RELATIONSHIP BETWEEN NEMATODE DENSITY AND WEED DENSITY IN AVOCADO GROVES [RELACION ENTRE LA DENSIDAD DE NEMATODOS Y LA DENSIDAD DE LAS MALAS HIERBAS EN LAS ARBOLEDAS DE AGUACATE]

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Accepted:
28. VII. 1980
Aceptado:

ABSTRACT

The relationship between density of plant parasitic nematodes and weed density was examined in three Florida groves planted to avocado *(Persea americana).* Soil and root samples were collected from 24 trees in each of two groves and from 80 trees in a third grove and assayed for plant parasitic nematodes. A rating of the percent of ground area beneath each tree covered by individual weed species and by all weed species together was obtained and correlation coefficients between each nematode density and each corresponding weed density were computed. Numbers of *Rotylenchulus reniformis* per 100 cm^3 of soil were correlated with total weed density at two of the three sites, with r = 0.233* (78 d.f.) and r = 0.602** (22 d.f.). Density of *R. reniformis* also showed a significant (P = 0.05) correlation with densities of several individual weed species at these two sites, including a weed host, *Bidens pilosa.* While *R. reniformis* density was not significantly correlated with total weed density at the third site (r = 0.249; 22 d.f.), it nevertheless did exhibit significant correlations with density of either *Sida acuta* (r = 0.442*; 22 d.f.) or *Blechum brownei* (r = 0.475*; 22 d.f.). Neither soil nor root densities of *Pratylenchus brachyurus* were correlated with total weed density or with densities of individual weed species, but this nematode was common in avocado roots at all sites. It is evident that information on the identity and distribution of weed species present is necessary in making diagnoses of possible *R. reniformis* problems in avocado groves.

Key Words: Helicotylenchus dihystera, Persea americana, Pratylenchus brachyurus, Quinisulcius acutus, Rotylenchulus reniformis, reniform nematode, lesion nematode, tropical fruit trees.

INTRODUCTION

Many different parasitic nematodes have been reported from soil samples taken from the rhizosphere of avocado *(Persea americana* Mill.) in several parts of the world (1, 4, 5, 9, 11, 12, 13, 14, 15, 17, 18, 19). Damage symptoms and root lesions on avocado attributed to *Radopholus similis* (Cobb) Thorne and *Pratylenchus brachyurus* (Godfrey) Filipjev & Schuurmans Stekhoven have been described from Florida (4, 17, 18, 19). *Pratylenchus vulnus* Allen & Jensen has caused stunting and reduced root growth in California tests (15). In addition, *Rotylenchulus reniformis* Linford & Oliveira, reported on avocado in other areas (9, 12, 13, 14), is often associated with other crops grown in Florida (10).

In Florida, the sampling of avocado groves for nematodes is often complicated by the presence of heavy weed growth beneath the trees. Numerous weed species are reported from local avocado groves (6). Mixed weed communities could be host to a wide variety of plant parasitic nematodes, perhaps leading to misinterpretations of diagnostic samples taken from the groves. Little information exists on the spatial

distribution of nematodes in groves relative to weed cover. For this reason, the distribution of plant parasitic nematodes in groves having a range of weed densities was examined.

MATERIALS AND METHODS

Three avocado groves located in Dade County, Florida, on Rockdale fine sandy loam soils, with a pH ranging from 6.4 to 6.8, were sampled in this study.

A REC Site. This grove was located on the grounds of the Agricultural Research and Education Center in Homestead, Florida. On 25 June, 1979, a contiguous block of 80 avocado trees was sampled. These trees were 33 years old, had been grafted onto 'Lula' rootstocks, and were arranged in 16 adjacent rows each five trees deep.

Florida City Site. This grove consisted of a large block of 20-year-old 'Hall' seedlings located approximately 2 km west of Florida City, Florida. On 23 October, 1979, four trees at each of six locations in the grove were selected at random for sampling. At each of the six locations, the four trees sampled were always the first through the fourth trees from the western edge of the grove. With this sampling scheme, nematode densities at the edge of the grove could be compared with those under trees in the second, third, and fourth rows of the grove.

Homestead Site. This grove consisted of a large block of trees on 'Waldin' rootstocks approximately 50 years old, located about 6 km north of Homestead, Florida. On 13 December, 1979, 24 trees from the grove were sampled randomly. None of the trees selected were at the edge of the grove in this sampling scheme.

One sample was collected for nematode analysis from each tree at the three sites. Each sample consisted of soil and roots collected from 4 locations, 1.5 m from the trunk. Samples were collected with a hand trowel to a depth of 15 cm. At the AREC site, the only grove where drip irrigation was used, samples were never collected closer than 1.0 m to the drip irrigation outlets. Each soil sample was passed through a 4 mm sieve to remove rock, and a 100 cm^3 subsample was then processed for nematodes by decanting and sieving, followed by suspension of the residues in modified Baermann funnels (2, 3). Roots were cut into small pieces (2-3 cm length) and incubated in aerated water for recovery of endoparasitic nematodes.

A rating was made of the percentage of ground covered by weeds in a 2.0 m radius around each trunk. A modification of a disease rating scale (7) was used, such that 1 = 0% of ground covered; 2 = 0.3%; 3 = 3-6%; 4 = 6-12%; 5 = 12-25%; 6 = 25-50%; 7 = 50-75%; 8 = 75-87%; 9 = 87-94%; 10 = 94-97%; 11 = 97-100%; 12 = 100% of ground covered. Individual ratings were made for each weed species present, as well as a total rating for ground covered by all weeds together.

RESULTS AND DISCUSSIONS

Plant parasitic nematodes encountered at the various sites included *Rotylenchulus reniformis, Pratylenchus brachyurus, Helicotylenchus dihystera* (Cobb) Sher, and *Quinisulcius acutus* (Allen) Siddiqi. Mean numbers of *R. reniformis* per 100 cm^3 of soil were 32.3 at the Florida City site, 4.6 at the AREC site, and 29.7 at the Homestead site. Mean numbers of *P. brachyurus* were 1.6 and 4.4 per 100 cm^3 at the AREC and Homestead sites, respectively. There were no *P. brachyurus* recovered from any of the soil samples at the Florida City site. Mean numbers of *H. dihystera* per 100 cm^3 of soil were 4.0 at the Florida City site, 2.2 at the AREC site, and 4.2 at the Homestead site. *Quinisulcius acutus* was relatively rare, averaging only 0.8 per 100 cm^3 at the Florida City site.

Table 1. Comparison of total weed densities and density of *Rotylenchulus reniformis* by position of individual avocado trees at the Florida City site.

Position of tree in grove	Total weed density [x] rating	*Rotylenchulus reniformis* [x] per 100 cm^3 soil
Edge of grove	5.2 a	88 a
Second from edge of grove	3.2 b	30 ab
Third from edge of grove	1.8 c	0 b
Fourth from edge of grove	2.2 c	11 b

[x] Mean of six replications. Means followed by the same letter were not significantly (P = 0.05) different, according to Duncan's New Multiple Range Test.

Table 2. Correlation coefficients between weed densities and densities of *Rotylenchulus reniformis* in soil under avocado trees at three sites.

	Site		
Weeds	AREC	Florida City	Homestead
Bidens pilosa	0.324**[x]	0.404*	----
Blechum brownei	0.028	0.326	0.475*
Centrostachys indica	0.091	0.575**	----
Momordica charantia	0.064	----	0.232
Poinsettia heterophylla	0.313**	----	-0.106
Ruellia lorenziana	0.221*	----	----
Sida acuta	----	----	0.442*
Zebrina pendula	----	----	-0.258
Grasses [y]	0.601**	0.610**	-0.004
Total weed density	0.233*	0.602**	0.249

[x] Asterisks (*, **) denote statistical significance at P = 0.05 and P = 0.01, respectively. Degrees of freedom = 78 at AREC site and 22 at the other two sites. Dashes (-) indicate weed was rare at a particular site.

[y] Grasses were *Tripsacum floridana* at the AREC site, *Paspalum* sp. at the Florida City site, and a mixture of *Paspalum* sp. and *Brachiaria* sp. at the Homestead site.

Pratylenchus brachyurus was recovered from avocado roots at all sites. Mean number per g of dry weight were 9.2 at the Florida City site, 18.3 at the AREC site, and 6.0 at the Homestead site. Trace numbers (less than 1.0/g) of young *R. reniformis* females and *H. dihystera* were also recovered from roots at the various sites. *Quinisulcius acutus* and *Meloidogyne* larvae were recovered in extremely low numbers (0.1/g) at the AREC site and the Homestead site, respectively.

Common weeds found in the groves were *Centrostachys indica* (L.) Standl., *Bidens pilosa* L., *Blechum brownei* Juss., *Brachiaria* sp., *Momordica charantia* L., *Paspalum* sp., *Poinsettia heterophylla* (L.) Kl. & Gke., *Ruellia lorenziana* Griseb., *Sida acuta*

Table 3. Correlation coefficients between weed densities under 80 avocado trees at the AREC site.

Weeds [x]	BB	BP	MC	PH	RL	TF
BB	1.000[y]					
BP	0.396**	1.000				
MC	0.335**	0.266*	1.000			
PH	-0.003	0.302**	0.346**	1.000		
RL	0.186	0.224*	0.220*	0.218	1.000	
TF	-0.119	0.154	0.337**	0.350**	0.393**	1.000

[x] BP = *Bidens pilosa;* BB = *Blechum brownei;* MC = *Momordica charantia;* PH = *Poinsettia heterophylla;* RL = *Ruellia lorenziana;* TF = *Tripsacum floridana.*
[y] Asterisks (*, **) denote statistical significance at P = 0.05 and P = 0.01, respectively.

Table 4. Correlation coefficients between weed densities under 24 avocado trees at the Florida City site.

Weeds [x]	BB	BP	CI	P
BB	1.000[y]			
BP	0.741**	1.000		
CI	0.551**	0.761**	1.000	
P	0.653**	0.881**	0.920**	1.000

[x] BB = *Blechum brownei;* BP = *Bidens pilosa;* CI = *Centrostrachys indica;* P = *Paspalum* sp.
[y] Asterisks (**) denote statistical significance at P = 0.01.

Burm., *Tripsacum floridana* Porter ex Vasey, and *Zebrina pendula* Schniel. Many additional weeds were also found in the groves, but were relatively rare, occurring in less than 10% of samples even at the site in which they were most common.

Patterns in weed densities were observed at all sites, with the heaviest densities occurring near the margins of the grove, and lower densities farther into the grove. The Florida City site was sampled in such a way as to allow comparison among trees at the edge of the grove with those in the second, third, and fourth rows. Parallel trends in mean density ratings of all weeds and in *R. reniformis* population densities were apparent (Table 1).

In order to more closely examine the apparent relationship between nematode and weed densities, correlation coefficients were calculated between the density of each nematode in soil and the density rating of each weed at each of the three sites. Correlation coefficients were also calculated between the density of each nematode and the total weed density rating. In the case of *R. reniformis,* many significant (P = 0.05) correlations with weed density were found (Table 2).

Table 5. Correlation coefficients between weed densities under 24 avocado trees at the Homestead site.

Weeds [x]	BB	G	MC	PH	SA	ZP
BB	1.000					
G	-0.122	1.000				
MC	0.221	0.095	1.000			
PH	-0.383	0.271	0.294	1.000		
SA	0.405*[y]	0.282	0.143	-0.243	1.000	
ZP	-0.454*	0.257	0.023	0.222	-0.380	1.000

[x] BB = *Blechum brownei;* G = *mixed grasses (Paspalum* sp. and *Brachiaria* sp.); MC = *Momordica charantia;* PH = *Poinsettia heterophylla;* SA = *Sida acuta;* ZP = *Zebrina pendula.*
[y] Asterisk (*) denotes statistical significance at P = 0.05.

In general, *R. reniformis* was positively correlated with total weed density, but some inconsistencies were observed in correlations with densities of individual weeds (e.g., *Blechum brownei*). Correlation coefficients were calculated between density ratings of all common weeds at each of the three sites (Table 3-5). The many significant (P = 0.05) correlations between pairs of weed densities at the AREC and Florida City sites (Tables 3-4) support the observation that several kinds of weeds were growing together at these sites, particularly around the grove margins. Since there is an association among the various weeds at these sites, it is not surprising that *R. reniformis* density was correlated with densities of each of several weeds (Table 2).

No grove margins were included in the sampling pattern used at the Homestead site, thus avoiding the dense weed associations occurring at the edges. This is reflected in the relative lack of correlation among pairs of weeds at this site (Table 5), where a variety of weeds were observed in scattered patches in the grove. While the correlation of *R. reniformis* density with total weed density was not significant (r = 0.249), nevertheless (P = 0.05) *R. reniformis* density was significantly correlated with densities of *Sida acuta* and *Blechum brownei.* A significant correlation existed between densities of these two weeds (Table 5), so it is difficult to draw conclusions about the influence of either one of these two weed species alone on *R. reniformis* in this instance. However, this was the only site at which *R. reniformis* density was significantly correlated with density of *B. brownei.*

Of several common weeds observed in this study, *Bidens pilosa* has been previously reported as a host of *R. reniformis* (16). Gravid females of *R. reniformis* were observed on the roots of this plant and on the roots of *Sida acuta* in the study sites. The closely related *Sida rhombifolia* L. has been reported as a host of *R. reniformis* in Cuba (16). Other reported hosts of *R. reniformis* (8, 16) encountered only occasionally at these sites were *Argemone mexicana* L. at the Homestead site and the AREC site, and *Sonchus oleraceus* L. at the AREC site.

Pratylenchus brachyurus was common in the roots of several weeds collected at the Homestead site. Mean numbers of *P. brachyurus* per gram of dry root weight were 36 for *Paspalum* sp., 114 for *Brachiaria* sp., 18 for *Sida acuta,* and 10 for *Blechum brownei.* Only low numbers of other nematodes were recovered from roots of various

weeds, with the exception of *H. dihystera,* which averaged 36 per gram of dry root weight in *Paspalum* sp. *Meloidogyne* larvae were recovered only from *Momordica charantia,* a reported host (5), at a mean of 2 per gram.

Few significant (P = 0.05) correlations existed between densities of nematodes other than *R. reniformis* and weed density. *Quinisulcius acutus* density and total weed density at the Florida City site were significantly correlated (r = 0.458*). However, densities of *P. brachyurus, H. dihystera,* and *Q. acutus* were not correlated with densities of any individual weed species at any site.

It is evident that information on the weed species and their distribution in a given avocado grove is necessary before attempting to make a diagnosis of a potential *R. reniformis* problem. Diagnositc samples should be taken away from the margin of the grove, preferably in areas having few or no weeds. It is not known whether weed hosts such as *Bidens pilosa* or *Sida* spp. could build up populations of *R. reniformis* to levels which would damage established avocado trees. Trees in the study sites showed no symptoms of decline or extensive root damage, and tree condition did not appear to vary with distribution of either *R. reniformis* or weeds.

RESUMEN

La relación entre la densidad de los nematodos parasíticos y la densidad de las malas hierbas fue examinada en tres arboledas de aguacate *(Persea americana)* de la Florida. Muestras de suelo y raíces fueron recogidas de 24 plantas en dos de las arboledas y de 80 plants en la tercera arboleda y todas fueron analizadas para determinar los nematodos parasíticos. Se calculó el porcentage de area de tierra debajo de cada planta cubierto con especies individuales de malas hierbas y con todas las especies juntas y se computaron los coeficientes de correlación entre las cantidades de cada nematodo y la correspondiente densidad de cada mala hierba. Las cantidades de *Rotylenchulus reniformis* por 100 cm^3 de suelo fueron correlacionadas con la densided total de malas hierbas en dos de las tres arboledas con valores de r = 0.233* (78 d.f.) y r = 0.602** (22 d.f.). La densidad de *R. reniformis* también mostró una correlación significativa (P = 0.05) con las densidades de varias especies individuales de malas hierbas en las mismas dos arboledas, incluyendo la yierba hospedera *Bidens pilosa.* Aunque la densidad de *R. reniformis* no estuvo correlacionada significativamente con la densidad total de malas hierbas en la tercera arboleda (r = 0.249, 22 d.f.), esta sin embargo mostró correlaciones significativas con la densidades de las especies *Sida acuta* (r = 442*, 22 d.f.) y *Blechum brownei (r* = 0.475*, 22 d.f.). La densidad de *Pratylenchus brachyurus* en el suelo y raíces no estuvo correlacionada con las densidades de ninguna de las especies individuales de malas hierbas presentes pero dicho nematodo fue común en las raíces del aguacate en las tres arboledas. Es evidente que la información sobre la densidad y distribución de las malas hierbas presentes es necesaria para hacer un diagnóstico del *R. reniformis* en las arboledas de aguacate.

Claves: Helicotylenchus dihystera, Persea americana, Pratylenchus brachyurus, Quinisulcius acutus, Rotylenchulus reniformis, nematodo reniforme, nematodo lesionador, plantas frutales tropicales.

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