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Effects of no-tillage and cropping sequence on population densities of some plant-parasitic nematodes

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Abstract

Population densities of *Pratylenchus brachyurus* and *Helicotylenchus pseudorobustus* were studied under two no-tillage and conventional tillage methods and under four cropping sequences over a period of two years. Tillage methods and cropping sequences resulted in significant differences in the nematode populations. The densities of *P. brachyurus* and *H. pseudorobustus* were highest in the no-tillage plots but lowest under the conventional tillage. The greatest populations of *P. brachyurus and H pseudorobustus* occurred under continuous maize-maize and rice-rice cropping sequences and were lowest under maize-cowpea and rice-cowpea cropping sequences.

Introduction

Current knowledge of comparative tillage studies has resulted in a shift towards less tillage in seed bed preparation over conventional tillage methods involving ploughing, harrowing and weeding (Ezedinma, 1964; Jones *et al* 1968; Shear and Moschler, 1969; Baumer and Bakerman, 1973; Lal, 1974, 1976; Lal, Maurya and Oseiyeboa, 1978; Aina, 1979 and Armon, Lal and Obi, 1980). These studies had claimed some advantages for zero-tillage which include: decreased soil erosion and water run off, higher infiltration rate of water, improved nutrient availability, increased crop yields and savings in labour. However, only a few studies have been carried out on the effects of minimum or zero tillage on pest and disease incidence, especially the soil borne pathogens and no trend has been established on the effect on nematode population.

Southards (1971) studied the nematode population on corn grown under two tillage practices. He reported that fall-ploughed plots contained 37% fewer *Meloidogyne incognita* than did spring-ploughed plots. Caveness (1974) found more *Pratylenchus* spp. in soil and maize roots in tilled than in non-tilled plots, but *M. incognita* were more numerous in the non-tilled plots. Thomas (1978) studied the population densities of nematodes in corn plots under seven different tillage practices. The tillage practices produced shifts in the population of *H. pseudorobustus*, *Pratylenchus* spp., *Xiphinema americanum* and dorylaimids. Except with members of Tylenchinae, highest densities occurred in the no-till plots, and lowest in the fall - or spring-ploughed plots.

Management of populations of plant parasitic nematodes by growing non-host plants is well established. Recent studies have provided evidence that different cropping sequences can affect nematode populations with some reducing the population to safer levels. It is also known that monocultures result in considerable increase in the population of nematodes (Good, 1968; Ferris and Bernard, 1971; Nusbaum and Ferris, 1973; Johnson, Dowler and Hauser, 1974; Amosu, 1975, 1982; and Ogunfowora, 1983). The purpose of the present work was to determine the influence of three tillage practices and four different double cropping sequences on population densities of some plant-parasitic nematodes overtime.

Materials and Methods

Experimental Site and Soil

The study was conducted over two years at the University Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife. The soil of the field used for the study belongs in the Iwo series and it is classified as Oxic Paleustalf. It is a well drained sandy loam consisting of sand, 72.5%; silt, 11.1%; clay, 16.4%; and has a slope of 5% (Harpstead, 1973). The land had earlier been planted to various crops including maize.

Experimental design

The experimental design was a factorial with tillage, cropping sequence and sampling dates for nematodes as factors. The tillage treatments has three levels: (a) no-tillage by which weeds were controlled using chemicals (herbicides), (b) no-tillage by which weeds were controlled by pulling with hand and (c) conventional cultivation for weeds which involved hand-hoeing. The cropping sequences comprised: (a) maize followed by maize (M-M), (b) maize followed by cowpea (M-Cp), (c) rice followed by rice (R-R), (d) rice followed by cowpea (R-Cp). Nematode samples were taken on the 15th of April, July, September and November of each year, giving a total of eight sampling dates. Each experimental plot was 6.5 m x 11 m and each treatment was replicated four times.

Plant Culture and fertilizer application

Cowpea (*Vigna unguiculata* (L) Walp ssp *unguiculata* cv. Ife Brown) was planted 30 cm within rows, 45cm apart every August 15 and harvested the following January/February. Maize (*Zea mays* L.) composite A x B was planted 30 cm within rows, 90 cm apart every March 15 for early crop and August 1 for the late crop. Rice (*Oryza sativa* L., cv. Os 6) was planted 30 cm within rows 30 cm apart every March 15 for the early crop and August 1, for the late crop. Early maize and rice were harvested in July and the late crops in January-February. At the start of the experiment and prior to planting, 220 kg/ha of phosphorus and 110 kg/ha of potassium were broadcast and ploughed into the soil. Subsequently the maize plots received a total of 260 kg/ha nitrogen per crop season in split application of ⅓ at planting and ⅔ four weeks later. Similarly, rice plots received a total of 130 kg/ha nitrogen in split application of ⅔ at planting and ⅓ at heading.

Two weedings were done per crop season by weeding with hoe, hand pulling of weeds and by application of Paraquat 24% depending on the tillage treatment. Paraquat 24% (1, 1, dimethyl-4-4 bipyridinium ion) at 500 ml. per 50 l. of water was sprayed to wet on weeds within the rows of plots receiving chemical as no-tillage treatment 15 days and 4-5 weeks after emergence.

All crop and weed residues were returned to each plot, except maize cobs and rice heads and hulls.

Soil and root sampling for nematodes

Soil samples (2.1 x 20 cm core) were collected from within the three inner rows at intervals of 3 m. within the row every 15th of April, July, September and November of each year. Two cores of soil were taken on either side of the plant at each stop for a total of 18 cores per plot.

Nematode populations in the soil and the root tissue were assayed by a combination of modified wet-sieving method (Christie and Perry, 1951) and Young's incubation technique (1954) for endoparasites. Nematodes in two-5 ml aliquots from each sub-sample were counted at 30 x magnification with a stereomicroscope. The data were subjected to analysis of variance.

Results

Significant differences ($P = 0.01$) in numbers of nematodes/150 cm^3 soil were observed between the two no-tillage methods and conventional tillage (Table 1). The populations of *P. brachyurus* and *H. pseudorobustus* were usually highest in the no-tillage plots and generally lowest under the conventional tillage (Figs 1, 2). The nematode populations did not differ significantly in the two no-tillage methods achieved through chemical application and hand-pulling. In both cases, the nematode populations were generally low at planting, but rose thereafter to a peak in November (Figs 1 & 2). The populations built up from one year to the other.

Similarly, differences ($P = 0.01$) in numbers of nematodes/150 cm^3 soil occurred between the continuous maize-maize and rice-rice crop sequences and the crop rotations of maize-cowpea and rice-cowpea crop sequences (Table 1). The greatest populations of *P. brachyurus* and *H. pseudorobustus* usually occurred in continuous maize-maize and rice-rice crop sequences while the lowest occurred in the maize-cowpea and rice-cowpea crop sequences (Figs. 3 & 4). Nematode populations under maize-cowpea and rice-cowpea crop sequences were also usually low soon after the planting of new crops in April and September of each year. However, under maize-maize and rice-rice crop sequences, the nematode populations of each species were generally low at planting in April, but rose thereafter to a peak in November. Regardless of the tillage method, the results showed that the crop sequences would also influence the nematode population.

Discussion

The data presented indicate that different tillage methods and crop sequences could result in significant changes in nematode populations. The population of *P. brachyurus* and *H. pseudorobustus* were greater in no-tillage plots and lower under conventional tillage. This agrees with the results reported by Thomas (1978) in a similar investigation but does not fully agree with the results reported by Caveness (1974) in another similar investigation. Caveness (1974) found more *Pratylenchus* spp. in the soil and maize roots from tilled than from non-tilled plots, but *H. pseudorobustus* were more numerous in non-tilled plots.

Possible explanations for reduced nematode numbers after soil disturbance are (i) delayed seedling emergence and reduced seedling stands (Aina 1978), (ii) less total nutrient contents in tilled than in no-tilled plots (Armon *et al.* 1980) and (iii) accumulation of surface debris with reduced tillage may act as a mulch affecting moisture retention, warming rate and depth of root growth (Johnson, Summer, Jaworski and Chalfant, 1977). Although no attempt was made to evaluate the importance of the increased nematode population densities resulting from reduced tillage on crop damage and yield, it is expected that increased damage to crops and reduced crop yields would result over time. Therefore, where nematode control in field crops is important, the use of reduced tillage for soil and energy conservation should be discouraged, since it might increase the damage caused by nematodes and lead to reduction in crop yield.

High densities of *P. brachurus* and *H. pseudorobustus* under continuous maize-maize and rice-rice crop sequences were not surprising, because both crops are good hosts to the two nematodes (Amosu, 1975). Moreover, monoculture usually brings about considerable increase in the population of nematodes (Nusbaum and Ferris, 1973; Johnson, Dowler and Hauser 1974, Alam, *et al* 1980). However, there was a break in the build up of nematode population under the maize-cowpea and rice-cowpea crop sequences especially in April and September when the different crops were just planted. This was not the case under the maize-maize and rice-rice crop sequences. (Figs 3 & 4). It is significant that cowpea, a moderate host (Amosu, 1975) to both *P. brachyurus* and *H. pseudorobustus* when planted in rotation with rice and maize was able to reduce nematode population build up. Therefore, in situations when non-host crops are not available for use in crop rotation for nematode control, a moderate host to the pathogen may be used effectively.

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Table 1: ANOVA TABLE FOR *PRATYLENCHUS BRACHYURUS* AND *HELICOTYLENCHUS PSEUDOROBUSTUS* POPULATIONS.

		Mean Squares	
Sources	**D.F.**	***P. brachyurus***	***H. Pseudorobustus***
Replicate	3	987.45 NS	2046.29 NS
Tillage Method	2	82262.94**	118340.25**
Crop Sequence	?	30623.29**	18189.27**
Till. x Crop Seq.	6	6710.19**	12315.86**
Sampling date	7	16075.55**	32286.93**
Till Samp. date	14	4229.22 NS	5888.61**
Crop seq. x Samp. date	21	6861.00**	8554.25**
Till. x Crop Seq. x Samp. date	42	1026.32 NS	946.52 NS
Error	244	2157.76	1046.25
Total	383	3094.09	3158.38

**; significance at 0.01 levels of P.

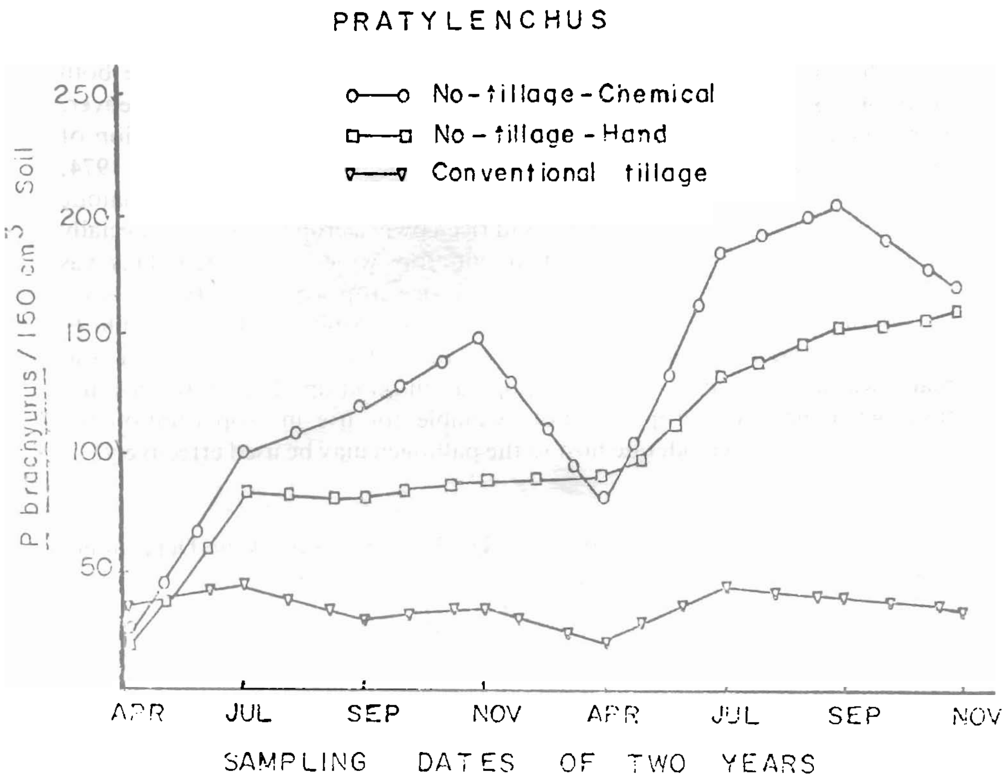

Fig. 1: Mean population densities of *Pratylenchus brachyurus* under three different tillage methods.

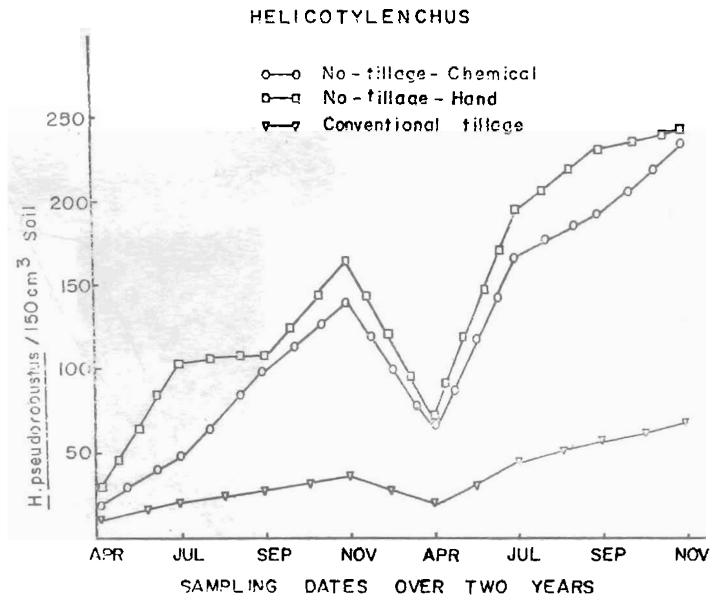

Fig. 2: Mean population densities of *Helicotylenchus pseudorobustus* under three different tillage methods.

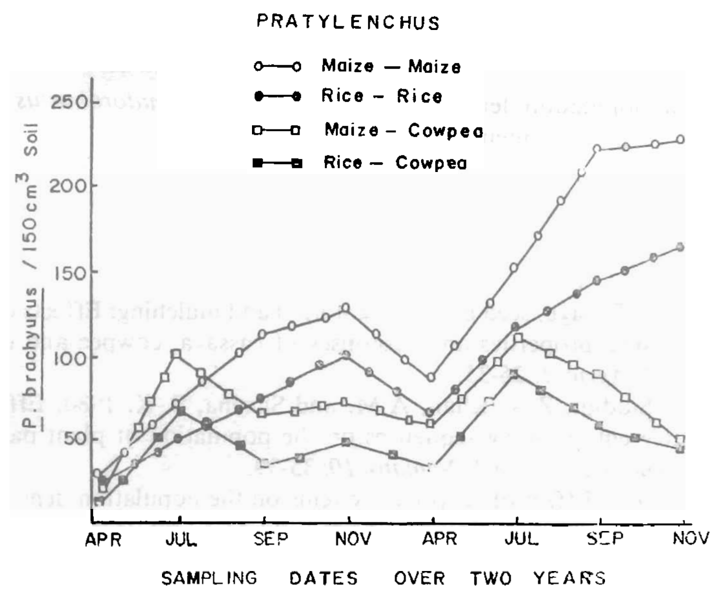

Fig. 3: Mean population densities of *Pratylenchus brachyurus* under four cropping sequences.

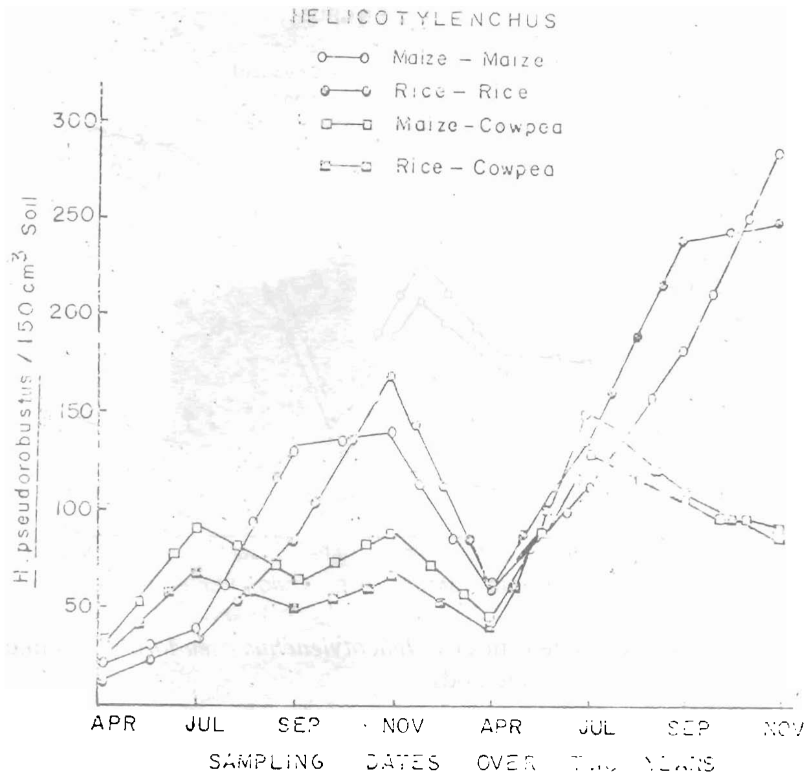

Fig. 4: Mean population densities of *Helicotylenchus pseudorobustus* under four cropping sequences.

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