Figure 1. Cover crops are growing in a citrus grove in Southwest Florida during the summer. Species that have done well in the summer months include sunn hemp, sorghum sudangrass, pearl millet, Egyptian wheat and buckwheat. *Photo by Sarah Strauss*

Using cover crops to improve soil health

By Sarah Strauss, Emma Dawson and Elena Karlsen-Ayala

The term "soil health" has become increasingly popular in the last several years. While there are many definitions of soil health, one of the more commonly cited ones is from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). It defines soil health as "…the continued capacity of a soil to function as a vital living ecosystem that sustains plants, animals and humans."

Soil health is often used interchangeably with other terms such as "soil quality" and "soil fertility." However, soil health differs from these terms because it includes and focuses on soil biology, such as earthworms and microorganisms. These organisms are important to include in discussions and measurements of soil health as they are critical to nutrient availability and disease and pest control.

The benefits of having healthy soil can include better water-holding capacity, increased nutrient availability and greater microbial activity. These traits can potentially lead to increased root growth and nutrient uptake by a tree. For citrus affected by huanglongbing (citrus greening), increased root growth and nutrient uptake can be critical as the disease significantly impacts these functions in the tree.

HOW IS SOIL HEALTH MEASURED?

One of the major challenges with the concept of soil health is that it is difficult to measure. There are over 20 indicators suggested by different organizations, including the USDA NRCS, that can be used to assess soil health. These include measurements of soil physical properties such as soil texture, soil chemical properties such as pH and nutrient concentrations, as well as soil biological properties such as microbial biomass and abundance of specific microbial groups.

However, for some indicators, there are multiple methods for measuring that indicator, and not all indicators may be appropriate for every soil and/or region. For example, soil organic matter (SOM) is a critical component of healthy soil. Organic matter,

and the resulting increases in soil carbon, are related to increases in microbial activity. SOM is extremely low in Florida citrus soils (often 1% or less). Building organic matter in Florida citrus soils can be a slow process as decomposition of plant material can occur very quickly due to the hot and wet climate.

To assess whether management practices are resulting in faster changes to soil carbon, it could be helpful to measure a more labile form of soil carbon through a measurement called permanganate oxidizable carbon (POXC). POXC measures available carbon in the soil that can be used by soil microbes for nutrient cycling. This is an important indicator because it can be more sensitive to environmental changes and/or management practices and therefore can reveal more about short-term changes in nutrient cycling. Preliminary data from some University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) field trials found a greater change in POXC in soils planted with cover crops compared to the change in SOM.

HOW DO COVER CROPS IMPACT SOIL HEALTH?

Two of the primary methods suggested for improving soil health are to keep the soil covered and maintain living roots in the soil all year. Both methods occur with the use of cover crops (Figure 1, page 18). Planting cover crops in the row middles of the grove can help reduce erosion, limit weed growth and herbicide applications, reduce mowing and build SOM from the leaf litter and roots of the cover crops. As SOM provides carbon and resources for soil microbes, building organic matter can increase microbial activity and potentially nutrient availability.

Previous UF/IFAS research found increases in the abundance of microbes that are involved in nitrogen cycling in soils with cover crops. Planting specific types of cover crops can also lead to increases in certain microbial groups and potential changes in soil nutrients. For example, planting legumes allows for the growth of symbiotic bacteria with the legume plant that fix nitrogen and can thus increase nitrogen availability in the soil. Previous trials showed that planting a mixture of legumes and non-legume plants increases the

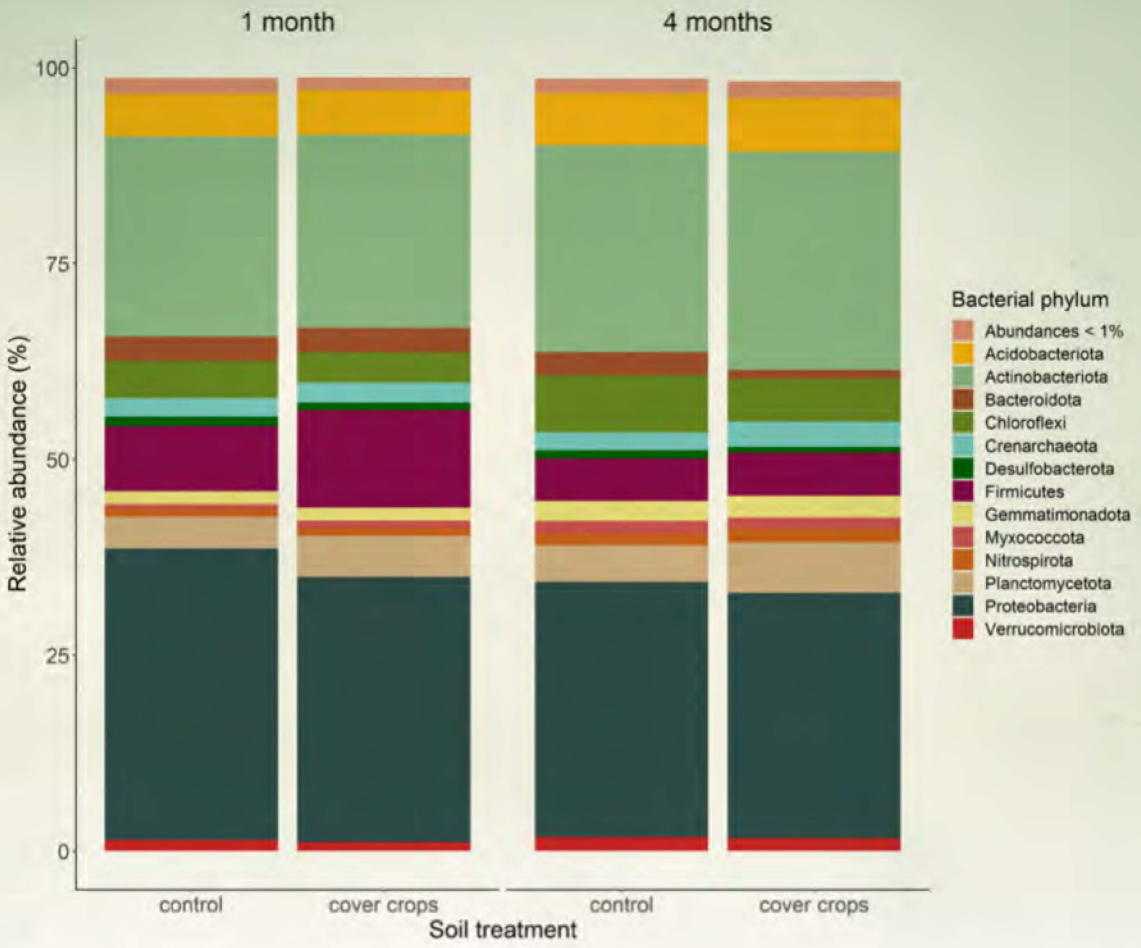

Figure 2. Relative abundance of dominant bacterial phylum in the citrus rhizosphere between cover crop and control soils at one and four months after transplanting citrus seedlings into the treated soils. Bacterial phyla with average relative abundance greater than 1% are shown.

amount of nitrogen in the soil more than just planting legumes alone.

See the June 2022 Citrus Industry issue for tips on planting cover crops in citrus row middles, including suggestions on what species of cover crops to plant.

In citrus, cover crops are generally planted only in the row middles. However, cover crops in the row middles can still change the microbes that grow around citrus roots as tree roots extend into the row middles.

In a recent greenhouse trial, citrus seedlings were planted in soil from the row middles of a grove that had cover crops for four years. We compared the microbes growing around the roots (known as the rhizosphere) of the seedlings in the cover crop soil to those planted in soils without cover crops. Preliminary examination of the data found significantly different bacterial communities in the rhizosphere of seedlings in the cover crop soil compared to the control soil (Figure 2). These included changes in the abundances of bacterial taxa that could provide plant-growth promoting benefits. Research is underway to further identify these bacteria and determine if they directly impact plant growth.

STUDYING SOIL HEALTH INDICATORS

Previous UF/IFAS research (see Citrus Industry articles in June 2022 and October 2020) found cover crops can impact several soil properties in citrus grove row middles and therefore have an impact on soil health. However, not all of the properties measured in the studies are practical or easy to measure frequently. There are over 20 possible indicators a grower could measure, which also is not practical.

Therefore, a study is currently being conducted to determine which soil-health indicators are most helpful at assessing the health of Florida citrus soils for short-term (within a year) and long-term (over a year) changes. To provide a comparison between soils of different health, groves are being used with different histories of cover crop use. At the conclusion of this study, researchers hope to provide a shorter list of indicators that might be helpful to monitor to determine if management practices, such as planting cover crops, are improving the soil health of groves.

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