Effect of some Botanical Extracts on the management of *Meloidogyne incognita* and on Growth of Tomato.

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. Nematodes have one of the major pests affecting tomato production worldwide, especially, in the tropical and sub-tropical regions. Screen 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 Makurdi screen house. The soil was sterilized before the experiment. Fresh leaves and seeds of Moringa, Castor bean and Jatropha were washed with tap water 15 g each of leaves and seeds of the different botanicals were macerated separately in an electric blender at high speed for 4minutes in 100ml distilled water. The mixtures were passed through a Whatman filter paper, the filtrates of the leaves/seed were then collected. Three tomato varieties viz: Roma Vf, Rio Grande and UC82B were inoculated with approximately 5000 freshly hatched *Meloidogyne incognita* juvenile two weeks after transplanting. 30%v/v aqueous extract of castor, moringa and Jatropha leaves and seeds were used, while distilled water (0%) served as the control. 30ml of various leaves and seed aqueous extracts was applied 48 hours after inoculation as soil drench. Application was done at 1weeks intervals thereafter for a period of 16weeks. Data collected include number of fruits per plant, root gall index, nematode reproductive factor, and final nematode population. The results showed that various 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 led to significant increase in mean number of fruits and mean fruit weight yield of all the three tomato varieties. Therefore, the application of leaves and seed aqueous extract of Moringa, Jatropha and Castor will serve as good alternative for the management of root knot nematode population.

Keywords: Tomato, Botanical extracts,*M.incognita*

Comment [AK1]: Nematicidal effect

Comment [AK2]: For

Comment [AK3]: Write recent name

Comment [AK4]: Root knot nematodes

Comment [AK5]: Pest

Comment [AK6]: Green

Comment [AK7]: Remove it

Comment [AK8]: Italic

Comment [AK9]: Italic

Comment [AK10]: Write botanicals name

Comment [AK11]: Space

Comment [AK12]: Double distilled water

Comment [AK13]: Specify number

Comment [AK14]: Italic

Comment [AK15]: Hatched second stage juveniles of

Comment [AK16]: Remove it

Comment [AK17]: Double distilled

Comment [AK18]: Thirty

Comment [AK19]: Space

Comment [AK20]: Write name of botanicals

Comment [AK21]: Name of treatment

Comment [AK22]: Meloidogyne incognita

Comment [AK23]: Arrange alphabetically

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 feed (2). It is also found to have medicinal value as it is important in weight 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 (27). (4) Identified nematodes as one of the major pests affecting tomato production worldwide, especially, in the tropical and sub-tropical regions. (5) stated that plant parasitic nematodes attack seedling roots after emergence there by affecting crop productivity. (6) Reported that a lot of plant species such as tomato, amaranth, soy bean, yam tubers, cassava, maize,rice e.t.c are prone to attack by the root-knot nematode.

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 and 9). Alternatively, research has focused on antagonistic plants (10, 26). These compounds can be developed for use as nematicides or they can serve as model compounds for the development of derivatives with enhanced activity or environmental friendliness (11). The objective of the study was to determine the effect of botanical extracts from leaves and seed of Moringa, Jatropha and castor on root-knot nematode infesting three Tomato varieties

Comment [AK24]: Italic

Comment [AK25]: Remove it

Comment [AK26]: Nematodes

Comment [AK27]: Natural nematicides

Comment [AK28]: Italic

Comment [AK29]: Meloidogyne incognita

MATERIALS AND METHODS

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

Soil Sterilization

The Soil for the pot experiment was sterilized using the steam sterilization method, using a metal barrel steam sterilizer. The steam sterilizer has two chambers, the lower chamber contained water and the upper part the soil. The soil was covered with wet jute sacks to conserve steam in the chamber. Fire wood was used as the source of heat. The soil was sterilized for 30 minutes at 100^{o} C; it was then left for 48hrs before used.

Comment [AK30]: Remove it

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 was lightly poured on it 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.

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 5000 root-knot nematode (*M. incognita*) juveniles. Inoculation took place one week after transplanting with the use of a syringe 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.

Comment [AK31]: Second stage juveniles of Meloidogyne incognita

Comment [AK32]: Pipette

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 each of leaves and seeds of the different plant (Castor, Jatropha and Moringa) were macerated separately in an electric blender at high speed for 4 minutes in 100ml 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

Application of Treatments

The stands were treated with 30ml of various leaves and seed aqueous extracts 48 hours after inoculation. The untreated seedlings/stand served as the controls. Application of the botanical extracts was done at weekly intervals thereafter until harvest.

Comment [AK33]: Specify plant name

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.

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.

RESULTS

Table 1 shows no significant difference ($P>0.05$) among the varieties on root gall index. However, there are differences ($P<0.05$) between the varieties in nematode final populations and reproductive factor, Roma VF recorded the highest final population and reproductive

factor of 2228 J_2/200g of soil and 0.45 while Rio Grande recorded the least population and reproductive factor of 1461J_2/200g and 0.29 respectively.
On the mean number of fruits, there was no significant difference (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 was significant difference (P<0.05) between the botanical extracts on root-knot nematode parameters and yield parameters. 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_2/200g of soil. Moringa leaf recorded the least final root-knot nematode population of 200 J_2/200g of soil. Similarly, Moringa leaf recorded0.04 reproductive factors.
There was significant difference (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 2 shows that there was no significant difference (P<0.05) between 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 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 between the varieties treated with different botanical extracts. Plants treated with Jatropha leaves and seed 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).

Table 1: Effect of botanical extracts applied on Tomato Varieties on Root-Knot Nematode on Final Population, Reproductive Factor, Root Gall Index and Yield in Pot Experiment

Varieties	Root-Knot Nematode Parameters				Yield parameters	
	Root Gall Index (RGI)	Initial Population (Pi)	Final Population (Pf)/200g 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**

157 **NS= Not Significant, FLSD= Fishers Least Significant Difference**

158

159

Table 2: Effect of Botanical Extracts on Root-Knot Nematode, Final Population, Reproductive Factor, Root Gall Index and Yield of Infected Tomato in Pot Experiment

Botanical Extracts	Root- Knot Nematode Parameters				Yield Parameters	
	Root Gall Index (RGI)	Initial Population (Pi)	Final Population (PF)/200g 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

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)/200g 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

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 parasitic nematodes is now the focus of researchers because they are eco-friendly, easy degradable, cost effective and also available. (27)

From this research, leaves and seed extracts from castor, moringa and Jatropha were able to 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.

This is in line with different promising results carried out by different researchers on the management of root knot nematode using different botanicals extracts.

On a studies carried out by (12) indicated that some pant parts caused reduction in gall formation by the root knot nematode. (13) Also found that application of sesame seed extract reduced the incidence of root knot nematodes and the severity of galling on okra roots. Previous studies indicated that some pant parts caused reduction in gall formation by the root knot nematode (12)

Report by (14) pointed out that Moringa leaf powder was not phytotoxic to sweet pepper plants but led to increase and even suppress nematode population. The soil populations of root-knot nematode juveniles were found to be significantly reduced within six months under the host plants most damaged by *Meloidogyne* spp (15).

(16) Also stated that plant extracts of basil, marigold, pyrethrum, neem and china berry are effective in the reduction of nematode population in soil. (17) Reported a reduction in number of egg masses, number of females and final larval population of the soil is a strong indication of the ability of neem leaf extract to control root-knot nematode in tomato.

(18) Found a positive correlation between number of Jatropha species and percentage reduction in nematode final population as well as percent reduction in root gall index caused by the root-knot nematode. So, from his study application of 4 plants of Jatropha caused the greatest reduction in the root gall index (83 % and 72% for *J. curcas* and *J. gossypiifolia* respectively). According to (19), sesame seed extracts have a systemic 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 (20) 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. (21) Reported the extracts of neem seeds, leaves and bark had the ability to significantly suppress root galling index and reduce population of *M. javanica* juvenile on sweet gourd.

The reduction in population of root-knot nematodes, nematode reproductive factor and number of root galls formed could be due to the ability of active ingredients present in the botanical extracts (castor,Jatropha and moringa) to get in contact with juveniles. This agrees with the findings of (13) that reported reduction on nematode final population and root

Comment [AK34]: Add plant

Comment [AK35]: Easily

Comment [AK36]: Remove it

Comment [AK37]: Remove it

Comment [AK38]: Italic

Comment [AK39]: Remove it

Comment [AK40]: Italic

Comment [AK41]: Italic

Comment [AK42]: Add second stage

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 effectively of different test plant extracts could be due to the differences in the chemical compositions and concentrations of toxic components contain in the plant material which led to higher yield from the treated plants as compared to the untreated. This agree with the findings of (22) 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 led to 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 extract. This is in line with the findings of (15) who also reported a lower reproductive factor (Pf) in tomato when treated with Crotalaria, *C. juncea* and African marigold (*T. erecta*) plants a. The finding of this studies agrees with (23) who pointed out that 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 botanicals extract on nematode affecting cowpea they pointed out that active ingredients contained in the plant materials suppressed the nematode populations in the field. (25) Also reported similar findings of the efficacy of neem compost on nematodes in spinach. Several other 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 (22).

CONCLUSION

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

Comment [AK43]: Italic

Comment [AK44]: Present

Comment [AK45]: Remove it

Comment [AK46]: Italic

Comment [AK47]: ???????

Comment [AK48]: Italic

REFRENCES

1. **Sesso H.D, Lius, Gaziamo J.M. (2003) Dietary lycopene tomato- based food products and cardiovascular disease in women.**
2. **Tindall H.D. (2005) Commercial vegetable growing. Oxford University press**
3. **Mumtaz K.J. (2003). The facts of Tomatoes.INDIAN COOK. Bawachi health and nutrition**
4. **Berlinger, M. J. (1986). Pest in the tomato crop: A scientific basis for improvement. Atherton, J.G and Rudich, J. (eds). Chapman and Hall, London. pp 391-432.**
5. **Ploeg, A.T. (2002). Effect of selected marigold varieties on root-knot nematodes and tomato and melon yields. *Plant Diseases*. 86: 505-508.**
6. **Sasser, J. N. and Carter, C.C. (1985). An Advance Treatise on *Meloidogyne* Vol 1, Biology and control. North Carolina State Uni. Raleigh N. Carolina. pp 178-187**
7. **Onalo, J.J.I. (1999). Non-chemical control of yam nematode (*Scutellonema brady*). Ph.D Thesis, University of Ibadan, 176pp.**
8. **Mashela, P.W., Shimelis, H.A. and Mudau, F.N. (2008). Comparison of the efficacy of ground wild cucumber fruits, aldicarb and fenamiphos on suppression of *Meloidogyne incognita* in tomato. *Phytopathology* 156:264-267**
9. **Pakeerathan, K., Mikunthan, G. and Tharshani, N. (2009). Eco-Friendly Management of Root-knot Nematode *Meloidogyne incognita* (Kofid and White) Chit- wood Using Different Green Leaf Manures on on Tomato under Field Conditions. American Eurasian Journal of Agriculture & Environmental Science., 6 (5): 494-497**
10. **Ismail, A.E., (2013). Feasibility of growing moringa oleifera as a mix-crop along with tomato for control of *Meloidogyne incognita* and *Rotylenchulus reniformis* in Egypt. *Archives of Phytopathology and Plant Protection*, 46(12): 1403-1407**
11. **Chitwood, D.J. (2002). Phytochemical based strategies for nematode control. *Annals review of Phytopathology*, 40: 221–249**
12. **Zawam, H.S., M.M.A. Youssef and M.H. El-Hamawi, 2003. Effect of lantana (*Lantana camara*) and castor (*Ricinus communis*) as green manure plants on *Meloidogyne javanica* infecting sunflower (*Helianthus annus*) plant. In the Tenth Congress of Phytopathology. *Egyptian Phytopathological Society* of December 2003, Giza. (Egypt), pp: 97-104.**
13. **Sikora, R. A and E. Fernandez. (2005). 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.**
14. **Sowleya, E.N.K., Kankama, F. and Adomakob J. (2013) Management of root-knot nematode (*Meloidogyne* spp.) on sweet pepper (*Capsicum annuum* L.) with moringa (*Moringa oleifera* Lam.) leaf powder*Archives of Phytopathology and Plant Protection***
15. **Bello, T.T. Fawole B., and Claudius-Cole, A. (2014). Management of Root-Knot Nematodes (*Meloidogyne* Spp) on Tomato using Antagonistic Plants *Journal of Biology, Agriculture and Healthcare*Vol.4, No.24**
16. **Azhar, R.M. and Seddiqu, M. (2007). Nematicidal Effects of Some Botanical against Root-Knot Nematode, (*Meloidogyne javanica*) on Tomato. *International Journal of plant Science*.,2:49-52**

17. Fassuliotis, G. (1985). The role of the nematologist in the development of resistant cultivars. Pp. 233-240 in J. N. Sasser, and C. C. Carter, eds. An advanced treatise on *Meloidogyne*, Vol. I Biology and Control, Raleigh: North Carolina State University Graphics.
18. Ismail, A. and S.A. Hassabo, (2014). Eco-friendly management of reniform nematode, *Rotylenchulus reniformis* using *Jatropha curcas* and *Jatropha gossypiifolia* as an intercropping with sunflower in Egypt. *Acta Advances in Agricultural Sciences*: In Press, 2(6). Under Pressing.
19. Akhtar, M. and Mahmood, I. (1993). Control of plant parasitic nematodes with "Nimin" and some plant oils by bare- root dip treatment. *Nematologia Mediterranea* 21: 89-92
20. Abid, M: M, A. Zaki and M.A M.A Magbool (1995): Effect of bare root dip treatment in oil-cake and neem leaf extract on root development and growth of tomato and eggplant. *Nematology*. 9 (1) 13-16
21. Yasmin, L., Rashid, M.H., Nazim Uddinm, M., Hossain, M.S. Hossain, M.E. and Ahmed, M.U. (2003). Use of Neem Extract in Controlling Root-knot Nematode (*Meloidogyne javanica*) of Sweet - gourd. *Pakistan Journal of Plant Pathology*., 2 (3): 161-168.
22. Izuogu N.B, Yakubu L.B, Abolusoro S.A and NwabiaI.W. (2015) Efficacy of Aqueous Leaf Extracts of Negro Coffee (*Cassia occidentalis*) and Lemon Grass (*Cymbopogon citratus*)in the Management of Nematode Pests of Okra (*Abelmoschus esculentus* L. Moench). *Science, Technology and Arts Research Journal* 4(3):
23. Olabiyi, T.I. and E.E.A. Oyedunmade (2005). Effects of carbofuran and aqueous extracts of Basil (*Ocimum gratissimum* L.) in thecontrol of a root- knot nematode, *Meloidogyne incognita* on *Celosia argentea* (L.). *Journal of Agricultural Research and Development*, 4(2): 228-235.
24 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
25. Olabiyi, T.I., Atungwu, J.J., Izuogu, N.B., Akintola, J. and Abolusoro, S.A (2013). Efficacy of Neem Compost on Root Knot Nematode Pest of Lagos Spinach, *Celosia argentia*. *Archives of Phytopathology and Plant Protection* 46(18): 2253-2258
26. Oluwatayo, J. I., Asiedu, R. and Adesiyan S. O (2011) Allelophathic potential of plant extracts against *Scutellonema bradys*. *African Journal of Root and Tuber Crops*. 9(1) 30-37. International society for root and tuber crops – Africa Branch (ISTRC-AB). IITA, LW. Lambourn and co., Dingwall Road, Croydon CR9 3EE, England UK (28-35)
27. Jidere,C.I. and Oluwatayo J.I (2018) The effectiveness of Botanical Extracts on Root-Knot Nematode (*Meloidogyne incognita*) Egg-Hatch and Juvenile Mortality in Vitro. Asian Journal of Agriculture and Horticultural research