African Journal of Basic & Applied Sciences 3 (2): 52-56, 2011
ISSN 2079-2034

"Phyto-Parasitic Nematodes: Sampling, Diagnosis and Their Management"

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Abstract: Nematodes are tiny, worm-like, multicellular animals adapted to living in water. The number of nematode species is estimated at half a million, many of which are. Free-living types found in the oceans, in freshwater habitats and in soils. Nematode populations are generally denser and more prevalent in the world's warmer regions, where longer growing seasons extend feeding periods and increase reproductive rates. Parasitic species form a smaller group. They cause farmers and nurserymen millions of dollars in crop loss annually, but also can cause problems in the urban world by damaging turfgrasses, ornamentals and home gardens. We are often unaware of losses caused by nematodes because much of the damage caused by them is so subtle that it goes unnoticed or is attributed to other causes. Nematode management should be multifaceted. Common management methods used include planting resistant crop varieties, rotating crops, incorporating soil amendments and applying pesticides.

Key words: Nematodes · Sampling · Nematode management

INTRODUCTION

Nematodes are microscopic and roundworms, which attack plants. They cause farmers and nurserymen millions of dollars in crop loss annually, but also can cause problems in the urban world by damaging turfgrasses, ornamentals and home gardens. We are often unaware of losses caused by nematodes because much of the damage caused by them is so subtle that it goes unnoticed or is attributed to other causes [1]. Nematode populations are generally denser and more prevalent in the world's warmer regions, where longer growing seasons extend feeding periods and increase reproductive rates. The distribution of nematodes within any site is very irregular, so the shape, size and distribution of areas with the most severe effects of nematodes will be erratic within the field. In the undisturbed soil of groves, turf and pastures, visible symptoms of nematode injury normally appear as round, oval or irregular areas that gradually increase in size year by year. If the numbers of harmful nematodes are large, plant growth is adversely affected. The primary groups of nematodes that cause problems in India are the root-knot, cyst, burrowing, lesion, foliar and reniform nematodes. The environmental conditions of Hawaii are ideal for maximizing nematode damage [2]. Control of nematodes can be optimized by basing management decisions on the relationship between nematode biology and plant response. Lacking a well informed management plan, arbitrary selection of control practices can be costly and ineffective. Nematodes thrive at the temperatures under which most crops and landscape plants are grown in India, especially where frequent rainfall or irrigation keeps the soil moist. Control of nematodes can be optimized by basing management decisions on the relationship between nematode biology and plant response.

Nematode Feeding and Host-Parasite Relationship: Ornamentals plants which are grown to decorate parks, gardens and homes, like other crops also have a wide nematode fauna, which causes tremendous economic losses. About 23.1% losses in ornamental plantations throughout the world due to plant parasitic nematodes. Plant parasitic nematodes feed on living plant tissues,

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using an oral stylet, a spearing device somewhat like a hypodermic needle, to puncture host cells. The damage they cause to plants is often subtle and is easily confused with nutrient problems. Although hundreds of different kinds of nematodes may infect vegetables plants or crops, less than a dozen are economically serious root-feeding pathogens in India and only one genus here causes significant damage by feeding on foliage.

Ectoparasitic nematodes feed on plant tissues from outside the plant; endoparasitic nematodes feed inside the tissues. If the adult female moves freely through the 61 soil or plant tissues, the species is said to be migratory. Species in which the adult females become swollen and permanently immobile in one place in or on a root are termed sedentary. Migratory endoparasitic and ectoparasitic nematodes generally deposit their eggs singly as they are produced, wherever the female happens to be in the soil or plant. Sedentary nematodes such as root-knot (*Meliodogyne* spp.), cyst (*Heterodera* spp.), reniform (*Rotylenchulus* spp.) and citrus (*Tylenchulus semipenetrans*) nematodes produce large numbers of eggs, which remain in their bodies or accumulate in masses attached to their bodies. The feeding/living relationships that nematodes have with their hosts affect sampling methods and the success of management practices. Ectoparasitic nematodes, which never enter roots, may be recovered only from soil samples. Endoparasitic nematodes often are detected most easily in samples of the tissues in which they feed and live (burrowing and lesion nematodes), but some occur more commonly as migratory stages in the soil (root-knot and reinform nematodes).

Endoparasitic nematodes inside root tissues may be protected from those kinds of pesticides that do not penetrate into roots. Root tissues may also shield them from many microorganisms that attack nematodes in the soil. Ectoparasites are more exposed to pesticides and natural control agents in the soil.

Foliar nematodes (*Aphelenchoides* spp.) are migratory nematodes that feed on or inside the leaves and buds of ferns, strawberries, chrysanthemums and many other ornamentals. They cause distortion or death of buds, leaf distortion, or yellow to dark-brown lesions between major veins of leaves. Other nematodes that attack plants above ground, but are not common in Florida, cause leaf or seed galls. Still others cause deterioration of the bulbs and necks of onions and their relatives.

Relationship Between Nematode Biology and Control: Management of nematodes must focus on reducing nematode numbers to levels below the damage threshold. In annual crops, the higher the nematode population numbers at the time of planting, the lower the yield [3]. In perennial crops, the relationship between plant growth and nematode populations is more complex. The initial numbers of nematodes are still important because they determine the early growth potential of the plant. However, even if numbers are low at planting, nematode populations will eventually increase and ultimately damage perennial plants. Thus, not only must the initial populations at the time of planting be low, but also the populations must be kept at a low level if the plant or crop is to remain vigorous. Management of nematodes in the tropical and subtropical environments of Hawaii is a challenge. There are a few control measures that are effective and these must be used under conditions in which they will work. For effective management of nematodes, the critical steps are accurate diagnosis and proper selection of the most effective control method.

The Significance of this research in favour of agriculture system and we will be provide best tool and strategies to farmers, gardeners for better growth of ornamental, vegetables and sugarcane production.

Sampling of Target Insects: The proper sampling method is based on the nematode and its location in the soil profile, which depends on the crop. With turf, for example, the nematodes occur primarily in the top 4 inches (10 cm) of soil, whereas with coffee and pineapple, the highest numbers of nematodes occur from 8 to 20 inches (20-50 cm) deep in the soil. Both large fields and small plantings such as home gardens should be sampled in a systematic, zigzag pattern. This sampling should consist of at least 15-20 cores or shovelfuls of soil composited into one sample per garden or 2-3-acre (3/4-11/4-hectare) section of a field. Research has shown that sampling in a pattern that systematically attempts to represent the entire area being sampled will produce a more accurate estimation of the actual numbers of nematodes than sampling at random. Single plants (such as a tree) should be sampled beneath the leaf drip line. The number of cores or shovelfuls of soil taken around a tree will depend on the size of the tree canopy (Table 1). For a small tree (<10 ft [3 m] diameter canopy), collect 6-8 cores of soil and composite. Prakash and his colleagues worked on sampling methods of some species of nematodes [4, 5].

Table 1: Plant Parasitic Nematodes extracted from soils sample in AGRA

Nematode Genera	Frequency of Occurrence	% Frequency Rating*	Nematode Population/200 ml soil
Rotylenchulus spp.	45	75.0	15500±175.6
Meloidogyne spp.	34	58.3	11542±160.8
Pratylenchus spp.	25	41.6	6650±147.2
Trichodorus spp.	15	25.0	3250±126.9
Rotylenchus spp.	12	20.0	1750±98.0

* n/ N x 100 (n = number of times individual nematodes occurred and N = Sample size (60)

Management of Nematodes: Nematode management should be multifaceted. Since eliminating nematodes is not possible, the goal is to manage their population, reducing their numbers below damaging levels. Common management methods used include planting resistant crop varieties, rotating crops, incorporating soil amendments and applying pesticides. In some cases, soil solarization also may be practical.

Crop Rotations and Cover Crops: Crop rotation to a non-host crop is often adequate by itself to prevent nematode populations from reaching economically damaging levels. However, it is necessary to positively identify the species of nematode in order to know what plants are its host(s) and non-hosts. A general rule of thumb is to rotate to crops that are not related to each other. For example, rotating from pumpkin to cucumbers would probably not be effective for keeping nematode populations down, as these plants are closely related. A pumpkin/bell pepper rotation might be more effective. Even better is a rotation from a broadleaf to a grass. Asparagus, corn, onions, garlic, small grains, Cahaba white vetch and Nova vetch are good rotation crops for reducing root-knot nematode populations. Crotalaria, velvet bean and grasses like rye are usually resistant to root-knot nematodes [6]. Rotations like these will not only help prevent nematode populations from reaching economic levels, they will also help control plant diseases and insect pests. Allelochemicals are plant-produced compounds (other than food compounds) that affect the behavior of other organisms in the plant.s environment. For example, sudangrass (and sorghum) contain a chemical, dhurrin that degrades into hydrogen cyanide, which is a powerful nematicide. Some cover crops have exhibited nematode-suppressive characteristics equivalent to aldicarb, a synthetic chemical pesticide. Other plants that suppress nematodes through chemical residues, especially when grown as cover crops and tilled into the soil, include castor beans, chrysanthemums and sesame. Marigold is another (non-brassica) crop that acts as a nematicide. Apparently, nematodes are attracted to marigold roots, but when the nema- tode attacks, the root releases ozone, killing the nematode. Planting just a few marigolds will not be effective. To get the full benefit, a cover crop of marigolds, free of weeds, must be planted for a full season. There is tremendous variability among cover crop species in their susceptibility to or suppression of the four major races of plant-parasitic nematodes. Cover crops that suppress root-knot nematodes may be susceptible to sting nematodes, for example. It is important to identify the nematode species in the field and know what their plant hosts and antagonists are before planning a cover-cropping strategy. Fields that are left fallow but kept weed-free for one to two years usually have an 80 to 90% peryear reduction in root-knot populations. This host-free period can be achieved in one season, rather than two years, by disking every ten days all summer. Such disking, however, while having the added advantage of reducing perennial weeds, is expensive in terms of fuel costs, possible erosion and loss of organic matter through oxidation.

Resistance Species: Resistance of plants to a specific pest is usually the least expensive and most effective means of minimizing losses to that pest. However, successful use of varietal resistance requires knowing the extent and limitations of the resistance and which pests are present in a particular situation. There are A nematode resistant varieties of tomatoes, soybeans, southern peas, sweet potatoes, cotton. It is necessary to know the pest species present in a field to select a variety with the appropriate resistance. In addition, varieties with the appropriate resistance must 64 be adapted to cultural conditions and requirements of your area. Another limitation to using nematode resistance as a major management practice is that high temperatures often weaken or destroy the resistant effect [7]. Tomatoes a resistant to root-knot nematodes may not be able to limit nematode.

Reproduction or effects if soil temperature is hotter than 81°F. It also is still necessary to use other methods to control any other nematodes that are present, because the resistance against one or two species is not going to affect the ability of any other nematodes to injure the crop [8].

Crop Root Destruction: It gets far less credit than it deserves as a nematode management practice. Nematodes, soil-borne diseases and many soil-borne insects will continue to feed and multiply on crop root systems as long as they remain alive. When soil temperatures are high, each month that a root system continues to live represents an additional generation and potential increase of about 10-fold for many nematodes [9, 10]. Even when soil temperatures are gradually declining, a two-month period may support at least one additional generation. Therefore, destroying root systems as soon as a crop is finished can stop nematode reproduction and should encourage their decline through normal mortality.

Flooding: It may sometimes be used to help reduce numbers of nematode pests. It is practical only where the water level can be controlled easily and maintained at a high level for several weeks. Where flooding can be practiced, alternating periods of about two or three weeks of flooding, drying and flooding again are apparently much more effective than a continuous period of flooding. The soil should be worked during the periods of drying to increase aeration and drying of soil and to prevent weed growth while the soil is exposed. Flooding probably kills nematodes by providing a long period without host plants rather than by some direct physical effect on the nematodes. It is also important to consider the possibility that flooding with contaminated water may actually spread some soil-borne pests such as nematodes.

Synthetic and Natural Pesticides (Nematicides): Nematicides are sometimes used in agriculture, but few of them are available in Hawaii. Most nematicides are highly toxic synthetic pesticides commercially available only to commercial growers. These products can be used only on particular crops and they usually must be purchased and applied by a licensed pesticide applicator [11]. Two types of nematicides are fumigants and nonfumigants. Fumigant nematicides are usually more effective, but nonfumigant nematicides can also be used effectively. Fumigant nematicides such as metam sodium and 1,3-dichloropropene are applied before planting. Some nonfumigant nematicides such as Nemacur®, Mocap®, or Vydate® are moderately effective and can be used both pre- and post-planting. Some "natural" products claiming to provide control of nematodes have been developed from biological sources. The apparent recovery of plants resulting from using these products can sometimes be due to growth enhancement by plant nutrients contained in the formulations. For hundereds of years, Indian farmers have used the neem tree (*Azadirachta indica*) for its pesticidal, antifungal and antifeedant properties. In research trials, potting soil amended with plant parts from the neem tree and Chinaberry tree (*Melia azadirach*) inhibited root-knot nematode development on tomatoes. There are however, no neem products registered in the U.S. for use against nematodes. Margosan O., Azatin., Superneem 4.5., Neemix. and Triact. are neem products registered as insecticides, fungicides and miticides. Neem cake, made from crushed neem seeds, provides nitrogen in a slow-release form in addition to protecting plants against parasitic nematodes. It can be mixed with fertilizers such as composted manures, seaweed and kelp. As with all pesticides, nematicide use is subject to state and federal regulations. The pesticide label must specifically allow its use in the crop or situation and label directions must be followed.

Biological Control: Many different bacteria and fungi that are nematodes natural enemies have been isolated from nematode populations apparently being kept at low levels by the bacteria and fungi [12]. Nematologists have been able to use some bacteria and fungi to reduce populations of some kinds of nematodes under laboratory conditions, but successes at the full-scale field level have been few. Most organisms recognized as promising for biological control of one or more nematode pests are quite specific in which nematodes they will attack, have been very difficult to culture in sufficient quantities to be useful for field application, or both. The conditions under which each is most effective are often quite specific and limited.Several microbial pathogens are effective against nematodes. These include the bacteria *Pasteuria penetrans* (formerly known as *Bacillus penetrans*), *Bacillus thuringiensis* (available in insecticidal formulations) and *Burkholderia cepacia.* Nematicidal fungi include *Trichoderma harzianum, Hirsutella rhossiliensis, Hirsutella minnesotensis, Verticillium chlamydosporum, Arthrobotrys dactyloides* and *Paceilomyces lilacinus*). Another fungus, *Myrothecium verrucaria*, found to be highly effective in the control of nematodes.

CONCLUSION

The most sustainable approach to nematode control will integrate several tools and strategies, including cover crops, crop rotation, soil solarization, least-toxic pesticides and plant varieties resistant to nematode damage. These methods work best in the context of a healthy soil environment with sufficient organic matter to support diverse populations of microorganisms.

As we begin to develop a better understanding of the complex ecologies of soils and agricultural ecosystems, more strategies for cultural and biological control of nematodes will be developed. The trick will be fine-tuning these general strategies to the unique ecology, equipment and financial situation of each farm.

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