PLANT-PARASITIC NEMATODES ASSOCIATED WITH MANGO AND RELATIONSHIP TO TREE CONDITION

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ABSTRACT

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Plant-parasitic nematodes found most frequently in 123 soil samples collected from mango groves in southeastern Florida were *Rotylenchulus reniformis* Linford & Olveira and *Hemicriconemoides mangiferae* Siddiqi. Both were found in 87.8% of the samples collected, and averaged 149.5/100 cm^3 of soil and 90.4/100cm^3 of soil, respectively. *Helicotylenchus* spp., *Macroposthonia* spp., and *Quinisulcius acutus* (Allen) Siddiqi were more abundant in samples from young trees (less than 3 years old) than from older trees (more than 10 years old). When data from all samples were analyzed, tree condition (1-6 scale) was significantly (P = 0.01) correlated with density of *H. mangiferae*, with r = 0.259. When data from older trees alone were analyzed, this correlation increased (r = 0.419, P = 0.001), and was greatest when using samples having more than 100 *H. mangiferae*/100 cm^3 of soil (r = 0.586, P = 0.01). Tree condition was not significantly correlated with *R. reniformis* density; instead, density of this nematode was significantly correlated with density of a weed host *Bidens pilosa L.*

Additional key words: Mangifera indica, spiral nematodes, sheath nematode, ring nematodes, stunt nematode, reniform nematode, host range, population dynamics, nematode survey, weed hosts.

RESUMEN

McSorley R., J. L. Parrado, y S. Goldweber. 1981. Nematodos parasiticos asociados con el mango y sus relaciones con la condición de la planta. Nematropica 11: 1-9.

Los dos nematodos parasíticos encontrados más frequentemente en 123 muestras de suelo recolectadas de arboledas de mango del sureste de la

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Florida fueron *Rotylenchulus reniformis* Linford & Oliveira y *Hemicriconemoides mangiferae* Siddiqi. Ambos fueron determinados en el 87.8% de las muestras analizadas con promedios de 149.5/100cm^3 de suelo y 90.4/100cm^3 de suelo, respectivamente. *Helicotylenchus* spp., *Macroposthonia* spp., y *Quinisulcius acutus* (Allen) Siddiqi fueron más abundantes en muestras de plantas jóvenes (menos de 3 años de edad) que en aquellas de plantas más viejas (más de 10 años de edad). Cuando los datos de todas las muestras fueron analizados resultó que la condición de la planta (escala 1-6) estuvo significativamente correlacionada con la densidad de *H. mangiferae*, (r = 0.259, P = 0.01). Cuando se analizaron solamente los datos de las plantas más viejas, esta correlaciòon aumentó (r = 0.419, P = 0.001) y fué aún mayor cuando se usaron muestras con más de 100 *H. mangiferae*/100cm^3 de suelo (r = 0.586, P = 0.01). La condición de la planta no estuvo significativamente correlacionada con *R. reniformis*; sin embargo la densidad de este nematodo estuvo significativamente correlacionada con la hierba hospedera *Bidens pilosa* L.

Palabras claves adicionales: Mangifera indica, nematodos espirales, nematodo revestido, nematodos de los anillos, nematodo del raquitismo, nematodo reniforme, gama de hospederos, dinámica de población, sondeo nematológico, hierbas hospederas.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important fruit crops grown in the tropics. Recently, the plant-parasitic nematodes *Hemicriconemoides mangiferae* Siddiqi and *Xiphinema brevicolle* Lordello & Da Costa have been reported from declining mango trees in South Africa (9), where they also cause decline of lychee, *Litchi chinensis* Sonn. (6, 7, 8, 10). The recent finding of *H. mangiferae* and *Rotylenchulus reniformis* Linford & Oliveira on declining mango trees in southern Florida (5) suggested that an extensive survey of the mango-producing areas of this region would be necessary to determine the distribution and possible impact of these nematodes. The current study was conducted during the rainy season of 1980, to concide with the period of maximum populations of *H. mangiferae* (3).

MATERIALS AND METHODS

From April 30 to August 6, 1980, 20 mango groves located in Dade County in extreme southeastern Florida were sampled for plant-parasitic nematodes. The soil types in most of the groves sampled were Rockdale fine sandy loam or Rockdale fine sand, although one grove was located on Perrine marl. Soil pH ranged from 6.7 to 7.9. Mango trees ranged from 1.5 to more than 25 years in age. The general sampling plan was to collect one soil sample for nematode assay per ha of mangoes, with no less than five samples collected from an individual grove. Using this plan, a total of 123 soil samples were collected from 108.5 ha of mangoes during the course of this study. Each sample consisted of soil and roots collected with a hand trowel to a depth of 15 cm from three locations around each of five different trees. Each soil sample was passed through a 4 mm sieve to remove rock and debris, and a 100cm^3 subsample was then processed for nematodes by sieving and centrifugation (2). Root incubations (11) were made for the first 60 samples collected, but discontinued because of very low nematode recovery.

Ratings of tree condition were made for each of the five trees in each sample, and an average rating of tree condition calculated. A 1-6 rating scale adapted from Milne et al. (8) was used, where 1 = healthy; 2 = first signs of decline; 3 = unthrifty, with bare twigs evident; 4 = many bare twigs and some dead branches; 5 = nearly dead; 6 = dead. Typical decline symptoms (Fig. 1) were evident at several locations. These symptoms included reduced numbers of secondary roots, chlorosis and necrosis of leaves, leaf drop from branch tips, bare terminal twigs, and occasional dead branches.

A rating was made of the percentage of ground covered by weeds in a 2.0 m radius around the trunks of the five trees included in each sample. Weed coverage was rated on a simple 1 to 5 scale, where 1 = weeds absent; 2 = trace (0 - 10% of ground covered); 3 = light (10 - 30% of ground covered); 4 = medium (30 - 50% of ground covered); 5 = heavy (more than 50% of ground covered). Individual ratings were made for the dominant weed species present as well as a composite rating of all weeds together.

Percent soil moisture was determined gravimetrically for the various soil samples. For each sample, the counts of each plant-parasitic nematode, rating of tree condition, weed ratings, and soil moisture were entered into a SAS data set (1) on an Amdahl 470 V/6 II computer. Simple correlation coefficients were calculated between each pair of variables.

RESULTS AND DISCUSSION

The most common weeds encountered at the various sampling sites were *Bidens pilosa* L., *Parthenium hysterophorus* L., *Lantana camara* L., *Sonchus oleraceus* L., *Lepidium virginicum* ., and various grasses. Plant parasitic nematodes recovered during this survey were *Hemicriconemoides mangiferae* Siddiqi, *Rotylenchulus reniformis* Linford & Oliveira, *Pratylenchus brachyurus* (Godfrey) Filipjev & Schuurmans Stekhoven, *Quinisulcius acutus* (Allen) Siddiqi, *Helicotylenchus dihystera* (Cobb) Sher, *H. pseudorobustus* (Steiner) Golden, *Macroposthonia* spp., *Xiphinema* sp., *Hoplolaimus* sp., and *Paratylenchus* sp. (Table 1). *Rotylenchulus reniformis* and *H. mangiferae* were the nematodes found most frequently and in the highest numbers. *H. mangiferae* was found more frequently in samples collected from old trees (10 years of age or older) than from young groves (3 years of age or younger).

Fig. 1. Mango tree exhibiting typical decline symptoms, with bare terminal twigs.

Young groves contained *Helicotylenchus* spp., *Macroposthonia* spp., and *Q. acutus* more frequently and in higher numbers than did older groves. *R. reniformis* was found in most samples and averaged high population levels regardless of tree age. This nematode was present in 23% of the samples in extremely high numbers (more than 200/100 cm^3 soil). *H. mangiferae* was also very abundant in certain samples with 11% of the samples containing more than 200/100 cm^3 soil of this nematode.

Significant correlations between pairs of variables measured in this study are summarized in Table 2. Tree condition was significantly (P = 0.01)

Fig. 1. Mango tree exhibiting typical decline symptoms, with bare terminal twigs.

Table 1. Frequency and density of plant-parasitic nematodes in samples from young and old mango trees in south Florida.

Nematode	All trees		Young trees		Old trees	
	Frequency (%)	Nos./100cm^3 soil^x	Frequency (%)	Nos./100cm^3 soil^y	Frequency (%)	Nos./100cm^3 soil^z
Rotylenchulus reniformis	87.8	149.5	100.0	157.5	83.9	146.9
Hemicriconemoides mangiferae	87.8	90.4	66.7	96.5	94.6	88.4
Helicotylenchus spp.	64.2	43.0	93.3	88.0	54.8	28.5
Macroposthonia spp.	52.1	27.0	60.0	50.5	49.5	19.4
Quinisulcius acutus	8.9	4.9	26.7	19.5	3.2	0.2
Xiphinema sp.	14.6	1.5	6.7	0.5	17.2	2.0
Pratylenchus brachyurus	1.6	0.08	3.3	0.2	1.1	0.05
Hoplolaimus sp.	0.8	0.04	3.3	0.2	0.0	0.0
Paratylenchus sp.	0.8	0.04	0.0	0.0	1.1	0.05

^{x}Mean of 123 samples.
^{y}Mean of 30 samples from trees 3 years of age or younger.
^{z}Mean of 93 samples from trees 10 years of age or older.

Table 2. Significant correlations found between pairs of variables measured in mango survey, based on age of trees.

Pairs of variables correlated		Correlation coefficients[x]		
X_1	X_2	All trees	Old trees[y]	Young trees[z]
Tree condition	*Hemicriconemoides mangiferae* density	0.259**	0.419***	NS
Tree condition	*Helicotylenchus* spp. density	0.228*	0.227*	NS
Tree condition	Total weed density	0.185*	NS	NS
Tree condition	*Bidens pilosa* density	0.205*	0.272**	NS
Soil moisture	*Rotylenchulus reniformis* density	0.234*	0.318**	NS
Soil moisture	*Helicotylenchus* spp. density	0.253*	0.322**	NS
Total weed density	*Hemicriconemoides mangiferae* density	0.264**	0.224*	0.374*
Total weed density	*Macroposthonia* spp. density	NS	0.240*	NS
Bidens pilosa density	*Hemicriconemoides mangiferae* density	0.279*	0.314**	NS
Bidens pilosa density	*Macroposthonia* spp. density	0.226*	0.347***	NS
Bidens pilosa density	*Rotylenchulus reniformis* density	0.367***	0.351***	0.521**
Parthenium hysterophorus density	*Helicotylenchus* spp. density	NS	NS	0.393*

[x]Asterisks (*,**,***) denote statistical significance at P = 0.05, P = 0.01, and P = 0.001, respectively.
NS indicates nonsignificant correlation coefficient.

[y]Based on 93 samples from trees 10 years of age or older.

[z]Based on 30 samples from trees 3 years of age or younger

Table 3. Correlation coefficients between tree condition and *Hemicriconemoides mangiferae* levels from selected sets of soil samples collected from beneath mango trees.

Samples included in analysis	No. of samples	Correlation coefficients between tree condition and:[x] *H. mangiferae* counts per 100 cm^3 soil	Logarithm of *H. mangiferae* counts per 100 cm^3 soil
Samples from all trees	123	0.259**	0.200*
Samples from old trees	93	0.419***	0.415***
Samples from young trees	30	0.100	0.048
Samples from old trees having *H. mangiferae* counts less than 100/100cm^3 soil	70	0.208	0.269*
Samples from old trees having *H. mangiferae* counts more than 100/100cm^3 soil	21	0.586**	0.552**
Samples from old trees having *H. mangiferae* counts more than 75/100cm^3 soil	32	0.463**	0.441*
Samples from old trees having *H. mangiferae* counts more than 50/100cm^3 soil	47	0.387**	0.334*

[x]Asterisks (*,**,***) denote statistical significance at P = 0.05, P = 0.01, and P = 0.001, respectively.

correlated with *H. mangiferae* density when all samples were considered. However, when samples from older trees alone were analyzed, this correlation became very highly significant ($P = 0.001$, with $r = 0.419$). No significant correlation was evident between these two variables when data from young trees were considered alone. Poor tree condition also showed a slight positive correlation with weed density in several cases. It is possible that this may reflect the heavier weed growth beneath those declining trees in which some leaf drop had occurred, allowing more light to penetrate the canopy. Both *R. reniformis* and *Helicotylenchus* spp. showed positive correlations with soil moisture, while *H. mangiferae* did not, even though this relationship has been documented previously (3). Densities of several species of plant-parasitic nematodes showed significant positive correlations with weed densities. Of particular interest are the very highly significant correlations between *R. reniformis* and *Bidens pilosa* density, a relationship which has also been observed in Florida avocado groves (4).

The relationship between *H. mangiferae* and tree condition is of particular interest since this nematode has been associated with declining mango trees in both Florida (5) and South Africa (9). While correlation does not imply causality, the correlation between tree condition and *H. mangiferae* density developed from samples collected from old trees was one of the strongest observed (Table 2). It is possible that the significant correlations between *H. mangiferae* and weed density in several cases may be indirect, since weed density was correlated with tree condition as well, and none of the weeds encountered in this survey have been reported as hosts of *H. mangiferae* (10). The association between *H. mangiferae* and tree condition was not evident in young groves (Table 3), and in fact, declining trees were observed in young groves where very few *H. mangiferae* were present, suggesting that decline of young trees is due to another factor. Among samples collected from older trees, several relationships between tree condition and *H. mangiferae* density were identified (Table 3). When only those samples from older trees having less than 100 *H. mangiferae*/100cm^3 of soil were included in the analysis, no significant correlation was apparent between tree condition and *H. mangiferae* counts. Significant positive correlations resulted when data taken from only those trees having 50 or more *H. mangiferae*/100cm^3 of soil were used. The magnitude of the correlation coefficients increased when only samples having more than 75 or more than 100 *H. mangiferae*/100cm^3 were used. Thus, in the older trees, the strongest relationship is between tree condition and *H. mangiferae* counts of more than 100/100cm^3 of soil, suggesting the likelihood of observing tree damage at the highest population levels of *H. mangiferae*. Logarithmic transformation of nematode counts produced only small changes in these relationships (Table 3).

It is evident from the results presented here that *H. mangiferae* and *R. reniformis* are widely distributed in south Florida mango groves. There is a strong relationship between the decline of established trees and *H. mangiferae* density, particularly at high population levels. Future experimentation is needed to determine whether declining trees will respond favorably to nematode control. Despite the occurrence of large numbers of *R. reniformis* in many of the mango samples collected, no significant relationship was observed between density of this nematode and tree condition. Instead, density of *R. reniformis* was strongly related to occurrence of *Bidens pilosa* in the groves.

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