URBAN FARM SOIL HEALTH

Management Practices for Urban Soil Health: Correcting Nutrient Test Results for Soils with High Organic Matter

We are assessing whether bulk density adjustments can substantially change the recommendations that accompany a soil test, especially for soils where large amounts of compost and purchased soil mixes were used. Across New York State, in many urban soils, home gardens, and even some high tunnel production, high levels of organic matter—anywhere from 8% to more than 30%—were found in agronomic soil tests. Soils with especially high levels of organic matter often have much lower bulk densities than "typical" soils. Before adjusting for bulk density, the majority of our soil tests showed potassium falling in the "optimal" range; after the adjustment, the majority showed potassium at "below optimal." This discrepancy can be the difference between recommending no additional potassium to recommending considerable rates of potassium soil amendments.

Background

The soil test results showed the same thing again and again: plenty of potassium. Yet, the foliar tests and visual symptoms showed the opposite: not enough potassium. Something wasn't adding up.

This was our experience when we started sending agronomic soil tests from urban farms all over New York City. As we tried to figure it out, we found that we weren't the only ones puzzling over this disconnect: Urban farmers and Extension specialists in other cities also frequently saw what appeared to be inflated nutrient levels in their soil test results, as did some home gardeners and even some high tunnel producers. What do all these soils have in common? High levels of organic matter—anywhere from 8% to more than 30%—which makes them less dense than most other soils.

When you get a standard agronomic soil test, the results will generally include the estimated amounts of key plant-available nutrients. Some labs return these levels in parts per million (ppm), but often they're communicated in pounds per acre, which can be quickly and easily used to calculate amendments. Converting ppm to lbs/acre is simple: multiply ppm by two.

Except, in some soils, that step turns out to be the problem. Pounds per acre refers to the pounds of each nutrient available in a 6- to 7-inch-deep slice of soil across an entire acre, known as a "furrow slice." If that soil has a typical bulk density (the dry weight of soil divided by its volume), a furrow slice will weigh somewhere around 2 million pounds—which is why we multiply ppm by 2 to calculate lbs/acre.

The problem is that soils with especially high levels of organic matter often have much lower bulk densities than those "typical" soils. Instead of 2 million pounds, a furrow slice of a highly organic soil might weigh 1 million or even 500,000 pounds. So, instead of multiplying ppm by 2, can we just multiply by a lower number—like 1 or 0.5—and get more predictive nutrient results in these soils?

Figure 1. Bulk density samples can be collected without specialized equipment using the "excavation method," as seen here, or with cylinders designed for this purpose.

Methods and Preliminary Results

We measured bulk density in the field—using the excavation method (Figure 1) to collect and estimate the volume of each soil sample, then dried, sifted, and weighed samples back in the office—at 9 urban farms in NYC and Buffalo, NY. We also obtained standard soil nutrient tests from the same plots and, where possible, foliar analysis to measure nutrient levels present in the plants. This data, along with several years of other soil and foliar tests, has demonstrated that bulk density adjustments can substantially change the recommendations that accompany a soil test. Before adjusting for bulk density, the majority of soil tests showed potassium falling in the "optimal" range; after the adjustment, the majority showed potassium at "below optimal" (Figure 2). In most of these soils, this was the difference between recommending no additional potassium and recommending as much as 150 lbs/acre of it. Foliar tests have backed up the notion that, in nearly all of these cases, recommending potassium was the right move.

We've been making these bulk density adjustments for urban farmers over the past few years. It has been working, most notably in predicting potassium needs. Where standard soil tests continue to show very high levels of potassium, adjusting these results for lower bulk density vastly improves our ability to predict future potassium deficiencies.

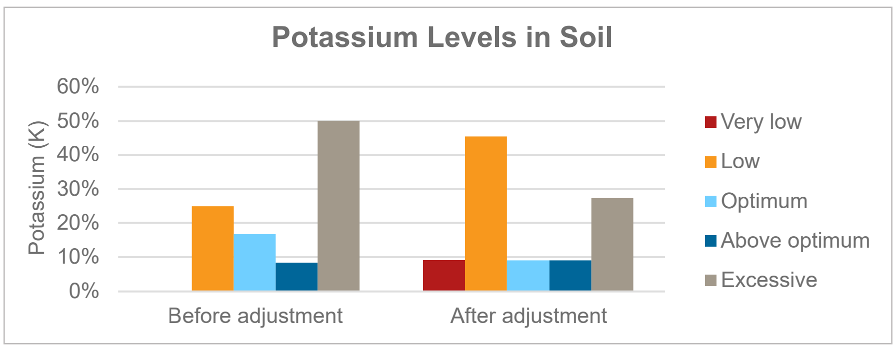

Figure 2. Potassium levels reported in agronomic soil tests from urban farms in NYC, before and after adjusting for bulk density. "Low" or "very low" results in a recommendation to add K.

How to Make a Bulk Density Adjustment

1. Measure or estimate the soil bulk density in g/cm^3.
2. In your soil test results, find the ppm value for the nutrient you're adjusting.
3. Plug these values into the formula:

soil bulk density x ppm x 1.5 = lbs/acre

Discussion

This improved estimate could have use well beyond New York City. On urban farms in NYC, soil organic matter levels of 8 to 14% are standard, but 20 or even 30% is also common, mostly comprised of municipal compost. Many urban farms in other cities also use large amounts of compost and purchased soil mixes, being unable to use the underlying soil due to contamination or other issues, leading to similarly inflated soil test results. But it's not limited to cities: Home gardeners anywhere who add large amounts of bagged soil or compost can have the exact same issue. We haven't started making these adjustments in high tunnels outside of NYC, but for those amending heavily with compost, low bulk density may also be affecting their soil test results.

The main catch is that, so far, we haven't found a consistent enough shortcut to guess a soil's bulk density based solely on soil test results. This means that we need to manually measure bulk density for each farm's soils in order to figure out the adjustment factor. The good news is that the bulk density figure need not be perfect. It's an estimate, an improvement on the much rougher estimate of "ppm x 2." For anyone puzzling over a disconnect between soil test results and nutrient deficiencies in the field, with a soil that's high in organic matter, this approach might be worth a try.

Interested in learning more?

Contact Sam Anderson (swa39@cornell.edu) of CCE Harvest NY, or Judson Reid (jer11@cornell.edu) of the CCE Cornell Vegetable Program.

This work is funded by a USDA NRCS Conservation Innovation Grant, "Best Management Strategies for High Organic Soils in Urban and Rural Vegetable Production."

Cornell Cooperative Extension | Cornell Vegetable Program

Cornell Cooperative Extension | Harvest New York