Managing plant parasitic nematodes in HLB groves

By Larry Duncan

Compared to most citrus industries in the world, plant parasitic nematodes are especially troublesome in the Florida citrus industry.

NEMATODE TYPES

The citrus nematode (*Tylenchulus semipenetrans*) causes the disease "slow decline." It is present in every citrus industry and is generally widespread, if not ubiquitous, in orchards worldwide. However, an additional four nematode species that are serious pests in Florida do not occur on citrus in most other parts of the world. Burrowing nematode (*Radopholus similis*), coffee lesion nematode (*Pratylenchus coffeae*), sting nematode (*Belonolaimus longicaudatus*) and dagger nematode (*Xiphinema vulgare*) all are economically important pests in the Florida citrus industry.

Burrowing nematodes are widespread in the tropics and a major problem in banana and other crops. But only Florida is known to have a race of the burrowing nematode capable of attacking citrus and causing the serious disease "spreading decline."

Similarly, coffee lesion nematode can cause severe damage to citrus in this state, but does not always infect the crop in many other parts of the world where it occurs. Citrus, burrowing and coffee lesion nematodes all exhibit endoparasitic habits to varying degrees.

Citrus nematode females feed while remaining partially embedded in feeder roots throughout their lives (Figure 1). They lay eggs on the root surface. Burrowing and coffee lesion nematodes migrate within the feeder roots where they feed and lay their eggs.

By contrast, sting and dagger nematodes are very large nematodes that remain in the soil and feed as ectoparasites (Figure 2). The coarse, sandy soils in Florida orchards undoubtedly favor these large nematodes that are rarely if ever encountered as pests of citrus elsewhere.

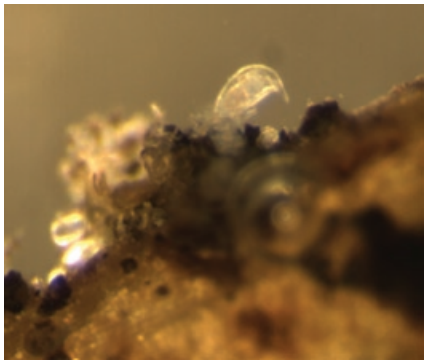

Figure 1. The posterior end of a female citrus nematode protrudes from the upper surface of a citrus feeder root. An egg mass (unfocused) covers a second female to the left on the upper root surface.

Figure 2. An adult female dagger nematode. Unlike citrus nematodes, dagger nematodes remain in the soil and only the stylet penetrates the feeder roots to withdraw nutrients.

MANAGEMENT TACTICS

Sanitation, use of resistant rootstocks and adoption of certain cultural practices have been the foundations of nematode management in Florida citrus for many decades. The Florida Department of Agriculture and Consumer Services, Division of Plant Industry (DPI) has regulated nurseries to prevent the spread of citrus, burrowing and coffee lesion nematodes since 1960. Unlike any other citrus-growing region in the world, much of Florida's industry is free of nematode problems due to the DPI nematode certification program, especially those groves that were newly planted in southern regions to escape recurrent freezes in the 1980s.

Rootstocks resistant to citrus and burrowing nematodes have also been long used by growers. The most widely planted rootstocks today include Swingle citrumelo and C-35, both of which resist infection by most biotypes of citrus nematode, and 'Kuharske' Carrizo citrange, which is resistant to burrowing nematodes. Because resistance-breaking populations of citrus and burrowing nematodes can eventually develop, it is best to replant entire groves with resistant rootstocks, rather than reset resistant trees adjacent to susceptible trees that will continuously produce nematodes to challenge the resistant rootstock.

Cultural practices that include avoidance of disking for weed management and frequent fertigation of trees have long been recommended, primarily for burrowing nematode management. These practices protect the feeder roots near the soil surface in order to provide adequate moisture and nutrients to trees via the shallow roots. The reason for these cultural recommendations is that burrowing nematodes cause spreading decline in groves on the deep, sandy soils of the Central Ridge.

The nematode is most abundant at depths well below the soil surface, thereby severely reducing the amount of deep roots, while leaving an abundant shallow root system. Trees

damaged by burrowing nematodes have almost no capacity to obtain water and nutrients deeper in the soil during the dry winter and spring months.

THE HLB FACTOR

As with all pests and parasites of the citrus root system, the arrival of huanglongbing (HLB) in Florida has intensified the detrimental effects of plant parasitic nematodes. The loss of roots and root function caused by HLB reduces the ability of trees to cope with damage from other root pests. However, understanding the profitability of managing root damage by pests, including root weevils as well as nematodes and pathogens such as *Phytophthora*, is critically important given the already high cost of HLB management and the steadily decreasing fruit yields caused by HLB.

Rational management decisions require some understanding of the damage likely to occur from a given pest level, the likely response (pest mortality and yield response) to management and its cost. Research initiated since the widespread occurrence of HLB offers some insight into these questions. Here we will describe ongoing field trials involving a highly specialized parasite — the citrus nematode — and a nematode only recently recognized as a widespread and serious citrus pest — the dagger nematode.

UNDERSTANDING CITRUS NEMATODES

The citrus nematode co-evolved with citrus and is one of the most highly specialized parasites among plant-feeding nematodes. In humid, subtropical regions such as Florida, well-managed citrus trees can support large numbers of these nematodes with few evident symptoms. Citrus nematodes tend to be somewhat more abundant and damaging in drier, Mediterranean-type climates. Although the visible symptoms caused by citrus nematodes (smaller leaves and fruit; thinning canopies) are much milder than most other nematode pests of citrus, citrus nematodes drain carbon from the tree, which causes higher than normal frequency of root growth, despite somewhat less root abundance along with less fruit production.

Although growers may be unaware of the burden posed by citrus nematode to a tree's ability to produce fruit, the use of nematicides to treat heavily infected roots on otherwise healthy trees can significantly increase the size and amount of fruit. When management of large populations has been effective in Florida, the average reported yield response is about 15 percent.

EXPERIMENTAL COMPOUNDS UNDER EVALUATION

Because the number and types of nematicides have declined over the years, and no products registered for use in Florida citrus are currently available, several experimental compounds are being evaluated. Results of field trials provide an indication of how nematode damage is interacting with that caused by HLB, and whether citrus nematode management on HLB trees is likely to be profitable.

Four treatments that include three products with demonstrated nematicidal activity have been applied for four years to mature (>25 years) Hamlin orange trees on Carrizo citrange rootstock. Each treatment is applied to 40 trees in 10, four-tree plots. Typical of most current nematicidal compounds, treatments are applied several times per year, and the efficacy has been modest (Figure 3, page 20). The trees were vigorous at the beginning of the trial, despite being heavily infected with citrus nematodes (Figure 4, page 20). However, HLB–associated decline symptoms have increased during the trial. Fruit yields from the untreated trees have exhibited the precipitous decline typical of HLB, dropping from more than 750 boxes

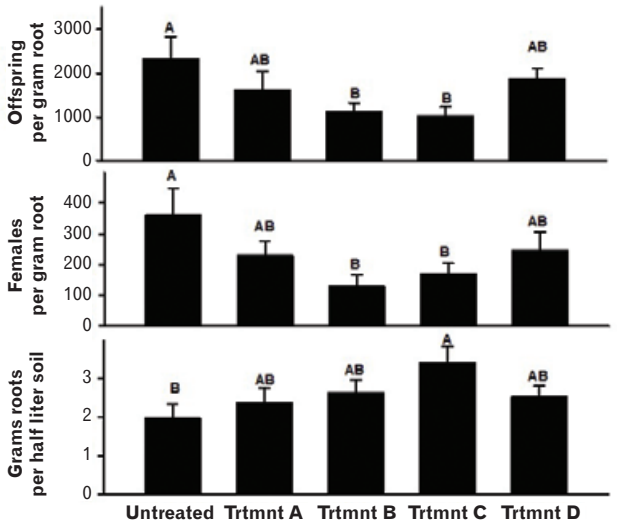

Figure 3. Effects of experimental nematicide treatments (A–D) on the infection rate of female citrus nematodes, their fecundity and the root-mass density of mature citrus trees at one point in time during a 4-year trial. Bars with different letters indicate treatments that differ significantly (P = 0.05). Error bars are standard errors of the mean.

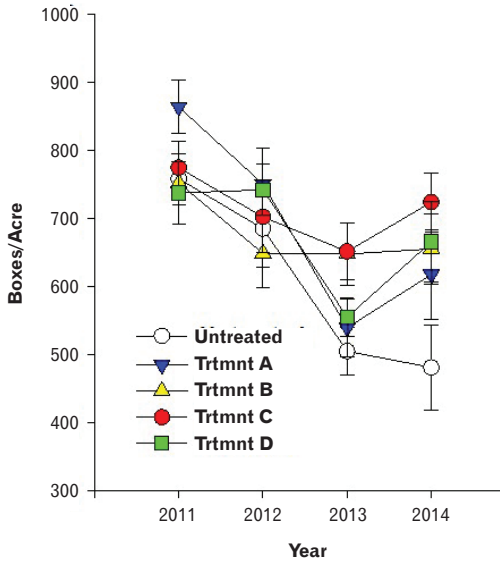

Figure 4. The average yields of untreated control plots and plots treated with combinations of experimental nematicides during four years.

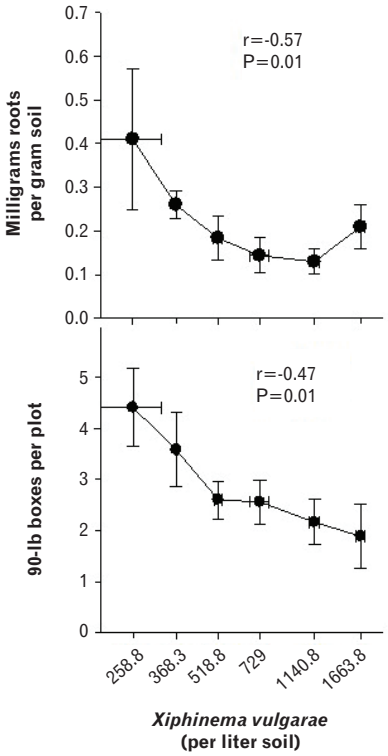

Figure 5. The relationship between population density of dagger nematodes and the abundance of citrus feeder roots and fruit yield during two years in an east coast grove of young Ray grapefruit on 'Kuharske' Carrizo citrange.

per acre to fewer than 500 boxes in four years. However, the most recent yields in the nematicide-treated trees ranged from 28 percent to 50 percent greater than that of the untreated trees, depending on the treatment.

The results to date suggest that citrus nematodes exacerbate the damage caused by HLB, and that nematode management may indeed be profitable in orchards during the initial period of HLB infection and subsequent tree decline. This trial remains ongoing, and a second trial using the same compounds to treat citrus-nematode-susceptible resets has been initiated.

DAGGER NEMATODES INCREASING

Dagger nematodes were present at trace levels in less than 1 percent of more than 1,000 citrus soil samples processed during 1982–1992 by the DPI Nematology Division. Dagger nematodes have only rarely been considered to be economically important in citriculture. However, more than half of 212 samples collected by DuPont Crop Protection in 2010–2011 from declining groves on the east coast were infested with large numbers of dagger nematodes. In a subsequent survey, these nematodes were identified as *X. vulgare*, and a field trial to investigate nematode and tree responses to experimental nematicides was initiated in a heavily infested grove of 3-year-old Ray grapefruit on 'Kuharske' Carrizo citrange rootstock near Fort Pierce.

The root mass and fruit yields in the trial were shown to be inversely related to the population density of the dagger nematodes, and half as much fruit was harvested from the heavily infested trees than from trees with low levels of dagger nematodes (Figure 5). The application of experimental nematicides tended to reduce infestation levels and increase root density and fruit yields (figures 6 and 7). However, the effects of HLB in these young trees was devastating. The untreated trees produced only 30 percent as much fruit in 2014 as in the previous year.

Given this level of HLB decline, managing the dagger nematodes in this grove was unprofitable despite the increased yield trends in those trees treated with nematicides. Therefore, the trial was discontinued at this site, but a second trial was recently initiated in Polk County on 2-year-old trees heavily infested with dagger nematodes and with incipient infection by HLB. The objective in the new trial is to measure the profitability of managing the dagger nematode on young trees with aggressive HLB management. It remains to be seen whether management of ectoparasitic

nematodes on these young trees will be as profitable as shown on the mature trees infested by citrus nematodes.

RESEARCH IMPLICATIONS

The results to date support the urgent need for discovery and registration of new nematicides and resistant rootstocks for use in citrus. The advent of HLB in Florida coincided with the dramatically increased incidence of damaging populations of ectoparasitic (both dagger and sting) nematodes and begs the question of whether HLB predisposes the roots to attack by these nematodes. Moreover, if management of a moderately virulent parasite such as citrus nematode is critical in the presence of HLB, the more virulent burrowing and coffee lesion nematodes obviously pose even greater threats. As the development of new chemical and genetic means of managing damaging nematode species continues, it remains critical that growers employ the currently available tactics (sanitation, resistance and cultural practices) for managing these pests.

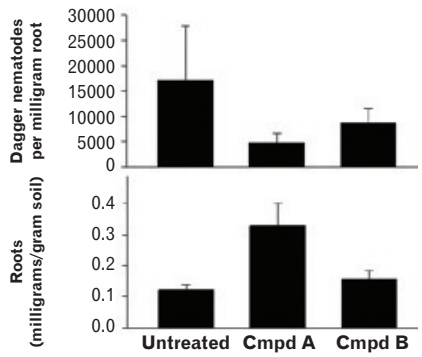

Figure 6. Treatment trends in the average feeder root abundance and dagger nematode infestation rates during two years in an east coast grove of young Ray grapefruit on 'Kuharske' Carrizo citrange.

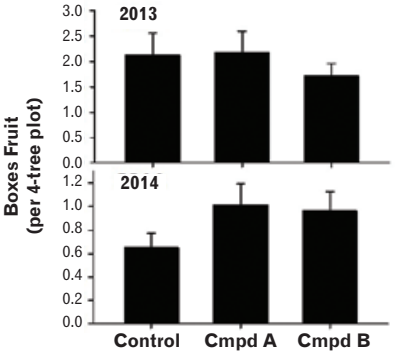

Figure 7. Effects of nematicides on fruit yield during two years in an east coast grove of young Ray grapefruit on 'Kuharske' Carrizo citrange that was heavily infested by the dagger nematode (*X. vulgare*).

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