause ~every 20 min**

**QUESTIONS?**

*Please stick to the topics presented today*

*Your homework: review your soils training*

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**Class Outline**

- Five fundamental points of soil savvy *(review of training)*
- Management practices for building/maintaining soil health
- Examples of soil issues to consider when addressing plant problems.

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**Soil Savvy -- 5 points**

1. Healthy plants depend on a healthy soil
 

**>80% of all plant problems are related to soil conditions**

***And yet the soil is the resource we usually know the least about.***

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Soil: The fundamental component of any landscape

- Crucial to plant health:
  - Supplies the necessary nutrients and water
  - Supplies O<sub>2</sub> needed for root metabolic processes

*Roots need oxygen as much as they need water*

**If the soil isn't healthy, the plants won't be either!**



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Soil: The fundamental component of any landscape

- Crucial to plant health:
  - If we manage for a healthy soil, then healthy plants will follow (more on this later)*

**If the soil isn't healthy, the plants won't be either!**



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Soil Savvy -- 5 points

- Healthy plants depend on a healthy soil
- We live in a semi-arid climate; this makes our soils different than soils formed in wetter climates.**

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Soils in dry climates are different:  
*We need to manage them differently*

Soils formed in semi-arid and arid climates:

- Usually high pH (*alkaline, pH>7; acidic pH<7*)
  - Makes some nutrients in the soil less plant-available (*Iron, Phosphorus, Zinc, Manganese, Boron*)
- Often calcareous (*contains free lime, CaCO<sub>3</sub>*)
  - Most plants prefer soil pH range 6.0 to ~7.2
  - Keeps the pH high, trying to drop soil pH is not successful

**– Review these soil properties**

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Soils in dry climates are different:  
*We need to manage them differently*

Soils formed in semi-arid and arid climates:

- Naturally low organic matter
  - Many landscape plants prefer higher)
- Irrigation issues
  - Many landscape plants need supplemental water
  - How you irrigate strongly drives soil/plant health

**– Review these soil properties**

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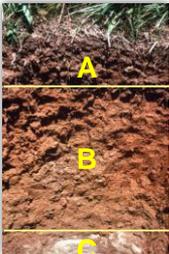
Soil Savvy -- 5 points

- Healthy plants depend on a healthy soil
- We have a semi-arid climate; our soils are different than soils in a wetter climate.
- Urban/landscape soils aren't real soils**
  - Soils next to
    - Buildings
    - Roads, parking lots, parks
  - Drastically disturbed by construction processes

**Most of us are growing our plants in this type of soil.**

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**Undisturbed  
Native Soil**



A living, self-sustaining system, thousands of years to develop

**Compacted, Unamended  
Landscape "soil"**



"Dead dirt", needs help if we expect our plants to live in this!

- ✓ Mixed horizons
- ✓ Loss of OM
- ✓ **Compaction**/loss of structure & porosity
- ✓ Poor aeration & water infiltration
- ✓ Few active soil organisms to start



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**Soil Savvy -- 5 points**

1. Healthy plants depend on a healthy soil.
2. We have a semi-arid climate, and our soils are different than soils in a wetter climate.  
*Much of what you learned in Iowa won't help you here!*
3. Urban/landscape soils aren't "real" soils
- 4. Adding too much stuff to the soil is a common problem and can lead to poor plant health (fertilizer, organic amendments, pesticides)**  
*(more on this later)*

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**Soil Savvy -- 5 points**

1. Healthy plants depend on a healthy soil.
2. We have a semi-arid climate, and our soils are different than soils in a wetter climate.  
*Much of what you learned in Iowa won't help you here!*
3. Urban/landscape soils aren't "real" soils
4. Adding too much stuff to the soil is a common problem
- 5. Use soil testing as a landscape management tool.**

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**Why Have Your Soil Tested?**

It's the best way to check the growing potential of your garden/landscape.

- Takes the guess-work out of decision making
  - Add fertilizer? *(are the necessary plant-available nutrients deficient, sufficient, or excessive)*  
*Need to change management!*
  - Add compost? *(is soil OM deficient, sufficient or excessive for the plants you want to grow)*

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**Why Have Your Soil Tested?**

It's the best way to check the growing potential of your garden/landscape.

- Takes the guess-work out of decision making (cont.)
  - How do I irrigate properly?  
– *Soil texture and OM content drive irrigation strategy*
  - Salinity problems?
  - Soil pH acceptable for the plants you want to grow?



**Too inaccurate to make good management decisions**



[https://images-na.ssl-images-amazon.com/images/I/61K3b2d6RL\\_AC\\_S1450.jpg](https://images-na.ssl-images-amazon.com/images/I/61K3b2d6RL_AC_S1450.jpg)

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**Soil Testing:  
A Tool for Making Management Decisions**

- **Before** you make management decisions *(add amendments & fertilizers, purchase plants, or develop an irrigation strategy...)*
- Get a soil test to determine basic soil properties
- Know what you're working with before making major management decisions
- **How do you know what to do if you don't know what you're working with?**

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### What Soil Testing Can't Tell You About Plant Problems

- Over-, under-, or inconsistent watering
- Diseases
- Insect damage
- Weed competition
- Too much shade/sun
- Poor plant varieties for the area
- **Compaction:** *poor aeration & drainage*
  - *The primary factor limiting plant growth in urban soils (affects both soil organisms and plant roots)*

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### Soil Testing: A Tool for Making Management Decisions

See additional handouts

1. **Table 1. Desirable range of soil properties for healthy plants**

- Use to interpret soil test data (*CSU Soil Testing Lab, 4 pp.*)
- Useful for reviewing soil property preferences for different plant types
- Ranges deficient/sufficient/high for different plant types

2. **Collecting and Processing Soil Samples for Analysis by the CSU Soil Testing Lab** (*if you don't collect/process soil samples properly, you can't trust the data*)

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- CSU Soil Testing Lab: lab director has retired; lab is scheduled to move to Denver in 2022
- Lab is in flux; still accepting soil samples (call first)
- Table 1 is still accurate (*unless lab methods are changed*)
  - Different labs can use different methods

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## QUESTIONS?

*Please stick to the topics presented*

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### Class Outline

- Five fundamental points of soil savvy
- **Management practices for building/maintaining soil health**
- Examples of soil issues to consider when addressing plant problems.

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*Healthy plants depend on a healthy soil*



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### What makes a soil healthy?

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### Healthy Soil: A Living Ecosystem

The main criteria for soil health is the presence of active organisms in the soil  
(microorganisms, insects, worms, etc.)

CSU Ext.

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### Healthy Soil: A Living Ecosystem

Soil organisms conduct many processes that directly influence plant health

- Some harmful (pathogens, pests)
- Most processes are beneficial (decomposition, aggregation, mycorrhizae, rhizobia, etc.)
- **Review training on microbial processes in the soil**

CSU Ext.

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### How do we build soil health?

If the main criteria for soil health is the presence of active organisms in the soil .....

- **Manage your soil to create a healthy environment for beneficial soil organisms (and plant roots)**
- No need to inoculate the soil with beneficial soil organisms (except for rhizobia in 1<sup>st</sup>-time peas/beans). Inoculation with mycorrhizae yields variable results.

**“If you create a healthy environment, they will come”**

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### Well-managed Healthy Soil Environment

**Whether native or urban :**  
**To support life: All soils must have four components**  
 2 Solids: mineral, OM  
 In the pore space  
 Air (soil atmosphere)  
 Water (soil solution)

A healthy environment for roots and microbes to grow

50% pore space

This class does not cover potting mixes or hydroponics

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### How to build/maintain soil health?

1. Disturb the soil as little as possible
2. Keep the soil covered as much as possible
3. Diversify the plant community as much as possible
4. Select native or adapted plant types as much as possible
5. Irrigate properly

Above from USDA-NRCS website [nrcs.usda.gov](http://nrcs.usda.gov)

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### How to build/maintain soil health?

1. **Disturb the soil as little as possible**
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### Minimize Soil Disturbance

- Disturbance of the soil
  - Creates a **hostile** rather than **hospitable** environment for beneficial soil organisms to live and work
  - Disrupts the working relationships between beneficial microorganisms and plant roots.

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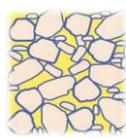
### How to build/maintain soil health?

- Minimize unnecessary disturbance of the soil
  - **Physical disturbance – compaction, digging/tilling**

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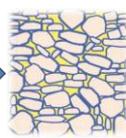
### Soil compaction:

- A reduction in **large pore space and aggregate size**



"Healthy"  
~ 50% pore space

→



Compacted Soil

↓ H<sub>2</sub>O Drainage  
↓ Soil O<sub>2</sub> levels  
↓ Rooting volume



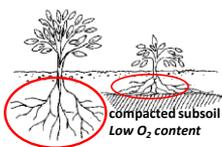
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### Plant Problems with Compaction

- Compacted soils are poorly aerated
- Roots won't penetrate poorly aerated soil even when moisture is adequate

Compaction/poor aeration is **the #1 problem** in urban soils, a major underlying cause of plant problems



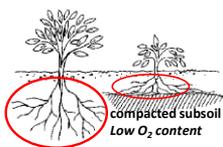
compacted subsoil  
Low O<sub>2</sub> content

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### Plant Problems with Compaction

- Smaller rooting volume, decreased rooting depth
  - Limits water uptake
    - Enhances drought conditions
  - Limits nutrient uptake
    - Enhances nutrient deficiencies
  - Stressed plants!!



compacted subsoil  
Low O<sub>2</sub> content

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## Review Soil Compaction

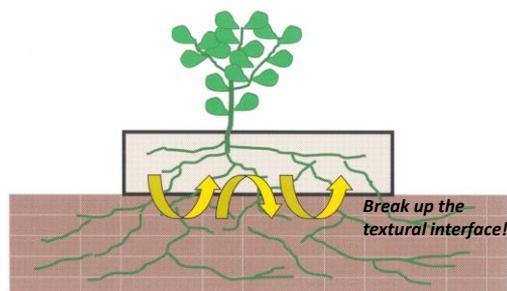
GardenNotes 215 Soil Compaction

- Avoid walking/driving on the soil—use paths
- Use mulch on the soil surface
- Aerate lawns
- Avoid excessive tilling
- Stay off wet ground! (*driving, walking, tilling*)

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## Review Textural Interfaces

GardenNotes 213 Managing Soil Tilt



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## How to build/maintain soil health?

- Minimize unnecessary disturbance of the soil
  - Physical disturbance – compaction, digging/tilling
    - Review compaction
  - Chemical disturbances
    - Pesticides –use them properly and only when necessarily
    - Organic amendments
    - Fertilizers
- **Review these topics (GardenNotes and Fact Sheets)**
- **See Table 1 and Calculating Fertilizer Rates handouts**

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## Over-fertilizing: *A common problem in landscapes*

Goal: Use only what is needed to fix a deficiency

- Adding fertilizer when none was needed
- Adding lots of fertilizer when a little was needed
  - Plants won't take up much more than they need at the time
  - Just adding excess salt to the soil—salinity issues
  - Nutrient imbalances
  - Pollution issues
    - nitrate leaching into the ground water
    - phosphorus in surface runoff contributes to algal blooms in surface waters (eutrophication)



See Table 1 Handout pp. 3-4  
See Handout on Calculating Fertilizer Applications

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## Over-amending: *A common problem in landscapes*

### Should I add some compost?

**First:** What is the current soil OM content ?

- Soil test to find out
- Deficient? Sufficient? Excess?  
*Need to change management strategy!*

**Second:** What do your plants prefer?

- Veggies, fruits, some ornamentals: prefer high OM (~4-6%)
- Trees, shrubs, lawns: do fine with moderate OM (~3-4%)
- Xerics, natives: most prefer low OM (<3%)



See Table 1 Handout pp. 1-2

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## Over-amending: *A common problem in landscapes*

### Should I add some compost?

Don't increase soil OM content to higher than ~6%

**Annual beds:** Add only 1-2" depth of compost/year, tilled 6-8" depth, until reach ~5-6% O.M. in the soil

**Perennial beds:** Review training on use of organic mulches

- Veggies, fruits, some ornamentals: like high OM (~4-6%)
- Trees, shrubs, lawns: do fine with moderate OM (~3-4%)
- Xerics, natives: most prefer low OM (<3%)

See Table 1 Handout pp. 1-2

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## Negative Consequences of Over-Amending

### Over-amending: build-up

- High salts *to levels that harm or kill plants*
- Excessive plant-available nutrients (*well beyond plant needs*)
  - Nutrient imbalances
  - High NO<sub>3</sub> inhibits flowering/fruit set
  - Ground water contamination (NO<sub>3</sub>)
  - Surface water pollution by P



The **quality** of the organic amendment matters as much as the **quantity**.  
*Manure/manure composts are 2-5 times saltier than plant-based composts*

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## How to build/maintain soil health?

1. Disturb the soil as little as possible
2. **Keep the soil covered as much as possible**
3. Diversify the plant community as much as possible
4. Select native or adapted plant types as much as possible
5. Irrigate properly

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## Keep the soil covered with living plants or mulch



See [CMG GardenNotes #245 on Mulches](#)

- Bare ground:
  - Soil dries out
  - Soil gets too hot/too cold (*kills plant roots, lowers microbial activity*)
  - Soil compacts more easily
  - Soil is exposed to wind and water erosion
  - Increased weed seed germination

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## How to build/maintain soil health?

1. Disturb the soil as little as possible
2. Keep the soil covered as much as possible
3. **Diversify the plant community as much as possible**
4. Select native or adapted plant types as much as possible (*it's hard to fight your soil and win!*)
5. Irrigate properly

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## Plant Diversity

Monocultures generally are not healthy systems

- Deplete soil nutrients (*fixable*)
- Encourage diseases, insect pests and weeds



Vegetable garden: Crop diversity, rotate crops



Landscape plants: Plant diversity



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## How to build/maintain soil health?

1. Disturb the soil as little as possible
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4. **Select native or adapted plant types as much as possible** (*it's hard to fight your soil and win!*)
5. Irrigate properly

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### Soils in dry climates: **harsh growing conditions**

High pH and lime, low precipitation and humidity

- **Plant selection** is especially important
  - Natives and plants that evolved in a similar dry climate *tolerate our soil conditions & climate better than do plants that evolved in a wetter climate*
  - Many popular landscape plants have a high susceptibility to iron chlorosis (*evolved in wetter climates in neutral-to-acidic soils*)

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### Soils in dry climates are different

- Many popular landscape plants have a high susceptibility to iron chlorosis [GardenNotes 223 Iron Chlorosis](#)
  - Fruit trees, small fruits
  - Conifers: Pine, Douglas-fir, Juniper, Spruce
  - Ornamental trees: Crabapple, Flowering Dogwood
  - Deciduous trees: Aspen, Beech, Birch, Elm, Maple, Mountain-ash, Honeylocust, Linden
  - Shrubs: Azalea, Cotoneaster, Magnolia

**Will require higher maintenance/effort to grow these plants in high pH soils (fertilizer, compost, irrigation, etc.)**

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### Soils With High pH and Lime Content

#### Alternative to popular landscape plants:

- Select plants that are less susceptible to iron chlorosis and better adapted to our soil properties

CSU Extension Fact sheets [www.cmg.colostate.edu/pubs](http://www.cmg.colostate.edu/pubs)

- *Xeriscape plants*
- *Wildflowers*
- *Native plants*

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### Soils With High pH and Lime Content

#### Alternative to popular landscape plants:

- **Plant Select** varieties
  - Collaboration of DBG, CSU, regional growers
  - [www.PlantSelect.org](http://www.PlantSelect.org)
- **High Country Gardens**
  - Good information on soil property requirements of different plants ("tolerates clay soils")
  - [www.HighCountryGardens.com](http://www.HighCountryGardens.com)

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### How to build/maintain soil health?

1. Disturb the soil as little as possible
2. Keep the soil covered as much as possible
3. Diversify the plant community as much as possible
4. Select native or adapted plant types as much as possible

#### **5. Irrigate properly**

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### Improper irrigation is a major cause of Colorado landscape plant problems.

Too much  
Too frequently



Too little  
(we need to winter water!)



Tony Koski, CSU Turf Expert: "Improper irrigation is the major underlying cause of weed, insect and disease problems in turfgrass"



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## Irrigation design and strategy

**How you irrigate HUGELY influences soil/plant health**

**Goals:**

- Keep the primary root zone well hydrated and well aerated (not saturated)
- Water as in frequently as possible (need time for gravity to move water out of pores and air recharge)
- Consider the moisture preferences of your plants (group heavy and light water users into separate irrigation zones)
- Irrigate by soil textural type



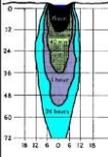
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## Irrigate by Soil Textural Type

\*WHC = Water Holding Capacity

**Sandy soils:**  
*Fast infiltration, fast drainage, low WHC\**

- Water more frequently
- Water for short enough periods of time to keep water from leaching below the root zone



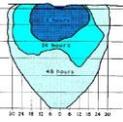
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## Irrigate by Soil Textural Type

\*WHC = Water Holding Capacity

**Clayey soils:**  
*Slow infiltration, slow drainage, high WHC\**

- Per irrigation, larger quantities of water, in multiple increments of short-period irrigations (avoid runoff but still wet up the root zone)
- Water less frequently, need time for oxygen recharge





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## Other Factors Influencing Irrigation Protocols

- Compaction
- Slope/Aspect
- Type of irrigation system
  - Drip
  - Sprinkler
    - Type (large drop to misty)
    - Output rate (0.5 to 2 inches/hour)

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# QUESTIONS?

Please stick to the topics presented

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## Class Outline

- Five fundamental points of soil savvy
- Managing practices for building/maintaining soil health
- **Examples of soil issues to consider when addressing plant problems.**

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### Approach for addressing plant health questions

Try to get a clear picture of the situation:

1. What type of plants, how old are they, what signs of stress over what time frame, planting issues
2. Where are the plants growing (slope, aspect, sun/shade)
3. Mulch used? What kind, how deep
4. Soil test? How old is your house?
  - Soil texture?
    - Clayey (*sticky when wet, brick when dry, slow draining*)
    - Sandy (*fast draining, dries out ~quickly, gritty*)

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### Approach for addressing plant health questions

Try to get a clear picture of the situation: (*cont.*)

5. Compaction (*hard to dig, screwdriver into moist soil, etc.*)
6. Irrigation type
  - Drip, sprinkler, hand-water; how much/how often*
7. Amendments
  - Fertilizer, compost, what kind, how much and when*
8. Pesticides
  - What kind, how much, when*
  - Possible herbicide drift from neighbors or elsewhere in yard*

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### Example 1

Why did my shrubs die? (*what kind, how old, symptoms, timing*)

*New junipers, planted in flower bed in the spring (it's now July)*

- Irrigation: *Sprinkler irrigate 2x/wk, ½" each time*
- Mulch? *Yes, old, thin layer of bark*
- Signs of voles, herbicide use nearby? *Didn't think so*
- Soil questions
  - Soil ever analyzed? Soil test report? *Yes, no soil issues*
  - Fertilizer/compost additions? *No*
  - Compacted site? Clayey/sandy? *Sandy Clay Loam, hard to dig in*
  - Describe the site and what else is growing there:
    - *Hilly, sunny site, only the weeds do well (irrigation issue; too dry)*
    - *Roots did not expand beyond planting hole (planting issues)*

Discuss going to xeric plants with drip irrigation

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### Example 2

Some of my veggies aren't looking good (*August*)

*(12-yr-old garden, no problems before; rotates crops)*

Irrigation: *Hand irrigates 3x/wk @ ½" to 1 inch each*

Soil questions:

- Fertilizer/compost additions: *Compost, manure and 10-10-10 each fall*
- Soil test: Sandy Clay Loam
  - *E.C. salinity = 4 (must leach to drop E.C. to <2)*
  - *%OM = 7.8% (very high, stop adding compost & manure)*
  - *P, K, Zn, Fe (very high, stop adding fertilizer)*
  - *Cu = 50 ppm (toxic from adding manure & compost)*

Call the lab for help. Resample? Deep till to dilute?

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### Example 3 Soil Test Report

3-yr old raised flower bed (*nothing has ever grown vigorously*)

*(July; What kind of flowers, size/depth of bed, textural interface?)*

Irrigation: *Hand waters*

Soil questions

- 70:30 Planter's mix, bought in bulk, local vendor. *No data*
- Fertilizer/compost additions: *Compost 1<sup>st</sup> & 2<sup>nd</sup> years, no fertilizer*
- Soil test: Sandy Clay Loam
  - *E.C. salinity = 3.5 (Must leach to drop E.C. to <2)*
  - *%OM = 7% (Very high, don't add more compost)*
  - *Nutrients all adequate-to-very high. None toxic.*
  - *Very high K indicates addition of manure or composted manure. Don't add fertilizer*

Use Table 1 to interpret soil data

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### Example 3

3-yr old raised flower bed (*nothing has ever grown vigorously*)

*(July; What kind of flowers, size/depth of bed, textural interface?)*

**To Do:**

1. Leach excess salts according to lab instructions & GN 224
2. May need to add some N
  - *Nitrate will be lost with leaching water*
  - *Let plants tell you if need N;*
  - *If needed, 0.1 lb.N/100 sq.ft. max*
3. Improve irrigation practices
4. The answer is NOT to add more compost or fertilizer
  - *Very high K indicates addition of manure or composted manure. Don't add fertilizer*

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