

EFFECT OF POULTRY MANURE ON ROOT KNOT NEMATODES (*MELOIDOGYNE* SPP.) IN TOMATO (*LYCOPERSICON ESCULENTUM* MILL.)

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ABSTRACT

A glasshouse and two field experiments were carried out in the upcountry intermediate zone to investigate the effect of poultry manure (PM) on root knot nematodes (*Meloidogyne* spp.). Results revealed that retardation of growth and reduction of yield due to root knot nematodes could be overcome by incorporation of PM into the nematode-infested soils. It was also found that application of high rates of PM (10 t/ha) reduced root knot nematode population considerably in infested soils.

KEY WORDS: Poultry manure, Root knot nematode, Tomato

INTRODUCTION

Tomato is one of the major crops grown in the upcountry intermediate zone (UCIZ) of Sri Lanka. The average extent under tomato cultivation in the region is about 700 ha per season (Sri Lanka Census of Agriculture, 1982). A survey (Lamberti and Ekanayake, 1981) revealed that soils of the UCIZ were highly infested with root knot nematodes (*Meloidogyne* spp.). Although the percentage of root knot nematodes observed in this survey was only 15% of the total nematode fauna identified, the plant symptoms and economic damage caused indicated that this group is a major pest of many vegetables, fruits and ornamental crops grown in the country (Ekanayake, 1986).

Root knot nematodes cause histopathological changes in root tissues of tomato. The results of these changes are the formation of giant cells and galls in the root system. This abnormality can upset the normal physiological activities of vascular tissue of the root system and finally causes wilting, stunting, leaf chlorosis and poor growth of plants (Ekanayake *et al.*, 1988).

UCIZ region is a unique region because all exotic as well as local vegetables, fruits and ornamental crops can be grown in it. Farmers in the region do not follow distinct growing seasons in cultivating vegetable crops as the soil and climatic conditions are favourable for throughout the year cultivation. A cultivable land is never kept fallow as a practice. Hence root knot nematodes are always provided with hosts as many of the cultivated crops are susceptible to the pest at varying degrees. This may cause high rate of multiplication of the pest. Though these facts show that the large extent of arable land in the region is not suitable for cultivating susceptible crops such as tomato without following appropriate control measures, farmers grow tomato and obtain very high yields without adding any nematicides. However, they add liberal amounts (10—15 t/ha) of poultry manure (PM) 3—7 days prior to transplanting of tomato seedlings. In addition, chemical fertilizer mixtures are added to the soil as basal and top dressings.

Even though cattle manure (CM) is available in abundance, farmers do not apply it for cultivation of tomato. As the available amounts of PM are not sufficient, it is transported from distant places such as Colombo and Kandy to meet the requirement of the region.

Studies conducted in the region (Wijewardena, 1985, Unpubl.) showed that PM gave higher yields of tomato than CM. Gaur and Prasad (1970) revealed that organic manures were very effective in suppressing parasitic nematode populations. Incorporation of organic manure not only increased the nutrient content in soil but also improved physical, chemical and microbial properties of the soil (Kononowa, 1966; Gaur *et al.*, 1971).

Besides these reasons, there may be some other important reason or reasons for giving preference to PM over the other sources of organic manure in cultivation of tomato in the UCIZ. A glasshouse experiment and two field experiments were therefore, conducted at the Regional Agricultural Research Centre, Bandarawela and farmers' fields in the region to investigate the effect of PM on root knot nematodes associated with tomato crop.

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MATERIALS AND METHODS

Field experiment at Endarugolla

An experiment was conducted at Endarugolla (OM 8%) during yala 1985 where nine different treatments were evaluated along with an untreated control (Table 1). The fungus *Pacilomyces lilacinus* was cultured on wheat under laboratory conditions.

Seeds of tomato variety, T-244 were sown in a nursery free of nematodes. Seedlings were kept in the nursery for 3 weeks.

Healthy vigorous seedlings were selected and transplanted at a spacing of 80 cm $\times$ 50 cm. The plot size was 3 m $\times$ 3.5 m. The treatments were replicated three times. Fertilizers were applied at the rate of 50 kg N, 85 kg P₂O₅, and 100 kg K₂O per ha as basal. Top dressings were given at 3 and 6 weeks after transplanting at the rate of 50 kg N and 50 kg N + 100 kg K₂O per ha respectively. Recommended fungicides to control early blight and late blight were sprayed as and when necessary. Fruit borer (*Heliothis armigera*) was controlled by using chlorfluazuron. Total weight of tomato/plot was recorded at harvest. Root systems of six randomly selected plants/plot were rated for their galling indices according to Taylor and Sasser (1978).

Glasshouse experiment at Bandarawela

A pot experiment was carried out in the glasshouse at Regional Agricultural Research Centre, Bandarawela during maha 87/88. Seeds of tomato variety, T-244 were sown in a tray containing nematode-free soil and kept in the glasshouse. Seedlings were raised in this tray for 3 weeks. Each pot was filled with 1500 g of 1:3 sterilized sand/soil mixture. Treatments tested and time of application of organic manure and chemicals are given in Table 2. The experiment was laid out in a randomized complete block design with 13 replicates.

Eggs and juveniles of *Meloidogyne* spp. were extracted from infected tomato roots using 0.1% sodium hyperchlorite solution (Hussey and Barker, 1973). All pots except the non-inoculated treatment were

inoculated with approximately 3000 eggs and juveniles of the nematode. Inoculation was done 3 days after transplanting. Fertilizers were added at the rate of twice the Departmental recommendation for tomato.

Plant height at 7 day-intervals starting from one month after inoculation was recorded. Gallling indices for each root system were rated as in the previous experiment on the 62nd day after inoculation (DAI).

Field experiment at Rahangala

A second field experiment was conducted at Rahangala (clayey soil) during yala 1989. Six treatments with an untreated control (Table 3) replicated four times were evaluated in a randomized complete block design. The tomato variety used was Bianz. Plot size was 4 m × 4 m. Plant spacing, raising of seedlings in the nursery, transplanting, fertilizer application, and pest and disease control were same as in the earlier field experiment. Plant height was taken from randomly selected five centre plants/plot at 1st harvest. Total weight of tomato and total number of fruits per plot were recorded at every harvest. After the final harvest five plants randomly selected from each plot were uprooted and root systems were graded for their gallling indices (Taylor and Sasser, 1978).

RESULTS AND DISCUSSION

Field experiment at Endarugolla

The lowest galling index (GI) value was observed with Fenamiphos and PM alone treatments (Table 1). Carbofuran 2 kg ai/ha alone, Ethoprophos, Ethoprophos + PM and the fungus *Pacilomyces lilacinus* gave lower values of GI than the untreated control. GI values given by carbofuran 1.0 kg ai/ha + PM, carbofuran 0.75 kg ai/ha + PM and carbofuran 1.0 kg ai/ha alone treatments were more or less same compared to the untreated control.

None of the treatments tested gave significantly higher tomato yield than the untreated control (Table 1). However, Fenamiphos and PM 10 t/ha treatments gave high yields as well as low GI values compared to the other treatments and the control.

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Table 1. Effect of nematicides and PM on yield and nematode population of tomato - Yala 1985

Treatment	Mean yield (t/ha)	Mean galling index
Carbofuran (3G) 1 kg ai/ha	40.2	4.5
Carbofuran (3G) 1 kg ai/ha + PM, 5t/ha	41.4	4.3
Carbofuran (3G) 0.75 kg ai/ha + PM, 5t/ha	41.1	4.8
Carbofuran (3G) 2 kg ai/ha	37.2	3.7
Fenamiphos (5G) 5 kg ai/ha	42.6	1.5
Ethoprophos (10G) 1 kg ai/ha	36.6	3.6
Ethoprophos (10G) 1 kg ai/ha + PM, 5t/ha	35.0	3.6
<i>Pacilomyces lilacinus</i> infected wheat 375 kg/ha	41.4	3.0
PM only, 10 t/ha	47.9	1.5
Untreated control	35.9	4.5
LSD (0.05)	NS	-
CV(%)	23.8	-

ai = active ingredient; PM = poultry manure

PM and *Pacilomyces lilacinus* were applied to planting hills 1 week before transplanting.

Carbofuran, fenamiphos and ethoprophos were applied to planting hills 1 day before transplanting.

Glasshouse experiment at Bandarawela

Thirty days after inoculation (DAI) highest plant height was observed in pots treated with PM 50 g/pot (Table 2). The treatments, PM 100 g/pot and CM 50 g/pot also gave significantly higher plant heights than the inoculated untreated control. However, there were no significant differences among the heights of plants treated with PM, and CM 50 g/pot (Table 2).

Table 2. Effect of PM, CM and Carbofuran on plant height and nematode population glasshouse experiment - maha 87/88

Treatment	Mean plant height (cm)					Mean galling index
	30 days A. I.	37 days A. I.	51 days A. I.	58 days A. I.	62 days A. I.	
PM 50 g/pot	17.7 a	35.4 a	60.6 a	67.4 ab	71.5 ab	4.7
PM 100 g/pot	14.7 ab	30.5 ab	61.6 a	69.8 a	76.3 a	0.9
CM 50 g/pot	15.3 ab	30.0 ab	51.5 b	57.5 c	64.5 b	4.1
CM 100 g/pot	12.8 bc	25.3 bc	52.2 b	59.2 c	65.3 b	4.1
Carbofuran	12.0 c	21.9 c	48.9 b	56.6 c	62.3 c	3.6
2 kg ai/ha Carbofuran	12.9 bc	25.5 bc	52.0 b	61.7 b	64.7 b	3.1
4 kg ai/ha Inoculated	10.9 c	21.0 c	45.7 b	54.0 c	61.2 c	4.6
but not treated						
No inoculation	12.5 bc	25.1 bc	50.9 b	60.8 b	63.3 b	0.0
no treatment						
CV (%)	27.5	35.1	16.8	14.6	14.8	

Means followed by the same letter are not significantly different at 5% level by DMRT

A. I. = after inoculation; PM = poultry manure; CM = cattle manure

PM and CM were applied 1 week and 1 day before transplanting respectively

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The observations recorded at 37 DAI were similar to those at 30 DAI (Table 2). It was found that plant height significantly increased over the inoculated control at 51 DAI in treatments which received PM.

PM treatments and Carbofuran 4 kg ai/ha treatment gave significantly higher plant heights than the inoculated control at 58 DAI (Table 2). Highest plant height, was recorded in the PM 100 g/pot treatment. At the end of the experiment (62 DAI) PM, CM and Carbofuran 4 kg ai/ha treatments significantly increased plant heights over the inoculated control. But the plant height observed with PM 100 g/pot was significantly higher than that observed with CM treatments (Table 2).

Though PM 50 g/pot treatment gave the highest plant height at the initial stage of the experiment, the highest plant height was observed with PM 100 g/pot treatment at the end of the experiment. It was also found that the GI value observed with the PM 50 g/pot was higher compared to other treatments (Table 2). This may be due to the lower rate of PM which may not be sufficient to control the nematode population for a longer period. It may possibly have reduced the multiplication of nematodes at the early stages of plant growth thus minimizing the effect of nematodes on growth of the plant. The lower rate of PM however, may not have been sufficient to control the nematode population increase which would have occurred at the later stage of the plant growth. Poor plant growth at initial stage in Carbofuran treatment is due to phytotoxic effect of the nematicide (Table 2).

When compared to non-inoculated control, the PM treatments seem to have given some other beneficial effects on plant growth other than controlling nematodes (Table 2).

Field experiment at Rahangala

All treatments tested gave significantly higher yield of tomato than the untreated control (Table 3). The highest number of tomato fruits/plant was observed in PM 7.5 t/ha treatment and it was significantly higher than the untreated control (Table 3).

Table 3. Effect of rates of PM and Carbofuran application on growth and yield of tomato and nematode population — yala 1989

<i>Treatment</i>	<i>Mean yield (t/ha)</i>	<i>Mean No. of fruits/plant</i>	<i>Mean plant height at 1st harvest (cm)</i>	<i>Mean dry weight/stem (g)</i>	<i>Mean galling index</i>
PM 2.5 t/ha	25.2 a	38.8 ab	83.7 ab	37.7 ab	4.0
PM 5.0 t/ha	26.9 a	40.6 ab	84.9 a	32.0 b	3.0
PM 7.5 t/ha	26.4 a	46.8 a	85.7 a	33.3 b	2.6
PM 10.0 t/ha	28.2 a	35.3 b	89.3 a	52.3 a	2.3
Carbofuran (3G) 2 kg ai/ha	24.3 a	30.4 b	69.7 d	28.2 b	3.0
Fenamiphos (5G) 5 kg ai/ha	24.8 a	31.3 b	77.1 bc	37.5 ab	1.9
Untreated control	21.1 b	31.3 b	72.9 cd	29.2 b	4.5
CV (%)	14.9	21.9	5.4	20.3	—

Means followed by the same letter are not significantly different at 5% level by DMRT.

PM = poultry manure; ai = active ingredient

PM was applied to planting hills 1 week before transplanting. Carbofuran and fenamiphos were applied to planting hill 1 day before transplanting.

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PM treatments gave significantly higher plant heights than the untreated control (Table 3). PM 5, 7.5 and 10 t/ha treatments significantly increased the plant heights over the Fenamiphos and Carbofuran treatments. PM 10 t/ha gave the highest mean dry weight/stem and it was significantly higher than the untreated control (Table 3). But there were no significant differences in mean dry weight/stem, among PM 2.5 and 10 t/ha treatments and Fenamiphos treatment. The mean GI observed with Fenamiphos, PM 10 and 7.5 t/ha were low compared to the other treatments (Table 3).

Results of these experiments revealed that PM has some controlling effect on root knot nematodes. In fact, low GI values with increasing PM rates suggest that some component of PM may be involved in the control of root knot nematodes.

It had been reported by many workers that application of organic manure to the soil increased soil microbial population (Kononowa, 1966; Gaur *et al.*, 1971). These microorganisms would compete with root knot nematodes for space, food, water etc. and also toxins produced by microorganisms may have adversely affected root knot nematodes.

Speed of nematode activity and movement in soil to reach the host are related to soil porosity, soil particle size, thickness of the water film present and relative activity of the nematode. Poor soil aeration decreases nematode survival and population density (Jatala, 1986). Therefore, a fine clayey soil may inhibit the infestation of nematodes as they require a minimum pore diameter of 0.02 mm for their movement in soil (Jatala, 1986). Hence, adding PM to a fine clayey soil such as the one used in this study may increase nematode population initially. But the increased population would be affected by the activities of increased microorganism population thereby suppressing the severity of nematodes. Continuous application of PM to the nematode infested soil for several seasons might give complete control of root knot nematodes. Further studies are required on this aspect.

CONCLUSIONS

It is evident from the above results that PM is effective in suppressing or reducing root knot nematode associated with tomato. The level of suppression or reduction depends on the amount of PM added. High amount of PM is likely to suppress nematode activities for a long duration. This suggests that continuous application of PM would help to control root knot nematodes in tomato, while increasing the yield.

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