E-ISSN: 2346-7290

Insect and nematode pests associated with kenaf (*Hibiscus cannabinus*) in Choba, Rivers State, Nigeria

Tanimola, A. A., Zakka, U.* and George, O.I.C.

Department of Crop and Soil Science, Faculty of Agriculture, University of Port Harcourt

Corresponding author (Email: uzakka@yahoo.com; Phone: 08065703350)

ABSTRACT

Kenaf is being cultivated for diverse uses, especially remediation of hydrocarbon contaminated sites, but limited information exists on pests that could constitute major menace to kenaf in Niger Delta region. A field experiment was laid out in a Randomized Complete Block Design to ascertain insect pests and plant-parasitic nematodes (PPNs) associated with kenaf in Choba. Seeds of five varieties of kenaf, Ex-Funtua, Ifeken 100, Tianung 1, Ex-Giwa and Ifeken 400 were sown and cultivated till 10 Weeks After Sowing (WAS). Insects were collected from four to 10 WAS and identified. Soil and root samples were collected at 10 WAS and PPNs were extracted using pie-pan method, identified and their population determined. Data were analysed using descriptive statistics and Analysis of Variance. *Lemi rubricollis* and *Nisotra dilecta* were the dominant insect species associated with kenaf in Choba. Five PPNs genera; *Tylenchus*, *Pratylenchus*, *Scutellonema* and *Helicotylenchus* were associated with kenaf in the soil. Ex-Funtua and Ifeken 100 kenaf varieties had the highest PPNs genera (3) associated with them in the soil. In the roots, Tianung 1 had two PPNs genera, *Meloidogyne* and *Tylenchus.* In the soil, Ex-Funtua and Ifeken 100 had the highest population density of PPNs of 30 nematodes/200 ml soil. In the roots, Tianung 1 had the highest population of PPNs of 20 nematodes/10 g roots. Tianung 1, Ex-Funtua and Ifeken 100 had more nematode pests associated with them. Insects and nematode pests could be some of the major bio-constraints to kenaf production in Rivers State.

Keywords: Identification, Kenaf, Plant-parasitic nematodes, Insect pests, Population

INTRODUCTION

Kenaf, *Hibiscus cannabinus* L. Malvaceae is an annual fibrous tropical crop that originated from Africa (Alexopoulou *et al.*, 2013). It is one of the most important fibre crops in the world after cotton (Tahery *et al.*, 2011) and with increasing global interest in its potentials (Alexopolou *et al.*, 2000). Kenaf is becoming a possible alternative in fibre production as larger fibre can be produced at lesser cost (Quaranta *et al.*, 2000). Kenaf is adaptable to a wide range of soil types and climate (Aimin, 2019). It is more adaptable than any commercially produced fibre crops (Sultana *et al.*, 2015).

Industrially, kenaf is used in the production of paper, fabrics, textiles, amongst others while medicinally; it is reported to cure blood pressure disorders, some cancers and cholesterol imbalance (Alexopoulou *et al.*, 2013). Kenaf is also used in the production of ethanol called kenafnol in the United States of America (Castleman, 2000) and

commonly cultivated for both food and fibre in West Africa (Adegbite *et al.,* 2005). In Nigeria, kenaf is very useful to farmers for several purposes including making of ropes and phytoremediation of polluted soils (Abioye, *et al*., 2009).

Despite its numerous uses, it is not widely grown in Nigeria due to competition with similar imported products resulting in glut and unstable market price (Adebisi *et al.,* 2014) but its production in Nigeria is constrained by attacks of insects such as flea beetle thereby constituting significant loss (Fadare and Amusa, 2005; Agbaje *et al.,* 2008). Other pathogens that have been reported as bane to the cultivation of kenaf include plant-parasitic nematodes, fungi, bacteria, amongst others and these constraints vary both in space and time (McSorley and Parrado, 1986; Swart and Tarekegn, 2007). Kenaf yield losses attributed to *Meloidogyne* infection have been documented (Nieschlag *et al.,* 1960; Sasser *et al.,* 1984). Lawrence and McLean (1992) reported an annual yield loss of 32-67 % based on population density of nematodes in the soil.

Recently, the cultivation of kenaf as an economic crop in Nigeria for diverse uses including oil spillage management received a boost. It is in this wise that kenaf has been introduced into the Niger Delta area in Nigeria for cultivation. However, there is scant information on pests that are peculiar to this crop in the region. Kenaf cultivation in the region without adequate knowledge of its pathogens and insect pest etiology and life cycle will only lead to a continual loss in yield. Therefore, the need to identify the insect and nematode pests associated with kenaf in the region and identification of kenaf accession(s) most likely to be adapted to the Niger-Delta region and other similar tropical humid ecology around the world will generate a baseline data for management of its insect pests and pathogens that will lead to improve growth and yield of kenaf.

MATERIALS AND METHODS

Experimental site

The study was conducted at the Teaching and Research Farm of the Faculty of Agriculture, University of Port Harcourt located at coordinates 4^{o} 52' 30" and 4^{o} 55' 00" N, 6^{o} 54' 40" and 6^{o} 55' 49" E with an elevation of 18 m above sea level, temperature of 28-33°C and with rainfall ranging from 2000-2680 mm per annum (Eludoyin *et al.*, 2015). The experiment was carried out between April and September, 2016.

Source of kenaf seeds

Seeds of five varieties of kenaf (Ifeken 100, Ifeken 400, Tianung-1, Ex-Giwa, Ex-Funtua) were obtained from the Institute for Agricultural Research and Training (IAR&T), Ibadan, Oyo State.

Experimental design

The field experiment was laid out in Randomized Complete Block Design (RCBD) on a field size of 27 m x 5 m with kenaf varieties as the main treatment. The experimental field was divided into three blocks and each block had five subplots. Each block with a length of 9 m and breadth of 1 m was sub-divided into sub-plots of 1 m x 1 m with an alley of 1 m between each sub-plot. There was an alley of 1 m between each block. Two seeds per hole of each kenaf variety were sown per subplot at a spacing of 50 cm between and within the rows. Kenaf seedlings were later thinned to one per hole after one week of germination. The experiment was carried out in two trials.

Data collection for insects

Any insects seen on kenaf within the research plots were visually counted using

tally counter and samples were handpicked for proper identification to species levels. Collection was done at about 6.30 am for six weeks. The samples were kept in a vial containing 75% ethanol. After collection, the samples were well labelled and identified properly using a prototype specimen.

Collection of roots and soil samples for plant-parasitic nematodes

Four kenaf stands per variety in a subplot were randomly selected for collection of soil and root samples at 10 weeks after sowing (WAS). The roots of the kenaf were carefully dug per stand with a hand trowel and knife. Soil samples were also collected from the rhizosphere of each kenaf stand to a depth of 15 cm using a hand trowel. Soil samples collected from the four kenaf stands were bulked together with roots within a polythene bag and labelled appropriately. Two bulked samples were collected from each subplot. The same procedure was followed in collecting soil samples from all the 15 subplots. The bulked roots and soil samples were later moved quickly to the Crop and Soil Science, Faculty of Agriculture Laboratory for extraction.

Extraction procedures for plant-parasitic nematodes

Extraction of plant-parasitic nematodes from roots of kenaf was done using the extraction tray method (Whitehead and Hemming, 1965; Coyne *et al.*, 2007) at the Crop Protection Laboratory in the Department of Crop and Soil Science, Faculty of Agriculture, University of Port Harcourt. Kenaf roots were collected from the labelled plastic bags and rinsed gently under flowing water to remove dirt and soil particles. The roots were chopped into 1-2 cm using knives and samples from each sampling unit were thoroughly mixed together. The chopped roots (10 g) were weighed using an electronic balance (Startfrit model 93016; d=1g). Facial tissue was placed in a plastic sieve and the sieve on an extraction tray. The weighed 10 g roots were poured on the facial tissue in the sieve and water was added to the extraction plate by the side. The extraction set-up stayed for 48 hours after which the sieve was removed and the water was poured out in a labelled beaker. The suspension rested for 24 hours after which it was decanted and the suspension containing nematode samples was poured into vial bottle and labelled appropriately. The vials were preserved in the refrigerator at 4ºC prior to identification and counting. The sample bottles containing the nematode suspension were then sent in heat insulated boxes for identification and population count at Nematology Research Laboratory, International Institute for Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria.

The extraction of plant-parasitic nematodes from soil samples was done using similar method for roots. Two hundred millilitres of the soil sample in the plastic bag was measured with a beaker and poured on the facial tissue in the extraction tray, and then water was added to the extraction plate by the side. The extraction set-up stayed for 48 hours after which the sieve was removed and the water was poured into a labeled beaker. Similar procedures for root samples towards identification and quantification of plant-parasitic nematodes were carried out for soil samples.

Data analysis

Descriptive statistics were used to analyze data and present information on occurrence and abundance of insects and plant-parasitic nematodes. Frequencies of occurrence of plant-parasitic nematodes in the samples collected were determined using the formula of Norton (1987). Population counts of

nematodes were logarithm transformed $\log_{10}(x+1)$ prior to analysis. Transformed counts were subjected to Analysis of Variance (ANOVA) and means partitioned using Least Significant Difference at 5% level of probability with Statistical Analytical System (SAS, 1990).

RESULTS

Insects population found on kenaf

Table 1 showed the insect species collected from kenaf plants in Choba at the Niger Delta region and they include *Aspervia armigera, Epilachna similis, Cletus notatus, Lemi rubricollis, Lema caephalotes, Nisotra dilecta* amongst others during the period of the experiment. The result shows that *L. rubricollis* and *N. dilecta* were the dominant species and *L. caephalotes* had the least population. Insects were more dominant in the second week of collection and the least number was observed in the fifth week of collection. *Epilachna similis* and *L. cephalotes* appeared during the third week of sampling. There was no clear trend of insect appearance in kenaf plants, but rather their peaks fluctuated.

Classification of insects associated with kenaf

Table 2 showed the orders of insects infesting kenaf in the study area. These insects were in the orders Hemiptera and Coleoptera belonging to five families. Majority of the insects belong to the Chrysomalidae with only one order in the families Pentatomidae and Coreidae. Insect species collected were mostly pestiferous and only one was found to be a parasitoid in the Chrysomalidae family.

Table 1: Insect species population found on kenaf

	Frequency of insect population dynamics:							**Frequency in percentage of insect population dynamics:**						
Scientific name	**Week1**	**Week2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Total**	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Total**
Aspervia armigera F.	5	23	18	14	7	15	**82**	6.09	28.05	21.95	17.07	8.54	18.29	**99.99**
Cletus notatus	14	23	16	16	30	23	**122**	11.48	18.85	13.14	13.14	24.59	18.85	**99.96**
Theganoplexyx aethiops	16	22	12	5	14	7	**76**	21.05	28.95	15.79	6.58	18.42	9.21	**100**
Lemi rubricollis	22	28	14	34	12	16	**126**	17.46	22.22	11.11	26.98	9.52	12.69	**99.98**
Epilachna similis	0	0	7	0	0	4	**11**	0	0	63.63	0	0	36.36	**99.99**
Lema cephalotes	0	0	2	0	0	0	**2**	0	0	100	0	0	0	**100**
Hapsidolema melanophthalma	0	26	18	7	0	0	**51**	0	50.98	35.29	13.73	0	0	**99.90**
Nisotra dilecta	42	28	36	54	22	36	**218**	19.27	12.84	16.51	24.77	10.09	16.51	**99.99**
Total	**99**	**150**	**123**	**130**	**85**	**101**	**688**	**14.38**	**21.80**	**17.88**	**18.89**	**12.35**	**14.68**	**99.98**

Table 2: Classification of insects associated with kenaf at Choba, Rivers State

Scientific name	Family	Order	Pest status
Aspervia armigera F.	Pentatomidae	Hemiptera	Pest
Cletus notatus	Coreidae	Hemiptera	Pest
Theganoplexyx aethiops	Blattidae	Hemiptera	Pest
Lemi rubricollis	Chrysomalidae	Coleoptera	Pest
Epilachna similis	Coccinellidae	Coleoptera	Pest
Lema cephalotes	Chrysomalidae	Coleoptera	Pest
Hapsidolema melanophthalma	Chrysomalidae	Coleoptera	Parasitoid
Nisotra dilecta	Chrysomalidae	Coleoptera	Pest

Occurrence of plant-parasitic nematodes in the soil and roots of five kenaf varieties in Choba

Table 3 showed the occurrence of plant-parasitic nematodes (PPNs) in soil of five kenaf varieties in Choba, Rivers State. Ifeken 400 had *Tylenchus* with the relative frequency of occurrence (RFOC) of 100% as the sole plant-parasitic nematode genus found in soil rhizosphere. Ex-Giwa had both *Pratylenchus* and *Scutellonema* species (RFOC of 50% each) as PPN genera associated with it. The highest number of PPN genera (3) of *Helicotylenchus, Tylenchus* and *Scutellonema* with RFOC of 33.3% each were obtained on Ex-Funtua whileTianung-1 had *Tylenchus* as the only PPN genus associated with it. *Pratylenchus* was the sole PPN genus (RFOC of 100%) associated with Ifeken 100.

Table 3 showed the occurrence of plant-parasitic nematodes in roots of five kenaf varieties in Choba. Ifeken 400 had only *Meloidogyne* species (RFOC 100%) associated with it. *Scutellonema* and *Pratylenchus* were the only nematode genera found on Ex-Giwa and Ex-Funtua, respectively. However, Tianung-1 had only *Melodogyne* species with RFOC of 100% found in its roots. Three PPN genera, *Tylenchus, Scutellonema* and *Pratylenchus* with RFOC of 33.3% each were frequently encountered on Ifeken 100.

Table 3: Plant-parasitic nematodes in soil of kenaf in Choba, Rivers State

Kenaf variety	Nematode Genera	Medium	Sample containing species	Absolute frequency of occurrence	Relative frequency of occurrence
		Soil			
Ifeken 400	*Tylenchus* spp.		2	33.33	100.0
Ex-Giwa	*Pratylenchus* spp.		2	33.33	50.0
	Scutellonema spp.		2	33.33	50.0
Ex-Funtua	*Helicotylenchus* spp.		2	33.33	50.0
	Tylenchus spp.		2	33.33	50.0
	Scutellonema spp.		2	33.33	50.0
Tianung 1	*Tylenchus* spp.		4	66.66	100.00
Ifeken 100	*Pratylenchus* spp.		2	33.33	100.0
		Roots			
Ifeken 400	*Meloidogyne* spp		2	33.3	100.0
Ex-Giwa	*Scutellonema* spp.		2	33.3	100.0
Ex-Funtua	*Pratylenchus* spp		2	33.3	100.0
Tianung 1	*Meloidogyne* spp.		2	33.3	100.0
Ifeken 100	*Tylenchus* spp.		2	33.3	33.3
	Scutellonema spp.		2	33.3	33.3
	Pratylenchus spp		2	33.3	33.3

Population of plant-parasitic nematodes in the soil and roots of five kenaf varieties in Choba

Scutellonema and *Pratylenchus* species which had equal population of 10/200 ml soil that translated to 50% each of total nematode population was found on Ex-Giwa (Table 4). *Tylenchus* species with population of 5/200 ml soil (100% of total plant-parasitic nematodes) were associated with Ifeken 400 across the plots (Table 4). *Scutellonema*, *Tylenchus* and *Helicotylenchus* species with population of 15, 10 and 5/200 ml soil that translated to 50%, 33.3% and 16.7%, respectively of the total population of nematode pests were obtained on Ex-Funtua variety. Tianung-1 had *Tylenchus* species with population of 20/200 ml soil (100% of the total nematode population on Tianung-1) as the only PPN genus nematode species. On Ifeken 100, *Tylenchus* species with a population of 30/200 ml soil (66.7% of the total population of PPNs) were the nematode species with the highest population. The PPN genus with the lowest population (5/200 ml soil) on Ifeken 100 was *Scutellonema* species that translated to 11.1% of the total PPNs.

Ex-Giwa had *Scutellonema* species as the only nematode species present with a population of 15/10 g of root that translated to 100% of the total population of PPNs. Ifeken 400 had *Meloidogyne* species present and with population of 5/10 g root (100% of the total PPNs). Ex-Funtua had *Pratylenchus* species with a population of 5/10 g root (100% of the total population of PPNs). *Meloidogyne* species with a population of 20/10 g of root (100% of the total PPNs) was the only PPN genus present on Tianung-. Ifeken 100 had *Pratylenchus*

species with a population of 20/10 g of root (100% of the total population of the PPNs). There was no significant difference (P>0.05) in mean population of plant-parasitic nematodes found in the rhizosphere of both the soil and roots of the five varieties of kenaf in Choba (Table 5).

Table 4: Population of plant-parasitic nematodes in soil and roots of kenaf in Choba, Rivers State

Kenaf accessions	Nematode genera	Soil		Roots	
		Nematode population**	% Nematode population***	Nematode population/10 g	% Nematode population***
Ex-Giwa	*Scutellonema* spp.	10.00	50.00	15.00	100.00
	Pratylenchus spp.	10.00	50.00	0.00	0.00
Ifeken 400	*Tylenchus* spp.	5.00	100.00	0.00	0.00
	Meloidogyne spp.	0.00	0.00	5.00	100.00
Ex-Funtua	*Helicotylenchus*	5.00	16.7	0.00	0.00
	Tylenchus spp.	10.00	33.3	0.00	0.00
	Scutellonema spp.	15.00	50.0	0.00	0.00
	Pratylenchus spp.	0.00	0.00	5.00	100.0
Tianung-1	*Tylenchus* spp.	20.00	100.00	0.00	0.00
	Meloidogne spp.	0.00	0.00	20.00	100.00
Ifeken 100	*Pratylenchus* spp.	10.00	22.22	20.00	100.00
	Scutellonema spp.	5.00	11.11	0.00	0.00
	Tylenchus spp.	30.00	66.66	0.00	0.00

*n/N x 100 (number of times individual nematodes occurred and N = Sample size per variety (6)
** Nematode population per 200 ml of soil ***In/TN x100/1 (In = individual nematode in all the samples and TN =Total population of all nematodes extracted in all the samples)

Table 5: Plant-parasitic nematode populations on five kenaf varieties in Choba, Rivers State

Kenaf variety	Nematode population in soil	Nematode population in roots	Total nematode population
Ex-Giwa	13.3	10	23.3
Ifeken 400	3.3	3.3	6.6
Ex-Funtua	20	3.3a	23.3
Tianung-1	13.3	13.3	26.6
Ifeken 100	6.6	15	21.6
LSD ($p \leq 0.05$)	27.6	32.2	44.5

DISCUSSION

Insect pests of kenaf during the study belonging to only Coleoptera and Hemiptera in five families in the region did not agree with the earlier findings of Hiramatsu *et al.* (2001) who recorded 38 insect species in 28 families belonging to eight orders. The difference could be attributed to seasonal abundance, sample size and the history of kenaf cultivation in the region which may have not attracted much of the insects during the sampling period. Insects are mostly attracted to food source due to the presence of chemical cues emitted by their host plant. The presence of beetles from the germination to the point of termination of the experiment feeding on the leaves and stems of the kenaf plants agrees with Eldin and El-Amin (1981) who earlier reported cotton flea beetles as an economic pest of kenaf. Their presence as pestiferous to kenaf may be attributed to what Gillot (2005) opined that 75% of beetle species are phytophagous in both larvae and adult stages. This may also explain why only one member of the Chrysomalidae was reported to be a beneficial insect.

Nisotra dilecta and *L. rubricollis* reported as major insect pests of kenaf in the Niger Delta region during the sampling period agrees with the findings of Eldin and El-Amin (1981) who earlier reported *P. puncticollis* a similar species as a pest of economic importance in kenaf. However, the result did not agree with Hiramatsu *et al.* (2001) who reported *Aphis gossypii; Anomala albopilosa albopilosa; Spodoptera litura; Anomis flava* and *Haritalodes derogate* as major insect pests of kenaf in Japan.

Five genera of plant-parasitic nematodes were associated with kenaf in Choba, Rivers State: *Tylenchus, Pratylenchus, Scutellonema, Helicotylenchus, Meloidogyne* and *Tylenchus* species. *Meloidogyne* appearing exclusively in the root confirms its endoparasitic feeding habit. The genera found in the soil: *Tylenchus, Pratylenchus* and *Scutellonema* are also endoparasitic in their feeding habits, but found more in the soil due to search for plants to infect. The outcome of this study on the identified plant-parasitic nematodes on kenaf was in agreement with an earlier report by Adegbite *et al.* (2005) that listed these same genera of plant-parasitic nematodes amongst others as being associated with kenaf in the Southwestern Nigeria. This showed that most kenaf varieties are likely favourable host of these genera of plant-parasitic nematodes encountered in this study. Some of the kenaf varieties have been reported as being susceptible to plant-parasitic nematodes, especially *Meloidogyne* species (Adegbite *et al.*, 2008)

The fact that Ex-Funtua, Ifeken 100 and Tianung-1 kenaf varieties had more plant-parasitic nematode genera and population associated with them than the others might be an indication of their susceptibility as hosts to these nematodes. This observation is in agreement with the findings of Adegbite *et al.* (2008) that these varieties supported greater nematode reproduction and were good hosts of some nematode pests. However statistically, the non significant difference in mean population of plant-parasitic nematodes of kenaf varieties grown in Choba suggests that there might be no differences in their reaction as hosts across varieties to these nematodes.

CONCLUSION

Insects in the order Coleoptera are the major insect pests of kenaf plant in Choba, Rivers State. They feed on the leaves of the plant and this can be attributed to most of them being beetles (biting and chewing insects). Ex-Funtua, Tianung 1 and Ifeken 100 appear to be highly susceptible hosts to plant-

parasitic nematodes having the highest occurrence and population of these nematode pests in both roots and soil samples in Choba. As such, their cultivation should be discouraged because of the likelihood of building up nematode population for succeeding crops pending their being screened and other kenaf varieties for resistance to PPNs. The major genera of plant-parasitic nematodes on kenaf in Choba are *Tylenchus, Pratylenchus, Scutellonema, Helicotylenchus, Tylenchus* and *Meloidogyne.*

RECOMMENDATIONS

The value of kenaf in the Niger Delta region is on the increase and so more location trials should be done in the region to facilitate generation and validation of information on its pests. Also, more kenaf varieties should be screened for resistance to insect and nematode pests. More work should be done on likely management strategies for these insects and plant-parasitic nematodes before the large scale introduction of kenaf into the Niger Delta region on commercial basis.

REFERENCES

Abioye, P.O., Abdul Aziz, A. and Agamuthu, P. 2009. Enhanced Biodegradation of Used Engine Oil in Soil Amended with Organic Wastes. *Water Air and Soil Pollution* 209(1), 173-179.

Adebisi, M.A., Esuruoso, O.A., Adetumbi, J.A., Abdul-Rafiu, A.M., Kehinde, T.O., Ajani, O.O. and Agboola, D.A. 2014. Shelf life of kenaf (*Hibiscus cannabinus* L.) seed stored under humid tropical conditions. *Plant Breeding and Seed Science*, 67(1): 75-86.

Adegbite, A.A., Agbaje, G.O., Akande, M.O., Amusa, N.A., Adetumbi, J.A. and Adeyeye, O.O. 2005. Expression of Resistance to *Meloidogyne incognita* in Kenaf cultivars (*Hibiscus cannabinus*) under field conditions. *World Journal of Agricultural Sciences*, 1(1), 14-17.

Adegbite, A. A., Agbaje, G. O., Akande, M.O., Adetumbi, J.A. and Adeyeye, O.O. 2008. Expression of resistance to *Meloidogyne incognita* in kenaf cultivars (*Hibiscus cannabinus*) under field conditions. *Journal of Plant Diseases and Protection*, 115 (5), 238–240.

Agbaje, G.O., Saka, J.O., Adegbite, A.A. and Adeyeye, O.O. 2008. Influence of agronomic practices on yield and profitability in kenaf (*Hibiscus cannabinus* L.) fibre cultivation. *African Journal of Biotechnology*, *7*(5), 565-574

Aimin, L. 2019. Making pulp and paper from kenaf, Retrieved online 18th July 2019 from https://siwafarms.wordpress.com/opportunities-for-kenaf-in-egypt

Alexopoulou E, Christou M, Mardikis M, Chatziathanassiou, A. 2000. Growth and yield of kenaf varieties in central Greece. *Ind. Crops Prod*. 11, 163-172.

Alexopoulou, E., Papatheohari, Y., Picco, D., Di Virgilio, N. and Monti, A. 2013. Crop Management. In *Kenaf: A Multi-Purpose Crop for Several Industrial Applications* (pp. 59-82). Springer London.

Castleman T. 2000. Hempanol, Kenafanol "Fuel for new millenium". Retrieved online from http://www.Fuelandfiber.com/Archive/Fuel/fuel.html.

Coyne, D, Nicol, J. and Claudius, C.A. 2007. Practical Plant Nematology; Field and Laboratory Guide IITA, Ibadan, Nigeria 82 pp.

Danalatos, N.G. and Archontoulis, S.V. 2004. Potential growth and biomass productivity of kenaf (*Hibiscus cannabinus* L.) under central Greek conditions: I. The influence of fertilization and irrigation. In 2nd World Conference on Biomass for Energy, Industry and Climate Protection, pp. 323-326.

Eldin, N.S and El-Amin, E.M. 1981. Review of research on the insect pests of kenaf and their control in the Sudan. *Beitr Trop Landwirtsch Veterinarmed.* 19(4), 433-7.

Eludoyin, O. S., Oladele, A. T. and Iyanda, O. M. 2015. Mapping and assessment of ethno-medicinal trees in built up areas - University of Port Harcourt, Nigeria. *South-east Eur. For.* 6 (1), 129-140.

Fadare, T. A. and Amusa, N. A. 2005. Evaluation of four spray regimes of monocrotophos for control of *Earias* spp. damage to seed kenaf (*H. cannabinus* L.). *World Journal of Agricultural Sciences* 1(1): 76-79

Gillott, C. 2005. *Entomology* 3rd Edition Springer Netherlands 832pp

Hiramatsu, A., Sakamaki, Y., Kusigemati, K. 2001. A list of pest-insects feeding on the Kenaf in Kagoshima City with seasonal abundance of some major pest-insects. Bulletin of the Faculty of Agriculture, Kagoshima University 51(9)1-7

Mc Sorley, R. and Parrado, J.T. 1986. *Helicotylenchus multicinctus* on bananas: An International Problem. *Nematropica* 16, 73-91

Quaranta, F., Belocchi, A., Bottazzi, P., Monotti, M., Del Pinto, A.M. and Desiderio, E. 2000. Limited water supply on kenaf (*Hibiscus cannabinus* L.) in central Italy. *Italian Journal of Agronomy*, 4(1),1-10.

Sultana, R., Quader, A.K.M.L., Haque, M., Mazumder, S. and Paul, S.K. 2015. Combined effect of hormonal concentrations (naa and bap) on root formation kenaf (*Hibiscus cannabinus* L.) *Applied Science Report* 12 (3), 128-133

Swart, J.W. and Tarekegan, G. 2007. First Report of *Fusarium verticilloides* on kenaf in South Africa. *Plant Disease* 91 (1), 112-112

Tahery, Y., Ab Shukor, N.A., Abdul-Hamid, H., Abdullah, M.P. and Norlia, B. 2011. Status of root-knot Nematode Disease on Kenaf Cultivated on Bris Soil in Kuala Terengganu, Malaysia. *World Applied Sciences Journal*, 15 (9), 1287-1295.

Whitehead, A. G. and Hemming, J. R. 1965. A comparison of some quantitative methods of extracting small vermiform nematodes from soil. *Ann. Appl. Bio.* 55, 25 – 38.