MANAGEMENT OF ROOT-KNOT NEMATODE MELOIDOGYNE INCognITA IN TOMATO IN EASTERN ETHIOPIA THROUGH ORGANIC SOIL AMENDMENTS

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ABSTRACT

Study was conducted in root-knot nematode infested sick plot soil to determine effect of poultry manure and rapeseed oilcake soil amendment against root-knot nematode infestation and yield of tomato. Well decomposed poultry manure and grounded rapeseed cake at 0, 5, 10, 15 ton/ha and 0, 5 and 10 ton/ha respectively applied in experimental plot three weeks before transplanting the seedlings. The experiment was laid in RCBD factorial arrangement. Application of poultry manure except 5 ton/ha with rapeseed oilcake at 10 ton/ha significantly affected (p<0.05) number of egg/egg mass, root galling, population of final J2, yield and growth of the crop. Root-knot nematode infestation significantly reduced as poultry manure increased from 5 ton/ha to 20 ton/ha with rapeseed cake at 20 ton/ha. Yield also increased as poultry manure application increased from 5 to 15 ton/ha with or without rapeseed oilcake.

KEYWORDS: Poultry, Manure, Rapeseed, Oilcake Root-Knot, Nematode, Infestation, Tomato

INTRODUCTION

Tomato (Lycopersicon esculentum Mill.) is one of the most important vegetable crops in Ethiopia. The national average yield is too low 9 and 25 and 40 ton/ha under farmers’ condition, at demonstration and experimental research plots respectively (Abdissa et al., 2010). The eastern part of Ethiopia is considered to be a high potential area for vegetable production and marketing despite production and market potential of the area the occurrence of several factors contributed a lot in reducing yield/unit of production and quality of produce this includes pest and wide range of disease including root-knot nematodes (Eshetu et al., 2006). Meloidogyne incognita (Kofoid and White) Chitwood is among key pest problem and it was identified as a pest causing root-knot in tomato (Tadele and Mengistu, 2000). Since then little research has been done on management aspects of root-knot nematode (Wondirad et al., 2009). Several methods have been suggested for the managements of root-knot nematode including chemical, biological and cultural methods with different levels of successes. Although chemical nematicides are effective in nematode control, their high costs, non availability at the time of need, the hazards they pose to human as well as on non-target organisms discourage users (Wachira et al., 2009). Soil amendments with cruciferous residues and other organic manures are reported to be effective in reducing the population densities of many soil-borne plant pathogens (Hassan et al., 2010; Ritu and Lodha, 2002). Studies in Nigeria, South East Asia and many other developing countries indicated that poultry manure soil amendment increased the yield of tomato and suppressed root-knot nematode (Ogulumba et al., 2010). Therefore, this study was conducted to determine the effect of poultry manure, rapeseed cake against root-knot nematode infestation, and yield of tomato.
MATERIALS AND METHODS

Experimental Site Description

The experiment was conducted from July to the end of December, 2012 at Haramaya University’s Research Station located at 9°6’N latitude and 41°8’E longitude at an altitude of 1197 meter above sea level. The site receives a mean annual rainfall of 520 mm, with mean minimum and maximum temperature of 14.5 °C and 34.6 °C, respectively.

Preparation of Experimental Plots and Seedling Transplanting

There were 15 experimental plots which were prepared based on spacing (30 cm x 70 cm) for tomato and replicated three times. Each plot had a 3.6 m x 2.8 m size. There were a total of 45 plots separated by 1 m and 1.5 m space between plots and blocks respectively. There were four rows in each plot. Ten four week old tomato seedlings were transplanted in each rows giving 40 plants/plot

Extraction and Counting of Nematodes from Soil and Eggs from Infested Root

Extractions of second stage juvenile (J2) was carried out using a Baermann funnel method as described by Coyne et al. (2007). After tomato fruits were harvested ten 100 gm soil samples from each plot were taken and thoroughly mixed and 100 gm sub sample were prepared for J2 extraction and determination of final density for each treatment. Soil samples were placed in 250 ml beakers. Then the beakers were covered with a piece of muslin cloth and tightly tied with a rubber band and clamp and assembled upside down on the glass funnel filled with water and mounted on metal stand. After 24 hours, the clamp was loosened slightly to allow 60 ml of suspension having nematodes to pass into a 100 ml beaker finally the suspensions were prepared and counted using stereo microscope at 40x magnification and expressed as J2/100 gm. Ten egg mass/plant were dissected out from three plants/plot to determine number of eggs/egg mass. The egg masses were transferred to a flask containing 60 ml of 5% sodium hypochlorite aqueous solution and vigorously shaken for 2 minutes and counted according to procedure described by Coyne et al. (2007).

Field Experiment

The experiment was carried out in RCBD with three replications in factorial arrangements. Treatments included: well decomposed poultry manure in five level viz., 0, 5, 10, 15, and 20 ton/ha and grounded rapeseed cake in three levels, viz., 0, 5, 10 ton/ha. Both soil amendments were applied in band placement manner by drilling to the depth of 15 cm in the experimental plot three weeks before transplanting the seedlings.

Data Collection

Days to flowering and maturity for each treatment were taken by direct stand count. Other growth and yield data including days to fruit maturity, plant height, fresh shoot weight, number of fruits/plant, average fruit weight and total yield/ha were taken from pre tagged ten plants from tow central rows.

Root Galling Assessment

Ten plants/plot were carefully uprooted washed with water to remove soil and other debris the roots then visually evaluated for root galling were scaled according to Taylor and Sasser (1978) (0= no galls, 2= 1–25% galling, 3=26–50% galling, 4=51–75% galling, 5=76–100% galling).
Data Analysis

The data on root galling index, number of eggs/egg mass, final J2 population, and yield and growth parameters were subjected to Analysis of Variance (ANOVA) using GenStat version 7.2 computer packages (Gomez and Gomez, 1984). Treatment mean were separated using Least Significant Difference (LSD) Test at 5% level of significance.

RESULTS

Effects of Poultry Manure and Rapeseed Oilcake on Root-Knot Nematode Infestation

The main effect of poultry manure was highly significant (p< 0.05) on root galling indices, final J2 and egg/egg mss (Table 1). Number of eggs/egg mass was reduced as poultry manure amendment was raised from 0 to 20 ton/ha by 14.8, 22.31, 54.88 and 86.14%, respectively, compared to unamended treatment. The lowest J2/100 g of soil was recorded at 20 ton/ha poultry manure and the second lowest number of J2/100 g was recorded at rapeseed cake at 10 and poultry manure at 15 ton/ha respectively (Table 1). The main effect of rapeseed cake was also significant at (p<0.05) on the same parameters. Density of J2 and egg/egg mass was reduced by 68.4 and 76.7 % while the rate increased from 0 to 10 ton/ha. Root galling index reduced when poultry manure applied at 5, 10, 15 and20 ton/ha by 15, 30, 44.3 and 61.57%, respectively compared to control treatment. There were also significant interaction effect of poultry manure and rapeseed cake at (p<0.05) on final density of J2/100 g of soil (Table 1) in this the lowest mean J2 density was obtained at 20 and 10 ton/ha applications of poultry manure and rapeseed oilcake at 20 ton/ha.

Effect of Poultry Manure and Rapeseed Oilcake on Yield of Tomato Fruit

There was highly significant (p<0.001) main effect of poultry manure on the number of fruit/plant, average fruit weight and marketable fruit. The main effect of rapeseed oilcake was non-significant on number of fruit/plant, average fruit weight, total and marketable fruit yield (Table 2).
Table 2: Main Effect of Poultry Manure and Rapeseed Oilcake on Fruit Yield of Tomato

<table>
<thead>
<tr>
<th>Treatment Fruit Yield</th>
<th>Number of Fruit/Plant</th>
<th>Average Fruit Weight in (G)</th>
<th>Total Yield Ton/Ha</th>
<th>Marketable Yield Ton/Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poultry Manure ton/ha</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>19.89&lt;sup&gt;a&lt;/sup&gt;</td>
<td>63.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.76&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.86&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>5</td>
<td>20.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>74.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.80&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.62&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>10</td>
<td>23.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>98.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>16.85&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15.29&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>15</td>
<td>25.99&lt;sup&gt;b&lt;/sup&gt;</td>
<td>207.9&lt;sup&gt;c&lt;/sup&gt;</td>
<td>22.27&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21.37&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>20</td>
<td>15.45&lt;sup&gt;d&lt;/sup&gt;</td>
<td>218.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>14.54&lt;sup&gt;c&lt;/sup&gt;</td>
<td>13.17&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>F-test</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapeseed cake ton/ha</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>19.62</td>
<td>59.1</td>
<td>7.85</td>
<td>5.88</td>
</tr>
<tr>
<td>10</td>
<td>20.93</td>
<td>64.3</td>
<td>8.08</td>
<td>7.05</td>
</tr>
<tr>
<td>20</td>
<td>21.08</td>
<td>66.7</td>
<td>7.34</td>
<td>6.67</td>
</tr>
<tr>
<td>F-test</td>
<td>ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV (%)</td>
<td>5.37</td>
<td>9.07</td>
<td>10.82</td>
<td>5.70</td>
</tr>
</tbody>
</table>

*significant at p<0.05, ns not significant at p<0.05. Means within a column followed by the same letter are not significantly different P<0.05

However, the interaction effect of poultry manure and rapeseed oilcake had a significant (p<0.05) interaction effect on the number of fruit/plant (Table 3). Poultry manure application significantly affected (p<0.001) total fruit yield of tomato (Table 2). However, sole rapeseed cake and the interaction of the two amendments were non-significant on total fruit yield. Total yield increased when application of poultry manure was raised from 0 to 15 ton/ha by 87.37, 119.6 and 199.5%, respectively compared to untreated control (Table 2).

Table 3: Interaction Effect of Poultry Manure and Rapeseed Cake on Number of Fruit/Plant

<table>
<thead>
<tr>
<th>Number of Fruit/Plant</th>
<th>Poultry Manure Ton/ha Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapeseed oilcake ton/ha</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>19.62</td>
</tr>
<tr>
<td>10</td>
<td>20.01</td>
</tr>
<tr>
<td>20</td>
<td>20.03</td>
</tr>
<tr>
<td>Mean</td>
<td>19.88</td>
</tr>
</tbody>
</table>

LSD (0.05) for poultry manure x rapeseed oilcake 1.893; CV= 5.4.

The main effect of poultry manure was highly significant (P < 0.05) on marketable fruit yield. There was also highly significant (P<0.05) interaction effect of poultry manure and rapeseed oilcake on marketable fruit yield. There was no significant main effect of rapeseed oilcake on marketable fruit yield at P<0.05. Marketable fruit yield increased positively as the level of poultry manure amendment and rapeseed oilcake increased from 0 ton/ha to 20 ton/ha and 0 to 20 ton/ha, respectively compared to the marketable fruit yield obtained from the untreated plots (Table 2). Increasing poultry manure amendment from 0 ton/ha to 20 ton/ha increased the marketable fruit yield by 98.11%, 145.9%, 211.5% and 91.14%, respectively. From the above results, the highest marketable fruit yield was recorded from treatments amended with 15 ton/ha of poultry manure and 20 ton/ha rapeseed oilcake. At the highest level of poultry manure, marketable yield was reduced by 60% compared to the marketable fruit yield obtained in 15 ton/ha poultry manure.
DISCUSSIONS

Application of both poultry manure and rapeseed oilcake significantly affected infestation of *M. incognita*. This finding is in agreement with Pakeerathan et al. (2009) who stated that low root galling index values with animal manure rates suggest that some components of manure might be involved in direct control of root-knot nematodes (Table 1). In our study the reduction in the number of eggs/egg mass was observed as treatment level increases this was due to treatment effect resulted in unfavorable soil conditions for *M. incognita* reproduction and multiplications. This finding agrees with that of Orisajo et al. (2008) who reported that *M. incognita* population densities decreased in with to increased rates of poultry manure amended soil. The lowest J2/100 g of soil was recorded at 20 ton/ha poultry manure and the second lowest number of J2/100 g was recorded at rapeseed cake at 10 ton/ha and poultry manure at 15 ton/ha (Table 1). The results of this study also corresponds with Amarasinghe et al. (2007) who reported that the lowest nematode population and gall indices were recorded for rice amended with poultry manure. Similarly Ogwulumba et al. (2010) reported that soil amended with organic materials (poultry droppings, grass ash and rice husk ash) at the range of 10 to 20 ton/ha significantly reduced the population of *Meloidogyne* spp in tomato in Nigeria.

According to the result of this study, number of fruit/plant, average fruit weight, total and marketable fruit yield significantly affected by both poultry manure and rapeseed oilcake. The result also revealed that negative correlation of infestation level with overall tomato yield. The lowest number of fruit/plant was recorded from the combination of poultry manure at 20 ton/ha and rapeseed cake at 10 ton/ha however at this level the highest average fruit was recorded. This result is in agreement with the findings of Ogwulumba et al. (2009) who reported that tomato plants treated with organic amendments including poultry manure in the range of 10 to 20 ton/ha produced higher number of fruit/plant as well as weight compared to control. Similarly Rhaman et al. (2002) indicated that plots treated with poultry manure at 3 ton/ha and mustard cake at 300 kg/ha produced better results in terms of the number of fruit/plant and fruit weight in tomato. However, in this study, plots amended with 20 ton/ha of poultry manure resulted in significant reduction in the number of fruit/plant. The decline in the number of fruit/plant at the highest poultry manure amendment may be attributed to the detrimental effect of excessive availability of nutrients particularly nitrogen, which leads to excesses vegetative growth at the expense of reproductive growth. This result is in line with the findings of Ayeni et al. (2010) who stated that the total yield of tomato fruit was decreased at higher rates of poultry manure compared to lower rates indicating that there might be nutrient imbalance at the highest rate of application of poultry manure. More over excessive availability of one nutrient can also affect the availability and the uptake of the other nutrient by plants due to antagonistic effects. Passam et al. (2007) reported that excessive nitrogen supply in tomato plant may considerably influence the total cation to anion uptake ratio.

The highest total yield was recorded from a treatment which was amended with 15 ton/ha of poultry manure and 20 ton/ha rapeseed oilcake. However, the total fruit yield declined significantly when the rate of application of poultry manure was raised to 20 ton/ha (Table 2). Compared to the total fruit yield obtained from plants that received no poultry manure, plants treated with 20 ton/ha poultry manure had increased total fruit yield by about 46.5%. The result clearly demonstrated that adding poultry manure had considerable positive effect on total fruit yield of tomato. This could be due to high availability of nutrients and improved soil physical and chemical characteristics that might promote uptake of the nutrients thereby promoting optimum plant growth and development. In addition to this plenty of manure availability on root zone of the plant might have been promoted tolerance against root knot nematode infection and increased total yield. This result agrees with the findings of Hassan et al. (2010) who indicated that amending soil infested with *Meloidogyne*
spp. with organic substances in the range of 15 to 40 ton/ha gave the highest tomato fruit yields. Similarly Rahman et al. (2002) who concluded that plots into which poultry refuse at the rate of 3 ton/ha and mustard cake at 300 kg/ha were incorporated produced better yields and higher economic returns as well as better root knot nematode suppression than the control treatment.

CONCLUSIONS

Application of poultry manure and rapeseed oilcake significantly reduced root-knot nematode J2 populations, number of egg/egg mass and root galling index. Application manure at the range of 5 to 15 ton/ha in combination with rapeseed cake at 10 ton/ha gave the highest yield and suppressed root-knot nematodes. Therefore, it could be conclude that incorporating poultry manure at 5 to 15 ton/ha and rapeseed cake at 10 ton/ha into the soil infested with root-knot nematode at least three weeks before transplanting tomato seedlings may significantly suppress root-knot nematode infestation thereby enhancing fruit yield of tomato.

REFERENCES

Management of Root-Knot Nematode *Meloidogyne incognita* in Tomato in Eastern Ethiopia through Organic Soil Amendments


