NOTE: Effect of Neem and Organic Amendments on Nematode Populations in a Coastal Savanna Tropical Soil

K. Agyarko,[*,1] P.K. Kwakye,[2] M. Bonsu,[2] B.A. Osei[2] and J.S. Asante[3]

Nematode numbers were assessed at 2-week intervals in a coastal savanna soil amended with neem leaves and animal manure for 12 weeks under fallow conditions. The number of plant-parasitic nematodes decreased significantly with the application of the neem-based amendments, whereas the number of non-parasitic nematodes increased.
KEY WORDS: Soil amendment; neem leaves; animal manure; plant-parasitic nematodes.

Farmers in Ghana and other developing countries control nematodes mostly with synthetic pesticides, with resulting high increases in crop yield (5). However, the health hazards to man and the environment associated with their use (12) have turned the attention of farmers and researchers to alternative means of nematode control. Nematodes have been managed with various organic amendments (6), biocontrol agents (11) and mixed cropping with plants antagonistic to parasitic nematodes (9). These methods work best in healthy soil environments with sufficient organic matter to support diverse populations of microorganisms and with high nutrient status.

The products of the neem tree (*Azadirachta indica* A. Juss., Meliaceae) have been found to enrich the soil when used as a soil amendment, and to control plant-parasitic nematodes (1).

The objective of the present work was to study the effect of soil amendment with neem leaves on population densities of plant-parasitic nematodes under fallow conditions in combination with poultry manure and cow dung. Dried neem leaves, dried poultry manure and cow dung were ground, passed through a 2-mm sieve and used in different combinations with one kg of soil per treatment. The soil was collected from the experimental site at a depth of 15 cm around established sweet pepper plants attacked by root-knot nematodes, and sieved through a 2-mm sieve.

Treatments are described in Table 1. The neem - poultry manure - cow dung - soil mixture was placed in a polythene bag (4.8 cm×15 cm), leaving 1 cm of space at the top. There were three replications. Each replicate consisted of a batch of ten polythene bags of a particular treatment. Batches of replicates were placed in the ground at the experimental site using a Completely Randomized Design (CRD). The polythene bags were buried in the ground at a depth of 14 cm, the level of soil in the polythene bags, with the top free space of the bags above the field soil level. Samplings were done at 0, 2, 4, 6, 8, 10 and 12 weeks after field placement of samples. At each sampling, one polythene bag per replicate was removed from the ground.

A modified Baermann's method for nematodes extraction was used (3). Nematodes were identified and counted under a stereomicroscope at 40X magnification.

The data were subjected to analysis of variance (ANOVA) and Duncan's Multiple Range Test for the separation of means using the MSTAT-C statistical software (4).

The total numbers of plant-parasitic nematodes decreased with time in all treatments (Table 1). *Meloidogyne* [Goeldi, 1892] and *Scutel-*

Received July 15, 2004; accepted April 7, 2005; http://www.phytoparasitica.org posting July 14, 2005.
[1]University of Education, Winneba, Dept. of Agricultural Education, Mampong/Ash., Ghana. *Corresponding author [e-mail: agyarkokofi@yahoo.com]
[2]University of Coast, Dept. of Soil Science, Cape Coast, Ghana.
[3]Crop Research Institute, Dept. of Nematology, Fumasua-Kumasi, Ghana.

lonema [Andrassy, 1958] followed a similar pattern of population decline (data not shown). The amended soils had significantly lower numbers of nematodes than the unamended soil throughout the sampling times. Such a trend of decrease in numbers after application of organic soil amendments has been reported by other workers (7).

Neem at 50 and 100 g leaves per kg soil and their combination with cow dung and poultry manure resulted in zero nematodes immediately after the application of the organic amendment. The nematodes at this time might have been weakened or killed through the preparation of the samples and the neem compounds, thus rendering their detection impossible. Some nematodes, however, were recovered in the second sampling, 2 weeks later. These nematodes could be the combination of some revived weakened nematodes at week zero and newly hatched ones. A greater proportion of the nematodes might have been killed by the neem treatments, in which nematode numbers were significantly lower than those in the poultry, cow dung and control treatments at this sampling time. Numbers of nematodes in neem-amended soils were fewer than in the other treatments for the remaining sampling times, especially the last sampling day, and the mean nematodes numbers across all sampling times.

Both poultry manure and cow dung have been found to be effective in controlling parasitic nematodes, their effectiveness increasing with increasing levels of the manure and also depending on the kind of manure applied (Table 1) (10).

The neem leaves at the rates applied in this study and their combinations with the other amendments proved to be better than the poultry manure or the cow dung alone in controlling plant-parasitic nematodes. Neem's higher potency in the control of the nematodes could be attributed to its compounds, especially azadirachtin (8). No significant differences were found in nematode numbers between the two rates of neem leaves at the end of the experiment or the mean across all sampling times (Table 1). The high rates of neem leaves might have overshadowed any effect that might have been brought about by the mixture of the poultry manure and the cow dung with the neem leaves.

Population densities of plant-parasitic nematodes declined in all the treatments, and this was attributed to the absence of a plant host (7). Although population densities of plant-parasitic nematodes tend to decline under fallow conditions, amending the fallow soils with organic matter, especially neem leaves with the special qualities mentioned above, might accelerate the natural rate of poplulation decline and drastically reduce nematode densities before subsequent cropping.

The application of the amendments initially reduced the numbers of the non-parasitic nematodes in all treatments where later they increased to levels significantly higher than those in unamended soil (data not shown). Nematode numbers at the end of the experiment and the mean across all sampling times were significantly higher in amended than unamended soil. Neem leaves at 100 g kg^{-1} soil and their combinations with cow dung and poultry manure recorded the highest nematode population densities. Contrary to these results, neem products of a seed base decreased the populations of non-plant-parasitic nematodes (1). However, in general, organic amendments increase the populations of non-plant-parasitic nematodes such as bacterivores, fungivores and omnivores (7). The probable increase in numbers of non-plant-parasitic nematodes might have contributed to the suppressive characters of the amendments against the plant-parasitic nematodes (2).

TABLE 1. Effect of amending the soil with neem leaves (NL), cow dung (CD) and poultry manure (PM) on total numbers of plant-parasitic nematodes in fallowing soil

Amendment (per kg of soil)	Nematodes per 100 g of soil							
	Week 0	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Mean[z]
Unamended soil	219 a[y] (24)[x]	226 a (31)	159 a (18)	88 bc (13)	85 a (15)	63 a (8)	63 a (12)	129 a (72)
10 g CD	132 b (15)	102 b (22)	99 b (10)	53 b (9)	41 b (8)	33 b (11)	28 f (7)	70 b (41)
5 g PM	107 bc (17)	88 a (13)	68 c (12)	44 c (11)	40 b (9)	29 b (7)	16 c (5)	56 b (33)
10 g PM	90 c (23)	68 c (8)	62 d (11)	25 d (7)	31 c (10)	24 c (10)	9 d (3)	44 b (29)
50 g NL	0 d (0)	27 d (9)	28 b (6)	20 e (4)	10 fg (3)	11 d (4)	4 def (1)	14 c (11)
100 g NL	0 d (0)	20 d (7)	21 g (4)	4 h (2)	2 i (1)	4 efg (1)	0 f (0)	7 c (9)
50 g NL + 10 g CD	0 d (0)	30 d (11)	36 e (9)	21 e (6)	11 ef (2)	4 efg (3)	8 de (2)	16 c(14)
100 g NL + 10 g CD	0 d (0)	22 d (10)	12 h (5)	8 g (3)	12 e (4)	5 ef (2)	1 ef (0)	9 c (8)
50 g NL + 5 g PM	0 d (0)	30 d (8)	24 fg (5)	13 f (4)	1 i (0)	8 de (5)	4 def (3)	11 c (12)
50 g NL + 10 g PM	0 d (0)	35 d (6)	22 g (8)	14 f (3)	18 d (5)	4 efg (2)	6 def (2)	14 c (12)
100 g NL + 5 g PM	0 d (0)	19 d (5)	22 g (6)	11 fg (5)	9 g (2)	0 g (0)	1 ef (0)	9 c (9)
100 g NL + 10 g PM	0 d (0)	13 d (7)	14 h (3)	1 h (0)	4 h (3)	2 fg (1)	0 f (0)	5 c (6)

[z] Across all sampling times.

[y] Within columns, figures followed by a common letter do not differ significantly ($P \leq 0.05$).

[x] In parentheses, standard deviation.

ACKNOWLEDGMENT

We thank the Centre for School and Community Science and Technology Studies (SACOST), University of Education, Winneba, Ghana, for supporting this project financially.

REFERENCES

1. Akhtar, M. (1999) Plant growth and nematode dynamics in response to soil amendments with neem products, urea and compost. *Bioresour. Technol.* 69:181-183.
2. Akhtar, M. and Malik, A. (2000) Roles of organic soil amendments and soil organisms in the biological control of plant parasitic nematodes. A review. *Bioresour. Technol.* 74:35-47.
3. Dropkin, V.H. (1989) Introduction to Plant Nematology. John Wiley and Sons, Inc., New York, NY.
4. Freed, R.D. (1992) How to Use MSTAT-C to Analyze On-Farm Experiments. Farming Systems Conference. Michigan State University, East Lansing, MI, USA.
5. Johnston, S.A., Probasco, P.R. and Phillips, J.R. (1994) Evaluation of soil fumigants and nematicides for the control of root-knot nematodes on carrot, 1993. *Fungicide and Nematicide Tests* 49:178.
6. Khan, F.A. (1994) Effect of soil amendments on the development of *Pratylenchus brachyurus* and growth and yield of okra. *Afro-Asian J. Nematol.* 4:84-87.
7. McSorley, R. and Frederick, J. J. (1999) Nematode population fluctuations during decomposition of specific organic amendments. *J. Nematol.* 31:37-44.
8. Neem Foundation (1997) Neem for fertilizer management. http://www.neemfoundation.org/fert.htm
9. Powers, L.E., McSorley, R. and Dunn, R.A. (1993) Effects of mixed cropping on a soil nematode community in Honduras. *J. Nematol.* 25:666-673.
10. Riegel, C., Fernandez, F.A. and Noe, J.P. (1996) *Meloidogyne incognita* infested soil amended with chicken litter. *J. Nematol.* 28:369-378.
11. Weibelzahl-Fulton, E., Dickson, D.W. and Whitty, E.B. (1996) Suppression of *Meloidogyne incognita* and *Meloidogyne javanica* by *Pasteuria penetrans* in field soil. *J. Nematol.* 28:43-49.
12. W.H.O. (1990) Global Estimates for Health Situation Assessment and Projections. Division of Epidemiological Surveillance and Health Situation and Trend Assessment, Geneva, Switzerland.