Experimenting with cover crops: Results from three years of trials

By Sarah Strauss, Antonio Castellano-Hinojosa, Davie Kadyampakeni, Ramdas Kanissery and Tara Wade

Cover crops, which are planted specifically for soil enhancement and not for sale or harvest, can improve soil conditions and production for a variety of crops. However, there have not been many studies documenting changes to soil conditions and production when using cover crops in citrus.

The University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) has been conducting field trials in two commercial citrus groves to measure how cover crops in citrus row middles change soil conditions and weed growth, and possibly impact tree productivity. While most cover crop studies conducted in other cropping systems found it can take a minimum of three years to see changes to the soil, researchers have already seen changes to soil microbes, some nutrients and weed growth during the first three years of the citrus trials.

PLANTING LESSONS

This study tested two different mixtures of annual cover crop species: one that included legumes and one without legumes. The germination and cover crop growth were generally better in the mixes with legumes compared to the mix without legumes throughout the trial. However, germination was also influenced by additional factors such as the grove location, management practices and the weather.

One of the key components of cover crops is that they should germinate and grow without fertilizers or irrigation. Timing the planting of cover crops with the rainy season is critical for successful germination and growth. Different mixtures were planted at the beginning of the rainy season (May/June) and the end of the rainy season (October/November). For the May/June planting, cover crops included sunn hemp, cowpea, millet and buckwheat. The October/November planting included daikon radish, sunn hemp, rye and oats. Sunn hemp grew especially well during the summer months, and daikon radish consistently grew well in the winter months.

Cover crops were only planted in the row middles, and herbicides were used to keep the area under the tree canopy clean. Because annual species of cover crops were used, there was interest in building a seed bank for these cover crops. Unlike when cover crops are planted during a fallow period for row crops, researchers were able to let the cover crops grow for nearly six months, flower and produce seeds before they naturally died. Before planting the next round of cover crops, the previous crop was completely terminated by herbicide and then mowed. Cover crop seeds were planted using a no-till drill.

SOIL BENEFITS

One of the biggest changes to the soil with cover crops has been seen in the soil microbes. One year after planting cover crops, the number of bacteria in the soil increased by an order of magnitude (Figure 1, page 19). This increase was seen in both cover crop mixes, but there was an even greater increase in soils planted with the legume and non-legume mix.

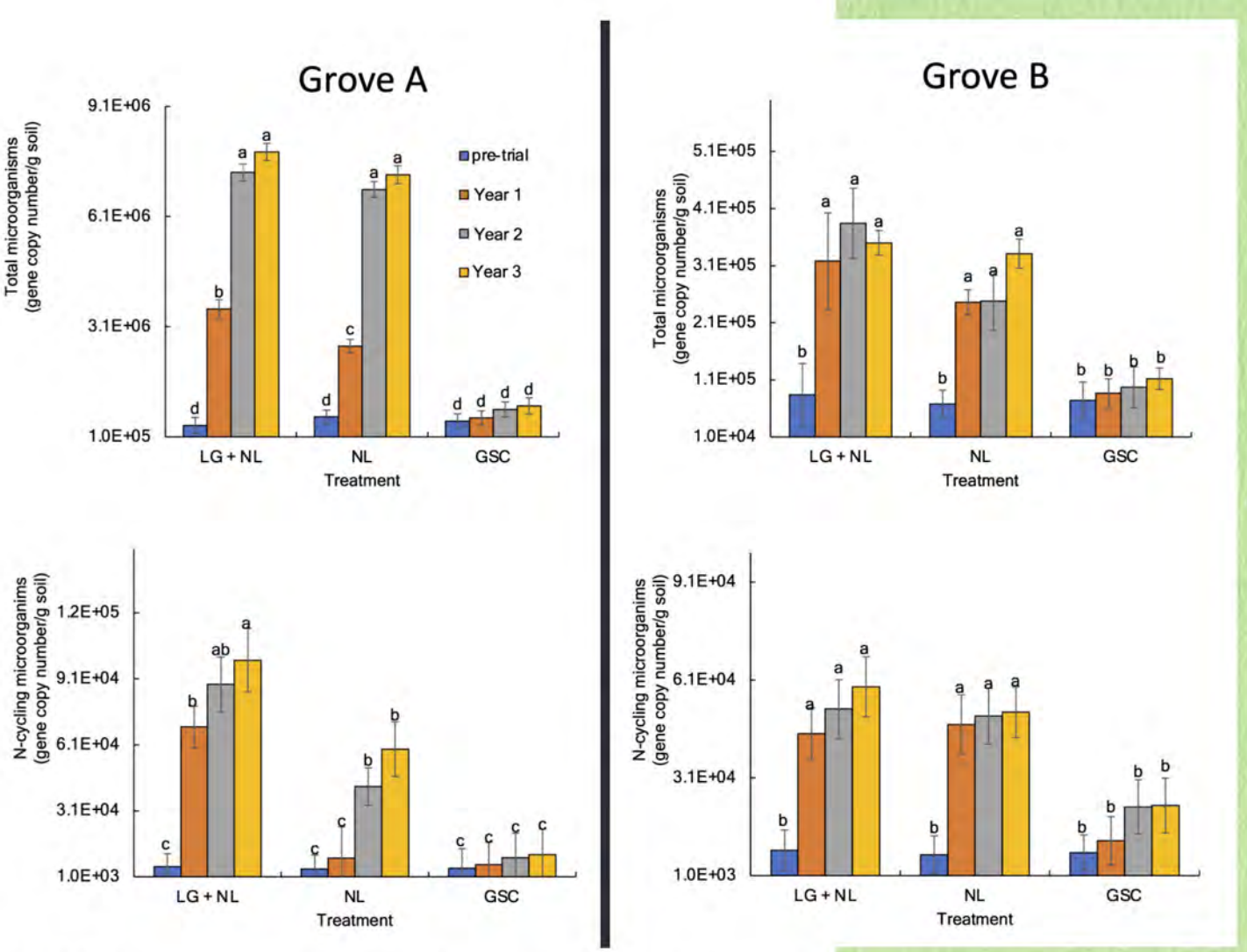

Figure 1. Effect of cover crops on the total abundance of microorganisms (bacteria and archaea) and nitrogen-cycling microorganisms in a grower-standard control (GSC), soil planted with legumes and non-legumes (LG + NL) or soil with non-legumes only (NL). Letters indicate significant differences.

Soil bacteria remained significantly greater in soils planted with cover crops during the three years of the trial. Increases in the abundance of microbes involved in the nitrogen cycle (Figure 1) also were observed. As legumes are colonized by specific bacteria that can fix nitrogen, it is not surprising even more nitrogen-cycling bacteria in soils under the legume cover crop mixture were found.

Increases in bacteria under the cover crops are likely contributing to the changes that were found in soil nitrogen and organic matter in soils planted with cover crops. However, changing soil organic matter and nitrogen concentrations is a complex process involving many factors.

While soil organic matter did increase under cover crops in Grove A during the first years of the study, there did not appear to be a continued increase. In other cover crop studies, it is common for the greatest increases in soil organic matter to occur in the first years after planting, with smaller changes occurring later. Variations in cover crop growth, precipitation and temperature can also impact soil organic matter development, as the biomass of the cover crops is critical for improving soil organic matter. These factors might have contributed to the smaller changes in soil organic matter in Grove B.

WEED MANAGEMENT ADVANTAGES

Another advantage of planting cover crops in citrus is their contributions toward weed management (Figure 2, page 21). Among the several factors affecting weed suppression by cover crops, the physical barrier provided by cover crops on the soil surface is important. Research from the trials has shown a strong negative relationship between the number of cover crop plants and the weed density in the row middles, clearly illustrating the significance of cover crop coverage and biomass in the effective suppression of weeds.

Shade is a natural weed killer. Dense growth of cover crops can provide shade and keep soils cool, preventing the weed seeds from germinating or growing aggressively.

Moreover, some cover crops release biochemical compounds that suppress the germination and growth of weeds in close proximity (also known as allelopathy) and are beneficial in managing tough

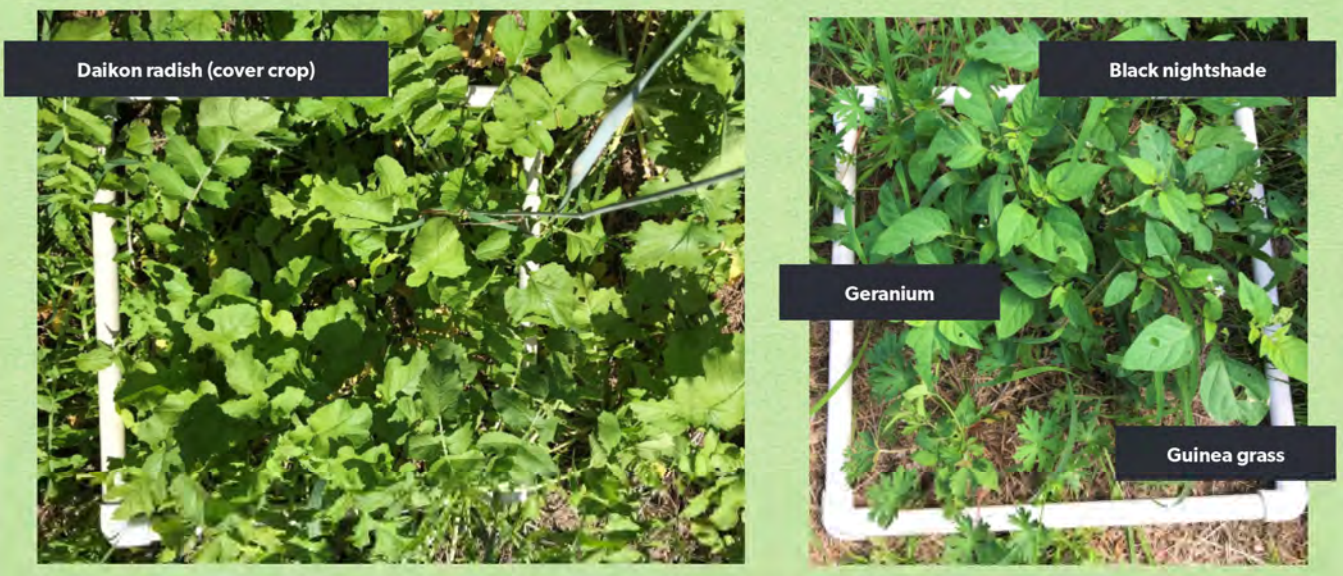

Figure 2. 'Weed-free' row middle in a citrus grove planted with a cover crop (left) and weeds growing in a row middle without a cover crop (right).

weeds. For instance, certain perennial weeds in citrus, such as grasses and sedges that potentially regrow from rhizomes or tubers, are relatively difficult to control, even with chemical control. However, the cover crop mixes evaluated in the study substantially suppressed the germination and growth of these grasses and sedges.

Unlike soil health benefits, weed reduction and savings in weed management costs are immediate benefits of cover crops use. The estimated cost to use cover crops is $220 per acre per year in citrus row middles This accounts for seed, labor, fuel and a no-till drill seeder rental. This value will vary depending on seed choice and application rate.

However, because the weed management strategy of mowing is not necessary with cover crops use, there can be an average cost savings of about $75 per acre per year. Thus, applying cover crops can increase the cost of production by $145 when mowing savings are considered.

Herbicide use can also be reduced if cover crops are grown under the tree canopy (which was not considered in this study). But these savings are marginal when only the row middles are considered because herbicides are not typically applied in row middles. If other hypothesized benefits of cover crops, such as reduced nutrient use or improved yields, are realized in the longer term, these benefits could provide additional offsets to cover crop costs.

CONTINUING RESEARCH

Cover crops were only planted in the row middles in this study, but trees have extensive roots throughout the row middles. Therefore, changes to soil microbes and nutrient cycling within the row middles may still impact the citrus trees themselves. Researchers have not seen any changes in root growth, yield or juice quality with the planting of cover crops during this three-year study. However, it is important to note that these trials were conducted in groves with trees older than 20 years, which may be slower to respond to changing soil conditions in the row middles.

Trials with cover crops in younger groves were recently started to see if there is a relationship between tree age and cover crop impacts on soil conditions. Annual or seasonal cover crop species will be the focus for these trials since perennial cover crop species can take several years to establish. However, there are perennial cover crop species, such as clovers and perennial peanuts, which have been successfully used by several citrus growers and for cattle grazing. UF/IFAS is starting trials to determine which species of perennial cover crops are most suitable for South Florida citrus and whether they can be integrated with any of the annual cover crop species.

There are still many questions about the optimization and implementation of cover crops in citrus, but the results of this initial trial are encouraging. The dramatic increase in soil microbes, particularly those involved in nitrogen cycling, indicates cover crops can change the soil environment. Cover crops also reduce weed pressure and the need for frequent mowing in the row middles. Overall, cover crops do have potential to impact soil health and management of Florida citrus.

Sarah Strauss, Ramdas Kanissery and Tara Wade are assistant professors; Antonio Castellano-Hinojosa is a postdoctoral associate — all at the UF/IFAS Southwest Florida Research and Education Center in Immokalee. Davie Kadyampakeni is an assistant professor at the UF/IFAS Citrus Research and Education Center in Lake Alfred.