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EFFECTIVENESS OF AQUEOUS LEAF EXTRACT OF *PEPEROMIA PELLUCIDA* AND *TERMINALIA CATAPPA* IN THE MANAGEMENT OF CYST NEMATODE (*HETERODERA SACCHARI)* ON SELECTED RICE VARIETIES

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ABSTRACT. Experiments were conducted at the teaching and research farm of Faculty of Agriculture, University of Ilorin, Nigeria to determine the effect of aqueous extract of *Peperomia pelliucida* and *Terminalia catappa* on the management of cyst nematode, *Heterodera sacchari* on some selected rice varieties. A screenhouse preliminary study was first carried out in December, 2014 to assess the pathogenicity of *H. sacchari* on ten varieties of rice from which five varieties were selected for field trials. The five selected rice varieties were grown on soil inoculated with cysts of *H. sacchari*. The field experiment was a 5x3 factorial type fitted into a randomized complete block design (RCBD). Soil nematode population, physiochemical soil analysis and phytochemical screening of the tests plants were carried out. Treatment application of aqueous leaf extract were conducted at the 2nd and 7th weeks after transplanting. Data were collected on the plant height, shoot, root weights, yield and soil nematode population. All numerical data were subjected to analysis of variance (Anova) using GENSTAT statistical package 12th edition and where significant differences were observed, means were separated using fisher's protected LSD. Results from the study revealed that treatment combination of *P. pellucida* and *T. catappa* singly with FARO 60, FARO 61, and NERICA 8 performed significantly higher (p>0.05) than the other rice varieties for most of the growth and yield parameter measured. Significant differences occurred between shoot, root, and yield weight of treated plants and their control counterparts. There was no significant difference between the two plant extracts used with respect to parameters measured. Treated plants performed significantly higher than the control. Based on the results of the study, paddy farmers experiencing *H. sacchari* infestation are encouraged to treat the field with *P. pellucida* and or *T. catappa*, especially when planting FARO 60, FARO 61, and NERICA 8 as these combinations promise to give higher yield.

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Keywords: *Peperomia peliucida*; *Terminalia catappa*; rice varieties; significant; pathogenicity; susceptible.

INTRODUCTION

Rice (*Oryza sativa* L.) is a member of grass family (Gramineae) and belongs to the genus *Oryzeae*. It is an important and nutritionally indispensable food commodity that feed more than half of the world's population (Imolehin & Wada, 2000; Saka & Lawal, 2009). In many regions of the world, rice is the most important part of the human diet providing about 20% of the dietary energy. It is also a good source of thiamine, riboflavin, niacin and dietary fibre. Rice is an important crop in West Africa and remains essentially a grain for human consumption and a staple food for about half of the world population (Coyne *et al.,* 2000; Nwilene *et al.,* 2008; WARDA, 2001). The crop is cultivated in at least 114 countries mostly developing countries and is a primary source of income and employment for more than one million households in Asia and Africa (FAO, 2004). Rice has contributed to socio-economic well-being of Nigeria both as a major element in the country's food security and as a commodity for internal commercial transaction (FAO, 2000). In Nigeria, rice can be boiled as cooked rice, rice water and so on. Rice flour made from 30% broken rice straw are used in making paper, as well as livestock feed. Major constraint to domestic production of rice in Nigeria include pests and diseases (Osanyinlusi & Adelegan, 2016; Ismaila *et al.,* 2010). Numerous disease of rice, caused by fungi, bacteria, viruses and nematodes, have been recorded in literature. Some diseases occur where ever rice is grown in commercial quantity. Rice pests are weeds, insects, rodents and birds (Jahn *et al.,* 2007). Coyne & Plowright (2004) reported that over 150 species of nematodes are parasites of rice. Nematodes of rice include: *Heterodera* spp., *Meloidogyne* spp., *Hirschmanniella* spp., *Practylenchus* spp. and *Aphelenchoides* spp. *Heterodera sacchari* is considered to be potentially important on rice in Nigeria and it was reported that it severely reduces rice grain yield (Coyne & Plowright, 2000). Yield losses due to *Heterodera sacchari* is up to 50%. The genus *Heterodera* contains at least 80 species, some of which cause serious yield reduction in crops (Subbotin *et al.,* 2010).

The protective cyst stage of these nematodes enables them to withstand desiccation and greatly enhances their dispersal and survival (Waeyenberge *et al.,* 2009). Several control measures have been adopted in the management of rice diseases. They include cultural control, biological control, the use of resistant varieties and chemical control to mention just a few. The use of chemicals such as insecticides, nematicides and fungicides is presently the most popular control measure in Nigeria (Udoh *et al.,* 2000), but these chemicals are expensive and not readily available. However, synthetic nematicide possess the capacity to leave harmful residues in food commodities if used incorrectly. They also have the ability to give rise to a rapid emergence of resistant strains. In the recent times however, attention has shifted to the integration of several approaches among which is the use of various parts of indigenous plants which have been known to contain many antimicrobial compounds that can control many plant pathological disorders. The use of botanicals is ting plant against microbial stress. Therefore, the objectives of this study were to evaluate the pathogenicity of *H. sacchari* infecting ten selected rice varieties, assess the efficacy of *T. catappa* and *P. pellucida* aqueous leaf extracts on the nematode, growth and yield of rice and determine the bio-active agents present in the botanicals.

MATERIALS AND METHODS

The top soil used for the pot experiment was sieved thoroughly through a 2 mm size sieve and sterilized in a drum at 60^{o}C for 12 hrs. The sterilized soil was later distributed into perforated plastic bucket and placed on elevated flat blocks to prevent re-infestation of pathogens.

A total of 10 varieties of rice collected from International Institute for Tropical Agriculture (IITA) Ibadan for the experiment include NERICA 8, NERICA 1, WAB 56-104, MOROBEREKAN, FARO 60, FARO 44, FARO 61, NERICA 2, FARO 52 and NERICA-L2. Twenty seeds from each rice variety were soaked in water for 24 hrs and later spread on the floor, seeds were incubated by covering them with raffia palms for another 48 hrs for the seeds to sprout for viability test.

Pathogenicity test (Pot experiment)

The sprouted seeds were planted at the rate of four seeds per pot. into 50 pots of sterilized soil in December 2014. The design of the experiment was a complete randomized design, replicated five times. Plants were watered every day to maintain good soil moisture content required for optimum crop growth. NPK 15:15:15 was applied 7 days after planting. The plants ware later thinned to two seedlings per pot after two weeks.

Two weeks after planting, the pots were inoculated with *Heterodera sacchari* cyst infected soil, collected from IITA Ibadan. Assessment was done on the effect of the nematode on rice based on colour change, plant height and yield. Number of cysts present in the soil were counted using the compound microscope.

Field experiment

The experiment was carried out between July and November, 2015, in the Teaching and Research Farm, University of llorin, Nigeria, located in the agro-ecological zone of derived guinea savannah, between Lat. 8°29'N and Long. 4°35'E at 310 m above sea level.

The land was ploughed harrowed and mapped out into plot size of 35 m by 30 m. Bunds were constructed round the plot to help retain rain water. The experimental design was a 5x3 factorial, fitted into a randomized complete block design (RCBD). The field was sprayed with pre-emergence herbicides, paraquat and atrazine.

Based on the result of the pathogenicity test, three of the rice varieties with good performance in terms of number of tillers, height and yield and two varieties that performed significantly lower (p=0.05) with respect to the above measured parameters were selected for field trials. These five varieties were raised on separate beds in the nursery for three weeks before transplanting to the field that had been inoculated with *Heterodera* cyst infectected soil a day before at the rate of two seedlings per hole.

Leaves of both *Peperomia pellucida* and *Terminalia catappa* were air dried for one week. Five kilograms of each of plant material was pulverized in a blender and soaked in 20 L of hot water for 24 hrs then sieved. The treatment was applied to the plants one week after transplanting at the rate of 100 ml per stand. N.P.K 15:15:15 was applied at the rate of 100 kg/ha. Weeding was carried out four times manually at three weeks interval.

Data collection

Data were collected on the plant height, shoot and root weights, yield, soil nematode population, soil nutrient analyses and phytochemical screening of Leaves extract. All numerical data were subjected to analysis of variance (Anova) using GENSTAT statistical package 12th edition and where significant differences were observed, means were separated using fisher's protected LSD.

Extraction of cyst nematode

Soil samples were taken from the rhizosphere of the infected rice plants using hand trowel and then transferred into a bucket. Water was added and stirred very well, then poured on sieves arranged in descending values of 500µm, 250µm, 90µm and 25µm. The 90µm sieve was thoroughly rinsed with wash bottle and the suspension was collected and screened under the compound microscope for cyst nematode.

Phyto-chemical screening of the leaves

Using standard methods, specific qualitative tests were performed at the Chemistry Department, University of Ilorin to identify bioactive compounds of nematicidal importance present in the leaves.

RESULTS

Pot experiment

Varietal effect on plant height indicates that there were significant differences among the varieties. Generally, the other eight varieties performed significantly higher than FARO 44 and NERICA 1, with respect to the height (*Table 1a*). Five varieties, FAROs 60, 61, 52, MOROBEREKAN and NERICA 8, performed significantly higher than other five, with respect to the number of tillers (*Table 1b*); whereas, varieties FAROs 61, 60, 52 and NERICA 8 were, generally, significantly higher than the other varieties in terms of yield weight**.**

Field trials

Effect of treatment combinations on mean plant height of rice infected with *H. sacchari* cyst (*Table 2a*) shows that, the treated plants were significantly (p>0.05) higher than their control counterparts. Varieties FAROs 60, 61 or NERICA 8, treated with *P. pellucida*, seemed superior to the other treatment combinations.

Table 1a - Varietal effect on mean plant height of rice infected with *Heterodera sacchari* cyst.

	Mean plant height of rice per week									
	2	3	4	5	6	7	8	9	10	11
FARO 61	33.35ab	38.45ab	44.07a	49.63bc	55.18b	60.57cd	70.48b	87.97a	92.02a	92.02a
NERICA 2	30.63cde	35.98bc	39.53b	42.82def	47.85cd	51.88ef	57.22de	65.98d	72.43d	72.43d
NERICA 2	28.95e	33.2cd	38.22bcd	43.43de	46.03cd	49.37f	54.08e	63.93de	69.57de	69.57de
FARO 44	29.57de	32.67d	35.8d	39.17f	43.78e	48.97f	54.17e	63.95de	63.95ef	63.95ef
WABL 2104	30.78cde	35.15cd	39.92b	55.08a	56.48ab	61.72bc	65.85c	72.03c	79.15c	79.15c
NERICA 1	29.1de	32.35d	36.2cd	40.7ef	43.8e	48.62f	53.28e	61.05e	61.05f	61.05f
NERICA 8	31.5bcd	35.92bc	40.68b	45.88cd	50.37c	56.22de	60.02d	71.77c	86.52ab	86.52ab
FARO 60	33.03abc	39.4a	46.03a	51.33ab	59.27a	65.2ab	78.1a	86.52ab	86.52ab	86.52ab
FARO 52	34.13a	40.2a	45.8a	52.8ab	58.92a	66.42a	77.18a	82.45b	82.45bc	82.45bc
MOROBEREKAN	31.53bcd	34.12cd	39.23bc	44.37de	48.22cd	51.25f	71.22b	82.15b	84.42bc	84.42bc
S.E.M.	0.863	1.078	1.121	1.457	1.283	1.622	1.441	1.582	1.999	1.999

(Mean±SD); S.E.M = Standard error of treatment means; Values followed by the same letters are not significantly different at p=0.05; WAP = Weeks after planting

Table 1b - Mean shoot, root and yield weight (g) of rice varieties infected with *H. sacchari* cyst.

	Shoot	Root	Yield
FARO 61	395.13a	125.7a	134.72a
NERICA 2	302.52cd	118.85ab	117.9d
NERICA 2	274.63d	109.2cd	116.83d
FARO 44	269.85d	107.43cd	115.77d
WABL 2104	329.88bc	103.62d	121.48cd
NERICA 1	284.5d	104.4d	117.43d
NERICA 8	343.48bc	109.95cd	128.85abc
FARO 60	372.07ab	121.7ab	131.82ab
FARO 52	347.92b	115.3bc	127.23abc
MOROBEREKAN	349.32b	108.23cd	126.5bc
S.E.M.	15.69	3.015	2.704

(Mean±SD); S.E.M. = Standard error of treatment means; Values followed by the same letters are not significantly different at p=0.05 by LSD; WAP = Weeks after planting.

Varietal effect on plant height indicates that there were significant differences among the varieties in most of the weeks except for weeks 8 and 11. Though there was no significant difference between NERICA 8 and the three FARO varieties, there was also no significant difference between NERICAs 8 and 1. Generally, the FARO varieties performed significantly higher than NERICA 1 (*Table 2b*).

Treatment effect on mean plant height of rice infected with *H. sacchari* (*Table 2c*) shows that significant differences occurred between treatments. The treated plants performed significantly higher than the control.

Table 3a shows that there were no significant differences between NERICA 8 and FARO 61, treated with *P. pellucida*, however FARO 60, treated with *P. pellucida*, seemed superior to the other treatment combinations with higher shoot weight, when compared with its control that was significantly lower than its treated counterpart. Generally, the treated plants were significantly higher than their control counterparts; whereas, there were no significant differences between FARO 44 treatment 1 and NERICA 1 (*P. pellucida*).

For the root weight, there were no significant differences between root weight of NERICA 8 and FARO 61, treated with *P. pellucida*. The root weight of FARO 60, treated with treatment 1 (*P. pellucida*), was significantly higher than FARO 44 and NERICA 1. Generally, the treated plants were significantly had higher root weight than their control counterparts.

Table 2a - Effect of treatment combinations on mean plant height of rice infected with *H. sacchari* cyst.

Rice variety	Plant height (cm) per weeks after planting									
	2	3	4	5	6	7	8	9	10	11
FARO60T1	35.4a	41.33a	48.23a	53.17ab	58.9a	65.87a	80.375.35	90.87a	96.73ab	98.07ab
FARO60T2	33.53ab	36.4bcd	42.47bcd	41.33de	53.07bc	58.83c	70.3	79.4bcd	85.57cd	86.8cde
CONFAR060	31.07bc	33.5cdef	35.77ef	39.83e	43.07f	47.37f	54.67	62.87g	67.93gh	69.97i
FARO44T1	26.77def	32.7def	39.27de	50.13a b	51.57cd	57.47cd	65.53	73.4cdef	80.4de	86.4cde
FARO44T2	29.6cd	38.034ab	44.17abc	54.1a	56.4ab	64.1ab	70.6	83.3ab	89.8bc	93.87bc
CONFAR044	28.2cde	33.3cdef	40.03cde	49.63ab	52.13c	54.43de	59.27	66.37g	71.87fgh	74.7ghi
NERICA1T1	23.5f	31.67f	36.8ef	42.53cde	46.4ef	51.7e	58.53	63.63g	72.8efgh	79.57efg
NERICA1T2	24.37f	31.27f	36.9ef	43.03cde	47.97de	53.07e	61.07	67.97efg	74.67efg	84.23def
CONNERICA1	25.93ef	31.17f	34.2f	41.23e	45.63ef	50.6ef	56.1	61.5g	65.2h	71.67hi
NERICA8T1	30.73bc	37.3abc	43.97abc	49.271ab	53.83bc	59.9bc	69.33	79.43bcd	88.67c	95.1ab
NERICA8T2	31.43bc	37.23abc	42.03bcd	47.27bcd	52.03c	59.03c	66.87	75.23bcde	84.9cd	90.87bcd
CONNERICA8	29.43cd	32ef	36.87ef	42.03de	47.33e	52.17e	58.17	62.6g	67.9gh	72.37ghi
FARO61T1	32.9ab	38.43ab	45.03ab	50.6ab	55.4abc	60.7bc	315.5	90a	98.63a	101.7a
FARO61T2	31.03bc	36.13bcde	43.37bcd	48.27abc	53.43bc	58.57cd	75.43	81.07bc	92.07abc	93.6bc
CONFARO61	33.1ab	37.53abc	43.73abcd	48.37abc	52.53bc	57.97cd	63.13	72.13def	75.73ef	78.07fgh
S.E.M.	1.13	1.48	1.62	2.079	1.37	1.48	61.8	2.82	2.65	2.61
							N.S			

S.E.M. = standard error of treatment means; Values followed by the same letters are not significantly different at p=0.05 by LSD;
WAP = weeks after plant.

Table 2b - Varietal effect on mean plant height of rice infected with *H. sacchari* cyst.

Rice variety	Plant height (cm) per weeks after planting									
	2	3	4	5	6	7	8	9	10	11
FARO 60	33.33a	37.08a	42.16a	44.78bc	51.68a	57.36a	68.44	77.71a	83.41a	84.94
FARO 44	28.19c	34.68a	41.16a	51.29a	53.37a	58.67a	65.13	74.36a	80.69a	84.99
NERICA1	24.6d	31.37b	35.98b	42.27c	46.67a	51.79b	58.57	64.37b	70.89b	78.49
NERICA8	30.53b	35.51a	40.96a	46.19bc	51.07a	57.04a	64.79	72.42ab	80.49ab	86.11
FARO 61	32.34ab	37.37a	44.04a	49.08ab	53.79b	59.08a	151.36	81.07a	88.81a	91.12
S.E.M.	0.705	1.063	1.303	1.532	1.38	1.666	36	3.05	3.38	3.48
							NS			NS

Table 2c - Treatment effect on mean plant height of rice infected with *H. sacchari* cyst.

Rice variety	Plant height (cm) per weeks after planting									
	2	3	4	5	6	7	8	9	10	11
Trt. 1	29.86	36.29	42.67a	49.14a	53.22a	59.13a	117.85	79.47a	87.45a	92.17a
Trt. 2	29.99	35.81	41.79a	46.8ab	52.58a	58.72a	68.85	77.39a	85.4a	89.87a
Control	29.55	33.5	38.12b	44.22b	48.14b	52.51b	58.27	65.09b	69.73b	73.35b
S.E.M.	0.992	0.934	1.097	1.33	1.088	1.684	27.9	2.17	2.11	1.75
	NS	NS					NS			

(Mean±SD) S.E.M. = standard error of treatment means; Values followed by the same letters are not significantly different at p=0.05 by LSD; WAP = weeks after planting.

Table 3a - Effect of treatment combinations on mean shoot, root, and yield weight of rice infected with *H. sacchari* cyst.

Rice variety/ plant extract	Growth and yield	Parameters of rice (g)	
	Shoot	Root	Yield
FARO 60T1	397.8a	108.7a	112.33a
FARO 60T2	340.03c	73.27cd	101.67abc
CONFARO 60	199.7fg	58.8e	51.9de
FARO 44T1	220.83ef	62.47de	56.93d
FARO 44T2	269.17d	63.73de	48.07de
CONFARO 44	109.17i	50.33e	39.93ef
NERICA 1T1	209.03f	58.07e	57.7d
NERICA 1T2	257.13de	64.43de	58.67d
CONNERICA 1	123.2i	51.17e	34.37f
NERICA 8T1	356.2b	82.73bc	109.83ab
NERICA 8T2	251.13de	63.67de	99.57bc
CONNERICA 8	145.33hi	52.47e	43.37ef
FARO 61T1	360.9ab	89.37b	100.43abc
FARO 61T2	307.47c	63.8de	92c
CONFARO 61	165.6gh	53.37e	41.4ef
S.E.M.	13.25	5.01	4.27

(Mean±SD); S.E.M. = standard error of treatment means; Values followed by the same letters are not significantly different at p=0.05 by LSD; WAP = weeks after planting.

Table 3b - Varietal effect on mean shoot, root and yield weight of rice varieties infected with *H. sacchari* cyst.

	Mean weight of infected rice varieties		
	Shoot weight (g)	Root weight (g)	Yield (g)
FARO 60	312.51a	80.26a	88.63a
FARO 44	199.72bc	58.84b	48.31b
NERICA 1	196.46c	57.89b	50.24b
NERICA 8	250.89abc	66.29ab	84.26a
FARO 61	277.99ab	68.84ab	77.94a
S.E.M.	27.6	5.34	8.04

(Mean±SD); S.E.M. = standard error of treatment means; Values followed by the same letters are not significantly different at p=0.05 by LSD; WAP = Weeks after planting.

For the yield, there were significant differences among the treatment combinations. FAROs 60, 61 and NERICA 8, with treatment 1 (*P. pellucida*), recorded the highest yield than FARO 44 and NERICA 1, which were not significantly higher than their control counterparts.

Table 3b shows that there were no significant differences between FAROs 60, 61 and NERICA 8, in terms of shoot weight. While there were no significant differences between FAROs 44, 60 and NERICAs 8 and 1. FARO 60 performed significantly higher than FARO 44 and NERICA 1.

Root weight shows no significant difference between FAROs 60, 61 and NERICA 8. FARO 60 was significantly higher than FARO 44 and NERICA 1, while there were no significant differences between FAROs 44, 61 and NERICAs 8 and 1.

Significant differences existed between the yields of the five varieties. FAROs 60, 61 and NERICA 8 recorded significantly higher yield than FARO 44 and NERICA 1, which were not significantly different from each other. Significant differences occurred between shoot, root, and yield weight of treated and untreated rice varieties. The treated plants had higher shoot, root and yield weight than the control (*Table 3c*).

Table 3c - Treatment effect on mean shoot, root and yield weight of rice infected with *H. sacchari* cyst.

	Mean weight of infected rice		
	Shoot weight (g)	**Root weight (g)**	**Yield (g)**
Trt. 1	308.95a	80.27a	87.45a
Trt. 2	284.99a	65.78a	79.99a
Control	148.6b	53.23b	42.19b
S.E.M.	14.91	3.5	5.47

(Mean±SD); S.E.M. = standard error of treatment means; Values followed by the same letters are not significantly different at *p*=0.05 by LSD; WAP = weeks after planting.

DISCUSSION

The aqueous plante extract of *P. pellucida* and *T. catappa* were found to be effective in the management of *H. sacchari*. The use of *P. pellucida* as antibacterial agent was reported by Khan & Omoloso (2002) and the antimicrobial activity of leaf extract of *T. catappa* was also reported by Chanda *et al.* (2011).

Results obtained from the different parameters measured showed that the treatment combinations had positive effect on the plant growth and yield, as well as reduction in soil nematode population. The performance of variety 5, FARO 61 and treatment 1, *P. pellucida* seemed superior to the other treatment combinations. The control plants were only significantly shorter than their treated counterparts. This is in line with the observation made by Audebert *et al.* (2000) that *H. saccahari* cause symptoms of physiological drought in upland rice fields. Though there were no significant differences between FAROs 60, 61 and NERICA 8, these varieties performed better than the other rice varieties, FAROs 1 and 44, with respect to yield. However, all the varieties were susceptible to cyst nematode. This study therefore underscores importance of varietal role in determining the pathogenicity of *H. sacchari* on rice.

Akpheokai *et al.* (2014) reported that some upland NERICA rice are susceptible to *H. sacchari*. The significant reduction in the yield of the control plot was as a result of higher number of nematode infestation. Coyne & Plowright (2000) reported yield losses due to *H. sacchari* to be 50%. The study also revealed that the aqueous plant extracts of *P. peperomia* and *T. catappa* had significant effect on the mean shoot, root and yield weight of rice against the control. There was reduction in nematode population, which translated to improved shoot, root and yield weight of the rice. This may be attributed to the presence of secondary metabolites (alkaloids, tannins, saponins, flavonoids, terpenoids, steroids, phenols etc.) present in the aqueous extracts of *P. pellucida* and *T. catappa* (*Tables 4,5*). Ritson & Nugroho (2007) and Khan & Omoloso (2002) reported the use of *P. pellucida* as antibacterial agent and the antimicrobial activity of leaf extract of *T. catappa* has also been demonstrated (Chanda *et al.,* 2011).

Table 4 - Phytochemical screening of result of *Terminalia catappa*

Secondary metabolites	Ethanol extract	N- Hexane extract
Alkaloid	+	-
Saponin	++	+
Tannin	+	-
Flavonoid	-	-
Terpenoid	+	-
Steroid	+	+
Phenol	+	-

absent (-); present at low levels (+); present at moderate levels (++); present at high levels (+++); low levels (+); present at moderate levels (++); present at high levels (+++).

Table 5 - Phytochemical screening of result of *Peperomia pellucida*

Secondary metabolites	Ethanol extract	N- Hexane extract
Alkaloid	++	+
Saponin	++	+
Tannin	++	-
Flavonoid	++	+
Terpenoid	+++	++
Steroid	++	+
Phenol	++	+
Glycosides	+	-

absent (-); present at low levels (+); present at moderate levels (++); present at high levels (+++).

Table 6a - Initial nutrients present in the soil

Soil nutrients present	Soil samples		
	1	2	3
Na^+ (cmol/kg)	0.37	0.45	0.32
K^+ (cmol/kg)	0.16	0.083	0.028
Ca^{++} (cmol/kg)	0.0026	0.0024	NT
Mg^{++} (cmol/kg)	0.0016	NT	0.0018
Phosphorus (ppm)	42.7	45.1	43.2
Nitrogen % (N)	11.24	11.20	9.25
Acidity (cmol/kg)	0.01	NT	0.03
E.C.E.C	3.21	3.25	3.27

NT = not traceable

Table 6b - Final nutrients present in soil

Soil nutrients present	Soil samples			
	1	**2**	**3**	**Control**
Na^+ (cmol/kg)	0.28	0.38	0.29	0.30
K^+ (cmol/kg)	0.062	0.071	0.022	0.015
Ca^{++} (cmol/kg)	0.0024	0.0025	0.0025	0.0023
Mg^{++} (cmol/kg)	0.0012	NT	0.0016	0.0014
Phosphorus (ppm)	37.2	38.6	33.2	31.2
Nitrogen % (N)	11.13	11.10	10.45	9.68

NT= not traceable

The physicochemical analysis of the soil showed that there was reduction in the quantity of nitrogen, potassium, phosphorus and magnesium at the end of week 12 (12 WAP) (*Tables 6a,b*). The reduction reveals the nutrient up-take ability of rice, which further fortified and possibly conferred higher resistance to the treated plants. The functions naturally performed by these elements in plants are noteworthy. For instance, nitrogen is a major building block for protein (Swan, 1971), calcium regulates the transport of the nutrient into plants, and all the energy transfer in plant cell is critically dependent on phosphorus (Wikipedia, 2015).

CONCLUSION

All the 10 rice varieties tested were susceptible to cyst nematode at varying degrees. The results of these experimental trials also have shown that the treated plants performed significantly higher ($p<0.05$) than the untreated control. Treatment combination of *Peperomia pellucida* with FAROs 60, 61 and NERICA 8 performed better than the other treatment combinations for growth and yield. The findings of this field work should be extended to paddy farmers, who are experiencing *Heterodera sacchari* infestation in their field and especially to those in the southern guinea savannah agroecology in Nigeria, where the experiment was carried out.

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