Nemotode populations as influenced by *Leucaena leucocephala* and *Flemingia congesta* in an alley cropping system

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SUMMARY

A study to determine the effect of *Flemingia congesta* and *Leucaena leucocephala* hedgerows, as sources of mulch, on the population of nematode species in an alley cropping system was conducted at the Crops Research Institute, Kumasi, Ghana from May 1991 to February 1994. Treatments comprised *Leucaena leucocephala* and *Flemingia congesta* hedgerows and a control (no hedgerows), arranged in a randomized complete block design with four replications. Soil samples were taken from both hedgerow and control plots and assessed for nematodes periodically. Plant parasitic nematodes isolated were *Meloidogyne* spp., *Pratylenchus* spp., *Paratylenchus* spp., *Helicotylenchus* spp., and *Rotylenchus* spp. Three years after planting of hedgerows, significantly ($P<0.05$) higher populations of *Meloidogyne* spp. (367 per 100 g soil), *Paratylenchus* spp. (92 per 100 g soil), *Helicotylenchus* spp. (8 per 100 g soil), and *Rotylenchus* spp. (308 per 100 g soil), were associated with *L. leucocephala* hedgerows than with *Flemingia congesta* hedgerows (42, 0, 83, 0 per 100 g soil) and the control (74, 50, 41, 0 per 100 g soil). These results clearly indicate that *L. leucocephala* is a good host for plant parasitic nematodes. On the other hand, *F. congesta* has qualities that suppress nematode populations. Thus, in alley cropping, studies on attributes other than improvement of soil fertility should be carried out on the hedgerow plant species before recommendation for adoption.

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RÉSUMÉ

BANFUL, B., DZIETROR, A., OFORI, I. & HEMENG, O. B.: *Les populations de nématode en tant q'influencées par* Leucaena leucocephala *et* Flemingia congesta *dans un systéme de culture d'allée.* Une étude pour déterminer l'effet des haies de *Flemingia congesta* et *Leucaena leucocephala* comme les sources de paillis, sur la population d'espéces de nématode dans un systéme de culture d'allée s'est déroulée à l'Institut de Recherches des Cultures à Kumasi au Ghana, du Mai, 1991 au février, 1994. Les traitements comprenaient les haies de *Leucaena leucocephala*, les haies de *Flemingia congesta* et un contrôle (haies nulles), arrangés dans un dessin de bloc complet choisi au hasard avec quatre replicatifs. Des échantillons de sol étaient pris de la haie et de lots de contrôle à la fois et évalués périodiquement pour les nématodes. Les nématodes parasitaires de de plantes isolées étaient *Meloidogyne* spp., *Pratylenchus* spp., *Paratylenchus* spp., *Helicotylenchus* spp. et *Rotylenchus* spp.. Trois ans aprés la plantation de haies, les populations considérablement ($P<0.05$) plus élevées de *Meloidogyne* spp. (367 par 100g de sol), de *Paratylenchus* spp. (92 par 100 g de sol), de *Helicotylenchus* spp. (8 par 100 g de sol) et de *Rotylenchus* spp. (308 par 100 g de sol), étaient associées à la haie de *L. leucocephala* qu'a la haie de *Flemingia congesta* (42, 0, 83, 0 par 100 g de sol) et que le contrôle (74, 50, 41, 0 par 100 g de sol). Ces résultats indiquent manisfestement que *L. leucocephala* est un bon hôte pour les nématodes parasitaires de plante. Par contre, *F. congesta* a des qualités qui suppriment les population de nématode. Ainsi, dans la culture d'allée les études sur les attributs autre que l'amélioration de fertilité de sol devaient être se livrer aux haies d'espéces de plante de la haie avant recommandation pour adoption.

Introduction

Damage caused by plant parasitic nematodes to crops contribute greatly to crop losses especially in the tropical countries (D'Hondt-DeFrancq, 1993). For instance, it is estimated that *Hirschmanniella* spp. infest 58 per cent of the world's rice fields, causing 25 per cent yield loss (Hollis & Keoboonrueng, 1984). Also up to 60 per cent yield loss has been recorded in upland rice infested with *Meloidogyne incognita* (Babatola, 1984). Crop losses in plantain has been partly attributed to damage caused by five plant parasitic nematodes, namely, *Meloidogyne* spp., *Pratylenchus* spp., *Helicotylenchus multicinctus*, *Rotylenchus reniformis*, and *Radopholus similis*. Collectively, these nematodes cause stunting of plants, reduction in bunch weight, and toppling of plants (Luc, Sikora & Bridge, 1993). In roots and tubers, yield losses vary depending on the cultivar and environmental conditions, but generally losses can be about 25 per cent or more, and it is mainly due to *Meloidogyne* spp. (Mai *et al.*, 1981). Similarly, high yield losses in maize is partly due to nematodes which considerably increase in population under continuous cropping (Maqbool & Hashmi, 1986). In general, crop losses vary with the nematode species as well as with their populations occurring in the soil (Brown & Kerry, 1987).

As a result of the potential damage nematodes can cause to crops, farming systems which aim at sustainable crop production need to be critically reviewed. One such system is alley cropping, an agroforestry system, where trees and shrubs are interplanted with crops. Earlier studies indicate that *Leucaena leucocephala*, a much promoted agroforestry tree species for its soil-improving qualities, is a good host for root-knot nematodes ((D'Hondt-Defrancq, 1993). Nevertheless, some species of trees and shrubs may adversely affect certain nematode species (D'Hondt-Defrancq, 1993). To effectively promote agroforestry as a sustainable farming system, information is therefore required on certain multipurpose leguminous species used in agroforestry, including their effects on soil nematode populations.

The study therefore aimed to determine the effect of *L. leucocephala* and *F. congesta* hedgerows as sources of mulch on the nematode population in alley cropping systems.

Materials and methods

The study was carried out at the Crops Research Institute, Fumesua, Kumasi, Ghana, from May 1991 to February 1994. Two multipurpose leguminous species, namely, *Leucaena leucocephala* and *Flemingia congesta,* and a control (absence of leguminous plants) were arranged in a randomized complete block design with four replications. Each plot, consisting of five hedgerows spaced at 3 m apart, measured 10 m long by 12 m wide. The intra-row plant spacing for the hedgerows was 1.0 m. The hedgerows were planted in May 1991 and were pruned to a height of 75 cm above soil level 15 months after planting. At each pruning period, the prunings made up of leaves and twigs were applied as mulch in the alleys between the hedgerows.

Nematode population was assessed before planting, and 3 years after planting of hedgerows. Twenty core samples from each plot were taken randomly at a depth of 0-15 cm with a 5 cm diameter augur. The samples were bulked, mixed thoroughly and sealed in a polyethylene bag which was stored in a refrigerator until needed. Nematode extraction was by the modified Whitehead Tray method (Hemeng, unpublished). Each composite sample was passed through a 2-mm sieve to get rid of stones and plant debris, and a representative 100 g soil obtained from each sample.

Shallow plastic trays were placed on a laboratory bench and a plastic sieve placed inside the tray. The inner portion of the sieve was lined with a two-ply tissue paper and the representative 100 g soil spread gently on the tissue paper. Water was poured by the side of the tray until the soil was moist. The setup was left undisturbed for 24 h to permit migration of nematodes from the soil into the water in the tray. The plastic sieves on which the soil was spread were carefully removed, rinsed with water, and the washing collected into a beaker. This was pooled with water in the tray and left undisturbed for 6 h to allow the nematodes to settle at the bottom of the beaker. The supernatant was decanted leaving the nematodes concentrated in 25 ml water.

The nematodes were killed by placing the beaker in a hot bath at 60 °C for 3 min and fixed with 2 per cent formalin acetic acid (FAA). They were transferred into a special specimen bottle, and were counted and identified using a stereoscopic microscope and the Commonwealth Institute of Helminthology descriptions of plant parasitic nematodes. Nematode populations were expressed on per 100 g soil basis.

Results and discussion

Five different genera of parasitic nematodes were identified, namely, larvae of *Meloidogyne* spp., *Paratylenchus* spp., *Pratylenchus* spp., *Helicotylenchus* spp., and *Rotylenchus* spp.

Before planting the hedgerows, differences between the different nematode genera among the various hedgerow treatments (Fig. 1) were significant ($P<0.05$). Populations of *Paratylenchus* spp. (62 per 100 g soil) and *Rotylenchus* spp. (167 per 100 g soil) were significantly ($P<0.05$) higher on *L. leucocephala* plots than on *F. congesta* plots (50 and 120 per 100 g soil) and the control (36 and 98 per 100 g soil). However, population of *Meloidogyne* spp. was significantly ($P<0.05$) higher on *F. congesta* plots (17 per 100 g soil) than on *L. leucocephala* plots (0 per 100 g soil) and the control (0 per 100 g soil). This indicates that populations of nematodes are not fairly distributed on the same piece of land.

After 3 years of hedgerow growth, soil under *L. leucocephala* hedgerows consistently recorded significantly ($P<0.05$) higher populations of nematodes than soils under *F. congesta* hedgerow and the control. *L. leucocephala* hedgerows were associated with significantly ($P<0.05$) higher populations of *Meloidogyne* spp. (367 per 100 g soil), *Paratylenchus* spp. (92 per 100 g soil), *Helicotylenchus* spp. (8 per 100 g soil), and *Rotylenchus* spp. (308 per 100 g soil) (Fig. 2). The results show that *L. leucocephala* is a good host for plant parasitic nematodes. This may possibly be due to the production of root exudates which serve as an attractant (Christie, 1959). Sasser (1979) also indicated that populations of pathogenic nematodes were high in the presence of suitable hosts. This is evident in the apparently

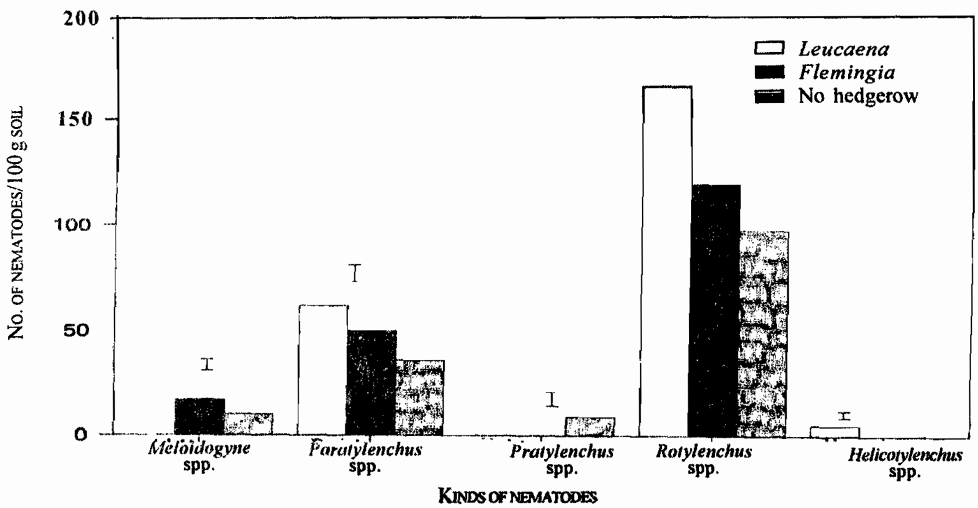

Fig. 1. Population of nematodes before planting of hedgerows.

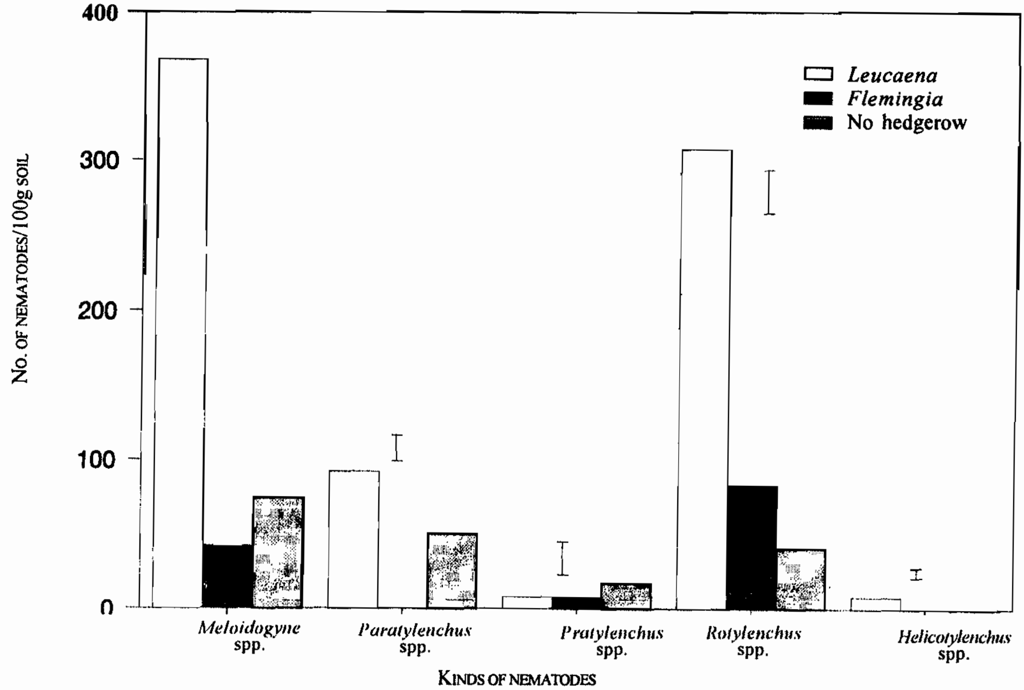

Fig. 2. Population of nematodes 3 years after planting of hedgerows.

high population of *Meloidogyne* spp. associated with *L. leucocephala* hedgerows (Fig. 2), which is also consistent with the report by D'Hondt-Defrancq (1993) that *L. leucocephala* is a good host for root-knot nematodes. This implies that *L. leucocephala* hedgerows can constitute a reservoir of nematodes for subsequent attack of susceptible crops in an alley cropping system.

Flemingia congesta hedgerows, on the other hand, were associated with populations of nematodes which were significantly ($P<0.05$) lower than the control, after 3 years of hedgerow growth. This may possibly be attributed to the production of root exudates which are toxic to the nematodes. Such toxic exudate has been identified as a glycoside for asparagus cultivars resistant to *Trichodorus* spp. (Rhode & Jenkins, 1958). The suppression of nematodes by the *F. congesta* hedgerows could also be due to some metabolic by-product of the decomposing mulch. Such decomposing mulch could stimulate the proliferation of organisms antagonistic to nematodes (Christie, 1959). Besides, the prunings of the *F. congesta* hedgerows may possess alkaloids or volatile fatty acids that are directly involved in suppressing nematode build-up (Daulton & Curtis, 1963).

Thus, *F. congesta* could be used for the biological control of plant parasitic nematodes.

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