Effect of Tillage and Liming on Nematode Populations

R. McSorley and R. N. Gallaher
Institute of Food and Agricultural Sciences
University of Florida

Abstract

The effects of tillage and liming on plant-parasitic nematodes were determined in a split-plot experiment with soybeans *(Glycine max* [L.] Merr.) in north Florida. Main plot treatments were no-tillage or conventional-tillage, and subplots were amended with lime at rates of 0, 1,000, 2,000, 3,000, or 4,000 lb/A. Population densities of ring *(Criconemellu ornata* [Raski] Luc and Raski), root-knot *(Meloidogyne incognita* [Kafoid and White] Chitwood), and stubby-root nematodes *(Paratrichodorus minor* [Colbran] Siddiqi) were significantly greater in no-tillage plots than in conventional-tillage plots, but densities of the lesion nematode *(Pratylenchus scribneri* Steiner) were greater in conventional-tillage plots. Liming affected soil pH, but did not affect nematode densities or soybean yield, which were greater in no-tillage plots than in conventional-tillage plots.

Introduction

Plant-parasitic nematodes are important pests of soybean and other agronomic crops grown in the southeastern United States (Johnson, 1982; Riggs and Niblack, 1993). With the decline and limitation of nematicide usage, it is essential to develop effective alternative practices for nematode management (McSorley, 1994) and to examine the effects of common agricultural practices on plant-parasitic nematode populations. In north Florida, crop rotation (McSorley and Gallaher, 1993) or use of certain winter cover crops (McSorley et al., 1991) can reduce densities of some nematode species. Crop rotation has been much more effective than tillage in lowering densities of plant-parasitic nematodes (McSorley and Gallaher, 1994a).

In general, effects of tillage practices on nematode populations have been somewhat inconsistent and deserving of further investigation (Minton, 1986). Although nematodes may be affected by extremes in pH, the consequences of liming on nematode populations have been little studied (McSorley and Gallaher, 1994b); Norton, 1978). The objective of the research reported here was to compare the effects of tillage and liming on population densities of plant-parasitic nematodes on a sandy soil in north Florida.

Materials and Methods

The experiment was conducted during 1990-91 at the University of Florida Green Acres Agronomy Research Farm in Alachua County on a Bonneau fine sand (91% sand, 4% silt, 5% clay). The design was a split-plot, with two levels of tillage (conventional vs. no-tillage) as main plots and five rates of lime as subplots. Following removal of a corn *(Zea mays* L.) crop in the fall of 1990, dolomitic limestone was applied to subplots (10 feet wide x 30 feet long) at rates of 0, 1,000, 2,000, 3,000, or 4,000 lb/A. A winter cover crop of wheat *(Triticum aestivum* L.) was planted in November 1990 and harvested in April 1991. Crop residues were then mowed and sprayed with 2.0 Ib ai/A of glyphosate. Plots receiving the conventional tillage treatment were rototilled twice in April/May. On May 28, 'Howard' soybeans were planted directly into all plots (conventional-tillage and notillage with wheat stubble) with a two-row Brown-Harden Superseeder. Each subplot consisted of four rows, 30 inches apart and 10 feet long; each treatment combination was replicated four times. Crop management is described in detail elsewhere (McSorley and Gallaher, 1994b).

All subplots were sampled for nematodes on June 11 and October 15. Each soil sample consisted of six cores (1.0-inch diameter x 8-inches deep) collected from the center two rows of a subplot and combined into a plastic bag for transport. In the laboratory, a 100 cm3 (ca. 0.2 pt) soil subsample was removed for nematode extraction using a modified sieving and centrifugation procedure (Jenkins, 1964). Nematodes were identified and counted under a dissecting microscope, and nematode count data were log-transformed before conducting an analysis of variance (ANOVA), but arithmetic means rather than transformed means are presented in the tables.

A portion of each soil sample was air-dried and screened, and soil pH was determined from a 1:2 soil solution ratio in water using a glass electrode. Soil nutrient analyses were also conducted and reported elsewhere (McSorley and Gallaher, 1994b). Soybean yields were determined by harvesting the middle two rows of each plot in mid-October.

Robert McSorley, Professor, Department of Entomology and Nematology, P.O. Box 110620, University of Florida, Gainesville, FL 32611-0620. Phone: 904-392-1901 ext. 137; Fax: 904-392-0190. R.N. Gallaher, Department of Agronomy, IFAS, University of Florida.

Table 1. Effects of tillage and lime rate on population densities of ring nematodes *(Criconemella ornata* at planting and harvest of soybeans.

Lime rate (lb/A)	Nematodes per 100 cm3 soil June 11 No tillage	Conv. tillage	October 15 No tillage	Conv. tillage
0	305	146	179	102
1,000	236	200	167	168
2,000	232	186	192	201
3,000	205	104	217	207
4,000	238	343	283	73
Mean	243	196	208	150
ANOVA effects:				
Tillage	ns		*	
Lime	ns		ns	
Tillaee x lime	ns		ns	

* Analysis of variance (ANOVA) effect significant at P 5 0.05; ns = not significant.

Table 2. Effects of tillage and lime rate on population densities of root-knot nematodes *(Meldogyne incognita)* at planting and harvest of soybeans.

Lime rate (lb/A)	Nematodes per 100 cm3 soil June 11 No tillage	Conv. tillage	October 15 No tillage	Conv. tillage
0	8	4	101	102
1,000	13	5	810	53
2.000	37	2	92	51
3,000	18	5	212	60
4,000	34	8	127	75
Mean	22	5	268	68
ANOVA effects:				
Tillage	**		*	
Lime	ns		ns	
Tillage x lime	ns		ns	

*, ** Analysis of variance (ANOVA) effect significant at P 5 0.05 and P ■ 0.01, respectively; ns = not significant.

Table 3. Effects of tillage and lime rate on population densities of stubbyroot nematodes *(Paratrichodorus minor)* at planting and harvest of soybeans.

Lime rate (lb/A)	Nematodes per 100 em3 soil June 11 No tillage	Conv. tillage	October 15 No tillage	Conv. tillage
0	37	17	47	28
1,000	58	22	26	27
2,000	44	24	38	24
3,000	38	27	30	42
4,000	28	17	53	30
Mean	41	21	39	30
ANOVA effects:				
Tillage	**		ns	
Lime	ns		ns	
Tillage x lime	ns		ns	

** Analysis of variance (ANOVA) effect significant at P 5 0.01; ns = not significant.

Results and Discussion

Population densities of the ring nematode were significantly lower in conventional-tillage plots than in no-tillage plots on one of two sampling dates (Table 1). The root-knot nematode showed a similar response, with lower densities in conventional-tillage plots on both sampling dates (Table 2), as did the stubby-root nematode, which was significantly lower in conventional-tillage plots on one sampling date (Table 3). None of these nematodes were affected by liming (Tables 1-3), even though the liming treatments resulted in a soil pH range from 5.9 (for the lime rate of 0 lb/A) to 6.6 (for the lime rate of 4,000 lb/A).

Unlike the other nematode species, the lesion nematode *(Pratylenchus scribneri* Steiner) was consistently more abundant under the conventional-tillage than under the no-tillage treatment (Table 4).

In the October sampling, a significant tillage x lime interaction was observed, with maximum numbers in the conventional-tillage subplots treated with 1,000 or 2,000 lb/A of lime (Table 4). This increase in abundance of *P. scribneri* under conventional tillage has been observed consistently in other locations and experiments (Alby et al., 1983; McSorley and Gallaher, 1994b). The reasons for this phenomenon are unknown, but could depend on the quality and degree of decomposition of the soybean roots, which the nematode inhabits (McSorley and Gallaher, 1994b). Other nematode species do not show this response, and in many cases are unaffected by tillage (McSorley and Gallaher, 1993; Minton, 1986) or favored by no-tillage, as observed here or in a previous study in Iowa (Thomas, 1978).

Soybean yields (Table 5) were significantly greater in no-tillage plots than in conventional-tillage plots, but were not affected by liming. Yields did not seem to be related to nema-

Table 4. Effects of tillage and lime rate on population densities of lesion nematodes *(pratylenchus scribneri* at planting and harvest of soybeans.

Lime rate (lb/A)	Nematodes per 100 cm3 soil June 11 No tillage	Conv. tillage	October 15 No tillage	Conv. tillage
0	4	74	111	96
1,000	44	70	140	727
2P00	22	42	234	528
3,000	42	91	223	479
4,000	50	55	258	344
Mean	32	66	193	435
ANOVA effects:				
Tillage	**		**	
Lime	ns		ns	
Tillage x lime	*		ns	

*, ** Analysis of variance (ANOVA) effect significant at P ■ 0.05 and P 5 0.01, respectively; ns = not significant.

Table 5. Effect of tillage and lime rate on yield of soybeans.

Lime rate (Ib/A)	Yield (bu/A)	
	No-tillage	Conventional tillage
0	34.3	25.7
1,000	34.3	19.3
2,000	37.5	17.2
3,000	29.0	18.2
4Po0	30.0	20.4
Mean	33.0	20.2
ANOVA effects:		
Tillage	**	
Lime	ns	
Tillage x Lime	ns	

** Analysis of variance (ANOVA) effect significant at P ■ 0.01; ns = not significant.

tode densities, because numbers of the most serious nematode parasite, *M. incognita,* and yields were both greater in no-tillage plots. Thus, while tillage practices may influence nematode populations, it does not seem practical to implement no-tillage practices for nematode management, but rather for other agronomic benefits.

Although tillage affected nematode population densities, liming had almost no effect on them. Many plant-parasitic nematodes appear to be well-adapted to the usual ranges in soil pH at which many field crops like soybeans are grown (McSorley and Gallaher, 1994b; Norton, 1978). According to our results, little effect on nematode populations should be expected if lime is applied to a site.

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