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Survey of Nematodes on Coffee in Hawaii[1]

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Abstract: Surveys of coffee fields in Hawaii during 1989–1991 indicated the presence of 10 nematode species in 8 genera. After coffee was planted in fields previously in sugarcane, populations of *Criconemella* sp. and *Pratylenchus zeae* gradually decreased, while *Rotylenchulus reniformis* and, in one field, *Meloidogyne incognita,* increased in numbers. Coffee is a poor host of *R. reniformis,* but weeds in coffee plantations may support this nematode. At present, nematodes pose no serious threat to Hawaii's expanding coffee industry.

Key words: Coffea arabica, coffee, *Criconemella* spp., *Meloidogyne incognita,* nematode, *Pratylenchus zeae, Rotylenchulus reniformis,* sugarcane, survey.

Coffee (*Coffea arabica* L.) has been grown in Hawaii for many years, mainly on the Kona coast of the island of Hawaii. The coffee industry is currently expanding into new areas on the islands of Kauai, Oahu, Molokai, and Maui. The new plantations are being established in fields previously planted in pineapple or sugarcane.

A major concern among producers is the threat to coffee by nematode species already present in Hawaii. One of the most damaging parasites of coffee, *Meloidogyne exigua* Goeldi (5,13), has not been reported in Hawaii; however, *M. incognita* Kofoid & White, *M. javanica* (Treub) Chitwood, and *Pratylenchus brachyurus* (Godfrey) Filipjev & Schuurmans Stekhoven occur in sugarcane (*Saccharum officinarum* L., *Saccharum* spp.) and pineapple (*Ananas comosus* (L.) Merr.) plantations. These nematode species can damage coffee, but generally less than *M. exigua* (5,9,10,15). *Pratylenchus coffeae* (Zimmerman) Filipjev & Schuurmans Stekhoven, pathogenic to coffee (7,13), has been reported in Hawaii (6) but has not been recovered from pineapple or sugarcane fields. *Rotylenchulus reniformis* Linford & Oliveira often multiplies to high numbers on pineapple and papaya roots in Hawaii, but sugarcane is not a host (11). Parasitism by *R. reniformis* on coffee was reported in Cuba (14) and India (2), but a later report from India (8) indicated that *R. reniformis* failed to infect coffee. *Radopholus similis* (Cobb) Thorne was common on Hawaiian sugarcane in the early 1900s; now it is found only on other crops such as banana, citrus, and anthurium (12). *Radopholus similis* has been reported on coffee (9,15), but it does not seem to be a major, widespread coffee pest.

Sugarcane fields in Hawaii contain diverse nematode species, usually in low numbers (12). The most common plant-parasitic species found are *Pratylenchus zeae* Graham, *P. brachyurus, Helicotylenchus dihystera* (Cobb) Sher, and *H. multicinctus* (Cobb) Golden. In contrast, pineapple fields have fewer species, but the pathogenic species are often present in high numbers (12). Thus, the initial populations in coffee fields depend on the previous crop.

The surveys reported here were intended to provide coffee growers with presence and abundance data on plant-parasitic species present in young coffee fields and, as much as possible, to predict potential problems. Surveys will be continued over the next few years in order to determine changes in nematode population structure and density.

MATERIALS AND METHODS

Field surveys: Fourteen fields on four islands were selected for sampling; several were sampled twice. The fields were from privately owned plantations. Field practices, irrigation, fertilization, and herbicide treatments varied among the plantations. Nematicides were not applied to the areas

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studied. Soil types were lava soils, lateritic silty clays, or silty clay loams. Sampling dates and numbers of samples collected per field varied (Table 1).

Each soil sample consisted of a composite of 6 cores taken to 10–15 cm deep except at a cultivar trial on Molokai, where several spadefuls of soil were subsampled and composited. Samples were placed in plastic bags, transported to the laboratory, and processed within 3 days. Nematodes were extracted from 50-cm^3 subsamples for 3 days on Baermann funnels (1) or from 250-cm^3 soil samples with a combination of elutriation and centrifugation (1).

Small-plot studies: A field trial was carried out on Oahu to determine the effect of *M. incognita* on several cultivars of coffee. The trial area was about 0.2 ha, divided into six equal sections. Three of the sections were planted with kenaf (*Hibiscus cannabinus* L.), a very susceptible host of *M. incognita*, which was allowed to grow for 3 months. Three other sections were maintained fallow. At the end of the 3-month period, the kenaf plants were heavily galled. Soil samples from kenaf plots were extracted on Baermann funnels, and the number of *M. incognita* averaged 48 per 50 cm^3 soil. Low numbers (<5 per 250 cm^3 soil) of *Helicotylenchus* spp. and *P. zeae* were also present. The kenaf was cut November 1990 and 10–15-cm-tall coffee seedlings (cv. Guatemala, Catuai, Pink Bourbon, Yellow Caturra) were planted in both the kenaf and fallow plots. There were 12 plots previously planted to kenaf and 12 in the fallow area. Each coffee plot was 70 m^2. Sudax (sorghum [*Sorghum bicolor* (L.) Moench] × Sudan grass [*S. drummondii* (Nees ex Steud.) Millsp. and Chase]) was planted between the coffee rows as a windbreak. The coffee plots were sampled in November 1990 and in January, February, and June 1991. Ten soil cores were taken 10–15 cm deep and composited. A 250-cm^3 subsample was used for nematode extraction by elutriation and centrifugation flotation.

Another small trial was set up to determine whether *R. reniformis* would infect coffee. The test was installed on Oahu in a papaya planting where the soil was infested with >1,000 *R. reniformis* per 50 cm^3. One tomato (cv. Bounty) and eight coffee seedlings (cv. Guatemala) were planted between the papaya trees. Tomato and coffee were removed from the soil at 2 and 3 months, respectively, for examination of *R. reniformis* infection.

TABLE 1. Location, sampling date, size, sample number, and coffee cultivar and age of 14 fields sampled during the coffee field survey.

Field no.	Location	Date	Field size	Sample no.	Age of coffee	Cultivar
1	Oahu	01/22/91	1.8 ha	20	<1 yr	Mixed
2	Maui	12/04/89	3.1 ha	13	<1 yr	Mixed
3	Kauai	01/11/91	12.7 ha	10	<1 yr	Guatemala
4	Kauai	01/11/91	21.3 ha	9	<1 yr	Guatemala
5	Kauai	01/11/91	21.8 ha	10	<1 yr	Guatemala
6	Kauai	11/30/90	40.1 ha	24	<1 yr	Guatemala
7	Kauai	08/28/89	2.5 ha	12	3 yr	Guatemala
7	Kauai	11/30/90	2.5 ha	12	4 yr	Guatemala
8	Kauai	07/10/89	31.4 ha	29	<1 yr	Guatemala
8	Kauai	01/04/91	31.4 ha	29	1 yr	Guatemala
9	Maui	02/08/91	6.2 ha	11	<1 yr	Guatemala
10	Maui	02/08/91	15.3 ha	10	<1 yr	Guatemala
11	Oahu	01/12/90	0.1 ha	6	1 yr	Mixed
11	Oahu	08/21/90	0.1 ha	6	2 yr	Mixed
12	Oahu	09/19/89	0.5 ha	9	2 yr	Mixed
12	Oahu	02/04/91	0.5 ha	20	3 yr	Mixed
13	Oahu	09/22/89	0.5 ha	12	2 yr	Mixed
13	Oahu	02/12/91	0.5 ha	12	3 yr	Mixed
14	Molokai	02/01/91	0.3 ha	23	2 yr	Mixed

TABLE 2. Percentage of soil samples containing plant-parasitic nematode species in 13 coffee fields (fields #1–13, Table 1) previously planted in sugarcane, by age of coffee field.

Species	Age of coffee field		
	<1 yr	1–3 yr	>3 yr
Criconemella spp.	22.8	1.3	2.0
Helicotylenchus spp.	83.8	42.7	58.0
Meloidogyne sp.†	2.9	6.6	8.0
Paratrichodorus sp.	2.9	0	2.0
Paratylenchus minutus	5.1	14.0	34.0
Pratylenchus brachyurus	14.7	4.0	0
Pratylenchus zeae	72.1	21.3	4.0
Rotylenchulus reniformis	2.9	22.7	20.0
Number of fields	9	5	4

† *M. incognita* verified in some fields.

RESULTS AND DISCUSSION

Surveys of 14 coffee fields previously planted in sugarcane showed seven plant-parasitic nematode genera (Tables 2 and 3). The *Helicotylenchus* species found were mainly *H. dihystera* and a few *H. multicinctus*. *Criconemella* spp., frequently found in sugarcane fields, were common in newly planted coffee fields but were rarer in older plantations. The same pattern was seen with *Pratylenchus zeae*, which multiples on sugarcane and also on sorghum but is not reported to parasitize coffee (3). It may have multiplied to some extent on the Sudax hybrid that was planted as windbreaks between the rows of coffee seedlings and later destroyed (Fig. 1).

Meloidogyne incognita and *P. brachyurus* were the only species present in coffee in Hawaii that were expected to be damaging, but these nematodes usually occurred at low numbers (<100 per 250 cm^3). *Paratrichodorus* sp. was rarely found. In four samples from Molokai and two from Kauai, a few individuals of *Pratylenchus* (tentatively identified as *P. coffeae*) were present. More specimens will need to be recovered to confirm the identification.

TABLE 3. Number of nematodes recovered from several coffee cultivars in a field (field #14, Table 1) previously planted in pineapple.

Coffee cultivar	No. of nematodes per 250-cm^3 soil sample			
	Rotylenchulus reniformis	*Helicotylenchus dihystera*	*Meloidogyne* sp.†	*Pratylenchus* sp.†
Caturra	30	0	0	10
Caturra	10	0	0	0
Caturra	210	190	0	0
Guadalupe	2,000	70	0	0
Jamaican Blue Mountain	0	0	0	0
Jamaican Blue Mountain	0	0	0	0
Kent	50	740	0	100
Kona	0	0	0	0
Kona	1,240	380	0	0
Kona cv. Typica	240	0	0	0
Margogipe	20	0	0	0
Mundo Novo	20	0	0	0
Pink Bourbon	0	0	0	0
Preanger	50	0	0	0
Progeny 502	580	10	0	0
Red Catuai	0	0	0	0
Red Catuai	0	0	0	0
Red Catuai	20	0	0	0
Red Caturra	40	0	10	0
Robustas	340	0	0	0
Yellow Bourbon	90	30	0	10
Yellow Catuai	10	0	0	0
6661	840	30	0	0

† Too few good specimens to identify to species.

FIG. 1. Rows of newly planted coffee seedlings flanked by Sudax windbreaks.

Three of the fields sampled were planted with a number of different coffee cultivars. None of the cultivars consistently supported high populations of any of the nematode species; however, isolated samples contained high numbers (>7,500) of the reniform nematode. Samples from coffee planted in a field previously cropped with pineapple contained counts as high as 2,000 per 250 cm^3 soil (Table 3). Some *R. reniformis* were recovered from coffee following sugarcane, even though sugarcane is not a host (11). Multiplication of *R. reniformis* probably occurred on weed hosts or roots of windbreak plants.

The results of the small trial in which coffee seedlings were planted in soil heavily infested with *R. reniformis* indicated that coffee is not a good host for this nematode species. After 2 months, the tomato plant was stunted and wilted. Nematodes on the roots were too numerous to quantify, and secondary and tertiary roots were almost entirely absent. The coffee seedlings at 3 months had vigorous, healthy root systems. Only seven *R. reniformis* females were found on the eight root systems and only one individual had produced eggs.

In addition, volunteer coffee seedlings were found growing in a banana plantation in which the soil was infested with about 200 *R. reniformis* per 50 cm^3. The coffee had grown from seeds fallen from an adjacent commercial coffee planting of unknown variety. Careful examination of the roots of six of these seedlings revealed no reniform nematodes.

In the small-plot trial, *M. incognita* juveniles averaged 85 per 250 cm^3 of soil sampled at the time coffee seedlings were planted and decreased to 3 per 250 cm^3 3 months later. Coffee seedlings of four cultivars were growing vigorously with extensive root systems. We conclude that *M. incognita* will not be a serious pest of coffee in Hawaii.

In conclusion, surveys of coffee plantations in Hawaii in land previously cropped to sugarcane or pineapple showed that no serious nematode problem exists as a result of nematodes associated with the latter two crops. When coffee was planted where sugarcane was grown previously, a general trend of a reduction in species diversity was observed.

LITERATURE CITED

1. Barker, K. R., J. L. Townshend, G. W. Bird, I. J. Thomason, and D. W. Dickson. 1986. Determining nematode population responses to control agents. Pp. 283–296 *in* K. D. Hickey, ed. Methods for evaluating pesticides for control of plant pathogens. St. Paul, MN: American Phytopathological Society Press.

2. D'Sousa, G. I. 1965. Problems in coffee nematology in South India. Indian Coffee 29:22–23.

3. Endo, B. Y. 1959. Responses of root-lesion nematodes, *Pratylenchus brachyurus* and *P. zeae*, to various plants and soil types. Phytopathology 49:417–421.

4. Esbenshade, P. R., and A. C. Triantaphyllou. 1985. Use of enzyme phenotypes for identification of *Meloidogyne* species. Journal of Nematology 17:6–20.

5. Flores, J. M., and G. Yepez T. 1969. *Meloidogyne* in coffee in Venezuela. Pp. 251–256 *in* J. E. Peachey, ed. Nematodes of tropical crops. Technical Communication No. 40. St. Albans, UK: Commonwealth Bureau of Helminthology.

6. Holtzmann, O. V. 1968. Plant–nematode association previously unreported from Hawaii. Plant Disease Reporter 52:515–518.

7. Kumar, A. C. 1984. The symptoms and diagnosis of the disorder, 'spreading decline' (cannoncadoo dieback) with a note on spread and control of the causal agent, *Pratylenchus coffeae*. Journal of Coffee Research 14:156–159.

8. Kumar, A. C. 1988. Nematode problem of coffee and its management. Indian Coffee 52:12–19.

9. Lordello, L. G. E. 1972. Nematode pests of coffee. Pp. 61–67 *in* J. M. Webster, ed. Economic nematology. New York: Academic Press.

10. Negron, J. A., and N. Acosta. 1987. Studies on host–parasite relationships of *Meloidogyne incognita*

and *Coffea arabica* cv. Borbon. Nematropica 17:71–78.

11. Roman, J. 1964. Immunity of sugarcane to the reniform nematode. Journal of Agriculture of the University of Puerto Rico 48:162–163.

12. Schenck, S., and O. V. Holtzmann. 1990. Evaluation of potential problems in a changing agricultural system: Nematode control in Hawaiian crops. Plant Disease 74:837–843.

13. Schieber, E. 1966. Nematodos que atacan al cafe en Guatemala, su distribución, sintomatologia y control. Turrialba 16:130–138.

14. Stoyanov, D. 1967. Additions to host records of *Meloidogyne* sp., *Helicotylenchus multicinctus* and *Rotylenchulus reniformis*. Nematologica 13:173.

15. Whitehead, A. G. 1969. Nematodes attacking coffee, tea and cocoa, and their control. Pp. 238–250 *in* J. E. Peachey, ed. Nematodes of tropical crops. Technical Communication No. 40. Commonwealth Bureau of Helminthology, St. Albans, UK.