INTERNATIONAL JOURNAL OF PHYTOFUELS AND ALLIED SCIENCES
(A Journal of the Society for the Conservation of Phytofuels and Sciences)
HD(http://www.phytofuelsciences.com) (ISSN 2354 1784)

The Potency of *Moringa oleifera* and *Jatropha curcas* Leaf extracts as Control for Root - Knot Nematode in Maize (*Zea mays*)

Izuogu, N.B.[1*], Badmos, A.A[2], and Raji, S.O.[1]

[1]Department of Crop protection; [2]Department of Animal Production, University of Ilorin

***Corresponding author:** Email: nkbetsyizuogu@yahoo.com

ABSTRACT

This study, using a 2 x 2 factorial design, was conducted to assess the potency of *Moringa oleifera* and *Jatropha curcas* as a biological control for root - knot nematode in Maize. Two varieties of maize (Early white DT quality protein maize hybrid variety and Extra early yellow DT quality protein maize) were each planted and inoculated with 3000 root-knot nematodes (*Meloidogyne incognita*) juveniles. The total number of pots used for the experiment was forty. Five plants each from the two maize varieties were treated with aqueous leaf extracts of *M. oleifera* and another set treated with *J. curcas* two weeks after planting, giving a total of twenty pots. The remaining half which did not receive treatment served as control. Plant growth parameters including plant height and number of leaves were recorded on weekly basis while the final soil nematode population and root gall indices were done at the termination of the experiment. Phytochemical screening of the plant extracts was also conducted. Results of phytochemical test showed that *M..oleifera* contains saponin, tannins, alkaloids, steroids and reducing sugars while *J. curcas* contains saponins, alkaloids, flavonoids, steroids, and reducing sugars. Growth parameters of plants treated with *M. oleifera* performed better ($p>0.05$) than plants treated with *J. curcas* while the untreated control plants recorded least growth. There were no statistical differences between the soil nematode population for both treatments, although visual observation showed that soil nematode population was lower in *J. curcas* treated soils than the *M. oleifera* treated soil. Thus, it is recommended that *M. oleifera* and *J. curcas* extracts be adopted for root – knot nematode control for maize production in the study area.

Keywords: Flavonoids, *Jatropha curcas, Moringa oleifera,* Reducing sugars,Saponin, Steroids,Tannins

INTRODUCTION

Maize or Corn (*Zea mays*) is a grain that is widely cultivated throughout the world, and a greater weight of this grain is produced each year than any other grain. Maize is the most important cereal crop in Sub-Saharan Africa and an important staple food for more than 1.2 billion people in Sub-Saharan Africa and Latin America. All parts of the crop can be used for food and non-food products. In industrialized countries, maize is largely used as livestock feed and as a raw material for industrial products. Maize accounts for 30−50% of low-income household expenditures in Eastern and Southern Africa (Olaniyi and Adewale 2012).

Major problems limiting the agronomy of Maize, however, are pests and diseases among which are plant parasitic nematodes. Many species of plant parasitic nematodes feed on maize, being commonly found anywhere that maize is grown.Nematodes account for an estimated 14% of all worldwide plant losses, which translates into almost $100 billion dollars annually. By far, root-knot nematodes are the most common and destructive nematode pathogens (Milkowski and Abawi, 2003).

For the past 50 years nematodes have been effectively controlled using chemical nematicides, (Anastasiadis *et al.*,2008). Most fumigant nematicides, however, have been banned by the Environmental Protection Agency as environmental toxins with the exception of 1,3 dichloropropene (Telone II), chloropicrin (tear gas), and dazomet (Basamid) (Mehrotra and Ashork, 2003). The adoption of alternative control measures in the use of botanicals, such as *Jathropha curcas* and *Moringa oleifera*, which are in-expensive, is therefore imminent.

The *Moringa oleifera* is a small, fast growing, drought resistant deciduous tree that ranges in height from 5-12 m with an open, umbrella shaped crown, straight trunk (10-30cm thick) with corky, whitish bark. The foliage has leaflets 1–2cm in diameter; the flowers are white or cream colored. The fruits (pods) are initially light green, slim and tender, eventually becoming dark green, firm and up to 120 cm long, depending on the variety (Martin, 2000). Fully mature, dried seeds are round or triangular shaped, the kernel being surrounded by a lightly wooded shell with three papery wings. It has a long, tuberous tap root that grows very deep into the soil to absorb water and mineral salts from the sub soil. This enables the plant to survive in dry seasons. Thus, *Moringa* plants remain evergreen. It flowers at least four times a year starting from January and produces long, triangular, slender pods about 30-50 cm long(Jahn, 1996). Among its numerous benefits, *Moringa* leaves and seeds have been found to possess pesticidal properties (Fahey *et al.*, 2005).

Jatropha curcas is a drought-resistant perennial plant, growing well in marginal/poor soil. It is easy to establish, grows relatively quickly and lives, producing seeds for 50 years

(http://www.jatrophabiodiesel.org). *Jatropha*, the wonder plant produces seeds with an oil content of 37% (Achten *et al.*, 2007). The oil can be combusted as fuel without being refined. It burns with clear smoke-free flame, tested successfully as fuel for simple diesel engine. The bye-products include *Jatropha* cake, a livestock feed as well as an organic fertilizer. The pesticidal properties of *Jatropha curcas* has been well documented (Makkar *et al.*, 1997; Habou *et al.*, 2011).

MATERIALS AND METHODS

Soil sterilization and experimental layout

Topsoil used for the project was collected behind the pavilion, in the Faculty of Agriculture, University of Ilorin, Nigeria. The topsoil was sieved and sterilized with heat in a metal drum for twenty-four hours and allowed to cool down for seventy-two hours using the method described by Gautam and Goswami (2002). It was then transferred into forty, ten-litre perforated buckets each containing 8kg of sterilized soil and were arranged on slabs to avoid contamination from the ground. The experimental design was a factorial type fitted into a complete randomized design (CRD).

Source of maize

Two varieties of maize, early white DT quality protein maize hybrid variety and extra early yellow DT quality protein maize were collected from IITA, Ibadan, Nigeria in November, 2012.

Planting and management

Three seeds of maize were planted in each of the perforated buckets earlier filled with soil. The buckets were randomly arranged and labeled for easy identification. Each variety was replicated five times for the two treatments and their control. The plants were later thinned, leaving only the most vigorous one in each bucket. They were watered with clean tap water daily.

Sources of root-knot nematodes

Roots of *Celosia argentea* plant infected with root-knot nematodes were collected from a vegetable garden in Oyun, Ilorin, Kwara state.

Extraction procedure of root-knot nematodes

The juveniles were extracted using the Baermann's method (Boerman and Hussey, 1992). Roots collected were carefully washed to remove soil particles. Galled roots of the plants were cut into small pieces and poured into a blender, water was added. The roots were then macerated in the blender. Double ply Serviette paper was laid in each sieve, and then placed in a tray. The content in the blender was poured into each sieve and water was gently poured into the trays and left on a flat slabs for 48 hours, to allow the nematodes migrate through the serviette into the water in the tray. The nematode suspensions in the trays were collected and standardized such that one ml contained approximately 150 juveniles.

Inoculation procedure

Twenty milliliters of the suspension collected containing approximately 3000 juveniles were inoculated into each of the forty buckets.

Aqueous extraction of plant materials, screening and application

Plant materials used in the management of the root-knot nematodes were *Moringa oleifera* and *Jathropha curcas.* Leaves of each plant materials were collected and air-dried (i.e. drying under room temperature of 27±2^{o}C), and ground, as described by Agbenin *et al* (2005). Phytochemical screening of the plant materials was carried out in Chemistry Laboratory of the University of Ilorin using the method described by Debella (2002). Five litres of water was later used to extract 2kg of each plant materials, to generate the stock solution of high concentration. Application involved pouring 5 litres of hot water into 2kg of the ground plant materials and covered for 24 hours. Thereafter, the residue was sieved out and 50ml of each of the filtrates which represented a treatment was applied to 5 buckets of each variety of maize. The remaining 10 buckets of each variety served as control. Forty buckets were used for the two varieties of maize.

Data collection

Plant height and number of leaves per plant were taken for each plant and recorded weekly. At harvest, rating of root galls was done using the method described by Taylor and Sasser (1978) as represented in Table 1. All data collected were subjected to analysis of variance of a factorial design and where appropriate, the means were separated using Duncan's multiple range tests.

Table 1: Root gall rating(Taylor and Sasser, 1978).

Rating	Number of galls	Host reaction
0	0	Immune
1	1–2	Resistant
2	3–10	moderately resistant
3	11–30	Susceptible
4	31 and above	highly susceptible

RESULTS AND DISCUSSION

Effects on plant height

The results in Table 2 show that till the third week after planting, there was no significant difference between treated and control plants, but from the fourth week to eleventh week (termination period). The plant heights of treated plants were significantly higher than their control counterparts.

Table 2: Effects of *M. oleifera* and *J. curcas* on mean plant height of two maize varieties infected with *Meloidogyneincognita*

Weeks	1	2	3	4	5	6	7	8	9	10	11
W.J.	47.50^{a}	66.40^{a}	78.69^{a}	96.27^{c}	103.73^{b}	109.93^{b}	120.80^{bc}	126.95^{bc}	126.10^{bc}	127.10^{bc}	127.10^{abc}
Control	43.79^{ab}	56.64^{abc}	65.58^{bc}	77.22^{de}	80.72^{d}	86.26^{c}	94.84^{de}	100.33^{d}	103.33^{d}	103.43^{d}	83.28^{de}
W.M.	42.83^{ab}	60.50^{abc}	71.98^{ab}	85.40^{d}	92.46^{c}	103.43^{b}	109.58^{cd}	110.09^{cd}	110.39^{cd}	110.34^{cd}	110.03^{bcd}
Control	38.40^{b}	51.16^{c}	57.96^{bc}	71.63^{e}	75.85^{d}	82.51^{c}	98.04^{d}	98.56^{d}	99.30^{d}	99.13^{d}	98.65^{de}
Y.J.	48.11^{a}	62.98^{ab}	84.48^{a}	120.83^{a}	132.13^{a}	139.50^{a}	146.05^{a}	147.52^{a}	148.84^{a}	148.84^{a}	148.64^{a}
Control	47.19^{a}	57.35^{abc}	64.62^{bc}	76.07^{de}	82.70^{d}	85.90^{c}	98.55^{d}	99.63^{d}	101.96^{d}	101.85^{d}	10.40^{cde}
Y.M.	40.2^{a}	55.58^{bc}	73.15^{ab}	108.71^{b}	123.49^{a}	130.61^{a}	133.15^{ab}	131.47^{b}	130.81^{b}	130.52^{b}	129.95^{ab}
Control	40.99^{b}	55.58^{bc}	62.08^{bc}	71.42^{e}	74.78^{d}	75.49^{c}	81.33^{e}	81.60^{e}	81.85^{e}	81.99^{e}	82.35^{e}
S.E.D	3.67	4.80	8.90	18.45	22.04	23.54	21.64	21.30	21.39	21.27	23.50
L.S.D	2.79	4.60	5.76	5.06	4.51	7.40	7.30	7.61	8.29	8.28	12.17

Means along the column followed by different superscripts are significantly different (P<0.05)

Key:W.J.: White variety of maize treated with *Jathropa curcas*; W.M.: White variety of maize treated with *Moringa oleifera*; Y.J.: Yellow variety of maize treated with *Jathropha curcas*; Y.M.: Yellow variety of maize treated with *Moringa oleifera*

Effects on number of leaves

The results on Table 3 showed the mean number of leaves of each plant. There was no significant difference between plants till the third week of growth, but at the fourth week, the number of leaves on all treated plants was significantly higher than the control until termination of trial.

Table 3: Effects of *M. oleifera* and *J. curcas* on mean number of leaves of two maize varieties infected with *Meloidogyne incognita*

Weeks	1	2	3	4	5	6	7	8	9	10	11
W.J.	7.60^{a}	9.00^{a}	9.60^{a}	10.40^{a}	12.80^{a}	14.00^{a}	14.00^{a}	14.00a	13.60^{a}	13.20^{a}	12.60^{ab}
Control	6.60^{bc}	7.40^{cd}	7.60^{b}	8.20^{bc}	10.0^{d}	11.20^{b}	12.40^{abc}	12.80^{ab}	13.00^{abc}	12.80a	12.80^{a}
W.M.	6.60^{bc}	8.60^{a}	9.00^{a}	9.20b	10.60^{cd}	12.20^{b}	11.20c^{d}	11.60^{b}	11.60^{bc}	12.00^{ab}	12.40^{ab}
Control	5.60^{d}	6.80^{d}	6.40^{b}	7.40^{c}	10.60^{cd}	10.20^{c}	9.80^{d}	11.40^{b}	12.60^{abc}	12.00^{ab}	10.20^{c}
Y.J.	7.00^{ab}	8.20^{abc}	9.80^{a}	10.60^{a}	12.40^{ab}	12.60^{ab}	13.20^{a}	13.40^{a}	12.80^{abc}	12.00^{ab}	12.00^{ab}
Control	6.80^{bc}	7.00^{d}	6.80^{b}	7.80^{c}	9.80^{d}	10.80^{c}	11.80^{bc}	12.60^{ab}	13.40^{ab}	13.20^{a}	13.20^{a}
Y.M.	6.00^{cd}	7.80^{bcd}	9.60^{a}	10.80^{a}	11.40^{bc}	11.00^{b}	11.00^{cd}	11.40^{b}	11.20^{c}	10.80^{b}	10.80^{bc}
Control	6.20^{bcd}	7.00^{d}	7.00^{b}	7.80^{c}	9.60^{d}	10.60^{c}	11.60^{bcd}	11.60^{b}	11.20^{c}	11.40^{ab}	11.60^{abc}
S.E.D	0.62	0.81	1.42	1.41	1.20	6.79	1.32	1.00	0.97	0.85	1.03
L.S.D	0.36	0.46	0.55	0.54	0.63	10.08	0.85	0.79	0.80	0.83	0.86

Means along the column followed by different superscripts are significantly different (P<0.05).

Key:W.J.: White variety of maize treated with *Jathropa curcas*; W.M.: White variety of maize treated with *Moringa oleifera*; Y.J.: Yellow variety of maize treated with *Jathropha curcas*; Y.M.: Yellow variety of maize treated with *Moringa oleifera*

Effects on shoot weight

The results on Table 4 show the mean weight of shoot of each plant. The treated plants were superior to the control plants, with the *Moringa oleifera*-treated plants having highest weight. Generally, the reduced growth parameters recorded in plant height, number of leaves and shoot weight of untreated control plants could be due to poor root system as a result of damage caused by the root knot nematodes in the soil which are insidious pathogens whose debilitating activities underground are not obvious most of the times until are determined from above ground symptoms and/or yield of crops. The result is in agreement with Agbenin (2004) who reported that the root damage caused by the root knot nematode in the soil reduces the rate at which water and nutrients are absorbed from the soil. Akhtar and Mahmood, (1994) had similar results in their investigations on the use of decomposed extracts of neem cake and leaf to control root knot nematodes. Izuogu *et al.* (2012) and Olabiyi (2004) also observed significant growth increase in plants treated with various plant extracts compared with their untreated control counterparts.

Soil nematode population and root galls were higher in untreated control plants than in the control plants indicating toxicity of the extracts on the root knot nematodes and proliferation of nematodes in the control trials due to absence of nematicidal materials corroborate with those obtained by Yakubu and Izuogu (2013) in their study on evaluation of *Calotropis procera*, *Crotalaria retusa* and *Hyptis suaveolens* in the control of root knot nematode. Azhar and Seddiqu (2007) also showed plant extracts of basil, marigold, pyrethrum, neem and china berry to be effective in the reduction of nematode population in soil.

Table 4: Mean Shoot Weight of *Meloidogyne incognita* treated with different extracts

	Jatropha	Control	*Moringa*	Control	S.E.D
White Maize	71.00^{b}	37.60^{c}	114.00^{a}	44.20^{a}	1.000
Yellow Maize	59.00^{b}	27.80^{c}	77.60^{a}	28.40^{a}	0.995

Means along the column followed by different superscripts are significantly different (P<0.05)

Table 5: Final soil nematode and root galls

Treatments	Nematode population(200ml)	Number of root galls
W.J.	108.40[a]	15[a]
Control	1604.26[b]	62[b]
W.M.	123.20[a]	20[a]
Control	1727.02[bc]	80[bc]
Y.J.	96.67[a]	13[a]
Control	1580.23[b]	58[b]
Y.M.	114.65[a]	17[a]
Control	1632.50[b]	74[b]
S.E.D.	126.41	6.08
L.S.D.	87.68	4.30

Means along the column followed by different superscripts are significantly different (P<0.05)

Table 5 shows the mean final soil nematode population and number of root galls. Generally, treated plants performed significantly higher than the untreated control ones. Though there were no statistical difference between the two treatments used, soil nematode populations were numerically higher in *Moringaoleifera* treated soil than in their *Jatrophacurcas* counterparts. The final soil nematode and number of root gall rating data obtained are in line with those obtained by Azhar and Seddiqu, (2007) that showed plant extract of basil, marigold, pyrethrum, neem and china berry to be effective in the reduction of nematode population in soil.

Results of the phytochemical screening showed that *M.oleifera* contains saponin, tannins, alkaloids, steroids and reducing sugars while *Jatropha curcas* contains saponins, alkaloids, flavonoids, steroids, and reducing sugars. These basic phytochemicals could be bio-nematicidal in nature and had been reported to confer pesticidal abilities in plants (Fatoki and Fawole, 2000; Izuogu and Oyedunmade, 2009; Adeniyi *et al.,* 2010). Some of these phytochemicals such as tannins, saponins, amongst others are reported to have nematicidal properties that caused disruption of membranes in organisms thereby facilitating penetration of toxic principles to the detriment of such organism (Agrios, 2005; D'Addabbo *et al.*,2010).

CONCLUSION

From the results of this study, it can be concluded that the use of *Moringa oleifera* and/or *Jathropha curcas* is an effective control measure against Root Knot Nematode (*Meloidogyne incognita)* of *Zea mays*, There is however, need for further research to be carried out on the use of these plant materials to control root-knot nematode of maize under field conditions.

REFERENCES

Achen, W.M.J, Mathiji, E., Verchot, L., Singh, V. P., Aerts, R.,and MUYs B. (2007). Jatropha Biodiesel, Biosustainability, Biofuels, Bioproducts and Biorefining, *The Jathropha Achives* .1(4), 283 – 291.

Adeniyi, S. A., Orjiekwe, C. L., Ehiagbome, J. E. and Arimal B. D. (2010).“Preliminary Phytochemical Analysis and Insecticidal Activity of Ethanolic Extracts of Poor Tropical Plants (*Vernomia amygdalina, Sida acuta, Ocinum gratissimum and Telfaria occidentalis*) Against Bean Weevil (*Acanthscelides obtectus*).*International Journal of Physical Sciences, 5(6)*: 753 – 763.

Agbenin, N. O., Emechebe, A. M., Marley, P. S. and Akpa, A. D.(2005). Evaluation of Nematicidal Action of Some Botanicals on *Meloidogyne incognita* In Vivo and In Vitro.A. D. *Journal of Agriculture and Rural Development in the Tropics and Subtropics.* 106 (1): 29–39

Agbenin, O.N., (2004). Potentials of Organic Amendments in the Control of Plant Parasitic Nematodes.*Plant pathology, Academic Press, San Diego.*

Agrios, G. N., (2005), “Plant Pathology” 5th Edition, Academic press, Sam Diego

Akhtar, M. and Mahmood, I. (1994).Control of Root Knot Nematode by Bare Root Dip in Undecomposed Decomposed Extracts of Neem Cake and Leaf.*Nematologia.Mediterranea*, 22(1): 55 – 57.

Azhar, R.M. and Seddiqu, M. (2007). Nematicidal Effects of Some Botanical against Root-Knot Nematode, (*Meloidogyne javanica*) on Tomato. *International Journal of plant Sciene*.,2:49-52

Anastasiadis, I.A., Giannakou, I.O., Prophetou-Athanasiadou, D.A., and Gowen, D.A. (2008). The Combined Effect of the Application of a Biocontrol Agent *Paecyliomyces lilacinus*, with Various Practices for the Control of Root-Knot Nematode. *Crop Protection*, 27: 352-362.

Boerman, H. R. and Hussey, R. S. (1992).Breeding Plants for Resistance to Nematodes.*Journal of Nematology, 24*: 242-252.

D’ Addabbo, T., Caboonara, T., Leonetti, P., Radicid, V., Tava, A. and Avato, P. (2010).“Control of Plant Parasitic Nematodes with Active Saponins and Biomass from *Medicago sativa*.Phytochemical Reveiw.doi 10.1007/511101 – 016 – 9180

Debella, A.(2002). Preliminary Screening Techniques of Secondary Metabolites. In: Manual of Phytochemical Screening of Medicinal Plants. Addis Ababa, Ethiopia: *Department of drug research, Ethiopia health and nutrition research institute*; Pp. 38-57.

Fahey J.W., Lewis B. and Dorothy C. (2005).*Moringa oleifera*: A Review of the Medical Evidence for Its Nutritional, Therapeutic, and Prophylactic Properties. Part 1.*Trees for Life Journal*1:5 21205-2185

Fatoki, O. K., and Fawole, B. (2000). “Identification of Nematicidal Ingredients From Neem Leaves, Siam Weed Leaves and Roots. *African Journal of Plant Production* 10: 33 – 48

Gautam, C. and Goswani, B.K (2002). Different Combinations of Neem Cake and Carbofuran against *Meloidogyne incognita* on *Vigna radiate*. *International Journal of Nematology*. Vol. 12, 106-110

Habou, Z. A, Haougui, A., Mergeai, G., Haubruge1 E., Toudou, A. and Verheggen, F.J. (2011).Insecticidal Effect of *Jatropha curcas* Oil on the Aphid *Aphis fabae (Hemiptera: Aphididae)* and on the Main Insect Pests Associated with Cowpeas *(Vigna unguiculata)* in Niger. *Tropicultura , 29(4):226-229*

Izuogu, N. B. and Oyedunmade, E.E.A. (2009).Effect of Methanonic Extracts from the Leaves of Brimstone, Cassia, Lemon grass and Chanca Ipiedra on *Meloidogyne incognita* in the Laboratory.*Journal of Agricultural Research and Development* 7 and 8: 53 – 60.

Izuogu, N.B., E. E. A. Oyedunmade, and Usman A. M. (2012).Toxicity of Aqueous and powdered sparrow grass, *Asparagus africanus to Meloidogyne incognita on egg plant*.***Journal of Organic Agricultural Research and Development*** 5: 36 -50.A publication of Nigerian Organic Agriculture Network (NOAN). Available online: URL: http/www.ijoard.org

Jahn, S. A. A. (1996). On the Introduction of a Tropical Multipurpose Tree to China Traditional and Potential Utilisation of *Moringa oleifera* Lamark.*Senckenbergiana Biologica, 75*(1-2), 243-254.

Makkar H.P.S., Becker, K., Sporer, F., and Wink, M. (1997).Studies on Nutritive Potential and Toxic Constituents of Different Provenances of *Jatropha*

curcas, SJournal of Agricultural Food. Chemistry, 45: 3152-3157.

Martin, L. P. (2000). The Moringa Tree: Revised in 2000 by Kristin Davis, pp. 1-14.

Mehrotra, R. S. and Ashork, A. (2003). Plant Pathology; Diseases caused by Nematodes and Flagelates, 2nd Edition. Tata McGraw. Hill, New Delhi. Pp 750-780.

Milkowski, N.A. and G.S. Abawi. (2003). Root-knot nematodes. *The Plant Health Instructor*. DOI:10.1094/PHI-I-2003-0917-01 Revised 2011. APS Net.

Olabiyi, T.I., (2004). Assessment of the Nematicidal Properties of Extracta *Tagetes erecta*, *Ocimum gratissimum*, *Hyptis suaveolens* and *Crotaloria retusa*.Ph. D.thesis submitted to Department of Crop Protection, University of Ilorin, Ilorin. Nigeria, Pg. 177.

Olaniyi O.A. and Adewale J.G. (2012).Information on Maize Production among Rural Youth: A Solution for Sustainable Food Security in Nigeria.*Library Philosophy and Practice* 2012.ISSN 1522-0222.

Taylor, A. L. and Sasser, J.N. (1978). Biology, Identification and Control of Root Knot Nematode (*Melooidogyne spp*), North Carolina University: Graphic Press. Pp 111.

Yakubu, L.B. and Izuogu, N.B. (2013). Comparative Evaluation of some Botanicals and Carbofuran in the Control of Root-Knot Nematode, *Meloidogyne spp*. on Cowpea (*Vigna unguiculater*).*Journal of Agriculture and Veterinary Sciences*, VoL 5(2): 205-115