PLANT-PARASITIC NEMATODES ASSOCIATED WITH SUNFLOWER AND MAIZE IN THE REPUBLIC OF ZAMBIA

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ABSTRACT

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Field trials were established during the 1985–86 cropping season at Mkushi in the Central Province and at Magoye in the Southern Province in the Republic of Zambia. Sunflower (*Helianthus annus*) cv. CCA 81 and maize (*Zea mays*) cv. MM 603 were planted in soil either fumigated with ethylene dibromide or not fumigated. Plant-parasitic nematodes present were *Helicotylenchus pseudorobustus, Paratrichodorus christiei, Pratylenchus zeae,* and *Scutellonema brachyurum* at Mkushi and *Meloidogyne javanica, S. brachyurum,* and *Tylenchorhynchus* sp. (undescribed) at Magoye. Populations of *P. christiei* increased on both crops, with greater increases occurring in fumigated plots. *Scutellonema brachyurum* numbers were greater on both crops in nontreated plots and increased during the growing season at both locations. Populations of *Tylenchorhynchus* sp. declined on sunflower in both fumigated and nonfumigated plots but increased on maize, with greater increases occurring in fumigated plots. Sunflower appeared tolerant to high populations of *P. christiei, S. brachyurum,* and *Tylenchorhynchus* sp., but control of *M. javanica* increased sunflower yield by 56%. Increased maize yields were associated with fumigation and subsequent control of *S. brachyurum.*

Key words: control, EDB, *Helianthus annus, Helicotylenchus pseudorobustus,* maize, *Meloidogyne javanica, Paratrichodorus christiei,* population dynamics, *Pratylenchus zeae, Scutellonema brachyurum,* sunflower, *Tylenchorhynchus, Zea mays.*

RESUMEN

Lawn, D. A., G. R. Noel y J. B. Sinclair. 1988. Nematodos fitoparásitos asociados al girasol y al maíz en la Republica de Zambia. Nematrópica 18: 143–154.

Se establecieron experimentos de campo durante la estación agrícola 1985-1986 en Mkushi en la provincia central y en Mogoye en la provincia del sur de la Republica de Zambia. Se sembraron, tanto en parcelas fumigadas como no fumigadas con, dibromo de etileno, al girasol (*Helianthus annus*) cv. CCA 81 y al maíz (*Zea mays*) cv. MM 603. Los nematodos fitoparásitos presentes en Mkushi fueron *Helicotylenchus pseudorobustus, Paratrichodorus christiei, Pratylenchus zea* y *Scutellonema brachyurum, y en Magoye Meloidogyne javanica, S. brachyurum,* y*Tylenchorhynchus* sp. (no descrita). Las poblaciones de *P. christiei* aumentaron en ambos cultivos, con incrementos mayores en las parcelas fumigadas. La pobliación de *S. brachyurum* fue mayor para ambos cultivos en las parcelas no fumigadas e incrementó durante la estación de cultivo en ambas localidades. Las poblaciones de

Tylenchorhynchus sp. declinaron en girasol tanto en las parcelas fumigadas como no fumigadas, pero aumentaron en maíz, con incrementos mayores en las parcelas fumigadas. El girasol parece tolerante a poblaciones elevadas de *P. christiei, S. brachyurum* y *Tylenchorhynchus* sp., pero el control de *M. javanica* aumentó su rendimiento en un 56%. Los incrementos en el rendimiento del maíz se asociaron con la fumigación y control subsecuente de *S. brachyurum.*

Palabras claves: BDE, control, dinámica de población, girasol, *Helianthus annus, Helicotylenchus pseudorobustus,* maíz, *Meloidogyne javanica, Paratrichodorus christiei, Pratylenchus zeae, Scutellonema brachyurum, Tylenchorhynchus, Zea mays.*

INTRODUCTION

Recent crop production in Zambia has been characterized by increased hectarage and diversity of crops, including sunflower (*Helianthus annuus* L.), a major source of edible oil in Zambia, and maize (*Zea mays* L.), the predominant food staple. Increasing crop diversity can lead to more effective plant-parasitic nematode management strategies useful to small-scale farmers. Such control programs attempt to maintain stable but low populations of nematodes in a diverse number of genera. Maintaining low nematode populations is feasible when rotation with either nonhost crops or cultivars resistant to indigenous nematode species is introduced into the cropping system.

Previous studies in the U.S.A. have shown that sunflower is a host to species of plant-parasitic nematodes in six genera (4, 13,15), whereas species in eight genera have been identified in production areas in southern Africa (1). The four economically important *Meloidogyne* spp., *M. incognita* (Kofoid & White) Chitwood, *M. javanica* (Treub) Chitwood, *M. hapla* Chitwood and *M. arenaria* (Neal) Chitwood reproduced on sunflower with *M. javanica* having the greatest reproductive potential (4). Previous reports have suggested that decreased growth and vigor due to *Meloidogyne* spp. (12–14) and damage associated with *Pratylenchus* spp. were dependent upon the species present (4,9,10). No significant sunflower yield losses were attributed to *Paratrichodorus christiei* (Allen) Siddiqi, *Belonolaimus longicaudatus* Rau, or *Helicotylenchus dihystera* (Cobb) Sher (13).

Maize is a host for many different plant-parasitic nematodes, and species from 23 genera have been reported from southern Africa (1). Reproduction of *Meloidogyne* spp. was reported on maize (17), but because it is a poor host, maize is recommended as a rotation crop for control of *Meloidogyne* (11). Significant population increases of other genera including *Pratylenchus* and *Scutellonema* were reported following cropping of maize grown in rotation (16). Depending upon the species present, high populations of *Pratylenchus* may cause significant yield loss to maize in tropical and subtropical areas of the world (7). Effects of *Scutellonema* on maize have not been studied adequately.

This paper reports the population dynamics of plant-parasitic nematode communities associated with sunflower and maize in the Republic of Zambia and yield losses associated with these species.

MATERIALS AND METHODS

Trials were conducted on a private farm 20 km south of Mkushi, Central Province and at the Magoye Regional Research Station, Southern Province. Preceding crops were pasture gras (*Chloris gayana* Kunth cv. Katambora) at Mkushi and soybean (*Glycine max* (L.) Merr.) and sunflower at Magoye. Soil types were an Oxic Paleustult (sandy loam/loamy sand topsoil and a sandy clay/clay subsoil) at Mkushi and a Typic (oxic) Palestalf (sandy clay/clay subsoil) at Magoye.

Following land preparation and application of 200 kg/ha of lime, separate sunflower and maize experiments were established at Mkushi on 11 December 1985 and at Magoye on 13 December. Treatments were no fumigation and fumigation with ethylene dibromide (EDB, MO-Shell Chemicals (Zambia) Ltd.) at the rate of 75 L a.i./ha broadcast, 14 days prior to planting, using a Shell® Fumigun. EDB was diluted in three parts water and 3 ml of this emulsion was injected to a depth of 30–35 cm every 30 cm in a 3 × 4 m grid. Two wk after fumigation, all plots were fertilized with 10-20-10-10 (N-P-K-S) at a rate of 300 kg/ha and hand-planted. Sunflower cv. CCA 81, a blend of open pollinated populations recommended to small-scale farmers in the Republic of Zambia and having a yield potential 10% less than current hybrids, was planted in hills 30 cm apart and 3–5 cm deep. Plants were thinned to one plant per 30 cm interval, 4 wk after planting (WAP). Maize cv. MM 603 was chosen for its resistance to maize streak disease virus and ability to yield well in late plantings. Maize was planted at 25-cm intervals in the center two rows, but border rows were planted with two seeds at every other 25-cm station to ensure that plant samples taken throughout the season would not affect harvest rows by causing overcompensation with gaps in border rows. At 8 WAP, maize was topdressed with ammonium nitrate (300 kg/ha). Each experimental unit consisted of four-row plots, 4-m long with 75-cm row spacing. Fumigation treatments were arranged in a randomized complete block design with four replications. Nematode data were analyzed as a split plot with EDB fumigation as main plots and sample dates as sub plots. Sunflower yield was determined by harvesting 17 heads from the center two rows of each plot and air drying prior to weighing. Maize yield was obtained by harvesting 3.5 m of each of the center rows in each plot, drying, and adjusting moisture to 15%.

Soil was sampled at planting, 4 WAP, 8 WAP and either 17 or 20 WAP (harvest), using a 2-cm-d soil sampler. Samples were collected from the center two rows of each plot, approximately 3 cm from the base of plants to a depth of 30 cm. After thoroughly mixing the soil, a 250-cm^3 aliquant was suspended in 3 L of water and nematodes were extracted by Cobb's gravity sieving technique (6) using 850- and 38-μm-pore sieves. Residue with nematodes was collected on the 38-μm-pore sieve and separated using the rapid centrifugal-flotation technique (8). Nematodes extracted from each sample were suspended in 25 ml of water, and populations were estimated by counting two 1-ml aliquots at planting and harvest and one 1-ml aliquot at 4 and 8 WAP.

Root samples taken at 4 and 8 WAP represented a mean of five subsamples of plants dug from border rows of each plot. All roots were rated for galling (3) before cutting into 2–3 cm sections and placing on a Baermann funnel (2) for 7 days. Nematodes were recovered from a 26-μm-pore sieve and counted. Roots were dried for 3 days at 75 C and weighed to estimate the number of nematodes recovered/g dry root.

RESULTS

Nematodes identified at the Mkushi location included *Pratylenchus zeae* Graham, *Helicotylenchus pseudorobustus* (Steiner) Golden, *Paratrichodorus christiei* (Allen) Siddiqi, *Scutellonema brachyurum* (Steiner) Andrassy, and *Xiphinema* sp. Those at Magoye included *S. brachyurum, M. javanica, Tylenchorhynchus* sp., and *Xiphinema* sp. At present the *Tylenchorhynchus* species is undescribed.

Sunflower: Average initial population levels in soil planted with sunflower at Mkushi were 188 and 250 *P. zeae*/250 cm^3 of soil in nonfumigated and fumigated plots, respectively. These populations declined to 12 and 0/250 cm^3 of soil by 17 WAP. Recovery of *P. zeae* from roots of sunflower plants grown in nonfumigated soil averaged 61/g dry root at 4 WAP and <1/g dry root by 8 WAP, whereas in treated soil 15 nematodes/g dry root at 4 WAP and <1/g dry root by 8 WAP were recovered. Sunflower also was a poor host for *H. pseudorobustus* at Mkushi. Populations decreased regardless of treatment from a mean of 250/250 cm^3 of soil at planting to less than 25/250 cm^3 of soil by harvest. During the growing season, populations of *P. christiei* at Mkushi increased in both treated and nontreated sunflower plots. Although more nematodes were recovered from treated than nontreated plots, no significant ($P < 0.05$) population differences were attributed to EDB treatment at any sample date (Fig. 1). Populations of *S. brachyurum* at both locations declined after planting, but by harvest, populations in nonfumigated plots were greater than those at planting (Fig. 2 and Table 1). There was a significant ($P < 0.05$) effect of sample date and an EDB

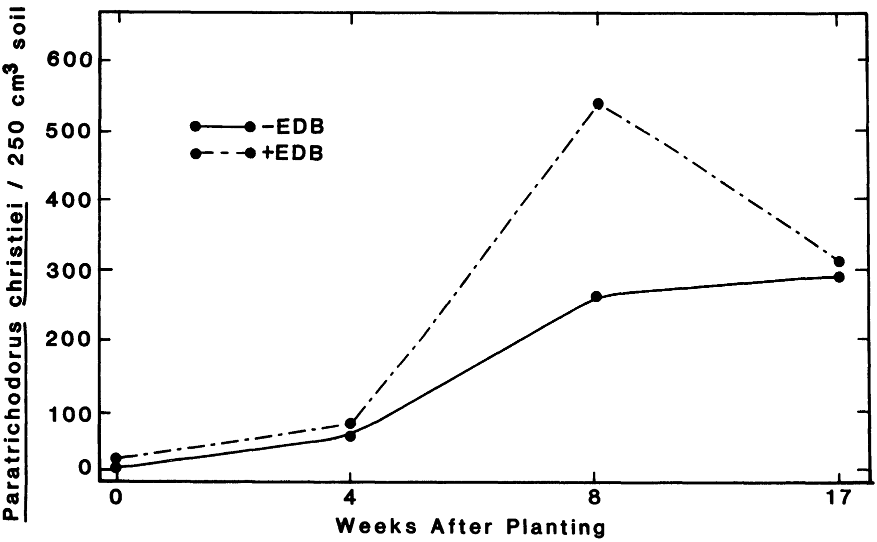

Fig. 1. Population dynamics of *Paratrichodorus christiei* in soil either fumigated with EDB or not fumigated and planted with *Helianthus annuus* cv. CCA 81 at Mkushi, Republic of Zambia.

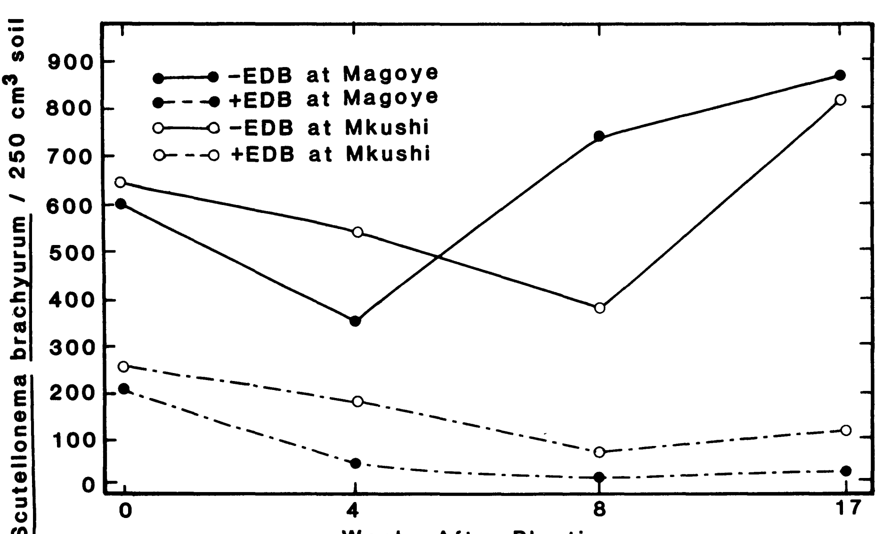

Fig. 2. Population dynamics of *Scutellonema brachyurum* in soil either fumigated with EDB or not fumigated at Magoye and Mkushi, Republic of Zambia and planted with *Helianthus annuus* cv. CCA 81.

Table 1. Analysis of variance of *Scutellonema brachyurum* populations on sunflower in soil either fumigated with EDB or not fumigated at two locations in Zambia.

		Mean squares	
Source of variation	df	Mkushi	Magoye
Block	3	116 946.61	73 802.08
EDB	1	1 498 613.28*	2 531 250.00*
Error A	3	103 769.53	15 885.42
Sample date (SD)	3	96 634.11	100 260.42*
EDB × SD	3	62 415.36	133 489.58*
Error B	18	34 246.96	20 190.97
CV %		49.2	39.9

*$P < 0.05$.

× sample date interaction at Magoye but not at Mkushi. At Magoye, *Tylenchorhynchus* sp. populations on sunflower increased in nonfumigated plots in the early part of the season but declined by harvest (Fig. 3). Significant differences ($P < 0.05$) in populations of *Tylenchorhynchus* sp. were detected for sample dates and there was an EDB × sample date interaction (Table 2).

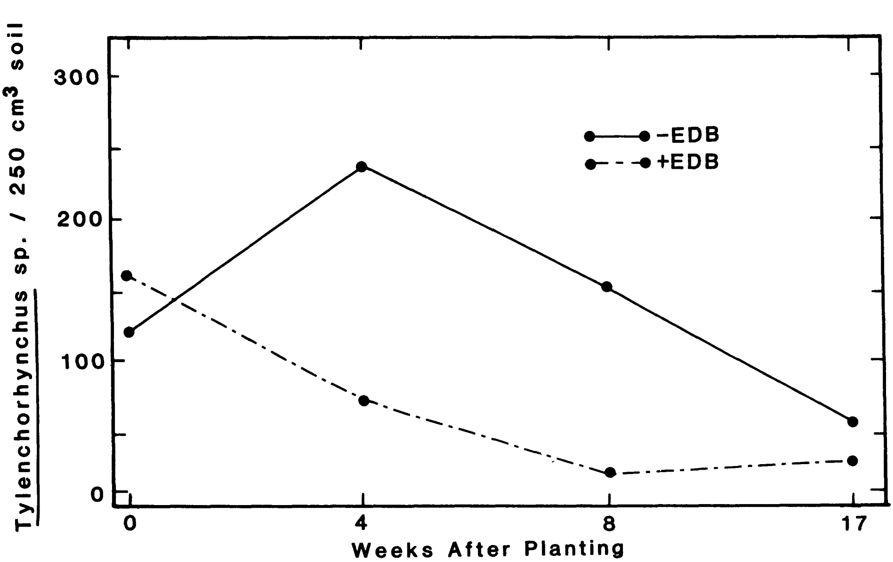

Fig. 3. Population dynamics of *Tylenchorhynchus* sp. in soil either fumigated with EDB or not fumigated and planted with *Helianthus annuus* cv. CCA 81 at Magoye, Republic of Zambia.

Table 2. Analysis of variance of *Tylenchorhynchus* sp. and *Meloidogyne javanica* (J2) populations on sunflower in soil either fumigated with EDB or not fumigated at Magoye.

		Mean squares	
Source of variation	df	*Tylenchorhynchus* sp.	*M. javanica*
Block	3	11 380.21	1 086 582.00
EDB	1	41 328.13	50 062 519.53
Error A	3	7 005.21	8 191 269.30
Sample date (SD)	3	20 130.21*	55 497 779.93*
EDB × SD	3	18 046.88*	49 480 800.80*
Error B	18	4 279.51	8 083 335.50
CV %		62.5	214.7

*$P < 0.05$.

Although second-stage juveniles (J2) of *M. javanica* in nonfumigated plots at Magoye averaged less than 10/250 cm^3 of soil at planting, and insignificant root galling was observed at 4 WAP, populations and gall indices increased on sunflower during the season. Mean root gall indices at 8 WAP were 5.4 and 1.8 in nonfumigated and fumigated plots, respectively. Recovery of J2 was less than 50/250 cm^3 of soil at 8 WAP, but by harvest, means of 10 000 and 300/250 cm^3 of soil were recovered from nonfumigated and fumigated plots, respectively. Analysis of variance indicated a sample date and an EDB × sample date interaction (Table 2).

At both locations, low numbers of *Xiphinema* sp. were recovered throughout the growing season. Populations were not affected significantly by sample date.

Maize: During the growing season at Mkushi, populations of *P. zeae* on maize declined from 325 to 10/250 cm^3 of soil by harvest (20 WAP) in nonfumigated plots and from 169 to 0/250 cm^3 of soil in those fumigated with EDB. Recovery of nematodes from roots placed on Baermann funnels declined from 50/g dry root at 4 WAP to 9/g dry root by 8 WAP in nontreated soil, whereas in treated soil 17 nematodes/g dry root at 4 WAP decreased to 13/g dry root by 8 WAP. Populations of *H. pseudorobustus* decreased from a mean of 150/250 cm^3 of soil at planting to less than 10/250 cm^3 of soil by harvest regardless of treatment. *P. christiei* reproduced on maize with greater population increases observed in fumigated plots, although these differences were not significant (Fig. 4). Fumigation gave excellent control of *S. brachyurum* at both locations, whereas populations in nonfumigated plots increased at both locations (Table 3 and Fig. 5). At Magoye maize was an excellent host for *Tylenchorhynchus* sp. Populations increased in both fumigated and nonfumigated plots, but significantly ($P < 0.05$) higher populations were reco-

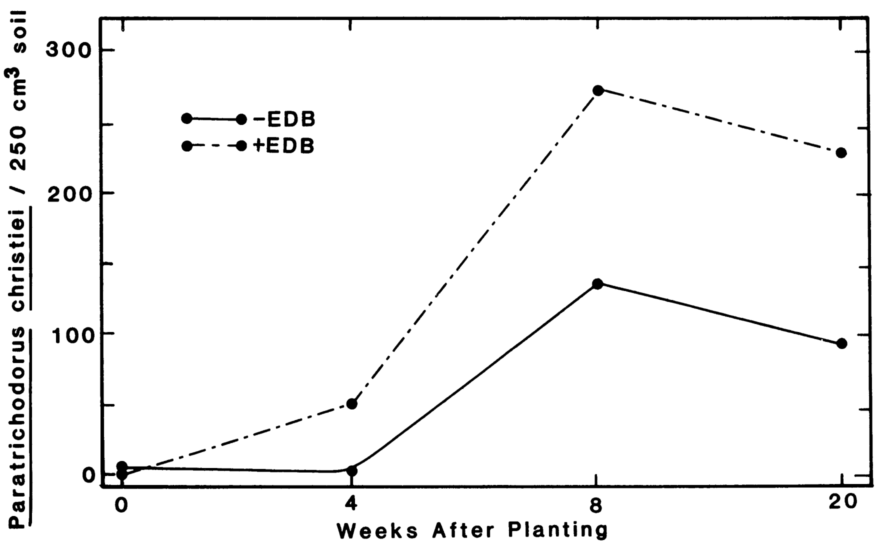

Fig. 4. Population dynamics of *Paratrichodorus christiei* in soil either fumigated with EDB or not fumigated and planted with *Zea mays* cv. MM 603 at Mkushi, Republic of Zambia.

vered from fumigated plots by harvest (Fig. 6). Root galling was not observed on maize and few *Meloidogyne* J2 were recovered.

At both locations low numbers of *Xiphinema* were recovered from maize. Populations were not affected significantly by sample date.

A uniform sunflower yield loss (15%) occurred at both locations due to bird damage. Fumigation did not increase sunflower yield at the Mkushi location (Table 4). However, at Magoye, the 56% yield increase associated with EDB fumigation was significant ($P = 0.06$). Effects of fumigation on maize yield at Magoye also were significant at $P = 0.12$.

Table 3. Analysis of variance of *Scutellonema brachyurum* populations on maize in soil either fumigated with EDB or not fumigated at two locations in Zambia.

		Mean squares	
Source of variation	df	Mkushi	Magoye
Block	3	2 276.04	71 796.88
EDB	1	750 312.50*	2 790 703.12*
Error A	3	29 635.42	54 192.71
Sample date (SD)	3	53 984.38	245 755.21*
EDB × SD	3	45 677.09	398 671.87*
Error B	18	52 764.76	20 651.04
CV %		112.2	39.8

*$P < 0.05$.

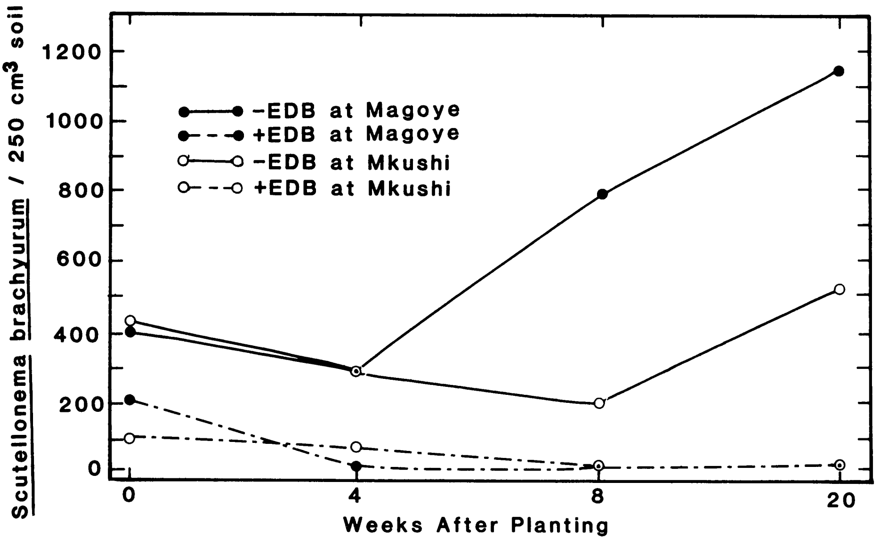

Fig. 5. Population dynamics of *Scutellonema brachyurum* in soil either fumigated with EDB or not fumigated at Magoye and Mkushi, Republic of Zambia and planted with *Zea mays* cv. MM 603.

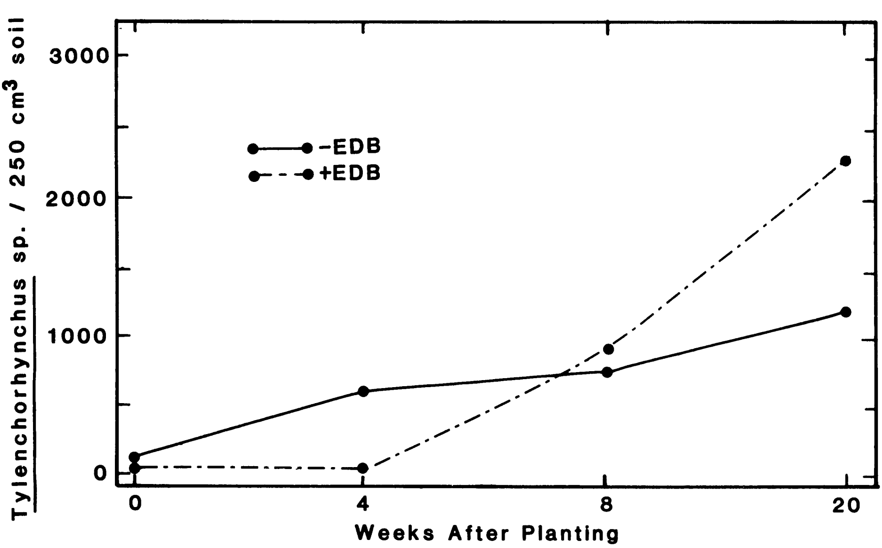

Fig. 6. Population dynamics of *Tylenchorhynchus* sp. in soil either fumigated with EDB or not fumigated and planted with *Zea mays* cv. MM 603 at Magoye, Republic of Zambia.

Table 4. Yield of sunflower and maize grown in soil either fumigated with EDB or not fumigated and at two locations in Zambia.

		Yield (kg/ha)	
Crop	EDB	Mkushi	Magoye
Sunflower	–	1 819.6	1 087.6[x]
Sunflower	+	1 832.7	1 702.0
CV%		20.5	22.7
Maize	–	4 819.1[y]	4 617.1[z]
Maize	+	5 485.7	5 001.9
CV%		4.8	5.1

[x]Difference in sunflower yield between fumigation and no fumigation at Magoye significant at $P = 0.06$.
[y]Difference in maize yield between fumigation and no fumigation at Mkushi significant at $P = 0.08$.
[z]Difference in maize yield between fumigation and no fumigation at Magoye significant at $P = 0.12$.

Due to cattle damage, maize yield was collected from only three replications at the Mkushi location where yield differences were significant at $P = 0.08$.

DISCUSSION

Sunflower and maize cropping seasons in the Republic of Zambia normally are preceded by a 6-mo dry season which may result in inaccurate estimates of certain plant-parasitic nematode populations at planting. In this study fumigation apparently had little effect on populations of *P. christiei*, probably resulting from protection provided by the overseasoning of thick-walled eggs. Population build-ups of *P. christiei* resulting from fumigation have been reported previously (5). In contrast, populations of *S. brachyurum* at planting were significantly lower in fumigated than in nonfumigated plots.

Declining populations of *P. zeae* and *H. pseudorobustus* on maize and sunflower indicated that these nematode species had increased previously on pasture grasses prior to planting maiz and sunflower. Both nematodes reproduced on maize cv. MM 603 in greenhouse cultures and *Pratylenchus zeae* also increased on carrot discs (Lawn, unpubl.). Population dynamics reported in the present field trial may have resulted from unique feeding and reproductive behaviors of the populations of these species, competition from the semi-endoparasitic behavior of *S. brachyurum*, or additional undefined interactions with the soil environment.

No significant sunflower yield increase was associated with EDB fumigation at Mkushi. Since fumigation provided excellent control of *S.*

brachyurum and populations of *P. christiei* did not differ significantly regardless of treatment, sunflower appeared tolerant to the population levels of these nematodes that were oberved at Mkushi. Similar population levels of *S. brachyurum* at Magoye and excellent control with EDB indicated that the significant yield increase associated with fumigation at this location was due to control of *Tylenchorhynchus* sp. and *M. javanica*. Analysis of variance of populations of all nematodes at Magoye revealed significant sample date and EDB × sample date interactions. These interactions together with the declining populations of *Tylenchorhynchus* sp. beyond 4 WAP suggest an inability to compete with *M. javanica*. The large late-season population increase of *M. javanica* in nonfumigated plots indicated that sunflower yield increase resulted from control of *M. javanica*. Sunflower yield loss attributed to *M. javanica* in this study was more extensive than reported previously (14) and probably was the result of either higher initial populations at *M. javanica* at planting or different environmental influences.

Maize cv. MM 603 is a host for *P. christiei, S. brachyurum*, and *Tylenchorhynchus* sp. Although yield data were significantly different at probability levels slightly larger than $P < 0.05$ at both locations, occurrence of yield reduction at two different locations indicated that nematodes were involved in the yield loss. The small population increase of *P. christiei* at Mkushi indicated that this species was not important in reducing yield of maize and that the oberved yield loss was due to *S. brachyurum*. At Magoye, *Tylenchorhynchus* sp. increased in both fumigated and nonfumigated plots, whereas *S. brachyurum* was controlled by fumigation, indicating that the reduction in yield of maize was due primarily to *S. brachyurum*.

Results from this study showed that *S. brachyurum* and *M. javanica* are important pests in certain cropping systems in the Republic of Zambia. Additional field trials complemented by greenhouse pathogenicity studies are needed to more definitively characterize the interrelationships among *S. brachyurum* and *M. javanica* and the other nematode species associated with maize and sunflower in the Republic of Zambia.

LITERATURE CITED

1. ANON. 1982. Checklist of plant-parasitic nematodes associated with plants in Southern Africa. Department of Agriculture and Fisheries, Pretoria, South Africa.
2. BAERMANN, G. 1917. Eine einfache methode zur auffindung von ankylostomum (Nematoden) larven in erdpoben. Geneeskundig Tijdschrift voor Nederlandsch-Indie. 57:131–137.
3. BARKER, K. R. 1985. Nematode extraction and bioassays. Pp. 19–35 *in* K. R. Barker, C. C. Carter, and J. N. Sasser, eds. An Advanced Treatise on *Meloidogyne*, Vol. II: Methodology. North Carolina State University and U.S. Agency for International Development: Raleigh, North Carolina, U.S.A.
4. BERNARD, E. C., and M. L. KEYSERLING. 1985. Reproduction of root-knot, lesion, spiral and soybean cyst nematodes on sunflower. Plant Disease 69:103–105.

5. CHRISTIE, J. R. 1959. Plant Nematodes: Their Bionomics and Control. The H. & W. B. Drew Co.: Jacksonville, Florida, U.S.A.
6. COBB, N. A. 1918. Estimating the nema population of soil. U.S. Department of Agriculture Technology Circular 1. U.S. Government Printing Office: Washington, D.C.
7. EGUNJOBI, O. A. 1974. Nematodes and maize growth in Nigeria. I. Population dynamics of *Pratylenchus brachyurus* in and about the roots of maize and its effects on maize production at Ibadan. Nematologica 20:181–186.
8. JENKINS, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Disease Reporter 48:692.
9. KAPLAN, D. T., R. A. RHODE, and T. A. TATTAR, 1976. Leaf diffusive resistance of sunflower infected by *Pratylenchus pentrans*. Phytopathology 66:967–969.
10. KAPLAN, D. T., T. A. TATTAR, and R. A. RHODE. 1976. Reduction of electrical resistance in sunflower roots infected with lesion nematodes. Phytopathology 66:1262–1264.
11. MARTIN, G. C. 1956. The common root-knot nematode (*M. javanica*) and crop rotation 13, maize (*Zea mays*). Rhodesia Farmer 27(24)22.
12. RICH, J. R. 1979. Pathogenicity and control of two root-knot nematodes on late season sunflower. Nematrópica 9:105–106.
13. RICH, J. R., and R. A. DUNN. 1982. Pathogenicity and control of nematodes affecting sunflower in North Central Florida. Plant Disease 66:297–298.
14. RICH, J. R., and V. E. GREEN, JR. 1981. Influence of *Meloidogyne javanica* on growth and yield of oilseed sunflower. Nematrópica 11:11–16.
15. ROBINSON, A. F., and C. C. ORR. 1980. Histopathology of *Rotylenchulus reniformis* on sunflower. Journal of Nematology 12:84–85.
16. SHEPHERD, J. A. 1977. Hosts of non-gall forming nematodes associated with tobacco in Rhodesia. Rhodesian Journal of Agricultural Research 15:95–97.
17. WHITEHEAD, A. G. 1969. The distribution of root-knot nematodes (*Meloidogyne* spp.) in tropical Africa. Nematologica 15:315–333.

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