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Effects of organic manure types on the growth, yield as well as root and soil populations of root-knot nematodes (*Meloidogyne incognita)* of tomato

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ABSTRACT

Studies on the effects of some organic manure types on plant-parasitic nematode (*Meloidogyne incognita*) of tomato *(Lycopersicon esculentum*) was conducted at Kabba College of Agriculture, Ahmadu Bello University, Kogi State, Nigeria in the year 2008 and repeated in 2009. The organic manure types (poultry manure, cow dung, compost and domestic waste) were applied as soil amendment and were incorporated into the soil at the rate of 5tons per hectare while there was an untreated control treatment that acted as standard check. The experiment design was complete randomization comprising of five treatments and each treatment was replicated 4 times. The result of the experiment shows that all the organic manures types were effective in reducing the population of root-knot nematodes with resultant increase in growth and yield of tomato. Poultry manure is more effective than other organic manures with respect to the tested parameters. There were significant differences between the various treatments and all the treatments were significantly different from the control with respect to the tested parameters. The result of this experiment confirmed organic manure as an effective farm input for managing *M. incognita* in all endemic areas with a resultant increase in the growth and yield of the plant.

1. Introduction

Tomato, (*Lycopersicon esculentum (L.)* Mill.) is an important fruit vegetable widely consumed across the globe. The crop has an appreciable protein as well as vitamins A, C and D content (Van Eck *et al.,* 2006). The yield is high in Europe, America and India but low in Nigeria, as a result of attack by pests, notable among which is plant-parasitic nematodes (Oyedunmade *et al.,* 2009). Damage on tomatoes by plant-parasitic nematodes usually result in serious yield reduction in addition to other visible physiological symptoms associated with the affected plant.

The Root-knot nematode (*Meloidogyne incognita)* is prominent among other categories of parasitic nematodes attacking crop. The attack of root–knot nematode on tomatoes is wide spread and devastating, leading to symptoms such as stunting, chlorosis, and early senescence culminating in serious yield reduction (Richard and Nicola, 1990). Application of soil amendments in form of organic manure and other biocides into the soil is an attempt to augment soil nutrients and suppress plant diseases under the nascent organic agriculture. Nigeria is used as a vibrant area of research interest. The agricultural sector in Nigeria is facing a new challenge as it is currently in transition stage between conventional and organic farming system. Natural plant products will continue to make sway under the new farming system because of their ability to produce environmentally less harmful but efficacious chemical substances (Schmutterer 1990). This will greatly minimize the use of toxic synthetic chemicals for plant pests and disease control.

Scarcity, high cost, environment safety and global restriction on the importation of chemical nematicides has spurred scientist to search for alternative control measures against nematode pests of economic food crops (Anon, 2004; Aktar and Malik, 2002). Soil amendments with organic manure have been shown to improve plant growth and reduce root-knot nematode infection (Alam *et al*., 1980; Derrico and Di Maio, 1980; Jatak, 2002; Mohammed and Mashkoor, 2003; Ullah *et al* 2008; El- Sheriff, 2008 and Summer 2011).

Farming and manure disposal problem can be avoided by the incorporation of this manure into the soil as soil amendment for enhancement and improvement of nutrient source and control of soil inhabiting pests including plant-parasitic nematodes. The objective of the study was to evaluate the effects of poultry manure, compost, cow dung, and domestic wastes on the growth, yield, soil and root population of root-knot nematodes (*M. incognit*a) on tomato in Nigeria over a period of two consecutive years (2008-2009).

2. Materials and methods

2.1. Experimental location and design

Green house experiment was conducted at Kabba College of Agriculture, Ahmadu Bello University, Nigeria in the year 2008 and repeated in 2009. The design of the experiment was complete randomization comprising of 5 treatments, control inclusive and each treatment was replicated 4 times. Tomato Roma VF seeds were obtained from the Institute of Agricultural Research (IAR) ABU Zaria, Nigeria. The tomato seeds have been confirmed to be susceptible to root-knot nematodes (*M .incognita)* from a previous experiment (Abolusoro, 2006). Four seeds were planted to each experimental pot and were later thinned to one healthy and thrifty plant per pot.

2.2. Soil sterilization

Top soil (1 -15cm) was mixed thoroughly, sieved (2 mm aperture) and steam sterilized (6 hours, 90 -100^{o} C). This is to rid the soil of pathogens or any other biotic factor that can affect the result of the experiment. Ten (10) kilogram of sterilized soil sample was measured in perforated plastic pots (15 liters capacity) and arranged in the screen house of the college. The experimental design was a completely randomized design in which there were 5 treatments including control and replicated 4 times.

2.3. Soil amendment

The treatments applied were control, domestic wastes, cow dung compost manure and poultry manures denoted by letters A, B, C, D and E respectively. Each of the manure type was applied as soil amendment and

incorporated into the soil at the rate of 5 tons per hectare (5t/ha). This was carried out a week after sterilization. The control received no treatment.

2.4. Crop establishment

Tomato Roma VF seeds which has been confirmed as susceptible to nematode damage in previous experiments (Abolusoro, 2006) was utilized. Five seeds were planted which were later thinned down to one healthy thrifty plant per plot.

2.5. Extraction and Inoculation of Tomato plant with Root-Knot Nematode

Root-knot nematodes were extracted from tomato in a previous pot experiment conducted in a screen house using a standard method (Whitehead and Hemming, 1965). Two hundred juveniles (2000) of *M.incognita* were inoculated into each of the stand of plant, 3 Weeks after Planting (WAP). Since a sterilized soil was used, any nematode present must have been eradicated before inoculation.

2.6. Data Collection and Analysis

In the two experiments, data was collected on plant height, number of leaves, yield component, final M. incognita population, number of juveniles in 5 g root and root gall index. The root gall index was assessed according to the following scale rating: 0 = no galls; 1=1- 2galls; 2=3-10 galls; 3=11 -30 galls; 4=31 – 100 galls; 5= more than 100 galls (Taylor and Sesser1978).

Data collected were subjected to analysis of variance and means were separated using Duncan's multiple range test at 5% probability level (Duncan 1955).

3. Results

3.1. Leaf Record

The effects of different organic manure, domestic waste, cow dung, compost and poultry manures on the number of leaves produced by *M.incognita* infected tomato are presented in Table 1. Tomato treated with organic manures produced more leaves considering record from week six of the experiment to week 12 when data collection on leaf record was terminated. The mean leaf number of tomato treated with organic manure at twelve weeks after planting (12 WAP) was of the range 21 ± 5 in 2008, 21.30 ±5 in 2009 while the control treatment recorded an average number of 15.87 and 16.02 in 2008 and 2009 respectively. However, the tomato plant treated with poultry manures produced more leaves than any of the organic manure treatments. See Table 1.

3.2. Plant Height

The result from Table 2 showed that different organic manure treatments resulted in a better growth compared with the untreated control. The mean height of tomato treated with different organic manures was of the range 66.03±12 in 2008 and 67.0±12 in 2009 as against the control that recorded an average height of 32.93 and 32.03 in 2008 and 2009 respectively. On the average, poultry manure treated plant is superior to other organic manure treatments with respect to height record. The control treatment recorded the lowest height among other treatments. See Table 2.

3.3. Soil Population of *M. incognita.*

The result presented in table 3 showed that more population of *M. incognita* were recorded in both the soil and root of infected tomato plants with corresponding increase in the root gall index (root damage) compared with the organic manure treated plants. The control treatment in the two years of the experiment recorded over 200 nematodes in the soil while the organic manure treatments recorded less than one hundred average each. Poultry manure recorded the least number of nematode (55.30 average in 2008 and 54.90 in 2009) among the organic manure treatments while the soil treated with domestic waste recorded the highest average number of nematode (84.40 in 2008 and 80.54 in 2009) see Table 3.

Table 1
Effects of organic manure types on the average number of leaf produced by *M. incognita* infected tomato.

Manure Types	2008 Trial 6 WAP	2009 Trial 6 WAP	2008 Trial 8 WAP	2009 Trial 8 WAP	2008 Trial 10 WAP	2009 Trial 10 WAP	2008 Trial 12 WAP	2009 Trial 12 WAP
Control	6.24[a]	6.84[a]	7.75[a]	8.50[a]	11.87[a]	12.27[a]	15.87[a]	16.02[a]
Domestic waste	7.18[b]	7.15[b]	9.64[b]	9.53[b]	16.99[b]	17.06[b]	21.00[b]	21.30[b]
Cow Dung	7.34[bc]	7.45[b]	10.26[b]	10.13[b]	18.75[bc]	19.33[c]	22.23[c]	22.67[c]
Compost manure	7.27[b]	7.50[b]	9.73[b]	9.97[b]	19.76[c]	20.70[d]	24.77[d]	23.90[d]
Poultry manure	7.62[c]	7.48[b]	9.80[b]	10.00[b]	22.57[d]	22.30[c]	26.37[c]	26.09[c]
S.E.	0.119	0.138	0.207	0.203	0.812	0.297	0.270	0.265

WAP: Weeks after planting.
[a,b,c,d]Means followed by the same letters along each column do not differ significantly according to Duncan multiple range test at p = 0.05.

Table 2
Effect of organic manure types on the average height of *M. incognita* infected tomato.

Manure Types	2008 Trial 6 WAP	2009 Trial 6 WAP	2008 Trial 8 WAP	2009 Trial 8 WAP	2008 Trial 10 WAP	2009 Trial 10 WAP	2008 Trial 12 WAP	2009 Trial 12 WAP
Control	17.17[a]	17.19[ab]	34.63[a]	34.47[a]	40.47[a]	36.30[a]	32.95[a]	32.03[a]
Domestic waste	17.97[a]	18.05[b]	37.77[b]	38.28[b]	58.99[b]	66.48[c]	66.03[b]	67.00[b]
Cow Dung	19.70[b]	16.37[a]	33.25[a]	34.55[a]	59.73[b]	72.00[c]	72.00[c]	72.03[c]
Compost manure	19.16[b]	19.37[c]	37.54[b]	38.70[b]	70.87[d]	74.57[d]	74.57[d]	74.70[d]
Poultry manure	19.50[b]	19.79[bc]	39.52[c]	38.35[b]	73.20[d]	78.50[c]	78.50[e]	79.00[e]
S.E.	0.496	0.359	0.809	0.687	0.771	0.982	0.821	0.700

WAP: Weeks after planting.
[a,b,c,d,e]Means followed by the same letters along each column do not differ significantly according to Duncan multiple range test at p= 0.05.

3.4. Root Juvenile of *M. incognita* Population

The number of Juveniles in the root of tomato plant as well the root gall index also follows the same trend. Less number of *M. incognita* juveniles were recorded in poultry manure treatment (7.40 and 7.03 in 2008 and 2009 respectively) while domestic waste treatment recorded the highest average (15.43 and 16.27 in 2008 and 2009 respectively) among the organic manure treatments as against the average number of 25.90 and 27.73 in 2008 and 2009 recorded by the control treatment.

3.5. Root gall index

More damages were recorded on the root of control treatment. Gall index of 4.15 and 4.35 in 2008 and 2009 respectively. Less damage was observed on the organic manure treatments compared with the control. Poultry manure treatments recorded the least value of gall index 2.07 average and 1.94 in 2008 and 2009 respectively) among the organic manure types.

3.6. Yield component

The effects of organic manure on the number of fruit per tomato plant are presented on table 5. The number of fruit was highest in poultry manure treated tomato. This is closely followed by tomato treated with compost manure and cow dung while the tomato plant treated with domestic waste recorded the least among the organic manure treatments. The performance of all the organic manure treatments is significantly different from the control treatment. The number of fruit of the treated tomato was of the average range of17 ±1.50 in 2008 and 2009 respectively while control had the least average fruit of 6.71 and 6.94 in 2008 and 2009 respectively.

The effects of different organic manure types on the fruit weight of tomato are presented in table 5. Tomato plants that were treated with poultry manures had higher fruit weight followed by compost manure and cow dung while domestic waste treated tomato recorded the least weights among the organic manure treatments. The control treatment recorded the least weight among all treatments in both years of experiments. The fruit weight

of tomato treated with organic manure was 45±8 g in 2008 and 2009 while a least average weight of 19.80 and 21.02g was recorded by the control treatment in 2008 and 2009 respectively.

The average number of fruits and fruit weight of the organic manure treatments are significantly different from the control treatment in the two years of experiment.

Table 3

Effect of organic manure types on the soil and root population as well as gall index of *M.incognita* infected tomato.

Manure Types	Final *M. Incognita* Soil Population (200ml Soil)		No of Juveniles in 5g Root		Root Gall Index	
	2008	2009	2008	2009	2008	2009
Control	247.65[c]	285.46[c]	25.90[e]	27.73[e]	4.15[c]	4.35[c]
Domestic waste	87.04[d]	80.54[d]	13.43[d]	14.27[d]	2.35[b]	2.43[b]
Cow Dung	76.42[c]	77.06[c]	10.00[c]	9.80[c]	2.27[b]	2.04[b]
Compost manure	64.92[b]	60.94[b]	7.25[b]	7.00[b]	2.19[b]	2.11[b]
Poultry manure	55.38[a]	54.92[a]	5.40[a]	5.03[a]	1.9[a]	1.40[a]
S.E.	7.530	5.221	1.420	1,612	0.421	0.283

WAP: Weeks after planting.

[a,b,c,d,e]Means followed by the same letters along the same column do not differ significantly according to Duncan multiple range test at p=0.05.

Table 4

Effect of organic manure on the yield component of nematode infested tomato

Treatments	Average fruit number		Average fruit weight	
	2008	2009	2008	2009
Control	6.71[a]	6.94[b]	19.80[a]	21.02[a]
Domestic waste	15.74[b]	16.00[b]	36.77[b]	36.80[b]
Cow Dung	17.22[c]	17.30[c]	40.77[c]	40.03[c]
Compost manure	18.63[d]	18.60[d]	48.53[d]	47.27[d]
Poultry manure	19.96[e]	19.50[e]	53.27[e]	52.61[e]
S.E	0.221	0.683	0.023	0.021

[a,b,c,d,e]Means followed by the same letter along each column do not differ significantly according to Duncan multiple range test a p=0.05.

4. Discussion

The use of organic manure for crop production can bring about reduction in root and soil nematode population which translates into increased growth and yield of the crop. This practice however can bring about reduction in the cost of producing a particular crop especially when the said organic manure is cheaply available as no money will be expended on the purchase of inorganic fertilizer. This practice of incorporating organic matter into crop production will assist tremendously in waste disposal which is becoming a threatening problem in most of our urban and peri- urban settlements.

Applications of different organic manure types have been shown to increase the growth and yield component as well as reducing the root and soil population of *M. incognita*. Hence culminating in enhanced growth and yield of crop (Pakeerathan *et al* 2009; Summer, 2011).The present study has really demonstrated that application of organic manures can reduce the negative effects of *M. Incognita* on treated crop with a resultant increase and growth and yield of the crop.

The mechanism involved in the reduction of nematode population was never part of this study. However, many researchers have presented opinion based on their research findings on the mechanism involved. Adesiyan (1990) reported that organic manure in the soil produces residues in form of decomposed products which may be detrimental directly to root-knot nematode on any susceptible crop. Mohammed and Alam (2003) reported that organic manure in form of livestock waste when incorporated into the soil stimulates the generation of predators and parasites of plant parasitic nematode hence decreasing the population of plant-parasitic nematodes with consequent growth and yield increase.

Beneficial micro-organisms are abundant in soils amended with different organic matter. Some beneficial fungi and bacteria parasitize nematode eggs and also prey on the nematodes. The predatory nematodes that prey on other nematodes are high in organic amended soil. Thus organic amendment enhances biological suppression of parasitic nematodes in soil (Summer, 2011).

Suppression of soil borne pathogen via incorporation or simple mulching of composted amendment are reputedly based on enhanced microbial activities and increased number of antagonists generated by decomposition of the amendments in soil (Anonymous 2009).

The reduction in population occasioned by organic manure amendment incorporated into the soil brought about a significant reduction in the root and soil population of root- knot nematode as well as the root gall index compared with the control. This resulted into reduction in the negative effects of the parasitic nematode on tomato, hence bringing about growth and yield increase which are significantly different from the control in respect of all the studied parameters.

This research work underscores the significance of using organic manure as soil nutrient enricher and as a suitable nematicide for managing root-knot nematode in susceptible crops, without causing any harm to the environment

5. Conclusion

The result of this study shows that organic manures has the potential to suppress soil and root nematode population with a resultant increase in growth and yield as a result of reduction in the negative impact of nematode attack on susceptible crop. The authors intend to carry out this research under field condition. The authors also intend to conduct another trial and vary the rates of the organic manure above and below the quantities used under the present study.

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