Influence of poultry litter and rapeseed cake on infestation of *Meloidogyne incognita* on tomato in Dire Dawa, eastern Ethiopia

T. Shiferaw[†], N. Dechassa[*] and P.K. Sakhuja[*]

College of Dryland Agriculture, *Jigjiga University*, *P.O. BOX 1020*, *Jigjiga*, *Ethiopia*
[*]*College of Agriculture and Environmental Sciences*, *Haramaya University*, *P.O. Box 138*, *Dire Dawa*, *Ethiopia*

[†]Corresponding author email: tadu1352@gmail.com

Abstract

Study was conducted at Dire Dawa, Haramaya University Research Station in naturally root-knot nematode infested soil to determine the influence of poultry litter and rapeseed cake application against root-knot nematode infestation in tomato var. Mraglobe. Five levels of poultry litter (control (0), 5, 10, 15 and 20 ton/ha) and three levels of rapeseed cake (control (0), 100, 200 kg/ha) was applied in experimental plot three weeks before transplanting the seedlings. The experiment laid in RCBD factorial arrangement. Application of poultry litre except 5 ton/ha significantly reduced eggs per egg-mass, root galling and final population of root-knot nematode at $p < 0.001$. Rapeseed cake at 200 kg/ha significantly reduced final population and eggs per egg-mass compared to control treatment at $p < 0.05$. Applications of poultry litter at 5 ton/ha to 15 ton/ha in combination with rapeseed cake at 200 kg/ha remarkably suppressed root-knot nematode infestation.

The eastern part of Ethiopia is considered high potential for vegetable production and marketing (Emana & Gebremedhin, 2007). Despite production and market potential of the area the occurrence of several diseases and insect pests contributed a lot in reducing yield/unit of production and reduction of produce qualities. One of the major vegetable disease occurring in this area is root-knot caused by *Meloidogyne incognita* (Kofoid & White) Chitwood. Dire Dawa Administrative Council and the neighboring arid lowlands areas have a favorable soil and climatic conditions for the root-knot nematode. Tefera & Huluka (2000) found root-knot nematode damages in low altitude and in soil containing higher amount of sand in Dire Dawa and Erergota than high land areas of east Hararghe. Bekele *et al*., (2007) also mentioned that root-knot nematodes are major problem in tomato production areas and requiring intensive control measures.

Most studies in Ethiopia on root-knot nematode have focused mainly on generating baseline information yet and lot of research has yet to be done to bring out the problem (Wondirad & Mekete, 2002). Several methods were suggested around the world for the managements of root-knot nematode in tomato including chemical, biological and cultural methods with different level of success. Although nematicides are effective in nematode control, but discourage users their high costs, non availability at the time of need, the hazards they pose on human as well as on on-target organisms (Wachira *et al*., 2009; Nagaraju *et al*., 2010). Studies in Nigeria, South East Asia and any other developing country indicated that soil amendment with different organic substances resulted in successful root-knot nematode control and with good crop yield (Ewulo *et al*., 2008; Adekiya & Agbede, 2010; Ogwulumba *et al*., 2010). Organic soil amendments are not only effective in controlling various soil-borne plant pathogens including

root-knot nematode and safe to use but also improve soil structure and encourage soil biological activity (Nagaraju *et al*., 2010). They are also cheaper than synthetic nematicides and their application can be compatible with existing practices of resource poor farmers and can be used in a safe manner. Therefore, this study was conducted to investigate influence of poultry litter and rapeseed cake against root-knot nematode infestation.

Materials and Methods

Experimental site: The experiment was conducted at Haramaya University's Research Station located in Dire Dawa. 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. Soil has an average pH 8.12 and organic matter, total nitrogen and available phosphorus content of 1.5%, 0.15% and 15.6 mg/kg, respectively for 0-30 cm soil depth and sandy loam soil texture.

Experimental materials: Tomato seed variety Marglobe was obtained from Melkasa Agricultural Research Center. The poultry litter was obtained from Haramaya University poultry farm. Rapeseed cake was obtained from the nearby oil factory Hamaressa.

Selection of field and preliminary soil sampling: Soil samples were collected from 5 fields at Tony Research farm at Dire Dawa, which were previously planted with vegetable crops viz., tomato, eggplant, onion, beetroot and lettuce and had a history of natural root-knot nematode infestation. Soil sampling was done before establishment of the field experiment. Sampling pattern was systematic in X pattern and sampling depth was 0-15 cm. The number of soil cores sampled/area was determined by the area which the particular crop occupied.

Raising seedlings: Nursery bed was prepared in a field at Tony Farm, the width and length of the bed was 1 x 2 m, respectively. Seed of the tomato variety Marglobe was manually drilled into the rows spaced 10 cm apart. Urea was applied at the rate of 100 g per 5 m^2. The nursery beds were mulched and irrigated two times per day.

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

Extraction and counting of root-knot nematode juveniles (J_2) from the soil: Extraction and counting of root-knot nematode juveniles (J_2) from the soil was conducted by taking 5 soil samples per plot from each experimental plots after uprooting tomato plant. Soils samples from each plots roughly mixed and 100 g sub samples were prepared for extraction of J_2. Extraction and counting of J_2 was carried out using a Baermann funnel method as described by (Coyne *et al*., 2007).

Extraction and counting of eggs from infested root: Ten egg-masses per plant were dissected out from three plants per plot, transferred to a flask containing 60 ml of 5% sodium hypochlorite (common bleach) aqueous solution and vigorously shaken for 2 minutes. The egg suspension was place on counting dish and counted according to procedure described by (Coyne *et al*., 2007).

Field experiment and treatment application: The experiment was carried out in Completely Randomized Block Design (CRBD) with three replications in factorial arrangements. Poultry manure in five level viz., control (0), 5, 10, 15 and 20 ton/ha. Rapeseed cake in three levels viz., control (0), 100, 200 kg/ha, both soil amendments were applied in band placement manner by drilling to the depth of 10 cm in the experimental plot three weeks before transplanting the seedlings.

Data collection: Root galling was scaled according to Taylor & Sasser (1978) (0= no galls, 2= 1–25% galling, 3=26–50% galling, 4=51–75% galling, 5=76–100% galling and also J_2 density per 100 g of soil and eggs per egg-mass were collected for each treatment plot.

Data analysis: The data on root galling index (GI), number of eggs/ egg-masses and final juvenile J_2 population were subjected to analysis of variance (ANOVA) using Gen Stat version 7.2 computer packages (Gomez & Gomez, 1984). Treatment means were separated using Least Significant Difference (LSD) Test at 5%.

Results and Discussion

Preliminary field population density: According to the preliminary field collected soil analysis highest density of *M. incognita* was recorded from the field which were previously cropped with tomato. There was difference among preliminary sampled plots in J_2 density; according to the result in the (Table 1) maximum J_2 density per 100 g of soil observed in the tomato fields.

Table 1. Vegetable crops, assessed area, number of soil cores and J_2 population density/ 100 g soil.

Vegetable crops	Area m^2	No. soil cores	Average density of J_2/100 g soil
Onion	732	30	224
Tomato[1]	437	8	446
Tomato[2]	714	30	428
Lettuce	418	8	349
Eggplant	353	8	325
Beetroot	240	8	281

1, 2 indicate two separate fields which were previously cropped with tomato.

Influence of poultry litter and rapeseed cake on root-knot nematode infestation: Application of poultry litter was highly significant ($P < 0.001$) on root galling indices, final (J_2) and eggs per egg-mass. However, effect of rapeseed cake and the interaction effect of the two amendments were non-significant on root galling index (Table 2). Root galling index reduced when poultry litter applied at 5, 10, 15 and 20 ton/ha by 15, 30, 44.3 and 61.57%, respectively compared to control treatment. The highest galling index was recorded from plants in the control treatment and the lowest was recorded from plants treated with 20 ton/ha poultry litter. This finding agrees with Orisajo *et al*., (2008) they reported that *M. incognita* population densities decreased in response to increasing rates of poultry litter in amended soil. Ogwulumba *et al*., (2010) also reported that soil amended with organic materials (poultry droppings, grass ash and rice husk ash) at the range of 10 to 20 ton/ha were significantly reduced the population of *Meloidogyne* spp. in tomato. The number of eggs per egg-mass decreased as the level of poultry litter supply increased from 0 to 20 ton/ha. The highest number of eggs per egg-mass was recorded from untreated control plot (Table 2). However, application of rapeseed cake at 100 kg/ha did not significantly reduce the number of eggs per egg-mass compared to the control treatment this could be the lower application rates.

Table 2. Effect of poultry litter and rapeseed cake against root-knot nematode infestation.

Treatments	Disease parameters		Density of J_2/100 g soil
	Root galling index	Eggs/egg-mass	
Poultry litter (ton/ha)			
0	4.33[a]	185.4a	864.8[a]
5	3.79[b]	160.7[b]	829.4[a]
10	3.33[c]	151.7[b]	765.9 [b]
15	3.00[d]	119.7[c]	486.3[c]
20	2.68[d]	99.6[c]	422.9[d]
F-test	**	**	**
Rapeseed cake (kg/ha)			
0	4.33	207.0 [a]	887.0 [a]
100	4.33	190.7 [a]	794.7[a]
200	4.67	158.7[b]	607.3[b]
F-test	ns	*	*
CV %	8.08	17.91	10.82

*significant at P< 0.05, **= highly significant at P < 0.001, ns = not significant at p < 0.001.
Means within a column followed by the same letters are not significantly different p<0.001.

The lowest J_2/100 g of soil was recorded at 20 ton/ha poultry litter and the second lowest J_2/100 g soil was recorded at rapeseed cake at 200 kg/ha and poultry litter at 15 ton/ha (Table 3). Compared to unamended plot, combination of these amendments at these levels reduced the density of J_2/100 g soil by 52.4 and 51.57%, respectively. Thus, high rate of poultry litter and lower rate of rapeseed cake have been required to bring down the population density of root-knot nematode. The combination of both amendments had an optimum suppression effect on reproduction and multiplication of root-knot nematode. This finding agreed with the findings of Rahman *et al*., (2002) who reported that plots incorporated with poultry manure at 3 ton/ha and mustard oilcake at 300 kg/ha produced better reduction in population of root-knot nematode in tomato. In general sole poultry litter application resulted in high level of root-knot nematode reduction (Table 2). At the same time sole application of rapeseed cake did not influenced root-knot nematode infestations. However, final population density of J_2 significantly reduced when poultry litter applied with rapeseed cake at higher level (Table 3). Riegel & Noe (2000) also reported in cotton that with increase in rate of chicken litter amendment in soil infested with root-knot nematode, density of root-knot nematode was significantly reduced.

Table 3. The interaction effect of poultry litter and rapeseed cake on final density of J_2/100 g soil.

Rapeseed cake kg/ha	Poultry manure ton/ha					
	0	**5**	**10**	**15**	**20**	**Mean**
1	887.0	851.7	777.3	475.4	422.9	669.6
100	858.4	828.3	776.2	554.3	455.3	694.66
200	848.7	808.2	743.7	429.5	456.7	657.73
Mean	864.5	829.43	765.9	486.3	422.9	

LSD (0.05) for poultry manure x rapeseed cake = 63.34; CV (%) = 10.82.

Conclusion

It is concluded that increasing the application of poultry litter and rapeseed cake significantly decreased infestation levels of the root-knot nematode. According to the results of this study application of poultry litter at 5 ton/ha to 15 ton/ha in combination with rapeseed cake at 200 kg/ha remarkably suppressed root-knot nematode infestation. Organic soil amendment options to reduce root-knot nematode infestation suggested for future root-knot nematode control.

Acknowledgements

The authors acknowledge the Federal Democratic Republic of Ethiopia Ministry of Education, for financial assistance and Haramaya University School of Graduate Studies for facilitation of this research work.

References

Adekiya, A.O. & Agbede, T.M. 2010. Growth and yield of tomato (*Lycopersicon esculentum* Mill.) as influenced by poultry manure and NPK fertilizer Nigeria. *Journal Food Agriculture* 21, 10-20.

Bekele, E., Azerefegne, F. & Abate, T. 2007. Experience with management of major plant diseases in Ethiopia. In: *Proceedings on Facilitating the Implementation and Adoption of Integrated Pest Management* (*IPM*) *in Ethiopia*, 25-26 pp.

Coyne, D.L., Nicool, J.M. & Claudius-Cole, B. 2007. Practical plant nematology: a field and laboratory guide. SP-IPM Secretariat. *International Institute of Tropical Agriculture (IITA)*, *Cotonou*, *Benin*, 84 pp.

Emana, B. & Gebremedhin, H. 2007. Constraints and Opportunities of Horticulture Production and Marketing in Eastern Ethiopia. *Drylands Coordination Group Report No. 46 Addis Abeba Ethiopia*, 7 pp.

Ewulo, B.S., Ojeniyi, S.O. & Kanni, D.A. 2008. Effect of poultry manure on selected soil physical and chemical properties, growth, yield and nutrient status of tomato. *African Journal of Agricultural Research* 3, 612-616.

Gomez, K.A. & Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research*. 2nd Edition. John Wiley and Sons. New York.

Nagaraju, N., Karemegam, N. & Kadalmani, B. 2010. Eco-friendly management of root-knot nematode *Meloidogyne incognita* using organic amendments on tomato. *International Journal of Research Pharmacological Science* 1, 530-532.

Ogwulumba, S.I., Ugwuoke K.I. & Ogbuji, R.O. 2010. Studies on *Meloidogyne javanica* infestation on Roma tomato (*Lycoperiscon esculentum* Mill.) under different soil amendment. *African journal of Biotechnology* 9, 3280-3283.

Orisajo, S.B., Afolami, S.O., Fademi O. & Atungwu, J.J. 2008. Effects of poultry litter and carbofuran soil amendments on *Meloidogyne incognita* attacks on cacao. *Journal of Applied Biosciences* 7, 214-221.

Rahman, M.A., Faruk, I., Kader M. A., Jasmine, H.S., Karim, A.N.M.R., Black, L. & Miller, S. 2002. Management of soil-borne pathogens in tomato and cucumber. *IPM CRSP*, *Annual Report* 8, 93-96.

Riegel, C.J. & Noe, J.P. 2000. Chicken litter soil amendment effects on soilborne microbes and *Meloidogyne incognita* on cotton. *Plant Disease* 84, 1275-1281.

Taylor, A.L. & Sasser, J.N. 1978. *Biology, identification and control of root-knot nematodes* (*Meloidogyne spp.*). Department of Plant Pathology, North Carolina State University and U.S. Agency for International Development, Raleigh, NC., USA., 111 pp.

Tefera, T. & Huluka, M. 2000. Distribution of *Meloidogyne incognita* (root-knot nematode) in some vegetables fields in eastern Ethiopia. *Pest Management Journal of Ethiopia* 4, 77-78.

Wachira, P.M., Kimenju, J.W., Okoth, S.A. & Mibey, R.K. 2009. Stimulation of nematode destroying fungi by organic amendments applied in management of plant parasitic nematode. *Asian Journal of Plant Sciences* 8, 153-159.

Wondirad, M. & Mekete, T. 2002. Root-knot nematodes in vegetable crops in the central and western Ethiopia. *Pest Management Journal of Ethiopia* 6, 37-44.

(Received: 20 October, 2013)