

COMPARATIVE EFFECTS OF NEEM EXTRACTS AND CARBOFURAN ON THE PERFORMANCE OF OKRA (*Abelmoschus esculentus*) INFESTED BY ROOT KNOT NEMATODE IN KOGI STATE, NIGERIA

¹Hinmikaiye, A.S., ²Izuogu, N.B. & ¹Babalola, T.S.

¹Kabba College of Agriculture, Division of Agricultural Colleges,
Ahmadu Bello University, Zaria, Nigeria

²Department of Crop Protection, University of Ilorin, Ilorin Nigeria
Corresponding Author's email: kaiyesolomon@gmail.com

Abstract

The nematicidal effect of aqueous *Azadirachta indica* (neem) leaf extract and a standard synthetic nematicide, carbofuran were evaluated for their effect on pathogenicity of *Meloidogyne* spp on growth and yield of okra. The experiment was carried out during the 2019/2020 cropping season. There were seven treatments and control replicated three times in a Randomized Complete Block Design to give a total of twenty-four plots. Data collected on growth and yield parameter were subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT) test at 5% level of probability. The results showed the effect of T7 (carbofuran) on okra to be significantly better than all other treatments tested.. Also at harvest, galling was significantly lower in carbofuran treated plants compared to the neem treated plants. The control plants were most galled with poor yield and had stunted growth. The moderate concentrations of both neem (100 and 200 ml aqueous, 100 and 200 ml ethanol, 25 and 50 g powdered neem and 0.26 g of carbofuran performed significantly ($p < 0.05$) better than control plants in suppressing the effects of root-knot nematode on yield and growth of okra. These suggest that the neem extract have nematicidal property and would be effective in the management of root-knot nematodes. Treatment T5 (Powdered neem 25 g) had significantly better plant height and was therefore recommended to farmers in the study area, pending further studies.

Keywords: okra, neem, carbofuran, aqueous, *Azadirachta*

Introduction

Okra (*Abelmoschus esculentus* (L.) moench) belongs to the family Malvaceae. Okra is usually grown in Nigeria for its mucilaginous content. The importance of Okra as a vegetable crop lies in a drawing quality that aids easy consumption of bulky staple food like Eba (made with Gari), Fufu, and pounded yam (Agbogidi and Nweke, 2005). The mucilaginous extract from okra is reportedly useful in curing ulcer as well as the relief of humour hoods and also a dealing agent in sugar processing. (Schippers; (2000) noted that the tender pod of okra contain vitamins A, C and traces of B it provide good source of calcium and other body building minerals that contribute to healthy living. It is native of tropical parts of Africa but it is now widely grown in the tropics. The fruit is a long pod, usually ribbed, spineless in cultivated kinds and harvested when three-four inches long. Pods are

harvested while still tender and immature. It is native of tropical parts of Africa but it is now widely grown in the tropics. It is available all year round, with a peak during summer months (Adekunle and Fawole, 2003). The pods grow rapidly being ready for harvest in about 30-40 days (depending on the variety) when grown from seed. But the plants will continue to bloom and produce pods if they are harvested continuously before they get too large. Root-knot nematodes (*Meloidogyne* spp.) infest almost all types of plants and may cause considerable damage. During surveys, most vegetable crops including okra were found to be affected with *Meloidogyne incognita*. Root-knot nematodes (*Meloidogyne* spp.) are minute, worm-like animals which are very common virtually in every environment. They are major pathogens of vegetables in the world, affecting The quantity and quality of marketable yields.

With severe infestations of nematodes, yield loss ranges between 10-50%, and the use of chemical (synthetic) nematicides have been discouraged because of its residual effects and high toxicity to the soil. At present, Nematode management is complicated and difficult and chemical control is employed in many crops to maintain their populations below economic threshold levels (Abad *et al.*, 2003, Eapen *et al.*, 2005). Therefore, the researcher sorts to compare the effect of neem extracts which are natural nematicides and environmentally friendly with synthetic nematicide (carbofuran) on the growth and yield performances of okra infested with root-knot nematode.

Materials and Methods

Description of Study Location

The experiment was carried out in the Teaching and Research Farm of Kabba College of Agriculture, Ahmadu Bello University, Nigeria during the cropping seasons of 2019/2020. The site is located on the latitude of 07° 35' N and longitude 06° 08' E and is 435 m above sea level, in Southern Guinea Savanna Agro-Ecological Zone of Nigeria. Rainfall usually spans between Aprils to November with the peak in June. The dry season extends from December to March. The mean annual rainfall is 1340 mm per annum with an annual temperature range of 18-32 °C. The mean relative humidity (RH) is 60% (College of Agriculture Meteorological data, 2019). The major soils in the experimental site are Alfisols and Ultisols (Babalola, 2010). The main vegetation of the area were tall grasses, shrub, some trees, plantains, oil palm, etc. Some parts of the site are used for production of arable crops such as cowpea, cassava, maize and tomato.

Field Work

Okra seeds were sourced from Horticultural section of Kabba College of Agriculture, Ahmadu Bello University. The experiment was conducted using single field of dimension 12 m x 8 m (96 m²) which consisted of eight treatments and were replicated three times. The experiment was laid out in a Randomized Complete Block Design (RCBD). The

treatments consisted of Aqueous extract of neem at 100 ml-T1, Aqueous extract of neem at 200 ml -T2, Ethanol extract of neem at 100 ml-T3, Ethanol extract of neem at 200 ml-T4, Powdered neem at 50 g-T5, Powdered neem at 25 g-T6, Carbofuran 1.5 kg ai/ha (0.26 g stand⁻¹) -T7 and control-T8.

Experimental Procedure

Seeds of Okra were sown on a flatbed; three seeds were planted at a spacing of 60 cm x 30 cm. The fully emerged plants were thinned to two healthy plants per stand.

Source of Botanical and Carbofuran

The botanical used, *Azadirachta indica* (neem) was sourced from around Kabba College of Agriculture and synthetic nematicide (carbofuran) was purchased from KI Bello Agro-Allied Nigeria Limited, Ilorin, Kwara State, Nigeria.

Preparation of Botanical

Fresh leaves of *Aradirachta indica* were harvested and chopped into pieces using blender. (1 kg) of botanical were taken and mixed with 1 litre of water and allowed to soak over-night, which was later sieved to obtain 100% test plant extract. From this 100% test plant extract, the different levels of the plant extract were obtained as treatments for application.

Extraction of Nematode Eggs

Galled root was collected from *Ceelosia argentea* on which a pure culture of *Meloidogyne incognita* was raised. The galled root was washed properly under the running tap in order to get rid of the attached soil. The root was cut into smaller pieces and shaken with 5% of Sodium hypochlorite solution (NaOCl) (5 ml Parazone + 5 ml distilled water for about 5 minutes in a Kilner's jar (Hussey and Barker, 1973) in order to digest the gelatinous matrix encasing eggs. This was carried out at Science Laboratory of LandMark University, Omu-Aran, Kwara State.

Inoculation

After fourteen days of planting, the experimental

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plots was inoculated with juveniles of *Meloidogyne incognita*. The size of each plot is 6 by 4 m; the experimental plots were inoculated with 50 g of infested root of *Celosia argentea* containing 1000 of *Meloidogyne incognita* at juvenile stage which was carried out in the field.

Data Collection

Data were collected from the experimental plots in the field one month after sowing. Subsequently, data were collected at weekly interval on the following parameters: Plant height (cm), taken with the measuring tape, number of leaves was obtained by counting numerically, leaf area (cm²) was taking with the use of measuring tape, the midrib length and breadth of 4 leaves of the selected plant was taken and calculated, stem girth at 30 cm from the base of the plant (cm) was taken with the use of Veneer-calipers, average pod weight (kg) obtained with the use of weighing scale, pod length (cm) using measuring tape, number of fruit per plant by numerical counting, pod diameter (cm) also with measuring tape and nematode population was taken at initial stage and final stage.

Data Analysis

Data collected from the experiments were subjected to the analysis of variance (ANOVA) using the SPSS version 21 and where there were significant differences in the means the New Duncan's Multiple Range Test (NDMRT) was used to separate them at a 5% level of significance.

Results

In the preliminary phytochemical investigations, it was observed that alkaloids tannins, phenols, flavonoids, terpenoids, sterols, saponins, glycosides and reducing sugar were present in the neem extract (Table 1). These compounds also served to protect the plant against infections by parasitic nematodes, microorganisms, predations by insects and herbivores, while their odour and flavour are responsible for their pigments (El-Mahmood *et al.*, 2008

Table 1: Phytochemical screening of leaf extracts *Azadirachta indica* in different solvent

Tests	Plant Extracts
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	Aqueous	Ethanol
Alkaloids	+	+
Flavonoids	+	+
Glycosides	+	+
Reducing Sugar	+	+
Terpenoids	-	+
Saponins	-	+
Polysaccharides	+	+
Phytosterols	+	+
Phenols	+	+

+: Present - : Absent

There was significant difference between the treatments for plant height (cm), number of leaves, stem girth (cm), leaf area (m²). The highest plant height was observed in treatment T5 (36.8 cm), powdered neem at 25 g, followed by T7 (36.4 cm) carbofuran at 0.26 g stand⁻¹ (Table 2). The highest number of leaves, stem girth and leaf area was obtained in treatment T7 (carbofuran), followed by T5 (powdered neem 25 g). The least values were observed in T8 (control).

Table 2: Effect of Treatments on Growth Parameter

Treatment	Plant height (cm)	Number of leaves	Stem girth (cm)	Leaf area (m ²)
T1 - Aqueous of neem 100 ml	29.4 ^b	20.4 ^a	1.66 ^a	1.14 ^c
T2 - Aqueous of neem 200 ml	26.8 ^b	19.5 ^a	1.84 ^a	1.08 ^c
T3 - Ethanol of neem 100 ml	32.1 ^{ab}	21.6 ^a	1.96 ^a	1.11 ^c
T4 - Ethanol of neem 200 ml	31.4 ^{ab}	18.7 ^a	1.81 ^a	1.23 ^{bc}
T5 - Powdered neem 25 g	36.8 ^a	22.4 ^a	1.96 ^a	1.31 ^{bc}
T6 - Powdered neem 50 g	29.6 ^b	20.1 ^a	1.87 ^a	1.54 ^{ab}
T7 - Carbofuran	36.4 ^a	22.8 ^a	2.01 ^a	1.63 ^a
T8 - Control	18.3 ^c	13.0 ^b	0.98 ^b	0.71 ^d

Average weight of pod (kg/plot), pod length (cm), pod diameter (cm), and number of fruit per plant, were higher and significantly better in T7 (Carbofuran 0.26g stand⁻¹) compared to all others treatments particularly the Control. The powdered neem of 25 g (T5) had the same pod length with T7 (Carbofuran, 6.1 cm). The Control (T8) had the lowest average pod weight (kg/plot), pod length (cm), pod diameter (cm), and number of fruit per plant (Table 3). The initial nematode population was collected and the final nematode population was also collected (Table 4). The effect of the treatments used to control the nematode population was express mathematically as:

$$\text{Efficiency of material used} = \frac{\text{value of treatment}}{\text{value of control}} \times 100$$

The result show that T7 (Carbofuran at 0.26 g stand⁻¹) was 0.71 time better than the Control,

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T3 was 2 times better than Control while T1 was 9 times better than Control.

Table 3: Effect of Treatments on Yield Parameters

Treatment	Average pod weight (kg/plot)	Pod length (cm)	Pod diameter (cm)	No of fruit per plant
T1 - Aqueous 100 ml	0.71 ^b	4.6 ^b	3.1 ^a	6.2 ^c
T2 - Aqueous of neem 200 ml	0.76 ^{ab}	5.3 ^b	3.1 ^a	7.4 ^c
T3 - Ethanol 100 ml	0.91 ^{ab}	5.8 ^{ab}	3.0 ^a	7.6 ^{bc}
T4 - Ethanol of neem 200 ml	0.94 ^a	5.7 ^{ab}	2.9 ^a	8.3 ^{ab}
T5 - Powdered neem 25 g	0.85 ^{ab}	6.1 ^a	3.4 ^a	9.4 ^{ab}
T6 - Powdered neem 50 g	0.76 ^{ab}	6.0 ^{ab}	3.0 ^a	9.3 ^{ab}
T7 - Carbofuran	0.93 ^a	6.1 ^a	3.6 ^a	10.1 ^a
T8 - Control	0.34 ^c	2.8 ^c	1.9 ^b	3.1 ^d

Table 4: Effect of Treatment on Nematode Population

Treatment	Initial nematode population	Final nematode population	Efficiency of material used
T1 - Aqueous 100 ml	1000	126	9.96
T2 - Aqueous of neem 200 ml	1000	84	6.64
T3 - Ethanol 100 ml	1000	31	2.45
T4 - Ethanol of neem 200 ml	1000	63	4.98
T5 - Powdered neem 25 g	1000	86	6.80
T6 - Powdered neem 50 g	1000	46	3.63
T7 - Carbofuran	1000	9	0.71
T8 - Control	1000	1264	

Discussion

The findings of this study showed that both growth and yield parameters were significantly increased in treatments with neem materials and synthetic nematicide (carbofuran) whether infested with *Meloidogyne spp* compared to the plants that were untreated with botanicals and carbofuran. This could be as a result of the presence of some active ingredient present in carbofuran and test plant (neem extracts). The results also revealed that the chemical components (alkaloids, tannins, phenols, flavonoids, terpenoids, sterols, saponins, glycosides, terpenoids, phenols and reducing sugar) present in *Azadirachta indica* leaf extracts are responsible for the nematicidal effect on the root knot-knot nematodes (Saravanapriya and Sivakumar, 2005; Hayat *et al.*, 2012; Onyeke and Akueshi, 2012). These compounds also serve to protect the test crop (okra) against infectious microorganisms, predations by insects and herbivores, while their odor and flavor are responsible for their pigments (El- Mahmood *et al.*, 2008). The results revealed that significant increase in plant growth and yield parameters was observed when neem leaves extracts were applied at 25 g of

powdered neem, 100 ml of aqueous extracted neem and 100 ml of ethanol extracted neem and carbofuran at 0.26 g compared to other doses. The aqueous neem extract and powdered neem improved plant growth parameters of okra over Control. Plant growth and yield parameters of okra were improved significantly by all the various doses over the Control. These results are in agreement with Ramkrishnan *et al.* (1997) who reported increase in plant growth characters through botanicals as soil amendments. The study supports the findings of other researchers who reported the importance of various soil amendments in reducing plant-parasitic nematodes population build up resulting in an increased plant yield (Abolusoro and Oyedunmade, 2008; Izuogu *et al.*, 2015; and 2016). The study revealed that the neem leaf extracts used had significant nematicidal effects on *Meloidogyne incognita* as it caused a reduction in nematode population in okra compared to the Control. This is in line with the reports of some earlier researchers who reported that the effect of the different levels of extract on juvenile mortality could be due to the presence of tannins, alkaloids and flavonoids which have been reported to killed nematodes leading to effective reduction in nematode population by botanicals (Adegbite and Adesiyan, 2005; Umar, 2012).

Conclusions

These findings provided valuable data and information on the need to provide a wide support for nematicidal activity and suggest that the addition of botanicals to soil has potential as novel nematicides for the control of the root-knot nematodes. Neem extracts incorporated to soil can be recommended as an alternative to synthetic nematicides. This knowledge will help in better developing the use of organic materials in the control of plant parasitic nematodes. However, more field trials needed to be carried out on this botanical to test its efficacy

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