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Nematicidal Effect of Some Botanical Extracts for the Management of *Meloidogyne incognita* and on Growth of Tomato

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Authors' contributions

This work was carried out in collaboration among all authors. Author JIO, CIJ and AN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript managed the analyses of the study, managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Tomato (*Solanum lycopersicum* L.) is an important and widely grown vegetable crop all over the world. Although tomato is nutritionally and economically important, its production is constrained by biotic and abiotic constraints leading to poor marketable quantity and quality worldwide. Root-knot nematodes are one of the major pests affecting tomato production worldwide, especially, in the tropical and sub-tropical regions. Green house experiments were laid out in Complete Block Design (CBD) with a 3x7 factorial arrangement replicated three times carried out at the Department of Crop and Environmental Protection, University of Agriculture. The soil was sterilized before the experiment. Fresh leaves and seeds of *Moringa oleifera*, *Ricinus communis* and *Jatropha curcas* were washed with tap water, 15 g from each of leaves and seeds of the different botanicals was

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macerated separately in an electric blender at high speed for 4 minutes in 100 ml distilled water. The mixtures were passed through a Whatman filter paper number 1; the filtrates of the leaves/seeds were then collected. Three tomato varieties *viz*: Roma Vf, Rio Grande and UC82B were inoculated with approximately 5,000 freshly hatched second stage juvenile of *Meloidogyne incognita*, two weeks after transplanting. Thirty percent aqueous extract each of Castor, Moringa and Jatropha leaves and seeds was used, while double distilled water (0%) served as the control. Thirty ml of each leaf and seed aqueous extract was applied, 48 hours after inoculation as soil drench. Application was done at 1 weeks intervals thereafter for a period of 16 weeks. Data collected include number of fruits per plant, root gall index, nematode reproductive factor, and final nematode population. The results showed that various *Moringa oleifera*, *Ricinus communis* and *Jatropha curcas* leaves and seed extracts significantly ($P<0.05$) reduced root gall index, final population of *M. incognita* in the soil and nematode reproductive factor than the control. Application of the various treatments *Moringa oleifera*, *Ricinus communis* and *Jatropha curcas* led to significant increase in mean number of fruits and mean fruit weight yield of all the three tomato varieties. Therefore, the application of leaf and seed aqueous extracts of Moringa, Jatropha and Castor will serve as good alternative for the management of root knot nematode *Meloidogyne incognita*.

Keywords: Botanical extracts; M. incognita; tomato.

1. INTRODUCTION

Tomato fruit is an important source of minerals, essential amino acids, sugars, dietary fibers, and vitamins as it contains vitamin A as carotene, vitamin B1 (thiamin), B2(riboflavin), niacin and vitamin C [1]. Tomato seed contains 24 percent edible oil, used for manufacturing of salad creams, margarine and soap, the residual pressed cake is used for fertilizer and livestock feeding [2]. It is also found to have medicinal value as it is important in management and reduction of cancer risk [3].

Although tomato is nutritionally and economically important, its production is constrained by biotic and abiotic factors leading to poor marketable quantity and quality worldwide. Berlinger [4] identified nematodes as one of the major pests affecting tomato production worldwide, especially, in the tropical and sub-tropical regions. Ploeg [5] stated that plant parasitic nematodes attack seedling roots after emergence by affecting crop productivity. Sasser and Carter [6] reported that a lot of plant species such as tomato, *amaranth*, soy bean, yam tubers, cassava, maize, rice are prone to attack by the root-knot nematodes.

The need for farmers to adopt strategies that do not pollute the environment has increased urgency in the search for alternative sustainable methods to manage nematodes [7,8,9]. Alternatively, research has focused on antagonistic plants [10,11]. These compounds can be developed for use as natural nematicides or they can serve as model compounds for the development of derivatives with enhanced activity or environmental friendliness [12]. The objective of the study was to determine the effect of botanical extracts from leaves and seeds of *Moringa oleifera*, *Ricinus communis* and *Jatropha curcas* on root-knot nematode *Meloidogyne incognita* infecting three Tomato varieties.

2. MATERIALS AND METHODS

2.1 Experimental Layout and Location

The experiment was carried out at the Department of Crop and Environmental Protection Laboratory University of Agriculture, Makurdi, laid out in 3x7 factorial arrangement laid out in Completely Randomized Design (CRD) replicated three times.

2.2 Soil Sterilization

The Soil for the pot experiment was sterilized using the steam sterilization method, by a metal barrel steam sterilizer.

2.3 Nursery Preparations and Agronomic Practice

Tomato seedlings were raised in three different buckets containing sterilized soils for the three different varieties, the seeds of the various varieties were spread and soil lightly poured on the seeds about two inches was used to cover the seeds. Mulch was provided to protect the seeds from excessive sunlight and to serve as

moisture conserver. Watering of the young seedlings was done daily until when the seedlings were ready for transplanting.

2.4 Transplanting and Inoculation of Seedlings

Tomato seedlings were transplanted into 72 plastic buckets. Seven kg of sterilized soil was put into each plastic buckets. The seedlings were transplanted, four weeks after germination. Each of the tomato stands contained in the pots was inoculated with approximately 5,000 second stage juveniles of *Meloidogyne incognita*. Inoculation took place, one week after transplanting with the use of a pipette and by pulling away the soil around the roots 2 cm deep and 3 cm from the root. The juveniles were inoculated into the hole and the soil was gently covered. Each bucket contained one seedling.

2.5 Source and Preparation of Plant Aqueous Extracts

Seeds/leaves of Moringa, Castor and Jatropha were obtained from the University Research Farm.

Fresh leaves and seeds of Moringa, Castor bean and Jatropha were washed with tap water. Fifteen grams from each of leaves and seeds of the different plant (Castor, Jatropha and Moringa) was macerated separately in an electric blender at high speed for 4 minutes in 100 ml distilled water. The mixture was left for 12 hours (overnight). Each mixture was passed through a Whatman filter paper. Filtrates of the leaves/seed collected served as standard solution 'S' for the experiment.

2.6 Application of Treatments

The stands were treated with 30ml each of various leaves and seeds aqueous extracts, 48 hours after inoculation. The untreated seedlings/stand served as the controls. Application of *Moringa oleifera*, *Ricinus communis* and *Jatropha curcas* extracts was done at weekly intervals thereafter until harvest and the treatment replicated 3 times.

2.7 Harvesting of Tomato Plants

The tested plants were harvested when fully matured (16 weeks). To ensure easy removal of the plants from the soil, the sides of the plastic pots was pressed in order to loosen the soil. The soil was then removed from the roots by gently shaking the plants.

2.8 Data Analysis

Data collected were analyzed, using the Genstat statistical package (Discovery edition 7). Least significant difference (LSD) at 5% was used for comparing mean differences.

3. RESULTS

Table 1 shows no significant ($P \leq 0.05$) differences among the varieties on root gall index. However, there are differences ($P<0.05$) among the varieties in nematode final populations and reproductive factor, Roma VF recorded the highest final population and reproductive factor of 2228 J_2/200 g of soil and 0.45, while Rio Grande recorded the least population and reproductive factor of 1461J_2/200 g and 0.29, respectively.

On the mean number of fruits, there were no significant differences ($P>0.05$). However, differences ($P<0.05$) were observed on the mean fruit weight (kg/ha) with Rio Grande yielding, higher fruit weight of 39.63 closely followed by UC28Bwith 36.87, while the least was observed from Roma VF with 34.95.

There were significant differences ($P<0.05$) among the botanical extracts on root-knot nematode parameters and yield parameters (Table 2). Jatropha seed recorded the lowest root gall index of 1.00, while the control had a root gall score of 5.0 (>75% of the root system galled). The untreated control plant recorded the highest nematode reproductive factor (2.4) and final population of 11978.00 J_2/200 g of soil. Moringa leaf recorded the least final root-knot nematode population of 200 J_2/200g of soil. Similarly, Moringa leaf recorded 0.04 reproductive factors.

There were significant differences ($P<0.05$) on the mean number of fruit and fruit weight (kg/ha). Moringa leaf had the highest number of fruits/ plant and weight of fruit, 8.56 and 47.22, respectively. The control recorded the least number of fruits/plant (1.89) and fruit weight (17.51) (Table 2).

Table 3 shows that there were no significant differences ($P<0.05$) among the three varieties treated with different botanical extracts (leaf and seeds) on the root gall index, mean number

of fruits and fruits weight. However, there was significant difference between the treated and the untreated pots. With the control having the highest root gall index and lower mean number of fruits and fruit weight for all varieties. On nematode final population and reproductive factor however, significant differences were observed among the varieties treated with different botanical extracts. Plants treated with Jatropha leaves and seeds recorded the final population of 0.00 for both the three varieties as compared to their respective untreated control (10233, 15533.00 and10167.00 J_2/200 g of soil).

4. DISCUSSION

Scientists are resorting to use botanicals for the control of pest since synthetic pesticides are expensive and hazardous. The use of botanicals as control measures against plant parasitic nematodes is now the focus of researchers because they are eco-friendly, easy degradable, cost effective and easily available [13].

From this research, leaf and seed extracts from *Moringa oleifera*, *Ricinus communis* and *Jatropha curcas* have effect on final population of root-knot nematodes, root gall index and nematode reproductive factor as well as improved the growth and yield of root-knot nematode infected tomato in the screen house. [14] also, found that application of sesame seed extract reduced the incidence of root knot nematodes and the severity of galling on okra roots.

Report by Sowleya et al. [15] pointed out that *Moringa* leaf powder was not phytotoxic to sweet pepper plants but led to increase in plant growth, yield and even suppress nematode population.

Table 1. Root-Knot nematode final population, reproductive factor, root gall index and yield as affected by three tomato varieties in pot experiment

Varieties	Root-Knot nematode parameters				Yield parameters	
	Root Gall Index (RGI)	Initial Population (Pi)	Final Population (Pf)/200 g of soil	Reproductive Factor (RF)	Mean number of fruits	Mean fruit weight/pot(g)
UC28B	1.67	5000.00	1474.00	0.29	6.90	36.63
ROMA VF	1.71	5000.00	2228.00	0.45	6.95	34.87
RIOGRANDE	1.67	5000.00	1461.00	0.29	6.29	39.95
$FLSD_{0.05}$	ns	Ns	491.90	0.098	Ns	2.984

Each value is average of 3 replicates. NS= Not Significant, FLSD= Fishers Least Significant Difference

Table 2. Effect of botanical extracts on root-knot nematode final population, reproductive factor, root gall index and yield of infected tomato (ROMA VF,RIO GRANDE AND UC28B) in pot experiment

Botanical extracts	Root- knot nematode parameters				Yield parameters	
	Root Gall Index (RGI)	Initial Population (Pi)	Final Population (PF)/200 g of soil	Reproductive Factor (RF)	Mean number of fruits	Mean fruit weight/pot(g)
Castor Leaf	1.11	5000	230.00	0.05	7.33	44.41
Castor Seed	1.33	5000	260.00	0.05	7.56	37.32
Jatropha Leaf	1.11	5000	350.00	0.07	7.33	38.90
Jatropha Seed	1.00	5000	500.00	0.10	7.78	36.33
Moringa Leaf	1.11	5000	200.00	0.04	8.56	47.22
Moringa Seed	1.11	5000	450.00	0.09	6.56	38.36
Control	5.00	5000	11978.00	2.40	1.89	17.51
$FLSD_{0.05}$	0.28		751.40	0.15	1.53	4.56

Each value is average of 3 replicates. FLSD = Fishers Least Significant Difference

Table 3. Effect of botanical extracts on root-knot nematode final population, reproductive factor, root gall index and yield of tomato varieties in pot experiment

	Botanical extracts	Root-knot nematode parameters			Yield parameters	
		Root Gall Index (RGI)	Final Population (Pf)/200 g of soil	Reproductive factor (RF)	Mean number of fruits	Mean Fruit Weight/pot(g)
UC28B	Castor Leaf	1.33	22.00	0.00	8.67	48.60
	Castor Seed	1.00	28.00	0.01	6.67	38.77
	Jatropha Leaf	1.00	34.00	0.00	8.33	40.40
	Jatropha Seed	1.00	54.00	0.00	8.00	38.03
	Moringa Leaf	1.00	20.00	0.00	8.67	49.73
	Moringa Seed	1.33	12.00	0.00	6.00	40.33
	Control	5.00	10233	2.05	2.00	21.53
Roma VF	Castor Leaf	1.00	17.00	0.00	6.00	48.66
	Castor Seed	1.67	8.00	0.67	9.67	39.33
	Jatropha Leaf	1.00	7.00	0.00	7.33	33.29
	Jatropha Seed	1.00	5.00	0.00	6.33	35.54
	Moringa Leaf	1.00	27.00	0.01	9.00	50.20
	Moringa Seed	1.00	5.00	0.00	8.00	35.26
	Control	5.00	15533.00	3.11	2.33	15.80
Rio Grande	Castor Leaf	1.00	5.00	0.00	7.33	35.97
	Castor Seed	1.33	7.00	0.00	6.33	33.85
	Jatropha Leaf	1.00	65.00	0.00	6.00	35.85
	Jatropha Seed	1.00	55.00	0.00	9.00	43.00
	Moringa Leaf	1.33	38.00	0.01	8.33	43.40
	Moringa Seed	1.00	8.00	0.00	5.67	39.50
	Control	5.00	10167.00	2.03	1.33	15.20
	$FLSD_{0.05}$	Ns	1301.40	Ns	Ns	Ns

Each value is average of 3 replicates. NS= Not significant

Azhar and Seddiqu [16] Also stated that plant extracts of basil, marigold, *pyrethrum*, neem and china berry are were effective in the reduction of nematode population in soil. Fassuliotis [17] reported a reduction in number of egg masses, number of females and final larval population of the soil as a strong indication of the ability of neem leaf extract to control root-knot nematode in tomato.

According to Akhtar and Mahmood [18], sesame seed extracts have a systemic nematicidal activity against nematodes which may have accounted for the lower number of galls and mean population in treated plants. The study agrees with that of [19] who stated that the application of neem led to decrease in nematode population, reduced galling index leading to increase plant growth of the plots as compared to that of the untreated plants. Yasmin et al. [20] reported the extracts of neem seeds, leaves and barks had the ability to significantly suppress root galling index and reduce population of *M. javanica* juveniles on sweet gourd.

The reduction in population of root-knot nematode, nematode reproductive factor and number of root galls could be due to the ability of active ingredients present in the botanical extracts (Castor, Jatropha and Moringa) to get in contact with the second stage juveniles. This agrees with the findings of [12] that reported reduction on nematode final population and root galling on the root of sweet paper and attributed it to the direct contact of the extracts with the eggs and juveniles of the root-knot nematodes which ensured that the active ingredients in the Moringa leaf extracts were effectively delivered to the nematode. The reduction in the nematode final population may be due nematotoxic substances found in the different botanical extracts used. All extracts were effective in increasing yield of the three varieties of tomato as compared to the untreated pots.

The differences in the effectiveness of the different tested plant extracts could be due to the differences in the chemical compositions and concentrations of toxic components present in the plant material which achieved higher yield from the treated plants as compared to the untreated plants. This agree with the findings of [21] who stated that application of coffee (*Cassia occidentalis*) and lemon grass (*Cymbopogon citrates*) led to provision of the necessary nutrients required by the plant for optimum yield.

Root-knot infestation caused stunted growth of all untreated plants and reduced vigor as well as tomato yield, decrease in nematode final population accompanied by increase in yield of tomato plants might be due to the nematicidal potential of the tested plant extract. The effects of the tested plant extracts on yield of tomato plant were different, in some cases.

Galling and reproductive responses are important indicators of host plant reaction than just root-knot galling index. From this study, nematode multiplication rate was high in the untreated plots as compared to those treated by the different botanical extracts. This is in line with the findings of Bello et al. [22] who also reported a lower reproductive factor (Pf) in tomato when treated with *Crotalaria*, *C. juncea* and African marigold (*T. erecta*) plants. The finding of this studies agrees with Olabiyi and Oyedunmade [23] who pointed out that some natural plants can control root- knot nematode in the laboratory or when incorporated into the soil under field condition.

The results of this study is also in line with that of [24] who evaluated some botanical extract on nematode affecting cowpea. They pointed out that active ingredients contained in the plant materials suppressed the nematode populations in the field. Olabiyi et al. [25] Also reported similar findings of the efficacy of neem compost on nematodes in spinach. Several plants and organic materials have also been reported to contain different metabolites necessary for plant growth, better yield and at same time toxic to pathogenic microorganisms in the soil [26].

5. CONCLUSION

The botanical extracts (Castor, *Jatropha and Moringa*) leaves and seeds used were able to decrease nematode population, reduce root galling as well as reproductive factor and increase yield of the tomato varieties. The botanical extracts can therefore serve as alternative to synthetic nematicides.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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