PLANT AND SOIL NEMATODES

MANAGEMENT OF PLANT-PARASITIC NEMATODES ON SUGARCANE

The plant-parasitic nematodes which reduce the yield of sugarcane are discussed in Fact sheet PSN 037. This sheet focuses on the management practices that can be used to reduce crop losses.

Traditional nematode management practices

One or more of the following tactics have traditionally been used to control plant-parasitic nematodes on sugarcane. Although they reduce nematode populations and limit nematode damage to some extent, they all have their limitations.

Bare fallowing. If soil is bare fallowed for 3-4 months between sugarcane crop cycles, populations of plant-parasitic nematodes will decline if soil temperature and moisture conditions are favourable for nematode activity. However, bare fallowing is not a sustainable option because the soil is subject to wind and water erosion during the fallow period. Also, populations resurge strongly when sugarcane is replanted and so a bare fallow does little to reduce nematode damage.

Crop rotation. Rotation crops of soybean or peanut will reduce populations of root-lesion nematode, the most important nematode pest of sugarcane. Peanut is also useful in coarse-textured soils where root-knot nematode often causes severe damage. However, if soybean is the preferred rotation crop in such situations, cultivars resistant to root-knot nematode must be grown (e.g. Stuart and A6785). Both crops improve the early growth of sugarcane but because nematode populations have usually returned to very high levels by the end of the plant crop, nematodes will again cause losses in the ratoons.

Resistant cultivars. Commercial sugarcane varieties have been derived from crosses between *Saccharum officinarum* and *S. spontaneum* and all are highly susceptible to plant-parasitic nematodes. However, clones of *S. spontaneum* and *Erianthus arundinaceous*, and some backcross clones derived from these wild canes, are resistant or moderately resistant to *M. javanica* and *P. zeae*. Consequently, plant breeders are now attempting to transfer resistance genes from wild species into commercially acceptable sugarcane varieties. Some progress has been made, as populations of root-knot nematode remained low on several introgression lines when they were grown for three years in field trials. However, commercially acceptable cultivars with nematode resistance have not yet been developed. Also, it is questionable whether this approach will ultimately be successful. Sugarcane is attacked by a diverse community of plant-parasitic nematodes and if varieties that limit the reproduction of one or two species are developed, the ecological niche they occupy may be filled by other plant-feeding nematodes.

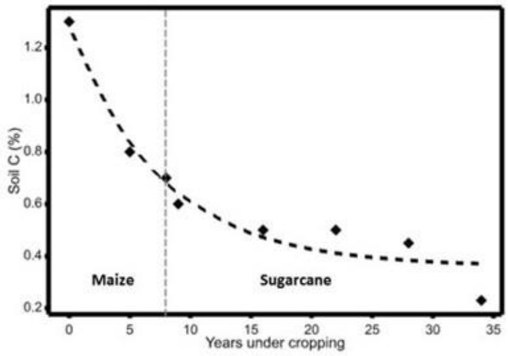
Tolerant cultivars. Tolerance (i.e. the capacity of a cultivar to grow well in spite of the damage caused by plant-feeding nematodes) is another trait that should be selected for in sugarcane breeding programs. Recent work has shown that some commercial cultivars yield well in the presence of high numbers of root-knot nematode but it is not yet known whether they tolerate all the plant-parasitic nematodes that feed on their roots.

Nematicides. Organophosphate and carbamate nematicides were never widely used in the sugar industry because they were relatively expensive. They have now been withdrawn from the market due to concerns about their toxicity and environmental impact and although some potential replacements have been developed, it remains to be seen whether they will be cost-effective enough to be used on sugarcane

An alternative approach to reducing losses from nematode pests

The main reason plant-parasitic nematodes are important pests of sugarcane is that cane-growing soils have been exploited for many years and are physically, chemically, and biologically degraded. The regulatory mechanisms that normally suppress nematode populations no longer operate effectively, while a sub-optimal physical and chemical environment means that plants are unable to tolerate the damage plant-parasitic nematodes cause to their root systems. Thus, inputs of water, fertiliser and pesticides are required to maintain production, further weakening an already depleted soil biological community.

Given that carbon levels in sugarcane soils are usually more than 50% lower than undisturbed soils in their natural state (see figure below), and that soil organic matter plays a central role in improving a soil's physical, chemical and biological properties, the ultimate solution to nematode problems is to focus on increasing carbon inputs, minimizing carbon losses, and reducing management impacts on soil organisms, thereby building an active and diverse biological community capable of suppressing nematode pests. The advantage of this approach is that it targets the primary cause of the problem (shortcomings in the farming system) rather than the secondary effect (the presence of a nematode community dominated by plant parasites).



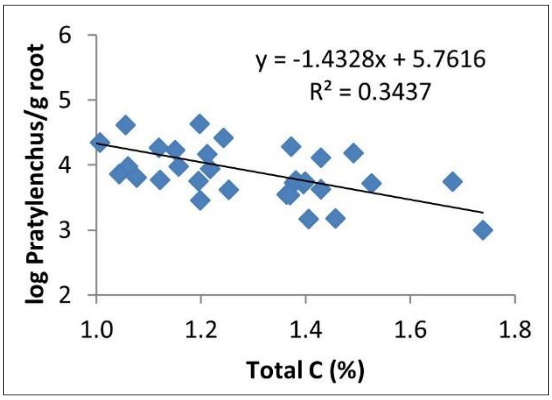
An example of the decline in a soil's carbon content that occurred in the 35 years after natural vegetation in the Burdekin was cleared and used to grow maize and sugarcane

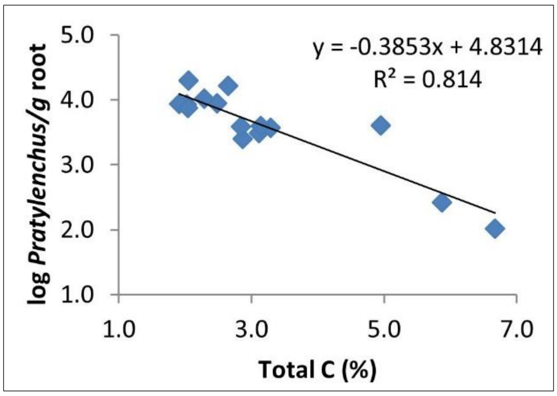
Benefits from a new sugarcane farming system

The Australian sugarcane industry began the long process of improving the biological health of its soils when a research program known as the Sugar Yield Decline Joint Venture was established in 1993. It took scientists ten years to develop a more sustainable sugarcane farming system and the first growers began to use it in 2003. The improved farming system had five key components: continuous inputs of organic matter from plants; a permanent cover of plant residues on the soil surface; soybean or peanut rotation crops; minimum tillage; and avoidance of compaction through traffic control.

In the 20 years since the new farming system was introduced, research has shown that it provides a range of benefits which collectively help to reduce losses from plant-parasitic nematodes.

- The rotation component of the farming system reduces populations of *Pratylenchus zeae* and *Meloidogyne javanica* to relatively low levels and these low populations are usually maintained for 3-6 months after sugarcane is planted.
- Conventional tillage initially reduces populations of plant-parasitic nematodes but populations then resurge strongly and are much higher at the end of the season than in direct-drill plots. Furthermore, conventional tillage is detrimental to the omnivorous and predatory nematodes that prey on plant parasites.
- Populations of plant-parasitic nematodes tend to decline once the new farming system has been in place for one or two crop cycles. However, improvements in soil health provide other important benefits. Plants can tolerate higher nematode populations because the soil is able to hold more water and nutrients, and roots grew more readily due to a reduction in soil strength.
- When sugarcane is harvested green and crop residues are retained, soil carbon levels will increase if the soil is not tilled and this enhances the soil's suppressiveness to plant-parasitic nematodes. This was confirmed in greenhouse and field experiments which showed that if sugarcane residue is incorporated into the soil or left as mulch on the soil surface, numbers of root-lesion nematodes in roots were markedly reduced.
- Results of bioassays in the greenhouse (see figures below) showed that that there is an inverse relationship between the soil C level in sugarcane soils and the number of *P. zeae*/g root. In sandy loam soils, an increase in soil C from 1 to 1.5% reduced root-lesion nematode populations by about 80% (from 21,550 to 4,160 nematodes/ g dry wt. root). In clay loam soils, an increase in soil C from 2 to 2.5% reduced root-lesion nematode populations by 36% (from 11,500 to 7,380 nematodes/ g dry weight of roots).





What natural enemies are suppressing nematode populations?

The natural enemies responsible for suppressing nematode pests have not been fully determined but in studies of one highly suppressive soil, 14 genera of nematode-trapping fungi were detected. Very high population densities (> 3 nematodes/g soil) of predatory nematodes were also present. Soil microarthropods were also likely to be reducing nematode populations, as more than 30 species of nematophagous mites were found in well-managed sugarcane soils. One mesostigmatid mite (*Protogamasellus* sp.) fed voraciously on nematodes in the laboratory and markedly reduced populations of root-lesion, stunt and microbivorous nematodes in a pot experiment. Bacteria in the genus *Pasteuria* are also playing a role in regulating populations of root-knot and root-lesion nematode. This parasite does not increase to high levels when sugarcane soils are tilled but there is some evidence to indicate that levels of parasitism have increased on farms where the new farming system has been in place for several crop cycles (see Fact sheets PSN 008 and 019 for further details).

Conclusions

Although plant-parasitic nematodes are always likely to cause some crop losses in sugarcane, current evidence suggests that the introduction of the new sugarcane farming system has reduced their impact. Provided growers continue to manage their soils in ways that sustain the natural enemies that regulate nematode populations, the amount of damage caused by pests such as root-lesion nematode and root-knot nematode will be reduced even further.

Further reading

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