Effect of Nematicide Treatments on Nontarget Nematode Populations Associated with Corn

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ABSTRACT

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Aldicarb was highly toxic to populations of Dorylaimida in corn. Although carbofuran and terbufos were less toxic than aldicarb, significant reductions in Dorylaimida populations occurred in 25–60% of the treated fields. Microbial-feeding nematodes were generally less sensitive to nematicide treatments, with reductions in populations occurring in 13–50% of the fields. Aldicarb was again more toxic than carbofuran or terbufos.

Additional key words: *Diabrotica* spp., insecticides, nutrient cycling

Many nonfumigant nematicides are effective for control of lesion nematodes (*Pratylenchus* spp.) in corn in the Midwest (1,9–11,16). In addition, certain of these compounds are also used for control of corn rootworms (*Diabrotica* spp.). There is little information concerning the effect of these compounds on nontarget nematode populations, although there is evidence that Dorylaimida and microbial-feeding populations may become tolerant to carbofuran following its continuous use (13). Many of the Dorylaimida that occur in South Dakota cornfields are predaceous (4,7,8,12,14), and microbial-feeding nematodes are important in nutrient cycling (6,15). Both groups of nematodes might be considered beneficial, and reduction of their population may partly offset the benefits of lesion nematode control.

The objectives of this study were to

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Table 1. Cropping practices, irrigation, and soil textures in South Dakota test plots, 1976–1980

Field	Corn history	Irrigation	Soil texture
1	Continuous	+[a]	Sandy loam
2	Continuous	+	Sandy loam
3	Continuous	+	Sandy loam
4	First year	–	Silty clay loam
5	First year	–	Silty clay loam
6	Continuous	+	Sandy loam
7	Continuous	+	Sandy loam
8	Continuous	–	Silty clay
9	Continuous	+	Sandy loam
10	Continuous	+	Sandy loam
11	Continuous	–	Silt
12	Continuous	+	Silt
13	Continuous	+	Sandy loam
14	Continuous	–	Silty clay
15	Continuous	–	Silty clay
16	Continuous	+	Sandy loam
17	Continuous	–	Silty clay
18	Continuous	+	Sandy loam
19	Continuous	+	Sandy loam
20	Continuous	+	Sandy loam

[a] + Indicates furrow or sprinkler irrigation.

measure the effects of aldicarb, carbofuran, and terbufos on Dorylaimida (excluding Longidoridae and Trichodoridae) and microbial-feeding populations in irrigated and dryland corn.

MATERIALS AND METHODS

Densities of Dorylaimida and microbial feeders were measured in conjunction with nematicide field trials conducted on eastern and western South Dakota dryland and irrigated corn during 1976–1980 (Table 1). Small plots were two or four rows by 9 m with four to six replicates of each treatment. Nematode densities were also measured in field-size plots four rows by 400 m with three replicates of each treatment. All field trials were arranged in a randomized complete block design. Nematicides were applied immediately after planting in an 18-cm band over the row and lightly incorporated.

Plots were sampled at midseason (late July through early August) and at harvest by digging three or four randomly selected plants from each plot. Root systems were quartered and one-quarter of each, along with adhering soil, was placed in a plastic bag and stored at 4 C until processed. Samples were processed within 2 wk of collection date. Soil was shaken from roots and mixed, and nematodes were extracted from a 200-cm^3 subsample by the Christie-Perry method (2). Nematode numbers were estimated by counting the number present in three 1-ml aliquants of a 50-ml suspension. Nematode suspensions from each plot were combined, and permanent mounts of approximately 150 randomly selected specimens were prepared from each field.

RESULTS AND DISCUSSION

Based on identification of nematodes in permanent mounts, the following genera comprised 86–100% of the Dorylaimida (excluding Longidoridae and Trichodoridae) and were considered to be predaceous: *Aporcelaimellus, Carcharolaimus, Discolaimium, Discolaimus, Ecumenicus, Eudorylaimus, Mesodorylaimus, Nygolaimus*, and *Thonus. Mylonchulus* was also included in the predaceous group. The remaining Dorylaimida were *Dorylaimellus, Tylencholaimellus*, and *Tylencholaimus*, which may contain plant-parasitic nematode species (5). The microbial feeders were composed of the following genera: *Acrobeles, Acrobeloides, Aphelenchoides, Aphelenchus, Cephalobus, Cervidellus, Chiloplacus, Eucephalobus, Mesodiplogaster, Mesorhabditis, Panagrolaimus, Paraphelenchus, Prismatolaimus, Rhabditis*, and *Zeldia*.

Effects on populations of Dorylaimida. Aldicarb at 1.12 and 2.24 kg a.i./ha significantly reduced Dorylaimida populations at midseason in all fields (Table 2). However, the 0.56 kg a.i./ha rate did not reduce numbers significantly at midseason or harvest. The 1.12 and 2.24 kg a.i./ha rates reduced harvest populations of Dorylaimida in 50 and 75% of the fields, respectively (Table 2). Terbufos at 1.12, 1.68, and 2.24 kg a.i./ha reduced midseason and harvest populations of Dorylaimida in 40–60% of the fields (Table 2). Carbofuran reduced midseason Dorylaimida populations in 38 and 46% of the fields at 1.12 and 2.24 kg a.i./ha, respectively. At harvest, numbers were reduced in 25 and 39% of the fields (Table 2).

In general, aldicarb was highly toxic to the Dorylaimida and suppressed populations for the entire growing season at the higher rate. Terbufos was less toxic than aldicarb, and carbofuran was less toxic to Dorylaimida than either aldicarb or terbufos. The significant midseason and harvest reductions of Dorylaimida at

Table 2. Number of Dorylaimida per 200 cm^3 of soil after nematicide application in South Dakota cornfields, 1976–1980

Treatment	Field number	Sampling period	Number of nematodes: Rate of nematicide application (kg a.i./ha) Control	0.56	1.12	1.68	2.24
Aldicarb	11	Midseason	1,063	750	388*[a]	···	454*
	11	Harvest	651	350	559	···	433
	15	Midseason	480	···	75*	···	77*
	15	Harvest	650	···	325	···	86*
	17	Midseason	584	···	76*	···	···
	17	Harvest	638	···	120*	···	···
	19	Midseason	776	···	250*	···	···
	19	Harvest	1,501	···	512*	···	···
	8	Midseason	303	···	···	···	90*
	8	Harvest	503	···	···	···	88*
	9	Midseason	874	···	···	···	90*
	9	Harvest	771	···	···	···	224*
Carbofuran	4	Midseason	154	···	117	···	88
	4	Harvest	305	···	221	···	208
	5	Midseason	404	···	121*	···	116*
	5	Harvest	888	···	404*	···	336*
	6	Midseason	1,030	···	1,205	···	800
	6	Harvest	699	···	412	···	388
	7	Midseason	434	···	425	···	381
	7	Harvest	893	···	663	···	630
	10	Midseason	724	···	275*	···	154*
	10	Harvest	714	···	379*	···	263*
	12	Midseason	909	···	247*	···	280*
	12	Harvest	871	···	742	···	672
	13	Midseason	808	···	567	···	648
	13	Harvest	873	···	770	···	822
	17	Midseason	584	···	439	···	···
	17	Harvest	638	···	583	···	···
	1	Midseason	830	···	···	···	209*
	1	Harvest	1,259	···	···	···	360*
	2	Midseason	1,048	···	···	···	175*
	2	Harvest	1,279	···	···	···	684*
	3	Midseason	688	···	···	···	283*
	3	Harvest	979	···	···	···	392*
	18	Midseason	1,250	···	···	···	1,078
	18	Harvest	1,350	···	···	···	950
	8	Midseason	303	···	···	···	247
	8	Harvest	503	···	···	···	534
	9	Midseason	874	···	···	···	509
	9	Harvest	771	···	···	···	584
Terbufos	14	Midseason	412	···	683	459	300
	14	Harvest	583	···	339*	226*	220*
	16	Midseason	1,190	···	873	367*	395*
	16	Harvest	595	···	395	617	249
	12	Midseason	909	···	221*	···	···
	12	Harvest	871	···	530*	···	···
	13	Midseason	808	···	709	···	···
	13	Harvest	873	···	886	···	···
	20	Midseason	1,067	···	572*	···	···
	20	Harvest	1,200	···	862*	···	···
		Fields with significant population reductions (%)					
Aldicarb		Midseason	···	0	100	···	100
		Harvest	···	0	50	···	75
Carbofuran		Midseason	···	···	38	···	46
		Harvest	···	···	25	···	38
Terbufos		Midseason	···	···	40	50	50
		Harvest	···	···	60	50	50

[a] * Indicates significant reduction compared with control at $P = 0.05$.

the 1.12 kg rate of terbufos and carbofuran (Table 2) is of further interest because this rate is within the recommendation for corn rootworm control. Thus, even in those instances where lesion or other plant-parasitic nematodes were not the target organisms, it is probable that Dorylaimida numbers will be reduced when chemical applications are made. It is also known that a species of Mermithidae, a group related to the Dorylaimida, parasitizes certain *Diabrotica* spp. (3). The use of an insecticide-nematicide may thus reduce the effectiveness of these biocontrol agents. Neither irrigation nor soil texture appeared to have any consistent influence on effectiveness of nematicide treatments on the Dorylaimida (Tables 1 and 2).

Effects on microbial-feeding populations. The microbial feeders were less sensitive to the nematicide treatments than were the Dorylaimida (Tables 2 and 3). Aldicarb was more toxic to microbial feeders than either terbufos or carbofuran at the 1.12 and 2.24 kg rates (Table 3). Aldicarb significantly reduced midseason microbial-feeding populations in 50% of the fields at 1.12 and 2.24 kg a.i./ha and in 50 and 25% of the fields at harvest (Table 3). Terbufos reduced populations at harvest more frequently than at midseason. Carbofuran at 1.12 and 2.24 kg reduced midseason microbial-feeding populations in 25 and 31%, respectively, of the fields, whereas at harvest reductions occurred in only 13 and 15% of the locations (Table 3).

Microbial-feeding nematodes were responsible for 5–23% of the decomposition of plant material in a rye field (15); if they are of equal importance in cornfields, suppression of their populations could slow nutrient cycling and thus increase production costs through increased fertilizer requirements.

Certain of the Dorylaimida prey on microbial feeders, and a reduction in Dorylaimida populations could result in an increase in numbers of microbial feeders. However, this did not occur in this study because in a majority of the fields a reduction in numbers of Dorylaimida was accompanied by corresponding decreases in microbial feeders.

Table 3. Number of microbial-feeding nematodes per 200 cm^3 of soil after nematicide applications in South Dakota cornfields, 1976–1980

Treatment	Field number	Sampling period	Number of nematodes				
			Rate of nematicide application (kg a.i./ha)				
			Control	0.56	1.12	1.68	2.24
Aldicarb	11	Midseason	708	920	443	...	700
	11	Harvest	451	388	609	...	496
	15	Midseason	704	...	233*[a]	...	213*
	15	Harvest	1,340	...	929*	...	397*
	17	Midseason	1,117	...	255*	...	...
	17	Harvest	991	...	375*	...	...
	19	Midseason	1,284	...	1,485	...	...
	19	Harvest	984	...	1,162	...	...
	8	Midseason	634	...	...	...	476
	8	Harvest	932	...	...	...	1,107
	9	Midseason	1,593	...	...	...	1,134*
	9	Harvest	1,070	...	...	...	1,407
Carbofuran	4	Midseason	422	...	254	...	737
	4	Harvest	854	...	493	...	498
	5	Midseason	924	...	293*	...	183*
	5	Harvest	1,555	...	950*	...	823*
	6	Midseason	1,809	...	1,613	...	2,055
	6	Harvest	1,484	...	1,140	...	1,550
	7	Midseason	1,375	...	1,018	...	1,133
	7	Harvest	1,275	...	1,367	...	1,163
	10	Midseason	1,372	...	838	...	713
	10	Harvest	1,130	...	1,354	...	1,104
	12	Midseason	1,284	...	763*	...	650*
	12	Harvest	729	...	820	...	600
	13	Midseason	1,250	...	1,184	...	1,288
	13	Harvest	825	...	880	...	785
	17	Midseason	1,117	...	1,138	...	...
	17	Harvest	991	...	1,000	...	...
	1	Midseason	1,748	...	...	...	426*
	1	Harvest	1,259	...	...	...	360*
	2	Midseason	1,883	...	...	...	588*
	2	Harvest	943	...	...	...	1,047
	3	Midseason	1,100	...	...	...	730
	3	Harvest	1,771	...	...	...	2,254
	18	Midseason	940	...	...	...	1,133
	18	Harvest	1,145	...	...	...	1,005
	8	Midseason	634	...	...	...	386
	8	Harvest	932	...	...	...	1,221
	9	Midseason	1,593	...	...	...	2,334
	9	Harvest	1,070	...	...	...	1,170
Terbufos	14	Midseason	417	...	600	500	414
	14	Harvest	775	...	467*	309*	359*
	16	Midseason	1,407	...	862	693	1,073
	16	Harvest	978	...	540	935	529
	12	Midseason	1,284	...	572*	...	...
	12	Harvest	729	...	711	...	...
	13	Midseason	1,250	...	1,137	...	...
	13	Harvest	825	...	572	...	...
	20	Midseason	956	...	1,410	...	...
	20	Harvest	1,210	...	1,489	...	...
	Fields with significant population reductions (%)						
Aldicarb		Midseason	...	0	50	...	50
		Harvest	...	0	50	...	25
Carbofuran		Midseason	...	...	25	...	31
		Harvest	...	...	13	...	15
Terbufos		Midseason	...	...	20	0	0
		Harvest	...	...	20	50	50

[a] * Indicates significant reduction compared with control at $P = 0.05$.

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