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Pathogenicity of *Meloidogyne* species on tomato (*Solanum lycopersicum*) in soil amended with different sources of green manure in Ishiagu, Southeast Nigeria

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Abstract

Pathogenicity of root-knot nematodes on tomato (*Solanum lycopersicum* L.) in soil amended with different sources of green manure was investigated at the research and teaching farm of Federal College of Agriculture Ishiagu, Ebonyi State, Nigeria, during the 2022 and 2023 cropping seasons. Hedge fig plants, African peach plants, and banana leaves at 10t/ha were used as green manure sources while the control plots did not receive any treatment. The experimental design used was a Randomized Complete Block Design (RCBD) with the four treatments replicated three times. Growth and yield parameters were evaluated from plant height, number of leaves, number of fruits, and weight of fruit at harvest while disease parameters were obtained from number of galled roots and number of galls per root. Data collected were averaged over the two cropping seasons and analyzed using analysis of variance (ANOVA) and significant treatment means were separated using least significant difference (LSD). All inferences were made at a 5% level of probability. The results showed that the treatments significantly ($P<0.05$) increased the plant heights at 6 and 9 weeks after transplanting. The treatments did not have any significant ($P>0.05$) effect on the number of leaves produced by the plants. The number and weight of fruits at harvest were significantly ($P<0.05$) increased by the treatments. The number of galled roots was significantly ($P<0.05$) reduced at the application of hedge plant leaves at 10 t/ha while there was no significant ($P>0.05$) effect on the gall index of the treatments at harvest when compared with other treatments and it was recommended for tomato farmers as an alternative to inorganic nematicide.

Introduction

Tomato (*Solanum lycopersicum* L.*)* is among the major vegetables being produced in the country and is consumed in various forms (Aditi *et al.,* 2011 and Aremu *et al*., 2016). Nigeria is among the world's leading producers of tomatoes (Ranked 16th), and the leading producer in Sub-Saharan Africa (Ugonna *et al.*, 2015). As of 2010, the country's production was about 1.8 million

metric tons, which represents about 68.4% of West African production (FAO, 2010). Despite this status in the global and regional ranking in tomato production, the country still imports tomatoes to meet its demands (Edeh, 2017 and Okojie, 2018).

According to Sunday *et al.* (2018), Nigeria's annual tomato imports are valued at US$170 million. This is because tomato is highly consumed across all the regions of the country, constituting about 18% of the daily vegetable consumption of households (Babalola *et al.*, 2010).

Tomato in Nigeria is widely cultivated in Northern parts of the country, because of the effect of seasonality (Aminu and Shehu, 2007). Small-scale farmers having less than 5 hectares of land constitute the majority (90%) of the producers (FAOSTAT, 2014 and Sahel Research, 2015). However, tomato production in the rainy season is usually affected by pests and diseases that are prevalent under such humid and warm conditions. FCAI

According to Ugonna *et al.* (2015), tomato farmers just like other farmers are constrained by poor production practices due to low soil fertility, lack of improved seeds, lack of improved technology, inadequate pest and weed control, higher postharvest losses, and lack of processing and marketing infrastructure among others. Similarly, the challenges of farmers are being compounded by the ravaging incidence of diseases.

Green leaf manures are organic manures made from leaves collected from all available sources and used to supply essential plant nutrients to the soil and increase soil fertility in a healthy manner (Larkin *et al.*, 2011). As organic manure, green leaf manure can supply the required plant nutrients while maintaining very good soil health.

Green manures may provide other benefits such as reduction of soil erosion, conservation of soil water, improved retention of other crop nutrients, and control of plant pests, pathogens, and weeds with less reliance on farm chemical inputs (Ross *et al.*, 2001).

Root-knot nematodes (*Meloidogyne* spp.) are economically important polyphagous obligate plant parasites, distributed worldwide, and are known to parasitize nearly every plant species of higher plants (Moens *et al.*, 2009). Root-knot nematodes belonging to *Meloidogyne* are sedentary endo-parasites and their parasitism life depends on the success of inducing feeding sites in the roots of host plants (Perry and Moens, 2006). The estimated yield loss on tomatoes is about 24-38%.

A large number of crops worldwide are affected by root-knot nematodes and so far, more than 100 species have been described (Hunt and Handoo, 2009). *Meloidogyne incognita*, *M. javanica,* and *M. arenaria* are the most common in the tropical regions while *M. hapla, M. fallax,* and *M. chitwoodi* are successful in temperate and cooler regions (Karssen and Van, 2001).

Materials and methods

This research was conducted at Research and Training Farm at Federal College of Agriculture Ishiagu, Ivo Local Government area of Ebonyi State of Nigeria during the 2022 and 2023 cropping seasons. Ishiagu, is located in the tropical region at longitude 07^0 46^1E and latitude 05^0 45^1N, with 1665 mm rainfall, 88% average humidity, and a temperature of 28.5^0C (FCAI Meteorological Station, 2012).

1. Nursery:

The tomato seeds were planted in a seed tray with sterilized soil and after three weeks, the seedlings were transplanted to the open field.

2. Experimental Design:

The experimental design used was a Randomized Complete Block Design (RCBD) with four treatments replicated three times.

3. Materials:

Susceptible local tomato seeds obtained from the Eke market in Ishiagu. The treatments used were Hedge fig plant (Igbo: *Ogbu*), African peach (Igbo: *Uvuruilu*), Banana leaves at 10t/ha each, and control (No treatment)

4. Land Preparation:

The experimental site was cleared, ploughed, and harrowed, pegged, and laid out into three blocks each year. Native hoe was used in making the beds and the plot size measured 2m x 1m with four plots in each block making a total of 12 plots.

5. Preparation of green manure:

Each of the treatments was harvested, chopped into pieces, weighed, and applied into designated plots by incorporating it into the soil one week before transplanting the tomato seedlings.

6. Data Collection:

Data were collected on the following parameters: Plant height (cm), number of leaves at 3, 6, and 9 weeks after transplanting, number and weight (g) of fruits at harvest, number of galled roots, and number of galls per root at harvest (Gall index). Gall index was scaled according to Ogwulumba and Okonta (2015), thus:

Rating	Number of Gall/Root	Infection Level
0.	No galls	No infection
1.	1-10	Mild infection
2.	11-20	Moderate infection
3.	21-30	Moderately high infection
4.	31-40	High infection
5.	41-50	Very high infection
6.	>51	Severe infection

7. Data analysis:

Data collected were averaged over the two cropping seasons and subjected to statistical analysis of variance (ANOVA). Significant treatment means were separated using Fisher's least significant difference (FLSD) at a 5% probability level as outlined in Obi (2002).

Results and discussion

The result in Table (1) showed that the various green manures did not have any significant (P>0.05) effect on the plant height at three (3) weeks after transplanting. At 6 and 9 weeks after transplanting, the applied green manures significantly (P<0.05) increased the plant heights. At 6 weeks, plots treated with African peach leaves at 10t/ha gave greater plant height (36.1cm), with the control plots recording the lowest plant height (24.6 cm). At 9 weeks after planting, plots treated with banana leaves at 10t/ha produced the highest (53.04 cm) plant height while the control plot recorded the lowest plant height (29.22 cm).

Table (1): Effect of different sources of green manure on the plant height at 3, 6, and 9 WAP (cm).

Treatment	3WAP	6WAP	9WAP
Hedge fig plant leaves at 10t/ha	15.26	31.3	52.32
African peach leaves at 10t/ha	15.79	36.1	47.45
Banana leaves at 10t/ha	17.11	31.0	53.04
Control (No treatment)	8.62	24.6	29.22
LSD (0.05)	NS	0.71	0.33

NS = Not significant

Table **(**2) showed that at 3,6 and 9 weeks after transplanting, there was no significant (P>0.05) difference in the number of leaves produced by the plants amongst the treated plots and control.

Table (2): Effect of different sources of green manure on the number of leaves of tomato at 3, 6, and 9 WAP.

Treatment	3WAP	6WAP	9WAP
Hedge fig plant leaves at 10t/ha	3.4	6.1	8.1
African peach leaves at 10t/ha	3.8	7	9.1
Banana leaves at 10t/ha	3.8	6.3	10.2
Control (No treatment)	3.2	4.1	6.3
LSD (0.05)	NS	NS	NS

NS = Not significant

Table (3) shows that the treatments significantly (P<0.05) influenced the number of fruits produced by the plants at harvest. Plots treated with banana leaves at 10t/ha recorded the highest mean number (10) of fruits/plot at harvest, followed by hedge fig plant leaves at 10t/ha which gave the mean number of seven fruits/plot while the least mean number of one fruit/plot was recorded in control plots. The results also showed the treatments were significantly (P<0.05) influenced by the weight of fruits produced by the plants at harvest. The highest fruit weight of 690 g/plot was obtained in the plots treated with hedge fig plant leaves at 10t/ha, followed by banana leaves at 10t/ha which gave a mean fruit weight of 212 g/plot while the least fruit weight of 12 g/plot was observed in control plots.

Table (3): Effect of different sources of green manure on the number of fruit and weight of fruit (g).

Treatment	Number of fruits	Weight of fruit (g)
Hedge fig plant leaves at 10t/ha	7.93	690
African peach leaves at 10t/ha	3.72	120
Banana leaves at 10t/ha	10.02	212
Control (No treatment)	2.71	12
LSD (0.05)	2.6	98

Results in Table (4) showed that the treatments significantly (P<0.05) reduced the number of galled roots at harvest when compared with the control. The mean highest number of galled roots of 11 was obtained in the control plots at harvest while the lowest mean number of galled roots of two was obtained from the plots treated with hedge fig plant leaves and banana leaves at 10t/ha plots respectively. The results further showed that there was no significant (P>0.05) influence on the mean number of galls per root by the treatments at harvest as also recorded in Table (4).

Table (4): Effect of different sources of green manure on the number of galled roots and number of galls (Gall index) per root.

Treatment	Number of galled roots	Number of galls per root
Hedge fig plant leaves at 10t/ha	2	11
African peach leaves at 10t/ha	6	39
Banana leaves at 10t/ha	2	14
Control (No treatment)	11	49
LSD (0.05)	0.2	NS

Different sources of green manure plots showed no significant influences when compared with the control plots statistically at the early stage. This could be the result of the green manure not fully decomposed in the soil. However, within the middle stage, the treatments significantly influenced the growth parameter, with hedge fig plant leaves at 10t/ha and banana leaves at 10t/ha performing better than other treatments. The decomposition of the leaves at this period facilitated the release of nutrients to the soil, which were made available to the plants for absorption, hence the increment in growth

parameters of the treated plants. The result corroborated the works of Ganry *et al.* (2001) who stated that green manure provides numerous beneficial effects on soil chemical, physical, and biological attributes of soils which in turn promotes plant growth.

The yield parameters of tomatoes in the treated plots were significantly improved when compared with the control. This could be attributed to the release of the required nutrients from the decomposed plant leaves in the soil which enhanced the yield of the fruits. The number and weight of fruits produced from the study showed that using hedge fig plant leaves yielded a better number and weight of fruits when compared with other treatments. This was attributed to nutrient contents of the leaves which were more than those contained in other leaves at 10t/ha. It could also be attributed to the ease of decomposition and release of necessary nutrients by the hedge fig plant leaves.

The pathogenicity of root-knot nematodes on the tomato in soil amended with different sources of green manure was significantly reduced when compared with the infections recorded in the control plots. This showed that green manure could reduce the incidence of nematodes. The reduction of nematode infections exhibited by hedge fig plant leaves at 10t/ha could be attributed to the higher content of nematocidal properties in the leaves when compared with other leaves. Fewer galls (Nematode infections) were observed in the plots treated with the various green manures when compared with plants in the control plots. This showed that green manures have varying degrees of nematocidal properties. Reduction in the root-knot index may also be attributed to the toxicity or high concentrations of the nematocidal properties of hedge fig plant leaves, which reduced the occurrences of nematodes.

Root-knot nematode is an economically important pathogen of tomatoes grown under open as well as protected cultivation. Considering the crops high nutritive value and the export potential, successful cultivation, and mitigation of nematode infections on tomatoes could be achieved with the application of hedge fig plant leaves at 10 t/ha as a soil amendment.

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