Soil health for citrus: considerations and challenges

Sarah Strauss, PhD
Assistant Professor, Soil Microbiology
strauss@ufl.edu
@SoilMicroSarah



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



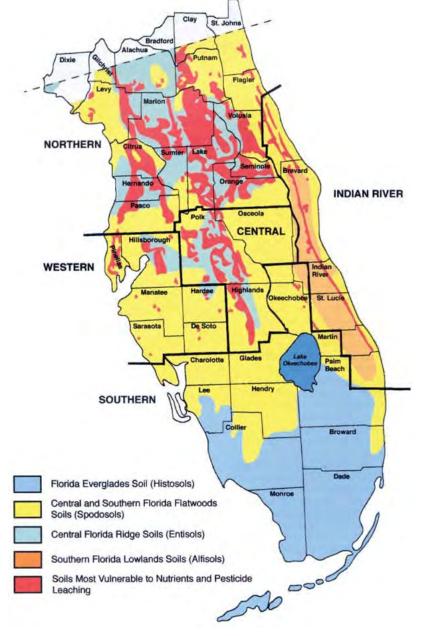




- related to low soil organic matter
- Citrus soils typically have 1-2% soil organic matter

How can you improve SOM in Florida citrus?

- Compost
- Cover crops





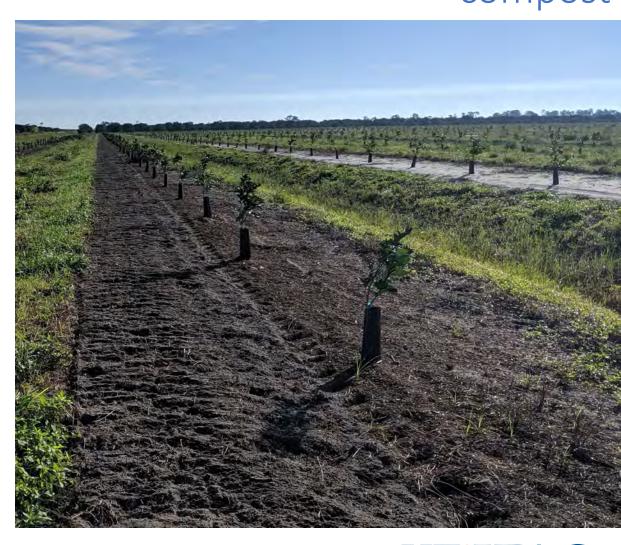
Building soil organic matter in Florida: compost

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!







Building soil organic matter in Florida: cover crops

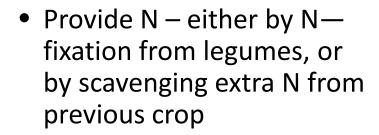
 Cover crops = crops planted to benefit the soil, generally not harvested for profit

- 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



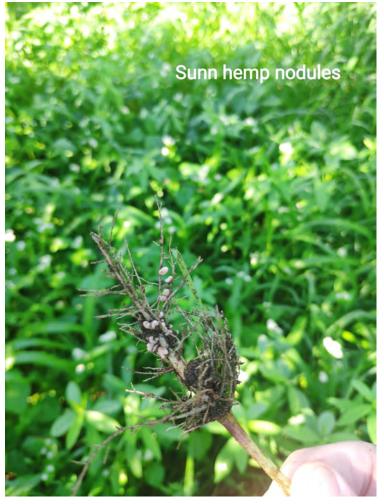


Why plant cover crops?



- Reduce weeds
- Reduce soil erosion
- Reduce soil compaction
- Increase soil moisture
- Increase soil organic matter

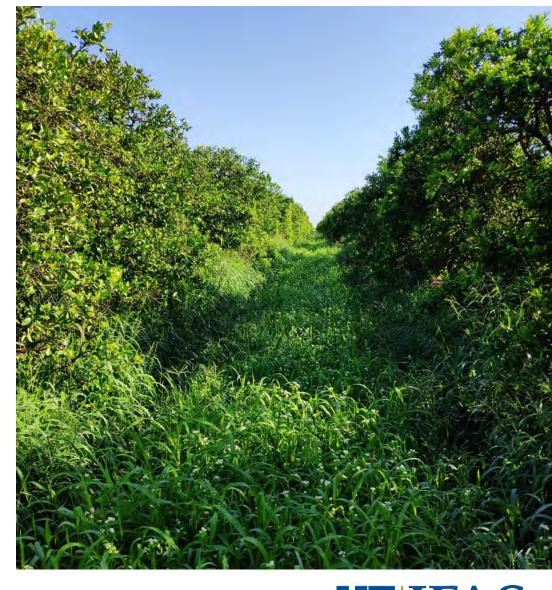






Challenges for planting cover crops in citrus

- 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





Challenges for planting cover crops in citrus:

varieties

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





Cover crops in citrus: field trials

Tree growth:

- Canopy diameter
- Canopy volume
- Leaf area

Soil nutrients : SOM and N. Soil microbial community

Weed growth

Co-Pls:

Dr. Davie Kadyampakeni (CREC)

Dr. Ramdas Kanissery (SWFREC)

Dr. Tara Wade (SWFREC)



Fruit yield and quality

Economic benefits

Root growth and density







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)



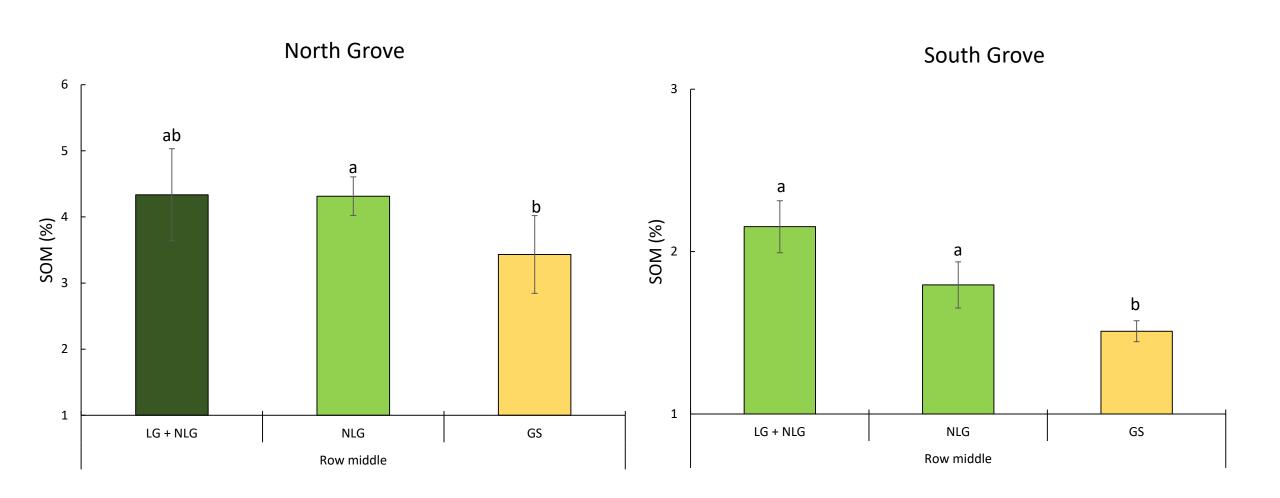






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SOM increased after 1 year of cover crops

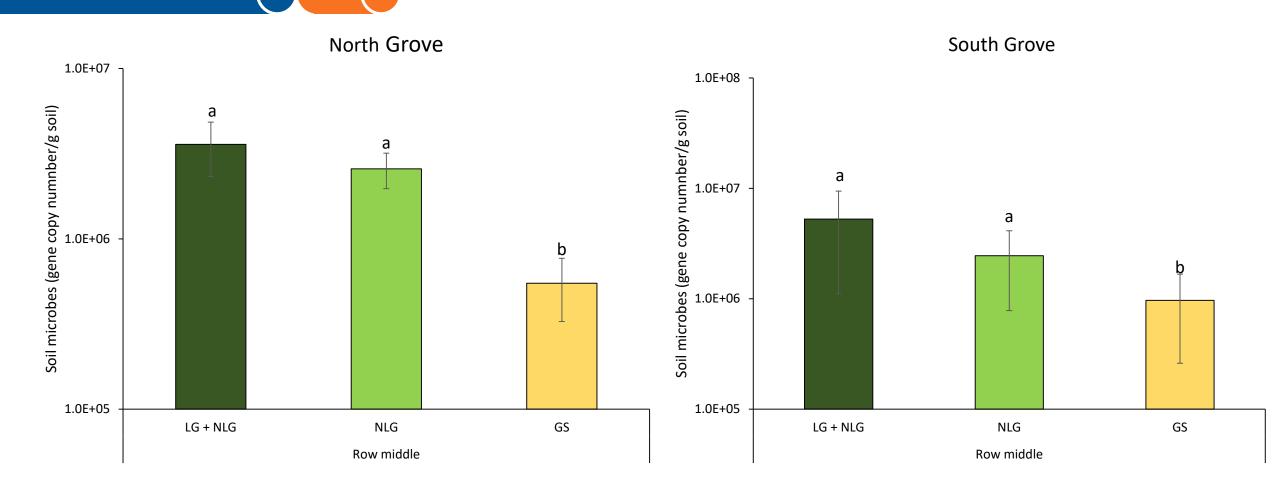


LG + NLG: legume + non-legumes cover crops

NLG: non-legume cover crops



Soil microbes increased with cover crops

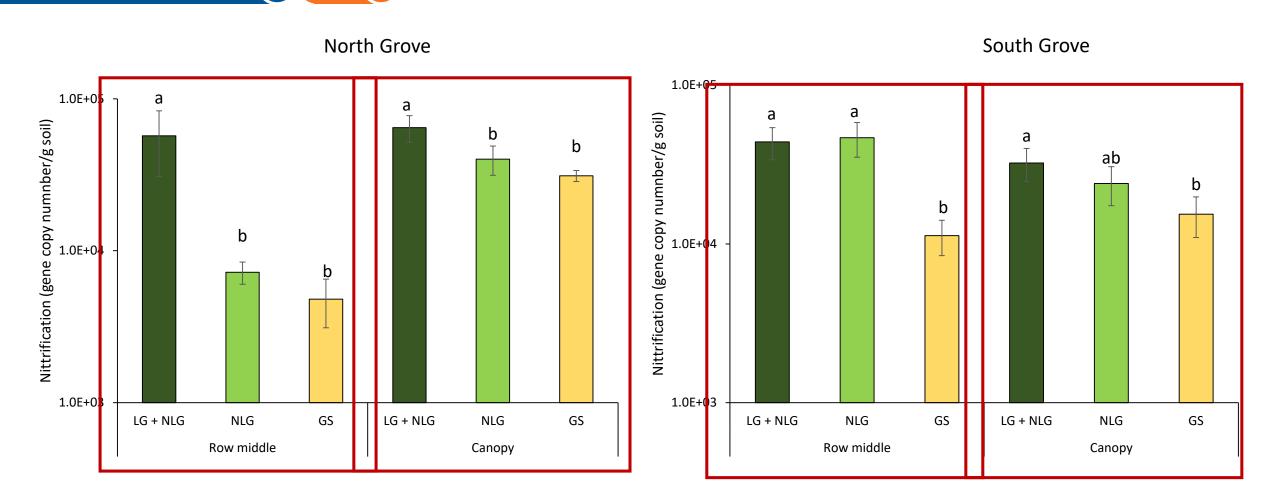


LG + NLG: legume + non-legumes cover crops

NLG: non-legume cover crops



Changes in N-cycling microbes with cover crops

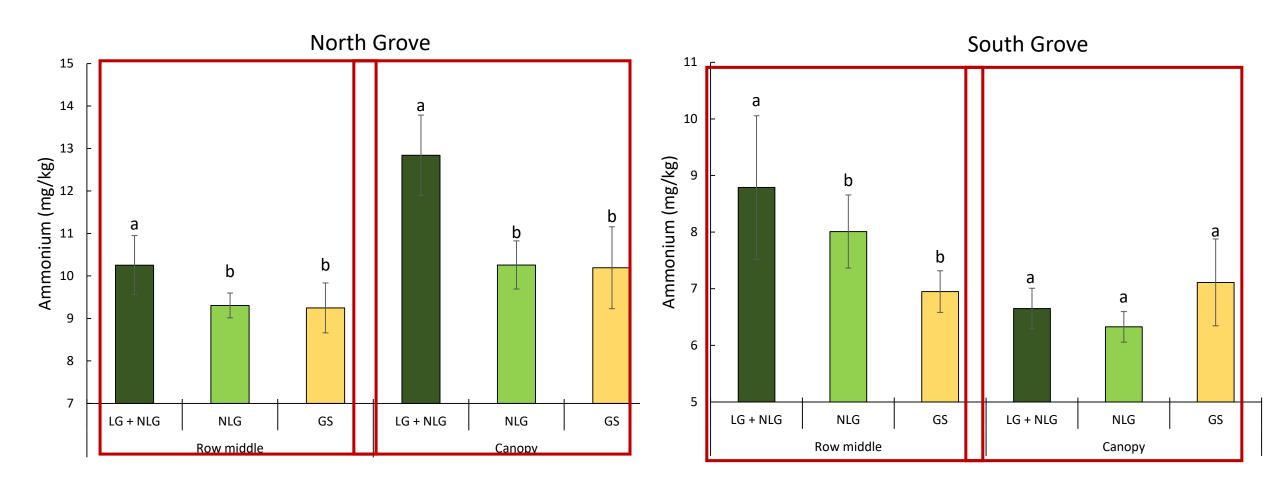


LG + NLG: legume + non-legumes cover crops

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Changes in soil ammonium with cover crops

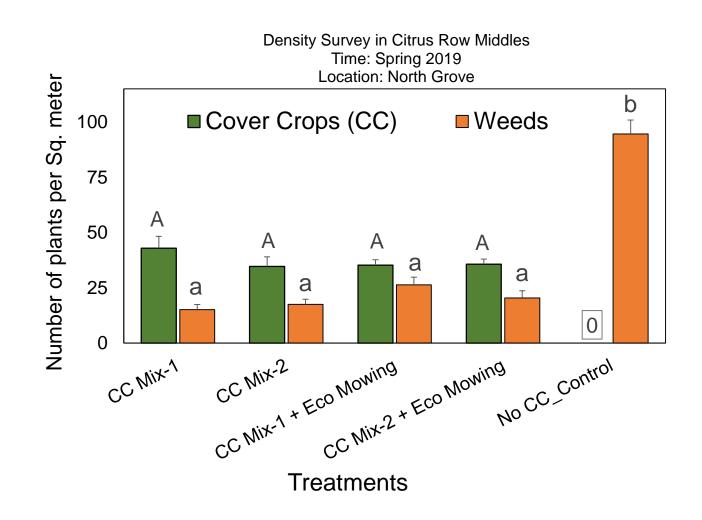


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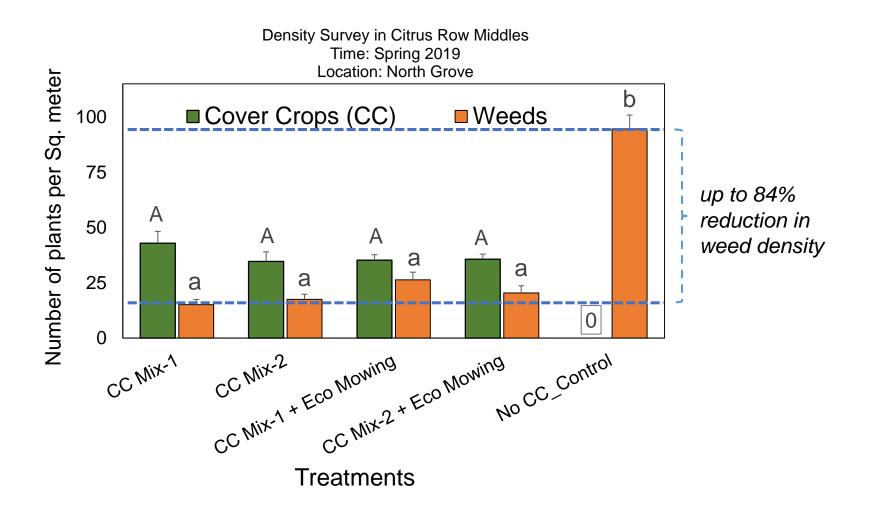
Weed pressure reduced with cover crops



- 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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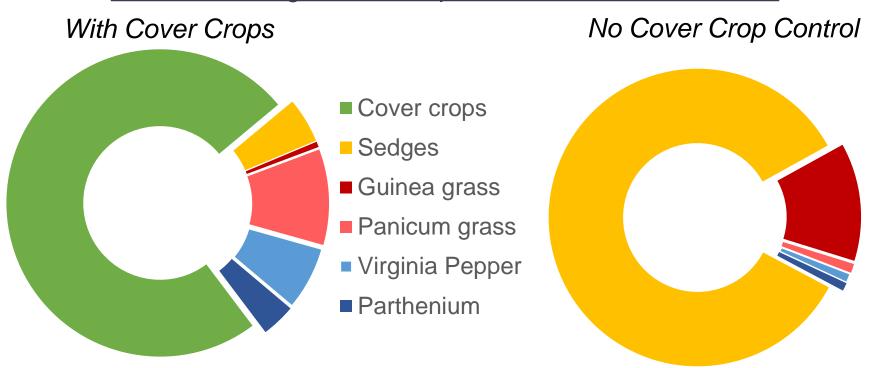




Changes in weeds present with cover crops

- 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



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





Combining cover crops and compost



Rate 1: 4.5 tons of compost/acre/year; Rate 2: 9 tons of compost /acre/year



Microbes and soil health

- 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?





Microbes and soil health

- 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!





Summary



- 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

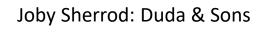




Dr. Davie Kadaympakeni Dr. Ramdas Kanissery Dr. Tara Wade Dr. Ute Albrecht

SWFREC Farm Crew

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



Strauss Lab:

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









