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Potency of plant-derived biological nematicides on root-knot disease of tomato, *Lycopersicon lycopersicum* (L.) Mill

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Abstract

The aim of this research was to evaluate the effectiveness of plant-derived biological nematicides in the management of root-knot nematode disease of tomato. A piece of land measuring 8 m × 54 m was ploughed and raised beds were the experimental plots. The land was divided into 4 blocks, each block comprising 12 treatments and 4 replicates with a total of 48 experimental plots were fitted into randomized complete block design (RCBD). The experiment was carried out at the Teaching and Research Farms, Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria (Longitude 40E and Latitude 8010N) during 2018 planting season. 20 g macerated root gall of Celosia was applied to tomato root rhizosphere (inoculation). The plant-derived biological nematicides that were assessed on root-knot nematode disease of tomato, UC8 cultivar, include the leaf water extract of neem, castor, wild sunflower, cleome, siam weed, phyllanthus, nitta, tobacco, lantana and calotropis, mixed with black soap, at rate of 9:1 v/w. The black soap and distilled water served as adjuvant and solvent respectively, and as the control experiments. The results showed that the root galling and soil population of root-knot nematode were significantly reduced with consequent enhanced growth and yield of tomato in the plots treated with plant-derived biological nematicides, compared with the tomato in the control experiments. The study has demonstrated that the use of plant-derived biological nematicides can be effectively explored in the management of root-knot nematode disease. The application of plant-derived biological nematicides is therefore recommended for sustainable management of root-knot nematode disease in tomato production. .

Keywords: *Biological nematicides, nematode, Meloidogyne incognita, Tomato*

Introduction

Tomato, *Lycopersicon lycopersicum* (L.) Mill, is an important fruit vegetable in Nigeria and elsewhere worldwide. Tomato contains important compounds that play important roles in the prevention of cancer, heart disease, cataracts and many other health challenges (10). Tomato is a savory, typically red edible fruit and is most widely grown fruit in the world and has great nutritional value. Tomato is excellence sources of vitamin A, C, B6, pantothenic acid and vitamin B2. It is a good source of molybdenum, potassium, manganese, chromium, copper, niacin, magnesium, iron and phosphorus. Tomato has been shown to be excellence source of antioxidants especially lycopene which prevents the growing of cancer including prostate gland, breast cancer, lung colorectal and pancreatic cancer (10).

The production of tomato, however, is confronted with a lot of problems, most especially nematode diseases. Root-knot nematode has been described as a major disease of tomato (9, 20) and had been reported to have a wide host range with greatest threat to global agriculture (6). *Meloidogyne* species have more than 2000 hosts among which tomato is one (6, 9).

The root-knot nematode is estimated to cause losses ranging from 10% to 69% in Nigeria (15). There is important need to develop effective and sustainable management strategy. Following this, the biological nematicidal potential of some plants have been evaluated and few are found effective in the management of root-knot nematode disease (2, 14). In addition, biological bionematicides have been found to be cheaper, less harmful to man and effective in the management of plant parasitic nematodes (12, 13). It had been reported (12) that biological bionematicides have consistent beneficial effects on soil biological activity and thereby improving the health of plant and reducing the population of plant parasitic nematode. The beneficial effect of biological bionematicides with respect to the management of plant parasitic nematodes has been recognized in recent years. Today there is an increasing interest in discovering nematostatic compounds from the plant products in nematode management (7, 11).

The objective of this study is to evaluate the effectiveness of plant-derived biological nematicides in the management of root-knot nematode disease of tomato.

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farms, Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo State,

Nigeria (Longitude 40E and Latitude 8010N) during 2018 planting season.

A piece of land measuring 8 m × 54 m was ploughed and raised beds (2 m x 1 m x 0.15 m) were the were made as experimental plots. The land was divided into 4 blocks. Each block comprises of 12 treatments with 4 replicate giving a total of 48 experimental plots in a randomized complete block design (RCBD). Alley-ways measuring 0.5 and 1.0 m were in between the plots and blocks respectively to prevent treatment interactions.

Prior to planting of tomato seeds and final tomato fruit harvest, 250 cm3 soil samples were randomly collected for initial and final nematode population counts. Five soil samples were randomly taken from each experimental plot at 0 – 15 cm depth and mixed thoroughly to form composite samples. A total of 240 labelled composite soil samples were assessed in the laboratory for nematode extraction, identification and count using the modified Baermann's technique (17) with stereo-microscope.

Seeds of tomato, UC8 variety, were sown in 3 rows per beds at intra row spacing of 60 cm and 30 cm inter row spacing using 2 - 3 seeds per hole which was later thin down to one healthy tomato plant per stand. Germination took place between 5 to 7 days after planting. Chopped roots of root-knot nematode (root gall) of infected Cock's comb, *Celosia argentea*, were weighed (20 g), assessed to contain approximately 1,500 second stage juveniles (J¬2) of root-knot nematode were incorporated into the tomato root rhizosphere at 3 weeks after planting. Stock solution (1.0 L) of each plant-derived biological nematicides was mixed thoroughly with water (2.0 L) in hand sprayer was applied at 20 ml per plant, at 6 and 9 weeks after planting within the tomato root rhizosphere. Weeding was done at week 4 and 9 after planting.

The plant-derived biological nematicides were water extract of the air died leaf of neem, castor, wild sunflower, cleome, siam weed, phyllanthus, nitta, tobacco, lantana and calotropis, mixed with black soap at ratio 9:1 v/w. Independent application of black soap and distilled water served as different control experiments. Distilled water served as medium of extraction and black soap served as adjuvant. During the preparation of plant-derived biological nematicide, 1 kilogram each of the plant material was soaked into 1.5 L warm water (40oC) for 24 hours. The content was sieved with muslin cloth and mixed with black soap at ratio 9:1 v/w (plant extract: black soap).

Data were collected on plant height, number of leaf per plant, number of branch per plant, fruit weight and number of fruit. Data on the nematode populations in the soil before planting and at final harvest of tomato fruits were also recorded. After final harvest of tomato fruits, tomatoes were uprooted to observe the gall. Galls were scored on 0-10 index scale: 0 = complete and healthy root system, no infestation, 1 = Very few small galls can only be detected upon close examination, 2 = Small galls but easily detected, 3 = Numerous small galls, some grown together, but function of roots not seriously affected, 4 = Numerous small galls, some big galls, majority of roots still functioning, 5 = 25% of root system severely galled and not functioning, 6 = 50% of root system severely galled and not functioning, 7 = 75% of root system severely galled and last for production, 8=No healthy roots, nourishment of plants interrupted, plants still green, 9 = Completely galled root system is rotting, plant is dying, 10 = Plants and roots are dead (5). Data were analyzed statistically to find out the level of significance and variations, while the data were compared following Duncan's new multiple range test at 5% probability level.

RESULTS AND DISCUSSION

Effect of plant-derived biological nematicides on the growth of tomato planted on root-knot nematode infested soil: The tomatoes treated with plant-derived biological nematicides have significant higher plant height compared to tomatoes treated with only black soap (adjuvant) and distilled water. The numbers of branch per tomato were significantly enhanced on tomatoes treated with plant-derived biological nematicides. The tomatoes that were treated singly with black soap (adjuvant) and distilled water have significantly lower numbers of branch compared with others that were treated with plant-derived biological nematicides. Numbers of leaf per tomato were significantly increased on tomatoes treated with plant-derived biological nematicides (Table 1).

Table 1: *Effect of plant-derived biological nematicides on the growth of tomato planted on nematode infested soil.*

Treatment	Plant height	Number of branch	Leaf number per plant
Neem leaf	53.4a	9c	157b
Castor leaf	51.5a	11c	110c
Sunflower leaf	57.0a	29a	334a
Cleome leaf	43.5b	15b	165b
Siam leaf	41.7b	10c	165b
Phyllanthus leaf	53.0a	16b	153b
Nitta leaf	51.7a	14b	103c
Tobacco leaf	50.2a	18b	157b
Lantana leaf	49.2a	8c	158b

Calotropis leaf	44.2b	9c	179b
Black soap (Control 1)	19.0c	4d	36d
Distilled water (Control 2)	12.6c	2d	28d

Means with same letters along the same column are not significantly different (P < 0.05)

Efect of plant-derived biological nematicides on soil nematode populations: The tomatoes treated with plant-derived biological nematicides have significantly low nematode population in the soil and plant root. There was significant reduction in the root gall index of tomatoes treated with plant-derived biological nematicides when compared with tomatoes treated singly with either black soap (adjuvant) or distilled water at final tomato fruit harvest (Table 2).

Effect of plant-derived biological nematicides on the yield of tomato planted on nematode infested soil: The tomatoes treated with plant-derived biological nematicides have significantly higher numbers of fruit compared to those tomatoes treated singly with either black soap (adjuvant) or distilled water. The fruit weights were significantly increased on tomato treated with plant-derived biological nematicides. The tomato plants that were treated with either black soap (adjuvant) or distilled water have significantly lower fruit weights when compared with plant-derived biological nematicides (Table 3).

Table 2: *Effect of plant-derived biological nematicides on the nematode populations in the soil and plant root.*

Treatment	Soil Nematode Populations			Root gall Index
	Before planting	At harvest	Root	
Neem leaf	3045a	278c	38.00a	2a
Castor leaf	3067a	287d	44.75a	3a
Sunflower leaf	3060a	211a	42.00a	3a
Cleome leaf	3054a	243b	38.75a	2a
Siam leaf	3045a	282d	47.50a	3a
Phyllanthus leaf	3091a	247b	35.25a	2a
Nitta leaf	3040a	284c	40.00a	3a
Tobacco leaf	3035a	255b	46.75a	5b
Lantana leaf	3068a	231b	47.50a	6b
Calotropis leaf	3063a	250b	48.75a	6b
Black soap (control 1)	3092a	3628e	110.00b	5b
Distilled water (control 2)	3012a	3618e	119.00b	8c

Means with same letters along the same column are not significantly different (P < 0.05)

Table 3: Effect of plant-derived biological nematicides on the yield of tomato planted on nematode infested soil.

Treatment	Number of fruits	Fruit weight (g)
Neem leaf	11b	255.4c
Castor leaf	14ab	271.0cd
Sunflower leaf	12bc	205.7d
Cleome leaf	13ab	301.5b
Siam leaf	10ab	208.0c
Phyllanthus leaf	16a	395.7a
Nitta leaf	14ab	251.3d
Tobacco leaf	14ab	221.3d
Lantana leaf	13ab	259.8c
Calotropis leaf	14ab	225.0d
Black soap (control 1)	6c	19.3e

Distilled water (control 2)	4c	16.1e

Means with same letters along the same column are not significantly different (P < 0.05)

The results showed that the plant-derived biological nematicides significantly (P<0.05) reduced root gall, suppressed the populations of nematode in the soil and root, and also increased the yield and growth of tomato compared to tomatoes treated singly with either the black soap (adjuvant) or distilled water. These results were in agreement with the previous findings (1, 3, 14) who reported that application of biological nematicidal plants causes significant reductions in nematode infestation, leading to increase in growth and yield of economic food crops.

The nematicidal potential of plant-derived biological nematicides found in this study was supported by the findings of some researchers (14, 18) who reported that fresh extracts of seeds, leaves and barks of neem inhibited the hatching of *Meloidogyne incognita*. Boiled water extract of fresh neem leaves was reported to be toxic to eggs and juveniles of root-knot nematodes, M. *incognita* (8). The neem constituents, namely: nimbin, salanin, thionemone, azadirachtin and flavonoids, have been reported to have nematicidal action (4). The results of the present study also showed that the use of plant-derived biological nematicides significantly suppressed the development of nematode populations both in the soil and root of tomato. A researcher (11), also reported Datura (*Datura stramonium L.*), Calotropis (*Calotropis procera L.*), Neem (*Azadirachta indica L.*) leaves and sawdust of Shisham (*Dalbergia sissoo*) alone and in combination against M. incognita in pots on tomato, had found significant increase in plant height and shoot weight and reduction in number of galls. Also (16) reported that soil amendments with oil cakes of castor and neem and leaves of castor, *Persian lilac* (bakain) and *Azadirachta indica* (neem), caused significant reduction in root gall and improved plant growth and chlorophyll content of okra and lentil. The liquid formulations of *Azadirachta indica* and *Cleome viscosa* with either black soap or *Tetrapleura tetraptera* seed as adjuvant, at the concentrations of 1:10 v/w (adjuvant: plant extract), have been reported to be effectively used in the management of nematode pests of okra under a field condition (14).

CONCLUSION

The current study was conducted to evaluate the effects of plant-derived biological nematicides on root-knot nematode disease of tomato. The study has demonstrated that the use of plant-derived biological nematicides can be effectively explored as alternative management strategy for root-knot nematode diseases. The application of plant-derived biological nematicides is therefore recommended for sustainable management of root-knot nematode disease in tomato production.

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COMPETING INTEREST

I hereby declared that there is no competing interest.

REFERENCES

1. Adegbite, A.A. (2011). Assessment of Yield Loss of Cowpea (Vigna unguiculata L.) due to Root Knot Nematode, Meloidogyne incognita under Field Conditions. American Journal of Experimental Agriculture, 1(3), 79-85.
2. Adegbite, A.A. and Adesiyan, S.O. (2005). Root extracts to control root-knot nematode on edible soybean. World Journal of Agric Science 1 (1): 18-21.
3. Ahmad, F., Rather, M. A. and Siddiqui, M.A. (2005). Impact of organic soil amendments and nematicides on Meloidogyne javanica infecting tomato. Indian Journal of Nematology, 37, 55-57.
4. Akhtar, M. and Malik, I. (2000).Control of plant parasitic nematodes with "Nimin" and some plant oils by bare-root dip treatment. Nematol. Medit., 21; 89-92.
5. Akhter, B., Humaun, M.R. and Ahamed, K.U. (2019). Management of root-knot disease of pointed gourd through the application of nematicides and different organic amendments. Int. J. Agril. Res. Innov. Tech. DOI: 10.3329/ijarit.v9i2.45410, volume 9(2): 51-56.
6. Amer-Zareen, Zaki, J.M. and Javed, N. (2003).Nematicidal activity of ginger and its effect on the efficacy Pasteuria Penetrans for the control of root-knot nematodes. Asian Journal of plant Science 2(11): 858-860.
7. Chitwood, D.J. (2002). Phytochemical based strategies for nematode control. Ann. Review of Phytopathology. 40. pp. 221-249.
8. Claudius-Cole, A. O., Aminu, B.R and Fawole, B. (2010). Evaluation of plant extracts in the management of root-knot nematode Meloidogyne incognita on cowpea [Vigna unguiculata (L) Walp] Mycopath, 8(2), 53-60.
9. De Lannoy, G. (2001). Vegetables. In: Crop production in tropical Africa. Romain H. Raemaekers (ed.) DGIC, Brussels. pp. 467-75.
10. Giovannucci, E., Rimm, E. B., Liu, Y., Stampfer, M. J. and Willett, W. C (2002). A prospective study of tomato products, lycopene, and prostate cancer risk. J Natl Cancer Inst. 2002; 94(5):391–98.
11. Khan Z, Kim S, Jeon Y, Khan H, Son S and Kim Y. A (2008). Plant growth promoting rhizobacterium. Paeneibacillus polymyxa strain gbr-1, suppresses root-knot nematode. Bioresource Technology: 99(8): 3016-3023.
12. Khan, M. R., Mohiddin, F. A., Khan, S. M. and Khan, B. (2005). Effect of seed treatment with certain biopesticides on root-knot of chickpea. Nematol. Mediterranea, 33: 107-112.

13. Oka, Y., Nacar, S., Putievsky, E., Ravid, U., Yaniv, Z. and Spiegel, Y. (2000). Nematicidal activity of essential oils and their components against the root-knot nematode. Phytopathology, 2000; 90:710–715.

14. Olabiyi, T. I., Akanbi, W. B. and Adepoju, I. O. (2007). Control of certain nematode pest with different organic manure on cowpea. American-Eurasian Journal of Agricultural and Environmental Sciences, 2(5), 523-527.

15. Olabiyi, T.I. and B.P. Ayeni (2016). Assessment of Azadirachta indica and Cleome viscosa liquid-formulations as bio-nematicides in the management of nematode pests of okra. African Journal of Agricultural Research, 11 (6): 467 – 471. Available at http://www.academicjournals.org/AJAR

16. Olowe, T. (2009). Cowpea Germplasm Resistant to Meloidogyne arenaria Race 1, Meloidogyne incognita Race 4 and Meloidogyne javanica. European Journal of Scientific Research, 28(3), 338-350.

17. Wani, A. H. (2006). Management of root-knot nematode, Meloidogyne incognita on okra and lentil by soil amendment with oil cakes and leaves of different plants. Nematologia Mediterranea, 34(1): 83-87.

18. Whitehead, A.G. and Hemming J.R. (1965). A comparison of some quantitative methods of extracting small vermiform nematodes from soil. Annuals of Applied Biol., 55: 25-38.

19. Yasmin, L., Rashid, M.H., Uddin Nazim, M., Hossain, M. E., and Ahmed, M. U. (2003). Use of neem extract in controlling root-knot nematode of sweet-gourd. Pakistan Journal of Plant Pathology 2(3):161-168.

20. Zhao H, Peng D.L and Zhu J.L (2003). Reviews on the root-knot nematodes. Plant Protection, 29: 6-9.

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