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Pathogenicity Study of *Meloidogyne incognita* on five different Yam Cultivars in Screen House and Field in Kogi State, Nigeria

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ABSTRACT:
The research was conducted to determine the pathogenicity of root- knot nematode *Meloidogyne incognita* on five different yam cultivars in the screenhouse/field in Kabba College of Agriculture Kogi State, Nigeria. Kabba College of Agriculture is located in the Southern Guinea Savannah Agroecological Zone of Nigeria of Latitude 07° 53N, 06°08E. Kabba has average rainfall of 1570mm, temperature ranges between 18°C - 32°C. It also has the mean relative humidity (R.H) of about 59% and four hundred and twenty seven metres (427m) above the sea level, according to Kabba College of Agriculture Metereological station, field survey (2014). In screenhouse and field, during the 2014 and 2015 seasons, four organic material treatments (powders of *Jatropha curcas, Ocimum gratissimum, Chromolaena odorata* and the control) were factorially combined with the five yam varieties and inoculation regimes of *Meloidogyne incognita*. The cultivars used as test crops are Okunmodo, Kerege and Sebukere as (white yam). Ewura (Water yam) and Olo (Yellow yam). The plant parasitic nematode caused stunted growth, galling of root of tuber and chlorosis on the white yam, water yam and yellow yam. The result of this research shows that white yam is susceptible to *M. incognita*, while water yam and yellow yam cultivars proved to be fairly resistant to *M. incognita*. The results further shows *Meloidogyne incognita* in screenhouse and field experiments significantly affected yam growth and yield. All the botanicals, powdered leaf of *Jatropha curcas, Ocimum gratissimum* and *Chromolaena odorata* had significant bio- pesticidal effect on *M. incognita* as they caused reduction in population both in the screenhouse and field experiments compared to the unamended plants (control). It is therefore advised that yam growers should not plant white yam cultivars on plant parasitic nematode endemic areas.
Keywords: Nematode, yield, *Jatropha, Chromolaena, Ocimum*, yam, *Meloidogyne incognita*

INTRODUCTION
Yam belongs to the family Dioscoreae and to the genus Dioscorea. Yam (*Discorea* spp.) constitutes one of the most important group of staple food crops in the tropics and most important group of staple foods especially in the yam zone (25° N and 15° S) of West Africa (Coursay, 1967; Babatola, 1990; FAO, 2000).Yam are valuable source of carbohydrate to the people of tropical and sub- tropical Africa, Central and South America, part of Asia, the Caribbean and Pacific Island. There are between 300 and 600 species of *Dioscorea*, of which a few are edible. The four most commonly cultivated yam spp are Water yam (*Dioscorea alata* Lour.), Yellow yam (*D. cayenensis* Lam.), Chinese yam (*D. esculenta* [Lour.] Burk.), and white yam (*D. rotundata* Poir). Moreover there are also few wild species of yam growing in Nigeria which are eaten in times of food shortage or scarcity. The bulk of global yam production is concentrated in West Africa, with Nigeria producing the largest proportion followed by Ivory Coast and Ghana (FAO-STAT, 2010).

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Yams are starchy staples in the form of large tubers produced by annual and perennial vines grown in Africa, the Americas, the Caribbean, South Pacific and Asia (IITA, 2009). Yam is the common name for some plant species in the genus *Dioscorea* (family *Dioscoreaceae*) that form edible tubers. These are perennial herbaceous vines cultivated for the consumption of their starchy tubers in Africa, Asia, Latin America, the Caribbean and Oceania. There are many cultivars of yam. Although the sweet potato (*Ipomoea batatas*) has also been referred to as *yam* in parts of the United States and Canada, it is not part of the family *Dioscoreaceae*; rather it is in the morning glory family *Convolvulaceae*. (IITA, 2009). Yam is a primary agriculturally and culturally important commodity in West Africa, where over 95 percent of the world's yam crop is harvested. Yams are still important for survival in these regions. Some varieties of these tubers can be stored up to six months without refrigeration, which makes them a valuable resource for the yearly period of food scarcity at the beginning of the wet season. Yam cultivars are also cropped in other humid tropical countries. (IITA, 2009).

Yams are food crops of major importance in tropical agriculture and they provide the staple food stuff for millions of people in many tropical countries, most notably in West Africa, the Caribbean area and parts of South East Asia. Yams had been reported to be vulnerable to nematode damage as they reduce the yield and quality of the tubers as a result of root gallings, root lesions, dry rots depending on the type of plant parasitic nematodes infecting the crop. The economically important nematode *Meloidogyne incognita* is a field and post-harvest pest. The presence of plant parasitic nematode could constitute serious impediments to the growth and yield of yams in Kogi State. Plant parasitic nematode infection is an important factor that affects the quality and yield of yam in both field and store. These nematodes especially the root knots are capable of forming galls on tubers, but in some cases, tubers may carry large numbers of females without showing knots or galls. In a survey carried out in twelve Local Government Area of Kogi State, Nigeria, soil borne nematodes *M. incognita* caused great reduction in size and qualities of yam produced on infected soil and even caused great damage of the inner part (of yam. The objective of this work therefore is to assess the pathogenicity of the identified nematodes on the different yam species.

Materials and Methods

Choice of Land and Land preparation

The experiment was carried out in a section of the research field of Kabba College of Agriculture Ahmadu Bello University, Nigeria in 2014 and 2015 cropping seasons. A piece of land which had been left fallow for 4 years was examined and assessed to be suitable for yam cultivation. The piece of land was cleared; shrub and stumps were removed and constructed into small heaps of 1.5 m distance apart.

Screen house and Field Experiment

Five different yam cultivars namely Okunmodo, Kerege, Sebukere, Ewura and Olo were purchased in seed form from neighbouring markets within and around Kabba/Bunu Local

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Government Areas of Kogi State. The experimental design was a 5x4x2 factorial experiment fitted into Randomized Complete Block Design (RCBD). This involves five yam varieties. White yam (Okunmodo, Kerege and Sebukere), water yam (Ewura), and yellow yam (Olo); four botanical treatments (powdered leaf of *Jatropha curcas, Ocimum gratissimum, Chromolaena odorata* and the control) and two nematodes treatment (i.e. *Meloidogyne incognita,* and non nematode. This means three factors (i.e. yams, botanicals and nematodes), a total of 40 treatment combinations was replicated three times each (120 observations). Each white yam, water yam and yellow yam was inoculated with M. *incognita* at sprouting stage. Mulching, staking and weeding operation of the experimental farm were carried out as at when due. Initial and final soil nematode population was taken for nematode bio-assay test.

Data Collection

At 2 months after planting, data were collected from the experimental pots in screenhouse and field. Subsequently, data were collected on monthly basis based on the following parameters: Number of leaves per plant, vine length and stem girth, Stem girth was measured at 5cm above the ground level in the screenhouse/field using vernier calliper. At harvest (10 months after planting) data were collected on number of tubers, weight of tubers, number of edible tubers and number of rotten tubers. Symptoms manifested on parts below ground and above ground level were also observed.

Data Analysis

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

RESULTS AND DISCUSSIONS

Effects of species, inoculum type and plant materials on growth Parameters of yam in Screenhouse/field experiment

Results of effects of treatments on growth parameter of yam are presented in tables 1 to 3 which shows the main effects of variety, inoculum and plant materials used on the vine length, number of leaves and stem girth at 5% level of significance of the treated plant for the two years 2014 and 2015 cropping season. Table 1 shows that yam variety used for the experiment resulted in significant difference in the vine length of yams. Vine length was significantly taller in *D. cayenensis,* (yellow yam) (171.06cm and 298.67cm) throughout the months of the experiment for 2014 and 2015 respectively. *D. rotundata* (white yam) (wk), (wo) and ws are significantly different from each other in terms of vine length during 2014 cropping season but not significantly different in vine length during 2015 cropping season. The result shows that all yam variety used in the field work were significantly taller in vine length compared to the screenhouse experiment. Table 2 shows effect of species, inoculum type and plant materials used on mean of number of leaves revealed that yam variety *D. rotundata* white yam (wk) and (wo) (158.67 and 226, 39) respectively was

significantly higher in number of leaves both in the screenhouse and field regardless of nematode infection. *D. rotundata* white yam (wo, ws and wk) are not significantly different from each other in number of leaves in 2014 and 2015 cropping season respectively, but significantly higher in number of leaves compared to non amended yam variety.

Table 3 shows effect of species, inoculum type and plant materials used on mean stem girth of yam shows that *D. rotundata* (wk) was significantly thicker in stem girth throughout the five months of the study in the screenhouse, while *D. cayenensis* (ca) (2.23cm) was significantly thicker in stem girth in the month of August in the field experiment. The result revealed that stem girth in the field study were significantly thicker compared to that of screen house experiment. Table 4 presented the effect of variety, inoculum type and plant materials on selected yield attributes of yam for both 2014 and 2015 cropping season respectively. Table 4 revealed that in all the growth parameters studied the best performance in terms of number of tubers was recorded in *D. rotundata,* white yam(wo) Okunmodo and white yam (wk) kerege having the values of 1.33 and 1.44 for both 2014 and 2015 respectively compared to other yam varieties. Table 4 further shows that *D. alata;* water yam (al) ewura was significantly different among other yam varieties in terms of weight of tubers with the values of 229.78g and 260.01g for both 2014 and 2015 cropping season. All the yam varieties in terms of number of edible tubers are not significantly different from each others in 2014 screenhouse experiment, while *D.rotundata* white yam (wk) (1.44) was significantly different from other yam varieties in the number of edible tubers in fieldwork. Table 4 further shows that *D. cayenensis,* yellow yam (olo) was significantly different from other yam varieties in term of number of rotten tubers in 2014 cropping season meaning that only *D.cayenensis* was rotten. All yam varieties are not significantly different in term of number of rotten tubers in 2015 field work indicating that there was no rotten tuber in all the yam varieties.

The findings of this study showed that both growth and yield parameter were significantly increased in treatments with plant materials whether infected or not with *Meloidogyne* compared to the plant that were untreated with botanicals. This is in line with the findings of Gangadhara *et al.,* (1990). This type of observation could be due to the possibility that the powdered leaf of *Jatropha curcas, Ocimum gratissimum* and *Chromolaena odorata* added to the soil nutrient upon biodegradation, which the plants then used for better growth and yield. This assertion has been corroborated by reports of earlier researchers (Thomas, 1987. Drechesel, 1991, 1998, Gautam and Goswami, 2002. Table 5shows effects of variety, inoculum type and plant materials used on mean final number of nematode (*Meloidogyne*) population on yam for 2014 and 2015 cropping season. Table 5 shows that among all the yam variety, *D. cayenensis,* yellow yam (ca) (olo) was significantly different with (20.14) value meaning that *D.cayenensis* was susceptible to nematode infection in 2014 screenhouse experiment. Table 5 further revealed that *D.alata,* water yam (al) (Ewura) was significantly different from other yam varieties having (120.53) value for 2015 field experiment. This implies that *D.alata* was susceptible to nematode infection. The result of the study indicated that Meloidogyne incognita caused

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considerable reduction in growth and yield as well as quality reduction (roughness and rottenness) of unamended tubers with *J. Curcas, O.gratissimum* and *C. odorata* both in screenhouse and field.(Karssen, 2002).

The study revealed that all the plant materials used had significant bio-pesticidal effects on *Meloidogyne* as they caused reduction in population both in the screenhouse and field compared to control. This is in line with the reports of some earlier researcher who reported effective reduction in nematode population by botanicals. Some of the organic materials of botanical origin that showed anti nematode properties includes; *African marigold, Ocimum gratissimum, Azadirachta indica, Chromolaena odorata* and Sugar cane bagasse(Saravanapriya and Sivakumar, 2005., Hayat *et al.*, 2012., Onyeke and Akueshi, 2012).

CONCLUSIONS AND RECOMMEDATION

Meloidogyne incognita in the screenhouse and field experiments was found to significantly affect yam growth and yield as they caused reduction to non amended yam variety. All organic materials i.e., powdered leaf of *Jatropha curcas, Ocimum gratissimum* and *Chromolaena odorata* have significant bio- pesticidal effect on *Meloidogyne* as they caused reduction in their population both in screenhouse and field in 2014 and 2015 cropping season respectively compared to the control. As long as indiscriminate use and over-dependence on chemical nematicides will continue to pose serious health and environmental hazard, the search for new commercializable bio-control agents will remain a viable option to protect crops, the environment and the users. It is therefore recommended that the use of the powdered leaves of *Jatropha curcas, Ocimum gratissiuum* and *Chromolaena odorata* as soil amendment for controlling plant parasitic nematodes be encouraged among yam growers. Besides, further research should also be carried out based on the phytochemical analysis of various plant materials at various seasons, localities and at different soils to ascertain their effective range of bioactive agents' content as also hitherto recommended by Sofowora (1982). Further research should be conducted to confirm the findings from this research, with the view of recommending it to farmers.

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Table 1: Main effects of variety, inoculum type and plant material used on mean vine length (cm) of yam (*Dioscorea* spp) 2014/205 cropping season in screenhouse/field
Means with the same letter(s) in any one segment of a given column are not significantly different at p=0.05

Variety	2014					2015						
	VltJun	VltJul	VltAug	VltSep	VltOct	VltFeb	VlMa	VltAp	VltMay	VltJun	VltJul	VltAug
Al	77.75ab	100.58b	123.64b	140.22bc	153.14d	119.67b	178.78b	196.44b	209.36b	217.78b	224.36b	226.33b
Ca	78.86a	114.69a	137.94a	155.58a	171.06a	209.86a	258.67a	270.44a	282.75a	293.11a	299.61a	298.67a
Wk	73.78ab	96.97b	119.94bc	140.92b	159.19b	123.00b	177.14b	188.75b	203.64b	211.00b	217.19b	218.61b
Wo	66.78c	98.03b	123.99a	141.17b	158.83bc	139.83b	175.92b	186.81b	199.08b	207.86b	214.22b	215.67b
Ws	72.64b	95.72b	117.28c	135.97c	154.64cd	118.75b	170.81b	183.92b	196.19b	207.44b	312.56b	214.08b
SE	1.87	2.07	1.82	1.62	1.50	6.98	6.05	6.05	6.11	6.24	6.15	6.41
Inoculum	-	-	-	-	-	-	-	-	-	-	-	-
Mi	69.80b	92.22c	115.43c	132.58b	150.35b	152.97a	207.92a	219.97a	234.55a	243.03a	250.28a	251.77a
Nn	74.02a	101.57b	126.17b	146.30a	162.35a	145.50a	188.25b	199.53b	211.47b	21987b	226.32b	227.95b
SE	1.45	1,61	1.40	1.25	1.62	5.41	4.69	4.68	4.73	4.83	4.76	4.97
Material	-	-	-	-	-	-	-	-	-	-	-	-
Co	80.44a	115.02a	138.36a	157.02a	176.16a	170.51a	225.33a	237.44a	249.56a	258.40a	265.11a	264.33a
Jc	76.36ab	103.09b	129.38b	148.62b	164.22b	164.87a	223.04a	233.60a	246.11a	256.44a	260.44a	262.38a
Og	75.09b	101.29b	127.22b	146.47b	162.96b	160.78a	211.93a	224.04a	236.29a	245.18a	252.42a	253.91a
Non	63.95c	84.40c	102.49c	118.98a	134.16c	72.73b	113.53b	126.00b	140.87b	149.73b	156.38b	158.07b
SE	1.67	1.86	1.62	1.45	1.34	6.24	5.41	5.41	5.46	5.58	5.50	5.73

SDKey: Al – *Alata*, Ca – *Cayenensis*, Wk – White yam Kerege, Wo – White yam Okunmodo, Ws – White yam Sebukere, Mi – *Meloidogyne incognita*, Sc – *Scutellonema*, Nn – No nematode, Co – *Chromolaena odorata*, Jc – *Jatropha curcas*, Og – *Ocimum gratissimum*, Non – Control, Vlt- Vine length

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Table 2: Main effects of variety, inoculum type and plant material used on mean number of leaves of yam (*Dioscorea* spp) 2014/205 cropping season in screen house/fiel

Variety	2014					2015						
	VltJun	VltJul	VltAug	VltSep	VltOct	VltFeb	VlMa	VltAp	VltMay	VltJun	VltJul	VltAug
Al	33.75d	60.58d	90.44c	102.11d	111.72d	63.49c	169.89a	184.81a	197.50a	209.36a	223.00a	224.81a
Ca	38.08cd	71.72c	101.19c	116.75c	124.28c	71.75bc	146.64b	160.28b	175.64b	192.44b	205.06b	206.97b
Wk	57.17a	99.92a	153.31a	154.56a	158.67a	82.19b	164.39a	178.64a	194.42a	206.44a	217.89ab	218.14ab
Wo	47.64b	86.22b	122.69b	143.42b	148.69b	96.11a	176.53a	190.00a	204.50a	215.11a	226.28a	226.39a
Ws	43.17bc	91.72ab	129.69b	142.67b	151.42b	72.78bc	167.14a	179.31a	192.97a	206.33a	217.47ab	219.33ab
SE	2,32	3.33	5,72	2.48	2.48	4.35	4.66	5.04	4.82	4.48	4.49	4.45
Inoculum	-	-	-	-	-	-	-	-	-	-	-	-
Mi	44.33	82.75ab	114.92b	126.87b	135.97b	76.70ab	168.93a	181.92a	197.43a	211.17a	224.42a	225.27a
Nn	42.05	87.80a	131.95a	138.45a	145.13a	72.13a	163.82a	175.90a	193.33a	204.47a	215.67ab	215.48a
SE	1.79	2.58	4.43	1.92	1.92	3.37	3.61	3.90	3.73	3.47	3.48	3.45
Material	NS	-	-	-	-	-	-	-	-	-	-	
Co	47.11b	86.64a	130.47a	139.11b	146.27a	90.82a	191.73a	205.69a	218.98a	232.07a	243.67a	244.82a
Jc	53.73a	94.53a	129.18a	143.00ab	149.67a	88.02a	185.80a	199.91a	211.47a	224.93a	236.78a	237.62a
Og	43.91b	87.24a	129.98a	147.00c	152.76a	89.49a	190.27a	204.69a	219.64a	230.84a	241.60a	242.91a
Non	31.09c	59.71b	88.24b	98.49c	107.13b	49.09b	91.87b	104.13b	121.93b	135.91b	149.71b	151.16b
SE	2.07	2.98	5.12	2.22	2.22	3.89	4.17	4.51	4.31	4.01	4.02	3.98

Means with the same letter(s) in any one segment of a given column are not significantly different at p=0.05
Key: Al – *Alata*, Ca – *Cayenensis*, Wk – White yam Kerege, Wo – White yam Okunmodo, Ws – White yam Sebukere, Mi – *Meloidogyne incognita*,
Sc – *Scutellonema*, Nn – No nematode, Co – *Chromolaena odorata*, Jc – *Jatropha curcas*, Og – *Ocimum gratissimum*, Non – Control, Vlt- Vine length

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Table 3: Main effects of variety, inoculum type and plant material used on mean stem girth (cm) of yam (*Dioscorea* spp) 2014/205 cropping season in screen house/field

Variety	VltJun	VltJul	2014 VltAug	VltSep	VltOct	VltFeb	VlMa	VltAp	2015 VltMay	VltJun	VltJul	VltAug
Al	0.61b	0.69ab	0.80c	0.79d	0.75c	0.64b	0.84c	1.07c	1.39c	1.76b	2.08bc	2.09b
Ca	0.64a	0.676a	0.91ab	0.94ab	0.85b	0.61b	0.88c	1.29a	1.61a	1.88a	2.21a	2.23a
Wk	0.64a	0.72ab	1.00a	1.03a	0.79a	0.78a	0.96b	1.18b	1.45b	1.77b	2.02cd	2.08b
Wo	0.68a	0.77a	0.84bc	0.90bc	0.82bc	0.85a	1.05a	1.23ab	1.47b	1.74b	1.98d	2.01c
Ws	0.55b	0.67b	0.76a	0.82cd	0.81bc	0.78a	0.99ab	1.21b	1.51b	1.81ab	1.10b	2.13b
SE	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03		0.02
Inoculum	-	-	-	-	-	-	-	-	-	-	-	=
Mi	0.67a	0.78a	0.89	0.91	0.85	0.75a	0.99a	1.22a	1.50a	1.80a	2.08ab	2.13a
Nn	0.64a	0.73a	0.87	0.91	0.86	0.76a	0.94ab	1.22a	1,51a	1.81a	2.11a	2.14a
SE	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0,02
Material	-	-	NS	NS	NS	-	-	-	-	-	-	-
Co	0.72a	0.82a	0.79a	1.01a	0.96a	0.78a	1.03a	1.31a	1.61a	1.92a	2.19a	2.22a
Jc	0.65b	0.76a	0.93a	0.96a	0.90a	0.81a	1.05a	1.28a	1.56a	1.86a	2.16a	2.19a
Og	0.67ab	0.78a	0.96b	0.99a	0.92a	0.80a	1.05a	1.32a	1.59a	1.87a	2.18a	2.20a
Non	0.45c	0.52b	0.60b	0.62b	0.58b	0.55b	0.66b	0.88b	1.18b	1.52b	1.78b	1.82b
SE	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.02

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Table 4: Main effects of variety, inoculum type and plant materials on selected yield attributes of yam (*Dioscorea* spp) 2014 cropping season screen house/field

Variety	2014 Mean number of tuber/s	2014 Mean weight of tuber/s (g)	2014 Mean number of edible tuber/s	2014 Mean number of rotten tuber/s	2015 Mean number of tuber/s	2015 Mean weight of tuber/s (g)	2015 Mean number of edible tuber/s	2015 Mean number of rotten tuber/s
Al	1.22a	229.78a	1.17a	0.00b	1.28ab	260.01a	1.28ab	0.00a
Ca	1.00b	120.22b	0.58b	0.31a	1.00c	223.00b	1.00c	0.03a
Wk	1.19ab	210.67a	1.19a	0.00b	1.44a	221.13b	1.44a	0.00a
Wo	1.33a	199.28a	1.22a	0.06b	1.14bc	231.12b	1.22abc	0.06a
Ws	1.14ab	225.31a	1.08a	0.06b	1.17bc	218.21b	1.14bc	0.00a
SE	0.07	12.21	0.08	0.04	0.09	0.08	0.08	0.02
Inoculum	-	-	-	-	-	-	-	-
Mi	1.07b	161.00b	0.90b	0.12a	1.20a	2.26b	1.22a	0.02a
Nn	1.28a	215.65a	1.07ab	0.10a	1.25a	2.45a	1.27a	0.00a
SE	0.06	9.46	0.07	0.03	0.07	0.8	0.06	0.02
Material	-	-	-	-	-	-	-	-
Co	1.24a	205.87	1.13a	0.09a	1.20a	2.74a	1.22a	0.00a
Jc	1.24a	222.18a	1.18a	0.04a	1.24a	2.75a	1.27a	0.04a
Og	1.16a	212.73a	1.00ab	0.07a	1.20a	2.89a	1.18a	0.00a
Non	1.07a	147.42b	0.89b	0.13a	1.18a	0 .84b	1.20a	0.02a
SE	0.06	10.92	0.08	0.03	0.08	0.07	0.07	0.02

Means with the same letter(s) in any one segment of a given column are not significantly different at p=0.05
Key: Al – *Alata*, Ca – *Cayenensis*, Wk – White yam Kerege, Wo – White yam Okunmodo, Ws – White yam Sebukere, Mi – *Meloidogyne incognita*, Sc – *Scutellonema*, Nn – No nematode, Co – *Chromolaena odorata*, Jc – *Jatropha curcas*, Og – *Ocimum gratissimum*, Non – Control, Vlt- Vine length

Table 5: Main Effects of variety, inoculum type and plant materials on Initial and mean final nematode population in Screenhouse/field for 2014/2015 cropping season

Varierty	2014 Initial nematode population in the pot	2015 Initial nematode population in the pots	2014 Final nematode population number /100mls of soil	2015 Final nematode population number /100mls of soil
Al	1000	2000	15.11b	120.53a
Ca	1000	2000	20.14a	109.61b
Wk	1000	2000	15.17b	99.78c
Wo	1000	2000	12.50b	73.61d
Ws	1000	2000	15.42b	103.00bc
SE	-	-	1.58	3.31
Inoculum	-	-	-	-
Mi	1000	2000	29.27a	138.97b
Nn	0.00	0.00	0.00c	0.00c
SE	-	-	1.23	2.57
Material	-	-	-	-
Co	1000	2000	16.49b	73.56b
Jc	1000	2000	11.18c	58.27c
Og	1000	2000	11.29c	69.13b
Non	1000	2000	23.71a	204.27a
SE	-	-	1.42	2.96

Means with the same letter(s) in any one segment of a given column are not significantly different at p=0.05

Key: Al – *Alata*, Ca – *Cayenensis*, Wk – White yam Kerege, Wo – White yam Okunmodo, Ws – White yam Sebukere, Mi – *Meloidogyne incognita*, Sc – *Scutellonema*, Nn – No nematode, Co – *Chromolaena odorata*, Jc – *Jatropha curcas*, Og – *Ocimum gratissimum*, Non – Control, VIt- Vine length

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