Management of Root Knot Nematodes (*Meloidogyne* spp.) on Tomato (*Lycopersicon lycopersicum*) Using Organic Wastes in Zaria, Nigeria

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Abstract

Hassan M.A., Chindo P.S., Marley P.S., Alegbejo M.D. (2010): **Management of root knot nematodes (***Meloidogyne* spp**.) on tomato (***Lycopersicon lycopersicum***) using organic wastes in Zaria, Nigeria**. Plant Protec. Sci., **46**: 34–39.

Field experiments were conducted in 2001/2002 and 2002/2003 dry seasons in Arewaci and Kurmi Bomo areas of Kaduna State, Nigeria, to test the efficacy of three organic wastes, namely refuse dump (RD), rice husk (RH) and sawdust (SD), for the management of root knot nematodes, Meloidogyne spp., on tomato. Organic wastes were applied at the rate of 15, 30 and 45 metric tons per hectare. Furadan (3G) was applied at the rate of 16, 32 and 64 kg/ha and non-amended plots served as control. The experiment was laid out in randomized complete block design (RCBD). Four weeks old tomato seedlings (cv. Roma VF) susceptible to root knot nematodes were transplanted at a number of eight seedlings per plot of 2 m × 1 m with 45 cm spacing between stands. Fertiliser application, weeding, irrigation and other practices were done as recommended. The results showed that RD treatment gave the significantly (P = 0.05) highest reduction in the nematode population compared to non-amended treatment. It resulted in a significant (P = 0.05) increase in the yield of tomato by 17–100% for RD, 13–84% for SD and 21–63% for RH.

Keywords: root knot nematodes; tomato; management; organic wastes

Nematodes of the genus *Meloidogyne* (root knot nematodes) have a wide range of hosts and very destructive pests. They can severely damage growing plants, including those in the hot weather areas of Africa.

Meloidogyne spp. are major pests on tomatoes (*Lycopersicon lycopersicum* Karst) where they cause considerable losses in yields. A reduction in tomato yields ranging from 28% to 68% in tomato have been reported (Chindo & Khan 1988; Adesiyan *et al.* 1990). Nematicides have been used to control these pests with remarkable results. However, they bring about the problems of high costs and availability, particularly to rural poor farmers in the Zaria area of Kaduna State, Nigeria, and attendant environmental hazards. This has made researchers look for alternative measures that are cheaper, readily available and sustainable with minimal negative effects on the environment. Many of the soil amendments used as nutrient sources for crop production have been found to control plant parasitic nematodes. Such materials include green manure, cow dung, poultry droppings, dried crop residues, botanicals, camel dung, and composted

agro-industrial wastes. A remarkable reduction in nematode populations both in greenhouses and field conditions with an attendant increase in crop yield and growth has been achieved (Akhtar & Alam 1990, 1992; Abubakar & Majeed 2000; Khan *et al.* 2002; Nwanguma & Awoderu 2002; Abubakar & Adamu 2004; Nico *et al.* 2004). RD, SD and RH are abundant in northern Nigeria and are often thrown away as wastes or burnt (as with RH and SD). They can be utilized positively for agricultural production.

This paper describes and evaluates an attempt at comparing three different organic wastes used as a means for suppressing the level of the nematodes, *Meloidogyne*, which are present on tomatoes and many plants and cause their damage in the Zaria area of Kaduna State. Two-year experiments were conducted using organic wastes in the form of refuse dump (RD), rice husk (RH), and sawdust (SD) in experimental plots for the management of root knot nematodes (*Meloidogyne*) on tomato plants in the field.

MATERIALS AND METHODS

Field experiments were conducted in the village of Arewaci near Zaria (11°11'N and 07°38'E) in the 2001/2002 dry season and repeated in the village of Kurmi Bomo also near Zaria (11°10'N and 07°36'E) in the 2002/2003 dry season. The chosen sites were naturally infested with root knot nematodes and tomatoes were grown there for at least three successive years. The land was harrowed and divided into three blocks representing three replications with 60 cm spacing between blocks. Each block was subdivided into thirteen plots of 2.0 m × 1.0 m with inter-plot space of 45 cm. The experiment was laid out in randomised complete block design (RCBD). The treatments consisted of refuse dump (RD), which is organic material from a site where household/kitchen wastes and animal droppings are dumped, obtained from Ahmadu Bello University, Zaria main-campus central refuse dump site, rice husk (RH) bought from a grain mill shop in the village of Samaru, Zaria, and sawdust (SD) collected from a furniture and wood workshop in the village of Palladan near Zaria. Each organic material was applied at three levels of 15, 30 and 45 t/ha. Furadan, used as chemical control, was applied at 0.01, 0.32 and 0.064 t/ha. Non-amended plots served as control.

SD and RH were composted for three months in a dug-out pit to allow for their decomposition. Thereafter, the three organic wastes were broadcast on the plots by hand and worked thoroughly into the top 20 cm soil layer using a hoe, then left to stabilize for three weeks before transplanting was done. Tomato seedlings, variety Samtom 6 (Roma VF), susceptible to RKNs, obtained from the Horticultural Research Programme of the Institute for Agricultural Research (I.A.R) in Samaru were raised on heat sterilized soil for four weeks. They were transplanted to the plots at a number of eight seedlings per plot with 45 cm spacing between stands. Furadan (3G) was applied during transplanting. The fertilizer was applied at the rate of 60, 30 and 30 N, P_2O_5 and K_2O, respectively, per hectare.

Fruit harvest started twelve weeks after transplanting and lasted for four weeks. Data on fruit weight were recorded at the end of harvest. After harvest plants were carefully uprooted making sure that the fibrous roots were not destroyed. Roots were carefully washed under a gentle stream of water making sure that the egg masses were not dislodged. 500 cm^3 of soil was collected from each plot around the area where roots were removed and used for nematode extraction, using Cobb's (1918) sieving and decanting method. Roots were severed from shoots. Root length and shoot height were measured using a meter rule. Afterwards, shoots and roots were oven dried for 72 h at 50°C.

Roots from five randomly selected plants from each treatment were stained in cotton blue and cleared in lacto phenol which rendered adult females conspicuous to be counted. Galls and egg masses were counted and the average number per plot was recorded. Data on root gall indices was also recorded based on a scale of 0–10 (Barker 1978). All recorded data on the population of *Meloidogyne* spp. in soil together with plant yield and growth parameters were subjected to analysis of variance (ANOVA). Means obtained were separated using Student-Newman-Kuel's (SNK) test ($P = 0.05$).

RESULTS

The results which were supported by statistical calculations proved that all three organic materials decreased the level of harmful nematodes and increased the yield. The refuse dump showed the

Table 1. Effect of soil amendment with three organic wastes on the number of galls, egg masses and populations of *Meloidogyne* spp. on tomato in the villages of Arewaci and Kurmi Bomo of Zaria, Nigeria

Treatment	Rates of application (t/ha)	Nematode populations per 500 cm^3			Nematode populations per 10 g root	Number of galls per 10 g root	Egg-masses per 10 g root	Root galls indices
		initial (Pi)	mid-season (Pm)	final (Pf)				
Rice husk	15	40.0^{a}	34.3^{b}	26.0^{b}	18.0^{b}	14.3^{b}	28.0^{a}	2.3^{b}
	30	38.5^{a}	27.3^{bc}	17.8^{bc}	9.7^{d}	8.0^{cd}	14.0^{b}	1.3^{c}
	45	37.0a	22.3^{bc}	13.2^{dc}	5.3e	3.3^{dc}	8.0^{b}	1.0^{c}
Sawdust	15	38.8^{a}	31.0^{bc}	24.5^{b}	14.3^{bc}	12.0^{bc}	19.0^{ab}	2.0^{b}
	30	32.3^{a}	23.2^{bc}	18.8^{bc}	8.3^{de}	6.3^{de}	11.7^{b}	1.0^{c}
	45	30.3^{a}	20.7^{bc}	13.0^{ef}	3.7^{ef}	2.3^{e}	5.3^{b}	1.0^{c}
Refuse dump	15	43.2^{a}	31.3^{bc}	20.3^{b}	11.0^{cd}	10.0^{bcd}	16.0^{ab}	2.0^{b}
	30	35.2^{a}	24.3^{bc}	14.7^{cd}	4.3^{ef}	3.0^{de}	6.7^{b}	1.0^{c}
	45	35.7^{a}	21.5^{bc}	8.3^{fg}	2.3^{f}	1.0^{e}	2.7^{b}	1.0^{c}
Furadan	0.01	42.5^{a}	18.5^{bc}	9.8^{ef}	5.0^{ef}	3.0^{de}	7.7^{b}	1.0^{c}
	0.032	44.5^{a}	15.3^{bc}	6.0^{g}	2.3^{f}	1.0^{e}	3.0^{b}	1.0^{c}
	0.064	36.2^{a}	11.5^{c}	2.8^{g}	1.0^{f}	1.0^{e}	1.7^{b}	1.0^{c}
Non-amended (Control)	–	37.0^{a}	53.0^{a}	66.8^{a}	45.3^{a}	39.7^{a}	38.3^{a}	4.3^{a}

Means followed by the same letter within each column are not significantly different ($P = 0.05$) as indicated by Student-Newman-Kuel's (SNK) test

Table 2. Effect of soil amendment with three organic wastes on the yield and growth of tomato in the villages of Arewaci and Kurmi Bomo of Zaria, Nigeria

Treatment	Rates of application (t/ha)	Tomato (fruit) yield (t/ha)	Plant dry weight (g)		Plant shoot height	Plant root length
			shoot	root		
Rice husk	15	4.7^{gh}	139.8^{j}	44.2^{i}	29.0^{e}	10.4^{fg}
	30	5.8^{fg}	144.4^{ij}	46.5^{gh}	29.1^{e}	11.2^{de}
	45	7.8^{d}	149.8^{hi}	48.1^{g}	33.7^{cd}	11.8^{de}
Sawdust	15	5.4^{fg}	159.7^{g}	42.4^{j}	29.9^{e}	10.3^{fg}
	30	6.6^{e}	164.4^{fg}	46.2^{hi}	31.3^{de}	10.8^{ef}
	45	8.9^{c}	171.3^{f}	47.6^{f}	36.2^{c}	11.6^{de}
Refuse dump	15	5.6^{fg}	209.4^{e}	55.4^{c}	30.0^{de}	13.1^{b}
	30	7.9^{dc}	215.6^{de}	57.9^{b}	32.7^{de}	14.2^{a}
	45	9.9^{b}	221.6^{cd}	60.3^{a}	40.9^{b}	14.8^{a}
Furadan	0.01	6.2^{ef}	227.3^{bc}	50.9^{e}	39.1^{b}	11.6^{de}
	0.032	8.0^{cd}	233.2^{ab}	53.2^{d}	42.0^{b}	12.0^{cd}
	0.064	11.8^{a}	239.7^{a}	55.5^{c}	51.5^{a}	12.6^{bc}
Non- amended (Control)	–	4.8^{gh}	127.7^{k}	45.8^{h}	28.9^{e}	9.9^{g}

Means followed by the same letter within each column are not significantly different ($P = 0.05$) as indicated by Student-Newman-Kuel's (SNK) test

greatest effect on nematodes with 70–88% reduction of the population. The plot treated with SD reduced the population by 63–81%, and the RH showed a decrease by 61–80%. However, the best result of a reduction in the nematode population was achieved with Furadan 3G.

Similarly, the increase in tomato fruit yield attributed to RD, SD and RH ranged from 17% to 101%, 13% to 84% and 21% to 63%, respectively. None of the organic wastes increased the yield as much as Furadan 3G – 29.2% to 146.8%. Compared to the other levels, forty-five tons of organic waste per hectare yielded the best result.

DISCUSSION AND CONCLUSION

The study showed that amending the soil with organic waste materials, namely RD, RH and SD, suppressed the populations of *Meloidogyne* spp. both in the soil and on the roots of tomato with a concomitant increase in the growth and yield of tomato. This is in agreement with previous findings of Chindo and Khan (1988) and Nico *et al*. (2004), who used poultry manure and decomposed agro-industrial waste products, namely composed dry cork, dry grape marc, dry olive marc and rice husk, as soil amendments for the management of *Meloidogyne* spp. Nico *et al*. reported that composted agro-industrial waste reduced the populations of *Meloidogyne* spp. by 24.4% to 87.9%. Beneficial effects of organic wastes on nematode control and crop growth were also observed by other researchers (Abubakar & Majeed 2000; Akhtaran & Abdul Malik 2000; Tijani *et al*. 2000; Nwanguma & Awoderu 2002; Abubakar & Adamu 2004; Nico *et al*. 2004).

Increasing the rate of organic amendments enhanced the reduction of nematode populations. Generally, forty-five tons per hectare of the different organic wastes gave the better control than the other levels. This is in consonance with the results of Nico *et al*. (2003), who observed exponential by 51.3% for the lowest level and 82.6% for the highest level of amendment.

Results also showed that RD performed best compared to the other amendments. This may be due to the lower C: N ratio of RD compared to SD and RH. Miller *et al*. (1973) concluded that the availability of more nitrogen enhances the availability of the organic amendment to control nematodes. Main and Rodriguez-Kabana (1982) similarly reported that the management potential of an organic soil amendment is directly related to its N content or inversely related to the C:N ratio.

In conclusion, this study has shown that soil amendment with organic wastes is very beneficial in the management of root knot nematodes in tomato production in the Zaria area of Kaduna State of Nigeria. These materials are common and are found in abundance in many parts of northern Nigeria of which the Kaduna State is a part. They are cheap with minimal negative effects on the environment. Therefore they can be used as efficient means of suppressing nematode problems with attendant yield increases. However, more work is needed to determine the actual contributions of the amendments towards controlling these nematodes which may contain toxic compounds released by the decomposing organic soil amendments, increase the populations of nematophagous fungi and release nutrients by decomposing organic matter. These factors were not investigated in this study.

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Received for publication January 19, 2009
Accepted after corrections October 24, 2009

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