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OCCURRENCE, DISTRIBUTION AND ABUNDANCE OF PLANT PARASITIC NEMATODES OF BANANAS IN UGANDA

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ABSTRACT

A survey of plant parasitic nematodes in the major banana growing areas of Uganda was conducted in 1993. A total of 120 root samples were collected from 24 sites. Eight nematode species belonging to four genera were encountered. The most widespread species were *Pratylenchus goodeyi* (Cobb) Sher and Allen, and *Helicotylenchus multicinctus* (Cobb) Golden, occurring in 96% and 83% of the sites, respectively. *Radopholus similis* (Cobb) Thorne and *Meloidogyne* spp. were also prevalent although their distribution was dependent on elevation. *P. coffeae* (Zimmerman) Goodey, *P. zeae* (Graham), *H. pseudorobustus* and *H. dihystera* (Colbran) which were previously not reported on bananas in Uganda, were also found in a few sites.

***Key Words*: Highland Bananas , *Helicotylenchus multicinctus*, *Pratylenchus goodeyi*, *Radopholus similis*, Uganda.**

RÉSUMÉ

Une enquête sur les nématodes parasites de plantes dans les principales régions productrices de bananes en Ougandan a été conduite en 1993. Un total de 120 échantillons de pieds de bananier a été collecté de 24 sites. Huit espèces de nématodes appartenant à quatre genres furent observées. Les espèces les plus répandues sont *Pratylenchus goodeyi* (Cobb) Sher et Allen, et *Helicotylenchus multicinctus* (Cobb) Golden, présentes à 96 % et 83 % respectivement des sites. *Radopholus similis* (Cobb) Thorne et *Meloidogyne spp.* sont répandues mais leur distribution varie en fonction. *P. coffeae* (Zimmerman) Goodey, *P. zeae* (Graham), *H.pseudorobustus* et *H. dihystera* (Colbran) qui n'avaient pas été signalées sur le bananier en Ouganda ont été observées dans quelques sites.

***Mots Clés*: Bananiers des hauts plateaux en Afrique de l'Est, *Helicotylenchus multicinctus*, *Pratylenchus goodeyi*, *Radopholus similis*, Ouganda.**

INTRODUCTION

Bananas (*Musa* spp.) constitute an important staple food crop in the Eastern African highland regions. Most production is by subsistence farming on small holdings. The East African Highland cultivars (AAA-EA), unique to this region, dominate production (Jameson, 1970).

Uganda is the most important banana producer in Africa (FAO, 1987). However, in spite of its importance, banana has, until recently, received little research attention, and average yields per hectare have declined by 50% over the last 30 years (Acland, 1971). As a result, cooking cultivars (AAA-EA) are being replaced with introduced, albeit less preferred, varieties, such as AB and ABB types, or with root crops (Gold *et al.*, 1993).

Pests and diseases are key constraints contributing to banana decline in Uganda (Gold *et al.*, 1993). Primary among these is a complex of banana nematodes. For example, severe toppling of bananas during the late 1980's in Masaka and Rakai districts of Uganda was attributed to nematodes and weevils (Ocen Ayer, unpublished). *Pratylenchus goodeyi* (Cobb) Sher and Allen, *Radopholus similis* (Cobb) Thorne, and *Helicotylenchus multicinctus* (Cobb) Golden were the most predominant species in failed plantations (Kashaija, I.N., unpublished).

Substantial yield losses have also been reported from other East African countries (Ngundo *et al.*, 1974; Bridge, 1988; Sikora *et al.*, 1988; Taylor, 1991) and throughout the world (Gowen and Queneherve, 1990). Nevertheless, species abundance patterns and importance vary over time and space. The underlying mechanisms (e.g. ecological factors and farming practices) influencing nematode distribution and pest status are unknown. In this study therefore, evaluation was made of the distribution of banana nematodes in Uganda, and the extent to which abiotic and biotic factors influenced species abundance patterns. In this paper, bananas refer to all edible *Musa* species grown in Uganda.

MATERIALS AND METHODS

Twenty four sites, representing the major banana-growing regions of Uganda (Fig. 1), were selected using a stratified random sample based on UNEP and CIAT data bases for rainfall, elevation and population. At each site, five farms in which bananas had been established for a minimum of two years and had at least 100 mats were selected and their altitudes in meters above sea level (asl) recorded.

On each farm, root samples were collected from ten recently (< 14 days) flowered plants and bulked (irrespective of cultivar) into a composite sample. Roots were collected from within 30 cm of the corm and 20 cm below the soil surface. Samples were transferred to the laboratory within 48 hours of collection.

Nematode extraction techniques were modified from existing methodology (Gowen and Edmunds, 1973; Hooper, 1986; Speijer, 1993). Roots were washed, chopped into 1 cm pieces and thoroughly mixed. Five sub-samples of 5 g were taken and macerated in a kitchen blender for 4 seconds, and the resulting homogenate placed on piepan dishes. Nematodes were then extracted over a 24 hr period using tap water.

Nematode identification and counts were made from 1-ml aliquots. Specimens were sent to the International Institute of Parasitology (IIP), U.K. for species confirmation. For each species frequency (%) and relative abundance were determined using the method applied by Adiko in West Africa (Adiko, 1988). Frequency corresponds to the number of sites where a species occurred. A species was considered widespread when it appeared in more than 30% of the sites. Abundance corresponds to the average number (N) of individuals of a species over the sample sites where the species was present. A species whose mean number was more than 10 individuals per gram of root was considered abundant (Adiko, 1988). Abundance (Log N+1) was plotted against frequency of occurrence to assess the relative importance of the nematode species, and were accordingly categorized into four groups as shown in Figure 2:

1) Widespread and abundant species (nematodes in frequency and abundance scales of 30–100% and 1–2, respectively)
2) Widespread but not abundant species: (nematodes in frequency and abundance scales of 30–100% and 0–1, respectively)
3) Localized but abundant (nematodes in frequency and abundance scales of 0–30% and 1–2, respectively)
4) Localized and not abundant species (nematodes in frequency and abundance scales of 0–30% and 0–1, respectively)

RESULTS

Eight parasitic nematode species belonging to four genera were encountered on banana roots (Table 1). The most common were *Pratylenchus*

TABLE 1. Occurrence, distribution and density[a] of plant parasitic nematodes on bananas in Uganda

Site	Nematode species							
	P. goodeyi	*H. multicinctus*	*R. similis*	*Meloidogyne* spp.	*H. dihystera*	*H. pseudorobustus*	*P. zeae*	*P. coffeae*
1	****	–	–	–	–	–	–	–
2	****	*	–	–	–	–	–	–
3	****	**	–	*	–	–	–	–
4	***	**	–	–	–	–	–	–
5	***	*	–	**	–	–	–	–
6	***	*	–	–	–	–	–	–
7	****	–	–	–	–	–	–	–
8	***	*	**	–	–	–	–	–
9	**	***	**	–	–	–	–	–
10	***	***	–	*	–	–	–	–
11	***	***	**	**	*	**	–	*
12	***	***	***	*	*	–	–	–
13	***	*	**	*	–	–	*	–
14	****	**	*	**	–	–	–	–
15	****	–	–	**	–	–	**	–
16	***	***	*	–	–	–	–	–
17	****	*	*	–	–	–	–	–
18	*	***	***	**	–	–	–	–
19	****	****	***	**	***	**	**	–
20	*	****	**	**	***	–	–	–
21	***	****	***	***	***	**	**	–
22	–	***	**	*	–	–	–	*
23	*	****	–	–	–	–	–	–
24	****	–	–	–	–	–	–	–

[a]Density (Number of nematodes 100^{-1} g of roots)
– = absent; * = 1–100; ** = 101–1,000; *** = 1,001–10,000; **** = 10,001–100,000

TABLE 2. Influence of elevation on distribution and density[a] of banana nematodes in Uganda.

Altitude (m)	Fields sampled	*P. goodeyi*	*H. multicinctus*	*R. similis*	*Meloidogyne* spp.	Combined
>1600	10	25200	0	0	0	25200
1600 - >1500	10	16770	20	0	0	16790
1500 - >1400	10	7800	160	0	0	7960
1400 - >1300	10	18430	120	0	460	18550
1300 - >1200	50	10740	4530	1110	124	16380
1200 - >1100	20	2640	4860	1440	380	12535
1100 - >1000	10	680	31960	6480	1430	39134

[a]Density (Number of nematodes 100^{-1}g of roots)

goodeyi and *Helicotylenchus multicinctus* occurring in 96% and 83% of the sites, respectively. These were followed by *Radopholus similis* and *Meloidogyne* spp. both being found in 53% of the sites. Other species present included *Helicotylenchus dihystera* (Colbran), *Helicotylenchus pseudorobustus*, *Pratylenchus zeae* (Graham) and *Pratylenchus coffeae* (Zimmerman) Goodey.

While *P. goodeyi*, *H. multicinctus* and *R. similis* were both widespread and abundant *H. pseudorobustus*, *P. zeae* and *P. coffeae* were localised and scarce. *Meloidogyne* spp were widespread but not abundant and *H. dihystera* was abundant but localised.

Pratydenchus goodeyi occurred at all elevations; in fact, it was the only species found above 1600 m asl. *H. multicinctus* occurred at elevations up to 1600 m asl while *R. similis* and *Meloidogyne* spp. were restricted to sites below 1400 m asl (Table 2). At lower elevations mixed populations of nematode species were common (Table 2). In general, nematode abundance, regardless of species, was similar for all elevations (Table 2).

DISCUSSION

Pratydenchus goodeyi, *H. multicinctus* and *R. similis* were both wide-spread and abundant, suggesting that they are the major plant parasitic nematodes on bananas in Uganda. *P. goodeyi* was first reported in Uganda in Mbarara and Bushenyi (formerly Ankole) districts during the 1960's (Whitehead, 1961). In addition to being widespread in Uganda, it is also well distributed across banana growing regions in Kenya and Tanzania (Gichure and Ondieki, 1977; Bridge, 1988; Speijer, 1993). It is regarded as a serious banana pest in these countries (Gichure and Ondieki, 1977; Bridge, 1988; Sikora *et al.*, 1988) and in the Canary Islands (Wehunt and Edwards, 1968). It is likely that this species is indigenous to East Africa (Gowen and Queneherve, 1990). While *P. goodeyi* has a localized distribution, *H. multicinctus* and *R. similis* are cosmopolitan pests of bananas (Gowen and Queneherve, 1990) causing substantial crop damage (Minz *et al.*, 1960; O'Banon, 1977). *P. coffeae* and *P. zeae*, species recorded for the first time in Uganda, are likely to be polyphagous and may have been present in the soil before bananas were planted.

Helicotylenchus multicinctus occurred at all sites below 1600 m asl. Presumably, its absence from higher elevations was temperature dependent although other factors (e.g. soils or cultivar occurrence) may play a role in its distribution. Since this nematode species has a wide host range, population levels in banana-based systems are probably influenced by cropping history as use of alternate hosts in crop rotations or mixed cropping systems may predispose bananas to higher levels of attack.

Rodopholus similis occurred primarily in central (sites 8, 9, 11, 12, 13) and eastern (sites 18, 19, 20, 21, 22) Uganda (Fig. 1) and was often associated with introduced AAB and ABB cultivars. It was first reported in Uganda, Kenya and Tanzania during a 1973 survey (Gichure and Ondieki, 1977) although it may have been long established before that time. The species is likely to have entered Uganda on infested planting material. The results suggest that the distribution of *R. similis* is restricted by elevation (temperature). A similar dynamic has been reported in Tanzania (Bridge, 1988).

Meloidogyne spp. distribution was similar to that of *R. similis* and also appeared to be limited

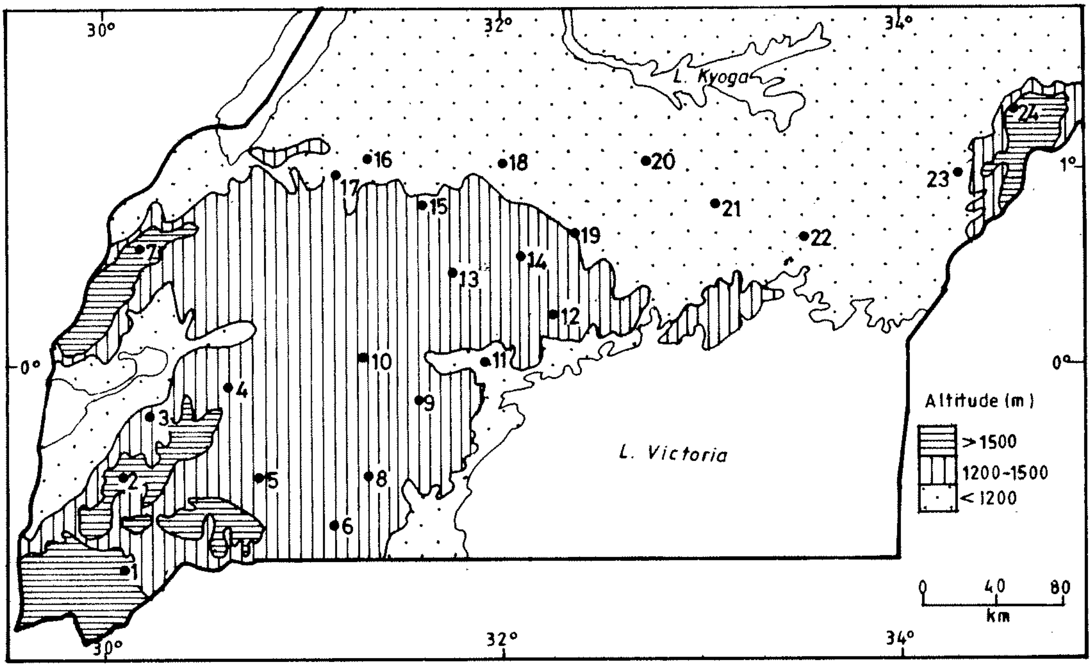

Figure 1. Sites in southern Uganda sampled for banana nematodes. Within each location five farms were sampled. Twenty-four sub-counties sampled were: 1 = Bukinda, 2 = Mitooma, 3 = Ryeru, 4 = Rukiri, 5 = Bubare, 6 = Rugaga, 7 = Buhesi, 8 = Kagamba, 9 = Matete, 10 = Ntusi, 11 = Kabulasoke, 12 = Buwama, 13 = Kitenga, 14 = Bulera, 15 = Madudu, 16 = Nkooko, 17 = Matale, 18 = Bukomero, 19 = Nyimbwa, 20 = Butuntumula, 21 = Kayunga, 22 = Bulongo, 23 = Butiru, and 24 = Kaserem.

by elevation. At higher altitude, developmental rates decline as temperatures decrease (Christie, 1959). On the other hand, mixed cropping (e.g. with coffee or beans) or unweeded fields common in central Uganda are likely to favor its occurrence. The nematode was most often encountered at low densities. These species may do poorly in the presence of other root or lesion forming nematodes (Blake, 1969) and low population density may have resulted from inter-specific competition. However, *Meloidogyne* spp. are polyphagous parasites and often attack intercrops (e.g. beans) commonly associated with banana. Therefore, banana may serve as a reservoir and source of inoculum for more susceptible intercrops.

Of the less common species encountered, only *P. coffeae* has reached pest status elsewhere in the world; this species was often associated with root injury and related yield losses in plantations in Central America (Wehunt and Edwards, 1968; Stover, 1972). *H. dihystera* , *H. pseudorobustus* and *P. zeae* are not considered important in banana production.

In general, densities of plant parasitic nematodes were high and similar among sites. Nevertheless, species composition of the three most important parasitic nematodes, *P. goodeyi*, *H. multicinctus*, and *R. similis*, was influenced by elevation and varied among sites and between farms within sites. Cultivar, cropping systems, farm management, and sources of planting material, probably affected abundance patterns of individual species (Wallace, 1963). For example, cultivar groups differ in host quality for individual nematode species (Davide, 1980; Speijer,1993). Future work will focus on nematode-cultivar-environment interactions.

Preliminary data from surveys (Gold *et al.*, 1993) suggest that nematodes are key constraints to banana production and cause major crop losses in Uganda. Our data on distribution and abundance patterns suggest that three species, *P. goodeyi*, *H. multicinctus* and *R. similis*, most likely cause a major proportion of this damage. Further studies are required to partition and quantify damage caused to bananas by individual nematode species.

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