THE EFFECTS OF ROTATION CROPS ON THE SURVIVAL OF ROOT-KNOT, ROOT-LESION AND SPIRAL NEMATODES [EFECTO DE ROTACION DE COSECHAS SOBRE LA SUPERVIVENCIA DE NEMATODOS NODULADORES, LESIONADORES Y ESPIRALIFORMES].

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ABSTRACT

Potential rotation crops for replacement of natural soil regeneration in tropical agriculture were grown in nematode infested soil following *Celosia argentea.* The aggregate nematode population mean was one-third the preplant mean after six months. *Meloidogyne incognita* juvenile soil populations were reduced under 15 crops and maintained under three. *Helicotylenchus pseudorobustus* populations were reduced under eight crops and maintained under 10. *Pratylenchus sefaensis* were maintained under 17 crops and significantly increased under *Crotalaria juncea.*
Key Words: rotation crops, root-knot nematode, spiral nematode, root lesion nematode.

INTRODUCTION

Development of cropping systems that provide natural deterrents to disease and pest build-up are essential for the maintenance and improvement of small farmer productivity in the humid tropics. Under increasing population pressure and food demands, land use intensification continues to accelerate and results in a shorter bush fallow period. The bush fallow period is known to regenerate soil fertility and suppress plant diseases and pests such as plant-parasitic nematodes (27).

Plant-parasitic nematodes are among the major soilborne plant pests that are effectively suppressed by the bush fallow system and for which effective controls must be developed where alternatives to the bush fallow are being considered (9,26,27). Cultivated plants differ in susceptibility and reaction to attack by plant-parasitic nematodes, thus, soil population changes depend on the plant species present as well as conditions of moisture, temperature, soil texture and the abundance of plant roots as a food source. The food quantity and quality greatly influence nematode numbers because such nematodes are obligate parasites whose reproduction depends on actively growing roots. Therefore, the growing of a less favored host plant would reduce the nematode carryover to the following crop. Seinhorst (20) found that following low preplant nematode population levels plant damage and yield losses are neglible but when nematode numbers surpass the crop tolerance limit the yields decrease progressively as the number of nematodes increases. Therefore, effective control measures limiting nematode populations to levels below crop tolerance would prevent serious crop injury and reduced yields.

Soils seldom contain only one plant-parasitic nematode species; more often mixed populations of three, four or more species occur in a given field. The potential for crop damage and nematode reproduction and distribution generally is different for each nematode species and host plant combination. Each field, therefore, may require a different crop sequence depending on the kinds of nematodes and the frequency of the preferred crop or crops (14,15,22).

The aim of this trial was to check the effectiveness of grasses and legumes that are potential alternatives to the bush fallow, on the suppression of plant-parasitic nematodes. *Meloidogyne incognita,* race 2, *Pratylenchus sefaensis* and *Helicotylenchus pseudorobustus* populations were monitored in the experimental plots.

MATERIALS AND METHODS

The field in which the rotation crops were grown followed 6 months cultivation of *Celosia argentea,* a local potherb that is known to build up root-knot nematode populations. The field was divided into microplots of 1 m^2 for small plants and 3 m^2 for the more aggressive trailing and tree-type legumes. Sixty cm alleyways separated each microplot. The design was a randomized complete block with 9 replications for the small plots and 4 for the large plots.

Preplant soil samples were collected in each microplot and again after 6 months' growth of the selected rotation crop. In each microplot, 6 samples were taken vertically with a 200 cm^3 capacity soil tube to a 20-cm depth. From each mircoplot, 6 root systems were comminuted with water in a blender for 15 seconds. Nematodes were extracted from the soil or comminution using the modified Baermann technique (24) and were concentrated using the settling-siphon method (4).

The legumes were: *Arachis prostrata, Centrosema pubescens, Crotalaria juncea, Desmodium trifolium, Indigofera sublata, Leucaena leucocephala, Psophocarpus palustris, Pueraria phaseoloides, Stylosanthus gracilis* and *Vigna unguiculata* cv 'TVu 1190'. The grasses were *Cynodon nlemfuensis* cv 'Ib-8', *Digitaria decumbens* and *Paspalum notatum. Amaranthus hybridus,* a local potherb, and *Tagetes patula* with known resistance to root-knot nematodes were included. The controls were *Celosia argentea* and clean weeding.

RESULTS AND DISCUSSION

The spiral nematode *(H. pseudorobustus)* and root-knot nematode *(M. incognita)* juveniles were recovered from all plots in the preplant sampling. The root-lesion nematode *(Pratylenchus sefaensis)* was less uniformly distributed (Table 1). After 6 months' growth of the rotation species, the aggregate plant-parasitic nematode soil population mean was about one-third of the preplant mean. Soil populations of root-knot nematode juveniles were significantly reduced under 15 treatments: *A. hybridus, A. hypogaea, C. pubescens,* clean weeded, *C. juncea, C. nlemfuensis, D. trifolium, D. decumbens, I. sublata, L. leucocephala, P. notatum, P. phaseoloides, S. gracilis, T. patula* and *V. unguiculata.*

Spiral nematode populations were also significantly reduced under 8 treatments: *A. hybridus, A. hypogaea, A. prostrata, D. decumberns, P. palustris, P. phaseoloides, S. gracilis* and *V. unguiculata.* The initially low root-lesion nematode population levels were only slightly reduced or maintained under all treatments except for *C. juncea,* where there was a significant increase in these nematodes; from 1 g of root tissue 2,100 root-lesion nematodes were recovered. *A. prostrata* and *P. palustris* did not significantly reduce root-knot nematode juvenile population levels. The data are summarized in Table 1.

The groundnut *(A. hypogaea)* has been shown to be a nonhost for root-knot nematodes in Senegal (16), Ivory Coast (12), Western Nigeria (2) and Northern Nigeria (J.J. Smit & W.S. Bos, personal communication). This nematode also failed to reproduce on groundnut in this trial (Table 1). Netscher and Taylor (18) reported that groundnut acts as a trap crop since the root-knot nematode juveniles penetrate the

Table 1. Plant parasitic nematode soil populations after six months' growth of selected rotation crops.

Plant species	Nematodes per liter of soil							
	Meloidogyne incognita [a]		*Helicotylenchus pseudorobustus*		*Pratylenchus sefaensis*		All parasites [c]	
	Preplant	6 mo. [b]	Preplant	6 mo.	Preplant	6 mo.	Preplant	6 mo.
Legumes								
Arachis hypogaea [d]	21	0	243	28	0	0	264	28
Centrosema pubescens [d]	51	0	332	127	2	0	385	127
Desmodium trifolium [d]	220	0	410	120	5	1	635	121
Indigofera sublata [d]	82	0	323	125	50	60	455	185
Pueraria phaseoloides [d]	180	0	239	24	110	27	520	51
Leucaena leucocephala [e]	549	0.07	340	118	20	8	909	126
Stylosanthes gracilis [e]	687	0.4	287	36	2	5	976	41
Crotalaria juncea [e]	498	0.5	259	199	4	412	761	611
Vigna unguiculata TVu 1190 [d]	96	10	242	42	9	32	347	84
Arachis prostrata [d]	301	132	425	26	10	6	736	164
Psophocarpus palustris [d]	345	199	263	12	0	38	608	249
Grasses								
Cynodon nlemfuensis IB-8 [e]	533	0	229	188	11	11	773	199
Digitaria decumbens [e]	658	0	344	88	11	5	1013	93
Paspalum notatum [e]	359	0.6	247	164	0	3	606	168
Miscellaneous								
Amaranthus hybridus [e]	440	3	289	76	4	5	733	84
Tagetes patula [e]	413	4	420	130	4	7	937	141

Table 1. Continued

	Nematodes per liter of soil							
	Meloidogyne incognita [a]		*Helicotylenchus pseudorobustus*		*Pratylenchus sefaensis*		All parasites [c]	
	Preplant	6 mo.[b]	Preplant	6 mo.	Preplant	6 mo.	Preplant	6 mo.
Controls								
Celosia argentea[df]	263	198	375	215	60	34	698	447
Celosia argentea[eg]	593	442	358	312	2	2	953	756
Clean weeded[e]	538	0.5	331	173	2	1	871	174

[a] Juveniles only.

[b] Preplant = Preplant samples before rotation crops; 6 mo. = six months growth of rotation crops.

[c] Trace numbers of *Scutellonema clathricaudatum*, *Xiphinema ifacolum*, *Rotylenchulus reniformis* and *Criconemoides* sp. were encountered.

[d] Based on four replications of six observations each. Sample size was 200 cm^3 of soil.

[e] Based on nine replications of six observations each. Sample size was 200 cm^3 of soil.

[f] Large plots.

[g] Small plots.

plant root but are unable to develop into adults and perish without producing eggs.

Taylor and Sasser (21) have helped to clarify the contradictions of many host range reports by determining the existence of races of root-knot nematodes, such as two races for *M. arenaria* and four for *M. incognita*. One *M. arenaria* race will reproduce on groundnut but the other will not. The nonreproducing race occurs in West Africa. Netscher (17) studied the morphological and physiological variability of certain root-knot nematode populations, and on the basis of field trials in Senegal, demonstrated that the choice of rotation crops needs to be made by testing the crops against naturally occurring populations in each particular field. These studies indicate that root-knot nematode delineation as to biotype and crop response need to be determined locally (14,15). However, the relatively low population densities of the root-knot nematode in this trial suggests that external conditions also should be considered, as dense root-knot nematode populations have been reported on *C. argentea* in medium textured soils (5,19) in contrast to the predominately clay soil of this trial (13,23).

Some of these plants species have been reported as host plants at other locations (3,6,10,22,25). Adeniji and Chheda (1) demonstrated that root-knot nematode soil populations were significantly reduced after 6 months under *C. nlemfuensis* and none was recovered after 18 months. *A. prostrata, C. nlemfuensis, D. decumbens, L. leucocephala, P. palustris* and *S. gracilis* apparently have not been demonstrated as hosts or nonhosts for the 3 genera of nematodes found in this trial; however. soil populations of the root-lesion nematodes have been shown to decline under a rotation of *S. gracilis* (7,8). *S. gracilis* was shown to be a poor host for *H. pseudorobustus* and *Scutellonema clathricaudatum* (3). *D. decumbens* did not become galled after being exposed to root-knot nematodes for 15 months (11).

The grasses and leguminous cover crops observed are, in general, among rotation species regarded as potential replacement for the natural regenerated bush fallow of the tropics (27). The ability to suppress parasitic nematodes enhances the effectiveness of a rotation species in the no-tillage (9) or mulch in situ (26) cropping systems being developed for reducing soil loss and increasing land productivity in the tropics.

RESUMEN

Especies de plantas de cultivo potencialmente utilizables en rotaciones para reemplazar la regeneración natural del suelo en la agricultura tropical se se sembraron en un suelo infestado con nematodos por haberse plantado *Celosia argentea*. El promedio de la población combinada de nematodos después de 6 meses fué un tercio del existente antes de la siembra. Las poblaciones de formas juveniles de *M. incognita* en el suelo disminuyeron con 15 de las especies de plantas y no cambió con 3 de ellas. Las poblaciones de *Helicotylenchus pseudorobustus* disminuyeron con 8 de las especies de plantas y no cambiaron con otras 10. El número de *Pratylenchus sejaensis* se mantuvo constante en suelo con 17 especies de plantas y aumentó con *Crotalaria juncea*.
Claves: rotación de cultivos, nematodos noduladores, nematodos espiraliformes, nematodos lesionadores.

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