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Management of Root-Knot Nematode (*Meloidogyne Javanica*) with Leaf Powder of Waltheria Indica (*Velvet Leaf*) on Okra (*Abelmoschus Esculentus L*)

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Abstract:
The research was conducted to find out the effect of Waltheria indica (Velvet leaf) on the management of root-knot nematode under screen house condition. Twelve perforated 20cm diameter plastic pots containing 4 kg sterilized loamy soil 50g/pot, 40g/pot, 30g/pot of Waltheria indica powder incorporated into them except the control pot. Okra seed of Wemson spineless were plant into the pots and inoculated with 1000 M. javanica juveniles one week after emergence. The results of the experiment showed plant treated with 50g/pot recorded the highest mean plant height (32.50cm), number of leaves (10.00), number of fruit (15.00), fruit weight (12.10g). It also recorded the lowest nematode population (81.00) and galling index (2.00). It was then concluded that W. indica leaf powder had nematicidal potential. Based on these findings, it is recommended that field studies should be tried under natural condition to ascertain the effectives of plant on M. javanica.

Keywords: *M. javanica, Juveniles, Waltheria indica, Powder*

1. Introduction

Okra (*Albelmoschus esculentus* (L.) Moench) is a flowering plant belonging to the family Malvaceae (Mallow family) (NRC, 2006). It is an annual crop grown mainly as a fruit and leafy vegetables in the tropics (Tiamiya *et al.,* 2012). It is an upright plant with a hibiscus-like flower (Smith *et al.,* 2002), grown in tropical and warm temperate climates (Ijewere, 2012). It is widely distributed in the tropical and sub-tropical regions from Africa to Asia, Southern Europe, the Mediterranean countries and the Americans (Andras, *et al*., 2005). Okra is widely cultivated and can be found in almost every market all over Africa (Schippers, 2000).

Okra is an important constituent of most local dishes in West Africa. It is grown mainly for the leaves and young pods which are frequently eaten as green vegetable. The young immature fruits are important fruit vegetable that are consumed in different form which can be sliced, dehydrated and preserved as dry okra for later use. It is used as a soup thickener and may also be served with rice and other food types (Tiamiyu *et al.,* 2012). Okra contains carbohydrates, protein and vitamin C in large quantities. Others are Iron, Magnesium and Phosphorus with essential and non-essential amino acids which is comparable to that of Soyabean (Adeboye and Oputa, 1996). Farrog *et al.,* (2010) reported that Okra seeds contain greenish-yellow edible oil which is suitable for use as a bio-fuel.

A notable bio-constraint in the production of okra is the plant-parasitic nematode (Saffiudin *et al.,* 2011). Phytonematodes cause loss of yield and quality okra which indirectly reduces as the economic value of the crop (Saffiudin *et al.,* 2011). Root-knot nematode (*Meloidogyne* species) have been reported as one of the major plant-parasitic nematodes on okra and are responsible for about 70-90% yield losses (Adesiyan and Akinlade, 1982; Saffiudin *et al.,* 2011).

Root-knot nematodes can be managed effectively chemicals, biological control agents.Addition of organic matter will decrease nematode population in the soil (Walker, 2004). However, use of synthetic chemical develops resistance in the pathogens and have hazardous effect on the environment, there is increasing demand for environment-friendly nematicides with low toxicity and short-term persistence (Vermis and Roberts, 1996). Therefore, alternative management strategies are needed for the control of the phytonematodes. The incorporation of plant parts or extracts into the soil alone or in combination with other biocontrol have been suggested as an alternative, safe and effective control method for the management of phytonematodes (Siddiqui and Alam, 1985). The present study was conducted to manage root-knot nematode *Meloidogyne javanica* on okra with leave powder of *Waltheria indica*.

2. Materials and Methods

2.1. Experimental Site

The experiment was carried out in the screenhouse of Department of Crop Protection, Modibbo Adama University of Technology, Yola, Nigeria. According to Bashir (2000), Yola lies between latitudes 8°N and 11` N and longitude 11.5°E and 13.5°E and at an altitude of 185.9m above sea level.

2.2. Phytochemical Analysis of Waltheria Indica (Velvet Leaf)

Phytochemical analysis of the plant material was carried out in the laboratory to identify the constituents of Alkaloids, Tanins, Saponins, Flavonoids and Phenols using the methods described by Trease and Evans (1989) and Sofowora (1993).

2.3. Sterilization of Soil

Sandy loam soils were collected from bank of River Benue which was sieved to remove gravels, stones and plants debris with a 2mm mesh sieve. The soil was poured into a metal drum and pasteurized for four (4) hours at 60°C with regular turning at 15minutes interval (Gautan and Goswami, 2007).

2.4. Source and Preparation of Waltheria Indica Leaf Powder

Fresh leaves of *W. indica* (*Velvet leaf*) was sourced around Teaching and Research Farm of the Department of Crop Protection, Modibbo Adama University of Technology, Yola and shed-dried on large polythene. The plant material was then ground into powder using pestle and mortar and was stored in air tight container.

2.5. Incorporation of W. Indica Powder and Experimental Design

Four (4 kg) of the sterilized soil that was allowed to cure for two (2) weeks contained in 20cm diameter perforated plastic pots were separately mixed with *W. Indica* leaf powder at 50g/pot, 40k/pot, 30g/pot and 0g/pot. This was done two (2) weeks prior to planting to allow decomposition of the powder. The layout was Complete Randomized Design (CRD) with four treatments replicated three times using a total twelve (12) pots.

2.6. Planting of Okra Seeds

Okra seeds (Klemson spineless variety) were planted at the rate of two seeds per pots and thinned down to one plant per pot. Agronomic practices like weeding irrigation were carried out as required.

2.7. Extraction and Inoculation of Meloidogyne Javanica

The inoculum for this experiment were second stage juveniles (j_2) *M. javanica* extracted from pure culture on infested roots. The extraction was done using the methods described Whitehead and Hemming (1965). The inoculation was done by removing soil from the root zones to expose the roots and about 1000 juveniles (J_2) of *M. javanica* were dispensed into root zones of the Okra seedlings. One week after sowing using a 10ml syringe.

2.8. Data Collection

Data were collected on plant height (cm), number of leaves, number of fruits per plant, fruit weight (g), fresh shoot weight (g) and dry shoot weight (g), fresh and dry root weight (g), galling index and final nematode population. All data were subjected to the analysis of variance (ANOVA) and means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of probability. Analysis of data was done using SAS Version 2001.

3. Results and Discussion

3.1. Mean Plant Height (cm)

The results of the experiments are presented in Table 1-2. Data on plant height showed that plants treated with *W. indica* powder gave the tallest plants. The significantly taller plants were observed in Okra treated with 50g of *W. indica*, followed by 30g treated plants and least plant height was shown in the control. This may be due to the decomposition of the *W. indica* powder and slow release of the phytochemicals (Alkaloids, Tanins, Saponins, Flavonoids and Phenols) (Table 1) and nutrients. This result is in agreement with those of Oyeke *et al*., (2014) who reported that application of *Hyptis Suaveolens* as soil amendment reduced the pathogenicity of *M. javanica* and improved the growth parameters of African Yam Beam *Sphenostylis stenocarpa*. The least plant height was observed in the control plants which is an indication that the nematodes deprived the plants of available nutrients which resulted in their poor growth. Khalid (2013) reported that common symptoms of infestation with root-knot nematodes are stunting, yellowing and wilting, but the major symptoms is gall formation in the plant roots.

3.2. Mean Number of Leaves

Mean number of leaves results indicated there was significant difference between the treated and untreated okra plants (Table 2). Plant treated with 50g of *W. indica* powder had the highest number of leaves. This was due to ability of *W. indica*powder to suppressed nematodes as a result of phytochemicals (Table 1) and subsequent release of nutrients that translated into increase number of leaves. The 40g and 30g of *W. indica* treated plants had a smaller number of leaves were in the untreated control plant (Table 2). This agrees with the finding of Mohammed and Umar (2012) who reported

that there was significant increase in plant height and number of leaves of okra plants treated with garlic, lemon grass, onion and Tridax than the untreated control.

Components	Qualitative
Tanins	+
Saponins	+
Flavonoids	+
Alkaloids	+
Phenols	+
Glycosides	-
Steroids	-

Table 1: Phytochemical Composition of Waltheria indica
Key: + = Slightly present, - = Absent

3.3. Mean Fresh and Dry Shoot Weight

Fresh and dry shoot weight results showed that treated plants had the highest mean fresh shoot and dry weight and the least in the control plants (Table 2). This may attribute to ability of the powder that inhibited the *M. javanica* juveniles from attacking the roots, thereby allowing the roots to translocate water and nutrients to the upper parts of the plants. The result of this study corroborates with those of Sajid *et al*. (2011) who reported that plant extracts of neem applied as root treatment improved shoot weight of tomato grown on *M. incognita* infested soil. The control plants on the other hand recorded lower fresh and dry shoot weight (Table 2) which resulted in stunted growth as a result of plant parasitic nematode infestation.

3.4. Mean Fresh and Dry Shoot Weight

The results of mean fresh and dry root weight indicated that the control had the highest mean fresh and dry root weight (Table 2). This could have happened because of the presence of galls which were caused by nematode feeding on the roots.Ojo and Umar (2013) in their studies on the effect of two botanicals, oil palm fibre and cocoa bean test in the control of root-knot nematode on tomato revealed that control plants recorded the lowest growth rates, high galling due to nematode activity at root zone resulting in giant cell formation, high population of nematode because the nematodes larvae were able to penetrate roots freely and reproduce without any inhibition. Gall formation is a diagnostic symptom of root-knot nematode infestation (HAL, 2014). Lower fresh and dry root weight were observed in the treated plants (Table 2). However, the least mean fresh and dry weight were observed in 50g *W. indica* treated plants this was as a result of few galls on the roots of the plants which signifies that 50g *W. indica* powder was more effective than the other treatments.

Treatments (g)	PH (cm)	NL	FSW (g)	DSW (g)	FRW (g)	DRW (g)
30	27.67^{ab}	8.00^{b}	34.48^{b}	6.18^{b}	3.67^{b}	1.32^{b}
40	28.36^{ab}	8.00^{b}	39.64^{b}	6.76^{b}	3.65^{b}	1.32^{b}
50	32.50^{a}	10.00^{a}	50.24^{a}	8.88^{a}	2.32^{c}	0.71^{c}
Control	18.44^{c}	7.00^{c}	17.03^{c}	3.02^{c}	4.55^{a}	2.15^{a}
S.E	5.89	3.17	12.79	0.24	0.06	0.006

Table 2: Effect of Different Levels of W. Indica Powder on Growth Parameter of Okra Plant Infested with M. Javanica Mean in the Same Column Followed by the Same Letter Are Not Significantly Different According to Duncan's New Multiple Range Test at $P \leq 0.05$
Key: PH = Plant Height, NL = Number of Leaves, FSW = Fresh Shoot Weight, DSW = Dry Shoot Weight, FRW = Fresh Root Weight, DRW = Dry Root Weight; S. E. = Standard Error

3.5. Mean Fruit Weight

Fruit weight results revealed that plants treated with 50g *W. indica* powder were higher than the rest of the treatments ($P \leq 0.05$) (Table 2). The mean fruit weight increased as quantity of *W. indica*powder increased, the control plants that received no powder recorded the lowest mean fruit weight. This suggests that*W. indica*suppressed the activities of root-knot nematode and that resulted in higher yield weight of Okra than the untreated (control). In a similar studies Onyeke *et al.,* (2014) reported the presence of certain phytochemicals (Terpenoids, Saponins, Tanins, Phenols, Flavonoids, Alkaloids, Resins, Glycosides and volatile oil) in the leaves of *Hyptis suaveolens* could be responsible for the reduction in the *M. javanica* population and reproduction on African Yam Bean.

3.6. Mean Number of Fruits

Result on mean number of fruits indicated the presence significant difference between the treated plants and the untreated plant (Table 2). Plants treated with 50g of *W. indica*powder had the highest number of fruits which may not be unconnected with the decomposition of the *W. indica*powder which help in nematodes suppression and promote the performance of the plant to produce more fruits. This is in line with studies of Khalil (2014) which stated that the composition of products from soil amendment are directly toxic to plant nematodes and manipulation of soil amendment initiates a cascade of events favoring the build-up of bacteria, nematodes trapping fungi and other soil antagonist that destroy parasitic nematodes. In this study, the untreated (control) plant had least number of fruits due to nematode

activity at root zone, which affected the performance of the roots which resulted in low yield. This agreed with the finding of Olabiyi (2008) who reported that *M. incognita* suppressed the growth and yield of tomato.

Treatments (g)	NF	FW (g)	GI	NP
30	12.00^{b}	8.69^{b}	4.00^{ab}	170.00^{b}
40	13.00^{b}	8.81^{b}	3.00^{b}	117.00^{c}
50	15.00^{a}	12.10^{a}	2.00^{c}	87.00^{d}
Control	6.00^{c}	4.67^{c}	5.00^{c}	1500.00^{a}
S.E	0.31	0.33	0.14	23.89

Table 3: Effect of Different Levels of Waltheria Indica Powder on Yield and Nematode Parameter on Okra Plant Infested with M. Javanica
Key: NF = Number of Fruit, FW = Fruit Weight, GI = Gall Index, NP = Nematode Population, SE = Standard Error of Mean

3.7. Mean Galling Index

The untreated control plants recorded the highest mean galling index (Table 3). This was due to lack of *W. indica* powder on the roots of the control plant which served as a deterrent. The nematodes were able to penetrate the plant roots and feed freely and produced all which lead to formation of higher gall index in the control. Similar observation was made by Umar (2009) where he recorded highest gall index of 5.0 in untreated cowpea in his studies of effect of locust bean leaves and bark on the control of *M. incognita* on cowpea.

The least galling index was observed in plants treated with 50g *W. indica* powder followed by 40g of the powder. This was due to the effectiveness of *W. indica* powder in inhibiting nematodes activity in the roots of okra and the phytochemicals present in the powder (Table 3).

3.5. Mean Final Nematode Population

The results on final nematode population revealed that the untreated plants recorded highest nematodes population (Table 3). This could be due to non-incorporation of *W. indica* powder which resulted in nematodes being free to penetrate, feed and reproduce within the roots of the control plants. This is in line with studies of Wondimench *et al.,* (2013) who reported that application of botanicals reduced the formation of galls in tomato roots, number of eggs and final nematode density in soil infested with *M. incognita*. Final nematode population was however lower in the treated plants which could be attributed to the bioactivities of *W. indica* powder which increased organic matter, nitrogen and possibly other nutrients and the phytochemicals (Table 1) released from the powder. Soil amendment with rice husk, saw dust cow urine, cow dung significantly reduces the reproductive factor and root-knot nematode *M. incognita* population and increase growth parameters of tomato (Nagaraju *et al.,* 2010).

4. Conclusion

In conclusion, *Waltheria indica*leaf (Velvet leaf) powder at different levels (50, 40 and 30g) were able to control *M. javanica* on okra in the screenhouse, among the treatment'sapplication of 50g was the most effective. Therefore, evident by findings of this study, *W. indica*leaf powder has nematicidal potentials. Hence, we recommend that further field studies should be tried under natural condition to ascertain the effectiveness of the plant.

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