Cornell Cooperative Extension

URBAN FARM SOIL HEALTH

Management Practices for Urban Soil Health: Cover Cropping

We are looking at the effect of cover cropping on urban soils and crop health. Cover crops offer numerous management benefits including increasing soil organic matter, reducing erosion, weed suppression, nitrogen fixation and attracting beneficial organisms. Cover crops have been shown to enhance soil carbon and nitrogen in rural settings but have not been sufficiently evaluated in urban agriculture. Urban growers are limited to cover crops that are suitable for intensively managed spaces. Furthermore, many growers do not possess the equipment needed to terminate and incorporate a cover crop compared to their rural counterparts, which inhibits adoption.

As part of our research, cover crop demonstration trials have been implemented on select urban farms. Urban growers choose species and timing of planting based on individual preferences and schedules. This is a research update on an urban farm in Erie County looking at the effect of growing oats and an oats/hairy vetch mixture cover crop on soil and crop health. Our hypothesis is that planting cover crops would lead to increased organic matter in the soil and overall crop health.

Farm Background

This cooperating urban farm in Erie County is roughly 2 acres and has been in operation for 15 years. The farmers have over 54 years of farming experience between the two of them. Prior to it becoming a farm, the space was a mosaic of neighboring vacant city lots. These lots had old houses that burned down or were demolished at various times in the site's history. In the first few years on the land, the entire site was planted in clover while waiting to receive soil test results for possible contamination. Farmers have added compost yearly. Crops are grown in the ground in heavy, clay mineral soil on top of unidentifiable fill.

Over a two-year period, this farm hosted an urban cover cropping demonstration trial with oats and oats/hairy vetch mix compared to two bare ground control plots (Figure 1). The farmers report their main motivations for growing cover crops are "to encourage soil health, prevent erosion, avoid leaving bare soil as much as possible to hold moisture, break up existing compaction, and help with weed suppression." Prior to our trial, the farmers report observing positive outcomes such as making the heavy clay soil easier to work with, reducing soil compaction, decreasing run-off, better weed suppression, and attracting beneficial insects to the farm.

Figure 1. Urban cover crop demonstration site in Fall 2021 (top). Oats and hairy vetch cover crop mix (bottom).

Methods

There are four plots at the trial site (Table 1). For two years, the treated plots had a cover crop planted in the fall and incorporated in the spring. Control plots were left bare. Vegetables or grass were planted during the summer growing season. The cover crop planting method was to hand broadcast the cover crop seed heavy and till in lightly with a BCS 853 walk behind tractor with a R2 Rinaldi Power Harrow attachment. Cover crop incorporation (Figure 2) was done by mowing and incorporating the cover crop in the spring with a BCS 853 walk behind tractor using R2 Rinaldi Power Harrow and Berta Flail Mower attachments. Cover crop incorporation took place in April of each project year.

Thus far, soil samples were collected at least once a year and submitted to Dairy One Agronomic Services to assess pH, nutrients, soluble salts, soil microbe active respiration, amino nitrogen and quality of soil structure. Basic fertility testing (pH, nutrients, organic matter), microbial respiration, amino nitrogen, and soil structure were assessed four times (May 2022, September 2022, May 2023, October 2023). Soil samples were collected twice throughout the trial (September 2022 and June 2023) and submitted to the Cary Institute to assess microbial biomass C and N content through the chloroform fumigation-incubation method (CFIM).

Preliminary Results

After cover crop incorporation in 2022, we saw the highest organic matter in the hairy vetch/oats plot (Figure 3). There does not appear to be consistent trends amongst differences in organic matter between plots throughout the trial.

Table 1. Crop history in high tunnel trial location

Treatment	Fall 2021	Summer 2022	Fall 2022	Summer 2023
south control	bare ground	peas	bare ground	corn/okra
oats/hairy vetch	oats/ hairy vetch	grass	oats/hairy vetch	corn/okra
north control	bare ground	beans	bare ground	corn/okra
oats	oats	buckwheat	oats	corn/okra

Figure 2. Cover crop incorporation in Spring 2023 using BCS 853 walk behind tractor with a R2 Rinaldi Power Harrow attachment.

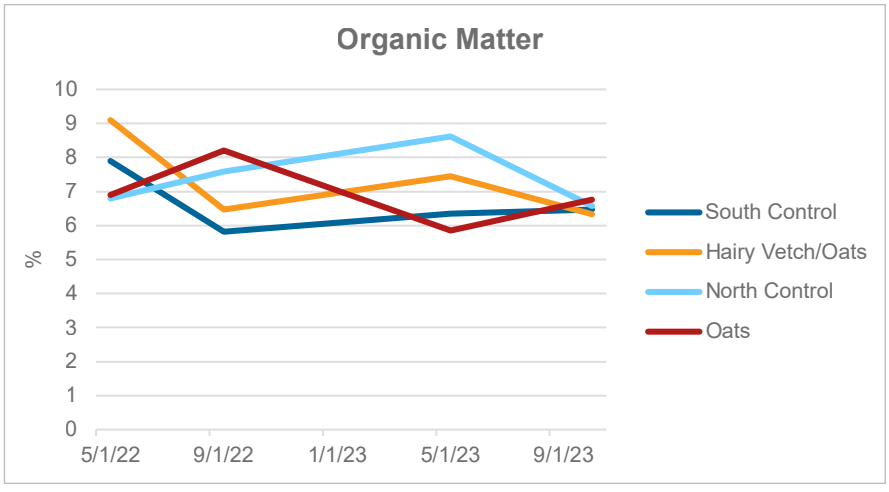

Figure 3. Tracking organic matter from May 2022 to Sept 2023.

Measures of microbial biomass can indicate the potential of soil microorganisms to serve as a source and a sink of specific nutrients in the soil. We found carbon microbial biomass is higher in the cover crop plots than our control plots in Fall 2022 (Figure 4). Nitrogen microbial biomass is higher in the cover crop plots than our control plots in Summer 2023, and is highest in hairy vetch/oats mixture compared to the rest of the plots in Fall 2022 (Figure 5). Mineralization and nitrification potential are higher in the cover crop plots than our control plots in Summer 2023.

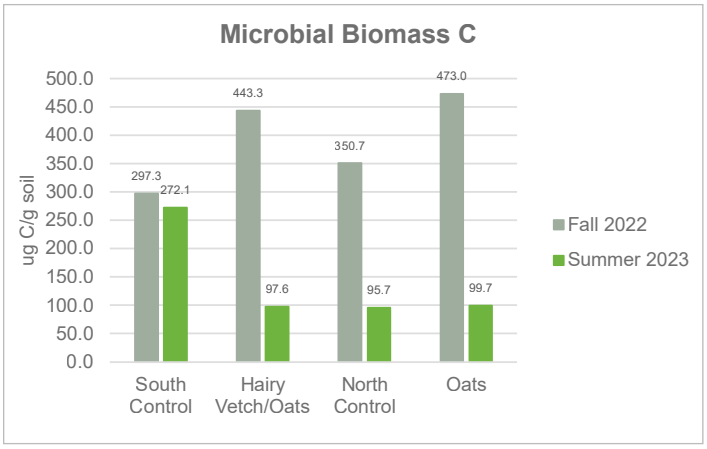

Figure 4. Carbon microbial biomass in Fall 2022 and Summer 2023.

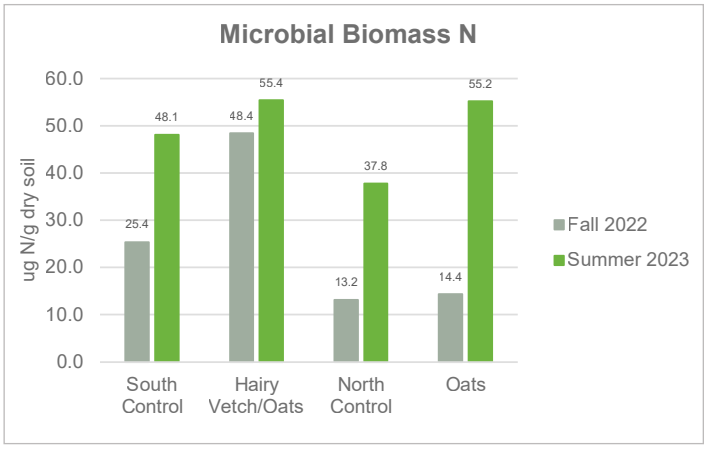

Figure 5. Nitrogen microbial biomass in Fall 2022 and Summer 2023.

Continuing to assess microbial activity in the soil, CO2 Burst is a measure of active respiration of soil microorganisms over a period of 24 hours. It serves as a volumetric reflection of microbial population in the soil. Throughout the multiyear demonstration, we see respiration is highest in our cover crop plots in Fall 2022 compared to the control plots. Respiration continues to be high in our oats plot for the rest of the trial and respiration in the hairy vetch/oats plot declines. The oats and control plots have a similar value and trendline over time (Figure 6). Another learning point here is seasonal cyclicality; microbial respiration is lower in the spring followed by rising levels during warmer months, with the notable exception of our vetch/oats plot.

The farmers reported numerous positive outcomes from growing cover crops including making the soil easier to work with, reducing soil compaction, decreasing run-off, better weed suppression, and attracting beneficial insects to the farm. During cover crop incorporation in Spring 2023, one farmer commented that the cover crop plots retained more moisture than the bare plots. The bare plots were drier and more compacted. The oat plot seemed to hold more moisture than the oats/hairy vetch mix and the farmer speculated this might be due to root structure.

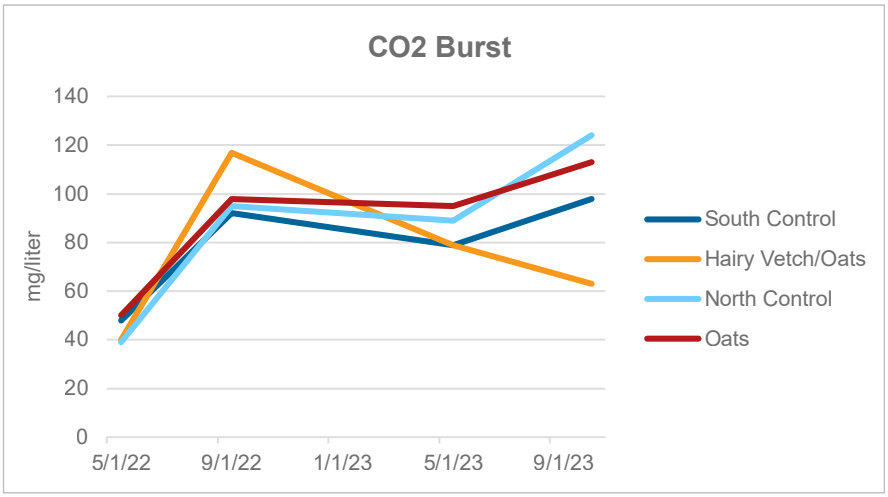

Figure 6. Tracking microbial respiration from May 2022 through October 2023.

In Fall 2023, one of the farmers commented a key benefit of cover cropping has been a decrease in runoff and erosion in the off season. The farm has a slight grade allowing strong rains to erode topsoil. They said, “We have such precious little topsoil, cover crops help us keep it in place.”

Figure 7. Vegetables growing in demonstration plots in summer 2023: corn (left) and okra (right).

For vegetable crops grown in areas that have been cover cropped, the farmers generally reported an increase in quality. The farmer speculates this could be due cover crops attracting a wide variety of beneficial organisms that contribute to a decrease in pest and disease pressure. A key part of the farm philosophy is to grow a diversity of crops and cover crops to attract a diversity of beneficial organisms such as insects and birds. The farmers report a decrease in labor time managing crops that have been grown in areas that have been cover cropped from less weeding and the soil being easier to work with. In Summer 2023, the farmers did not report an increase in crop yields in areas that had been cover cropped and reported that yields were down in general across the farm most likely due to weather. Corn and okra were planted in the demonstration site (Figure 7); okra was not able to successfully establish most likely due to weather and wildlife damage.

Plant tissue analysis of corn in Summer 2023 showed higher potassium (K) % in the cover cropped plots compared to the control plots. There were not clear trends among nitrogen (N) % and phosphorus (P) % (Figure 8).

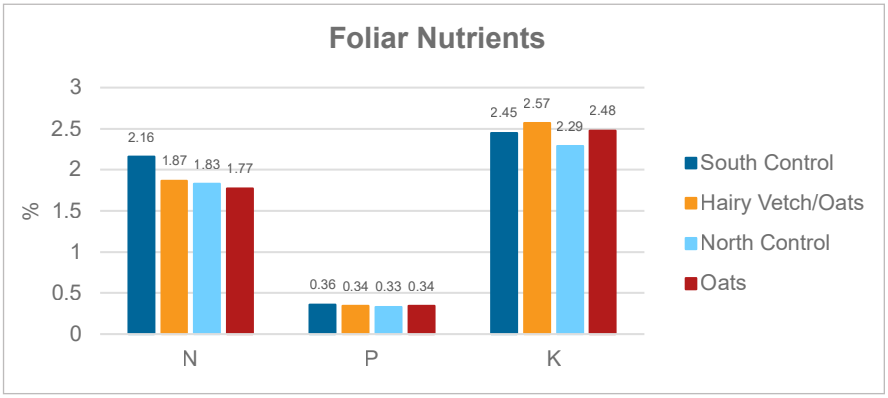

Figure 8. Plant tissue analysis of nitrogen (N), phosphorus (P) and potassium (K) from foliar testing on corn in Summer 2023.

Control plots showed slightly higher pH than cover crop plots, although trends are parallel over time for all plots (Figure 9). After conversations with the project team in Fall 2022, the farmers decided to not apply compost to beds in Spring 2023 and only applied peat moss after cover crop incorporation. Through the 2023 growing season, the farmers noticed nutrient deficiencies in some crops but felt those might be more a result of weather effects. The farmers reported less weed pressure by not adding in compost. These actions reflect BMP adoption by the farm, although not directly related to cover cropping, rather other programmatic exposure with the project.

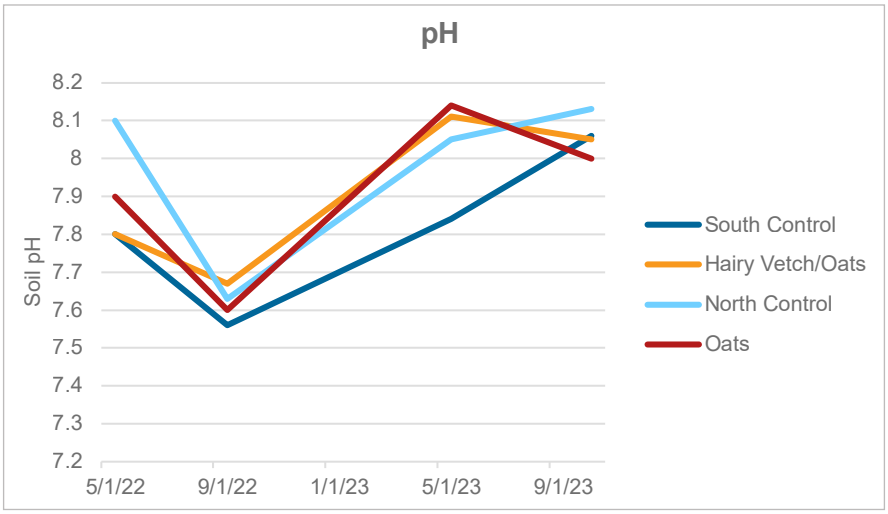

Figure 9. Tracking pH in each plot from May 2022 to Sept 2023.

A final note is that the location of the plots could be influencing inherit soil characteristics and affect results. South control and hairy vetch/oats plot are located next to each other. North control and oats plot are located next to each other. When assessing nutrients in the soil, such as phosphorus (P) and calcium (Ca), we see plots next to each other tend to have similar trends (Figure 9 and 10).

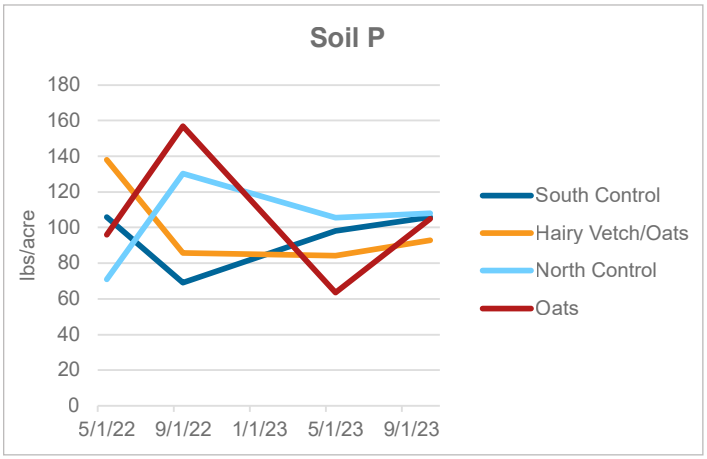

Figure 9. Tracking phosphorus (P) in the soil for each plot from Spring 2022 to Fall 2023.

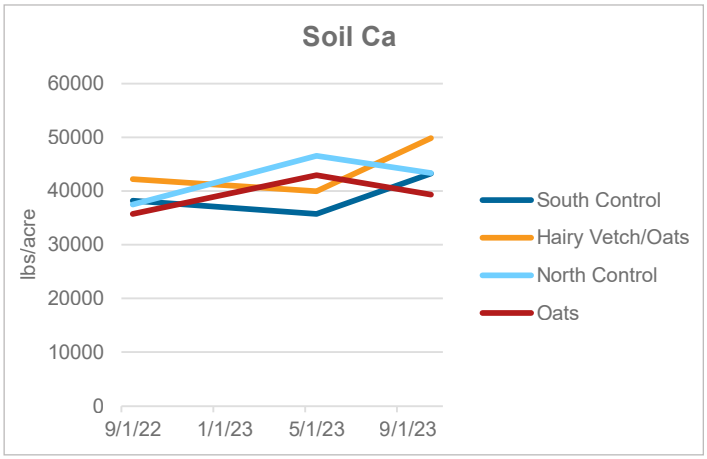

Figure 10. Tracking calcium (Ca) from Fall 2022 to Fall 2023.

Discussion

Our demonstration at this farm provided some evidence of cover crop benefits on urban farms. In particular, we found higher microbial respiration, microbial biomass nitrogen and carbon in both of our cover crop plots than control plots at times throughout the trial. The farmer reported improved tilth could lead to decreased tillage, labor and fuel inputs. Combined with farmer observations of increased moisture retention, crop quality and decrease in erosion, this indicates cover cropping can positively affect the biological part of the soil. Increased microbial biomass nitrogen indicates cover cropping can play a role in stabilizing nitrogen sources for urban farms and decreasing the need for additional amendments. We did detect some benefit to crop health as measured by foliar potassium nutrient levels but did not see any differences in foliar nitrogen and phosphorus nutrient levels. This could be caused by abiotic factors such as soil compaction, pH or other excess nutrients. Moving forward, we are exploring soil testing options to take a closer look at physical and biological components of soil.

Interested in learning more?

Contact Lori Koenick (lbk75@cornell.edu) or Judson Reid (jer11@cornell.edu) of the CCE Cornell Vegetable Program.

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