Prevalence and Farmers' Perceptions of Parasitic Nematodes in Yam Rhizosphere Soils from some Yam Producing Areas of Ghana

K. Osei.[1†], R. T. Awuah [2], M. A. Tabil [3] and J. S. Asante [1]
[1]Crops Research Institute, P. O. Box 3785, Kumasi, Ghana.
[2]Dept. of Crop Science, KNUST, Kumasi, Ghana.
[3]Dept. of Horticulture, University for Development Studies, Box 1350, Tamale, Ghana.
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Résumé

Osei, K., Awuah, R. T., Tabil, M. A. & Asante, J. S. *La Predominance et des Perceptions des Paysans Envers les Nematodes Parasitiques dans les Sols Rhizopheriques de L'igname. Etude de Cas de Quelques Zones de Culture De L'igname au Ghana.* Des échantillons des sols rhizopheriques de l'igname d'Adidwan, Ejura, Kintampo, Mampong, Nkoranza et Techiman dans la zone transitionelle agro-écologique du Ghana et des tubercules d'ignames du Marché de Techiman ont été analysés pour déterminer la présence des nématodes des parasitiques des plantes en août et septembre 2002. Des cultivateurs des ignames dans les zones ont été échantillonnés en utilisant des questionnaires pour déterminer leur perception sur les nématodes. Treize genres des nématodes ont été identifiés dans les échantillons du sol rhizophérique de l'igname. Ce sont *Aphelenchoides*, *Criconemella*, *Helicotylenchus*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Paratylenchus*, *Pratylechus*, *Rotylenchulus*, *Scutellonema*, *Trichodorus*, *Tylenchus* et *Xiphinema*. Parmi ce groupe, *Aphelenchoides*, *Meloidogyne*, *Paratylenchus*, *Pratylenchus* et *Rotylenchulus* étaient présents dans toutes les six zones de culture de l'igname. Le genre le plus fréquemment détecté était *Paratylenchus* (21,8% en abondance relative) et le moindre était *Longidorus* (0,4%). Tous les tubercules des ignames achetées du marché étaient infectés par nématodes parasitiques comme *Meloidogyne*, *Paratylenchus* et *Scutellonema*. Parmi ces nématodes, *Paratylenchus* était le plus fréquemment recouvert. Les paysans avaient des pauvres perceptions à propos de nématodes de l'igname. A part Techiman et Ejura où 40% et 10% respectivement des cultivateurs de l'igname savaient quelque chose à propos de nématodes, les cultivateurs des autres zones ne savaient rien à propos du parasite. Les matériaux des cultivateurs n'ont pas été traités pour le contrôle des nématodes.

Mots clés : L'igname, *Dioscorea*, nématodes parasitiques des plantes, sol rhizophérique, zone transitionnelle agro- écologique.

Abstract

Rhizosphere soil samples of yam from Adidwan, Ejura, Kintampo, Mampong, Nkoranza and Techiman, in the transitional agro-ecological zone of Ghana, and yam tubers from Techiman market were analysed for the presence of plant parasitic nematodes in August and September, 2002. Yam farmers from the areas were also surveyed using questionnaire to determine their perceptions of nematodes. Thirteen genera of nematodes were identified in

[†]*Corresponding author*

the yam rhizosphere soil samples. These were *Aphelenchoides, Criconemella, Helicotylenchus, Hoplolaimus, Longidorus, Meloidogyne, Paratylenchus, Pratylenchus, Rotylenchulus, Scutellonema, Trichodorus, Tylenchus* and *Xiphinema.* Of these, *Aphelenchoides, Meloidogyne, Paratylenchus, Pratylenchus* and *Rotylenchulus* were found in all the six yam-growing areas. The most frequently detected genus was *Pratylenchus* (21.8% relative abundance) and the least was *Longidorus* (0.4%). All yam tubers purchased from the market were infected by parasitic nematodes such as *Meloidogyne, Pratylenchus* and *Scutellonema* with *Pratylenchus* being the most frequently recovered. Farmers had poor perceptions of yam nematodes. Apart from Techiman and Ejura where 40 and 10%, respectively, of yam farmers knew about nematodes, farmers from the remaining areas did not know about the pest. Planting materials were not treated for control of nematodes.

Keywords: Yam, *Dioscorea*, plant parasitic nematodes, rhizosphere soil, transitional agro-ecological zone.

Introduction

Yam (*Dioscorea* spp.) is a major source carbohydrate for most people in West and Central Africa (Okoli and Onwueme, 1987). In Ghana, yam is a major cash and food security crop (FAO, 1990). The crop is cultivated mainly in the Afram plains, the three northern regions, Brong Ahafo region and the Ashanti region. The social importance of yam in Ghana is indicated by Coursey and Coursey (1971) who stated that in the eighteenth century, the king of Ashanti instituted the "New Yam Festival" to demonstrate the indispensability of the crop. This festival is celebrated today in most parts of Ghana in variant forms. Globally, some *Dioscorea* spp. are commercially grown to provide a source of diosgenin used in the manufacture of oral contraceptives, sex hormones and cortisone (Kay, 1987).

A major constraint to yam production and marketing is nematode infestation (Adesiyan and Odihirin, 1987). Economically important nematodes are endoparasites of roots and tubers. Prominent amongst these nematodes are *Scutellonema bradys*, *Pratylenchus coffeae* and *Meloidogyne* spp. (Jatala and Bridge, 1993). Nematodes cause direct damage to yam tubers in the form of dry rot or necrosis, cracks, corkiness, and galls (Bridge and Page, 1984). Tubers with symptoms of nematode infection have low market value because, apart from the unsightly appearance, infected tubers have reduced weights. Yield loss of 30% due to tuber infection by nematodes has been reported in Nigeria (Wood *et al.*, 1980).

Yams may be intercropped with cereals, vegetables or legumes (Singh *et al.*, 1986). Selection of wrong intercrops can be detrimental to yams as far as nematode infection is concerned. Atu and Ogbuji (1986) for example, reported

that intercropping crops that are highly susceptible to *Meloidogyne* such as okra (*Hibiscus esculentus*) and pumpkin (*Cucurbita pepo*) with yam increases damage to yam tubers by *M. incognita*.

For sustainable yam production, plant parasitic nematodes need to be managed without much damage to the environment. Proper identification of nematodes associated with yam rhizosphere soils and their populations are required for studies on their management. In Ghana, such baseline information is scanty. Also lacking is information on farmers' perceptions of plant parasitic nematodes. If farmers are aware of nematodes and are appreciative of their damage to yam tubers, it will greatly facilitate implementation of recommended nematode management strategies.

In the present study, we conducted a survey of nematodes associated with soils of yam rhizosphere at six locations in Ghana and determined farmers' perceptions of parasitic nematodes of yam. We also determined the kinds of nematodes associated with yam tubers sold in the market.

Materials and methods

Soil samples

In August and September 2002, soils from the rhizosphere of yams were obtained from farms at Adidwan, Ejura and Mampong in the Ashanti Region and Kintampo, Nkoranza and Techiman areas of the Brong Ahafo Region. All the towns are located in the transitional agro ecological zone of Ghana and are major yam growing areas.

Soils from the rhizosphere of yam were taken from five mounds randomly selected and three samples of approximately 200 ml were taken from the root zone of the plant with a clean hand trowel. The soil samples were bulked in a black polyethylene bag into a composite sample from which 10 representative samples of 200 ml were extracted for nematodes using the sieving and filtering method (Hooper, 1993). Each 200 ml soil was passed through 2 sieves to remove all stones and debris. The sample was then spread thinly on a 2-ply tissue paper placed in a plastic basket nested in a shallow plastic tray. About 25ml of water was poured by the side of the basket into the tray. The set up was left for 24 hrs for the nematodes to penetrate the tissue paper and settle in the water in the tray below. The nematode suspension was poured into a beaker, the supernatant siphoned off and the concentrated nematodes killed in warm water at 60 °C, for 3min and fixed with formal acetic acid solution made of 10 ml of 40% formalin, 1 ml glacial acetic acid and 89 ml distilled water. One millilitre of the fixed nematode suspension was placed in a counting dish and the nematodes identified under a stereoscopic binocular and compound microscopes using established standards as reference

(Anon, 1975). They were counted and expressed as number per 200 ml of soil. In all, a total of 60 farms made of 10 from each of the six yam-growing areas were sampled.

Yam tuber samples

To determine the types of nematodes associated with yam tubers, ten tubers were randomly obtained from white yam varieties including Dente, Pona and Larebeko retailed in a local market in Techiman. From each tuber, lesions on the skin suspected to be caused by nematodes were peeled off together with a bit of the underlying tissue and 5 g of the tissue extracted for nematodes as described above.

Farmers' perceptions of nematodes

This was ascertained by interviewing 10 randomly chosen farmers in each of the six areas using a questionnaire which included questions on their knowledge about nematodes, years in farming, treatment of planting material for protection against nematodes and type of treatment, varieties of yam grown, scale of operation and farming system used.

Results

Thirteen genera of nematodes were found associated with soils of the yam rhizosphere in the six yam growing areas surveyed (Table 1). The largest number of genera was recorded at Adidwan and Kintampo (12 each) and the least number of genera (6) was recorded at Mampong. The 13 genera of nematodes encountered belonged to three orders *viz.* Tylenchida (10 genera), Dorylaimida (two genera) and Triplonchida (one genus) (Table 2).

Five genera, *Aphelenchoides, Meloidogyne, Paratylenchus, Pratylenchus* and *Rotylenchulus* occurred in all six areas (Table 1). The Yam nematode, *Scutellonema bradys* occurred in five of the surveyed areas, being absent only from the Mampong area. *Longidorus* was observed only at Adidwan.

The largest number of nematodes per 200 ml of rhizosphere soil was obtained from farms in the Techiman area while the least was obtained at Mampong (Table 1). *Pratylenchus* spp. and *Meloidogyne* spp. were most abundant with each constituting approximately 22% of the total nematode population (Table 2). All the other genera had relative abundance of less than 10%. The least abundant (< 1%) were *Longidorus* and *Xiphinema*. Between *Pratylenchus* and *Meloidogyne*, the former was more abundant in the study areas, occurring in 52 of the 60 farms while *Meloidogyne* occurred in 49 farms (Table 2).

Three nematode species, *Pratylenchus brachyurus, Scutellonema bradys* and *Meloidogyne* spp. were recovered from yam tubers purchased from the market (Fig. 1). The largest population of 225

Table 1. Plant parasitic nematode genera in six yam-growing areas of Ghana.[*]

Nematode genera	*Location*					
	Adidwan	***Mampong***	***Nkoranza***	***Techiman***	***Ejura***	***Kintampo***
Aphelenchoides	16	3	25	41	25	16
Criconemella	0	0	23	0	0	1
Helicotylenchus	34	16	10	29	0	62
Hoplolaimus	16	0	14	19	10	19
Longidorus	7	0	0	0	0	0
Meloidogyne (juveniles)	138	20	59	99	48	43
Paratylenchus	19	4	13	10	39	15
Pratylenchus	72	11	56	131	85	55
Rotylenchulus	23	23	7	26	10	32
Scutellonema	42	0	41	29	8	36
Trichodorus	12	0	24	60	41	38
Tylenchus	13	0	18	17	44	24
Xiphinema	2	0	0	4	0	4
Total genera	**12**	**6**	**11**	**11**	**9**	**12**

[*]*Numbers are mean nematode population counts for four farms at each location. At each farm, four replicate 200 ml rhizosphere soils were assayed.*

nematodes per 5 g yam peel was recorded for *P. brachyurus* and the least of 125 for the *Meloidogyne* spp.

Yam varieties cultivated by farmers included, Dente, Pona, Dundu bansa, Labreko, Leelee which are *D. rotundata* varieties while Matches and Akaba belong to *Dioscorea alata*. Generally, most of the farmers had not been cultivating yam for too long, having grown the crop for between 1 and 10 years. In this category, the highest percentage of 80 was from Mampong and the least of 10 from Techiman (Table 3). In general, Kintampo farmers had been in the yam business for the longest period (21-30 years). No farmer at Adidwan and Mampong had grown yam for that length of time (Table 3). Generally, holdings were at the subsistence level, with farmers cultivating between 1 and 5 hectares of land annually (Table 3). All farmers in the study practiced mixed cropping (Table 3). Yam was intercropped with crops such as okra, cowpea, maize, tomato, pepper, cocoyam and melon. Most farmers were unaware of yam nematodes and treatment of planting material against nematodes was not practiced by any of the farmers (Table 3).

Table 2. Abundance of various plant parasitic nematodes in soils of yam rhizosphere from all 60 farms.

Nematode genera	*Order*	*Population*[1]	*Frequency of occurrence*[2]	*Relative abundance (%)*
Aphelenchoides	Tylenchida	1008	41	6.7
Criconemella	Tylenchida	193	13	1.3
Helicotylenchus	Tylenchida	1208	34	8.0
Hoplolaimus	Tylenchida	626	22	4.2
Longidorus	Dorylaimida	57	6	0.4
Meloidogyne (juveniles)	Tylenchida	3256	49	21.6
Paratylenchus	Tylenchida	802	39	5.3
Pratylenchus	Tylenchida	3283	52	21.8
Rotylenchulus	Tylenchida	970	38	6.4
Scutellonema	Tylenchida	1249	48	8.1
Trichodorus	Triplonchida	1401	36	9.3
Tylenchus	Tylenchida	930	27	6.2
Xiphinema	Dorylaimida	79	16	0.5
Total		**15062**	-	-

[1]Population per 200 ml rhizosphere soil for 60 farms in six areas.
[2]Number of farms where the nematodes were encountered.
[3]Ratio of genera encountered/ the total nematodes for all 60 farms x 100

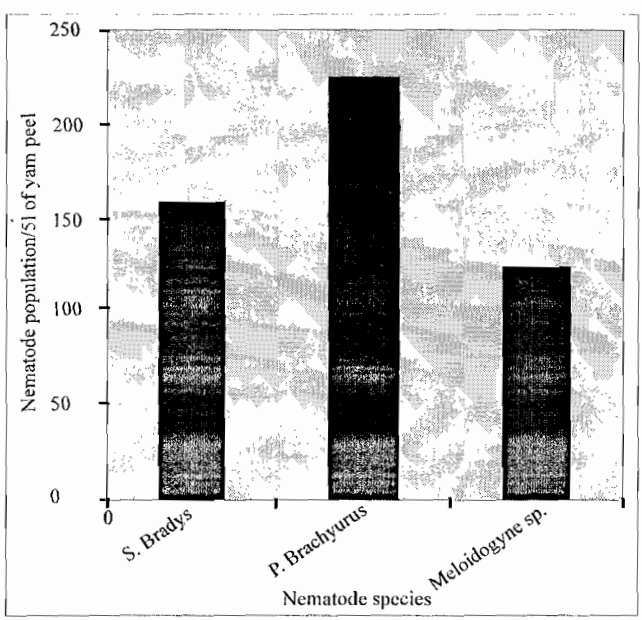

Figure 1. Plant parasitic nematodes associated with yam tubers.

Table 3. Responses of farmers to various questions about their farming activities (%).

Town	*Length of farming (years)*			*Scale of operation (hectares)*		*Farming system*		*Awareness of yam nematodes*		*Treatment of planting material*	
	1-10	*11-20*	*21-30*	*Subsistence 1-5*	*Large >5*	*Sole*	*Mixed*	*Aware*	*Unaware*	*Treatment*	*No treatment*
Adidwan	70	30	0	100	0	0	100	0	100	0	100
Ejura	20	50	30	80	20	0	100	10	90	0	100
Kintampo	40	20	40	80	20	0	100	0	100	0	100
Mampong	80	20	0	100	0	0	100	0	100	0	100
Nkoranza	50	20	30	100	0	0	100	0	100	0	100
Techiman	10	70	20	70	30	0	100	40	60	0	100

Discussion

Plant parasitic nematodes particularly *Pratylenchus*, *Meloidogyne* and *Scutellonema* were consistently found associated with rhizosphere soils of yam in all the six yam growing areas studied. These nematodes were also extracted from yam tubers purchased from the market. Our finding of association of plant parasitic nematodes with yam tubers accords with reports by other investigators (Kermarrec *et al.*, 1987; Jatala and Bridge, 1993).

In West Africa, the *Dioscorea* spp. known to be attacked most by nematodes are *D. alata*, *D. cayenensis* and *D. rotundata* (Kermarrec *et al.*, 1987). These yam species are the very types cultivated by farmers in the area covered by the present study. Most yam farms were intercropped with various crops including cowpea and melon, two crops known to support high populations of the three most important yam nematodes, *Meloidogyne*, *Pratylenchus* and *Scutellonema* (Bridge, 1982).

Atu *et al.* (1983) reported the economic threshold of *M. incognita* in yam to be 50-250 eggs per plant. Nematode population levels recorded in the six areas are comparatively smaller than the threshold reported for *Meloidogyne*. However, the short life cycle of nematodes (20-30 days, Thompson *et. al.*, 1973; Nwauzor and Fawole, 1981) and their high reproductive rates under favourable soil conditions could result in a rapid build-up of the population during the growing season of yam to cause economic damage to the crop. Interaction between nematodes and other pathogenic soil organisms such as fungi and bacteria in the development of certain diseases in plants (Moura, *et al.*, 1975; Harrison, 1977) makes soil nematodes, even at very low densities, very important.

Parasitic relationship between nematodes and yam tubers results in yield loss (Wood *et al.*, 1980). Tubers with nematode infection symptoms such as dry rot and or superficial necrosis, galls and cracks (Bridge and Page, 1984) also have reduced market value. Thus, parasitic nematodes of yam need to be controlled.

We have shown in the present study that the yam tuber harbours parasitic nematodes and thus, becomes an important source of inoculum for introducing yam nematodes to yam fields when such tubers are used for planting without treatment. Elimination of nematodes from tubers meant for planting would be an effective management method. In Ghana, hot water treatment of plantain suckers has been shown to be very effective against *Helicotylenchus multicinctus*, *Pratylenchus coffeae* and *Meloidogyne javanica* (Brentuo, 1999). Bridge (1975) and Gall (1985) have both reported the efficacy of hot water

treatment (53-55 C, for 20 min) against nematodes borne in planting materials. This approach could be employed against the yam tuber nematodes. Hot water treatment of yam tubers could also rid the tuber of yam moasic virus and the water yam chlorosis virus, both of which are known to be tuber-borne (Thèberge, 1985). Studies in these areas are, however, needed to form the basis of such control. Botanicals such as the neem seed powder, and a chemical pesticide such as Marshal 5G could also be evaluated for efficacy against soil nematodes of yam.

Farmers in the study areas are unaware of yam nematodes, let alone their harmful effects. Thus, creating awareness of the pest in these areas is necessary to facilitate patronage of management intervention measures that would be put in place.

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