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 4E and Latitude 8°10N) 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 biocontrol 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 biocontrol 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 biocontrol have 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 × 1 m × 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 dried 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).

| 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                  |
### 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 |                          |
| 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               | 19.3c            |
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 Tetrablepta 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.

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