OCCURRENCE OF *MELOIDOGYNE* SP. AND *PRATYLENCHUS* SP. IN CONVENTIONAL AND ORGANIC COFFEE SYSTEMS IN NICARAGUA

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ABSTRACT

Herrera, I., T. Bryngelsson and A. Monzón. 2011. Occurrence of *Meloidogyne* sp. and *Pratylenchus* sp. in conventional and organic coffee systems in Nicaragua. Nematropica 41:82-90.

Conventional and organic coffee management systems can have a significant impact on soil biota. Plant-parasitic nematodes are important members of the soil biota community and they may be affected by management practices. The main objective of this study was to compare the effect of coffee management systems, shade trees and no shade trees on the population of *Meloidogyne* sp. and *Pratylenchus* sp. associated with coffee cultivation in Nicaragua. Five management systems, resulting from the combination of input levels and shade species were evaluated. The management systems were conventional with shade from nitrogen fixer species, conventional with shade from non nitrogen fixer species, conventional with no shade, organic with shade from nitrogen fixer species and organic with shade from non nitrogen fixer species. Soil samples were collected from June 2006 to February 2008, during the rainy and dry seasons. *Meloidogyne* sp. and *Pratylenchus* sp. were present in all five managements systems. The population of *Meloidogyne* sp. was significantly lower in the organic management with shade from non nitrogen fixer species than in conventional management with shade from nitrogen fixer. The population of *Meloidogyne* sp. in conventional management with no shade (open sun) and organic management with shade from non nitrogen fixer were similar. The population of *Pratylenchus* sp. was lower than the *Meloidogyne* sp. population in all five management systems. Higher densities of *Pratylenchus* were observed in conventional and organic management where non nitrogen fixer shade species were present. Lower densities of *Pratylenchus* sp. were found in conventional and organic management with shade from nitrogen fixer species, and in conventional management with no shade (open sun). The occurrence of *Meloidogyne* and *Pratylenchus* spp. was significantly affected by shade conditions and input levels, with different response from both genera; therefore these factors should be regarded when designing programs for integrated pest management of nematodes in Nicaraguan coffee plantations.

Key Words: coffee management systems, *Meloidogyne*, conventional, organic, *Pratylenchus*, shade cultivation.

RESUMEN

Herrera, I., T. Bryngelsson and A. Monzón. 2011. Ocurrencia de *Meloidogyne* sp. y *Pratylenchus* sp. en sistemas de manejo convencional y orgánico en el cultivo de café en Nicaragua. Nematropica 41:82-90.

La prácticas de manejo de café utilizadas en sistemas de producción convencional y orgánico pueden tener un impacto significativo en la comunidad de organismos vivos del suelo. Los nematodos fitoparásitos como miembros importantes de esta comunidad pueden ser afectados por dichas prácticas de manejo. El principal objetivo de este estudio fue comparar el efecto de los sistemas de manejo de café, incluyendo el nivel de insumos y el tipo de sombra sobre la población de *Meloidogyne* sp. y *Pratylenchus* sp. asociados al cultivo de café en Nicaragua. Se evaluaron cinco sistemas de manejo, resultantes de la combinación de los niveles de insumo y tipos de sombra. Los sistemas de manejo fueron convencional con sombra de especies fijadoras de nitrógeno, especies no fijadoras y sin sombra, así como manejo orgánico con sombra de especies fijadoras de nitrógeno y especies no fijadoras. Las muestras de suelo se obtuvieron entre Junio 2006 y Febrero 2008, durante la época lluviosa y la época seca. Los resultados revelaron la presencia de *Meloidogyne* sp. y *Pratylenchus* sp. en todos los sistemas de manejo evaluados. La población de *Meloidogyne* sp. fue significativamente menor en el sistema de producción orgánico con sombra de especies no fijadoras de nitrógeno que en el sistema de producción convencional con sombra de especies fijadoras de nitrógeno. La población de *Meloidogyne* sp. en el sistema de producción convencional sin sombra (pleno sol) fue similar a la encontrada en el sistema de producción orgánico con sombra de especies no fijadoras de nitrógeno. La población de *Pratylenchus* sp. fue inferior a la población de *Meloidogyne* sp. en todos los sistemas de manejo evaluados. Las mayores densidades poblacionales de este nematodo se observaron en el sistema de producción convencional y orgánica con sombra de especies no fijadoras de nitrógeno. Las menores poblaciones de *Pratylenchus* sp. fueron encontradas en los sistemas de producción convencional y orgánico con sombra de especies fijadoras de nitrógeno y en el sistema de producción convencional sin sombra. Los sistemas de manejo de café, afectaron significativamente y de forma diferente las poblaciones de *Meloidogyne* sp y *Pratylenchus* sp. Con base a estos resultados y considerando la importancia de estos nematodos para el cultivo de café, los factores de sombra y nivel de insumo deben ser considerados al diseñar programas de manejo

Palabras clave: convencional, *Meloidogyne* sp., orgánico, *Pratylenchus* sp., sistemas de manejo de café, café con sombra

INTRODUCTION

Coffee (*Coffea* spp.) is an economically important crop for several countries, e.g. Brazil, Vietnam, Colombia, Indonesia, Ethiopia, Costa Rica and Nicaragua (IICA-PROMECAFE, 1997; Ferraz, 2008). In Nicaragua, coffee production is one of the most important activities in the economy of the country. Coffee represents about 25% of Nicaragua´s exports and is one of the main sources for employment representing up to 63 % of all employees in the rural areas and approximately 13% in the country as a whole (MIFIC, 2005). Coffee production is affected by several limiting factors such as parasitic nematodes, insect pests and fungal diseases (Soto-Pinto *et al.*, 2002).

Plant-parasitic nematodes are a major limiting factor in coffee production and worldwide coffee losses have been estimated to yields by 15% (Campos *et al*., 1990). The major species affecting the crop are *Pratylenchus* sp. and *Meloidogyne* sp. (Villain *et al.*, 2000; Barbosa *et al*., 2004). Damage by these nematodes has been reported throughout the world, especially in Latin America (Campos *et al.*, 1990; Anzueto, 1993; Villain *et al.*, 2002) and Central America (Fernández, 1968), where nematodes of these two genera are often found parasitizing the coffee tree simultaneously (Villain *et al.*, 2002).

In the past 20 years the impact on the nematode community has increased due to intensified cultivation through the use of higher-yielding varieties planted at high densities (Villain *et al.*, 1999) and reduced or absence of shade trees (Villain *et al.*, 2002).

The coffee cultivation systems in Nicaragua vary from traditional systems where coffee is grown at high shade densities with limited external inputs to intense management where coffee is grown at high density, in open sun and with high use of agrochemicals (Perfecto *et al.*, 1996). Where agrochemical inputs are available, shading is not used for coffee cultivation, whereas in areas with more intense solar radiation, the use of shade trees is considered beneficial as the shade decrease exposure of coffee plants to extreme heat or cold, reduces wind speed, controls erosion, and helps maintain soil fertility (Beer *et al*., 1998; Somarriba *et al*., 2004).

Within shaded coffee systems, organic production represents a new market for farmers and an opportunity to increase their income. Factors such as biological conservation, low environmental impact, environmental services (e.g. water and soil conservation, carbon sequestration) and the fall of international coffee prices have placed organic coffee in a preferential position in the market over coffee produced with conventional practices (Beer *et al*., 1998; Somarriba *et al*., 2004).

Management practices in tropical agroecosystems have a significant impact on soil macrofauna communities, microbial biomass and soil organic matter content (Lavelle *et al*., 2001).These factors are essential for the maintenance of soil fertility and sustainable agricultural production in tropical regions through their influence on soil biological, physical and chemical properties (Scholes *et al*., 1994; Lavelle *et al*., 2001). These properties may also be affected in soils of coffee plantations where management practices, such as input levels and changes in shade levels and species are frequently used.

The maintenance of high levels of organic matter by shade trees might help to stabilize the plant-parasitic nematode population (*Meloidogyne* sp. and *Pratylenchus* sp.) below damaging levels in coffee (Araya, 1994). Similarly, the reduction in environmental stress provided by shade may increase the tolerance of coffee plants to infection by nematodes (OFICAFE, 1978).

In tropical countries such as Nicaragua where coffee export is a critical component of the country's economy, interest in improving the sustainability of coffee production is increasing among producers (Somarriba *et al*., 2004). Sustainability can be achieved by a better understanding how biological interactions occur in different coffee agroecosystems. Few studies, however, have focused on evaluating the effect of the management system on the population of plant-parasitic nematodes in coffee. The objective of this study was to compare the effect of different coffee management systems and shade trees on the population of *Meloidogyne* sp. and *Pratylenchus* sp. in Nicaragua.

MATERIALS AND METHODS

Field and experimental design

The study was conducted from 2006 to 2008 in experimental coffee fields established in Jardín

Botánico and Campos Azules, Municipality of Masatepe, Province of Masaya, Nicaragua. Jardín Botánico is located at 11°53´50´´N, 86° 08´55´´W 463 m.s.l. and about 5 km from Campos Azules which is located at 11° 52´00´´N, 86° 09´44´´W and 493 m.s.l. Both locations have similar agroecological conditions. The average annual precipitation in this zone is 1400 mm, the mean annual temperature is 24°C and the relative humidity is 70-80%. This zone is regarded as a dry and low elevation zone (Guharay *et al*., 2000).

The experiments were arranged in a randomized block design with two replicates in Jardín Botánico and one replicate in Campos Azules. Plot size was 800 square meters and plot management was the same in the two sites. The coffee variety used was Pacas, planted at a density of 4000 plants per hectare. Five management systems were evaluated: Conventional with shade from nitrogen fixer species (*Inga laurina* and *Samanea saman*), conventional with shade from non nitrogen fixer species (*Tabebuia rosea* and *Simarouba glauca*), conventional with no shade, organic with shade from nitrogen fixer species and organic with shade from non nitrogen fixer species.

In the conventional management, nutrients were supplied by synthetic fertilizers, and pests were controlled with insecticides, fungicides and herbicides. In the organic management, organic matter was used (chicken manure and coffee pulp) to supply nutrients and undesired herbaceous vegetation was removed manually. Insects and fungal diseases were not controlled (Table 1).

Nematode sampling and extraction

Soil samples were collected in June 2006 and February 2007 as well as June 2007 and February 2008, during the rainy (June) and dry (February) seasons. Five composite samples were randomly taken per plot at each sampling date. Samples were collected with a garden spade after removing surface litter. Each sample consisted of approximately 1 kg soil taken from 5 adjacent trees in a circle of 15 cm from the coffee tree stem and 15 cm deep. Each sample was placed in a plastic bag, labeled and taken to the laboratory for extraction. From each sample, 200 g of soil was used for extraction of nematodes.

The extraction method used was sieves and cotton filter (75 µm pore size) (Herrera and Biljmakers, 1993). Soil was mixed and homogenized in 1 l of water. After 20 s, the supernatant was filtered through a set of extraction sieves (0.425, 0.25, 0.1 and 0.045 mm pore diameter). This step was repeated three times. The soil retained in the 0.1 and 0.045 mm pore sieves was poured in an extraction sieve with cotton filter and placed in an extraction dish containing 100 ml of water for 24 hours. After extraction, 30 ml of the resulting solution

Table 1. Fertilizers, herbicides, fungicides, biological control and organic matter applied in the experimental coffee management systems, during 2006 - 2008, Municipality of Masatepe, Department of Masaya.

	Input levels	
Management	Organic	Conventional
Soil fertilization	Coffee pulp (2 kg/tree) twice per year Chicken manure (1.5 kg/tree) twice per year	Chemical fertilizers: In July: 27-9-18, 33 g/plant In August: 12-30-10, 70 g/plant. In November: 46-0-40, 40g/plant.
Foliar fertilization	No application	Micro elements Boron: 1.25 g/L; Zinc: 1.5 g/L; Urea: 5.6 g/L; Application: March and July
Management of diseases	No application	Fungicides One preventive application of Cooper Nordox: 2.5 g/L, Systemic fungicides: Anvil, 3 ml/1 L. Three applications in June, August and October. The applications were based on threshold (10% incidence of coffee leaf spot and rust)
Management of insects	Biological control: *Beauveria bassianna* 57 g per hectare, first application in July, Second application in September	Endosulfan: 0.2 ml/L
Management of weeds	Manual control, 2-4 times/season times/season	Herbicides: Glyphosate + Flex, 0.2 ml of each in 1 L

was used to determine the number of nematodes by direct counting with a dissecting microscope. The numbers of *Pratylenchus* sp. and the second stage juveniles (J2) of *Meloidogyne* sp. were recorded. Identification of *Meloidogyne* sp. and *Pratylenchus* sp. at the genus level was based on mmorphological characteristics (C. I. H., 1972). Light microscopy was used for this analysis. Other plant-parasitic nematodes such as *Helicotylenchus* sp., *Criconemoides* sp., and *Xiphinema* sp. were also found in the samples, but they were not included in this analysis.

Statistical analysis

The number of nematodes per 200 g of soil was tested for normality by the Kruskal-Wallis test (Infostat, 2009). Due to lack of normality, the data were submitted to logarithmic transformation. A two-way ANOVA test, using a split plot approach (PROC GLM) was used to compare population levels between treatments and between sampling dates. Means were compared using the least significant difference (LSD) when statistical differences between treatments or between sampling dates were detected. Number of nematodes obtained from each plot during the sampling dates was averaged to obtain the means per treatment. In addition, linear contrasts were performed to compare the effect of shade versus no-shade, and to compare organic management versus conventional management on the population of *Meloidogyne* sp. and *Pratylenchus* sp. All statistical analyses were performed using SAS Version 9.1 (SAS Institute Inc. 2003), and the significance level was set at $\alpha = 0.05$.

RESULTS

Effect of coffee management on Meloidogyne sp. population

The number of *Meloidogyne* J2 was significantly different in the coffee management systems ($P<0.0036$; Table 2), and varied significantly between sampling dates ($P<0.0001$; Table 3), but no significant interactions were found. The mean population in the organic management system with shade from *T. rosea* and *S. glauca* was 2337 nematodes/200 g soil and was significantly lower ($P < 0.0036$) compared to conventional management with shade from *I. laurina* and *S. saman* where the mean population was 4216 nematodes/200 g soil . No significant differences were found between conventional management without shade (open sun) and conventional management with shade from *T. rosea* and *S. glauca*. The population was significantly lower ($P<0.0008$) in samples collected from plots with organic management compared to conventional management. When the population of *Meloidogyne* sp. from plots with open sun was compared to plots shaded with both nitrogen fixing

Table 2. Effect of coffee management systems on the occurrence of *Meloidogyne* sp. and *Pratylenchus* sp. during 2006-2008. Municipality of Masatepe, Department of Masaya.

		Nematodes/200 g of soil			
		Meloidogyne sp.		*Pratylenchus* sp.	
Coffee management	Shade type	Mean (n=60)	LSD (α=0.05)	Mean (n=60)	LSD (α=0.05)
Conventional	*Tabebuia rosea*[z] and *Simarouba glauca*[z]	3470	ab	161	a
	Inga laurina[z,x] and *Samanea saman*[y,x]	4216	a	87	b
	No shade	3936	a	54	b
Organic	*Inga laurina*[z,x] and *Samanea saman*[y,x]	2824	ab	70	b
	Tabebuia rosea[y] and *Simarouba glauca*[z]	2337	b	157	a

[z]Evergreen; [y]Deciduos; [x]Nitrogen fixer

Table 3. Population of *Meloidogyne* sp. in the experimental coffee management systems, during the sampling period, Municipality of Masatepe, Department of Masaya.

Sampling date	Mean (n=75)	LSD (α=0.005)
June 2006	2423	a
February 2007	4051	b
June 2007	491	c
February 2008	6461	d

Table 4. Statistics of linear contrast test for the population of *Meloidogyne* sp. and *Pratylenchus* sp. in coffee management systems, during the sampling period 2006-2008, Municipality of Masatepe, Department of Masaya.

	Meloidogyne sp.		*Pratylenchus* sp.	
	F value	*P value*	*F value*	*P value*
Conventional and organic shaded systems vs. Conventional with no shade	1.17	0.2801	42.99	0.0001
Conventional wit nitrogen fixer vs. non fixer shade	2.08	0.1500	72.36	0.0001
Organic with nitrogen fixer vs. non fixer shade	1.18	0.2785	63.43	0.0001
Organic vs. Conventional management	11.57	0.0008	0.38	0.5383

and non nitrogen fixing species in both organic and conventional management no significant differences were found. There was no significant difference in population size of *Meloidogyne* sp. in soil samples from coffee grown with nitrogen fixing shade trees and non nitrogen fixing species.

The mean population of nematodes varied over the season with significant differences between sampling dates (P<0.0001; Table 3). The largest population was 6461 nematodes/200 g soil and was found in samples collected during the dry season in February 2008. The smallest population size was 492 individuals/200 g soil and was found in samples collected in June 2007.

The contrast analysis showed that there was an effect of the conventional management and organic management on the population of *Meloidogyne* sp. (P<0.0008). However, there was no effect on the nematode population when organic and conventional management with nitrogen fixer shade and non fixer shade was compared within management systems. When data from shaded systems from both organic and conventional management was compared to open sun conventional management no significant differences were found (Table 4).

Effect of coffee management on Pratylenchus sp. population

The population of *Pratylenchus* sp. varied significantly between the coffee management systems (P<0.0001; Table 2). The population size in conventional management in open sun was 54 nematodes/200 g soil and was significantly lower than the other management systems. Conventional and organic management with shade from *T. rosea* and *S. glauca*, were statistically similar and they showed the highest densities of *Pratylenchus*. Conventional management with *I. laurina* and *S. saman* and organic management with *I. laurina* and *S. saman* showed low densities of this genus and were statistically similar to the conventional management with no shade.

The contrast analysis showed that there was a significant difference between the effect of conventional and organic shaded systems and conventional management open sun on the population of *Pratylenchus* sp. (P<0.0001). Similarly, in conventional management, the population of this nematode was significantly lower in plots with shade of nitrogen fixer species than in plots with shade of non fixer (P<0.0001). We also found that the population of *Pratylenchus* sp. was significantly different between nitrogen fixer and non fixer shade species in organic management (P<0.0001). However, there was no differences between organic and conventional management (P=0.5383; Table 4).

The population of *Pratylenchus* sp. observed during the study period showed low density levels compared to the *Meloidogyne* population and there were no differences between sampling dates, and no significant interactions were found.

DISCUSSION

In this study, we found the two major groups of parasitic nematodes on coffee, *Meloidogyne* and *Pratylenchus*, in all five coffee management systems. The population densities were different between coffee management systems, and *Meloidogyne* sp. was the predominant species compared to the population of *Pratylenchus* sp. There are few published studies on plant-parasitic nematodes and their presence in Nicaraguan coffee management systems. Rosales *et al.* (1991) and Herrera and Marbán-Mendoza (1999), reported the presence of *Meloidogyne* sp. and *Pratylenchus* sp. associated with coffee in the South Pacific coffee growing zone of Nicaragua. These nematodes have also been reported in the northern coffee region of the country (García and Pantoja, 1990). *Meloidogyne* and *Pratylenchus* sp. are often found attacking the coffee tree simultaneously, *Meloidogyne* sp. being the predominant species (Rosales, 1995). Predominance of *M. paranaensis* and *M. exigua* over *P. coffea* has also been reported in coffee plantations in Guatemala (Hervé *et al.*, 2005). The reduced populations of *Pratylenchus* sp. found in our study, correlated to higher population densities of *Meloidogyne* sp., suggesting competition between these two genera. Several studies report competition between *Meloidogyne* and *Pratylenchus* with predominance of *Meloidogyne* (Umesh *et al*., 1994) and biological aspects that explain the greater competitive ability of *Meloidogyne* have been mentioned (Chapman and Turner, 1975). These results support the findings of our study, where *Meloidogyne* sp. was predominant in all coffee management systems, suggesting that *Meloidogyne* is dominant over *Pratylenchus* when both genera are present.

The coffee management system had a significant impact on the nematodes. *Meloidogyne* sp. was predominant in the conventional management system with no shade (open sun), which could indicate that the population of this nematodes is favored by this management system. In contrast, the population of *Pratylenchus* sp. had low densities in this management system. Results reported by Cruz *et al*. (1998) in coffee plantations in the South Pacific coffee growing zone of Nicaragua, found high populations of *Meloidogyne* sp. in coffee plantations growing in sunny condition. One possible factor influencing the high density of *Meloidogyne* sp. and low density of *Pratylenchus* sp. in the conventional open sun system is the temperature requirement of the species. While *Meloidogyne* is favored by higher temperatures, and is less tolerant to low temperature (Souza and Bressan-Smith, 2008), *Pratylenchus* sp. seems to be adapted to a wider range of temperature fluctuations (Inomoto and Oliveira, 2008), but with less capacity of competition (Chapman and Turner, 1975). Direct solar radiation in open sun plots may increase soil temperature providing conditions favorable to the development of *Meloidogyne* sp. The results of our study indicate that the combination of type of management and shade can influence the occurrence of important plant-parasitic nematodes.

In our study, the high populations of *Meloidogyne* sp. found in conventional management compared to organic management suggest that the occurrence of this nematode is more related to input levels than to type of shade. In the case of *Pratylenchus* sp., similar densities were found in both conventional and organic management and differences found between shade species suggest that the density of this nematode is more related to the type of shade trees than to input levels. Although the relevance of pests and diseases interactions with agroforestry systems was recognized many years ago (Epila, 1986; Huxley *et al*., 1989), few specific studies have been done on such interactions. Hence there is little available information that can explain our results on the presence of plant-parasitic nematodes in coffee plantations under conventional management. Staver *et al*. (2001) mentioned that coffee production in conventional systems with high yield cultivars in open sun creates favorable conditions for numerous pests which were previously uncommon in shaded coffee. Villain *et al.* (1999) report that reducing shade in coffee plantations results in reduction of organic matter and therefore decline of soil organic matter (SOM). This has been linked to increased nematode damage which may be particularly accentuated on the often smaller and less vigorous root systems of the coffee varieties. Carcache (2002) reported that the population of *Meloidogyne* and *Pratylenchus* in coffee plantations in Costa Rica were high in conventional coffee management compared to organic coffee management. In our study, this result was very clear in the case of *Meloidogyne* sp, but not in the case of *Pratylenchus*, which showed different behavior in conventional and organic coffee management. Therefore our results are only partially supported by earlier results.

Regarding the effect of shade species on plant-parasitic nematodes, we found that the population of *Meloidogyne* sp. was increased by shade from *I. laurina* and *S. saman* in conventional management systems, whereas *Pratylenchus* sp. showed similar densities in both organic and conventional management shaded by *T. rosea* and *S. glauca*. Reports in the literature about shade effect on plant-parasitic nematodes are not consistent. Beer *et al.* (1990) found that the SOM content may increase with time in agroforestry systems of coffee and cacao under pruned leguminous *Erythrina poeppigiana*, compared with unpruned non leguminous *Cordia alliodora*. According to Araya (1994), the maintenance of high SOM levels by shade trees might help to stabilize *Meloidogyne* and *Pratylenchus* sp. populations below critical levels. At the same time, the reduction of environmental stress provided by shade increases the tolerance of coffee plants to infection by these nematodes (OFICAFE, 1978). Abundant litter produced in shaded coffee plantations can increase the microflora and microfauna antagonists to plant-parasitic nematodes (Stirling, 1991). Higher diversity of nematodes, including predators has been reported from shaded coffee, compared to open sun under conventional management, where less diversity, no predator nematodes and higher densities of *Meloidogyne* sp. has been found (Cruz *et al*., 1998). However, shade species could have the opposite effect. *Inga* sp. for example, has been identified as alternative hosts for coffee nematodes (Zamora and Soto, 1976; Aragón *et al*., 1978) but it is not clear whether this would actually increase or decrease the nematode pressure on coffee.

Today the effects of shade cover on coffee pests, diseases and yield are less clear. Some authors have reported an increase in pest problems and disease with increasing light (Wrigley, 1988) while others have reported the opposite (Eskes, 1982). According to our results, it seems that there is a possible effect of the shade trees on the population of *Meloidogyne* sp. and *Pratylenchus* sp. The effect of each type of shade tree was different on each nematode group. *Meloidogyne* showed higher densities under nitrogen fixer shade trees while *Pratylenchus* showed higher densities in non nitrogen fixer shade trees. Many factors might be influence the *Meloidogyne* and *Pratylenchus* dynamic population under these conditions. Based on our results, we can assume that the presence of alternative hosts may be harmful to coffee due to an increase of the population size of plant-parasitic nematodes.

Taking into account that coffee is a perennial crop and nematodes are soil dwelling pests, host status studies need to be conducted to determine the role of shade tree species in coffee plantations affected by these nematodes.

Organic coffee management systems with non nitrogen fixer shade species had the lowest densities of the *Meloidogyne* sp. population. These results suggest that management practices used in organic coffee systems can reduce the population of this nematode. Stirling (1991) mentioned that the addition of organic matter to soil infected by plant-parasitic nematodes is a satisfactory control method. In our study, coffee pulp and chicken manure was periodically applied every year during nine consecutive years in the organic coffee management systems, and these applications could reduce the population of *Meloidogyne* sp. D´Addabbo (1995) reported that the incorporation of agro-industrial wastes such as coffee pulp in the soil might represent a way to control nematodes. However, little information on the effect of coffee pulp on nematodes is available. The mechanism of the effect of organic matter on the nematode population is not fully understood, but direct and indirect effects are suggested. Monterroso and Calderón (1994), studying the effect of coffee pulp on leaf spot (*Cercospora coffeicola*) and nematodes, found that the effect of coffee pulp could be improved nutrition to the coffee plant rather than direct control of plant-parasitic nematodes and leaf spot. The effect of chicken manure to the soil has been well documented. Rodríguez-Kábana (1986), reported that the addition of organic soil amendments, in particular those with high nitrogen contents, may be effective alternatives for control of *M. arenaria*, *M. chitwoodi* and other plant-parasitic nematodes. The nematode suppressive effect of organic matter such as chicken litter has been attributed to the nitrogen content, particularly to the release of ammoniacal nitrogen and to the enhance the amount of microbial populations that have harmful effects on plant-parasitic nematodes (Kaplan and Noe, 1993). Our results are supported by Samayoa (1999), who found lower populations of *Meloidogyne* sp. in organic than in conventional coffee plots in Costa Rica, suggesting that the level of soil organic amendment provided by chicken manure and coffee pulp in organic management could affect the population's size of plant-parasitic nematodes present in coffee plantation.

During the period studied, the highest *Meloidogyne* population densities were observed in samples collected in February and low densities were observed in samples collected in June. No differences were observed between the sampling dates for the *Pratylenchus* populations. These results could be due to the low densities of this group during the study period. Nematode population dynamics are influenced by the soil moisture and as nematodes are ectothermic and aquatic animals they are confined to the water film surrounding soil particles (Freckman *et al*., 1987). The high population of *Meloidogyne* observed in February could be related to the soil moisture present from the previous rainy season. The soil humidity could also have an effect on root growth dynamics in the coffee plantations (Inomoto and Oliveira, 2008; Villain *et al*., 2008). Our results indicate that *Meloidogyne* is building up its population as long as the rainfall season progress. Similar results were found by Cruz *et al.* (1998) in the same coffee growing zone. Nevertheless, the mechanisms that can explain the relationship between nematodes and the amount of precipitations is still unknown (Mc Sorley, 1997).

In summary, this study demonstrates that *Meloidogyne* sp. and *Pratylenchus* sp. are present in both organic and conventional coffee management systems and that *Meloidogyne* sp are predominant. The occurrence of these nematodes is significantly affected by the farming system. The largest population of *Meloidogyne* sp. is associated to conventional coffee management systems where nitrogen fixer shade species are present or under sunny conditions. *Pratylenchus* sp. occurred at low densities when coffee is grown under sunny conditions. The largest population of *Pratylenchus* was in conventional and organic coffee management systems where nitrogen fixer shade species are present. This different response of *Meloidogyne* sp. and *Pratylenchus* sp. to shade species should be considered when designing programs of integrated pest management for this crop.

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