PLANT AND SOIL NEMATODES

ARE RECENTLY DEVELOPED NEMATICIDES DETRIMENTAL TO THE SOIL BIOLOGICAL COMMUNITY? RESEARCH REQUIREMENTS

Prior to about 2010, organophosphate and carbamate nematicides were widely used in Australia's fruit and vegetable industries. These chemicals were phased from use due to their toxicological profile and are being replaced by a new generation of nematicides. This fact sheet looks at the research required to determine whether these chemicals are detrimental to the biological control agents which regulate nematode populations in healthy soils.

The development of Integrated Nematode Management practices

When the organophosphate and carbamate nematicides were developed in the 1960s, integrated pest management approaches were in their infancy, particularly for soilborne pests such as nematodes. Thus, nematicides were often the only control tactic that could be used to reduce losses from plant-parasitic nematodes. That situation has now changed, as a range of non-chemical control measures can be integrated into a farming system to maintain populations of pest nematodes at levels below the economic threshold. Many different tactics can be included in integrated nematode management programs, but the following are commonly used: nematode-resistant or tolerant cultivars and rootstocks, biofumigation, organic amendments, mulching, removal of susceptible volunteers and weeds, biological stimulants, and improved crop husbandry (see Fact sheets PSN 011 and PSN 012).

A new generation of non-volatile nematicides

In the last decade, a range of nematicidal compounds with varying modes of action have been discovered (Chen at al. 2020). Fluensulphone (Nimitz™), fluopyram (Indemnify™), and fluazaindolizine (Salibro™) are now registered for some uses in Australia or are undergoing the registration process, while other nematicides are being evaluated (see Fact sheet PSN 007). Consequently, research is underway in many countries to determine whether these chemicals are effective against the key nematode pests of various crops.

Do nematicides have a place in Integrated Nematode Management programs?

Although there will always be a place for safe and effective nematicides in modern agriculture, an increasing number of growers are trying to improve the health of their soils and make their farming system more sustainable. Practices such as cover cropping, retention of crop residues on the soil surface, and minimum tillage are now being used to increase organic matter levels and improve the soil's physical, chemical, and biological properties. Organic amendments are also included in some farming systems to improve soil fertility and further enhance the nematode-suppressive services that begin to operate more effectively when soil organic matter levels increase. Thus, growers who have an integrated nematode management program in place, or are aiming to improve the biological health of their soil are likely to ask questions such as the following when considering whether they should use a new nematicide.

- My current Integrated Nematode Management program is reasonably effective, as my crops never suffer the huge losses from nematodes that often occurred ten years ago. However, my current program is not perfect, as I sometimes see nematode damage that reduces yields by 5-10%. As new nematicides are expensive and I am unlikely to obtain major yield increases, will it be economically worthwhile applying these chemicals?
- In the last few years, I have been able to increase the carbon content of my soil and suspect that a range of natural enemies are now helping to keep nematode pests under control. Will this new nematicide be detrimental to those biocontrol agents?

The first question can only be answered by undertaking on-farm field trials in which a nematicide is applied and yield responses are assessed. Thus, the remainder of this sheet focuses on the research that has been done or is required to answer the second question.

Effects of nematicides on beneficial soil organisms

One problem with current pesticide registration systems is that multi-national companies seeking registration of a new nematicide do not have to provide data showing its effects on non-target organisms. Consequently, studies of this nature are either not undertaken or they focus on a limited number of soil organisms. Recent studies on fluazaindolizine are a good example, as the company marketing the nematicide (Corteva) initially looked at the effects of their new product on one bacterivorous nematode (Thoden and Wiles 2019). Later tests in the laboratory and greenhouse were more useful because the effects of three nematicides on all trophic groups within the soil nematode community were compared. Those results showed that fluazaindolizine, fluensulphone and fluopyram reduced numbers of omnivores and carnivores in some tests, with the degree of reduction depending on the concentration of the chemical in soil. Fluazaindolizine had the least impact on these nematodes whereas fluopyram was often detrimental (Thoden et al. 2020).

A field study in which nematicides were repeatedly applied to turfgrass also showed that there was a substantial decline in beneficial nematodes in plots treated with fluopyram, whereas abamectin had a moderate impact and fluensulphone a minimal impact (Waldo et al. 2019). Samples were also collected to assess the effects of these nematicides on microarthropods and the results showed that abamectin significantly increased the abundance of fungivorous mites and decreased collembolan abundance. Fluopyram increased predatory mite abundance, decreased collembolan abundance, and increased phytophagous insect abundance at some sampling times whereas fluensulphone had little impact (Waldo et al. 2020)

Research requirements

Results from the above studies suggest that the nematicides currently registered in Australia or undergoing the registration process affect the composition of the free-living nematode and microarthropod communities to some extent. Consequently, field trials are required to determine whether these chemicals, when applied using normal application rates and methodologies, are detrimental to three important groups of natural enemies: omnivorous nematodes, predatory nematodes and predatory microarthropods.

It is also important to assess the effects of these chemicals on nematophagous fungi, as they are the most widespread and probably the important nematode suppressive agents in soil. For example, nematode trapping fungi in the family Orbiliaceae were thought to be responsible for suppressing root-knot nematodes in some New Zealand pastoral soils (Bell et al. 2016) and *Hyalorbilia oviparasitica* and related species have the capacity to substantially suppress populations of root-knot and cyst nematodes in California (Stirling et al. 1979; Witte et al. 2021). Thus, research on the effects of nematicides on nematophagous fungi is required, particularly as one of them (fluopyram) was initially patented as a fungicide.

As nematode suppressive services are provided by a community of soil organisms acting collectively, it is not always clear which organisms are the key suppressive agents in a particular field or environment. Consequently, one key component of the above research program would be to apply a nematicide, assay the soil for suppressiveness, and determine whether the level of suppression is maintained when the nematicide is present in the soil, and in the first few weeks after its concentration has declined to low levels.

Literature cited

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