Asian Journal of Agricultural and Horticultural Research

2(3): 1-13, 2018; Article no.AJAHR.44736
ISSN: 2581-4478

Efficacy of Some Botanical Extracts on Root-Knot Nematode (*Meloidogyne incognita*) Egg- Hatch and Juvenile Mortality *in vitro*

C. I. Jidere[1*] and J. I. Oluwatayo[2]

[1]Department of Pest Management, Federal College of Horticulture Dadin - Kowa, P.M.B 108, Gombe State, Nigeria.
[2]Department of Crop and Environmental Protection, University of Agriculture, P.M.B 2373, Makurdi, Benue State, Nigeria.

Authors' contributions

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

Article Information

DOI: 10.9734/AJAHR/2018/44736
Editor(s):
(1) Dr. Paola A. Deligios, Department of Agriculture, University of Sassari, Italy.
Reviewers:
(1) Muhammad Shahzad Aslam, University Malaysia Perlis, Malaysia.
(2) Mahmoud M. A. Youssef, National Research Centre, Egypt.
Complete Peer review History: http://prh.sdiarticle3.com/review-history/27122

Original Research Article

Received 25 August 2018
Accepted 02 November 2018
Published 08 November 2018

ABSTRACT

The study was conducted at the Department of Crop and Environmental Protection Laboratory University of Agriculture Makurdi to compare the nematicidal activity of 3 different plant leaf and seed extracts from *Ricinus communis, Jatropha curcas* and *Moringa oleifera* Lam on egg-hatch inhibition and juvenile mortality in vitro. The experiment was laid out in Completely Randomised Design (CBD) with a 3x7x3 factorial arrangement replicated three times. Aqueous extracts from leaves and seeds of *Moringa oleifera*, *Jatropha curcas* and *Ricinus communis* (15 g/100ml) were further diluted into 10, 20 and 30% V/V respectively. A 10ml aliquot of aqueous extract dilutions (10, 20 and 30%V/V) was introduced into Petri dishes containing 50 and 100 fresh egg- masses and juveniles of M. incognita, respectively. Egg masses and second stage juveniles were exposed to the concentrations of the aqueous leaf and seed extracts for 24, 48 and 72hrs. The results show that

**Corresponding author: E-mail: calebjdr@gmail.com;*

there was a significant difference (P<0.05) between the various exposure time on eggs-hatch inhibition and juvenile mortality. The Highest number of eggs-hatch inhibition and juvenile mortality were recorded at 72 >48>24 hours. There was also a significant difference (P<0.05) between the different concentrations used on percentage egg-hatch inhibition and juvenile mortality. 10% v/v concentration recorded the least percentage mortality while 30% v/v concentration recorded higher egg-hatch inhibition and juvenile mortality. There was no significant difference (P>0.05) between the different leaf and seed extracts as all botanicals had an effect on egg-hatch and juvenile mortality. However, all untreated control recorded (0%) egg-hatch inhibition and juvenile mortality. The study showed that leaf and seed extracts of *Moringa oleifera*, *Jatropha curcas* and *Ricinus communis*, decreased egg hatch and increased juvenile mortality. The study also revealed that egg hatch and juvenile mortality were dependent on the time of exposure and concentration of the extracts.

Keywords: Egg hatch; juvenile mortality; botanical extracts; M. incognita.

1. INTRODUCTION

Many plants have remained untapped for the control of root-knot nematodes. Root-knot nematodes infect a wide range of important crop plants and are particularly damaging to vegetable crops in tropical and subtropical countries [1]. There are more than 90 described species in the genus *Meloidogyne,* but the four most commonly occurring species are *Meloidogyne incognita*, *M. arenaria, M. javanica* and *M. hapla* [2,3]. Nematodes are generally regarded as hidden enemies; losses of up to 40-80% have been associated with them in both greenhouse and field conditions [4,5,6]. For decades the use of chemical nematicides has been one of the successful methods for the control of nematodes, although nematicides are efficient, they are being faced with many challenges such as environmental pollution, the high cost of purchase as well as unavailability to many small-scale farmers. Scientists are now resorting to the use of botanicals for the control of nematode because they are eco-friendly, easy to apply and available to farmers.

Some plants are known to posses nematicidal capability which may be utilised as organic amendments or bio-pesticides. A few plant extract had been reported to suppress nematode pests in Nigeria. Root extracts of Siam weed (*Chromolaena odorata*), castor oil (*Ricinus communis*) and lemongrass (*Cybopogon citratus*) root bark extract of *Bixa orellana*, root and leaf of African marigold (*Tagetes erecta*), rattleweed (*Crotalaria retusa*), nitta (*Hyptis suaveolens*) and basil, (*Ocimum gratissimum).* Leaf, stem, root and flower of African marigold, (*Tagetes erecta),* neem fruits (*Azadirachta indica*) and neem leaf (*Azadirachta indica*) were among the few plant extracts reported to be effective against nematode pests in Nigeria [7,8,9,10,11,12,13].

The roots extracts of marigold, nitta and basil plant have been reported to reduce root-knot nematode population in the soil and subsequently to increasing plant growth parameters [14]. Adekunle and Akinlua [15] studied the leaf and root extracts of *Gliricidia sepium* and *Leucaena leucocephala* against *Meloidogyne incognita* on okra and suggested that both extracts at the rate of 40,000 mg/kg could be useful in root-knot nematode management in vegetable beds. The activity of some essential oils extracted from 27 spices and aromatic plants was studied *in vitro* and pots. It was found that essential oils of *Carum carvi, Mentha rotundifolia, Foeniculum vulgare, Mentha spicata Origanum vulgare, O. syriacum* and *Coridothymus capitatus* have some nematicidal potential against root-knot nematodes [16]. Hassan et al. [17] reported the nematicidal efficacy of neem and marigold extracts against *M. javanica*. Javed et al. [18] studied the nematicidal efficacy of algaefol (sea algae extract), nimbokil (neem product), a microbial product and mehndi for egg inhibition and root gall index reduction. Nimbokil was the most effective. Hassan et al. [19] tested powder and extract of ginger against root-knot nematodes and showed better growth of the plant with lower root galling index on brinjal. Nidhi Sharma and Trivedi (2002) found that the leaf extracts of *Ricinus communis* and *Calotropis procera* were highly effective against root-knot nematode. Javed et al. [20] also reported the efficacy of ginger extract for egg inhibition and larval mortality *of M. javanica* [21] found that extract of neem seed was more effective against juvenile of *M. javanica* than leaf and bark.

The objective of the study was to determine the effectiveness of botanical extracts from leaves and seeds of *Moringa oleifera*, *Jatropha curcas* and *Ricinus communis* on root-knot nematode (*M. incognita*) egg-hatch and juvenile mortality.

2. MATERIALS AND METHODS

2.1 Experimental Location and Design

The research was conducted at the Department of Crop and Environmental Protection Laboratory University of Agriculture, Makurdi, Nigeria. The experiments were laid out in Completely Randomised Design (CRD) in a 3x7x3 factorial replicated three times.

2.2 Preparation of Plant Aqueous Extracts

Fresh leaves and seeds of *Moringa oleifera Ricinus communis* and *Jatropha curcas* were washed with tap water, 15 g each of the leaves and seeds of the different botanicals was macerated separately in an electric blender at high speed for 4minutes in 100ml distilled water. The mixture was left for 12 hours (overnight). After which, the mixtures was passed through a Whatman filter paper. Filtrates of the leaves/seeds collected served as standard solution 'S' further dilutions were made viz,10, 20 and 30%v/v by adding required amount of distilled water.

2.3 Source and Extraction of Inoculum (Root- Knot Nematode Eggs)

2.3.1 Egg extraction

Egg masses of *M. incognita* were extracted from infected tomato roots, using the methods of [22]. The roots were thoroughly washed with distilled water, cut into small pieces and put into a measuring cylinder. 0.5% sodium hypochlorite (household bleach) was poured into the measuring cylinder, tightly capped, and was shaken actively for two minutes to dissolve the gelatinous matrix. The mixture was then poured through a 200 mesh sieve, set inside a 500 mesh sieve; the sieves were shaken as liquid passed through. The 200 mesh sieve was washed and the eggs caught in the 500 mesh sieve were washed with distilled water.

2.3.2 Juvenile extraction

Second stage juveniles of root-knot nematode were extracted using modified Baermann tray [23] technique. The counting was done using Don Caster counting tray. Counting was done three times and the mean was recorded.

2.4 Application of Botanical Extracts on Egg- Hatching and Juvenile Mortality

Each of the different aqueous dilutions was introduced into different Petri dishes. Fifty eggs were handpicked using a pair of forceps and 10ml containing 100 juveniles was introduced into separate Petri dishes containing the different extracts. The set up was replicated three times, distilled water served as the control. The experiments were kept on laboratory benches at room temperature. Egg- hatching and juvenile mortality were observed after 24, 48 and 72hrs.

2.5 Statistical Analysis

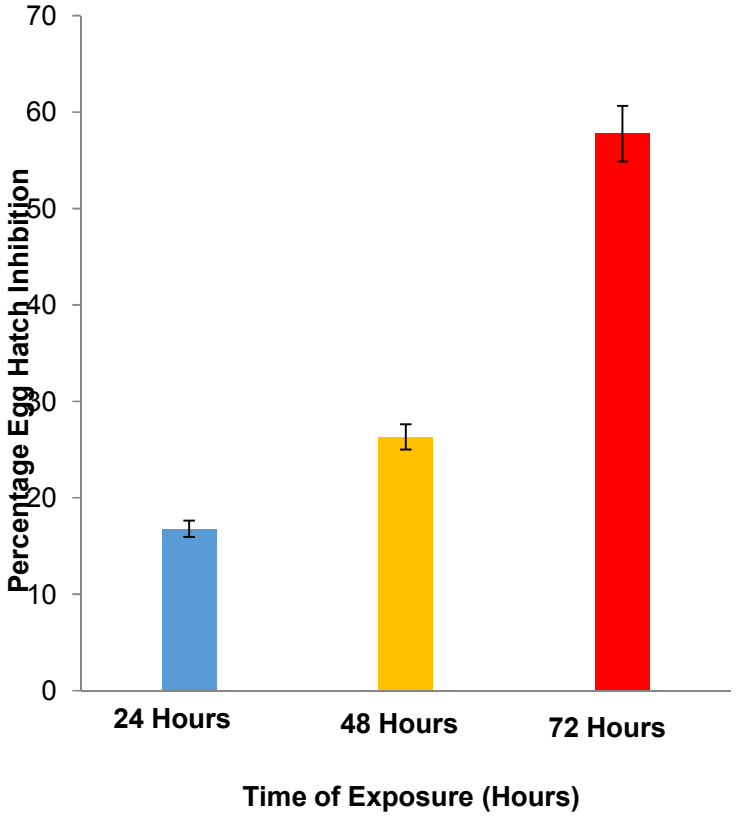
Data collected were analysed, using the Genstat statistical package (Discovery edition 7). The least significant difference (LSD) at 5% was used for comparing mean differences. All counting data were transformed using square root transformation of $\sqrt{(x+0.5)}$, where x is the mean count.

3. RESULTS

In Fig. 1, exposure time had a significant difference ($P<0.05$) on egg-hatch inhibition and Juvenile mortality. The longer the exposure time, the greater its effects on egg-hatch inhibition and juvenile mortality. A higher number of eggs-hatch inhibition was recorded at 72 hours (57%) after exposure, closely followed by 48 hours (26%), but 24 hours after exposure recorded the lowest percentage egg- hatch inhibition (16%). The lower value of Juvenile mortality (18%) was recorded at 24 hours after exposure. At 48 hours, an increased in juvenile mortality was observed (38%). Furthermore, after 72 hours of exposure to the botanical extracts, mortality of 43% was recorded.

Fig. 2 shows that there was a significant difference ($P<0.05$) between the different concentrations used on percentage egg-hatch inhibition and juvenile mortality. 30 v/v>20 > 10%v/v concentration. The higher the concentration of the various botanicals, the greater its effect on egg-hatch inhibition and juvenile mortality.

Fig. 3 shows the effect of different botanical extracts on egg-hatch inhibition and juvenile mortality. There was a significant difference between the different leaf and seed extracts. Jatropha leaf (>40%) extracts recorded higher egg-hatch inhibition, closely followed



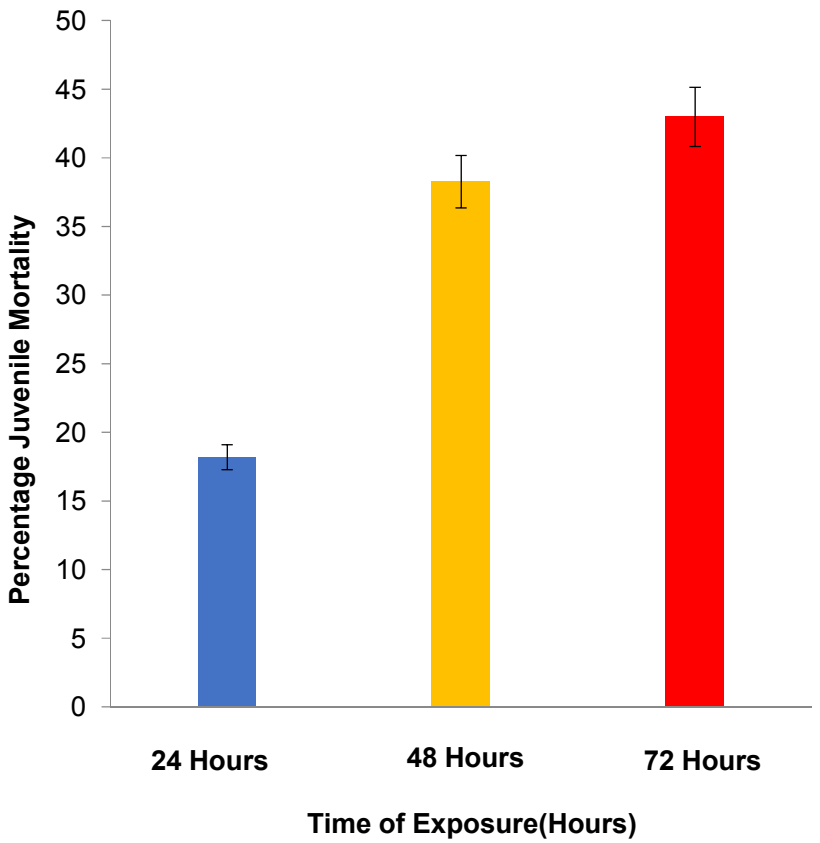


Fig. 1. Effect of exposure time on percentage egg-hatch inhibition and juvenile mortality of root-knot nematode

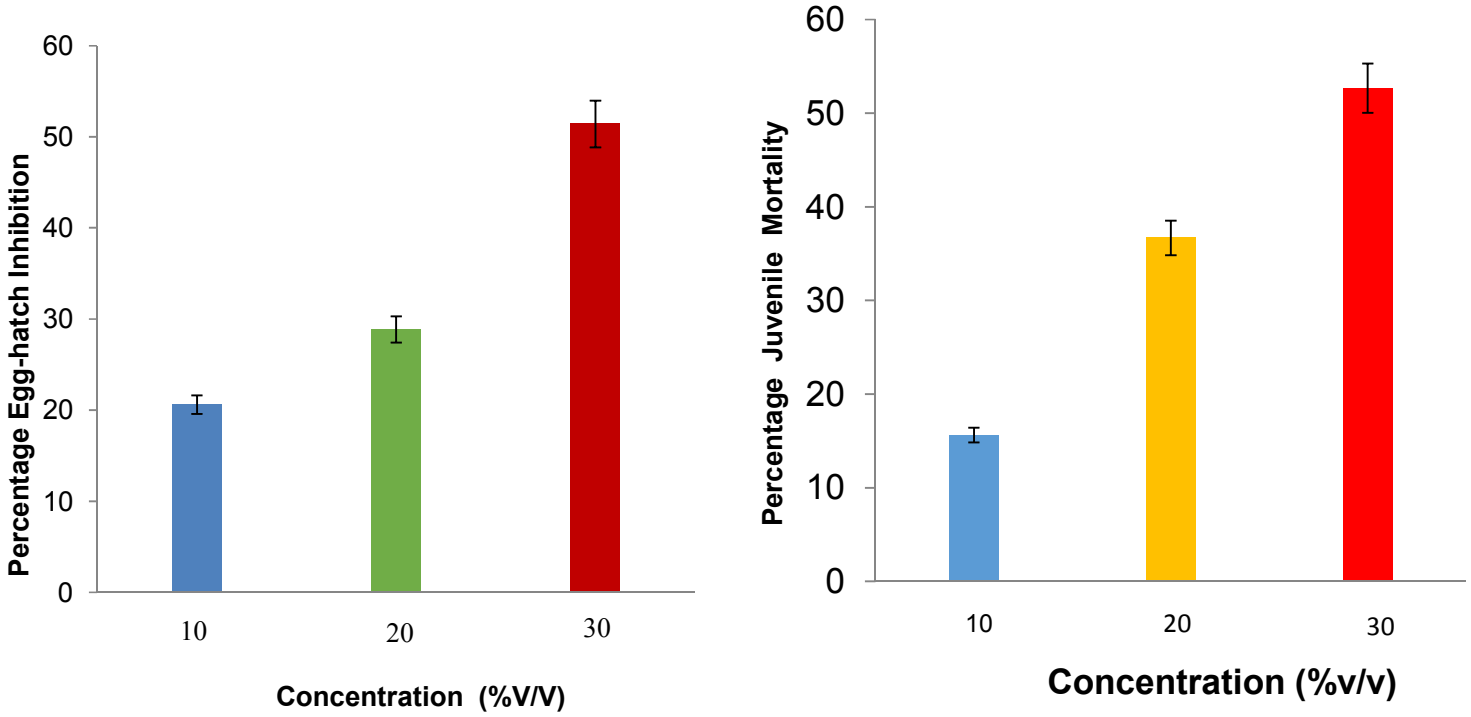


Fig. 2. Effect of concentration (% v/v) on percentage egg- hatch inhibition and juvenile mortality of root-knot nematode

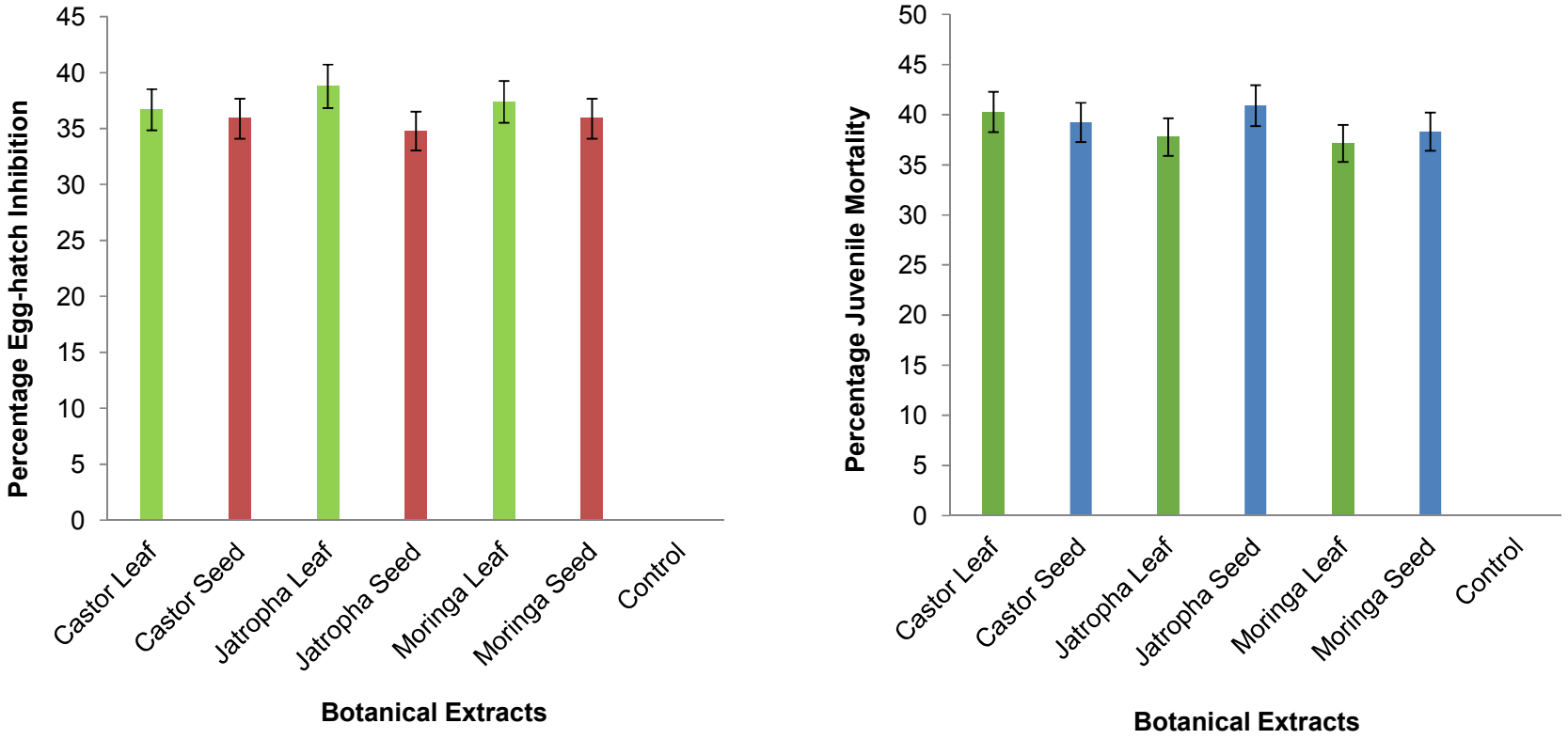
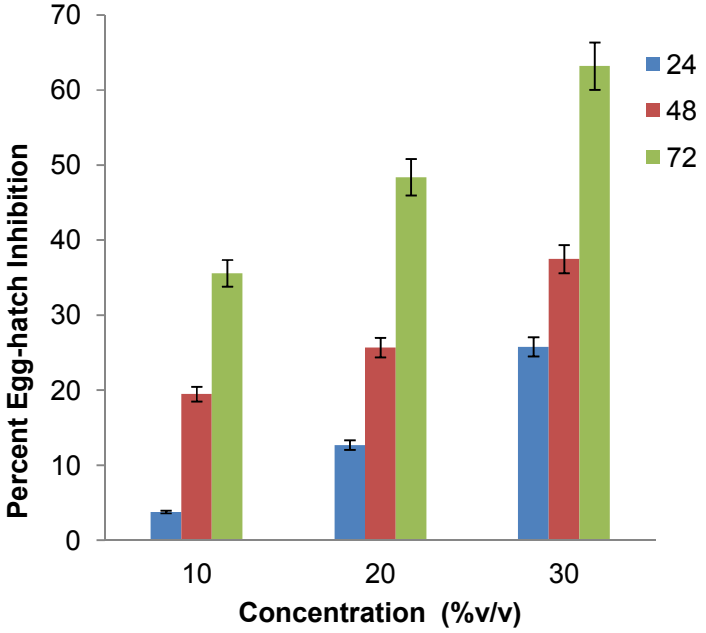


Fig. 3. Effect of botanical extracts on percentage egg-hatchability and juvenile mortality of root-knot nematode



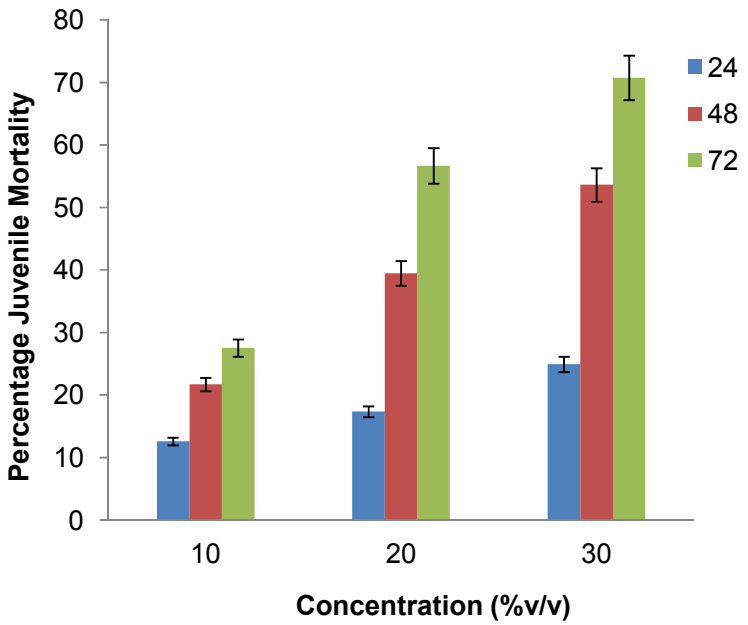


Fig. 4. Effect of concentration and exposure time on percentage egg-hatch inhibition and juvenile mortality of root-knot nematode

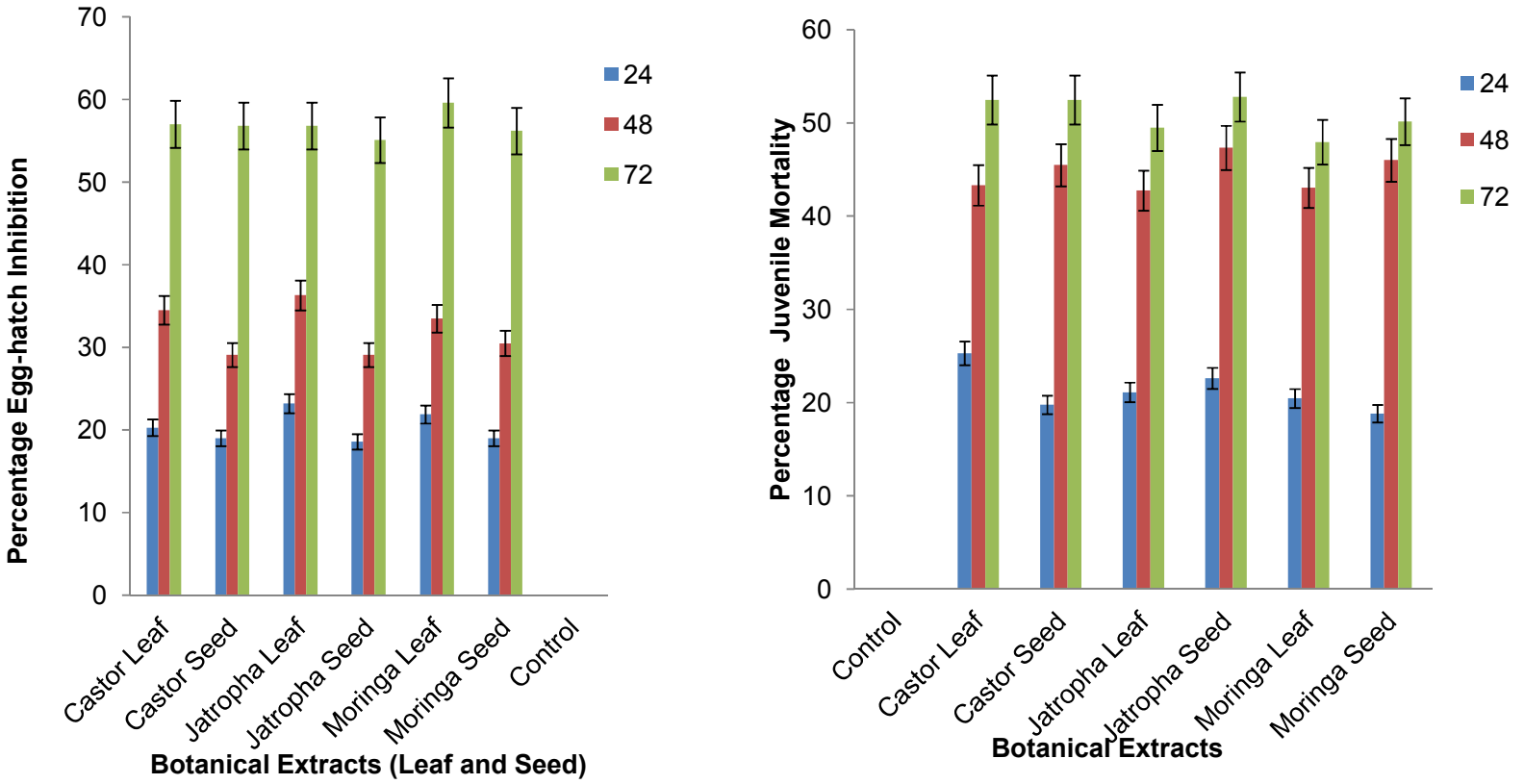


Fig. 5. Effect of botanical extracts and exposure time on percentage egg-hatchability and juvenile mortality of root-knot nematode

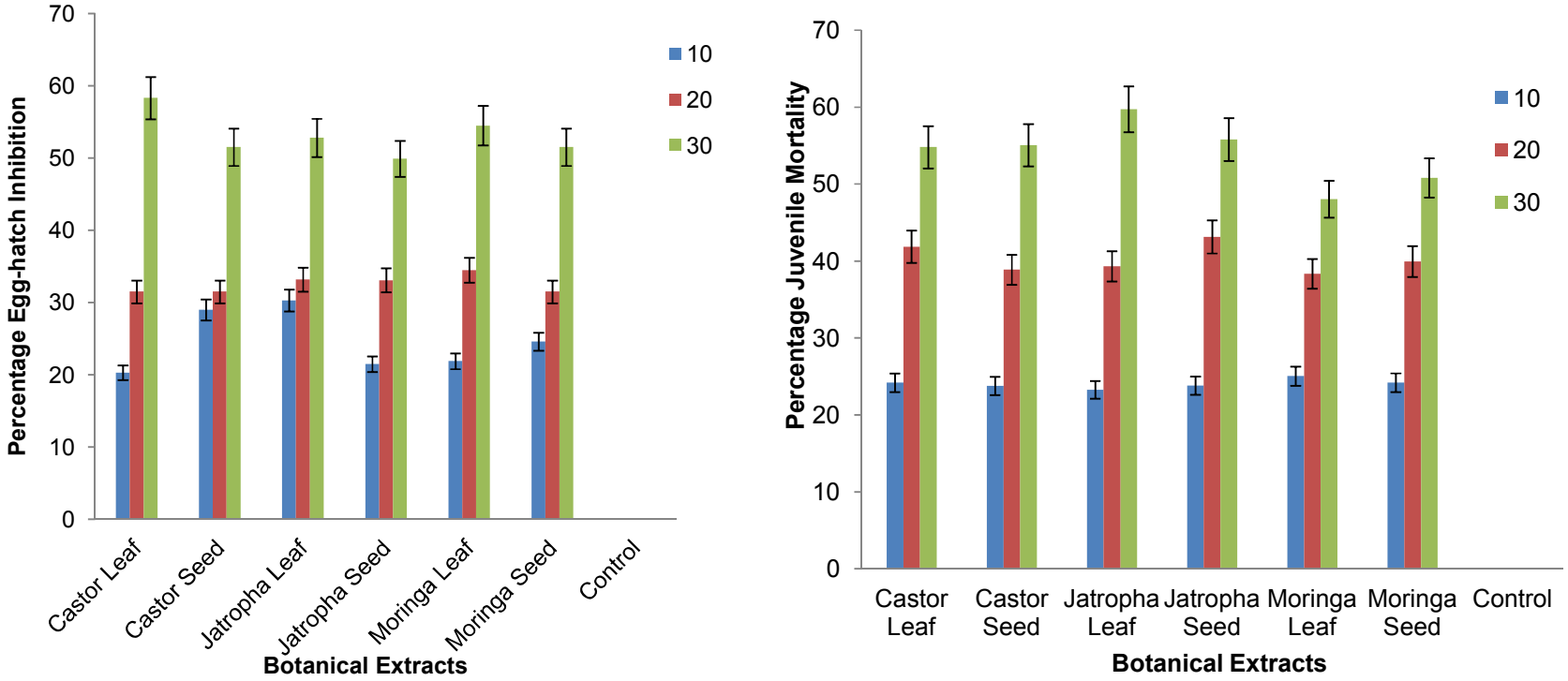


Fig. 6. Effect of concentrations (%v/v) and botanical extracts on percentage egg-hatch inhibition and juvenile mortality of root-knot nematode

by *Ricinus communis* and *Moringa oleifera* Leaves. Juvenile mortality, however, Jatropha seed, recorded the highest percentage of juvenile mortality of 41% followed by *Ricinus communis* leaf with 40% and *Moringa oleifera* leaf (37%). The untreated control recorded (0%) egg-hatch inhibition, and the lowest mortality was 0%.

Fig. 4 shows the Effect of different concentrations, and exposure time, on percent egg-hatch Inhibition and juvenile mortality. The high significant difference ($P<0.05$) was obtained between the botanical concentrations and different times, of exposure. Higher percentages, egg-hatch inhibition and juvenile mortality were obtained after 72 hours of exposure for all concentrations (10, 20 and 30%v/v), while at 24 hours after exposure, the least percentage, egg-hatch inhibition and juvenile mortality were recorded. Higher mortality value was obtained at higher concentration and longer exposure time as compared to lower concentration.

All the plant extracts used at longer exposure time were effective in decreasing egg-hatch inhibition and increasing juvenile morality as compared to the control. There was a significant difference between the botanical extracts. (Fig. 5), at 72 hours after exposure, Moringa leaf recorded higher egg-hatch inhibition compared to the other treatments. At 24 and 42 hours after exposure, Jatropha leaf extract inhibited more eggs than the other botanical extracts. For Juvenile mortality, however, 53 and 47% were obtained from Jatropha seed, at 72 and 48 hours after exposure after exposure respectively. At 24 hours after exposure, Castor leaf recorded 25%, while Moringa seeds (18%) for the highest and the lowest juvenile mortality, respectively. The untreated control recorded 0.00 percent in egg inhibition and juvenile mortality for all the periods of exposure.

Fig. 6 shows a significant difference ($P<0.05$) between the various concentrations and percentages nematode egg-hatch inhibition and juvenile mortality. All plant extracts recorded significant effect on percentage inhibition than the control. Greater egg-hatch inhibition was recorded at 30%v/v and the least was recorded at 10%v/v for all the various leaf and seed extracts. At 10 and 20 %v/v, Jatropha leaf recorded higher percentage egg-hatch inhibition of >30% at 30%v/v, Castor leaf recorded the high egg-hatch inhibition closely followed by Moringa leaf and Jatropha leaves. At 30% v/v, Jatropha leaf recorded juvenile mortality of 59%, with Moringa leaf recording the lowest mortality percentage of 48. At 20%v/v Jatropha seed and Moringa seed had the highest and lowest percentage, mortality of 43 and 38%, respectively. Furthermore, at 10%v/v Moringa leaf and seed recorded mortality >24%. The least juvenile mortality of 0% was recorded from the untreated control. The untreated control recorded the least egg -hatch inhibition.

4. DISCUSSION

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

The results show that all the plant extracts contained some nematicidal properties against root-knot- nematode eggs and juvenile in vitro although they have a different nematotoxic effect even at very low concentrations, and their effects are very easily recognised. Direct contact of the botanical extracts ensures that the active ingredients were effectively delivered to the eggs and juveniles of the root-knot nematode.

A higher percentage, of egg-hatch inhibition and juvenile mortality, were recorded from the treated dishes as compared to the untreated control, this is because the normal life cycle of the nematode did not interfere. Claudius et al. [24], from their investigations, stated that water-soluble extracts, although with different degrees of nematotoxicity from oitter leaves (*Vernonia amygdalina)*, neem (*Azadirachta indica*), African basil (*Ocimum gratissimum*) and moringa (*Moringa oleifera*), were toxic to *Meloidogyne incognita* both in the laboratory and under greenhouse conditions, they pointed out that direct contact of the extracts with the eggs and juveniles ensured that the active ingredients in the leaf extracts were effectively delivered to the nematode. Moringa (*M. oleifera*) has been reported to contain pesticidal properties that inhibit egg-hatch and juvenile mortality of *Meloidogyne* spp. [25,26,27,28]. It was also, reported elsewhere, to be used in water treatment and in this present study, it was found to be a good inhibitor of nematode egg- hatch and juvenile mortality. Water extract of moringa was reported to be toxic to *M. incognita* as standard pesticides [29]. Claudius et al. [24] stated that *M. oleifera* caused

more 50 % egg- inhibition and juvenile mortality in laboratory studies.

Mafeo and Mashela [30] reported the inhibitory ability of castor oil (*Ricinus communis*) on eggs and juveniles of root-knot nematode. Female to male ratio was also reported to decrease as well as abortions *M. incognita* eggs were influenced by *R. communis* [31]. Sellami and Mouffarah [32] reported that aqueous leaf extract of Castor (R. *communis)* reduced egg inhibition and juvenile mortality of 55.67 and 95%, respectively within 48hours of exposure. The study is also in line with the findings of [33] who reported the nematicidal property of Castor, *R. communis* on egg inhibition and juvenile mortality at various concentrations and different times of exposure. They reported that Castor has lethal effects on both the eggs and juveniles. They pointed out that both egg and juvenile mortality increased with increase in concentrations and exposure time. Egg hatch inhibition was influenced by exposure time, and exudates from its environment [34]. From this study, both egg hatch and juvenile mortality were dependants on concentration and time of exposure. This agrees with the findings of [35,36] who pointed out that the increase in concentration and duration, led to a decrease in egg hatching ability of nematode and vice versa.

In general, the highest concentrations of water extracts of all tested plants gives>80% mortality of nematode. Larva hatching and nematode mortality are strongly influenced by the concentrations of extracts, plant species and duration of exposure as reported by Ndana and Oyedunmade [37]. It is evident as pointed out by Adegbite and Adesiyan [11], that toxicity decrease, with an increase in dilution which results in a decrease in inhibition, the inhibitory effect might be due to the chemicals present in botanicals which possess ovicidal properties this chemical, affects the embryonic development, or dissolved the eggs. The mechanisms of plant extract action may include denaturing and degrading of proteins, inhibition of enzymes and interfering with the electron flow in the respiratory chain or with ADP phosphorylation [38]. Khan [39] also, stated that many wild and cultivated medicinal plants have been shown to possess nematicidal properties against several plant-parasitic nematodes. This finding also agrees also with that of [40], who reported that eggs and juveniles exposed to extracts of *Melothria purpusilla* (Blume) Cogn for a longer period decreased in their rate of hatching as compared to those exposed to a shorter period of the same extracts. In another experiment carried out by Saravanpriya and Sivakumar [6], they reported water extracts of 8 plant species namely: *Solanum surattense, Thevetia peruviana, Calotro pisprocera, Thuja sinesis, Parthenium hysterophors, Croton sparsiflorus, Colosia antiquorum* and *Datur stramonium* had nematicidal properties against second stage juveniles of *Meloidogyne incognita* having mortality range of 50-100%.

5. CONCLUSION

From the results obtained in this study, *Moringa oleifera, Jatropha curcas* and *Ricinus communis* leaves and seeds extracts were effective in decreasing egg-hatch and increasing juvenile mortality of root-knot nematode (*M. incognita*) in the laboratory. The botanical extracts offer promising results, an alternative to nematicides and therefore recommended for further trials under screen house and field conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sikora RA, Fernandez E. Nematode parasites of vegetables. Pp 319-392. In Luc, M., R. A. Sikora and J. Bridge (eds). Plant-Parasitic Nematodes in Subtropical and Tropical Agriculture. 2nd Edition. CAB International; 2005.
2. Karssen G. The plant parasitic nematode genus *Meloidogyne goeldi,* (Tylenchida) in Europe. Brill Academic publishers, Leiden, The Netherlands. 2000;160.
3. Hunt GI, Manzanilla-Lopez RH. Identification, morphologys and biology of plant parasitic nematodes. Pp 11-52. In Luc, M., Sikora, R. A. and Bridge, J. (eds.). Plant-parasitic nematodes in subtropical and tropical agriculture. CAB International; 2005.
4. Siddiqui ZA, Mahamood I. Role of bacteria in the management of plant parasitic nematodes. Annual Review of Bio Resource Technology. 1999;69:167-179.
5. Kaskavalci G. Effects of soil solarization and organic amendment treatments for controlling Meloidogyne incognita in tomato cultivars in Western Anatolia.

Turkish Journal of Agriculture. 2007;31:159-16.
6. Saravanpriya B, Sivakumar M. Management of root knot nematode, Meloidogyne incognita on tomato with botanicals. Natural Product Radiance. 2005;4(3):158–161.
7. Anonymous. Intergovernmental forum on chemical safety information circular (IFCS). Pesticides and Alternatives. 2004;23:2-3.
8. Olabiyi TI, Oyedunmade EEA, Oke JM. Bio-nematicidal potentials of African marigold (*Tagetes erecta* L.), rattle weed (*Crotalaria retusa* L.), nitta (*Hyptis suaveolens* Poit.) and (basil *Ocimum gratissimum* L.). Journal of Agricultural Research and Development. 2006;5:27-35.
9. Olabiyi TI, Olabode MO. The effects of neem (*Azadirachta indica*) fruits on nematodes in cowpea cultivation. African Scientist. 2001;2:73-76.
10. Olabiyi TI, Gwazah RY. Efficacy of neem leaf powder in the control of root knot nematode (*Meloidogyne incognita*) on soyabean. African Scientist. 2001;2:77-80.
11. Adegbite AA, Adesiyan SO. Root extracts of plants to control root knot nematode on edible soybean. World Journal of Agricultural Science. 2005;1(1):18-21.
12. Oladoye SO, Olabiyi TI, Ayodele ET, Ibikunle GJ. Phyto-Chemical screening and nematicidal potential of root bark extract of *Bixa orellana* on nematode pests. Research on Crops. 2007;8:222-228.
13. Oyedunmade EEA. Laboratory and field toxicities of the African marigold (*Tagetes erecta*) to root knot nematodes. African Scientist. 2000;1:177-182.
14. Olabiyi TI. Pathogenicity study and nematoxic properties of some plant extracts on the root-knot nematode pest of tomato, *Lycopersicon esculentum*. Plant Pathology Journal. 2008;7(1):45-49.
15. Adekunle OK, Akinlua A. Nematicidal effects of *Leucaena leucocephala* and *Gliricidia sepium* extracts on Meloidogyne incognita infecting okra. Journal of Agricultural Sciences. 2007;52(1):53-63.
16. Yuji Oka, Nacar S, Putievsky E, Ravid U, Yaniv Z, Spiegel Y. Nematicidal activity of essential oils and their components against the root-knot nematode. Phytopathology. 2000;90(7):710-715.
17. Hassan SME, Rahman MS, Amin MR, Majumdar UK, Ahmad MU. Effect of neem (*Azadirachta indica*) on the root-knot (*Meloidogyne javanica*) of sweet gourd. Pakistan Journal of Biological Sciences. 2000;3(11):1853-1854.
18. Javed N, Qurashi FF, Ahmad R, Ashfaq M. Evaluation of products of bionature against root-knot nematode *M. javanica* (Treub.) on tomato. Pakistan Journal of Phytopathology. 2001;13(2):155-159.
19. Hassan SME, Rahman M.Sq, Amin MR, Majumdar UK, El Taj HF. Study of ginger on root knot disease of Brinjal. Journal of Biological Sciences. 2001;1(7):560-562.
20. Javed N, Zaki MJ, Zareen A. Nematicidal, activity of ginger and its effect on the efficacy of *Pasteuria penetrans* for the control of root-knot nematodes on tomato. Asian Journal of Plant Sciences. 2003;2(11):858-860.
21. Yasmin L, Rashid MH, Nazim Uddinm M, Hossain MS, Hossain ME, Ahmed MU. Use of neem extract in controlling root-knot nematode (*Meloidogyne javanica*) of sweet - gourd. Pakistan Journal Plant Pathol. 2003;2(3):161-168.
22. Hussey RS, Barker KR. A comparison of methods of collecting inocula for *Meloidogyne* spp., including a new technique. Plant Disease Report. 1973;61: 328-331.
23. Whitehead AG, Hemming J. A comparison of some quantitative methods of extracting small vermiform nematodes from soil. Annals of Applied Biology. 1965;55:25–38.
24. Claudius CAO, Aminu AE, Fawole B. Evaluation of plant extracts in the management of root knot nematode Meloidogyne incognita on cowpea, *Vigna unguiculata* L. (Walp). Mycopathology. 2010;8(1):53-60.
25. Salawu EO. Effect of neem leaf extract and ethoprop singly and in combination on Meloidogyne incognita and growth of sugarcane. Pakistan Journal of Nematology. 1992;10(1):51-56.
26. Aralepo OE. Nematicidal potentials of pirimiphosmethyl and leaf extracts of *Ocimum gratissimum* in the control of *Meloidogyne incognita* on cowpea, M. Sc. Dissertation Department of Agric. Biology, University of Ibadan. 1989;205.
27. Jahn SA. *Moringa oleifera* for food and water purification – selection of clones and growing of annual short stems. Entwicklung Landlicher Raum. 1989;23(4): 22-25.

28. Ajayi VA. Comparison of nematicidal potential of *Vernonia amygdalina* (Bitter leaf) and carbofuran (Furadan) on the growth and yield of root-knot infested soybean *Glycine max* L. M.Sc. Dissertation, University of Ibadan. 1990;283.
29. Guzman RS. Toxicity screening of various plant extracts, *Anthocephalus chinensis* (Lamb.) Rich. ex Walp., *Desmodium gangeticum* (Linn.) DC., *Artemisia vulgaris* Linn., *Eichhornia crassipes* (Mart.) Solms, *Leucaena leucocephala* (Lam.) De Wit., *Allium cepa* Linn., *Allium sativum* Linn. and *Moringa oleifera* Lam. against Meloidogyne incognita Chitwood and *Radopholus similis* Cobb and characterization of their nematicidal components. Ph.D Thesis University of the Philippines at Los Banos, College, Laguna Place College, Laguna (Philippines). 1984;197.
30. Mafeo TP, Mashela PW. Allelopathic inhibition of seedling emergence in dicotyledonous crops by Cucumis bio-nematicide. African Journal of Biotechnology. 2010;9:49.
31. Hackney RW, Dickerson OJ. Marigold, castor bean, and chrysanthemum as controls of *Meloidogyne incognita* and *Pratylenchus alleni.* Journal of Nematology. 1975;7:84-90.
32. Sellami S, Mouffarah A. Effect of aqueous plant extracts on juvenile hatching and larval mortality against Meloidogyne incognita. Medelingen Faculteit-Land Bouwkundige-EN TOEYE Paste lologi shewntensch APPEN Univesitei Gent. 1994;59(26):813-816.
33. Adomako J, Kwoseh CK. Effect of castor bean (*Ricinus communis* L.) aqueous extracts on the performance of root-knot nematodes (*Meloidogyne* spp.) on tomato (*Solanum lycopersicum* L.). Journal of Science and Technology. 2013;1-11.
34. Barker ADP. Novel approaches to potato cyst nematode control. In Abstracts Conference on Potato Production - Living with Pesticide Changes, York, 25 November 2003.
35. Hasabo SA, Noweer EMA. Management of root-knot nematode Meloidogyne incognita on Eggplant with some plant extracts. Egyptian Journal of. Phytopathology. 2005;33(2):65-72.
36. Ranjitsingh KN, Sucheta KR. Effect of plant root extract to control root-knot nematode (*Meloidogyne* spp) of soybean (*Glycine max*). Biological Forum-International Journal. 2009;1(1):65-68.
37. Ndana RW, Oyedunmade EEA. In vitro Studies of the effectiveness of five plants extracts compared to Carbofuran in controlling the root - knot nematode Meloidogyne incognita. Agrosearch No. 2009;1&2:1-10.
38. Konstantopoulou I, Vassilopoulou L, Mawogantisi PP, Scouras G. Insecticidal effect of essential oils: A study of essential oils extracted from eleven Greek aromatic plants on *Drosophila auroria.* Experientia. 1994;48:616–619.
39. Khan AF. Nematicidal potential of some naturally growing medicinal plants against *Pratylenchus zeae.* Reveu de Nematolologie. 1990;13(4):463-465.
40. Joymati L, Dhanachand C, Devi LS. Effect of plant extracts on Meloidogyne incognita. Indian Journal of Nematology. 1998;28: 225-230.

Peer-review history:
The peer review history for this paper can be accessed here:
http://prh.sdiarticle3.com/review-history/27122