EFFECT OF LONG-TERM ROTATION AND TILLAGE PROGRAMS ON PLANT-PARASITIC NEMATODES

R. McSorley and R. N. Gallaher[1]

ABSTRACT

Effects of tillage and crop rotation on nematode densities in tropical corn (*Zea mays* L. Pioneer Brand X304C) were determined in each of three seasons (1990-1992) in north Florida. Treatments in the factorial experiment consisted of conventional or no tillage and rotation with sorghum *(Sorghum bicolor* [L.] Moench) or soybean *(Glycine max* [L.] Merr.). Tillage and rotation treatments were maintained for 14 previous years, including the 1989 season. In subsequent corn crops (1990-1992). effects of treatments depended on nematode species. The most serious nematode pest in the site, the root-knot nematode *(Meloidogyne incognita* [Kofoid & White] Chitwood) was lower in plots rotated to sorghum and remained so for three seasons, but was not affected by tillage practices.

INTRODUCTION

Plant-parasitic nematodes are serious pests of many crops grown in the southeastern United States (Christie, 1959; Johnson, 1982: Taylor and Sasser, 1978). As nematicide usage becomes more limited, it will be necessary to develop alternative methods for managing nematodes. Two alternatives which can often be implemented easily and inexpensively are crop rotation and changes in tillage practices (McSorley and Gallaher, 1991; Minton, 1986). Crop rotation can be effective against root-knot nematodes *(Meloidogyne* spp.), which are major pests in the Southeast (Johnson, 1982; McSorley and Gallaher, 1991, 1992, 1993a; Rodriguez-Kabana et al., 1989). Effects of tillage practices on nematode populations have been less consistent (McSorley and Gallaher, 1993b; Minton, 1986). The objective of the current research was to compare the effects of crop rotation and tillage on population densities of plant-parasitic nematodes, in a location where both methods had been practiced for many years.

[1] Dept. of Entomology and **Nematology and** Dept. of Agronomy. Institute of **Food** and Agricultural Sciences. University of Florida, Gainesville. FL 32611.

MATERIALS AND METHODS

The experiment was conducted at the University of Florida Green Acres Agronomy Research Farm in Alachua County, on an Arredondo sand (94% sand, 3.5% silt, 2.5% clay; pH 6.2; 1.7% organic matter). As of 1989, conventional and no-till plots had been maintained at this site for 14 years as part of a double-cropping rotation with soybean *(Glycine max* [L.] Merr.) or sorghum *(Sorghum bicolor* [L.] Moench) in the summer and oat *(Avena sativa* L.) in the winter. In the spring of the 15th year (1990). a factorial experiment with tropical corn *(Zea mays* L., Pioneer Brand X304C) was initiated on the site. The factorial involved two crop rotation treatments soybean cv. (Centennial and sorghum cv. DeKalb BR64 during the previous year, 1989) and two tillage treatments (conventional and no-till). All treatment combinations were replicated four times, and the experiment was repeated in 1991 and 1992 in the same plots.

A winter cover crop of oats cv. Florida 501 was planted in all plots in late November-early December each year. Oats were harvested and mowed in early May. In conventional-till plots, the soil was rototilled twice before planting corn. In May of each year, tropical corn was planted directly into no-till or conventional-till plots with a two-row Brown-Harden Superseeder. Individual plots consisted of four rows, 10 m long and 0.75 m apart. Fertilizer and herbicide usage is described elsewhere (McSorley and Gallaher, 1993b).

Plots were sampled for nematodes each year at the planting of the corn crop in May and the harvest of the corn crop in September. Each soil sample consisted of six cores 2.5 cm in diameter x 20 cm deep collected within plant rows in a plot in a systematic pattern. A 100-cm^3 subsample was removed for nematode extraction using a modified sieving and centrifugation procedure (Jenkins, 1964). Nematode count data were log-transformed ($\log_{10}$ [x + 1]) before conducting an analysis of variance (ANOVA). but arithmetic means rather than transformed means are presented in the tables.

Table 1. Effects of tillage and rotation crop on population densities of root-knot nematodes (Meloidoavne incognita) at planting and harvest of tropical corn crops, 1990-1992.

Tillaae	Rotation crop (1989)	Nematodes per 100 cm’ soil 1990 Mav	1990 Sept.	1991 Mav	1991 Sept.	1992 Mav	1992 Sept.
No-till	Soybean	1	3	10	26	1	112
No-till	Sorghum	0	0	0	2	0	0
Conventional	Soybean	0	10	1	104	3	91
Conventional	Sorghum	0	0	0	1	0	3
ANOVA effects:							
Tillage		ns	ns	ns	ns	ns	ns
Rotation		ns	*	ns	*	ns	•
Tillage x rotation		ns	ns	ns	ns	ns	ns

• Analysis of variance (ANOVA) effect significant at P $\leq$ 0.05;
ns = not significant.

Table 2. Effects of tillage and rotation crop on population densities of ring nematodes (Criconemella spp.) at planting and harvest of tropical corn crops, 1990-1992.

Tillaae	Rotation crop (1989)	Nematodes per 100 cm^3 soil 1990 Mav	1990 Sept.	1991 Mav	1991 Sept.	1992 May	1992 Sept.
No-till	Soybean	40	138	361	374	374	552
No-till	Sorghum	98	202	160	234	460	643
Conventional	Soybean	20	246	149	291	448	1178
Conventional	Sorghum	138	314	391	647	965	999
ANOVA effects:							
Tillage		ns	ns	ns	ns	ns	ns
Rotation		*	ns	ns	ns	ns	ns
Tillage x rotation		*	ns	ns	•	ns	ns

* Analysis of variance (ANOVA) effect significant at P $\leq$ 0.05;
ns = not significant.

RESULTS AND DISCUSSION

The root-knot nematode *(Meloidogyne incognita* [Kofoid & White] Chitwood) was not affected by tillage practices, but each year in September, population densities of *M. incognita* were lower in corn plots in the sorghum rotation than in plots in the soybean rotation (Table 1). These results are consistent with those obtained previously (McSorley et al. *1993a)* with DeKalb BR64 and certain other sorghum cultivars which are beneficial in rotations against *M. incognita.* It is interesting to note that the significant effects of sorghum rotation on *M. incognita* lasted for three years in the tropical corn crops examined here (Table 1). In contrast, reductions of *M. arenaria* (Neal) Chitwood in a rotation with sorghum and susceptible peanut *(Arachis hypogaea* **L.)** lasted only a single season (Rodriguez-Kabana and Touchton, 1984).

Densities of ring nematodes *(Criconemella* spp.) were affected by treatments in the first season, when they were greater following sorghum rotation (Table 2). However, ring nematodes are not major pests of most crops in Florida, where root-knot nematodes are the key nematode pests on most crops (McSorley and Gallaher, 1991). The stubby-root nematode *(Paratrichodorus minor* [Colbranl Siddiqi) was unaffected by the treatments in this series of experiments, and its population densities increased during the three seasons of corn (Table 3). Effects of treatments on lesion nematodes *(Pratylenchus* spp., primary *P. scribneri* Steiner) varied, but lesion nematode numbers were greatest in Sept. 1990 in conventional-till plots following soybean and in Sept. 1991 in plots which had received conventional tillage (Table 4). Alby et al. (1983) also observed higher densities of *P. scribneri* in conventional-till compared with no-till soybean plots.

It is clear from our results that effects of tillage or crop rotation depend on the nematode species involved. The most damaging nematodes occurring in our study site are probably root-knot and stubby-root nematodes (Christie, *1959;* McSorley and Gallaher, *1991).* Therefore any incentive to use tillage or crop rotation for nematode management would depend on results expected with these two species. Little effect from rotation or tillage on *P. minor* would be expected. Rotation with sorghum was much more important than tillage for management of *M. incognita.* Therefore the choice to change tillage practices should not be expected to have much impact on *M. incognita* populations, and should be made for reasons other than nematode control.

Table **3.** Effects of tillage and rotation crop on population densities of stubby-knot nematodes (<u>Paratrichodorus</u> minor) at planting and harvest of tropical corn crops, 1990-1992.

		Nematodes per 100 cm^3 soil					
	Rotation crop	1990		1991		1992	
Tillage	(1989)	May	Sept.	May	Sept.	May	Sept.
No-till	Soybean	4	2	20	24	45	39
No-till	Sorghum	3	3	34	48	40	40
Conventional	Soybean	3	4	24	64	52	23
Conventional	Sorghum	3	5	49	52	48	38
ANOVA effects:							
Tillage		ns	ns	ns	ns	ns	ns
Rotation		ns	ns	ns	ns	ns	ns
Tillage x rotation		ns	ns	ns	ns	ns	ns

* Analysis of variance (ANOVAI effect significant at P $\leq$ **0.05:**
ns = not significant.

Table 4. Effects of tillage and rotation crop on population densities of lesion nematodes (Pratylenchus spp.) at planting and harvest of tropical corn crops, 1990-1992.

Tillage	Rotation crop (1989)	Nematodes per 100 cm^3 soil					
		1990		1991		1992	
		May	Sept.	May	Sept.	May	Sept.
No-till	Soybean	5	338	48	608	199	1866
No-till	Sorghum	6	196	186	440	144	1964
Conventional	Soybean	3	734	221	1350	341	2164
Conventional	Sorghum	0	56	189	1325	241	2487
ANOVA effects:							
Tillage		*	ns	ns	*	ns	ns
Rotation		*	*	ns	ns	ns	ns
Tillage x rotation		ns	*	ns	ns	ns	ns

* Analysis of variance (ANOVA) effect significant at $P \leq 0.05$;
ns = not significant.

LITERATURE CITED

Alby, T., J. M. Ferris, and V. R. Ferris. 1983. Dispersion and distribution of *Pratylenchus scribneri* and *Hoplolairnus galeatus* in soybean fields. J. Nematol. 15:418-426.

Christie, J. R., 1959. Plant nematodes. Their bionomics and control. Agric. Exp. Stn., Univ. of Florida, Gainesville.

Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Dis. Reptr. 48:692.

Johnson, A. W. 1982. Managing nematode populations in crop production. p. 193-203. *In* R. D. Riggs (ed.). Nematology in the Southern Region of the United States. Southern Coop. Serv. Bull. 276. Ark. Agric. Exp. Stn., Fayetteville.

McSorley, R., and R. N. Gallaher. 1991. Cropping systems for management of plant-parasitic nematodes. p. 38-45. *In* A. B. Bottcher, K. L. Campbell, and W. D. Graham (eds.). Proc. Conf. Environmentally Sound Agriculture. Fla. Coop. Extn. Serv., Univ. of Florida, Gainesville.

McSorley, R., and R. N. Gallaher. 1992. Comparison of nematode population densities on six summer crops at seven sites in north Florida. Suppl. J. Nematol. 24:699-706.

McSorley, R. and R. N. Gallaher. 1993a. Population densities of root-knot nematodes following corn and sorghum in cropping systems. p. 26-29. *In* P. K. Bollich (ed.). Proc. 1993 Southern Conserv. Tillage Conf. for Sustainable Agriculture. Louisiana Agric. Exp. Stn. Ms. No. 93-86-7122, Monroe, LA.

McSorley, R., and R. N. Gallager. 1993b. Effect of crop rotation and tillage on nematode densities in tropical corn. Suppl. J. Nematol. 25:814-819.

Minton, N.A. 1986. Impact of conservation tillage on nematode populations. J. Nematol. 18:135-140.

Rodriguez-Kabana, R., D. G. Robertson, L. Wells, P. S. King, and C. F. Weaver. 1989. Crops uncommon to Alabama for the management of *Meloidogyne arenaria* in peanut. Suppl. J. Nematol. 21:712-716.

Rodriguez-Kabana, R., and J. T. Touchton. 1984. Corn and sorghum as rotational crops for management of *Meloidogyne arenaria* in peanut. Nematropica 14:26-36.