

## **Cover Crops: What is their Relationship to Soil Health?**

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Soil health refers to the ability of the soil to support various uses, including agriculture. Although this is a broad, ecosystem trait, soil health (rather than soil quality) often refers to the status of soil quality parameters that are sensitive to management, rather than static, such as soil texture or slope. These parameters include infiltration capacity, diversity of organisms, nitrogen mineralization potential, and aggregate stability. Many of the parameters often used are related to soil organic matter. These include total soil organic carbon, macroaggregate stability, and microbial biomass carbon. Soils with higher values of these parameters are also typically rated as having higher quality by farmers (Weil and Magdoff, 2004).

Cover crops can influence soil health by improving many of these organic matter-related parameters. In addition, they can assist with other direct or indirect benefits, such as reducing soil erosion and potentially reducing weed populations. This presentation will discuss the inter-related contributions that cover crops make by affecting the rapidly-cycling forms of soil organic matter and soil biological processes, particularly microbial populations. It will also discuss how to integrate cover crops into existing systems and for conserving soil organisms.

### Soil Organic Matter

We often consider soil organic matter to be something that must be conserved in order to maintain its beneficial effects on soil (aggregate stability, improved water holding capacity, nutrient storage, and so on). Especially as vegetable farmers, you are very aware that intensive cropping systems and frequent tillage may lead to the rapid depletion of soil organic matter. While this is true, it is also important that some organic matter be cycled in the soil. This feeds the soil's living creatures, and their presence and by-products are essential for a healthy soil.

In particular, easily-decomposable materials are important for feeding soil organisms from bacteria to earthworms. One way to add these types of materials is through the use of cover crops. Immature cover crops tend to have high levels of simple carbohydrates and proteins that are decomposed quickly in comparison to the materials in mature cover crops or cash crops. More succulent cover crops, such as legumes or buckwheat, are also good sources of these easily-decomposed materials. The increased populations of soil organisms are indicators of soil health, and some of the decay products improve soil aggregation as well.

### Soil Organisms: Bacteria, fungi

Some of the most basic soil organisms are bacteria and fungi. These are responsible for the primary decomposition of soil organic matter and help create humus, cycle nutrients, form symbiotic relationships with plants, and improve soil structure. Although experimental results vary, it appears that in general, the use of cover crops increases the activity of these soil microbes, increases their diversity, and increases the types of substrates used (increases functional diversity). In turn, this may lead to better long-term functioning of the soil because of

the number and types of organisms involved in microbial activity. The soil may also show an increased ability to reduce soil-borne disease through competition and predation by other organisms.

One of the reasons cover crops can cause these changes in soil microbial populations is because they extend the period during which plants are growing in the soil. As primary decomposers, bacteria and fungi need a steady supply of organic matter to thrive. Cover crop residue can supply organic matter, but plant roots release organic matter directly to the soil. This may be as much as 40% of the net carbon that is accumulated by the plant. When these inputs cease, as in a fallow period, it is lethal to large numbers of soil microbes. Another benefit of cover crop use is that it increases the diversity of plant residues added to the soil, which in turn increases the microbial biomass.

High populations of soil bacteria and fungi are also important because they feed the next step in the food chain--nematodes and protozoa. In turn, these are eaten by other predators. Since it is easily eaten and decomposed, the microbial biomass is usually considered part of the easily-decomposable part of soil organic matter. Although the amount of material in the microbial biomass is small (only 1-5% of the total organic carbon and 2-6% of organic nitrogen in the soil), turnover of the microbial biomass is responsible for cycling about 95% of organic matter-derived plant nutrients.

### Integrating Cover Crops into Vegetable Systems

By growing at times when soil would otherwise be fallow, cover crops are able to improve soil health in many ways. They can reduce soil erosion, provide habitat and food for soil organisms, and increase the total organic matter contribution to the soil. At the same time, they increase the amount of easily-decomposed organic matter and favor the development of soil microbes. Therefore, increasing the use of cover crops at any point in the season and for any length of time is beneficial. Finding ways to add cover crops to your system may require some testing on your part: what works for someone else may not work as well for you. Planting cover crops during fallow periods, experimenting with overseeding into standing cash crops, and frost seeding are all techniques that might be useful.

This experimentation, best done on a small scale, may also reveal some possible challenges. These challenges can counteract any soil health benefits you might otherwise derive. Under many conditions, thickly sown, fast-growing cover crops can suppress weed germination and growth. However, under poor growing conditions or in very weedy fields, the cover crops may not be successful. If soils are dry, a cover crop may reduce soil moisture and increase bulk density to an unacceptable level for the following crop. Similarly, a living cover crop planted with a cash crop can greatly increase water needs. Very mature cover crops that are high in carbon and low in nitrogen (such as a mature grain stand) will lead to the immobilization of nitrogen in the microbial biomass, rather than the release. Some cover crops produce chemicals that are toxic to small-seeded plants, both weeds and crops. Although increased soil microbial activity may reduce the incidence of some soil-borne diseases, the decay of some cover crops can lead to higher short-term levels of diseases such as *Pythium*.

### Conclusion

Cover crops provide many benefits to vegetable cropping systems—everything from reducing soil erosion to providing organic matter that feeds soil organisms. By increasing the length of time crops are growing in the soil and adding more types of organic matter (including

easily-decomposable materials), cover crops help increase the diversity in and improve the functioning of the soil. Nutrients are cycled more easily, soil-borne diseases may be reduced, and soil aggregation is improved. While each farmer will need to experiment with the best way to incorporate cover crops into the farm system, their successful integration can be a good contributor to increased soil health.

Resources for additional cover crop information:

*Northeast Cover Crop Handbook*. 1994. Marianne Sarrantonio. Soil Health Series, Rodale Institute, Kutztown, PA. [www.rodaleinstitutestore.org](http://www.rodaleinstitutestore.org)

*Managing Cover Crops Profitably, 3<sup>rd</sup> Edition*. 1998. Sustainable Agriculture Network, Handbook Series, #9. USDA Sustainable Agriculture Research and Education Program. Beltsville, MD. [www.sare.org](http://www.sare.org)

*Building Soils for Better Crops, 2<sup>nd</sup> Edition*. 2000. Fred Magdoff and Harold van Es. Sustainable Agriculture Network, Handbook Series, #4. USDA Sustainable Agriculture Research and Education Program. Beltsville, MD. [www.sare.org](http://www.sare.org)