Proc. Fla. State Hort. Soc. 124:93–94. 2011.

A Summary of Nematode Soil Sampling Results from the Indian River Area in 2010–2011

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Additional index words. *Belonolaimus longicaudatus*, crop loss assessment, *Radopholus similis*, survey, *Tylenchulus semipenitrans, Xiphinema vulgare*

Soil samples containing feeder roots were collected at 212 locations in 2010 and 2011 from Martin, St. Lucie, Indian River, and Okeechobee counties. Representative samples containing four to six subsamples were taken in February through May or September through November from areas with declining trees in 31 groves. Assays were conducted for citrus (*Tylenchulus semipenetrans*), burrowing (*Radopholus similis*), dagger (*Xiphinema* spp.), and sting (*Belonolaimus longicaudatus*) nematodes and evidence of root sloughing or fragmentation. Citrus nematodes were found in 47% (99) of the samples, with 10% (22) at population levels above 1,600 nematodes per 100 g of soil. Dagger nematodes were found in 54% (114) and sting nematodes in 14% (27) of the samples. No burrowing nematodes were detected in the samples. Root sloughing or fragmentation was noted in 34% (72) of the samples and sampled root weights were inversely related ($P < 0.001$) to numbers of dagger nematodes.

One of the characteristics of bedded citrus groves in the Indian River area on the central East Coast of Florida are shallow, limited rooting systems as a result of naturally poorly drained soils and high water tables during the summer rainy season. Common citrus root pests in these groves include the parasitic fungi *Phytophthora nicotianae* and *P. palmivora*, all five members of the Florida root weevil complex, and several plant parasitic nematode species. In Florida, five species of nematodes have been recognized as economically important pests of citrus (Duncan, 2009). "Spreading decline of citrus" is caused by the burrowing nematode, *Radopholus similis*. The citrus nematode, *Tylenchulus semipenetrans*, is the causal agent of "slow decline of citrus." The sting nematode, *Belonolaimus longicaudatus*, feeds on root tips causing stubby roots and severely stunted growth in young trees. Of more localized importance are *Pratylenchus coffeae* and *P. brachyurus*, two species of lesion nematodes. Some reports also suggest that a dagger nematode, *Xiphinema vulgare*, may cause stubby root symptoms and growth reduction in citrus similar to the damage caused by sting nematodes (Corio et al., 2002; Leone et al., 1997). Managing these pests should be a routine part of production programs in order to attempt to maintain long-term tree health and yield. The citrus nematode has been identified as a major citrus root pest for many years, although several years of poor economic returns for Indian River growers have recently limited the focus of growers on nematode testing and treatment.

Nematode populations normally peak in April–May and again in November–December following the root flushes that precede those periods. Populations are at their lowest during the rainy part of the year. Sampling soil and roots during the two peak periods is recommended to maximize accuracy and the probability of determining if nematodes are a potential problem. In addition, samples taken in the same block in successive years should be taken near the same calendar dates to better enable a reasonable comparison between the samples.

Sampling and analysis of the resulting data for this survey was conducted by UF-IFAS Extension and DuPont Corporation as a free grower service for the purpose of determining the extent of plant parasitic nematode populations in areas of declining trees in citrus groves in the Indian River growing area.

Materials and Methods

A total of 212 combined soil and root samples were taken in the spring and fall of 2010 and early spring of 2011 in 31 groves in Martin, St. Lucie, Indian River, and Okeechobee counties. The citrus varieties sampled include red and white grapefruit, 'Murcott' mandarin, and 'Valencia', 'Early Gold', 'Pineapple', and 'Navel' oranges on various unidentified rootstocks. Soil and roots to a depth of 12 inches were taken with a shovel at the drip line of unthrifty or declining trees. Samples consisted of 3 to 4 qt of soil and roots taken as subsamples from 4 to 8 trees, 30 to 90 ft apart in the same row. When several blocks of trees were sampled within a grove, distances between blocks ranged from 150 to1,000 yards. The samples taken each day were kept cool after collection and shipped overnight to the D.D. Diagnostics laboratory in Lake Alfred, FL. Citrus nematodes were recovered from 60 cm^3 soil, extracted on Baermann funnels (Hooper, 1986). All other species were extracted either from 500 cm^3 soil by sucrose centrifugation (Jenkins, 1964) or from known quantities of roots by incubation (Tarjan, 1968).

Results and Discussion

Citrus nematodes were found in 99 of the 212 samples, with one sample containing 12,168 nematodes per 100 g of soil. No citrus nematodes were found in 9 groves, with a total of 37

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samples taken from those groves. The application of nematicides to manage citrus nematode populations is not recommended when population densities are lower than 1,600 juveniles per 100 g of soil (Garabedian et al., 1984). This threshold was exceeded in 15 (7%) of the samples, indicating that citrus nematodes continue to be a significant pest of citrus in the Indian River area. The incidence of samples with citrus nematodes (47%) is about double that reported by Esser et. al. (1993) using data from an 11-year survey (1977–1987; 2,314 samples) conducted by Florida Department of Agriculture and Consumer Services, Division of Plant Industry. The 11-year survey covered 37 counties in Florida and did not report results by region. Areas that contain newer citrus plantings have a lower incidence of nematodes that attack citrus due to the nursery certification program that prevented spread of nematodes on nursery stock beginning in 1957. Because the area covered by the present survey is one of the oldest citrus growing regions in Florida, it is likely to have a higher incidence of nematodes than a statewide average. The effectiveness of nursery certification is supported by the fact that samples positive for citrus nematode were more frequently encountered in older groves near the coast than from newer groves further inland (data not shown). Nevertheless, the incidence of citrus nematode is high considering the widespread planting on the coast of the citrus nematode-resistant rootstock Swingle citrumelo during the past 30 years. Although rootstocks were not identified in this survey, the data suggest that resistance breaking biotypes of this nematode may be becoming more prevalent (Duncan et al., 1994a).

No burrowing nematodes were found in any of the 212 samples. Burrowing nematodes are primarily restricted to sandy, well-drained soils on the central Florida ridge with highest populations occurring at soil depths below 30 inches. Effective detection of the nematodes in shallow roots requires larger quantities of roots than were collected in these samples (Duncan et al., 1994b).

Dagger nematodes were found in 114 of the 212 samples, with counts ranging up to 288 nematodes per 500 cm^3 of soil. Moreover, dagger nematodes were detected in all but one of the groves sampled. The incidence of *Xiphinema* spp. in these samples (54%) is much higher than that reported by Esser et al. (1993). *X. americanum* was found in 7% of samples and *X. vulgare* in less than 1% in the 11-year survey. Three other species of *Xiphinema* were detected in just 2 of the 2,314 samples. It is unknown whether changes in cultural practices (e.g., increased reliance of microjet rather than flood irrigation) have caused the incidence of dagger nematodes to increase or whether east coast groves harbor more of these nematodes than groves elsewhere.

Twenty-seven samples from 25 groves contained sting nematodes. The most *B. longicaudatus* found in 500 cm^3 of soil was just 28 nematodes, although it is not uncommon to encounter much higher population densities in groves where sting nematodes are an economic problem. It is noteworthy that many samples in which sting nematodes were not detected contained fibrous roots with stubby root symptoms typical of sting or dagger nematode. Although dagger nematode has not traditionally been considered an important pest of citrus in Florida, it is reported to damage citrus in other countries (Cohn and Orion, 1970; Yassin, 1974). Moreover, *X. vulgare* in Florida has been reported at high densities in citrus (Duncan et al., 1994b) and has been associated with poor growth of trees (Leone et al., 1997). Although the quantities of fibrous roots recovered in these samples had no significant relationships with numbers of citrus or sting nematodes, they were inversely related to numbers of dagger nematodes ($r = 0.25$; $n=218$; $P < 0.001$; Fig 1). Thus, an apparent dramatic increase in the occurrence of *Xiphinema* spp. in citrus and its association with citrus root damage suggests a need for additional research on the economic importance of *Xiphinema* spp. and possibly methods to manage these nematodes.

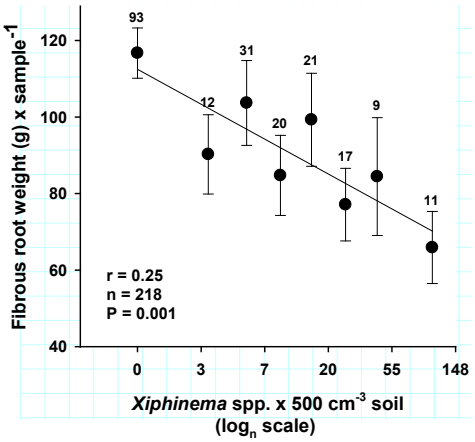

Fig. 1. Relationship between fibrous root weight per sample and numbers of *Xiphinema* spp. per 500 cm^3 soil. For graphic visualization, samples were grouped by half log units of $\log_n$ (X+1) transformed population data. Error bars are standard errors of means and numbers of samples per group are shown above bars.

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