Soil health for citrus: considerations and challenges

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Soil health = soil quality

Generally think of “healthy” in a way that will benefit crop production:

• Increase soil nutrient availability
• Low abundance of pathogens
• Increase plant growth
Critical for improving:

- Water-holding capacity
- Soil structure
- Erosion prevention
- Nutrient cycling and retention
- Provides nutrients for microbes
Difficulties with SOM in Florida
Most citrus soils are classified as vulnerable to leaching
  - related to low soil organic matter

Citrus soils typically have 1-2% soil organic matter

*How can you improve SOM in Florida citrus?*
  - Compost
  - Cover crops
Building soil organic matter in Florida: compost

Benefits
• Availability
• Application
• Nutrient source

Difficulties
• Expensive
• Application – timing – repeat applications
• Availability
• Variability
• Potential source of weed seed

• Little large-scale quantitative data on impact of compost at citrus planting
• Possibility for rootstock-specific differences

• Collaboration with Dr. Ute Albrecht
  *Stay tuned!*
• Cover crops = crops planted to benefit the soil, generally not harvested for profit

• Increasingly common practice for grains, cotton, corn, soybean farmers, but also used with some vegetable production

• Cover crops planted during fallow season

• Cover crop use more frequently combined with conservation or no-tillage management practices
• Provide N – either by N—fixation from legumes, or by scavenging extra N from previous crop

• Reduce weeds

• Reduce soil erosion

• Reduce soil compaction

• Increase soil moisture

• Increase soil organic matter
Challenges for planting cover crops in citrus

• **Location:**
  • Trunk to trunk vs. row middles

• **Timing:**
  • Multiple plantings per year

• **Management:**
  • Mowing
  • Herbicides

  • Preparing row middles:
    • Herbicide
    • Mow?

• **Seed planting:**
  • No-till drill
  • Light disk
Nitrogen-fixing cover crops:
- Cowpeas (*Vigna unguiculate*)
- Vetches (*Vicia* spp.)
- Crimson clover (*Trifolium incarnatum*)
- Sunnhemp (*Crotalaria juncea* L.)
- Perennial peanut

Nematode management (non-host plants):
- Cereal rye (*Secale cereale*)
- Wheat (*Triticum aestivum*)
- Crimson clover (*Trifolium incarnatum*)

Weed suppression:
- Subterranean clover (*Trifolium subteraneum*)
- Buckwheat (*Fagopyrum esculentum*)
- Sorghum-sudangrass
**Tree growth:**
- Canopy diameter
- Canopy volume
- Leaf area

**Soil nutrients:** SOM and N

**Soil microbial community**

**Root growth and density**

**Fruit yield and quality**

**Weed growth**

**Economic benefits**

Co-PIs:
Dr. Davie Kadyampakeni (CREC)
Dr. Ramdas Kanissery (SWFREC)
Dr. Tara Wade (SWFREC)
Cover crops in citrus: field trials

- Treatments:
  - Cover crop mix with and without legumes
  - Eco-mowing (reverse mowing) or standard mowing

- Cover crop mixtures include:
  - Sunnhemp
  - Sesbania
  - Hairy indigo
  - Pearl millet
  - Japanese millet
  - Brown-top millet
  - Buckwheat
  - Daikon radish (winter only)
  - Dove millet
  - White clover
  - Crimson clover
  - Oats
  - Sunflower (low to no germination)
SOM increased after 1 year of cover crops

LG + NLG: legume + non-legumes cover crops
NLG: non-legume cover crops
GS: grower-standard
Soil microbes increased with cover crops

LG + NLG: legume + non-legumes cover crops
NLG: non-legume cover crops
GS: grower-standard
Changes in N-cycling microbes with cover crops

LG + NLG: legume + non-legumes cover crops
NLG: non-legume cover crops
GS: grower-standard
Changes in soil ammonium with cover crops

North Grove

- LG + NLG: legume + non-legumes cover crops
- NLG: non-legume cover crops
- GS: grower-standard

Ammonium (mg/kg)

South Grove

- LG + NLG: legume + non-legumes cover crops
- NLG: non-legume cover crops
- GS: grower-standard
Density Survey in Citrus Row Middles
Time: Spring 2019
Location: North Grove

Weed pressure reduced with cover crops

- No. of observations per treatment (n) = 18
- Error bars represent standard error
- Bars with the same letters do not significantly differ (Tukey’s HSD, P<0.01)

- Data from Dr. Ramdas Kanissery
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Cover Crops (CC) vs. Weeds

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Data from Dr. Ramdas Kanissery

- up to 84% reduction in weed density
Changes in weeds present with cover crops

- Cover crops improved the biodiversity in the treated row middles
- Sedges and grasses took over the non-treated controls

Row middle vegetation composition in citrus row middles

With Cover Crops

- Cover crops
- Sedges
- Guinea grass
- Panicum grass
- Virginia Pepper
- Parthenium

No Cover Crop Control

- Data shown from cover crop mix-1 (n=18)
- Cover crops: Daikon radish, White Clover, Crimson Clover & Buckwheat
- Similar trend for other treatments

- Data from Dr. Ramdas Kanissery
Combining cover crops and compost

Rate 1: 4.5 tons of compost/acre/year; Rate 2: 9 tons of compost/acre/year
• Are there specific microbes in a healthy soil?
• Is there a “healthy” level of microbial diversity?

• Keystone species for particular region and/or crop – easy to ID and quantify?
  • Likely specific for region and crop

• Resiliency and robustness of soil microbial community unclear
  • Functional redundancy?
  • What determines redundancy?
• Are there any tests for measuring soil health?

• USDA-NRCS Soil Health Division has proposed several methods
  • Include: soil organic matter, general microbial activity, available carbon and nitrogen, and microbial diversity
  • Scale/ranking difficult, particularly for Florida

• More work needed!
• Cover crops can improve soil organic matter, nutrient availability, microbial activity, and suppress weeds

• Optimizing cover crops for citrus is necessary

• Influence of cover crops on citrus will likely require several years
Thanks to:
Dr. Davie Kadaympakeni
Dr. Ramdas Kanissery
Dr. Tara Wade
Dr. Ute Albrecht

SWFREC Farm Crew

Bob Newsome, John Hoffman, and Forrest Taylor:
Barron Collier Partnership

Joby Sherrod: Duda & Sons

Strauss Lab:
Dr. Antonio Castellano Hinojosa
Rachel Berner
Kira Sorochkina
Clayton Nevins
Diderot Saintilma

This work is supported by the CRDF 18-059C and CRDF 19-030C