FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 4 No. 1, March, 2020, pp 76 – 84

EVALUATION OF MAHOGANY (*Khaya senegalensis* L.) STEM BARK POWDER FOR THE MANAGEMENT OF ROOT-KNOT NEMATODE (*Meloidogyne* spp.) ON COWPEA (*Vigna unguiculata* (L.) Walp)

[*]Tijjani, I. and Abdullahi, N.

Department of Crop protection Faculty of Agriculture Bayero University, P.M.B. 3011, Kano. Nigeria.

*Corresponding author. Tel.:+2348067062748; E-mail: ***ibrahimtijjani99@yahoo.com***

ABSTRACT

A Field and screen house experiments were carried out to test the efficacy of mahogany (*Khaya senegalensis* L) bark powder at different concentration for the management of root-knot nematodes on cowpea. Its efficacy was compared with that of synthetic nematicide (cabofuran) as standard check. Twelve treatments were replicated four times in a completely randomized design. Each treatment was inoculated with 0 or 5000 eggs of *Meloidogyne* spp. extracted from the roots of highly susceptible garden egg (*Solanum gilo)* using 0.52 % a.i. sodium hypochlorite (NaOCl).Two replications were terminated at 60DAI to obtain data on number of galls and final nematode populations. Data were collected at 4, 6 and 8WAI on plant height, stem girth, number of days to 50 % flowering, number of pods/plant and number of seeds/pod. Data obtained were subjected to Analysis of Variance. Means were separated using Least Significant Difference at 5 % level of probability. Correlation analyses were performed on all the parameters assessed. Results obtained showed that 60g bark powder of the mahogany plant significantly ($P<0.05$) reduced the number of galls and population of the nematodes compared to the other treatments. The result also revealed that inoculated seedlings treated with 60g mahogany bark powder recorded higher value on plant height, stem girth, number of pods/plant, number of seeds /pod and seeds weight/plan when compared with other treatments and statistically significant at ($P<0.05$).Correlations between root galls, with plant height, stem girth, number of pods, plant, number of seeds/pod and seed weight/plant were negative and significant at ($p<0.01$).Hence, the results indicated that mahogany bark powder has potentials for use as a botanical resource for the management of *Meloidogyne* spp.

Keywords: Biopesticides, Mahogany, Organic Agriculture, Root-knot nematode

INTRODUCTION

Cowpea {*Vigna unguiculata* (L.)Walp} is one of the widely cultivated leguminous crops in the world, especially in semi-arid regions of Africa. In 2017, global yield was 7.4 million tonnes of dry grains on 12.5 million hectares (FAOSTAT, 2017). Nigeria is the largest producer of cowpea in the world, with grain production estimated at 3.4 million tonnes on 3.78 million ha (FAOSTAT, 2017).

Among the legumes, cowpea is the most extensively grown, distributed and traded food crop (Agbogidi, 2010). Cowpea is an essential component of cropping systems in the drier regions of the tropics and subtropics (Singh *et al*., 2003) and is important to the livelihood of millions of people (Quin, 1997). As a legume, cowpea can contribute to soil fertility, mainly through its nitrogen fixing abilities. Its residue is an important fodder resource for ruminant livestock (Tarawali *et al*., 1997) and provides an inexpensive and nutritious food for human consumption (Quin, 1997).

Despite the numerous benefits of cowpea, production has remained low due to the problems of pests and diseases (Ajibade *et al.,* 2001). Root-knot nematodes have been identified as a bane in cowpea production (Olowe, 1992) in which *M. incognita* and *M. javanica* are the major species implicated on a world basis. Symptoms of infection are presence of root galls, excessive branching of roots, and reduced root systems. In addition, poor germination, death of seedlings and yield loss may be observed in cases of heavy infestations (Mishra, 1992). A cowpea grain yield loss of 20-90 % caused by root-knot nematode was also reported by (Olowe, 2005).

Nematode control is necessary in order to reduce crop losses and ensure self-sufficiency in the requirement for food and industrial raw materials. Currently, various control options have been employed for the management of root-knot nematodes. These include the use of synthetic chemicals (Adegbite and Agbaje, 2007), crop rotation (Adesiyan *et al,* 2000), use of resistant varieties (Odihirin, 1981), intercrop (Agu, 2008), organic manure (Ogaraku *et al.,*2007), biological agents (Kumar *et al.*, 2011) and botanicals (Adegbite and Adesiyan, 2005). Use of chemical nematicides is one of the most reliable means of managing root-knot nematodes. However, their negative impact on the environment and human health has led to regulatory restrictions in the use of many synthetic nematicides. Today, there is a growing movement in many countries to reduce the amount of chemicals being released into the environment, this mark the dawn of using botanicals in the management of crop pests and diseases. The use of botanicals appears the most feasible especially for low income farmers who constitute about 98% of the farming population (Odinakachi, *et al.,* 2015). Applications of these botanicals do not constitute a threat to the environment, they are easily affordable, require less skill and above all increase soil fertility (Enyiukwu *et al.*2014).

The globalization of organic agriculture, envisaged that search should be intensified on the use of botanicals instead of synthetic nematicides in crop protection. *Khaya senegalensis*is one of the most popular medicinal meliaceous plants used in traditional African remedies. The decoction of its stem bark is commonly used as a bitter tonic in folk and popular medicines for an anthelmintic (Ademola *et al*., 2004), and a taeniacide remedy (Iwu, 1993). Therefore, this research is designed to test the potency of mahogany stem bark powder which is known to possess anthelminthes properties for treatment of intestinal worm infection of humans in the management of cowpea root-knot disease caused by *Meloidogyne* spp.

MATERIALS AND METHODS

Experimental Design Set up: The experiments were conducted in the field and screenhouse during 2017 cropping season. Field experiment was conducted at the Faculty of Agriculture Bayero University, Kano (BUK) Research Farm while the screenhouse experiment was conducted at the Center for Dry Land Agriculture BUK. Two cowpea varieties (IT 90K 277-2and IT 97K 499-35) were obtained from the International Institute of Tropical Agriculture (IITA) Kano station. On the field, prior to planting, experimental field was ploughed and harrowed to a fine tilth, ridged 60cm apart and then marked into plots. Twelve (12) treatments were replicated four times in Randomized Complete Block Design (RCBD). Each plot was 1.2 m x 1.8 m (2.16 m^2) with space of 0.5 m between the plots in a column and 1.0 m between the rows. For screenhouse experiment, sandy-loam top soil was used as planting medium because of its good tilth, good structure and moderate soil moisture. The soil was steamed and sterilized manually (by heating the soil in a drum) for 2 hours. The soil was then allowed to cool for 20 minutes before transferring in to jute sac where it was allowed to settle for six weeks. Prior to planting, samples from the sterilized soil were tested for presence of nematodes using Whitehead and Hemming's (1965) method and no live nematode was found. Also, twelve treatments were replicated four times in completely randomized design (CRD). The treatments were:

V1T1= Inoculated cowpea without treatment, V1T2= Inoculated cowpea + mahogany 20g

V1T3= Inoculated cowpea + mahogany 40g , V1T4= Inoculated cowpea + mahogany 60g

V1T5= Inoculated cowpea + cabofuran (check), V1T6 = Un inoculated cowpea without treatment (control)

V2T1 = Inoculated cowpea without treatment, V2T2 = Inoculated cowpea + mahogany 20g

V2T3 = Inoculated cowpea + mahogany 40g, V2T4 = Inoculated cowpea + mahogany 60g

V2T5 = Inoculated cowpea + cabofuran (check)

V2T6 = Un inoculated cowpea without treatment (control)

Preparation of the Plant Extract: Bark of *K. senegalensis* was obtained from the mother tree around Dotsa, Zaria road, kano State, Nigeria. The preparation was carried out in accordance with the methods described by Akhtar and Mahmoud (1994). The dried stem bark was pounded using pestle and mortar and later sieved using sieves. In order to obtain varying concentration 60g, 40g and 20g of dried powder was weighed and labeled as the standard treatment.

Application of Treatments: At two weeks before sowing, mahogany powder was added to the soil which was thoroughly mixed to ensure homogeneity and to facilitate decomposing of the organic matter (mahogany powder). While for the screenhouse experiment, two weeks before sowing, 7-litre buckets were filled with 5kg of the sterilized soil and mahogany powder were added which was thoroughly mixed to ensure homogeneity. Also,cabofuran 3G 3.4 ai/ha were applied to the appropriate treatment only at planting

Preparation and calibration of Inoculum: Eggs of *Meloidogyne* spp. were extracted from the roots of garden egg (*Solanum gilo*) that is highly susceptible to root-knot nematodes from farmer's plot (Netscher and Sikora, 1990) using 0.52 % a.i. sodium hypochlorite (NaOCl) method of Hussey and Barker (1973).The plants were lifted gently from farmers' field and washed under gentle stream of cool tap water in the laboratory. The roots were chopped in to 1-2 cm pieces and poured in to1 liter conical flask containing 0.52 % a.i NaOCl solution prepared from commercial bleach using the formula of Theodore *et al*. (2009) as follows:

$$M_1V_1=M_2V_2$$

Where

M_1 = molar concentration of the bleach (3.8 M)

V_1 = volume of the NaOCl to be added in to water for extraction (27.4 ml)

M_2 = molar concentration used for extraction (0.52 M).

V_2 = volume of solution (200 ml).

The conical flask was corked tightly then manually and vigorously shaken for four minutes to dissolve the gelatinous egg matrices. The suspension now containing free eggs was poured over 200-mesh sieve nested upon 500-mesh sieve. The 500-mesh sieve containing the eggs was rinsed gently under cool gentle stream of tap water to remove the residual bleach. The mesh was thereafter rinsed into a beaker to collect the eggs. The suspension was adjusted to150 ml volume and the number of eggs per ml was estimated with the aid of Doncaster (1962) counting dish under a stereomicroscope.

Inoculation of Cowpea Seedling: At seven days after germination, cowpea seedlings were inoculated with approximately 5,000 eggs of root-knot nematode (*Meloidogyne* spp.) by pipetting the eggs in to the holes around the base of the plant and filling the holes with moist soil. Seedlings with 0 inoculations served as control (V1T6 and V2T6).

Data collection and Analysis: At four, six and eight weeks after inoculation (WAI) data were collected on plant height using measuring tape and stem girth using thread and ruler. Also, data on number of days to 50 % flowering was collected. For the two experiments (field and screenhouse), two replicates were terminated at 60 days after inoculation (DAI) to determine nematode reproduction and also to rate gall indices. The remaining two replicates were allowed to grow to maturity to obtain grain yield data. At maturity, data were also collected on number of pods/plant and number of seeds/pod and seed weight per/bucket and seed weight per plot after threshing. Data collected were subjected to analysis of variance and significant means were separated using least significant difference (LSD) at 5 % level of probability.

RESULTS

Table 1 and 2 shows the effect of mahogany bark powder on plant height and stem girth of cowpea plant inoculated with *Meloidogyne* spp. in the screenhouse and field respectively. The results of variety 1 (V1) and variety 2 (V2) followed same trend (table 1 and 2). Plant height and stem girth were significantly ($p<0.05\%$) affected by *Meloidogyne* spp. as indicated by comparing control (uninoculated untreated) with inoculated untreated plants. The tables revealed that inoculated cowpea seedlings treated with mahogany bark powder have resulted to an improved plant height and stem girth when compared to untreated cowpea seedlings at all levels of concentration (20g, 40g and 60g). Also, control seedlings recorded highest plant height and stem girth at 4, 6 and 8 WAI followed by inoculated seedlings treated with cabofuran. The plant height and stem girth of all the other seedlings inoculated but treated with the mahogany powder 20g, 40g, 60g and check; vary significantly ($p < 0.05\%$) from the inoculated untreated seedlings at 4, 6 and 8 WAI (Table 1 and 2).

Table 3 and 4 shows the effect of mahogany bark powder on days to 50% flower, yield indices, yield/plant, yield/plot, gall index and reproductive factor on cowpea plant inoculated with *Meloidogyne* spp. in the screenhouse and field respectively. The result showed that days to 50% flowering were lower in control and inoculated cowpea treated with cabofuran. Also, inoculated cowpea without treatment recorded the highest number of days to 50% flowering. However, application of mahogany bark powder significantly reduced the effects of *Meloidogyne* spp. on number of days to 50% flowering when untreated inoculated cowpea seedlings were compared with inoculated cowpea seedlings treated with mahogany bark powder. Also, there were significant difference ($p < 0.05\%$) among the cowpea seedlings treated with 60g, 40g and 20g mahogany bark powder. The higher the quantity, the lower the number of days to 50% flowering. The results further showed that treated plants recorded more number of pods and seed weights than the inoculated but untreated seedlings (Tables 3 and 4). Amongst the treated plants, those treated with 60g mahogany bark powder recorded higher pods and seed weights than inoculated but untreated seedlings in both screenhouse and field. As the quantity/dosage of the mahogany increased, the number of pods/plant, seed/pod and yield/plant also increases. Furthermore, the tables (3 and 4) showed that application of 60g, 40g and 20g mahogany bark powder significantly ($p < 0.05\%$) increase the number of pods/plant, seed/pod and yield/plant compared with inoculated untreated cowpea. Also, the result showed a significant reduction ($P<0.05$) in the number of galls obtained from the surrounding roots of cowpea treated with the varying quantity/concentrations of the powder. The inoculated but untreated seedling has the highest number of galls and reproductive factor which was observed to be significantly higher than those seedlings treated at all levels of dosage/concentration ($P<0.05$). The result also showed a significant variation ($P<0.05$) in the extent of galling and reproductive factor in cowpea treated with different levels (quantity/dosage) of the mahogany bark powder. All the levels displayed significantly lower number of galls and reproductive factor over the inoculated untreated control (4.00). It has been observed that among the treated seedlings, as the quantity of the mahogany decreased, the extent of galling and reproductive factor also increases.

Table 5 showed the results of correlation between growth indices, root galls, eggs and yield parameters for the two experiments (screenhouse and field). At the screenhouse, the correlation between number of pods/plant with root galls and egg were highly significant ($p < 0.01$) and negatively correlated (-0.58 and -0.62) respectively. Also, the correlation between galls with number of seeds/pod and yield/plant were also highly significant ($p < 0.01$) and negatively correlated (-0.66 and -0.73). Increase in root galls will leads to decrease in seeds/pod and yield/plant. However, in the field the correlation between root galls with yield/ha and between eggs and yield/ha were highly significant ($p < 0.01$) and negatively correlated (-0.77 and -0.71) respectively. Also, the correlation between numbers of pod/plant and seed/pod was highly significant ($p < 0.01$) and positively correlated (0.88 and 0.78). Increase in numbers of pod/plant and seed/pod will leads to the increases in yield/ha.

Table 1. Effect of mahogany bark powder on plant height and stem girth of Cowpea plant inoculated with *Meloidogyne* spp. in the screenhouse.

	Plant height(cm)			Stem girth(cm)		
Treatment	**PH4WAI**	**PH6WAI**	**PH8WAI**	**SG4WAI**	**SG6WAI**	**SG8WAI**
V1+nematode without treatment	15.72	17.00	17.03	0.75	0.92	0.95
V1+ nematode+ 20g mahogany	18.07	19.32	19.32	1.04	1.21	1.58
V1+ nematode+ 40g mahogany	19.12	20.90	22.22	1.18	1.39	1.60
V1+ nematode+ 60g mahogany	20.62	22.30	26.32	1.23	1.59	1.93
V1+nematode + cabofuran	20.93	23.80	28.73	1.37	1.79	2.10
Control	22.21	26.20	32.00	1.45	1.95	2.28
LSD ($p \leq 0.05\%$)	0.68	1.30	1.78	0.11	0.14	0.15
V2+nematode without treatment	15.43	16.76	17.00	0.78	1.00	1.01
V2+ nematode+ 20g mahogany	17.96	19.19	19.30	1.05	1.23	1.61
V2+ nematode+ 40g mahogany	19.06	20.83	22.20	1.19	1.41	1.64
V2+nematode+60g mahogany	20.56	22.24	26.31	1.25	1.58	1.91
V2+nematode + cabofuran	20.88	23.69	28.70	1.38	1.78	2.12
Control	22.09	26.11	31.92	1.43	1.98	2.35
LSD ($p \leq 0.05\%$)	0.66	1.27	1.77	0.12	0.15	0.16

KEY: PH4WAI= Mean plant height at four weeks after inoculation, PH6WAI= Mean plant height at six weeks after inoculation, PH8WAI= Mean plant height at eight weeks after inoculation, SG4WAI= Mean stem girth at four weeks after inoculation, SG6WAI= Mean stem girth at six weeks after inoculation, SG8WAI= Mean stem girth at eight weeks after inoculation, V1= variety one, V2= variety two, LSD= Least significant difference.

Table 2. Effect of Mahogany bark powder on plant height and stem girth of Cowpea plant inoculated with *Meloidogyne* spp. in the field

	Plant height(cm)			Stem girth(cm)		
Treatment	**PH4WAI**	**PH6WAI**	**PH8WAI**	**SG4WAI**	**SG6WAI**	**SG8WAI**
V1+nematode without treatment	15.81	17.15	17.06	0.94	1.01	1.01
V1+ nematode +20g mahogany	18.30	19.40	21.19	1.20	1.25	1.30
V1+ nematode +40g mahogany	20.81	21.27	24.06	1.69	1.72	1.79
V1+ nematode +60g mahogany	22.70	23.70	27.40	1.78	1.94	2.04
V1+ nematode + cabofuran	23.45	25.30	29.51	2.06	2.22	2.38
Control	23.60	27.53	32.09	2.16	2.46	2.59
LSD ($p \leq 0.05\%$)	0.70	1.34	1.81	0.13	0.15	0.18
V2+nematode without treatment	15.62	16.83	17.31	1.01	1.04	1.04
V2+ nematode +20g mahogany	18.21	19.23	21.07	1.24	1.32	1.46
V2+ nematode +40g mahogany	20.63	21.16	24.08	1.65	1.78	1.86
V2+ nematode +60g mahogany	22.67	23.66	27.27	1.81	2.00	2.12
V2+ nematode + cabofuran	23.41	25.32	29.39	2.11	2.29	2.37
Control	23.48	27.42	32.03	2.24	2.45	2.60
LSD ($p <0.05\%$)	0.68	1.32	1.80	0.14	0.17	0.19

Key: PH4WAI = Mean plant height at four weeks after inoculation, PH4WAI = Mean plant height six weeks after inoculation PH8 WAI= Mean plant height at eight weeks after inoculation, SG4WAI= stem girth at four weeks after inoculation, SG6WAI= stem girth at six weeks after inoculation, SG8WAI= stem girth at eight weeks after inoculation, V1= variety one, V2= variety two, LSD= Least significant difference.

Table 3. Effect of mahogany bark powder on D50%flower, yield indices, yield, gall index and reproductive factor on cowpea plant inoculated with *Meloidogyne* spp. in the screenhouse.

Treatments	Days 50%F	POD/POT	SEED/POD	Yield (g^{-1} plant)	GI	RF
V1+nematode without treatment	74.50	9.95	5.10	98.65	4.00	1.70
V1+nematode+ 20g mahogany	69.00	22.50	7.01	142.10	3.00	1.10
V1+nematode+ 40g mahogany	65.50	29.62	8.10	175.86	3.00	0.60
V1+nematode+ 60g mahogany	61.00	37.95	9.60	195.84	3.00	0.40
V1+nematode+carbofuran	57.00	43.06	11.00	223.47	2.00	0.05
Control	56.50	48.50	11.20	250.38	0.00	0.00
LSD (p < 0.05%)	3.01	4.03	1.23	21.12	-	-
V2+nematode without treatment	74.00	10.07	5.12	84.38	4.00	1.73
V2+nematode+ 20g mahogany	68.50	22.38	7.07	124.30	3.00	1.20
V2+nematode+ 40g mahogany	65.00	30.02	8.22	185.02	3.00	0.61
V2+nematode+ 60g mahogany	62.50	37.23	9.71	160.16	3.00	0.40
V2+nematode+carbofuran	56.00	42.78	11.05	219.92	2.00	0.06
Control	56.00	47.65	11.17	242.93	0.00	0.00
LSD (p < 0.05%)	3.00	2.92	1.23	21.04	-	-

Key: D50%f= days to 50% flower, Pod/pot= Mean number of pods per pot, Seed /pod= Mean number of seed per pod, GI= gall index, RF = Reproductive factor, V1= variety one, V2= variety two, LSD= Least significant difference.

Table 4. Effect of mahogany bark powder on D50%flower, yield indices, yield, gall index and reproductive factor on cowpea plant inoculated with *Meloidogyne* spp. in the field.

Treatments	Days 50%F	POD/PLT	SEED/POD	Yield Kg^{-ha}	GI	RF
V1+nematode without treatment	73.00	10.30	5.30	204.75	4.00	1.74
V1+nematode+ 20g mahogany	68.50	28.10	6.70	439.25	3.00	1.12
V1+nematode+ 40g mahogany	62.00	36.12	8.64	674.74	3.00	0.63
V1+nematode+ 60g mahogany	60.00	42.60	9.30	964.00	3.00	0.40
V1+nematode+carbofuran	56.00	46.00	10.70	1229.25	2.00	0.04
Control	56.00	49.50	12.10	1431.50	0.00	0.00
LSD (p < 0.05%)	2.96	3.10	1.25	192.4	-	-
V2+nematode without treatment	73.00	10.09	5.22	199.00	4.00	1.74
V2+nematode+ 20g mahogany	69.00	26.20	6.61	419.00	3.00	1.13
V2+nematode+ 40g mahogany	64.00	37.50	7.73	616.50	3.00	0.64
V2+nematode+ 60g mahogany	60.00	43.50	9.12	898.00	3.00	0.41
V2+nematode+carbofuran	57.50	45.00	10.48	1093.50	2.00	0.05
Control	57.00	49.00	12.01	1374.50	0.00	0.00
LSD (p < 0.05%)	3.00	3.08	1.23	190.8	-	-

Key: D50%f= days to 50% flower, Pod/plt= Mean number of pods per plant, Seed /pod= Mean number of seed per pod, GI= gall index, RF = Reproductive factor, V1= variety one, V2= variety two, LSD= Least significant difference.

Table 5. Correlation coefficient relationships between growth indices, root galling, eggs and yield parameters of cowpea in the Screenhouse and Field.

	PH8WAI	SG8WAI	GALLS	EGGS	POD/PLANT	SEED/POD	Yield kg^{-ha}
SCREEN HOUSE							
PH8WAI	1.00						
SG8WAI	0.52**	1.00					
GALLS	-0.29**	-0.41**	1.00				
EGGS	-0.25**	-0.40**	0.92**	1.00			
POD/PLANT	0.20**	0.91**	-0.58**	-0.62**	1.00		
SEED/POD	0.22**	0.86**	-0.66**	-0.73**	0.21**	1.00	
Yield (g^{-1}plant)	0.28**	0.82**	-0.73**	-0.75**	0.85**	0.74**	1.00
FIELD							
PH8WAI	1.00						
SG8WAI	0.54**	1.00					
GALLS	-0.30**	-0.44**	1.00				
EGGS	-0.39**	-0.50**	0.93**	1.00			
POD/PLANT	0.20**	0.91**	-0.71**	-0.81**	1.00		
SEED/POD	0.23**	0.87**	-0.76**	-0.77**	0.23**	1.00	
Yield kg^{-ha}	0.30**	0.82**	-0.77**	-0.71**	0.88**	0.78**	1.00

** = significant at 0.01 level of probability, * = significant at 0.05 level of probability

Key: PH8WAI=Plant height eight weeks after inoculation, SG8WAI=stem girth eight weeks after inoculation, GALLS= number of galls EGGS= eggs number, POD/PLT= number of pod/plant, SEED/POD= number of seed/pod, SWT/HA= yield/ha

DISCUSSION

The results of this study revealed that mahogany back powder affected the root-knot nematode development and survival and subsequently resulted in enhanced cowpea plant growth parameters. This is in line with the previous results on the use of plant extracts in the control of *Meloidogyne* spp. (Fatoki and Fawole, 1999; Adegbite, 2011; Fabiyi *et al.,* 2016).Also, this study supported the findings of (Nakatani *et al*., 2001, 2002) that, the chemical constituents of mahogany back powder have nematicidal properties, and in agreement with findings of Khan (1990), who reported that many wild and cultivated medicinal plants have been shown to possess nematicidal properties against several plant parasitic nematodes. Similarly, Liman *et al.,* (2010) reported that, leaf extracts of the mahogany plant significantly reduced the population of root-knot nematode on tomato.

Plant height and stem girth were negatively affected by *Meloidogyne* spp. as indicated by comparing control (uninoculated untreated) with inoculated untreated plants. This is conformity with finding of (Tijjani and Atungwu, 2017) reported that *Meloidogyne* spp. induced stunting which results in poor growth. This was most likely due to damage caused by the increasing number of nematodes that invaded plant roots, probably causing reduced nutrient and water uptake (Karssen and Moens, 2006). The reduction in stem girth can cause a significant yield loss which is similar to the finding of (Robert, 1987 and Sikora and Fernandez, 1990) reported that flow of water and nutrients in to the plants is greatly influenced due to reduction in stem girth. Khan *et al*., 2000 reported that in addition to nematode infestation reduction in stem girth causes disturbance in nutrients up take and leads to nutrient deficiency. Among the cowpea plants, those treated with 60g of mahogany bark powder had highest plant height, stem girth and yield than those treated with 20g and 40g. This is suggestive that with increasing volume/concentrations, the efficacy of the botanicals checking *Meloidogyne* root-knot disease could probably be improved upon. Plant growth parameters are enhanced in this study by the metabolites, while the reduction in nematode population attested to the nematicidal effect of bark powder from *Khaya senegalensis* which is similar with the findings of (Fabiyi *et al.,* 2016).

The control (uninoculated) and inoculated cowpea plants treated with mahogany bark powder started flowering earlier than the untreated inoculated cowpea. Early flowering is very important because it affects the time of maturity and harvesting of plants. The inability of the untreated inoculated plants to flower early is probably due to the combined action of the nematode and inadequate availability of nutrients (Netscher and Sikora, 1990). Moreover, the tested materials reduced the number of galls and egg masses on cowpea roots, as compared to untreated nematode-infected plants. The reduction of GI and RF is a strong indication of the ability of the mahogany bark powder to control root-knot nematode in cowpea. According to Adegbite and Adesiyan (2005) the high juvenile mortality effect by the botanicals might be due to the chemical properties present in the extracts that possess anthelmintic properties. However, cowpea seedlings treated with the highest dosage (60g) recorded a lowest reproductive factor in both screenhouse and field experiments than other dosages (40g and 20g). All the levels of concentrations displayed significantly lower reproductive factor over the inoculated untreated seedlings. It has been observed that among the treated seedlings, as the dosage of the mahogany powder decreased, the extent of galling and reproductive factor also increases.

However, the present study recorded significant increase in yield among plants treated with mahogany bark powder compared with the control. This was probably due to the efficacy of the mahogany bark powder which controls the nematodes and resulted in the production of more pods and seeds in the treated plants. This result is in line with that of Chindo and Khan (1986), who reported that incorporation of amendments into the soil reduced nematodes population and improved the yield of crops.

CONCLUSION

The study showed that mahogany bark powder has potentials for the control of root-knot nematodes of cowpea. Therefore, the use of mahogany bark powder should be considered in integrated disease management strategies. Hence, farmers should use mahogany bark powder to control root-knot nematodes on their cowpea farms since it is economical and environmentally friendly. It is suggested that further trials be conducted on the basis of the promising results from this study.

ACKNOWLEDGEMENT

The authors are highly grateful to the staff and management of Center for Dry Land Agriculture Bayero University Kano and International Institute of Tropical Agriculture (IITA), Kano station for graciously providing the screenhouse and cowpea varieties respectively.

REFERENCES

Adegbite, A. A. and Adesiyan, S. O. (2005). Root extracts of plants to control root-knot nematode on edible soybean. *World Journal of Agricultural Sciences* 1:18-21.

Adegbite, A.A. (2011). Effect of some indigenous plant extracts as inhibitors of egg hatch in root knot nematode (*Meloidogyne incognita* Race 2). *American Journal of Experimental Agriculture*. 1(**3**): 96-100

Adegbite, A.A and Agbaje, G.O. (2007). Efficacy of Furadan in the control of root-knot nematode (*M. incognita* race 2) in hybrid yam varieties in south-western Nigeria, *World Agricultural Science*, 2:256-262

Ademola, I.O., Fagbemi, B.O., Idowu, S.O. (2004). Evaluation of the athelmintic activity of *Khaya senegalensis* extract against gastrointestinal nematodes of sheep: *in vitro* and *in vivo* studies. *Veterinary Parasitology*122: 151-164.

Adesiyan, S. 0., Caveness, F. E., Adeniyi, M. O. and Fawole, B. (2000). Nematode Pests of Tropical Crops. Heinemann Educational Books (Nigeria) Plc.

Agbogidi, O. M. (2010). Screening six cultivars of cowpea (*Vigna unguiculata* (L.) Walp) for adaptation to soil contaminated with spent engine oil.*Journal of Environmental Chemistry and Ecoloxicology*. 7: 103-109.

Agu, C.M. (2008). Root gall nematode diseases of pineapple as affected by seed material, amount and type of organic soil amendment. *Plant Science Research* 1 (**2**): 6-39.

Ajibade, S.R. and Amusa,N.A (2001). Effects of fungal diseases on some cowpea lines in humid environment of South-Western Nigeria. *Journal of Sustainable Agriculture and Environment* 3:246-253.

Akhtar, M. and Mahmood, I. (1994). Control of Plant-Parasitic Nematodes with 'Nimin' and some plant-soils by Bare-Root dip treatments. *Nematologica Journal of Mediterranean* 21:89-92.

Chindo, P.S, Khan, F. A. (1986). Effects of organic amendments with poultry manure on the damage caused by root- knot nematodes. International Nematoogy Network, Newsletter 3(**4**): 30 – 33.

Doncaster, C.C. (1962). Acounting dish for nematodes. *Nematologica* 7: 334-336

Enyiukwu, D.N.; Awurum, A.E., Ononuju,C.C and Nwaneri, A. (2014).Significance of characterization of secondary metabolites from extracts of higher plant in plant disease management. *International journal of Advanced Agric Research* 2:8-28.

Fabiyi, O.A, Olatunji, G.A, and Olagbenro, M.O (2016). Response of the root-knot Nematode-infected *Celosia argentea* to Bark Extracts of *Khaya ivorensis. Ife Journal of Agriculture* 28 (**2**) 24-36pp

FAOSTAT, (2017).http://fao.org/faostat/en Food and Agricultural Organization of the United Nations. Rome, Italy.Accessed on 15th January, 2019.

Fatoki, O.K. and Fawole, B. (1999). In vitro toxicity of some selected plant extracts on eggs and second stage juveniles of *Meloidogyne incognita*. *African Journalof Plant protection*. 9: 83-92.

Hussey, R. S. and Barker, K. R. (1973). A comparison of methods of collecting egg of *Meloidogyne spp.*, including a new technique. *Plant Disease Report.* 57: 1025-1028.

Iwu M (1993).Hand book of African medicinal plants, Pharmacognostical profile of selected medicinal plants. CRC Press Inc. pp. 196-197.

Karssen, G. and Moens, M. (2006). Root-knot nematodes. pp. 59-90. In: Perry, R. N. and Moens, M. (Eds). *Plant Nematology*. CABI publishing.

Khan, A. F. (1990). Nematicidal potential of some naturally growing plants against *Pratylenchus zeae*. *Reveue nematology*, 13(**4**), 463-465.

Khan, H. U., Ahmed, W. And Khan, M. A. (2000). Evaluation of resistance of fifteen tomato cultivars against root-knot nematode (*Meloidogyne incognita*), *Pakistan Journal of Phytopathology*, 12: 50 -52

Kumar, N. and Singh K.P. (2011). Bioefficacy of spore suspensions and mass culture of *Dactylaria brochopaga* on *Meloidogyne incognita* [Kofoid and White) Chitwood causing root-knot disease of tomato (*Lycopersicon esculentum* Mill.).*Asian International Plant Pathology*, 5(**1**): 54-61.

Liman, B., Ibrahim, M., Ibrahim, N.T.and Rabah, A.B. (2010). Effect of Mahogany (*Khaya senegalensis* L) Leaf Extract on Root-Knot Nematode of Tomatoes (*Lycopersicum esculentum* L.) *Nigerian Journal of Basic and Applied Science*, 18(**2**): 272-276

Mishra, S. D. (1992). Nematode pests of pulse crops In: Nematodes pests of Vegetable crops, D. S. Bhatti and R. K.Walia, (eds.) CBS Publishers and Distributors, Delhi India. 140pp.

Nakatani, M., Abdelgaleil, S. A, Kurawaki, J., Okamura, H., Iwagawa, T.,and Doe, M (2001). Antifeedant rings B and D opened limonoids from *Khaya senegalensis*. *Journal of National Production, 64*: 1261-1265.

Nakatani, M., Abdelgaleil, S.A., Kassem, S.M., Takezaki, K., Okamura, H.,Iwagawa, T. and Doe, M. (2002). Three new modified limonoids from *Khaya senegalensis*. *Journal of National Production,* 65: 19-216.

Netscher, C. and Sikora, R. A.; (1990).Nematode parasites of vegetables; in: *Plant Parasitic Nematode in Subtropical and Tropical Agriculture*, edited by Luc, M., Sikora, R. A. and Bridge, J.; chap. 7; C.A.B. International.

Odihirin, R. A. (1981). Screening of some West African cowpeas for resistance to root-knot nematodes, *Meloidogyne incognita* and *M. javanica*. Proceedings of the Third Planning Conference on Root-knot Nematodes, *Meloidogyne* spp. November 16- 20, 1981, llTA Ibadan, p. 232- 240.

Odinakachi , C.C., Madubuko, A.C. and Chuka, O.G. (2015). Efficacy of some Botanicals in the Control of Root-knot Nematode Disease of Cowpea (*Vigna unguiculata*) Journal of Global Biosciences 4(**4**) 1966-1970

Ogaraku, A.O. (2007) Effect of animal manure on susceptible of cowpea VAR.Moussa local to infection by root-knot nematode; *M. javanica* Treub. *Pakistan journal of Biological Science* 10(**17**):2980-2983.

Olowe, T .O.(1992). Economic importance of nematode legumes and cereal crops in Nigeria: ln proceedings of the first regional symposium on the biology and control of nematode pests of food crops in Africa, 61-91. (eds. B. Fawole, O.A. Egunjobi, S.O. Adesiyan, J.O. Babatola and A.A. ldowu)

Olowe, T.O. (2005). Effect of cowpea cropping system on the root knot nematodes *Meloidogyne* spp. in Nigeria. *International journal of Nematology*.15: 21-29.

Quin, F. M. (1997). Importance of cowpea. Pp. Ix-xii In: *Advances in cowpea research* Co-publication of IITA and JIRCAS IITA, Ibadan Nigeria. Proceeding of the 2nd Cowpea Research Conference held in Accra, Ghana 3-7 September, 1995, p190-196.

Roberts, P. A. (1987). The influence of planting date of carrot and *Meloidogyne incognita* reproduction and injury to roots. *Nematologica* 33: 335 - 342.

Sikora, R. A. and Fernandez, E. (1990). Nematodes parasites of vegetables. pp319 - 392 In: Plant parasitic nematodes in Subtropical and Tropical Agriculture. Luc, M. Sikora, R. A. and Bridge, J. (eds.) 1st edition, Wallingford, UK, CABI Bioscience Publication. 917pp

Singh, B. B., Ehlers, J. D. Sharma, B. And Freirefilho, F. R. (2003). Recent progress in cowpea breeding. Pp. 22 - 40 In: *Challenges and opportunities for enhancing sustainable cowpea production. Proceedings of the World Cowpea Conference III held at IITA* Ibadan, Nigeria. 4 - 8 September, 2002.

Tarawali, S. A., Singh, B. B., Peters, M. and Blade, S.F. (1997). Cowpea haulms as fodder. pp 313–325 In: Singh, B. B., Mohan Raj D. R, Dashiell, K. E, Jackai LEN (eds.) *Advances in Cowpea Research. Co publication of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS). Sayce, Devon, UK.*

Tijjani, I. and Atungwu, J. J. (2017). Variability of host damage and response of some cowpea breeding lines to root-knot nematodes, *Meloidogyne* spp. *Bayero Journal of Pure and Applied Science;* 10(**1**): 215-222