PLANT AND SOIL NEMATODES

ORGANIC INPUTS TO IMPROVE SOIL HEALTH AND REDUCE LOSSES FROM NEMATODE PESTS IN VEGETABLE CROPS

Inputs of organic matter improve soil biological health and enhance the soil's capacity to suppress nematode pests. This fact sheet explains why such inputs play a vital role in sustainable vegetable production.

Organic matter: the key to a healthy soil

Although organic matter comprises only a tiny fraction of the total mass of a soil, it has a huge impact on soil properties. Soil organic matter promotes aggregation of mineral particles, stabilises soil structure, increases water infiltration rates, improves water holding capacity, stores and releases nutrients, contributes to cation exchange capacity and nourishes the organisms that cycle nutrients and prey on or compete with pests and pathogens. In fact, the effects of organic matter are so all-encompassing that increasing carbon inputs and reducing carbon losses is the key to improving the health of a soil.

Carbon inputs from cover crops

Because plants convert energy from the sun and carbon dioxide from the atmosphere into organic materials, the simplest way of providing the carbon inputs required to improve soil health is to grow cover crops. However, the soil health benefits obtained will depend on the amount of biomass produced and how the cover crop is terminated.

Cover crops are often a component of vegetable production systems, but most growers use a rotary hoe or other tillage equipment to incorporate the aboveground biomass into the soil. The problem with this approach from a soil health perspective is that the crop residues are rapidly decomposed by microbes and most of the carbon in those residues is soon returned to the atmosphere as CO_2. Also, the tillage involved disrupts the soil biology, particularly the fungi, predatory microarthropods and other organisms that prey on nematodes and various pests.

To obtain greater soil health benefits from cover cropping and overcome the detrimental effects of tillage, scientists and growers around the world are trying to find alternatives to current production systems. The ultimate goal is to simulate nature by keeping active roots in the soil throughout the year and mulching the biomass produced by cover crops and the cash crop so that the soil surface is permanently covered by a layer of organic matter.

Organic amendments

Another way of providing the carbon inputs required to improve soil health is to incorporate an organic amendment into the soil. Many different types of waste materials are available and they include animal manures, composts, plant residues, biosolids, yard wastes, by-products of meat and fish processing industries, worm castings and seaweed extracts. Most of these materials are relatively expensive, particularly if they are transported long distances, and so the quantity that can be applied will always be limited by economics.

Organic materials such as sawdust, poultry manure and compost are useful soil amendments

Benefits from organic amendments

Organic amendments produce a range of effects when added to soil, but their main effect is to provide the following benefits:

- Provision of nutrients in quantities that will partly or fully meet the needs of a following crop
- Enhancement of soil organic carbon levels
- Improved soil structure
- Enhanced pest and disease suppression

The use of organic amendments for nematode control has a long history and there is a large body of evidence to indicate that provided organic materials are applied at rates greater than 10 t/ha, populations of damaging nematodes will be reduced. However, results tend to be inconsistent and so rather than viewing amendments as a means of reducing nematode populations, they should be thought of as soil conditioners. Their main effect is to improve the soil physical, chemical and biological environment, thereby enhancing crop growth and increasing the capacity of plants to cope with nematode damage.

One reason some organic amendments reduce nematode populations is that they release nematicidal chemicals during the decomposition process. The most important of these chemicals is ammonia, which is toxic to nematodes at high concentrations. It is released when animal manures and other nitrogenous materials are added to soil and may have a short-term effect on nematode populations.

Another reason why organic amendments are detrimental to nematodes is that microbial activity increases, and this results in flow-on effects that enhance populations of fungi, microarthropods and free-living nematodes. Some of these microorganisms are predators of nematodes. Thus, when carbon inputs increase, biocontrol mechanisms begin to operate more effectively and greater numbers of pest nematodes will be consumed by their natural enemies.

On-farm research

Although overseas and local research has clearly shown that organic amendments improve soil health and reduce losses from nematode pests, their effects will vary with soil type, environment, the type of organic matter, application rate, placement, and many other factors. Thus, it is not possible to provide recommendations on which amendments should be incorporated into a vegetable farming system or provide guidelines on how they should be used. Consequently, it is up to growers to purchase organic materials or grow them on-farm, and then set up field trials to determine whether economic benefits or soil health improvements are obtained from various amendments.

The key message

There is no doubt that minimising tillage, maintaining crop residues on the soil surface as mulch, eliminating bare fallows, and increasing the soil's carbon content with cover crops and organic amendments are the keys to improving the biological health of soils used for vegetable production. However, soil health cannot be improved by simply growing a cover crop or adding an organic amendment. Thus, the challenge facing growers is to find ways of incorporating all the above practices into their farming system.

Further reading

Lal R (ed.) (2022) Soil organic matter and feeding the future. Environmental and agronomic aspects. CRC Press. ISBN: 9780367609702

Magdoff F, Weil RR (2004) (eds.) *Soil organic matter in sustainable agriculture*. CRC Press, Boca Raton. 398 pp.

Norris CE, Congreves KA (2018) Alternative management practices improve soil health indices in intensive vegetable cropping systems. A review. *Frontiers in Environmental Science* 6, article 50, 1-18.

Stirling GR (2014). *Biological Control of Plant-parasitic Nematodes. 2nd edition. Soil Ecosystem Management in Sustainable Agriculture*. CAB International, Chapter 9, pages 255-279.

Author: Graham R Stirling, Plant and Soil Nematodes. **Contact details:** graham.stirling@biolcrop.com.au