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Research Article

Incidence and control of root-knot nematodes (*Melodogyne incognita*) on egg plant (*Solanum melongene* Mill.) in Zamafara State

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Abstract

A Survey was conducted to determine the incidence of root-knot nematodes, *Melodogyne incognita* on five vegetable crops (tomatoes, okra, eggplant, pepper and spinach) in Zamfara state of Nigeria. Five cultivars of eggplants were tested for susceptibility to root-knot nematode. A nematicide and poultry dropping were used to test their effects on the control of the root-knot nematodes. The result of the research indicated that egg plants surveyed were found to be infested by *Melodogyne incognita*. Among the five cultivars of eggplant tested for susceptibility to root knot nematode infestation, SMG 1 var. Zaria was found to be highly susceptible to nematode attack with root-knot index of 4.5 while SMG 2 var. Ilorin was found to be resistant due to absence of galls on the roots. Nematicide trial showed that chemical Nematicide was more effective in the control of root-knot nematodes but could be toxic to plants at higher dose. Poultry dropping was less effective but reduced the population of the nematodes as well as suppressed their development. More research should be carried out to study the distribution of root-knot nematode, *Melodogyne incognita* and other species of nematodes that are prevalent and attack various crops in Zamfara State. More, so farmers should be advised to use poultry droppings on their farms as soil amendment to see its full scale effects on the control of root-knot nematodes thereby cutting down on the use of chemicals as they are toxic to plants and humans.

Keywords: Root-Knot, Nematodes, Vegetable and Control.

Introduction

Root-knot nematodes are plant-parasitic nematodes from the genus *Melodogyne*. They exist in soil in areas with hot climates or short winters. About 2000 plants are susceptible to infection by root-knot nematodes and they cause approximately 5 % of global crop loss. (Hussey and Grundler, 1998) The problems caused by root-knot nematodes often start from the seed beds. The seedlings are readily attacked by nematodes and their roots develop the characteristic galls. This prevents the normal development of the root system. Consequently, the translocation of water and nutrients to the aerial parts of the plants is hampered and the plants growth is retarded (Ahmad, 2010). Generally, control of root-knot nematodes is based on two principles, first, to reduce damage in already infested fields and later, preventing further spread of nematodes to non-infested fields (Anon, 2000, Bos, 1998).

Root-knot nematodes infect various varieties of eggplant causing considerable losses of yield in Talata Mafara and Bakura local government areas of zamfara state. Due to reduction in yield, quality and market values of *Solanum melongena* varieties as a result of root knot nematode infestation, it become necessary to screen the varieties that are susceptible to the root-knot nematodes attack. A survey will be conducted to determine the incidence of root-knot nematode (*Melodogyne incognit*a) in association with five vegetable Crops, Tomato, Okra, Eggplant, Spinach and pepper in Matusgi, Makera Dambo and Bakura area of Zamfara state. The research also identifies the effects of root-knot nematodes on five cultivars of eggplant. Poultry manure and a Nematicide (Carbofuran) will be applied to determine their effects on the control of root knot nematodes.

Knowing the species of eggplant that are resistant to root knot nematode attack, and the *Melodogyne* species that are prevalent in a particular area will aid farmers in the choice of variety to use so as to avoid the cost of controlling diseases of the susceptible varieties. More so, adopting the cheapest and affordable method of controlling nematode with less toxic effect (Poultry dropping) on plants and humans tends to reduce cost and health hazard associated with the use of chemical in the control of nematodes.

The aim of this research is to document the species of root-knot nematodes that attacks vegetable crops in Bakura, Dambo, Makera, T/mafara and Matusgi areas of Talata Mafara and Bakura Local Government areas of Zamfara state. To determine the effects of root-knot nematodes (*Melodogyne incognita*) on selected eggplant varieties in order to rate their susceptibility and finally to determine the effects of poultry droppings and carbofurasn in the control of root-knot nematodes

Materials and Methods

Study Areas

The research was conducted in five localities which include,T/mafara, Makera, Matusgi, Dambo and Bakura of Talata Mafara and Bakura Local Government areas of Zamfara State. Talata mafara lies in the latitude of 12^0, 33^1, 51^{11} N, longitude of 6^0, 4^1, 0^{11} E and altitudes of 314-317M while Bakura have the latitude of 12^0, 42^1, 37^{11} N, longitude of 5^0, 62^1, 23^{11} E and altitude of 269-270 M respectively.

Survey

During the course of general survey of root-knot nematodes, vegetables plants showing disease symptoms of root-knot nematode were uprooted and the roots were examined for the infection of root-knot nematodes, such samples were collected from some vegetables growing areas of Makera, Matusgi, Bakura and Dambo of Talata Mafara and Bakura local Government areas of Zamfara State.

The infected roots of Okra *(Hibicius esculentum)* Spinach *(Celosia argentea)* Tomatoes *(Lycopersicum esculentum),* egg plant *(Solanum melongena)* and pepper *(Capsicum spp),* showing the symptoms of galls were carefully placed along with adhering soil in polythene bags. Each sample was tagged with necessary information in respect of the name of the host plant, locality and date of collection before they were taken to the laboratory for further examination.

Isolation

In the laboratory, the adhering soil particles were removed from around the roots by placing them in water in a plastic bucket. The infected roots containing galls were then examined and the root-knot index in respect of each sample was determined and rated according to the scale suggested by Taylor and Sesser (1998). This scale 0 – 5 represent the following infestation classes:-

1. No root-knot infestation Root is free from galls and egg masses of root-knot nematodes.

Very light infestation: Galls and egg masses usually inconspicuous require a careful search.

2. Light infestation with numerous small scattered galls and egg masses.

3. Moderate infestation with numerous small scattered galls and egg masses.

4.Severe infestation with few large galls and egg masses.

5. Very severe infestation with numerous large galls and egg masses often the root system is rotted

Identification of the Nematodes *(Melodogyne incognita)*

The infected roots containing adult females were stained by the following methods.

A staining solution, lactophenol cotton blue was boiled for a minute in which the infested roots were placed for about three minutes. During this process, both plant tissue and the nematodes embedded in them were stained. The roots were then removed from the staining solution and washed with cold water. They were later transferred to a clear lactophenol solution until properly distained.

In this medium, the plant tissues become translucent leaving the nematodes stained and clearly visible. The stained nematodes were then carefully removed from the plant tissues with the help of needles and mounted on glass slides for identification.

Preparation for the Identification of Root-knot Nematode (*Melodogyne incognita)*

Identification of various species of root-knot nematode is based on structural different of the perineal patterns. The perineal pattern was prepared in the nematology laboratory in crop protection Department of faculty of agriculture, Ahmadu Bello University, Zaria. The following method was adopted for the preparation of perineal pattern of preserved adult female. Mature female from the root galls were selected and placed in Petri dish containing tap water. The cuticle of the female was cut near the neck and body surface containing vulva and anal region representing the perineal pattern was transferred into a drop of glycerin on a clean glass microscope slide. Coverslip was gently placed on it. Excess of glycerin was absorbed with a piece of filter paper and then the slide was examined under the microscope.

Development of Pure Culture of *Melodogyne incognita*

In order to obtain enough inoculum for subsequent studies, pure culture of root-knot nematode population was maintained in pot raised from egg masses of *Melodogyne incognita*. This was done on the most susceptible variety of tomato plants. The tomatoes plants containing egg masses of *Melodogyne incognita* were carefully uprooted washed to remove the adhering soil particles under a gentle stream of tap water.

Nematodes and the eggmasses were collected from the galled root system by putting them into a blender with 100cc of water and the blender was operated for 10-13 seconds, the crushed roots containing mixture of eggmasses, nematodes and root tissues was passed through a coarse 20-40 mesh sieve by washing gently with streams of water. Residues on the coarse sieves were discarded, and the ones collected on the fine sieve (200 – 250) mesh was examined for nematodes and eggmasses of *M. incognita.*

Susceptibility Trials

The egg masses of *Melodogyne incognita* removed from the galled roots were transferred in a measuring cylinder of 1 litre containing 200ml of 0.5% sodium hypochlorite (Clorox) solution. The jar was vigorously shaken manually for 3 minutes. This dissolved the gelatinous matrix of the egg masses. The eggs were exposed to the Clorox solution for 4 minutes. The egg was later transferred into the water. Eggs separated from the egg masses pass through a sieve with 25m opening and washed under a slow stream of tap water. The eggs were then raised into 1 litre flask. The concentration of the egg was determined by counting the number of eggs in each egg mass. About 1000-2000 eggs are present in one egg mass. Two egg masses were used as inoculums per polythene bag that is, 2000-4000 eggs per polythene bag. The polythene bags were arranged using complete randomized block design with three replication. Thirty polythene bags were used for each of Carbofuran and poultry droppings treatments, that is, sixty polythene bags all together. The type of soil used for the experiment was soil with low clay content since clay particles can absorb the nematicide and reduce its dispersion.

The soil sample to be used for the experiment was sieved thoroughly to be free of debris and large clods. The soil was sterilized by watering the soil to make it wet and clear plastic of 1-2 mils was used to cover the top surface and buried the edges in a foot deep trench. These allow the solar energy from the sun to heat up the soil to the temperature of 118^{oc} in order to kill any existing pathogens in the soil. The soil was cooled off and 13kg was poured in each polythene bag.

Preparation of Experimental Plants

Five different cultivars of *Solanum melongena* were raised separately in nurseries. The germinated seeds were transplanted after four weeks into experimental polythene bags.

Eggplant Varieties Tested

The following varieties of *Solanum melongena* were used during the susceptibility trial against root-knot nematode, *Melodogyne incognita*.

Type 1- *S. melongena* Var. Zaria (SMG – 1) tall, leaves deeply lobed, fruit white in colour with green strips.
Type 2- *S. melongena* Var. Ilorin (SMG – 2) Dwarf leaves, slightly lobed, fruit long and oval pointed, yellow in colour with green strips.
Type 3- *S. melongena* Var. Giwa (SMG – 3) Dwarf leaves, slightly lobed, fruit short, oval and milk white without stripe.
Type 4- *S. melongena* Var. Ogunmo (SMG – 4) tall leaves deeply lobed, fruit round, green with blue purple splashes.
Type 5- *S. melongena* Var. Akabe (SMG – 5) Dwarf leaves deeply lobed, fruit short oval, green with purple splashes.

Poultry Dropping and Nematicidal (Carbofuran) Trials

The varieties of *Solanum melongena* were selected to determine the efficacy of poultry manure and a nematicide (carbofuran) for the control of root-knot nematode *(Melodogyne incognita)*. The poultry manure and the nematicide were applied in three different doses as follows:

1.Carbofuran – 13gms/pot, 15gms/pot, 17gms/pot, respectively.
2.Poultry manure - 1.5kg/pot, 2.5kg/pot and 3.5kg/pot respectively.

Poultry droppings was broadcasted and incorporated into the soil with a hand hoe to the depth of about 8-18cm. Carbofuran was properly mixed with the soil and After the recommended waiting periods (3 weeks), the *Solanum melongena* seedlings were transplanted into the polythene bags. The polythene bags were regularly watered every morning, routine weeding was done and 5gms of DDT powder was applied to protect against insect and fungal diseases. Ten weeks after transplanting, data was collected from the experimental plants. The number of fruits harvested daily was taken and the height of each plant was recorded and after the last picking, the plants were uprooted and taken to the laboratory to determine the levels of infestation of root-knot nematodes, *Melodogyne incognita* and rate their susceptibility using the index of 0-5. The data collected were taken for statistical analysis.

Results

The result of survey conducted in five different localities in Zamfara state to determine the incidence of root-knot nematode infestation association with egg plant is presented in Table 1, it was observed that Eggplant (*Solanum melongena*,) was susceptible to the infestation of root-knot nematode in all farm surveyed. However the degree of infestation (as measured by root-knot index) by the nematode varied substantially among the farm location the rate of infestation ranged from 2.0 to 4.5 root-knot index, with the highest rate (4.5) being recorded in makera and dambo locations. The lowest infestation rate (2.0) was recorded in Talata Mafara location. On identification, *Melodogyne incognita* was recorded as the most dominant species of nematodes in these areas except for one location in Dambo, The nematode specie showed two different types of perennial patterns. In the case of *Melodogyne incognita*, the perennial pattern was characterized by the presence of a high, squarish dorsal arch with a distinct whorl in the tail terminal area. Severe root-knot infestation was

recorded in eggplants, *Solanum melongena* with root-knot index of 3.5. Table: 1.

Susceptibility of *Solanum melongena* to Root-knot Nematode *(Melodogyne incognita)*

Five varieties of *Solanum melongena* were tested against root-knot nematode (*Melodogyne incognita)* and the degree of susceptibility rated. The results obtained indicate that S. *melongena* 1 var. Zaria was found to be highly susceptible to root-knot nematode attack with the average root-knot index of 4.5. S. *melongena* 4 and 5 were tolerant to root-knot nematode infestation with root-knot index of 2.1 and 2.0 respectively (Table 2).

S. melongena 3 var. Giwa was rated as resistant because of its ability to resist the activities of the root-knot nematode resulting into the root knot index of 1.0. *S. melongena* 2 var. Ilorin was found resistant to the root-knot nematode infestation as it did not develop any gall on the root system, having root-knot index of 0.

Effect of doses of poultry dropping and carbofuran on the *Solanum melongena* control of nematodes

Little differences were observed from the different doses of Nematicide applied.

In case of the fresh root weight of the plants, low dose gave 0.31g medium doses resulted to reduction of fresh root weight from 0.31g to 0.28g. High doses application gave a fresh root weight which is almost the same with that of the control plant, 0.20g against 0.19g from the control plants. The higher the doses the higher the performance as observed in the case of fresh root weight. The number of fruit yield also responded in different ways to different doses. Low dose gave average number of 11 fruits, medium doses increased the average yield from 11 to 13. The number of fruits dropped under high dose from 13 to 12 against 12 fruits from the control plants. The average plant height of 43cm was observed under low dose against the 52cm from the control plants, medium dose gave the average plant height of 45.3cm against 52cm from the control plants. This number also reduced under high dose as the average height dropped to 44.0g against 52cm from the control plants. The reduction in average numbers of fruits and average plants height under high doses may be attributed to hypertoxicity. At high dose, the application may become toxic to the plant which is expressed by reduction in height and numbers of fruits. The medium dose gave the best results as far as the average numbers of fruits and average height of the plants are concerned. Effective control of nematode was achieved under high dose of application as applicable to fresh root weight of the plants. The average root-knot index ranges from 1.8 for low dose, 1.6 for medium dose and 1.4 at high dose against the average root-knot index of 1.2 from the control plants (Table 4).

Discussion

The weight of the fresh roots of all the inoculated varieties of eggplants was higher than those under control. High fresh root weight above normal is an indication that the root-knot nematode is causing some damages to the root.

The extensive gall formation and the presence of adult nematodes, their eggmasses and larvae in the roots gradually added to the fresh root weight. Similar research experiment was carried out on cowpea by Ogunfowara (2002). The result revealed that the susceptible varieties of cowpea affected by root-knot nematode, *Melodogyne incognita* which are highly galled have high root weight compared to the less susceptible varieties because of the nematodes and their larvae that inhabited the roots of those plants. The total numbers of fruit yield was also affected drastically due to root-knot infestation. There was high reduction in yield recorded from the inoculated eggplants as compared to those under control experiment. The poor yield witnessed among the inoculated eggplant varieties is also connected to damages done to the root by root-knot nematodes. Roots attacked by root-knot nematodes develops characteristic galls and prevent the normal development of the root system and consequently,

Table 1. Root-knot nematode, *Melodogyne incognita* infestation on *Solanum melongena* in Zamfara State.

Farm Location	Root-not Index
Makera	4.5
Dambo	4.5
Matusgi	3.5
Bakura	3.0
Talata Mafara	2.0

Table 2. Varietal susceptibility of egg plant to Root-knot Nematode

Variety	Fresh root weight in (gm)	Numbers of Fruit	Height of plant in (CM)	Effect of Nematode (0-5)
SMG 1	$0.47 \pm .27088^{a}$	9 ± 3.77297^{c}	28.6 ± 9.05629^{b}	4.5^{a}
SMG2	0.20 ± 02635^{C}	16 ± 3.69242^{a}	55.8 ± 13.65782^{a}	0^{c}
SMG3	$0.29 \pm .11213^{b}$	13 ± 41662^{ab}	47.4 ± 16.43963^{a}	1.4^{b}
SMG4	$0.31 \pm .12001^{b}$	12 ± 4.66386^{b}	45.1 ± 16.76997^{a}	2.1^{b}
SMG50.	$31 \pm .12034^{b}$	9 ± 4.07968^{c}	44.2 ± 16.89259^{a}	2.0^{b}
Control	$0.19 \pm .00816^{c}$	13 ± 1.44914^{c}	52.7 ± 1.56702^{a}	1.2^{b}

★ Means with the same letter(s) along the column are not statistically different (P>0.05).

Table 3. Management/control of root-not nematode on egg plant using poultry dropping and carbofuran

Nematicide	Fresh root Weight in (gm)	Numbers of Fruit	Height of plant in (CM)	Level of infestation
Carbofuran	0.22 ± 08905^{b}	13 ± 4.22809^{a}	48.5 ± 17.77463^{c}	1.1^{c}
Poultry droppings	$0.40 \pm .18441^{a}$	10 ± 5.37925^{b}	$39.9 \pm 15.2.4407^{d}$	2.3^{b}
Carbofuran control	0.20 ± 00548^{b}	12 ± 1.22474^{ab}	50.4 ± 89443^{b}	1.2^{c}
Poultry dropping ctrl.	$0.18 \pm .00548^{b}$	14 ± 1.0954^{a}	$54 \pm .70711^{a}$	1.0^{c}

*Means with the same letter(s) along the column are not statistically different (P>0.05).

Table 4. Effect of doses on varieties of *Solanum melongena* and nematode infestation

Nematicide	Fresh root Weight in (gm)	Numbers of Fruit	Height of plant in (CM)	Level of infestation
Low dose	0.31 ± 16930^{a}	$11 \pm 4,71778^{c}$	34 ± 16.93951^{c}	1.8^{a}
Medium dose	0.28 ± 14148^{a}	13 ± 4.98331^{b}	45.3 ± 17.85523^{b}	1.6^{b}
High Dose	0.20 ± 12950^{b}	$12 \pm 5.1`8674^{c}$	44.0 ± 16.82568^{b}	1.4^{c}
Control	0.19 ± 00816^{b}	12 ± 1.44914^{c}	5.2 ± 1.56702^{a}	1.2^{c}

Means with the same letter(s) along the column are not statistically different (P>0.05).

the translocation of water and nutrients to the aerial parts of the plants is hampered and growth and development retarded, Since roots that are responsible for the absorption or uptake of water and nutrients into the plants were damaged.

The vegetative growth or height of the inoculated *Solanun melongena* varieties was also affected by root-knot nematode, *Melodogyne incognita.* After taking the measurement of the height of the inoculated eggplant, it was discovered that the height of the control plants are always higher than the susceptible varieties, other vegetative parts of the control plants are also more developed than the susceptible varieties. Stunted and poor vegetative growth was observed among the inoculated varieties as compared to the control plants.

Amosu and Franchoviak, (1994) Carried out similar research on tomato cultivars for resistance against *Melodogyne incognita* and discovered that some are susceptible while others are resistant to root-knot nematode infestation. The susceptible varieties of tomatoes showed stunted growth, poor vegetative growth and poor yield.

Although poultry dropping controlled root-knot nematode to some extent, yet chemical nematicides is the most important and reliable means of controlling root-knot nematode but could be toxic to plants at higher dose.

Conclusion

Root-knot nematode, *Meloidiogyne incognita* affect most vegetables such as tomatoes, Okra, Eggplants, pepper and spinach found in Dambo, Matusgi, Makera and Bakura areas of the Talata Mafara and Bukara local government areas of Zamfara state.
Five cultivars of eggplants, *Solanum Melongena* was tested to determine the effect of root-knot nematode, *Melodogyne incognita* on each variety. SMG1 var. Zaria was found most susceptible to root-knot nematode infestation, while SMG2 var. Ilorin was completely resistant to root-knot nematode infestation as there was no formation of galls on the root systems. Sections made from infected roots showed great damage done to the root cells. The cortical surface suffered damages such as cell wall breakdown, giant cell formation and formation of eight nuclei in a single giant cell. The damage done to the roots lead to the disruption of easy flow of nutrients to the plants and resulted into poor vegetative growth, poor yield, stunted growth and increased fresh root weight. Nematicide recorded the best control of root-knot nematode in this experiment as the overall root-knot index was brought to 1.1 against the root-knot index of 1.2 from the control plants but may be toxic to plants and man. Poultry dropping had significant effect on the control of nematode as it was able to suppress the activities of the root-knot nematodes.

Recommendations

Since this research is limited to only five areas of two Local Government Areas of Zamfara state, more research should be carried out to study the distribution of root-knot nematode, *Melodogyne incognita* and other species of nematode that are prevalent and attack various crops in the state.

This will enable farmers to be aware and concentrate on using resistant varieties instead of wasting time, money and energy on controlling diseases of susceptible varieties. Poultry dropping used in the research is limited to pot experiment and within a short period of time which may affect its efficacy. This should serve as baseline for farmers to use poultry droppings on their farms in order to control of root-knot nematodes thereby cutting down on the use of chemicals as they may be harmful to plants and man.

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