PLANT AND SOIL NEMATODES

INTEGRATED SOIL BIOLOGY MANAGEMENT

Many of the tactics used in integrated nematode management programs are detrimental to the soil biota. This fact sheet describes a management approach that is more sustainable, as control practices detrimental to the soil biological community are not included.

Integrated nematode management

As discussed elsewhere (Fact sheet PSN 011), integrated nematode management is a strategy that uses multiple tactics to maintain nematode populations at levels below the economic threshold. However, the problem with that approach is that some commonly used tactics have an unacceptable impact on the soil environment. Soil fumigation, intensive tillage, solarisation, and bare fallows may markedly reduce populations of plant-parasitic nematodes, but they also deplete soil carbon levels, kill beneficial organisms, reduce the soil's biological buffering capacity, and have a negative impact on other soil health parameters.

Two practices commonly used in the vegetable industry (soil fumigation and bare fallowing) reduce populations of plant-parasitic nematodes but have a devastating effect on the soil biological community

Integrated Soil Biology Management (ISBM)

The main reason plant-parasitic nematodes reach high population densities on many crops is that the soils used for agriculture have been exploited for many years and are physically, chemically, and biologically degraded. Nematode pests multiply readily because the regulatory mechanisms that should be suppressing their populations are no longer operating effectively, while a sub-optimal physical and chemical environment means that the crop struggles to cope with the damage nematodes cause to their root systems. The ultimate solution to such a problem is to tackle its primary cause: shortcomings in the farming system and management-induced diminution of the soil biota. Thus, the most appropriate response is to build an active and diverse biological community capable of providing a full array of ecosystem services. This can be done by increasing carbon inputs, minimising carbon losses, and reducing management impacts on soil organisms, an approach that is termed 'Integrated Soil Biology Management'.

Tactics compatible with ISBM

A wide range of practices can be incorporated into integrated nematode management programs and as the table below shows, most are compatible with the concept of ISBM. Thus, growers should focus on including these practices in their farming system. Improved soil health and enhanced sustainability will be the most important outcomes of such an approach, but biological mechanisms that suppress nematodes will also be activated. Other outcomes are likely to be better soil heath, improved crop nutrition, broad-spectrum suppression of soilborne pathogens, and an increased capacity of crops to tolerate the effects of these pathogens. At the other end of the spectrum, tactics such as soil fumigation, intensive tillage, solarisation, and bare fallowing should never be used by growers because they are clearly detrimental to the soil biological community.

The compatibility of nematode management tactics with the concept of Integrated Soil Biology Management.

Compatible	Possibly compatible	Not compatible
Exclusion, quarantine	Biofumigation	Intensive tillage
Diagnosis and prediction	Removal of infested roots	Long periods of bare fallow
Organic amendments	Trap crops	Solarisation
Crop rotation	Short periods of bare fallow	Soil fumigation
Mulching	Some new nematicides?	Most nematicides
Multiple cropping		
Cover crops		
Antagonistic crops		
Nematode-free planting material		
Bio-enhancement		
Inundative biocontrol agents		
Resistant cultivars and rootstocks		
Tolerant cultivars		
Improved crop husbandry		
Changes in planting and harvest dates		

In the table above, several practices are listed as possibly being compatible with the concept of ISBM. The reason for this caveat is that it is not clear whether these practices have positive or negative effects on the soil biota. Also, as shown in the examples below, the effects of practices will vary, depending on how they are implemented.

- Biofumigation involves macerating the foliage of a *Brassica* cover crop and incorporating it into the soil so that chemicals are released which are toxic to nematodes and other soilborne pathogens. There is certainly evidence to show that including brassicas in a cover cropping program is worthwhile, but as the tillage involved in the incorporation process is likely to be detrimental to soil organisms, field trials should be established to determine whether it is better to use brassicas as a green manure crop rather than a biofumigation crop.
- Uprooting the roots of a nematode-infested crop and destroying them with a rotary hoe is a post-harvest tactic that is sometimes used to reduce the number of nematodes carried over to the next crop. However, given the detrimental effects of tillage, it may be better to remove the roots by dragging a single tine along the planting row, and then leaving the roots on the soil surface so they are exposed to the heat and drying effects of the sun.
- Trap cropping involves growing a nematode-susceptible crop for a short period, allowing juveniles of a sedentary endoparasitic nematode to enter the root system and establish a feeding site, and terminating the crop before any eggs are produced. Again, the question here is whether the trap crop should be terminated with tillage, or whether a herbicide would have fewer environmental impacts.
- Fumigants have a broad-spectrum of activity and most nematicides have off-target effects. Consequently, these chemicals are incompatible with ISBM. There are claims that some recently developed nematicides have little impact on non-target organisms, but further research is required to confirm this.

The way forward for growers

Growers who attempt to establish an ISBM program that improves soil health and reduces losses from nematode pests are embarking on a journey that may take years to complete. There are many useful practices that can be incorporated into a farming system but it will take time to determine the best options. Nevertheless, if you have an innovative mindset, are willing to learn from your experiences and gradually refine your farming system, the journey is worth taking. The end result will be healthier soils, a more profitable and sustainable farming enterprise, and fewer detrimental effects on the environment.

Further reading

Stirling GR (2014) *Biological Control of Plant-parasitic Nematodes: Soil Ecosystem Management in Sustainable Agriculture*. 2nd Edition. CAB International. Chapter 11, pages 304-341.

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