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Effect of Yard Waste Compost on Nematode Densities and Maize Yield

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Abstract: The effects of a yard waste compost on densities of plant-parasitic nematodes and forage yield of maize (*Zea mays*) were determined over three seasons in two sites in north Florida. In each test, the experimental design was a randomized complete block with five replications and three treatments: 269 mt/ha of a yard waste compost C:N ratio = 35:1 to 46:1) applied to the soil surface as a mulch, 269 mt/ha of compost incorporated into the soil, and an unamended control. Of the nematodes found in these sites, *Paratrichodorus minor* was affected most by compost treatments, with densities at harvest reduced by a compost treatment on at least one sampling date in all three seasons ($P \leq 0.05$). *Meloidogyne incognita* was not consistently affected by compost application. Densities of *Criconemella* spp. and *Pratylenchus* spp. were reduced by compost treatment much more often in the third season than in the first two seasons of the study ($P \leq 0.05$). Forage yield of maize was increased ($P \leq 0.05$) by both compost treatments in every test, with yield increases ranging from 10% to 212% over yield levels in unamended control plots and varying with season ($P \leq 0.05$). Use of yard waste compost on agricultural sites may provide a beneficial amendment for crop production and a convenient means for disposal of a common waste product from urban areas. Effects of this compost with high C:N ratio on nematodes were long-term, often not appearing until the third season of the study.

Key words: C:N ratio, compost, *Criconemella* spp., cultural practice, maize, management, *Meloidogyne incognita*, mulch, nematode, organic amendment, *Paratrichodorus minor*, *Pratylenchus* spp., sustainable agriculture, *Zea mays*.

In the United States, lawn and landscape maintenance in the urban environment generates large quantities of organic waste products such as grass clippings, shrubbery trimmings, leaves, sticks, branches, and other wood material. Disposal of organic yard wastes can pose problems for landfills because they are bulky and can occupy considerable space. Interest in the composting and recycling of these materials is increasing, and the use of municipal yard wastes as agricultural amendments is being investigated in New Jersey (4) and Florida (1,5).

The benefits of organic amendments and mulches in improving crop performance are well-known (5,8). Organic amendments can be particularly useful in sites where soil organic matter is low, since increases in soil organic matter are associated with improvement in soil cation exchange capacity, water holding capacity, and crop yields (1). Reductions in population densities of plant-parasitic nematodes have been attributed to application of organic amendments in some cases (7,10–12,14), which could provide an additional benefit for plant growth. However, reductions of nematode populations in response to organic amendments are not always observed (6,12). The objectives of the current study were to determine the effects of a yard waste compost on population densities of plant-parasitic nematodes and on yield of maize (*Zea mays*).

Materials and Methods

Experiments were conducted at two adjacent sites of 1.0 ha each, located slightly northwest of Gainesville, Florida, at 29° 40′N and 82° 30′W. Soil in each field was a Bonneau fine sand, with 92% sand, 2% silt, 6% clay and pH = 5.2 and <2.0% organic matter before 1992. In February 1992, 269 mt/ha of a yard waste compost was applied to one of the sites, which was then plowed to bury the compost to a depth of 15 to 25

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cm. The compost (Table 1) consisted of 4- to 6-month-old composted urban yard wastes such as sticks, clippings, and wood fragments, all <5 cm in length and obtained from Wood Resource Recovery of Gainesville, Florida. Both sites were planted with Pioneer cv. 3154 hybrid maize in 1992.

In 1993, a separate experiment was established in each site in a randomized complete block design with three yard waste compost treatments and five replications. The yard waste compost treatments were 269 mt/ha applied in late January and incorporated into the top 20 cm of soil by plowing, 269 mt/ha applied in late January and maintaind on the soil surface as a mulch, and an unamended control. The rate of 269 mt/ha was used because this was the amount of compost required to cover mulched plots to a depth of approximately 6 cm. Before application of compost, all plots were fertilized with 145 kg inorganic N, 5 kg P, and 100 kg K per ha. Maize was planted in all plots at both sites in early March 1993. Individual plots consisted of six rows, 0.75 m apart and 30 m long. All plots were sampled for nematodes on 10 March and again at harvest on 16 July. Each sample consisted of six soil cores, 2.5-cm-diam. and 20-cm deep, collected within the center two plant rows in each plot. The cores were composited and mixed, and a 100-cm^3 subsample was removed for nematode extraction using a modified sieving and centifugation procedure (3). At the end of the experiment, maize stalks were cut (6–7 cm above soil surface) from the center two rows of each plot and forage yield measured at 30% dry matter.

Both experiments were repeated in 1994, when each plot received the same compost treatment applied the previous year. Thus, a plot treated with 269 mt/ha of mulch in 1993 received an additional 269 mt/ha of mulch in 1994. The composition of the yard waste compost varied slightly each year (Table 1). Nematode sampling dates in 1994 were 10 March and 17 June, corresponding to planting and harvest, respectively. Both experiments also were sampled in 1995, on 10 March and 21 June. There was no yard waste compost applied in 1995. Data from each season and experiment were examined by analysis of variance and followed by mean separations with Duncan's multiple-range test using MSTAT-C software (Michigan State University, East Lansing, MI).

TABLE 1. Analysis of yard waste compost applied at two sites.

Property analyzed	Year of application		
	1992	1993	1994
Dry matter (% of fwt)[a]	57.2	50.7	51.5
Organic matter (% of dwt)[b]	77.2	66.5	63.5
C (% of dwt)	39.8	33.5	32.0
N (% of dwt)	0.86	0.92	0.90
C:N ratio	46.3	36.4	35.6
pH	5.8	7.0	6.2
Ca (% of dwt)	1.43	2.30	2.44
Mg (% of dwt)	0.13	0.20	0.18
K (% of dwt)	0.19	0.32	0.28
P (% of dwt)	0.08	0.19	0.15
Cu (ppm)	11.7	16.3	16.0
Fe (ppm)	1,580	1,473	1,793
Mn (ppm)	146	142	173
Zn (ppm)	91	112	96

[a] % of fresh compost weight.
[b] % of dry matter.

RESULTS

Soil organic matter increased over time in treatments receiving yard waste compost, reaching maximum levels of 4% to 5% in sites amended with compost for 3 years (Table 2). Yard waste compost, whether incorporated or used as mulch, greatly increased forage yield over that of unamended controls in all tests (Table 3). This effect was greatest in 1993, when yields of amended plots were more than double those of the controls. Yield differences between amended plots and unamended control plots decreased over time. Yields of plots in which compost was incorporated were not significantly different from those in which compost was used as mulch.

The plant-parasitic nematodes *Crico-*

TABLE 2. Soil organic matter content at 0 to 20-cm depth at two sites during 1993 to 1995.

Compost treatment	Compost amount (mt/ha)[a]	Soil organic matter (%)					
		1993		1994		1995	
		10 Mr.	16 July	10 Mar.	17 June	10 Mar.	21 June
Site 1: no previous treatment with compost							
Incorporated	269	1.58	2.98	3.08	3.27	2.79	3.30
Mulch	269	1.58	2.46	3.51	2.87	3.14	3.12
Control	0	1.58	1.71	1.80	1.60	1.59	1.66
Site 2: treated with 269 mt compost/ha in 1992							
Incorporated	269	2.67	3.70	3.99	4.25	3.92	3.33
Mulch	269	2.67	3.35	3.75	5.15	3.94	4.28
Control	0	2.67	2.41	2.23	2.30	2.45	2.40

[a] Compost amount applied to site in 1993 and again in 1994.

nemella spp. (mostly *C. ornata* with some *C. sphaerocephala*) and *Pratylenchus* spp. (mostly *P. scribneri* with some *P. brachyurus*) were present in both sites and usually were not affected by the compost treatments during 1993 and 1994, but in 1995 tended to be lower in plots amended with compost than in unamended control plots (Table 4,5). *Meloidogyne incognita* was not consistently affected by compost treatment during any year. *Paratrichodorus minor* showed the most frequent responses to compost amendment, with densities reduced by at least one of the compost treatments in comparison with the control, in every season at the site that had received compost in 1992 (Table 4). *Xiphinema* spp. were uncommon (initial densities <10/100 cm^3 soil) and not affected by treatment in 1993 and absent from both sites in 1994 and 1995 (data not shown). *Dolichodorus heterocephalus* was found only on 10 March 1994 in the site that had not been amended with compost in 1992 (data not shown). Numbers of *D. heterocephalus* present in plots with incorporated compost (0.6/100 cm^3 soil) or compost used as mulch (0.8/100 cm^3 soil) were less than numbers in control plots (2.4/100 cm^3 soil ($P \leq 0.05$).

DISCUSSION

During the first 2 years of this study, most kinds of plant-parasitic nematodes were not affected by the yard waste compost applied here. *Meloidogyne incognita* was not affected by similar material in another study involving compost amendment on vegetable crops (6). Although decomposition products from organic amend-

TABLE 3. Effect of yard waste compost treatments on maize forage yield in 1993 to 1995 at two sites.

Compost treatment	Compost amount (mt/ha)		Yield (mt/ha)[a]		
	1993	1994	1993	1994	1995
Site 1: no previous treatment with compost					
Incorporated	269	269	21.3 a	30.2 a	37.1 a
Mulch	269	269	23.1 a	33.6 a	37.6 a
Control	0	0	9.8 b	23.1 b	33.6 b
Site 2: treated with 269 mt compost/ha in 1992					
Incorporated	269	269	26.0 a	38.5 a	39.9 a[b]
Mulch	269	269	28.4 a	41.0 a	38.8 a
Control	0	0	9.1 b	29.8 b	34.8 b

Data are means of five replications. For each site, means in columns followed by the same letter do not differ ($P \leq 0.05$).
[a] Forage yield at 30% dry matter.
[b] These means differ at $P \leq 0.10$ but not at $P \leq 0.05$.

TABLE 4. Effect of yard waste compost treatments on initial (March) and final (June–July) nematode population densities on maize crops during 1993 to 1995 at a site treated with 269 mt compost/ha in 1992.

Compost treatment	Compost amount (mt/ha)[a]	Nematodes per 100 cm^3 soil					
		1993		1994		1995	
		10 Mar.	16 July	10 Mar.	17 June	10 Mar.	21 June
				Criconemella spp.			
Incorporated	269	50	205	14	14	3 a	69 a[b]
Mulch	269	147	22	15	14	12 ab	40 a
Control	0	73	56	39	91	26 b	172 b
				Meloidogyne incognita			
Incorporated	269	1 a	50	1	17	9	125
Mulch	269	21 b	16	2	12	15	164
Control	0	5 ab	16	2	24	15	59
				Paratrichodorus minor			
Incorporated	269	9	127 a	1	19 a	4 a	27 a[b]
Mulch	269	16	275 b	3	39 a	4 a	20 a
Control	0	22	323 b	2	74 b	12 b	63 b
				Pratylenchus spp.			
Incorporated	269	108	990	49	176	23 a	137 a
Mulch	269	142	1,468	33	307	30 a	289 b
Control	0	235	1,275	57	181	56 b	123 a

Data are means of five replications. For each nematode, means in columns followed by the same letter do not differ at $P \leq 0.05$ according to Duncan's multiple-range test. No letters indicate no differences (at $P \leq 0.10$) with treatment for a given nematode.

[a] Compost amount applied to site in 1993 and again in 1994.

[b] These means differ at $P \leq 0.10$ but not at $P \leq 0.05$.

ments can be toxic to nematodes, it is believed that nematicidal activity, at least from nitrogenous byproducts, should be most evident when the C:N ratio of the amendment is less than 20:1 (12). The yard waste used here had C:N ratios >35:1, and so little effective release of byproducts toxic to nematodes could be expected. Nevertheless, densities of the stubby-root nematode *P. minor* were reduced by yard waste compost amendment in three of four of the maize crops examined during the first 2 years, suggesting that this nematode may be particularly susceptible to this material. It is not clear whether the nematode is overly sensitive to this material or whether a completely different mechanism may be involved. Although stubby-root nematodes occur in many different soil types, they are most abundant in sand or sandy loam soil (9) and, under controlled conditions, increased more rapidly in sandy loam than in other soil types (13). If this nematode has a preference for sandy soil (presumably with low organic matter, although not reported), then perhaps the habitant modification of doubling the soil organic matter following compost application affects nematode survival and reproductive potential.

By the third season of this study (1995), densities of several different nematodes were affected by compost application. By this time, more of the woody compost material had broken down and soil organic matter had increased substantially in amended plots. It is not known whether breakdown products may have affected nematodes directly or whether the increased organic matter and related changes provided a more suitable habitant for naturally occurring antagonists of nematodes (12), since these were not measured in the experiments. If antagonists built up gradually over time, a lag period would be expected before effects on nematode densities could be observed. Additional research is needed to determine the mechanism(s) by which nematode densities are reduced under such conditions, but current research demonstrates the relatively long-term nature of nematode re-

TABLE 5. Effect of yard waste compost treatments on initial (March) and final (June–July) nematode population densities on maize crops during 1993 and 1994 at a site not previously treated with compost.

Compost treatment	Compost amount (mt/ha)[a]	Nematodes per 100 cm^3 soil					
		1993		1994		1995	
		10 Mar.	16 July	10 Mar.	17 June	10 Mar.	21 June
				Criconemella spp.			
Incorporated	269	154	645	44 a	140	22 ab[b]	92 a
Mulch	269	141	968	25 a	65	6 a	155 a
Control	0	125	864	203 b	180	62 b	660 b
				Meloidogyne incognita			
Incorporated	269	16	985	5	72	11	28
Mulch	269	33	707	3	55	6	72
Control	0	36	196	14	51	6	70
				Paratrichodorus minor			
Incorporated	269	20	125	5	11 a	4	28
Mulch	269	19	199	4	24 a	8	28
Control	0	17	225	14	55 b	9	60
				Pratylenchus spp.			
Incorporated	269	184	1,699	88	110	20 a	138
Mulch	269	162	988	34	76	21 a	120
Control	0	145	400	114	84	43 b	126

Data are means of five replications. For each nematode, means in columns followed by the same letter do not differ at $P \leq 0.05$ according to Duncan's multiple-range test. No letters indicate no differences (at $P \leq 0.10$) with treatment for a given nematode.

[a] Compost amount applied to site in 1993 and again in 1994.

[b] These means differ at $P \leq 0.10$ but not at $P \leq 0.05$.

sponses to amendments with high C:N ratio.

Addition of the yard waste compost greatly improved maize forage yield in all tests, regardless of whether the compost was incorporated or used as mulch. The yield response did not appear to be related to nematode control since most nematodes were unaffected by treatment during 1993 and 1994. *Paratrichodorus minor* was not affected in one site and affected by only one compost treatment at the other site in 1993 (Tables 4,5), yet large yield responses to both compost treatments were observed in that year. Nematode reductions from use of compost or other amendments are often inconsistent (6,12), and plant responses may be due to improved tolerance rather than reductions in nematode densities (6). Many other benefits to crop growth can result from addition of compost including improved soil structure, increased soil organic matter, improved water-holding capacity and cation exchange capacity, moderation of soil temperature, and improved crop nutrition (1,6,8). Potential drawbacks of compost usage may be N immobilization, cost, and buildup of toxic elements (1,6,8). It is difficult to evaluate which of these factors is most important in a given situation. In the present study, soil organic matter was greatly increased and soil water content in one of these sites (site with compost in 1992) in 1994 was increased by compost treatments to levels 65% to 75% greater than that found in the unamended control (2).

Large amounts of yard waste compost were used to induce the responses observed in this study. Future studies with dosage-response are needed to determine the benefits of adding reduced levels of yard waste compost. The transport of large amounts of compost can be expensive but may be practical for farm sites located near large municipalities. Utilization of yard waste compost in this manner should be mutually beneficial, supplying farmers with useful organic amendments and providing municipalities with a convenient means of disposal for a common waste product.

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