SHORT COMMUNICATION

Distribution of *Meloidogyne incognita* (root-knot nematode) in Some Vegetable Fields in Eastern Ethiopia

Tadele Tefera and Mengistu Hulluka
Department of Plant Sciences, Alemaya University of Agriculture
P O Box 138, Dire Dawa, Ethiopia.

Abstract

A survey of root-knot nematode, *Meloidogyne incognita,* in major tomato, pepper and cabbage growing areas of eastern Ethiopia was conducted in 1997 cropping season. The objective of this work was to study distribution of *M. incognita* in relation to altitude, soil texture and pH. A total of 150 soil samples and some infected root portions were collected from six vegetable growing areas of eastern Ethiopia. Ninety percent of the soil samples were detected to have *M. incognita*. Population density of root-knot nematode increases as sand content and pH of the soil increase ($r = 0.88$, $P<0.01$; $r = 0.54$, $P<0.05$), respectively. Whereas, clay, silt content and altitude had shown an inverse relationship ($r = -0.88$, $r = -0.74$ and $r = -0.83$, $P<0.01$), respectively.

Introduction

Vegetable production constitute a major farming activity and represent a considerable economic importance to the eastern Ethiopia because of its proximity to export marketing, Djibouti and Middle east countries (Anon. 1987). Tomato, pepper and cabbage are some of the widely grown crops both under rainfed and irrigation. Despite the ecological and market potential for vegetables, the occurrence of diseases had resulted to low yield per unit of production area and reduced quality. Most of the vegetable crops in the region are severely attacked by root-knot nematode, *Meloidogyne incognita* (Kofoid & White) Chitwood, because of the year round production of vegetables (Solomon 1987). Vegetable crop losses in the tropics due to this nematode ranged from 20-30 % (Taylor & Sasser 1978).

No research work, however, has been done in Eastern Ethiopia. Therefore, empirical information on distribution of this nematode in relation to altitude, soil texture, and pH is lacking. Knowledge about the ecological requirements of root-knot nematode can be used to identify areas where this disease is most likely to occur, thereby design appropriate and effective management strategy. This study reports the distribution of *Meloidogyne incognita,* in relation to altitude, soil texture, and pH.

Materials and Methods

Survey

Soil and root samples were collected from tomatoes, peppers and cabbages growing farmers' fields of eastern Ethiopia from February through March, 1997 cropping season. The survey sites were Alemaya, Bisidimo, Dire Dawa, Errer Gota, Finkle, and Kombolcha (Figure 1). These sites are major vegetable producing areas in the region and are of different agroecologies. Bisidimo, Dire Dawa and Errer Gota belong to lowland irrigated situation. Their altitude ranges from 1085 to 1340 m.a.s.l. Whereas, Alemaya, Finkle and Kombolcha are highland rainfed with an altitude of 1930 to 2050 m.a.s.l. For each crop at each site, four fields were randomly selected. Thirty soil core samples / ha were collected in zigzag manner at 4 m intervals across the field (Barker 1985a). Where possible, samples of infected roots were also collected. For each sample reference number, sampling date, altitude (from altimeter reading), cultivar names were recorded. Samples were taken to Plant pathology laboratory of Alemaya University of Agriculture on the same day and kept in the laboratory benches at room temperature (21-22^0 C) until used for analysis.

Nematode extraction from soil

From each soil sample nematodes were extracted by centrifugal-flotation method within 2-3 days after collection (Barker 1985b). The nematode suspensions were counted under streomicroscope. The count was repeated three times and an average was taken. After counting nematodes were fixed (FA 4:1) and kept at room temperature.

Root-knot nematode population

Total nematode was counted in 100 cm^3 soil. To determine the relative abundance of root-knot nematode juveniles, a subsample of twenty nematodes was glycerin mounted and examined in detail for their tails, stylet and body size, using compound microscope. Root-knot nematodes were counted excluding others. The relative abundance of root-knot nematodes were converted to total numbers of nematodes per 100 cm^3 of soil (Barker 1985b). For confirmation, representative temporary slides of female perineal patterns were sent to Professor K.R. Barker of North Carolina State University, Department of Plant Pathology (USA).

Soil particle size analysis

Soil texture determination was accomplished by hydrometer method (Day 1965).

Soil pH analysis

Fine dry, 50 g soil was put into a 100 ml glass beaker filled with 50 ml distilled water. The solution was mixed intermittently and the pH was measured after 30 minutes by a glass electrode electrometrically (Peech 1965). For samples from pepper and cabbage fields, soil analysis was not done. The *M. incognita* population data from tomato fields were then subjected to correlation and regression analysis using MSTATC computer software.

Results

Distribution and occurrence

Tomato was the most frequently encountered crop (100 %) in all the survey locations followed by pepper (67 %) and cabbage (50 %) (Table 1). Cabbage was restricted to high atitudinal areas of Alemaya, finkle and Kombolcha. Of 155 soil samples collected from the six surveyed locations, 90 % of the samples were positive for *M. incognita*. *M. incognita* infestation ranged from 76 % in the cabbage fields tp to 89 % in pepper and 98 % in tomato fields. The incidence of root-knot namatode was 100 % in Bisidimo and Dire Dawa for both tomato and pepper.

Relation of *M. incognita* population density to soil texture, pH and altitude

The linear regression of root-knot nematode population density in tomato fields versus percent sand content and soil pH revealed direct relationship (Figures 2 a, d). Whereas, Percent silt, clay content and altitude had shown an inverse relationships (Figures 2 b, c, e). Sand content was highly significant ($P < 0.01$) and positively correlated to nematode population density ($r = 0.88$). With the increase in sand content of the soil the nematode population density increased (Figure 2 a). The pH of the soil was significant ($P < 0.05$) and positively correlated ($r = 0.54$) with nematode population density (Figure

2 d). However, percent silt and clay content were highly significant ($P < 0.01$) and negatively correlated ($r = -0.74$; $r = -0.88$), respectively, to nematode population density (Figures 2 b, c). Highly significant ($P < 0.01$) correlation ($r = -0.83$) was observed between nematode population density and elevation of the sites (Figure 2 e). The variation (R^2) in the mean nematode population densities accounted for by the linear function of percent sand, silt, clay, pH, and altitude were 78 %, 54 %, 77 %, 29 % and 69 %, respectively (Figure 2).

The highest population density, 573 nematodes per 100 cm^3 soil, was recorded at Errer Gota with sand (90 %), silt (3 %), clay (7 %), pH (7.4) and altitude (1085 m.a.s.l.). However, the lowest, 117 nematodes per 100 cm^3 soil, was encountered at Kombolcha, sand (52.9 %), silt (12 %), clay (35.1 %), pH (6.0) and altitude (2050 m.a.s.l.) (Table 2) .

Discussion

All three crops surveyed were found infected by *Meloidogyne incognita*. Among the three hosts, *M. incognita* seems to be widely distributed in tomato and pepper fields. This indicates that tomato and pepper suffer more to *M. incognita* infection than cabbage.

The presence of root-knot nematode in almost all soil samples collected (90 %) indicated that the disease is widely distributed in the region. Most farmers in the locations surveyed grow entirely tomato cultivar 'marglobe' which was reported to be very susceptible to root-knot nematodes (Kallo 1988). The use of this cultivar year to year coupled with the absence of management practices would undoubtedly intensified the buildup, distribution and occurrence of the disease in eastern Ethiopia. Serious problems of the disease were observed in low land irrigated areas: Bisidimo, Dire Dawa and Errer Gota. Even though it is a serious pest, all the farmers in the survey sites didn't have the knowledge of root-knot nematode damage to their crops, and attribute the disease to poor soil fertility and associated problems.

In this study, the soil particle size distribution, pH and elevations of the sample areas affected the distribution of *Meloidogyne incognita* in tomato fields. With an increase in sand content, the population density of root-knot nematode was increased. The impact of soil texture on the reproduction and damage potentials of *Meloidogyne* species has been well documented. Published reports would indicate that in coarse textured soils aeration increases and hence reproduction and motility of nematodes are encouraged (Koenning et al. 1996).

M. incognita distribution appeared to be limited by elevation. At higher altitudes, developmental rates decline as temperature decreases (Santo & O'Bannon 1981). Soil pH had affected the density of root-knot nematode. *Meloidogyne* spp. can survive, hatch and reproduce over a wide pH range, 4.0-8.0. However, at low pH the occurrence and accumulation of some chemicals such as phenols which are not conducive for the growth of nematodes are initiated (Wallace, 1973). However, our survey sites were relatively few and restricted only to some vegetable crops, thus, the probability of detecting other *Meloidogyne* species was narrow. Further works, with additional crops over many locations may reveal another species.

The differences in nematode population densities at these locations may, at least in part, be explained by the differences in abiotic factors that govern the ecology of root-knot nematodes. Nevertheless, ecological work with a single or few species relative to one or few environmental parameters may help provide at least a partial, if not total, explanation of the presence and population density of a given nematode species. Since environmental factors affect both hosts and nematodes, it is difficult to single out the pure effects of one component of environmental factors on nematode population under field conditions. Future work should focus on nematode-host-environment interaction under controlled condition. A good understanding of these interactions is essential for development of root-knot nematode management programs for specific crop in a specific geographical region.

As more areas of land come under cultivation due to population pressure, specially with irrigated low lands, this disease will be the major menace to vegetable crops production in eastern Ethiopia.

Since damage is high in coarse textured soils and at low altitudes attention must be given in selecting sites for vegetable crops production and to use of proper management options.

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Table-1: Spatial patterns of *Meloidogyne incognita* by locations in eastern Ethiopia during 1997 cropping season

Location	Crop	Total no of sample	No. Of samples infested	Samples infested with *M. Incognita*	Crop coverage (ha)	Nematod density
Alemaya	Tomato	10	10	100	0.3	224
	Pepper	8	6	75	0.2	110
	Cabbage	12	10	83	0.4	172
Bisidimo	Tomato	13	13	100	0.4	260
	Pepper	12	12	100	0.4	88
Dire Dawa	Tomato	17	17	100	0.6	375
	Pepper	13	13	100	0.4	188
ErerGota	Tomato	15	15	100	0.5	546
	Pepper	15	12	80	0.5	329
Finkle	Tomato	4	4	100	0.1	159
	Cabbage	11	8	73	0.4	104
Kombolcha	Tomato	14	12	86	0.5	130
	Cabbage	11	8	73	0.4	158
Total		155	140	90	5.1	2843

Table2. The relationship between some abiotic factors and Population density of *Meloidogyne incognita* in tomato fields

Sampling site	Population density/100 cm^3	Soil Particle disn (%) Sand	Silt	Clay	pH	Altitude (m)
ALM1	202.3	67.6	11.0	21.4	6.6	1980
ALM2	296.0	89.5	2.0	8.5	7.7	1950
ALM3	197.0	66.3	10.3	23.4	6.6	2010
ALM4	199.0	68.5	11.0	20.5	6.8	1980
BSD1	215.0	72.0	4.0	24.0	7.0	1340
BSD2	344.0	82.6	5.0	12.4	6.3	1340
BSD3	257.7	76.6	4.7	18.7	7.1	1340
BSD	223.0	71.8	4.1	24.1	7.0	1340
DRD1	405.6	90.0	2.2	7.8	7.2	1110
DRD2	396.0	89.7	3.1	7.2	7.0	1110
DRD3	323.0	89.1	3.1	7.8	7.2	1110
ERG1	557.0	88.8	3.3	7.9	6.9	1085
ER	573.0	90.0	3.0	7.0	7.4	1085
ERG2	509.4	88.6	3.0	8.4	6.9	1085
FNK1	104.4	61.7	9.0	29.3	6.8	1930
FNK2	213.5	64.5	4.5	31.0	7.1	1930
KOM1	124.0	62.9	10.1	27.0	6.2	2050
KOM2	117.0	52.9	12.0	35.1	6.0	2050
KOM3	158.5	65.3	8.9	25.8	6.3	2050
KOM4	121.0	59.4	9.2	31.4	6.1	2050

KOM: Kombolcha; BSD: Bisidimo; DRD: Dire Dawa; ALM: Alemaya; ERG: Erer Gota; FNK: Finkle.

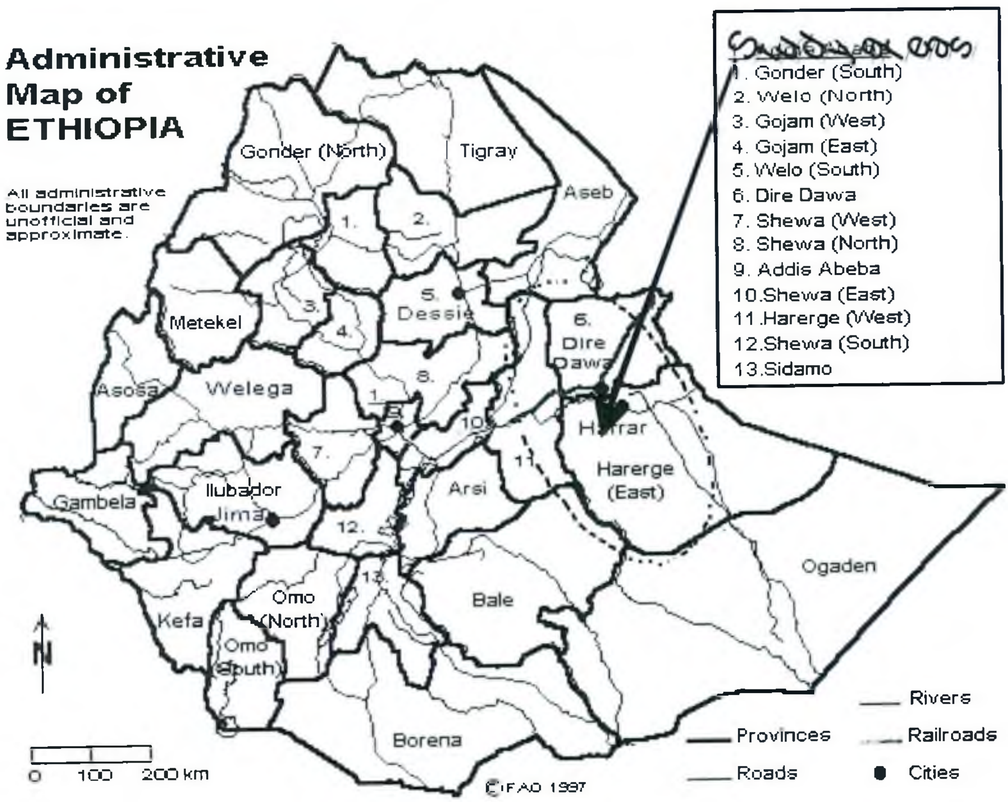

Figure 1. A map showing the survey areas

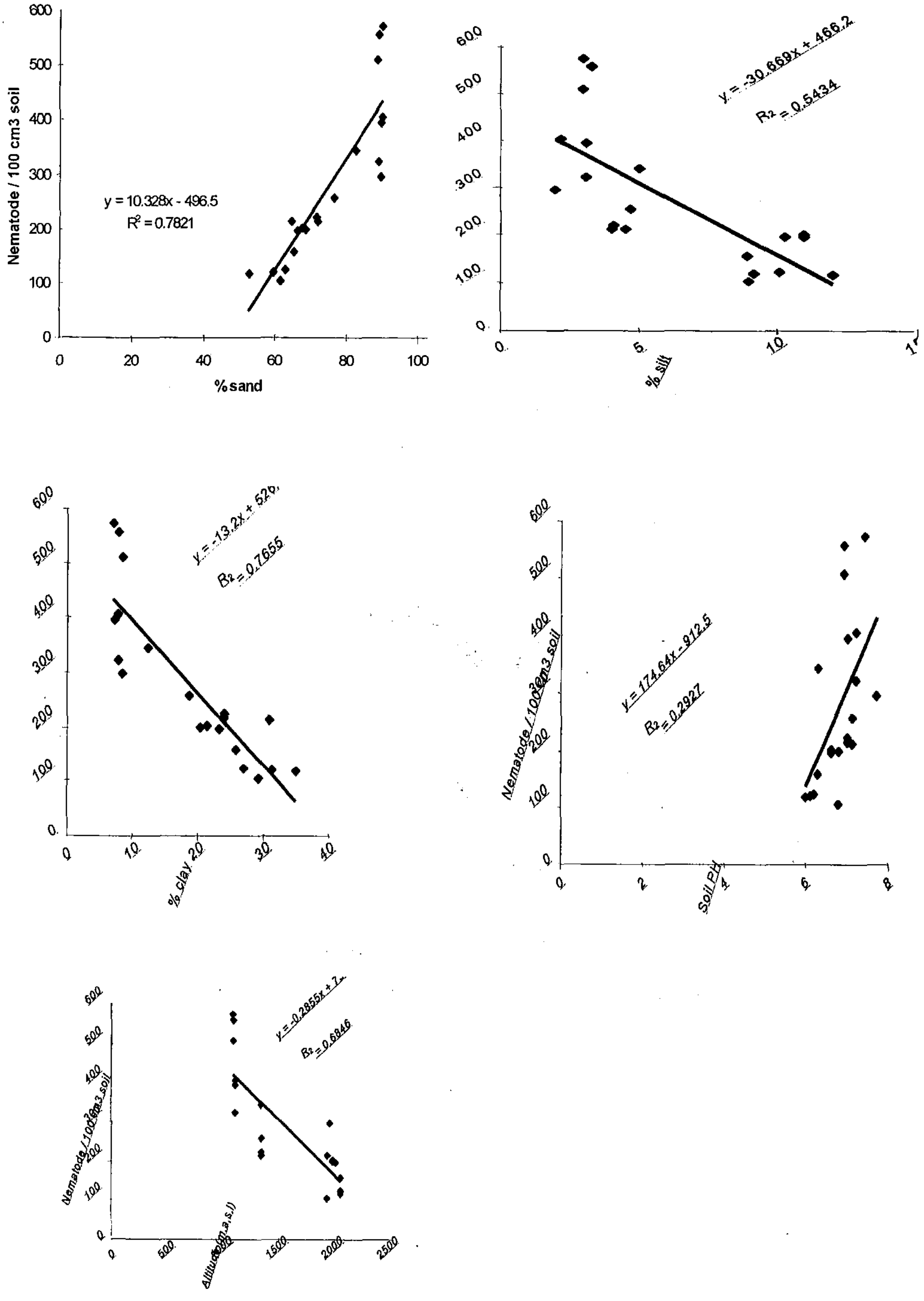

Figure 2. The relation of *Meloidogyne incognita* population densities in tomato to soil texture, pH and altitude: (a) % sand, (b) % silt, (c) % clay, (d) soil pH, (e) altitude.