Soil and Water Evaluation and Management

Phoebe Gordon, Ph.D.

Madera and Merced Cos.

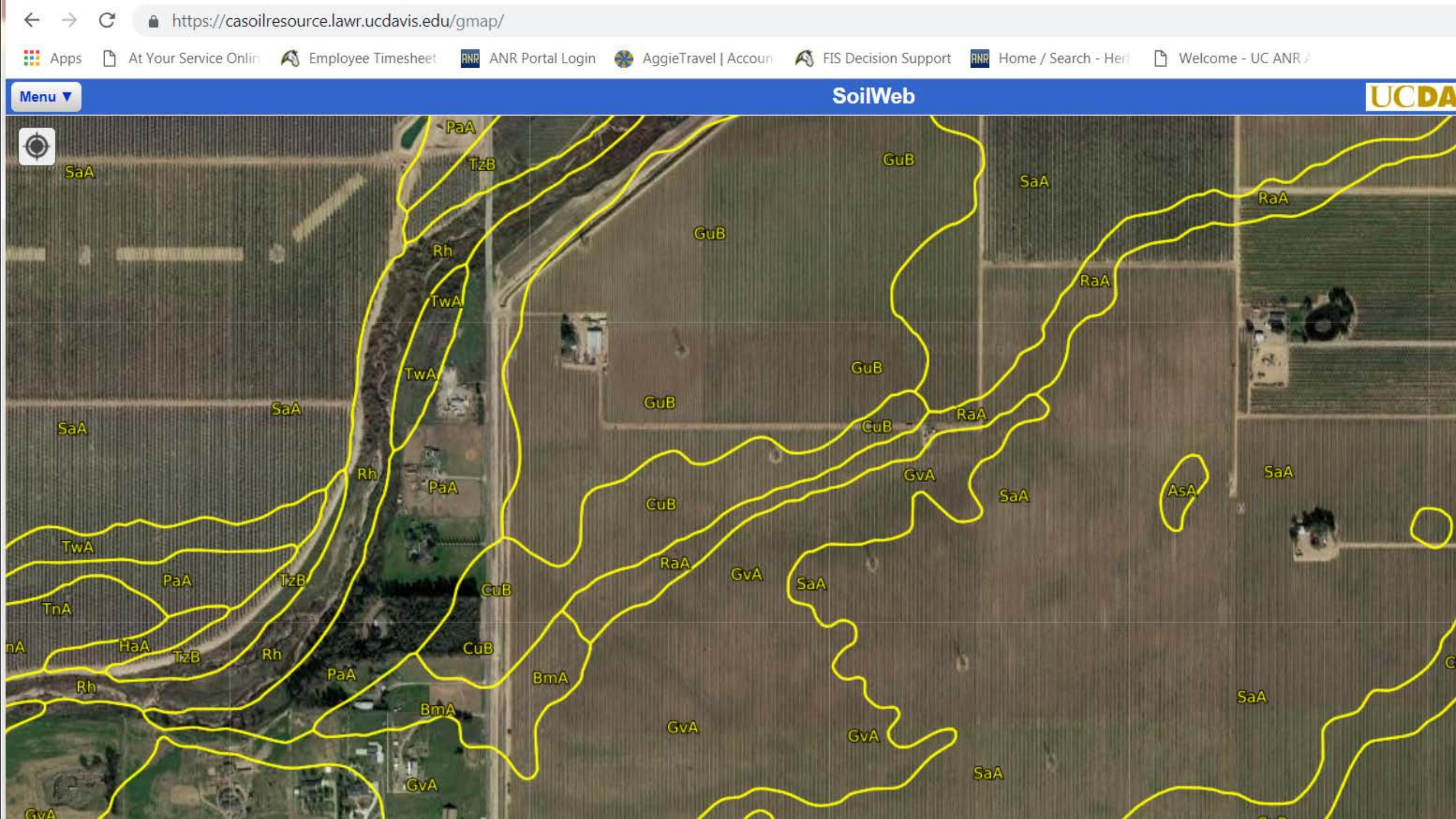
University of California Cooperative Extension

Reasons for pre-plant site evaluation

- Understand your soil's chemistry
- Look for possible drainage issues
- Properly design an irrigation system
- Select the correct rootstock and spacing

Ideal Orchard Site

- Deep, well drained, soil
- Uniform texture across the field and by depth
- No layers that impede percolation
- Good water holding capacity and good aeration
- Low ECe, neutral pH
- Good quality water is easily accessible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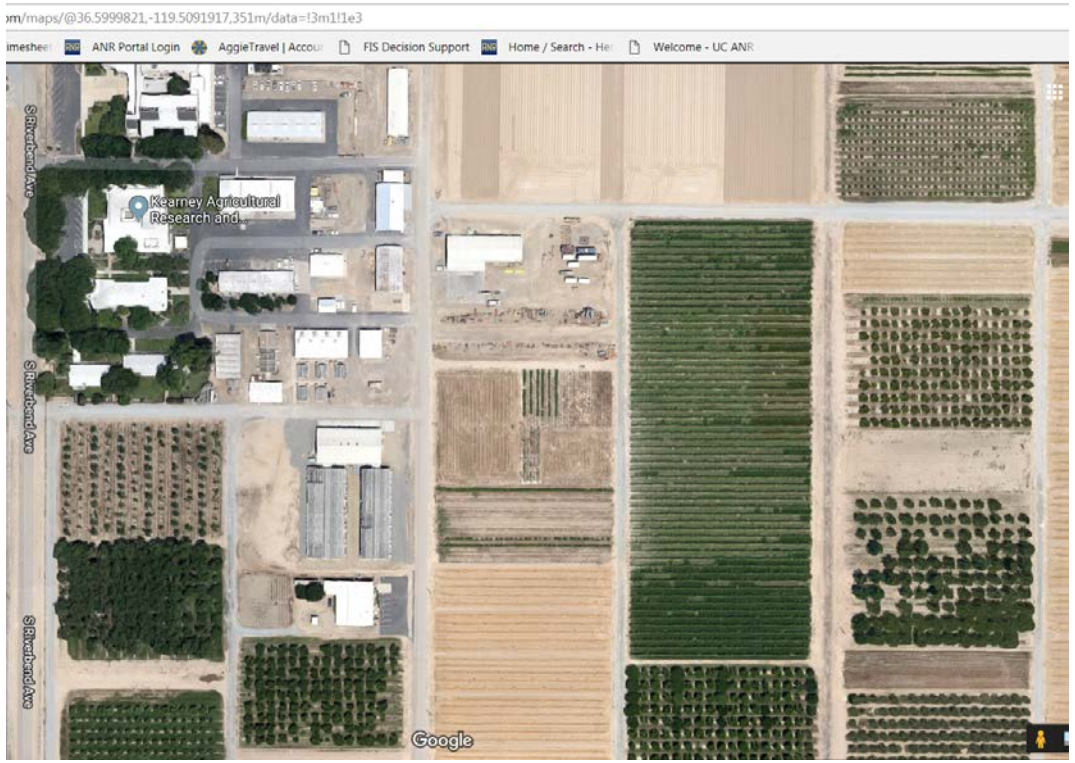

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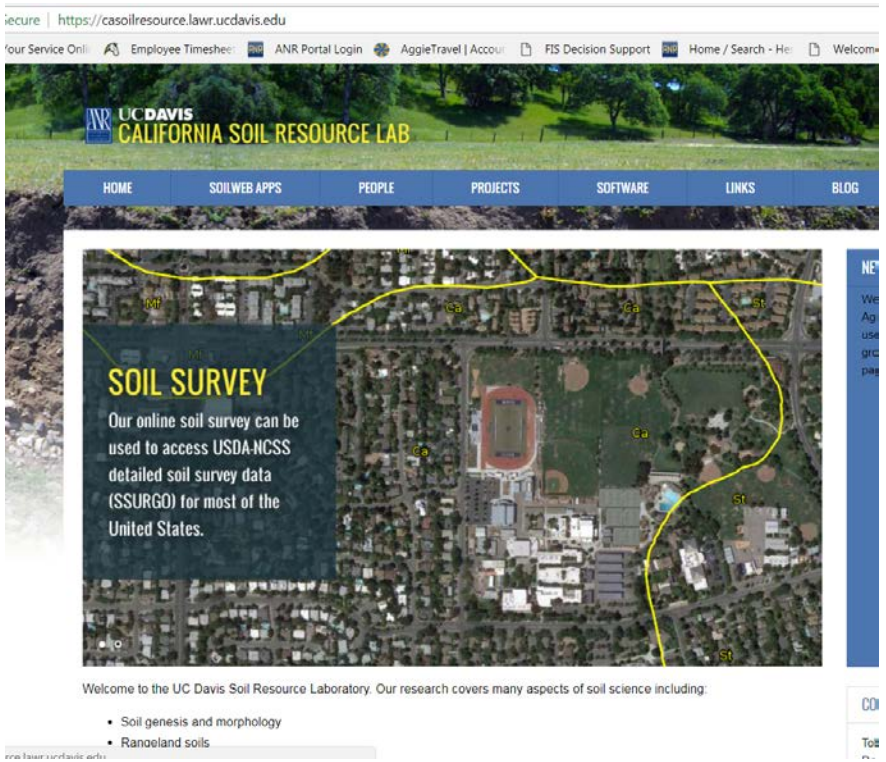
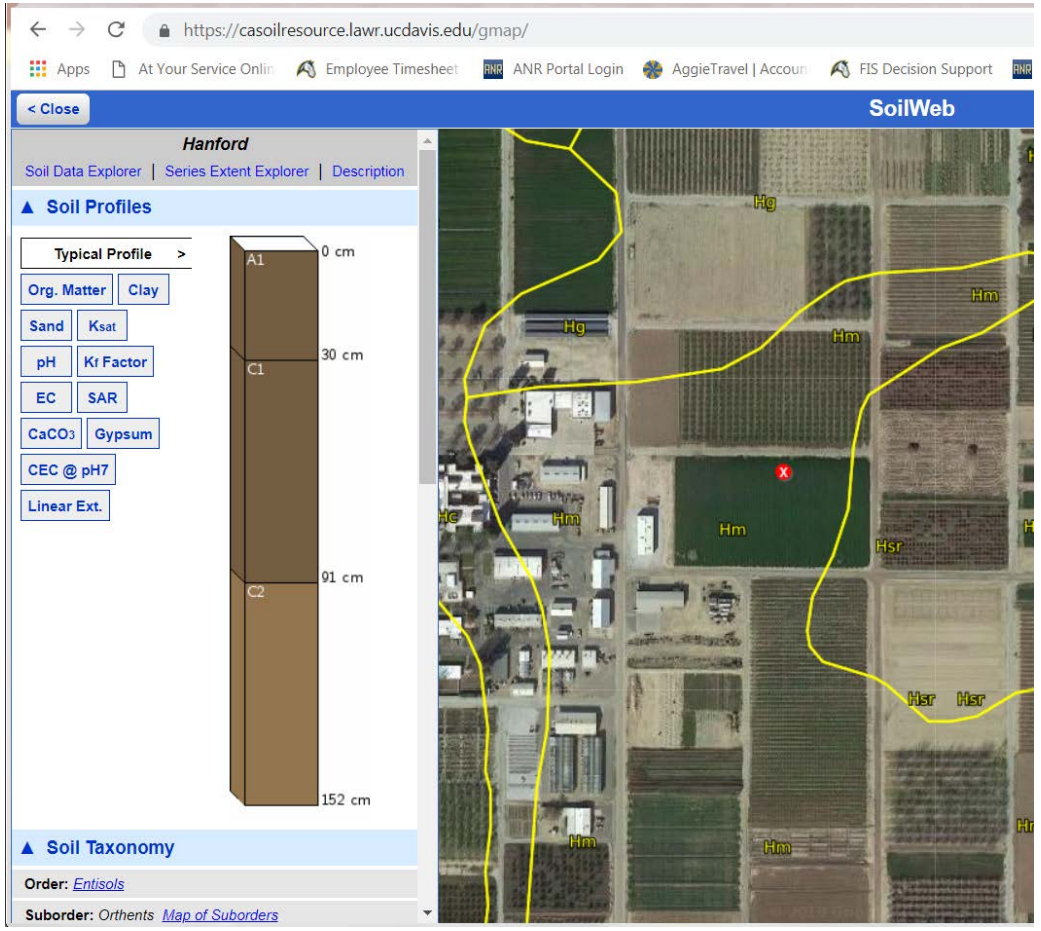


https://casoilresource.lawr.ucdavis.edu/

Where should you start?

What information can a soil survey provide?

- California Storie Index/Land Capability Class
  - How hard is it going to be to farm this land?
- General texture trends
  - Infiltration rate
  - Soil water holding capacity
- Clay/hardpans/layered textures
  - Drainage impediments
  - Need for soil ripping, tillage
- General boundaries for soil series
- **Cannot** give good information on soil chemistry



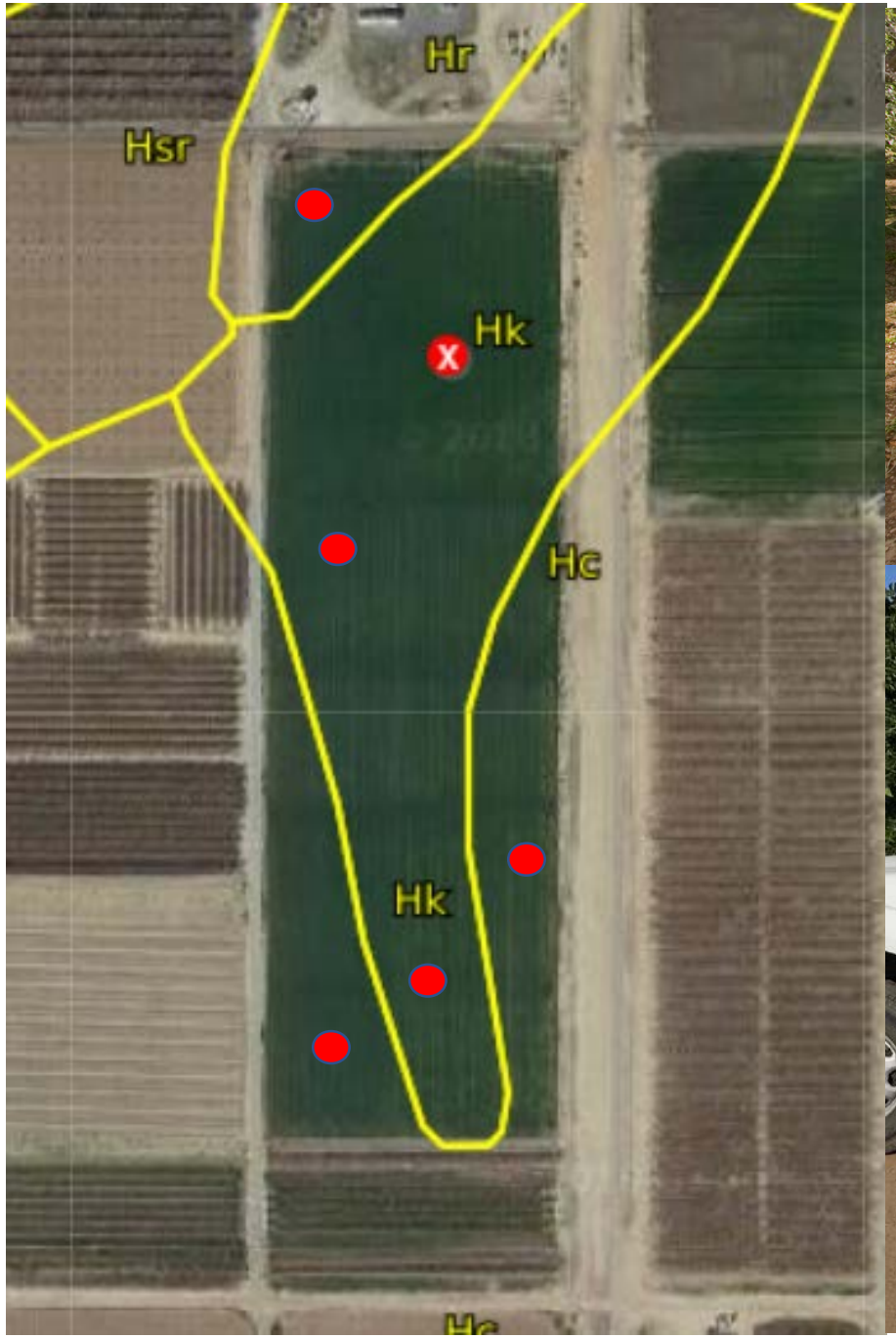


Photo: A. Fulton

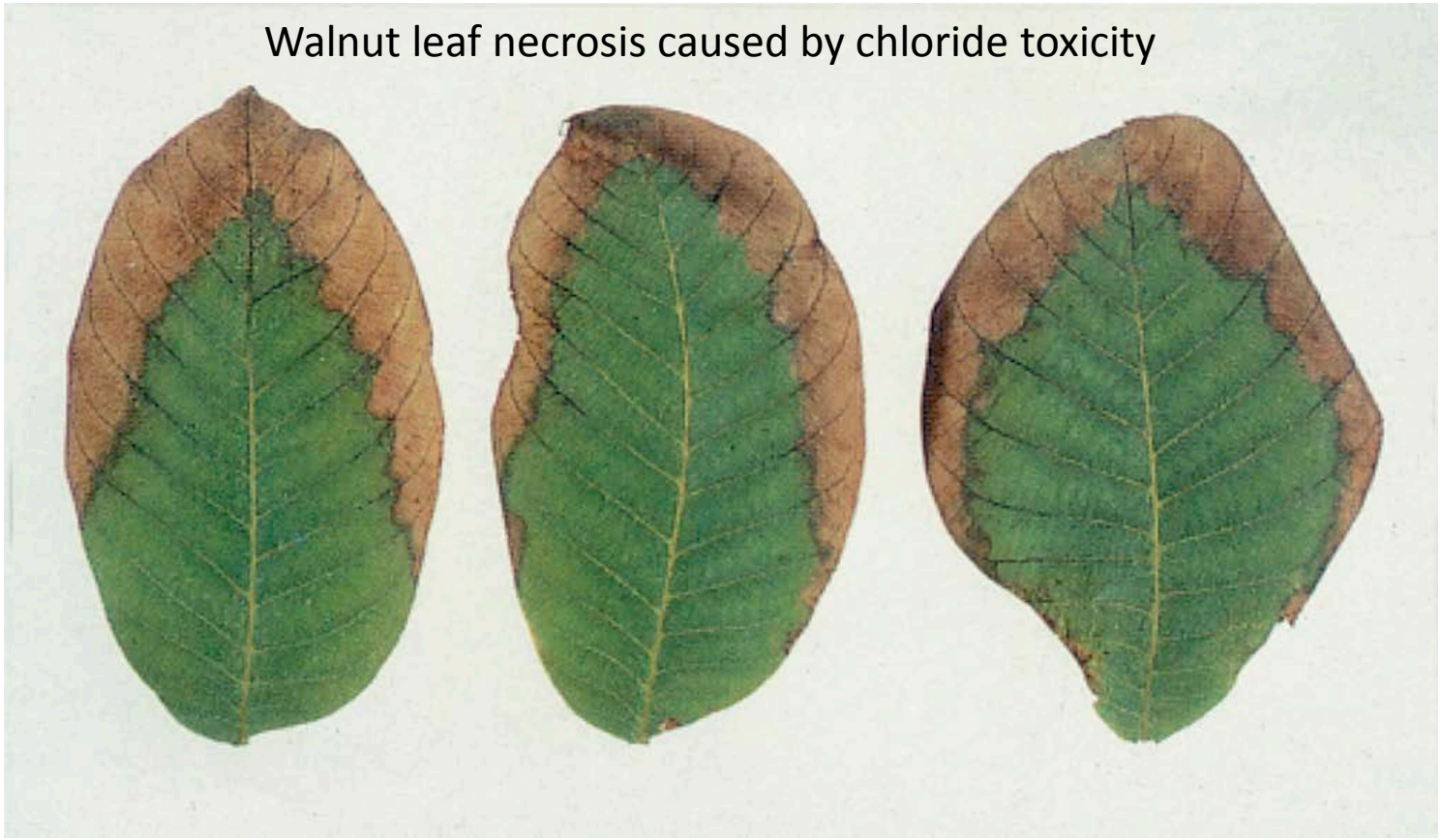
Soil sampling

- Dig backhoe pits in unfamiliar sites to look at soil layers
- Look for water tables
- Confirm changes in soil type found in NRCS soil surveys
- Supplement with auger soil samples
- Send soil samples in for testing

Water Sampling

- Pull water samples from every source you'll be using
- Well water sampling
  - Pull well water samples after the pump has been running for at least 30 minutes
  - Many well drilling companies will submit analyses of water from new wells
- Soil pH, ECe, Na, Cl, B will eventually look like your water

Soil and Water Chemistry



What should you request from a lab?

- Soil pH
  - Availability of Zn, Fe, Mn
  - Free lime?
- Soil texture
  - K management
  - CEC size
- Soil and water sodium
  - Specific ion toxicity
  - Water infiltration
  - Crusting
- Soil and water chloride, boron, ECe
  - Specific ion toxicity

Soil and Water Chemistry Guidelines

		Degree of Growth Restriction		
Parameter	Unit	None	Increasing	Severe
Root Zone ECe	dS m^{-1}	< 1.5	1.5 – 4.8	> 4.8
Water ECw	dS m^{-1}	< 1.1	1.1 – 3.2	> 3.2
SAR soil		< 5.0	5.0 – 15.0	> 15.0
SAR water		< 3.0	3.0 – 9.0	> 9.0
Soil Chloride	meq L^{-1}	< 5.0	5.0 – 10.0	> 10.0
Water Chloride	meq L^{-1}	< 4.0	4.0 – 10.0	> 10.0
Soil Boron	ppm or mg/L	< 0.5	0.5 – 3.0	> 3.0
Water Boron	ppm or mg/L	< 0.5	0.5 – 3.0	> 3.0

Adapted from: Ramos, D.E. 1998. Walnut Production Manual. Pgs 58-59

Soil Structure

Drainage, impenetrable layers, and whether to remediate them

Percolation and Drainage

- Impediments to drainage can be caused by
  - Heavy soil texture
  - Impenetrable barriers
  - Layered soils
  - Existing water tables
- Walnut roots do not tolerate prolonged periods of saturated soils


Photo: Astrid Volder

Water Tables and Flooding

- Standing water tables will permanently limit the root zone depth
- Fluctuating water tables can prevent successful orchard establishment
  - High water tables during dormancy or early spring are associated with increases in stream flows
  - High water tables during the growing season are associated with unlined canals, flooding in nearby fields
- Orchards established on stream banks may be subject to occasional flooding

Break Up Impenetrable Barriers

- Why destroy impenetrable barriers?
  - Create a channel for water drainage
  - Increase the root zone volume
- Barriers must be shallow and thin enough to be broken through and/or mixed
  - The soil beneath must be permeable, however
- Impenetrable barrier must be no deeper than 2/3 of the shank

Photo: A. Fulton


Photo: A. Fulton

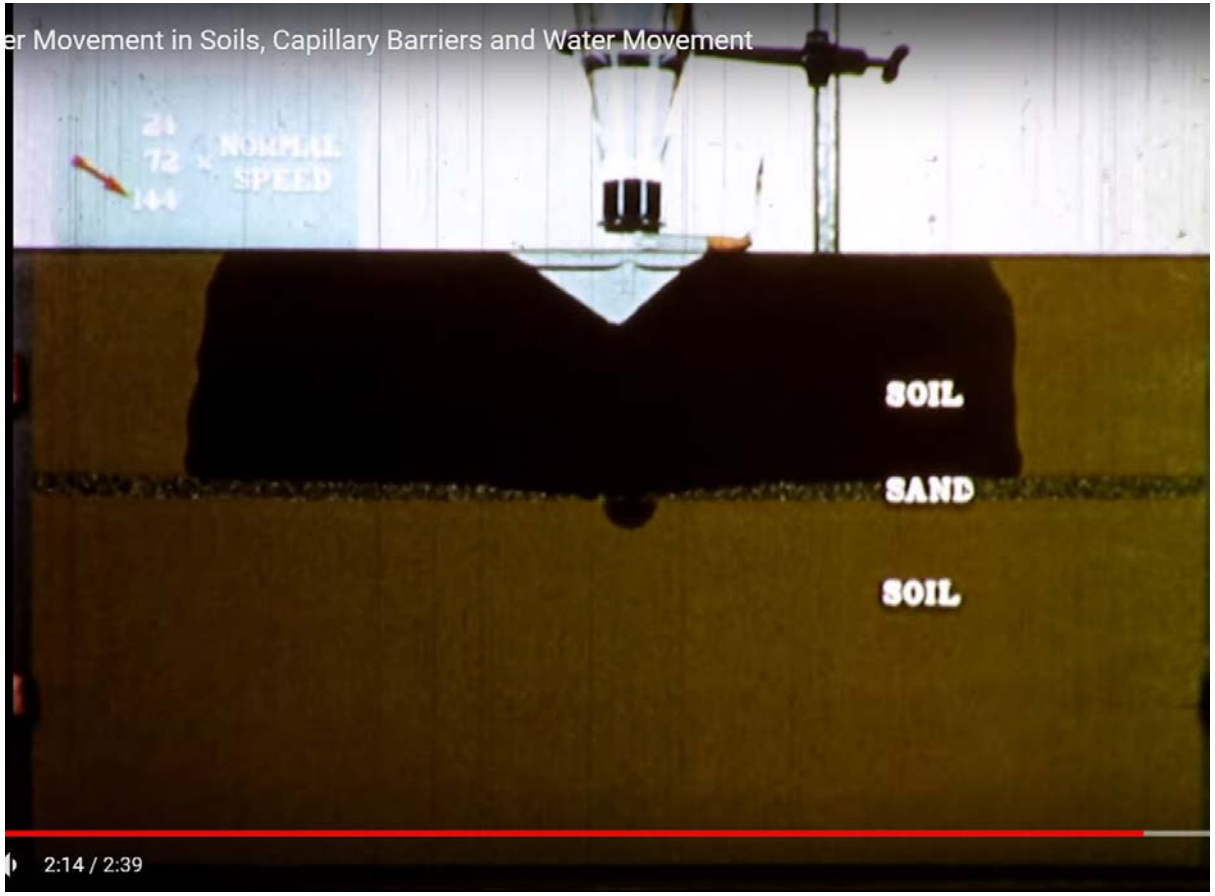
Stratified soils can also impede drainage

- Water will build up at the interface
- Temporary saturated layers can develop
  - Can lead to a reduction in rooting depth
  - Or lead to situations conducive to root diseases
- Soil mixing can break up the interface between the layers

Stratified soils can also impede drainage

Fine textured soil overlying coarse – Water stops at sand layer

Fine textured layer overlying coarse – Water moves through sand layer



From: Chapter 2 of *Water Movement in Soils*: Capillary Barriers and Water Movement. Dr. Walter Gardner and Jack Hsieh. Washington State University. 1959. Film. Accessed via Youtube 10/3/2018.

Tillage may not always provide benefits – almond example

Claypan 12 – 15” deep.
Conducted in Shandon, Ca

Treatment	Trunk circumference at 4th leaf (cm)	# roots in 0-3 feet at 8th leaf	Yield at 8th leaf (lbs/acre)
No tillage	37.5	78	1009
Ripper	42.2	94	1120
Slip plough	42.3	118	1185
Moldbord plough	43.3	175	1433

Wildman, W.E., and K.D. Gowans. 1978 UC ANR Publication 2280.

Claypan 30-60” deep.
Conducted in Arbuckle, Ca

Treatment	4th leaf yield (lbs/acre	9th leaf yield (lbs/acre)
No tillage	830	1841
Slip plough	894	1548

Rooting was observed to be slightly deeper in treated soil

Edstrom, J. P., 2008. Slip plow tillage effects in almonds. UC Nickels Soils Lab Report

Microirrigation can help overcome restrictive layers

- Irrigation can be managed to prevent perched water tables in soils with restrictive layers
- The orchard is still vulnerable to mistakes, leaks, or extreme rain events

For tillage to be effective, it must be…

- Close enough spacing to loosen lower soil
- Deep enough to fix problem
- OR deep enough to increase the effective rooting depth
- Conducted in moderately dry soil so that clays don’t re-form and machinery doesn’t compact soil
- Conducted in soil wet enough so that aggregates aren’t pulverized

Excavation could be more effective for restrictive layers deeper than 30-36 inches

The best time to effectively remediate soils is pre-plant

- Gypsum, lime, sulfur need to be incorporated to significantly modify soil chemistry
- Post-plant ripping has not been shown to be effective in remediating deep soil problems and could damage stressed trees

Pick the correct irrigation system based on soil texture

Soil type	Max application rate (in/hr) by slope		
	0-5%	5-8%	8-12%
Coarse sand	1.5-2.0	1.0-1.5	0.75-1.0
Light sand	0.75-1.0	0.5-0.8	0.4-0.6
Silt loam	0.3-0.5	0.25-0.4	0.15-0.3
Clay loam	0.15	0.1	0.08

NRCS, 1985

Plugging it all in to orchard design

- Do I need to select a certain rootstock based on soil pH, ECe, texture, nematode pressure?
- Does the soil limit growth enough that I want to increase tree densities?
- Are there any areas I should avoid planting?
- Should I even be planting walnuts here?

Questions?

Phoebe Gordon, Ph.D

Madera and Merced Counties

pegordon@ucanr.edu

559-675-7879 ext. 7209

www.growingthevalleypodcast.com

Delayed foliation in walnut. Ventura County, June 3, 1926
UC Cooperative Extension Archive