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Nematicidal activities of carbofuran and some organic materials on plant parasitic nematode control on tomato

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Abstract. The effect of nematicidal activities of carbofuran and some organic (plant) materials on plant parasitic nematode control on tomato were studied in the field in Nigeria during 2005-2006. The plant materials used for nematode control were the leaves of bitter leaf (*Vernonia amygdalina*) and brimstone (*Morinda lucida*), and the peels of the fruit of sweet orange (*Citrus sinensis*) and neem (*Azadirachta indica*). The treatments were applied in aqueous (liquid) and powder (solid) forms. The aqueous extracts of the plant materials were applied at the rates of 25, 50, 75, and 100% while the powder form were applied at 0.5, 1.0, 1.5 and 2.0 t/ha. Carbofuran was also applied in liquid (2500, 5000, 7500 and 10000 ppm) and solid (1.0, 1.5, 2.0 and 2.5 kg a.i/ha) forms. The experimental plots where no treatment was applied served as the control. All treatments were significantly more effective than the untreated control in increasing the height, number of leaves, fruit number and weight per tomato plant. Moreover, carbofuran and plant materials at all concentrations and forms of application significantly reduced the population of plant parasitic nematodes in the roots of tomato and soil, and also reduced root gall index of tomato. It was concluded therefore that these plant materials can be used instead of carbofuran to control nematodes in tomato.

Keywords. *Azadirachta indica*, carbofuran, *Citrus sinensis*, *Morinda lucida*, nematodes, organic materials, tomato, *Vernonia amygdalina*.

INTRODUCTION

Tomato, *Lycopersicon esculentum* (L.) Mill. of Solanaceae family, is an important fruit vegetable which contains a very powerful antioxidant (lycopene) which can help prevent the development of many forms of cancer. Tomato has an appreciable protein as well as vitamins A, C and D content (Van Eck *et al.*, 2006). The crop has a high fruit yield in the Americas, Europe and India but the yield is low in Nigeria as a result of attack by insect pests and pathogens notable among which are the plant parasitic nematodes (Olabiyi, 2005).

Tomato is often affected by fungal and bacterial diseases, and susceptible cultivars suffer from virus diseases and often massive infection by nematodes. A relatively poorer yield of tomato in southern Nigeria has been attributed to nematode diseases (Alofe and Somide, 1982). Root knot nematode infection has been reported as one of the limiting factors in tomato cultivation which in some cases results in 90-100% yield loss of the crop under no appropriate management (Olabiyi, 2008). Nematode infection has been reported to cause 80-90% yield loss in susceptible tomato varieties (Ogunfowora, 1977). Susceptible and resistant tomato varieties have been reported in Nigeria (Wonang & Akueshi, 1990).

The use of plant materials in nematode management on tomato is desirable in Nigeria because of the low cost and technology involvement as well as environmental and crop safety (Oyedunmade, 2004). This study was therefore carried out to compare the nematoxic effects of carbofuran with the aqueous extracts of the leaves of bitter leaf and brimstone, and the dry powder of the fruit peels of sweet orange and neem in the control of plant parasitic nematode infections of tomato in Nigeria over two consecutive years (2005-2006).

Table 1. Effects of levels and forms of application of carbofuran and organic (plant) materials on mean number of leaves per tomato plant infected with nematodes.

MATERIALS	2005 trial 6 WAP	2006 trial 6 WAP	2005 trial 8WAP	2006 trial 8WAP	2005 trial 10 WAP	2006 trial 10 WAP	2005 trial 12 WAP	2006 trial 12 WAP
Carbofuran	8.52ab	8.57a	15.32	15.93	33.94c	34.60d	39.35c	39.12b
Morinda lucida	8.23a	8.31a	15.16	15.76	32.96b	32.50bc	37.92bc	38.00b
Vernonia amygdalina	8.80b	8.91b	14.93	16.00	34.62c	33.60d	39.23c	38.45b
Azadirachta indica	8.48ab	8.49a	15.55	16.15	29.89a	30.16a	35.95a	34.86a
Citrus sinensis	8.5 lab	8.59a	15.22	16.21	31.96a	37.75b	37.58bc	37.70a
S.E.	0.104	0.115	0.334 NS	0.406 NS	0.514	0.487	0.484	0.700
LEVELS (Treatment combinations)	**2005 trial 6 WAP**	**2006 trial 6 WAP**	**2005 trial 8 WAP**	**2006 trial 8 WAP**	**2005 trial 10 WAP**	**2006 trial 10 WAP**	**2005 trial 12 WAP**	**2006 trial 12 WAP**
Control	7.52a	7.82a	13.26a	14.11a	21.60a	19.88a	24.18a	3.06a
0.5 t/ ha, 1.0 kg a.i/ ha, 25%, 2500 ppm	8.70b	18.60b	15.51b	16.03b	32.66b	32.18b	37.60b	36.58b
1.0 t/ ha, 1.5 kg a.i/ ha, 50%, 5000 ppm	8.67b	8.78b	15.57b	16.20b	34.41c	35.17c	40.45c	40.35c
1.5 t/ ha, 2.0 kg a.i/ ha, 75%, 7500 ppm	8.82b	8.74b	15.96b	16.84b	36.08d	36.40c	42.95d	42.23d
2.0 t/ ha, 2.5 kg a.i/ ha, 100%, 10000 ppm	8.84b	8.92b	15.88b	16.86b	37.56e	38.72d	44.86e	43.93e
S.E.	0.104	0.115	0.334	0.406	0.514	0.487	0.484	0.700
FORMS OF APPLICATION	**2005 trial 6 WAP**	**2006 trial 6 WAP**	**2005 trial 8 WAP**	**2006 trial 8 WAP**	**2005 trial 10 WAP**	**2006 trial 10 WAP**	**2005 trial 12 WAP**	**2006 trial 12 WAP**
Powder fruit peels (Solid)	8.46a	8.59a	15.00a	15.53a	32.63b	32.68b	38.18b	37.84b
Aqueous leaf extracts (Liquid)	8.55a	8.53a	15.47a	15.55a	32.30a	32.26a	37.82b	37.69a
S.E.	0.65	0.308	0.211	0.215	0.325	0.308	0.306	0.313

WAP = Weeks After Planting.

MATERIALS AND METHODS

Collection and preparation of test plants

The organic (plant) materials used for nematode control in this experiment were: the leaves of bitter leaf (*Vernonia amygdalina*) and brimstone (*Morinda lucida*), and the peels of the fruit of sweet orange (*Citrus sinensis*) and neem (*Azadirachta indica*). The materials were collected separately and air-dried on the laboratory bench for a month under the ambient temperature of 28±2°C, and thereafter crushed into powder with an attrition mill. For the extract preparation, 1 kg of each of the materials was crushed into powder, thereafter soaked in 1 litre distilled water in a 2 litre conical flask for 24 hours, after which the content of the flask was filtered through a one mm sieve. The resultant filtrate was taken as the stock solution of 100% concentration from which serial dilutions were made with distilled water to obtain 75, 50 and 25% concentrations The crushed plant materials in powder form were weighed on a sensitive scale.

Table 2. Effects of levels and forms of application of carbofuran and organic (plant) materials on mean plant height (cm) of tomato infected with nematodes.

MATERIALS	2005 trial 6 WAP	2006 trial 6 WAP	2005 trial 8 WAP	2006 trial 8 WAP	2005 trial 10 WAP	2006 trial 10 WAP	2005 trial 12 WAP	2006 trial 12 WAP
Carbofuran	17.53a	17.64a	38.45	38.76	71.33b	71.64b	75.87b	76.66b
Morinda lucida	18.24b	18.67b	38.50	38.65	70.41b	71.33b	75.87b	75.42b
Vernonia amygdalina	17.19a	17.50a	39.36	39.64	69.57b	70.21b	75.87b	73.66b
Azadirachta indica	17.19a	17.66a	37.92	38.10	63.00a	63.19a	67.55a	66.95a
Citrus sinensis	17.38a	17.69a	37.92	37.75	63.01a	62.42a	68.36a	66.90a
S.E.	0.197	0.918	0.624	0.918	1.007	1.058	0.911	1.058
			NS	NS				
LEVELS (Treatment combinations)	**2005 trial 6 WAP**	**2006 trial 6 WAP**	**2005 trial 8 WAP**	**2006 trial 8 WAP**	**2005 trial 10 WAP**	**2006 trial 10 WAP**	**2005 trial 12 WAP**	**2006 trial 12 WAP**
Control	16.82a	17.26a	36.42ab	36.28a	47.56a	47.06a	50.37a	49.05a
0.5 t/ ha, 1.0 kg a.i/ ha, 25%, 2500 ppm	17.63b	17.94ab	38.90bc	39.13b	69.70b	67.94b	73.65b	72.02b
1.0 t/ ha, 1.5 kg a.i/ ha, 50%, 5000 ppm	17.45b	17.72ab	37.56ab	38.06ab	73.25cd	74.89cd	78.36c	80.16d
1.5 t/ ha, 2.0 kg a.i/ ha, 75%, 7500 ppm	17.62bc	17.90ab	39.49c	39.69b	73.25cd	74.89cd	78.36c	80.16d
2.0 t/ ha, 2.5 kg a.i/ ha, 100%, 10000 ppm	18.18c	18.53b	39.42c	39.74b	75.46d	76.86d	81.63d	81.79d
S.E.	0.197	0.918	0.624	0.918	1.007	1.058	0.911	1.058
FORMS OF APPLICATION	**2005 trial 6 WAP**	**2006 trial 6 WAP**	**2005 trial 8 WAP**	**2006 trial 8 WAP**	**2005 trial 10 WAP**	**2006 trial 10 WAP**	**2005 trial 12 WAP**	**2006 trial 12 WAP**
Powder fruit peels (Solid)	17.50	17.84	38.10	68.37	67.56b	68.57b	72.18	72.92b
Aqueous leaf extract (Liquid)	17.58	19.84	38.60	67.30	67.38a	67.30a	72.20	69.57a
S.E.	0.125	0.172	0.394	0.794	0.637	0.794	0.576	0.669
	NS	NS	NS	NS			NS	

Ground preparation in the field

In each of the two planting seasons of 2005 and 2006, an area of land measuring approximately 500 m^2 was ploughed and later constructed into beds (3 m×3 m). The land was divided into 4 blocks and marked out to accommodate a 5×5×2 factorial experiment with 4 replicates fitted into a randomized complete block design. Spaces were left between the blocks (1 m), plots (0.5 m) and sub-plots (0.5 m) to prevent treatment interactions.

Planting and treatment application

Four-weeks-old tomato seedlings that were previously raised on steam sterilized soil in the nursery were transplanted into the field at a spacing of 60 cm×60 cm on the beds. Treatments were applied a week after transplanting close to tomato roots (5 cm radius) by banding. The aqueous extracts of plants were applied at the rates of 25, 50, 75, and 100% while the powder form was applied at the rate of 0.5, 1.0, 1.5 and 2.0 t/ha.

Table 3. Effects of levels and forms of application of carbofuran and organic (plant) materials on the mean number of fruit and fruit weight (g) produced per tomato plant infected with nematodes.

MATERIALS	Mean number of fruits per plant		Mean fruit weight (g) per plant	
	2005 trial	2006 trial	2005 trial	2006 trial
Carbofuran	18.35c	17.09c	436.01c	405. 70d
Morinda lucida	16.58b	16.49c	391.33b	390.30c
Vernonia amygdalina	15.36b	15.67b	376.67b	376.00bc
Azadirachta indica	15.28b	15.09b	369.33b	365. 70b
Citrus sinensis	14.20a	14.40a	328.33a	332.00a
S.E.	0.221	0.683	0.023	0.021
LEVELS	**Mean number of fruits per plant**		**Mean fruit weight (g) per plant**	
(Treatment combinations)	**2005 trial**	**2006 trial**	**2005 trial**	**2006 trial**
Control	6.71a	6.94a	98.00a	102.00a
0.5 t/ ha, 1.0 kg a.i/ ha, 25%, 2500 ppm	15.74b	16.00b	369.70b	368.00b
1.0 t/ ha, 1.5 kg a.i/ ha, 50%, 5000 ppm	17.22c	17.30c	407.70c	400.30c
1.5 t/ ha, 2.0 kg a.i/ ha, 75%, 7500 ppm	18.63d	18.60d	485.33d	472.71d
2.0 t/ ha, 2.5 kg a.i/ ha, 100%, 10000 ppm	19.96e	19.50e	532.67e	521. 60e
S.E.	0.221	0.683	0.023	0.021
FORMS OF APPLICATION	**Mean number of fruits per plant**		**Mean fruit weight (g) per plant**	
	2005 trial	**2006 trial**	**2005 trial**	**2006 trial**
Powder fruit peels (Solid)	16.05b	16.03b	390.67b	389.67b
Aqueous leaf extracts (Liquid)	15.32a	15.28a	357.33a	369.00a
S.E.	0.144	0.0164	0.034	0.034

Carbofuran was also applied in both liquid and solid forms. The liquid form was applied at the rate of 2500, 5000, 7500 and 10000 ppm while the solid form was applied at 1.0, 1.5, 2.0 and 2.5 kg a.i/ ha. The experimental plots where no treatment was applied served as the control. Each treatment, including the control, was replicated 4 times.

Data collection and analysis

Plant height and number of leaves/plant were measured and recorded at 6, 8, 10 and 12 weeks after planting (WAP). Data was also collected on the number of fruits and fruit weight. Soil samples were collected randomly in a zigzag pattern at final harvest, and thereafter assayed for plant parasitic nematode population after extracting the nematodes using method of Whitehead & Hemming (1965). Immediately at final harvest, tomato roots were rated for galls using a scale of 0-5 described by Taylor & Sasser (1978) while the number of nematode juveniles' in 5 g root samples was also estimated. All the data collected were subjected to analysis of variance and where necessary, means were partitioned using Duncan's (1955) Multiple Range Tests at 5% probability level.

RESULTS

Table 1 shows the effect of carbofuran and plant extracts in powder (solid) and aqueous (liquid) forms on the mean number of leaves of tomato infected with plant-parasitic nematodes. In most cases, the number of leaves produced by tomato treated with carbofuran and plant extracts was not significantly different at 8 weeks after planting (WAP) during both the 2005 and 2006 trials from the untreated control. However, at 6, 10 and 12 WAP, plant extracts (*Morinda lucida, Vernonia amygdalina, Azadirachta indica, Citrus sinensis*) and carbofuran treatments seemed to be significantly more effective than the untreated control in increasing the number of leaves per tomato plant. Table 2 shows the effect of carbofuran and

Table 4. Effects of levels and forms of application of carbofuran and organic (plant) materials on mean final soil nematode population, number of nematode juveniles in 5 g root and root gall index of infected tomato.

MATERIALS	Final nematodes population per 200 ml soil									
	Meloidogyne spp.		*Pratylenchus* spp.		*Scutellonema* spp.		No. of juv./5 g root		Root gall index	
	2005 trial	2006 trial	2005 trial	2006 trial	2005 trial	2006 trial	2005 trial	2006 trial	2005 trial	2006 trial
Carbofuran	962.25a	972.43a	10.93	15.55	2.59	5.17	12.63a	13.83a	2.30a	2.45a
Morinda lucida	1063.55b	1034.30b	15.12	12.32	3.51	7.85	12.87a	14.10ab	2.81b	2.86b
Vernonia amygdalina	1070.23b	1074.65c	10.99	11.97	2.97	6.59	14.00b	14.67bc	2.94b	2.99bc
Azadirachta indica	1097.90c	1098.49c	20.36	18.79	1.75	4.83	14.90c	15.20c	3.22c	3.14cd
Citrus sinensis	1117.88d	1108.63c	17.35	19.13	4.56	3.28	15.83d	16.20d	3.40d	3.26d
S.E.	6.937	14.351	NS	NS	NS	NS	0.243	0.207	0.53	0.059
LEVELS	*Meloidogyne* spp.		*Pratylenchus* spp.		*Scutellonema* spp.		No. of juv./5 g root		Root gall index	
(Treatment Combinations)	2005 trial	2006 trial	2005 trial	2006 trial	2005 trial	2006 trial	2005 trial	2006 trial	2005 trial	2006 trial
Control	2473.50e	2454.65e	40.76b	69.52b	14.15b	12.96b	25.90e	27.73e	4.15d	4.35c
0.5 t/ ha, 1.0 kg a.i/ ha, 25%, 2500 ppm	870.40d	865.48d	3.81a	2.96a	0.86a	1.20a	15.43d	16.27d	2.85c	2.83b
1.0 t/ ha, 1.5 kg a.i/ ha, 50%, 5000 ppm	764.20c	770.61c	6.55a	2.35a	1.01a	1.56a	12.23c	12.60c	2.77c	2.67b
1.5 t/ ha, 2.0 kg a.i/ ha, 75%, 7500 ppm	649.82b	648.48b	4.07a	3.51a	2.11a	1.79a	9.27b	9.67b	2.54b	2.50a
2.0 t/ ha, 2.5 kg a.i/ ha, 100%, 10000 ppm)	553.87a	549.28a	4.075a	1.08a	2.34a	1.85a	7.40a	7.73a	2.37a	2.34a
S.E.	6.937	14.351	0.193	0.207	0.153	0.256	0.243	0.207	0.53	0.059
FORMS OF APPLICATION	*Meloidogyne* spp.		*Pratylenchus* spp.		*Scutellonema* spp.		No. of juv./5 g root		Root gall index	
	2005 trial	2006 trial	2005 trial	2006 trial	2005 trial	2006 trial	2005 trial	2006 trial	2005 trial	2006 trial
Powder of fruit peels (Solid)	1025.58a	1022.63a	5.07	4.75	2.43	2.58	13.49a	14.09a	2.95a	2.891a
Aqueous leaf extract (Liquid)	1099.14b	1092.70b	3.15	3.89	2.12	3.17	14.60b	15.51b	2.91a	2.986a
S.E.	4.387	9.077	NS	NS	NS	NS	0.154	0.131	0.034	0.037

plant extracts on the mean height of tomato infected with plant parasitic nematodes. At 8 WAP there was no significant difference among the treatments but at 6, 10 and 12 WAP, carbofuran and plant extracts treatments were significantly more effective than the untreated control.

The effect of different concentrations of carbofuran and plant extracts in solid and liquid forms on the mean number of fruit and fruit weight (g) of tomato are shown in Table 3. A significant increase in weight and number of fruit was seen as compared with the untreated control with carbofuran treatment showing the highest effect.

Table 4 shows the effect of carbofuran and plant extracts at different concentrations on the soil and root populations of plant-parasitic nematodes, and also root gall index of tomato at final harvest. The results show that these criteria were significantly lower in the carbofuran treatment as compared with the plant extract treatments. All the treatments reduced nematode population in both the soil and root at harvest and moreover in the tomato root damage (gall index) as compared with the control. There was no significant difference in the soil population of *Pratylenchus* and *Scutellonema* nematode species during both trials (2005 and 2006).

DISCUSSION AND CONCLUSION

Carbofuran and the organic (plant) materials effectively controlled plant parasitic nematodes associated with the field tomato during the two planting seasons (2005 and 2006). As a result of these effects, treated tomato plants had better vegetative growth and yield than the untreated control. The extent of root damage (root galls) and nematode population in both the soil and roots was significantly lower in the treated plants than in the untreated control. These types of controlling effects of carbofuran and organic (plant) materials on plant parasitic nematodes have been reported by many workers including Oyedunmade (2004); Oyedunmade *et al.*, (2001) and Olabiyi (2004).

The different application forms of plant materials particularly *Morinda lucida Vernonia amygdalina* and *Azadirachta indica* compared favourably with carbofuran in nematode control. This might suggest the presence of larger quantities of nematicidal/nematoxic properties in *M. lucida*, *A. indica* and *V. amygdalina* than in other test plants. The exhibited nematicidal properties may be due to the presence of flavonoids, tannins, alkaloids and saponins in these plants (Olabiyi *et al.*, 2008a).

The presence of saponins, flavonoids, tannins, sterols, glycosides and alkaloids had been reported in brimstone, *M. lucida* (Olabiyi *et al.*, 2008b). Moreover, significantly increased number of leaves, plant height, number of branches, fresh leaf and root weight, and reduced gall index were recorded for *Celosia argentea* (amaranth) grown in nematode-infested soil and treated with 50 and 100% concentrated aqueous extract, and 1 and 2 t ha^{-1} of brimstone (Olabiyi *et al.*, 2008b). Brimstone contains antiplasmodal, antimicrobial, antifungi and antihelmintic properties (Moody *et al.*, 1994).

Flavonoid (Bose *et al.*, 1993), sterols, alkaloids of pyridine, quinoline and diterpenoids (Arene, 1972) are the active ingredients in bitter leaf, *V. amygdalina*. The release of these active ingredients from *V. amygdalina* leaf incorporated into plant parasitic nematode infested soil have been reported to suppress nematode population build-up, and also resulted in enhanced growth and yield of soybeans (Oyedunmade and Olabiyi, 2004).

Neem leaf extract was found to possess nematicidal activity (Abid & Maqbool, 1991; Siddiqui & Alam, 1989; Olabiyi & Olabode, 2001). The nematode-destroying factors in neem are nimbine, nimbinine, thionemone and margosine-o (Husain *et al.*, 1984). Azadirachtin, a triterpenoid compound, from neem has systemic action against root knot nematode, *Meloidogyne* spp. (Siddiqui & Alam, 1989).

In conclusion, therefore, the findings from this study show that different application forms (solid or liquid) of plant materials (*M. lucida, V. amygdalina, A. indica* and *C. sinensis*) can be used instead of carbofuran in plant parasitic nematode control in tomato.

LITERATURE CITED

Abid, A. and M. A. Maqbool 1991. Effects of bare-root dip treatment in oil cakes and neem leaf extract on the root knot nematode development and growth of tomato and egg plant. *Pakistan Journal of Nematology* 9, 13-16.

Alofe, C. O. and O. Somide 1982. Influence of spacing on the performance of three cultivars of tomato. *Nigeria Journal of Science* 16, 119-127.

Arene, E. O. 1972. 7, 24 (28) Stigmastadien-3# 01 from *V. amygdalina*. *Phytochemistry* 11, 2886-2887.

Bose, P. L., P. Chakrabarti, S. Chatravatis, S. P. Buta and A. K. Barns 1993. Flavonoid. *Phytochemistry* 12, 667-671.

Duncan, D. B. 1955. Multiple range and multiple *F* tests. *Biometrics* 11, 1-42.

Husain, S. I., R. Kumar, T. A. Khan and A. Titov 1984. Effect of root-dip treatment of egg plant seedlings with plant extracts, nematicides, oil cake extracts and anthelmintic drugs on plant growth and root knot development. *Pakistan Journal of Nematology* 2, 79-83.

Moody, J. O., P. J. Hylands and D. H. Bray 1994. Droplet counter currents separation of bio-active

constituents of *Morinda lucida*, Benth root bark. *Pharmaceutical Pharmacology Letters* 4, 29-31.

Ogunfowora, A. O. 1977. The effects of different population levels of *Meloidogyne incognita* on the yield of tomato, *Lycopersicon esculentum* in south western Nigeria. *Journal of Plant Protection* 31, 61-67.

Olabiyi, T. I. 2005. Application of plant materials in the control of nematode pests of tomato in rural areas of Nigeria: A case study. *Afro-Asian Journal of Rural Development* 38, 49-55.

Olabiyi, T. I. 2008. Pathogenicity study and nematoxic properties of some plant extracts on the root knot nematode pest of tomato, *Lycopersicon esculentum* (L.) Mill. *Journal of Plant Pathology* 7, 45-49.

Olabiyi, T. I. and M. O. Olabode 2001. The effects of neem (*Azadirachta indica*) fruits on nematodes in cowpea cultivation. *African Scientist* 2, 73-77.

Olabiyi, T. I., E. E. A. Oyedunmade, G. J. Ibikunle, G. O. Adesina, K. A. Adelasoye and T. A. Ogunniran 2008a. Chemical composition and bio-nematicidal potential of some weed extracts on *Meloidogyne incognita*. *International Journal of Nematology* 18, 29-34.

Olabiyi, T. I., E. E. A. Oyedunmade and G. T. Ibikunle 2008b. Phytochemical screening and nematoxic effect of brimstone, *Morinda lucida*, on nematode pests of amaranth, *Celosia argentea*. *Biological Agriculture & Horticulture* 26, 131-137.

Oyedunmade, E. E. A. 2004. Laboratory and field toxicities of the African marigold (*Tagetes erecta*) to root knot nematodes. *The Plant Scientist* 4, 115-121.

Oyedunmade, E. E. A. and T. I. Olabiyi 2004. In vitro and in-vivo toxic effects of bitter leaf, *Vernonia amygdalina* Del to the root knot nematode, *Meloidogyne incognita*. *Nigerian Society for Experimental Biology Journal* 4, 15-19.

Oyedunmade, E. E. A., O. F. Ayo-Oke and T. I. Olabiyi 2001. Comparative efficacies of soil amendments and a synthetic nematicide on growth, yield and food components of a root-knot infected soyabean (*Glycine max* L. Merrill). *Nigerian Society of Experimental Biology* 1, 367-371.

Siddiqui, M. A. and M. M. Alam 1989. Control of stunt nematode by bare dip in leaf extract of margosa (neem) and Persian lilac (bakain). *Pakistan Journal of Nematology* 71, 33-38.

Taylor, A. L. and J. N. Sasser 1978. Biology, identification and control of root knot nematodes (*Meloidogyne* species). A Cooperative Publication of the Department of Plant Pathology, North Carolina States University and the United States Agency for International Development, Raleigh, North Carolina, pp. 111.

Van Eck, J., D. D. Kirk and A. M. Walmsley 2006. *Methods in Molecular Biology* 343, 459-473.

Whitehead, A. G. and J. R. Hemming 1965. A comparison of some quantitative methods of extracting small vermiform nematodes from soil. *Annals of Applied Biology* 55, 25-38.

Wonang, D. L. and C. O. Akueshi 1990. Relationship between population densities of *Meloidogyne incognita* and crop yield in tomato. *International Nematology Network Newsletter* 7, 38-41.