Soil microbes flourish with reduced tillage

4 October 2016

The type of tillage equipment used impacts soil microbial biomass. Credit: Pixabay

For the past several decades, farmers have been abandoning their plows in favor of a practice known as no-till agriculture. Today, about one-third of U.S. farmers are no longer tilling their fields, and still more are practicing conservation tillage—using equipment that only disturbs the soil to a minimal degree. No-till and, to a lesser degree, conservation tillage maintains or improves soil quality by preserving soil structure and moisture, increasing soil organic matter, and providing habitat for soil microbes.

It's the microbes that matter most.

"Soil microbes are the workhorses of the soil. They break down crop residues and release nitrogen, phosphorus, potassium, and other nutrients back to the soil so they're plant-available. We want a healthy, diverse microbial community so that those processes can happen and improve our soils," says University of Illinois doctoral student Stacy Zuber.

Until now, most studies linking tillage intensity and microbial activity have been done at the scale of individual farms. Most of these studies do find more soil microbes with no-till management, but the magnitude of that result varies a lot from farm to farm. That's because each farm is influenced by different environmental factors, agronomic practices, and soil type. Where no-till is compared with tillage, the type of equipment and tillage depth also differs.

Zuber wanted to cut through the confusion to detect a true "signal" of the effect of tillage on soil microbes. To do that, she compiled and analyzed data from 62 studies from all across the globe.

"When you're doing individual field experiments—even if you have several in one area—you're still focused on the one region," Zuber notes. "Sometimes it's hard to see the big picture because there's so much variability. The meta-analysis allowed us to look at different field studies from around the globe to determine the overall effect. This process lets us see that big picture."

Zuber compared measures of microbial biomass and metabolic activity in no-till and tilled systems. For tilled systems, she included categories that accounted for the type of tillage equipment and tillage depth. She also accounted for the nitrogen fertilization rate, mean temperature and precipitation, the presence or absence of cover crops, and other variables.

When the data from all 62 studies were analyzed together, it turned out that microbial biomass and enzymatic activity were greater in no-till than in tilled systems. In tilled systems, the type of tillage equipment mattered. In contrast to other tillage equipment, such as moldboard plows or disc plows, the use of chisel plows was associated with greater microbial biomass. Chisel plows, which theoretically result in minimal soil disturbance, are commonly used as part of a conservation tillage system.

But experimental use of a chisel plow, as represented in the studies Zuber analyzed, may be

different from how they are used in the real world.

"Tillage seems simple: you break up the soil or you don't. Things get complicated when you start looking at tillage implements, because there is no clear definition and common use for them. You can have two implements called chisel plows, but they can work the soil completely differently. For example, if they go across the field in one pass, that's not much disturbance. But if they make two or three passes, it's a lot more disruptive," Zuber explains.

The study suggests that since soil microbial biomass and enzymatic activity can stand in as proxies for soil quality, farmers should consider moving toward no-till or conservation tillage systems.

Zuber says, "Helping the soil function better helps your crops grow better, and can also maintain high quality soil for sustainability purposes. In Illinois, we have such great soil; it's our biggest resource. Farmers can help protect it by making sure the microbial community is healthy."

The article, "Meta-analysis approach to assess effect of tillage on microbial biomass and enzyme activities," is published in *Soil Biology & Biochemistry*. Zuber and co-author Maria Villamil are in the Department of Crop Sciences at U of I. The work was part of a regional collaborative project entitled "Cropping Systems Coordinated Agricultural Project (CSCAP)" and was supported by USDA-NIFA.

More information: Stacy M. Zuber et al, Meta-analysis approach to assess effect of tillage on microbial biomass and enzyme activities, *Soil Biology and Biochemistry* (2016). DOI: 10.1016/j.soilbio.2016.03.011

Provided by University of Illinois at Urbana-Champaign