Effect of Yard Waste Compost on Crop Tolerance to Root-knot Nematodes

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Abstract: The effects of a yard waste compost amendment and crop establishment on nematode populations and yields of susceptible vegetable crops were determined in two tests in Florida in sites infested with the root-knot nematode, *Meloidogyne incognita.* Main plot treatments consisted of 269 mt/ha of a yard waste compost applied as a mulch, 269 mt/ha of the compost incorporated into the soil, and an untreated control. Subplots involved two methods of crop establishment, transplanted three-week-old seedings of yellow squash *(Cucurbitapepo,* test 1) or okra *(Hibiscus esculentus,* test 2) and direct seeding. Root-knot nematode population densities were unaffected by all treatments and increased greatly on both vegetable crops. However, yield of yellow squash was improved ($P \leq 0.05$) by incorporation of yard waste compost and by use of transplanted seedlings rather than direct seed. The yield of plots with incorporated compost and transplanting was more than 3.5 times that of direct-seeded, unamended plots. Similar results were obtained on okra. with maximum yields from transplanted seedlings and incorporated compost. Results show the potential of compost amendment and planting method for improving the tolerance of susceptible crops to damage by root-knot nematodes.

Introduction

Numerous methods are available for managing damaging species of plant-parasitic nematodes (McSorley, 1994; McSorley and Duncan. 1995; Trivedi and Barker, 1986). Most of these methods involve the reduction of nematode population densities to levels below damage thresholds (McSorley and Duncan, 1995). Less attention has been devoted to methods which improve plant health for the purpose of increasing tolerance to existing nematode populations.

The advantages of organic amendments in improving crop performance are well known (Gallaher and McSorley, 1994; 1995). Organic amendments have also been used to reduce nematode populations, but results have not been consistent (McSorley and Gallaher, 1995b; Trivedi and Barker, 1986). Opportunities for using organic amendments in crop production are increasing as large amounts of yard waste accumulate from the urban landscape (Gallaher and McSorley, 1995). Previous work with compost derived from urban yard waste has revealed consistent benefits in crop production, but not in reduction of plant-parasitic nematode populations (Gallaher and McSorley, 1994; 1995; McSorley and Gallaher, 1995a. b). The objective of the research presented here was to use a yard waste compost amendment and crop establishment with three-week-old seedlings for improving the tolerance of highly-susceptible vegetable crops to root-knot nematodes *(Meloidogyne spp.).*

Materials and Methods

Two separate experiments, one with yellow squash *(Cucurbita pepo* L.) and the other with okra *(Hibiscus esculentus* L.), were conducted during I994 at the University of Florida Green Acres Agronomy Research Farm in Alachua County on an Arredondo fine sand (92% sand, 4% silt, 4% clay). Similar methods were used in each experiment, and in both cases the experimental design was a split-plot, with three compost treatments as main plots and two methods of crop establishment as subplots, with four replications. The compost treatments consisted of a yard waste compost applied to the soil surface as a mulch, compost applied to the soil surface and incorporated by rototilling, and an unamended control. The compost contained about 50% dry matter and consisted of 592g organic matter/kg dry weight, with pH = 7.5 and a C:N ratio of 34.4 (Table 1). Additional descriptions of the compost and its acquisition and application are described elsewhere (Gallaher and McSorley, 1995; McSorley and Gallaher, 1995a).

Main plots were 3.0 m wide and 4.5 m long, and contained four rows of plants. Plots were split on 12 April 1994, when half of each plot (2 rows, 4.5 m long) was planted with seeds of 'Dixie' yellow squash (or 'Clemson Spineless' okra in the other test), and the remaining subplot received three week-old seedlings. Crop management is described in detail elsewhere (McSorley and Gallaher, 1995a). Total yield of squash per subplot was determined from 12 harvests between 9 May and 20 June, and total okra yield was determined from 7 harvests between 27 May and 5 July.

Main plots were sampled for nematodes on 13 April and all subplots were sampled on 30 June. Each nematode sample consisted of six cores of soil (2.5-cm diameter x 20 cm deep)

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Table 1. Nutrient analysis of yard waste compost (YWC) used on research site in 1994.

Macronutrient	Amount (g/kg dry YWC)	Micronutrient	Amount (mg/kg dry YWC)
C	313.0	Cu	18
N	9.1	Fe	1825
Ca	34.1	Mn	188
Mg	1.9	Zn	118
K	2.9		
P	1.8		

collected in a systematic pattern and then combined into a plastic bag for transport. In the laboratory, a 100-cm^3 soil subsample was removed for nematode extraction using a modified sieving and centrifugation procedure (Jenkins, 1964). Extracted nematodes were then identified and counted under a dissecting microscope. Following the final harvest of each crop, five root systems were removed from each subplot, and the number of root-knot nematode galls per plant were determined. All data were analyzed using an analysis of variance (ANOVA) for a split-plot design (Freed et al., 1991), followed by Duncan's multiple-range test to compare means of main effects or means within treatment combinations if the treatment x planting method interaction was significant.

Results and Discussion

The root-knot nematode *Meloidogyne incognita* (Kofoid and White) Chitwood was the dominant nematode pest present in both test sites; data on other nematodes present are reported elsewhere (McSorley and Gallaher, 1995a). In the experiment with yellow squash, numbers of *M. incognita* present in soil increased greatly from 13 April to 30 June, reaching very high population densities regardless of compost treatment or crop establishment method (Table 2). At final harvest, more than 100 root-knot nematode galls per root system were observed on every plant examined in all subplots, regardless of treatments. Despite this lack of treatment effects on *M. incognita* populations, yield of squash was affected ($P \leq 0.05$) by both compost treatment and planting method (Table 3). Average yield of plots in which yard waste compost had been incorporated was 155% greater than that of unamended control plots, and using transplanted seedlings rather than direct seed improved yield by 38%. The yield of the best treatment combination (incorporated compost and transplanting) exceeded the state average of 12,983 kg/ha (Florida Agricultural Statistics Service, 1994) by 46% and was more than 3.5 times that of direct-seeded, unamended plots (Table 3).

Root-knot nematode densities also increased greatly over time in the experiment with okra, although lower final densities were reached on the stunted plants resulting from direct seeding than on the transplanted material (Table 4). Root systems from all subplots were heavily galled (more than 100 galls per root system). Growth of okra was poor, and plants in the direct-seeding treatment were especially stunted and had minimal yield. Greatest okra yields were obtained from transplanted plants in plots with incorporated yard waste compost (Table 5).

The lack of effect of yard waste compost on root-knot nematode numbers is not unexpected. In other tests, this material has not shown consistent activity against several species of nematodes (Gallaher and McSorley, 1994; McSorley and Gallaher, 1995b). On the other hand, the beneficial effects of yard waste compost on plant growth are well documented (Gallaher and McSorley, 1994; 1995; McSorley and Gallaher, 1995a, b). It is significant that these benefits of improved plant growth and increased yield can be achieved even in the presence of high numbers of a damaging nematode pest such as *M. incognita.*

The benefits realized through addition of an organic amendment, such as improved soil fertility, increased soil organic matter, and improved water-holding capacity, are apparently quite important in improving plant tolerance to nematode damage and infection (McSorley and Gallaher, 1995a). In contrast to direct seeding, the larger root systems of transplanted material early in the season can improve plant establishment and performance in nematode-infested sites.

Table 2. Effect of yard waste compost (YWC) treatment and crop establishment treatments on root-knot nematode densities in yellow squash.

	Nematodes per 100 cm^3 soil			
		30 June		
Compost[1]	13 April	Transplanted	Seeded	Mean
YWC incorporated	6	416	303	360
YWC mulch	8	270	362	316
Control	16	460	340	400
Mean	10	382	335	
ANOVA effects:[2]				
Compost	ns	ns		
Planting method	--	ns		
Compost x Planting	--	ns		

[1]YWC incorporated or YWC mulch applied at 269 mt/ha.
[2]Analysis of variance (ANOVA) effects not significant (ns) at $P \leq 0.10$.

Table 3. Effect of yard waste compost (YWC) treatment and crop establishment treatment on yield of yellow squash.

	Yield (kg/ha)[2]		
Compost'	Transplanted	Seeded	Mean
YWC incorporated	18,900	15,300	17,100a
YWC mulch	14,800	9,800	12,300ab
Control	8,100	5,200	6,700b
Mean	13,900A	10,100B	
ANOVA effects:			
Compost	*		
Planting method	*		
Compost x Planting	ns		

'Analysis of variance (ANOVA) effect significant at $P \leq 0.05$; ns = not significant at $P \leq 0.10$. Means in column followed by the same small letter or means in row followed by the same capital letter do not differ at $P \leq 0.05$.
'YWC incorporated or YWC mulch applied at 269 mt/ha.
Total of 12 harvests.

Table 4. Effect of yard waste compost (YWC) treatment and crop establishment treatment on root-knot nematode densities in okra.

	Nematodes per 100 cm³ soil			
		30 June		
Compost'	13 April	Transplanted	Seeded	Mean
YWC incorporated	3	330	94	212
YWC mulch	6	276	206	241
Control	24	106	110	108
-Mean	11	237 A	137 B	
ANOVA effects:				
Compost	ns	ns		
Planting method	–	*		
Compost x Planting	–	ns		

*Analysis of variance (ANOVA) effect significant at $P \leq 0.10$; ns = not significant. Means in row followed by different capital letters differ at $P \leq 0.10$.
[1]YWC incorporated or YWC mulch applied at 269 mt/ha.

Table 5. Effect of yard waste compost (YWC) treatment and crop establishment treatment on yield of okra.

	Yield (kg/ha)[2]		
Compost'	Transplanted	Seeded	Mean
YWC incorporated	2,270 a A	340 a B	1,310
YWC mulch	450 b A	30 a A	240
Control	610 b A	40 a A	330
Mean	1,110	140	
ANOVA effects:			
Compost	ns		
Planting method	ns		
Compost x Planting	*		

'Analysis of variance (ANOVA) effect significant at $P \leq 0.10$; ns = not significant. Means in columns followed by the same small letter or means in rows followed by the same capital letter do not differ at $P \leq 0.10$.
'YWC incorporated or YWC mulch applied at 269 mt/ha.
[2]Total of 7 harvests.

Unfortunately, the ability of a host plant to tolerate nematode damage varies with the plant cultivar, characteristics and dynamics of the nematode population, and numerous physical and environmental factors (McSorley and Duncan, 1995; Roberts, 1982). Much future research will be needed to improve the consistency and reliability of this promising strategy for nematode management.

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