Supplement to the Journal of Nematology 27(4S):545–549. 1995.
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Effect of Yard Waste Compost on Plant-Parasitic Nematode Densities in Vegetable Crops[1]

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Abstract: The effects of yard-waste compost on densities of plant-parasitic nematodes were determined on four crops at two sites in north Florida. Separate experiments were conducted with sweet corn (*Zea mays*), cowpea (*Vigna unguiculata*), yellow squash (*Cucurbita pepo*), and okra (*Hibiscus esculentus*). In each test, the design was a randomized complete block replicated four times and involving three treatments: 269 mt/ha yard-waste compost applied to the soil surface as a mulch, 269 mt/ha compost incorporated into the soil, and an unamended control. Final population densities of *Criconemella* spp. and *Meloidogyne incognita* were lower in plots receiving a compost treatment than in unamended control plots in only one of eight tests ($P \leq 0.05$). Final densities of *Paratrichodorus minor*, *Pratylenchus* spp., and *Xiphinema* spp. were unaffected by compost treatment in all tests ($P > 0.10$). Vegetable yields were either unaffected by treatment or, in some tests, were lowest following the mulch treatment ($P \leq 0.10$). Results indicate that the yard-waste compost used had little effect on densities of plant-parasitic nematodes associated with short-term (ca. 4 months) vegetable crops.

Key words: compost, *Criconemella* spp., cultural practice, *Meloidogyne incognita*, mulch, nematode, organic amendment, *Paratrichodorus minor*, *Pratylenchus* spp., sustainable agriculture, *Xiphinema* spp.

Organic amendments and mulches can improve crop performance and yield (4,8). Reductions in population densities of plant-parasitic nematodes in response to application of organic amendments have been reported in many studies (7,9,11,13). Practical use depends on a large and readily available supply of these materials. Yard and lawn maintenance in the urban environment generates large amounts of organic waste material, mainly sticks, leaves, branches, grass clippings, wood chips, and other yard waste products. The volume of material poses problems for urban landfills, and the composting and recycling of these biodegradable organic products are encouraged by urban municipalities for financial and environmental reasons (1,4). Composted yard waste may be useful as an agricultural amendment, and improved plant performance and soil water-holding capacity have been demonstrated from its use (2,4). The objective of this research was to determine the effects of yard-waste compost amendments on densities of plant-parasitic nematodes and yields of several vegetable crops.

Materials and Methods

Experiments were conducted at two sites, about 4–5 km apart near 29°40′N and 82°30′W, and within 10 km of Gainesville, Florida. Soil at each site was an Arredondo fine sand, consisting of 92% sand, 4% silt, 4% clay, with pH 5.4 and 1.9% organic matter at the Green Acres site, and 92% sand, 2% silt, 6% clay, with pH 5.2 and 2.6% organic matter at the Haufler site. At each site, experiments were conducted with four different crops, planted in separate plot areas: sweet corn (*Zea mays*), cowpea (*Vigna unguiculata*), yellow squash (*Cucurbita pepo*), and okra (*Hibiscus esculentus*).

In early March 1993, a yard-waste compost obtained from Wood Resource Recovery of Gainesville, Florida, was applied to all sites. The material consisted of 4- to 6-month-old composted yard wastes such as sticks, clippings, and wood fragments, all <5 cm in length. At the time of application, the compost contained 507 g dry matter/kg fresh material. The dry matter consisted of 665 g organic matter/kg dry compost, with pH 7.0, and 335 g C and 9.2

Received for publication 12 April 1995.
[1] Florida Agricultural Experiment Station Journal Series No. R-04449.
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The authors thank John Frederick Howard Palmer, Jim Chichester, and Tom Schmid for technical assistance; Nancy Sanders for manuscript preparation; Donald and Dale Haufler for assistance and use of a study site; and Wood Resource Recovery for providing and hauling compost.

TABLE 1. Effect of yard-waste compost treatments on initial (Pi) and final (Pf) population densities of *Criconemella* spp. on four crops at two sites in north Florida, 1993.

Compost treatment	Compost amount (mt/ha)	Nematodes per 100 cm^3 soil: Sweet corn Pi	Sweet corn Pf	Cowpea Pi	Cowpea Pf	Squash Pi	Squash Pf	Okra Pi	Okra Pf
				Green Acres site					
Incorporated	269	117	1,262	200	137	124	391	180	920
Mulch	269	108	879	91	49	166	112	184	654
Control	0	180	624	242	156	286	129	178	440
				Haufler site					
Incorporated	269	100	1,443	174	350	176	230	111	483 b
Mulch	269	156	1,517	98	307	131	206	253	397 b
Control	0	214	3,887	173	504	389	422	307	1,327 a

Data are means of four replications. Within a site, means in columns followed by the same letter are not different ($P \leq 0.05$), according to Duncan's multiple-range test. No letters in a column indicate no differences at $P \leq 0.10$.

g N/kg dry compost, for a C:N ratio of approximately 36:1. The dry compost also contained 23.0 g Ca, 2.0 g Mg, 3.2 g K, 1.9 g P, 16.3 mg Cu, 1473 mg Fe, 142 mg Mn, and 112 mg Zn/kg dry matter. Before application of compost, all plots were fertilized with 145 kg N, 5 kg P, and 100 kg K/ha. The following three compost treatments were applied to individual plots in all experiments: 269 mt/ha fresh compost applied to the soil surface as a mulch, 269 mt/ha fresh compost applied to the soil surface and then incorporated with a rototiller, and an unamended control, which was rototilled. The three treatments were replicated four times on each crop in randomized complete blocks.

On 22 March 1993, seeds of 'Silver Queen' corn, 'Pinkeye Purplehull' cowpea, 'Dixie' squash, or 'Clemson Spineless' okra were planted in the appropriate experiment at both sites. Cowpea seeds were planted 2 cm apart in rows, and other crops were planted 10 cm apart. Individual plots consisted of four rows spaced 0.76 cm apart, with a length of 4.5 m at the Green Acres site and 3.0 m at the Haufler site. Plots were irrigated as needed, but no pesticides or additional fertilizers were applied. Squash was harvested every 3–4 days during May and June, okra was harvested four times between 2 June and 6 July, cowpea was harvested 15 June, and harvest data for sweet corn were unavailable.

TABLE 2. Effect of yard-waste compost treatments on initial (Pi) and final (Pf) population densities of *Meloidogyne incognita* on four crops at two sites in north Florida, 1993.

Compost treatment	Compost amount (mt/ha)	Nematodes per 100 cm^3 soil: Sweet corn Pi	Sweet corn Pf	Cowpea Pi	Cowpea Pf	Squash Pi	Squash Pf	Okra Pi	Okra Pf
				Green Acres site					
Incorporated	269	89	540	68	1,247	48	988	86	78
Mulch	269	118	719	90	1,361	100	876	95	446
Control	0	61	629	62	1,532	118	1,332	77	102
				Haufler site					
Incorporated	269	22	350	17	1,282 a	10	534 ab	16	2,180 a
Mulch	269	25	499	12	499 b	12	1,505 a	34	258 b
Control	0	13	209	13	226 b	8	180 b	14	1,795 a

Data are means of four replications. Within a site, means in columns followed by the same letter are not different ($P \leq 0.05$ on squash, okra; $P \leq 0.10$ on cowpea), according to Duncan's multiple-range test. No letters in a column indicate no differences at $P \leq 0.10$.

TABLE 3. Effect of yard-waste compost treatments on initial (Pi) and final (Pf) population densities of *Paratrichodorus minor* on four crops at two sites in north Florida, 1993.

		Nematodes per 100 cm^3 soil							
		Sweet corn		Cowpea		Squash		Okra	
Compost treatment	Compost amount (mt/ha)	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf
		Green Acres site							
Incorporated	269	14	16	7	14	7	4	7	17
Mulch	269	6	15	8	10	15	10	10	8
Control	0	7	32	10	11	10	17	8	12
		Haufler site							
Incorporated	269	18	138	14	57	16	22	15	144
Mulch	269	11	162	6	154	14	53	11	205
Control	0	10	95	19	121	22	37	11	160

Data are means of four replications. No treatment differences ($P \leq 0.10$) on any crop at either site.

All plots in the eight experiments were sampled at planting on 22 March for initial nematode population densities (Pi) and once after harvest for final nematode densities (Pf). The dates of the sample for Pf were the same at both sites, but varied with the crop: 23 June for squash, 1 July for sweet corn, 7 July for cowpea, and 14 July for okra. A composite soil sample consisting of six cores, 2.5-cm-d × 20 cm deep, was collected within plant rows in a systematic pattern from each plot. A 100-cm^3 subsample was removed for nematode extraction with a modified centrifugal flotation procedure (3). Data were subjected to analysis of variance (ANOVA) with MSTAT-C software (Michigan State University, East Lansing, MI), followed by mean separation with Duncan's multiple-range test when F values were significant at $P \leq 0.10$.

RESULTS

Within each experiment and site, nematode Pi were similar in all plots (Tables 1–5) and not affected by the compost application 3 weeks earlier. Final nematode densities were not often affected by the compost treatments (Tables 1–5). Final density of *Criconemella* spp. was reduced by compost treatment in only one of eight trials ($P \leq 0.05$) (Table 1). Final density of *Meloidogyne incognita* was lowest following compost used as a mulch in one experiment (Haufler okra), but was highest in another test (Haufler squash) after this

TABLE 4. Effect of yard-waste compost treatments on initial (Pi) and final (Pf) population densities of *Pratylenchus* spp. on four crops at two sites in north Florida, 1993.

		Nematodes per 100 cm^3 soil							
		Sweet corn		Cowpea		Squash		Okra	
Compost treatment	Compost amount (mt/ha)	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf
		Green Acres site							
Incorporated	269	100	167	138	36	84	36	70	14
Mulch	269	116	238	73	26	144	58	106	35
Control	0	90	358	80	46	121	76	89	32
		Haufler site							
Incorporated	269	26	153	23	32	36	29	32	87
Mulch	269	53	211	46	28	36	28	70	32
Control	0	26	118	62	48	33	35	42	80

Data are means of four replications. No treatment differences ($P \leq 0.10$) on any crop at either site.

TABLE 5. Effect of yard-waste compost treatments on initial (Pi) and final (Pf) population densities of *Xiphinema* spp. on four crops at a site (Haufler site) in north Florida, 1993.

Compost treatment	Compost amount (mt/ha)	Nematodes per 100 cm^3 soil: Sweet corn Pi	Sweet corn Pf	Cowpea Pi	Cowpea Pf	Squash Pi	Squash Pf	Okra Pi	Okra Pf
Incorporated	269	1	28	11	5	4	15	2	32
Mulch	269	4	23	15	9	2	12	1	8
Control	0	2	37	23	11	20	20	4	55

Data are means of four replications. No treatment differences ($P \leq 0.10$) on any crop.

treatment, and in a third test (Haufler cowpea) was greatest following incorporated compost (Table 2). Final densities of *Paratrichodorus minor, Pratylenchus* spp., and *Xiphinema* spp. were unaffected by compost treatment ($P > 0.10$) (Tables 3–5). Thus, out of 36 nematode-crop combinations for which Pf was evaluated, Pf was reduced by a compost treatment in two (5.5%) cases, was increased under a compost treatment in two (5.5%) cases, but was unaffected in 32 (89%) combinations.

In several cases, crop yields were not affected by compost treatment ($P > 0.10$) (Table 6). However, in a few cases (squash at both sites, okra at Haufler site), yield of the mulched treatment was lower than at least one of the other treatments ($P \leq 0.10$), probably because germinating seedlings had difficulty in penetrating the thick (>4 cm) layer of mulch. It was not possible in any case to relate crop yield to nematode management or lack thereof.

Discussion

Although reductions in nematode population densities in response to organic amendments have been reported often (7,9,11), it is clear from our tests that such reductions should not be taken for granted. It has been proposed that nematode populations may be suppressed by toxic by-products from decomposition of organic amendments or by biological antagonists stimulated by organic amendments (11), but the effects of neither of these mechanisms were evident here. Any toxic by-products that might have been produced by compost decomposition had no immediate effect on nematode densities, although it is possible that, because of the high C:N ratio (36:1) and therefore slow decomposition rate of the material used, any such products might be released gradually over time in concentrations too low to be effective. In general, materials with C:N ratios <20:1 have more nematicidal activity (12). Perhaps, if maintained for a long time, the compost amendments could stimulate increased activity of biological antagonists of nematodes. Although potential biological control agents were not assayed, if present, they had no impact on nematode populations after 4–4.5 months, and a longer time period may be required to establish their efficacy.

Although compost treatments had little effect on nematode densities, some differences in densities were observed among the various crops. Densities by crop cannot be compared directly because of the exper-

TABLE 6. Effect of yard-waste compost treatments on yield of vegetable crops at two sites in north Florida, 1993.

Compost treatment	Compost amount (mt/ha)	Crop yield (kg/ha): Cowpea	Squash	Okra
		Green Acres site		
Incorporated	269	580	29,100 a	290
Mulch	269	610	19,400 b	240
Control	0	1,010	24,900 a	359
		Haufler site		
Incorporated	269	490	16,000 a	1,778 a
Mulch	269	600	10,200 b	410 b
Control	0	550	17,400 a	600 b

Data are means of four replications. Within a site, means in columns followed by the same letter are not different ($P \leq 0.10$), according to Duncan's multiple-range test. No letters in a column indicate no differences at $P \leq 0.10$.

TABLE 7. Ratio between final (Pf) and initial (Pi) nematode population densities in unmulched control plots on four crops at two sites in north Florida, 1993.

Nematode	Pf/Pi[a]			
	Sweet corn	Cowpea	Squash	Okra
	Green Acres site			
Criconemella spp.	3.5	0.6	0.4	2.5
Meloidogyne incognita	10.3	24.7	11.3	1.3
Paratrichodorus minor	4.6	1.1	1.7	1.5
Pratylenchus spp.	4.0	0.6	0.6	0.4
	Haufler site			
Criconemella spp.	18.2	2.9	1.1	4.3
Meloidogyne incognita	16.1	17.4	22.5	128.2
Paratrichodorus minor	9.5	6.4	1.7	14.5
Pratylenchus spp.	4.5	0.8	1.1	1.9
Xiphinema spp.	18.5	0.5	1.0	13.8

[a] Pf/Pi from values in Tables 1–5.

imental design used; nevertheless, examination of the ratios of Pf to Pi reveals some interesting trends (Table 7). Densities of most nematodes increased on these crops, especially on sweet corn, but densities of *Pratylenchus* spp. (primarily *P. scribneri*) decreased on cowpea at both sites. Such information may be useful in choosing or avoiding certain crops for cropping sequences (5). Of course, Pf/Pi depends on the magnitude of Pi (6,10); therefore, additional research is needed to develop relationships between Pf/Pi and Pi over the practical range of Pi for these crops.

As organic yard-waste materials become more abundant from urban sources, concern about their disposal increases (1,4). Application of yard-waste compost to agricultural sites may provide a practical means of disposal and also may result in a number of agronomic benefits, especially increased soil organic matter and improved water-holding capacity (1,2). Although not observed here, plant growth and yield responses to similar materials have been observed in other studies (4). Application of yard-waste compost may have several practical benefits, but consistent reductions in nematode population densities, at least over the short term (ca. 4 months), may not be one of them.

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