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Research Article

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Use of Tick weed (*Cleome viscosa*) Extract and Powder to Control Rootknot Nematode (*Meloidogyne javanica*) on Tomato in Yola, Nigeria

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Abstract

This study conducted in the Modibbo Adama University Yola was aimed at determining the efficacy of *Cleome viscosa* leaf powder and extract on *Meloidogyne javanica* in Yola, Nigeria in 2022 and 2023. Extract of the powdered leaves of *C.viscosa* was diluted with distilled water to 95%, 90% and distilled water were used as treatments for both juvenile mortality and egg hatchability tests. The leaf powder of *C.viscosa* was thoroughly mixed with 14kg sterilized soil in perforated plastic pots into which tomato seeds were plant and 1000 J2 *M.havanica* juveniles were inoculated into soil of tomato seedlings that emerged. Data was collected and analyzed on percentage juvenile mortality and egg hatch inhibition. The 95% extract concentration treatment gave the highest juvenile mortality (60.33%) and least egg hatch (20%) after 92 hours of exposure to the extract. The 25g powder treatment produced the tallest tomato plants (58.67cm/58.33), the greatest number of fruits (115/114), least final nematode population (1,045.16/.161045.16), galling index (1/1) and reproductive factor (1.04/1.04) for both 2022 and 2023 respectively. *M.javanica* enjoyed unrestricted reproduction and galling of tomato roots as it has no extract or powder of *C.viscosa* to contend with. *C.viscosa* has proven itself to be capable of putting a check on *M.javanica* on tomato and can substitute chemical nematicides in control of the nematode. Field trials are recommended.

Keywords: *C.viscosa, Meloidogyne javanica,* juvenile mortality and egg hatch inhibition.

Introduction

Tomato (*Lycopersicon esculentus,* Mill.), a member of the family Solanaceaesub family Solanoideae tribesolaneae and genus Lycopersicon (Kodama, 2012), is an important vegetable crop cultivated worldwide and consumed in various forms(Quinet, 2023). The Food and Agricultural Organization (FAO, 2019), reported that tomato is the second most cultivated vegetable crop in the world after potato. Countries around the world exported a total of $9.1 billion US dollars in 2016 which represented 10.8% increase in the value of tomato shipment (Bird *et al.* 2010).

According to Sasser and Carter (1982), there are nematodes found worldwide and they target various annual and perineal plant species of economic importance. Root-Knot nematodes (*Meloidogyne* spp.) which belong to the family Meloidogynidae, in the order *Tylenchidia*,are important soil borne pathogens (Chitwood, 1949). Plant-parasitic nematodes present a formidable pest problem for various crops among various pests and diseases which damage crops, and root-knot nematode (*Meloidogyne* spp.) is key pest of vegetables (Nimbalkar and Rajurkar, 2009).

These nematodes may cause losses at 29% of yield (Mukhtar *et al.,* 2013) and are major limiting factors that suppress tomato productivity (Hussain *et al.,* 2011).This damage has continued as a result of ignorance of this pest's activities by the farming populace in developing countries like Nigeria. It has been observed in some countries such as Pakistan, that root-knot nematode infection is so common and wide-spread that galled roots are considered to be normal (Saifullah *et al.*, 1990).

Concerted efforts have been made to reduce the damaging activities of the rootknot nematodes including *M.javanica* on tomato and other plant species of economic importance to man. Control of RKN in tomato and other crops as demonstrated by researchers include: use of organic matter or soil amendment (Umar and Chubado (2009), Kago *et al.* (2013), Abolusoro *et al.* (2015), Das and Bahera (2019); use of plant oil extracts (Oka *et al.*(2000), Wani and Bhat (2012), Kong *et al.* (2007); use of antagonistic plants (Shaukat *et al.* (2002), Gommers and Bakker,(1988, Bhattacharyya, (2017); use of plant extracts (Sidhu *et al.* (2017), D'Errico *et al.* (2018), Thligene *et al.*(2019); Use of chemical nematicides (Soltani *et al.* (2013), Yeon *et al.* (2019); use of biological control agents (Ajitomi *et al.* (2018), Abd El-Rahman *et al.* (2019), Ahmed and Monjil (2019), Wille *et al.* (2019) and other methods. This work was carried out to test the efficacy of the leaf extract and powder of Cleome viscosa (Tick weed) in reducing the damaging activities of *M.javanica* in Yola, Adamawa State, Nigeria.

Materials and Methods

Experimental Site: The experiments were conducted at the laboratory (egg hatchability and juvenile mortality test) and Screen house of the Department of Crop Protection, Modibbo Adama University (MAU), Yola. The test for presence of phytochemicals was conducted at the laboratory of the Department of Biochemistry, MAU, Yola.

Preparation of Plant Powders and Extracts

The leaves of *Cleome viscosa* (tick weed), were sourced within and around the environment of Modibbo Adama University, Yola. The plant was identified at the Department of Forestry MAU, Yola.

The leaves were prepared using the method described by Kaskavala (2007) and Umar and Mohammed (2013). The leaves were shade-dried on a clean polythene sheet in the laboratory for seven days after which it was ground to powder using mortar and pestle. Using a digital weighing balance, 10 g of the leaf powder was weighed and soaked in a conical flask containing 100 ml distilled water and left to stand for 24 hours. The extract was then filtered using Whatman No. 1 filter paper to obtain 100% undiluted concentration or crude extract (C). Ten millilitres(10ml) of the crude extract were serially diluted with distilled water. There were four treatments as follow: C1 = 95% concentration, C2 = 90% concentration,C3 = 85% concentration and C4 = Control (Distilled water).

Egg Hatchability Test

Root knot nematode egg hatchability test was determined using the method described by Ononuju and Nzenwa (2011). Nematode egg suspension at approximately 100 eggs/ml was introduced into each of 15 petri dishes followed by the addition of the different concentration of the plant extracts and distilled water as control. Completely random design was used for the egg hatchability test which comprised of twenty-one treatments and replicated three times in the laboratory. The eggs that hatched were observed under the microscope at intervals of 24 hours for 96 hours and counted.

Juvenile Mortality Test

Using a 10 ml syringe, 10ml each of the leaf extract was taken and diluted to 5ml, 10ml, and 15ml of water-soluble plant extracts of *Cleome viscosa* were dispensed separately into each Petri dishes containing approximately 100 second stage Juveniles (J_2) of *M. Javanica* in 10ml of distilled water. The experiment consists of five treatments and replicated three times and was laid in a Completely Randomized Design (CRD). Dead nematodes were identified by touching them with a needle under a binocular electric microscope to observe wither they exhibit mobility or not. Nematodes were considered dead when immobile. The mortality was observed after 24, 48, 72, 96 hours (Rakesh, 1990).

Screen House Experiment

The potted experiment was carried out at the screen house of Modibbo Adama University (MAU), Yola. Sandy loam soil was collected from the landscape garden of MAU, Yola and steam sterilized at 60^{o}C for 45 minutes and 14 kg of the soil was weighed using top pan loading balance and put into each of 12 perforated plastic buckets. There were four treatments replicated three times and laid out in a completely randomized design (CRD). Leaf powder of *C.viscosa* was incorporated into the soil in the pots in treatment levels as follow: T1 = 5 g, T2 = 10 g, T3 = 15 g and T4 = Control (No powder). The pots were watered. After two weeks, one-week old seedlings of tomato (Roma VF variety) previously raised in the nursery, were transplanted into the pots at the rate of two seedlings per pot and thinned down to one seedling per pot one week after transplanting.

The second stage juviniles(J_2s) were extracted and used to inoculate all the potted plants in the screen house with approximately 1000 J_2 of *M.javanica* contained in 20ml suspension. The second stage juviniles J_2 suspension was applied at the base of each plant three weeks after emergence of the seedling using 20ml disposable syringe. ll other agronomic practices were applied as required.

After harvest, soils from similar treatments were pooled together and thoroughly mixed; 250cm^3 of the soil was measured in a beaker and used for final nematode extraction through the method described by Whitehead and Hemming (1965).Gall index was determined using the rating scale of Anwar *et al.*(2007) as follows: 0= no galls, 1 =1 - 2 galls, 2=3 – 10 galls, 3 = 11 – 30 galls, 4 =31 – 100 galls and 5 = >100 galls.

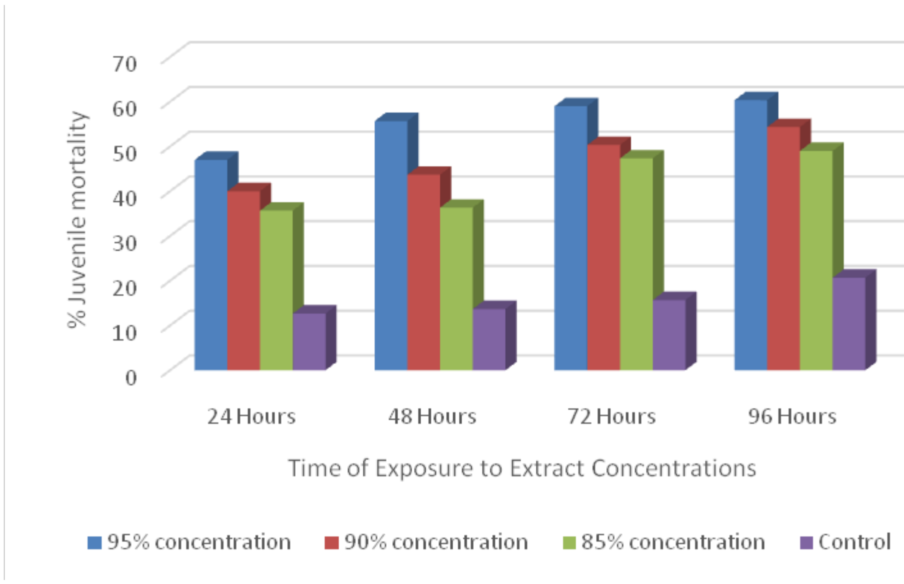
Data were collected on some growth, yield and nematode parameters**.** Data collected were subjected to analysis of variance (ANOVA) using SAS procedures and the Standard Error of the Mean (SEM) was used for mean separation.

Results

Results of the juvenile mortality showed that after 24 hours of exposure of *M.javanica* juveniles to *Cleome viscosa* extract concentrations, the 95% concentration recorded the highest mortality of the juveniles (47%), followed by the 90% concentration with 40%. The difference between these two concentrations is not is not significant (p=0.05) but both are significantly higher than 85% concentration (35.67%) which significantly (p=0.05) higher than control (12.67%) and least.

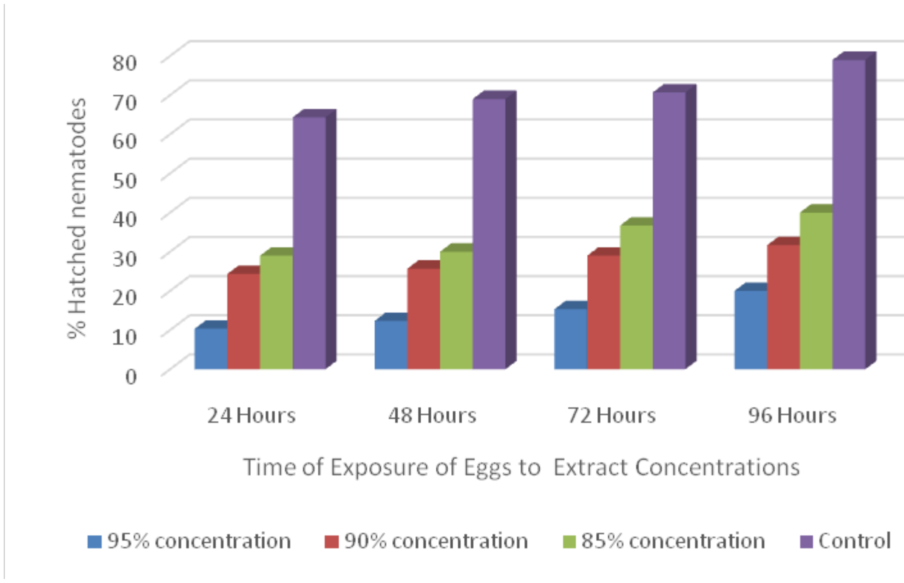
After 48 hours of exposure to *C. viscosa* extract concentrations, juvenile mortality increased for each treatment with the 95% concentration recording significantly (p=0.05) higher mortality (55.67%) than all other treatments followed by 90% concentration (43.67%) and least was control (13.67%). There was also increased mortality of juveniles through the 72 hours up to the 96 hours of exposure of juveniles to the extract concentrations. After 96 hours of exposure, the 95% extract concentration recorded the highest mortality of juveniles with 60.33% followed by the 90% concentration (54.33%) and least was control with 20.67% (Fig.1).

Fig. 1: Effect of Leaf Extract of *C. viscosa* on Mortality of *M. javanica* Juveniles



Results of the egg hatchability test in Fig. 2 showed that after 24 hours of exposure of *M.javanica* juveniles to *Cleome viscosa* extract concentrations, the 95% concentration recorded the highest mortality of the juveniles (47%), followed by the 90% concentration with 40%. The difference between these two concentrations is not is not significant (p=0.05) but both are significantly higher than 85% concentration (35.67%) which significantly (p=0.05) higher than control (12.67%) and least. After 48 hours of exposure to *C. viscosa* extract concentrations, juvenile mortality increased for each treatment with the 95% concentration recording significantly (p=0.05) higher mortality (55.67%) than all other treatments followed by 90% concentration (43.67%) and least was control (13.67%). There was also increased mortality of juveniles through the 72 hours up to the 96 hours of exposure of juveniles to the extract concentrations. After 96 hours of exposure, the 95% extract concentration recorded the highest mortality of juveniles with 60.33% followed by the 90% concentration (54.33%) and least was control with 20.67% (Fig.2).

Fig. 2: Effect of Leaf Extract of *C. viscosa* on *M. javanica* Egg Hatch Inhibition



Results for the pot experiment is given in tables 1 and 2 below. For vine length, results show that the 15g *C.viscosa* treatment produced tomato plants with longer vines than all other treatments for both 2022 and 2023 (58.67 cm and 58.33 cm respectively) followed by the 10g treatment at 51.33 cm and 50.67 cm for both years respectively. The difference between 15g and 10g *C.viscosa* powder treatments was not significant (p=0.05) but was highly significant for when compared to the 5g treatment and control which produced the shortest plants with 21.30 cm and 22.03 cm in both years (Table 1).

For number of leaves, results show that tomato plants treated with 15g *C.viscosa* powder produced significantly (p=0.05) more leaves than all other treatments for both 2022 and 2023 (54.20 and 53.01 respectively) followed by the 10g treatment with 41.30 and 40.66 for both years respectively. The least was control with 23.30 and 23.66 leaves for both years respectively (Table 1).

In 2022 and 2023, tomato plants treated with 15g and 10g of *C.viscosa* powder produced significantly (p=0.05) higher number of fruits than all other treatments though the difference between them was not significant. The 15g treatment recorded 115.00 and 114.00 fruits followed by 10g treatment (95.00 and 97.00 fruits) and least was control with 25.00 and 26.00 fruit in 2022 and 2023 respectively(Table 1).

Table 1: Effect of *C.viscosa* leaf powder on *M.javanica* on Some Parameters of Tomato

Parameters	VL (cm)		NL		NB		NF	
Treatments	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
5 g	33.67	34.00	35.50	34.06	13.66	13.33	54.00	52.00
10 g	51.33	50.67	41.30	40.66	15.13	16.03	95.00	97.00
15 g	58.67	58.33	54.20	53.01	20.33	21.03	115.00	114.00
Control	21.3	22.03	23.30	23.66	9.66	10.33	25.00	26.00
SEM (±)	8.46	8.17	6.41	6.14	2.21	2.27	20.22	20.21

VL-Vine length, NL-Number of leaves, NB-Number of branches, NF-Number of fruits, SEM-Standard Error of the Mean

The highest population of *M.javanica* was recorded by the control which had significantly (p=0.05) more final nematode population of 20,772.60 and 20,903.20 nematodes (2022 and 2023 respectively) than all other treatments. This was followed by 5g treatment with 3,527.42 and 3,658.06 nematodes, 10g treatment (2,482.26 and 2,612.90) and least was 15g treatment with 1,045.16 and 1,045.16 nematodes in both 2022 and 2023 respectively. There was no significant difference between the three levels of powder treatments (Table 2).

Control treatment produced significantly (p=0.05) more galls than all the other treatments that received *C.viscosa* powder in 2022 and 2023 with 5 and 5 galling indices respectively. The 5g *C.viscosa* powder treatment was next to control with 3 and 3, 10g treatment with 2 and 2 and least was the 15g treatment with 1 and 1 galling indices all for2022 and 2023 respectively (Table 2).

Result of the reproduction factor (RF) showed control recorded significantly (p=0.05) higher (RF) of 20.77 and 20.50 in 2022 and 2023 respectively followed by 5g treatment (3.52 and 3.65, 10g treatment (2.48 and 2.61) and least was 15g treatment with 1.04 and 1.04 (Table 2).

Table 2: Effect of *C.viscosa* leaf powder on *M.javanica* on Some Parameters of Tomato

Parameters	FW		FNP		GI		RF	
Treatments	2022	2023	2022	2023	2022	2023	2022	2023
5 g	35.3	34.66	3527.42	3658.06	3	3	3.52	3.65
10 g	59.67	60.54	2482.26	2612.90	2	2	2.48	2.61
15 g	72.23	71.33	1045.16	1045.15	1	1	1.04	1.04
Control	25.3	24.66	20772.6	20903.2	5	5	20.77	20.90
SEM (±)	10.80	10.89	4633.25	4647.24	0.85	0.85	4.63	4.64

FW-Fruit weight, FNP-Final nematode population, GI-Galling index, RF-Reproduction factor, SEM-Standard Error of the Mean

Discussion

From the juvenile mortality test result, it can be seen that more *M. javanica* juveniles were killed by C. viscosa extracts than by control and as exposure time increased, the percentage mortality also increased. This is also the case presented by other workers (Umar and Mamman, 2014; Aji *et al*., 2019; Mamman, 2023). Extracts of eucalyptus, cinnamon and nerium recorded maximum mortality of juveniles (100, 97.1 and 95.6%) respectively whereas garlic had minimum mortality % (65.2%) in 10% concentration, while the control had significantly reduced mortality of juveniles (13%) from other treatments in both concentrations (Hussein *et al,* 2016).

The study shows that phytochemicals contained in the leaves of *C. viscosa* were able to act against *M.javanica* eggs and inhibit their hatching thereby reducing their population which in the soil, made room for the plants to grow and give good yield. The inhibitory effect of extracts may have resulted from the presence of chemicals in the extracts that possess ovicidal and larvicidal properties (Mohammed, 2022).

Result of the pot experiment showed that application of leaf powder of *Cleome viscosa* caused reduced reproduction factor and galling and consequently a lowering of the final nematode population. In the control whose soil received no powder/amendment, *M.javanica* had a free rein and reproduced to such high populations compared to those treatments that received powders of *C.viscosa.* The result also showed that as the level of powder increased, the lower the galling index, reproduction and fanal nematode population. This is similar to work done by many other workers on use of amendments for the control of *M.javanica* and other rootknot nematodes.

Brassica tissue treatments at 1908 g and 5292 g and the other treatments suppressed nematode population during the third season compared with the control treatment that recorded an increase in nematode population (Kago *et al.,* 2013).In a nematode-infested sugarcane field, among organic amendments tested, neem cake recorded the maximum reduction of nematode population density (89.36%) and the cotton seed oil cake (60.84%) the minimum, compared with control treatments (Mohan, 2011).Thermally degraded products of fresh *Cymbopogon citratus* (CMGC/th/fresh) was the most promising at 90 mg/mL and could be used in place of the toxic synthetic nematicide (Fabiyi *et al.*, 2018).Cabbage and Cauliflower leaves used in pot experiments against plant parasitic nematode population infecting okra resulted in reduction of root knot nematode (40.7%), lance nematode (40.8–80.1%), spiral nematode (49.1–79.7%) and stunt nematode (40.8–81.3%) with improvement of plant growth parameters like shoot length (23.3–54.6%), root length (14.1–46.5%), fresh shoot weight (28.4–81.9%), fresh root weight (22–38.7%), dry shoot weight (11.6–85.7%) and dry Root weight (24–39%) of okra plants as compared to untreated control (Das and Bahera, 2019). A combination of poultry manure and neem leaves recorded the lowest nematode populations (464, 369 and 289) larvae/ 200 g soil at 30, 60 and 90 days respectively when compared with the control (Cookey *et al.,* 2019).

Conclusion and Recommendations

The study concluded that the leaf extract and powder of *Cleome viscosa* was able to reduce the harmful activities of *Meloidogyne javanica.* The 95% concentration treatment gave the highest juvenile mortality and egg hatch inhibition while the 25g powder treatment produced the best growth and nematode parameters on tomato. Field trials should be conducted to see how well the *C.viscosa* leaf extract and powder perform in the field

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