Synergistic Effect of Poultry Manure and Some Botanicals on Cowpea Root-Gall Nematode Infection in a Naturally Infested Soil of Owerri, Imo State, Nigeria

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ABSTRACT

This study was carried out at the Postgraduate Teaching and Research Farm of the Federal University of Technology Owerri in 2017 cropping season to ascertain the synergistic effect of poultry manure and some botanicals on root-gall nematode infection on cowpea in a naturally infested soil. The experiment was laid out in a 2 x 3 factorial in randomized complete block design with four replications. The factors whose effects were investigated included: cowpea varieties (Ife brown and Oloto brown) and organic soil amendments (poultry + siam weed, poultry + neem leaves and control). Data were collected on nematode population in the soil, galling index using scoring scale of 0 - 4, number of leaves, plant height, peduncle length, number of pod, pod length, fresh pod weight. Results revealed significant effect ($P < 0.05$) of the combination of poultry manure and neem leaves which recorded the lowest nematode populations (464, 369 and 289) larvae/ 200 g soil at 30, 60 and 90 days respectively when compared with the control. However, Ife brown variety planted on plots with the mixture recorded the highest growth and yield attributes with reduced nematode infection when compared with Oloto brown on plots with mixture of poultry manure and siam weed and also the control plots. Consequently for increased grain yield, Ife brown cowpea variety susceptible to root-gall nematode (*Meloidogyne incognita*) can be planted in an infested soil amended with the mixture of poultry manure and neem leaves for effective control of root-gall nematode.

Keywords: *Cowpea, Botanicals, Galling index, Neem leaves, Nematode population, root-gall nematode.*

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Highlights of this paper

- This study was carried out at the Postgraduate Teaching and Research Farm of the Federal University of Technology Owerri in 2017 cropping season to ascertain the synergistic effect of poultry manure and some botanicals on root-gall nematode infection on cowpea in a naturally infested soil.

1. INTRODUCTION

Cowpea, an important protein source in our diet, is believed to have originated in Africa [1]. Most cowpea is produced and consumed in Sub-Saharan African. Information across the globe indicated that almost 5.5 million tons of dried cowpeas are produced worldwide, with Africa producing close 5.2 million [2]. In Africa and globally, Nigeria ranks the largest producer and consumer of cowpea Quinn [3]. According to Nielson, et al. [4] and Fatokun [5] the dry grains serve as food for humans while the haulms are feeds of livestock. It serves as a means of revenue for the poor resource farmers also helps to enrich soil fertility due to their ability to fix nitrogen in the soil.

Cowpea plants are attacked by numerous pest and diseases at different stages of growth which hamper their productivity. Root-gall nematodes had been reported as one of the most important limiting factors to cowpea production leading to about 70% grain yield loss [6]. Also cowpea grain yield loss of 69% caused by root-knot nematode had been reported by Babatola and Omotade [7]. Adegbite [8] reported that high *M.incognita* population in the untreated control plots decreased growth and yield of cowpea.

Many management strategies have been adopted in the management of the menace caused by root-knot nematode on crops. The use of synthetic nematicides in the management of root-knot nematodes are highly effective but are expensive, not sustainable and affect the agro-ecosystem adversely [9, 10]. Due to the problems associated with the use of synthetic nematicides in the management of root-knot nematode, there is the need to explore other management options that are less expensive, sustainable and environmentally friendly. Therefore the present study was carried out to evaluate the synergistic effect of poultry manure and some botanicals in the management of root-knot nematode infection on cowpea in a naturally infested soil of Owerri, Southeastern Nigeria.

2. MATERIALS AND METHODS

2.1. Experimental site

The field experiment was carried out at the Post graduate Teaching and Research Farm, under naturally infested with root-knot nematode (*M. incognita*) [11]. The experiment was carried out in 2017 cropping season. The experimental site was located in the rain forest belt on latitude 5°27'50.23" North and Longitude 7°02'49.33" East at 55 m above sea level (Handheld Global Positioning System). Owerri has a rainforest Agro-ecology characterized with more than 2,500 annual rainfalls, 27- 29°C annual temperature and 89 – 93% humidity. The soil was loamy sand (91.40% sand, 5.14 %clay, 3.46% silt).

2.2. Land Preparation, Experimental Design and Treatment Allocation

A piece of land measuring 15 m x 10 m (150 m^2) was mapped out in the field. The area was manually cleared and tilled and measured using a tape.

The area of land was divided into four blocks and each block was made up of six plots with 1.0 m pathways between blocks. Each plot measured 2 m x 1.5 m with 0.5 m pathways.. Before planting, the 1kg of each cowpea variety seeds were first seed dressed with one sachet of Apron Star before sowing. Two seeds were planted per hole at a depth of 3 cm at 0.6 m x 0.3 m spacing and later thinned to one plant per stand to give a plant population of 111,111 plants per hectare.

The experiment was laid out in a 2 x 3 factorial in randomized complete block design with four replications. Treatments comprised of cowpea varieties (Ife brown and Oloto brown) and organic amendments (poultry + siam weed, poultry + neem leaves and control). All the treatments were associated to each plot completely at random giving a total of six (6) treatments combinations. All the plots were amended with the mixture of poultry manure and organic soil amendments of plant origin comprising (siam weed and neem leaves) each at 200 kg/ha each except the control plots. The application was done twice, first at two weeks before planting and second application was done at four weeks after planting.

2.3. Assay for Root-gall Nematode Population

Assay for root-gall nematode populations were determined prior to treatment and from one to three times (30, 60, 90 days) following treatments. The nematode population in the soil was estimated using the modified Baermann technique. Soil samples were taken from the experimental site using a soil auger at the depth of 0 – 30 cm. These soil samples were bulked together to make one composite sample. Sub-samples of 200 g of soil were measured for the nematode extraction. The measured soil samples were placed on plastic sieves lined with tissue paper place on plastic trays. Water was then carefully poured down the gap between the tray and the sieve. Extract from the samples were stored for two days and these were constantly checked to ensure they do not dry up. The sieves were carefully drained and removed from the tray and the tissue paper and soil discarded. The water containing the nematodes poured into labeled beakers and the trays thoroughly rinsed into the beakers. The samples were left to settle for overnight. The suspensions were reduced by decanting and collected in a beaker for nematode assessment. The extracted suspensions were then concentrated to precised volume (10 ml) in a measuring cylinder. Aliquots were removed from the suspensions using a pipette and placed into a petri dish. This was placed under a dissection stereo-microscope with under stage lighting for root gall nematode (*Meloidogyne incognita)* counting.

2.4. Data Collection

Data were collected on number of leaves, plant height, peduncle length, number of pod, pod length, fresh pod weight. Also data on root gall infection assessment was collected. The galling index was assessed on a scale of 0-4 according to Agu and Ogbuji [12]. Manual weeding was done at four weeks after planting.

2.5. Data Analysis

These data were subjected to analysis of variance procedure using [13]. The differences between means were separated using least significant difference at 5 % level of probability.

3. RESULTS AND DISCUSSION

Table 1 shows the synergistic effect of different organic soil amendments on root-gall nematode population at different interval. Cowpea varieties on plots treated with soil amendments recorded lower nematode population at 30, 60 and 90 days over the corresponding untreated plots (control). The plots where mixtures of poultry manure and neem leaves were applied recorded the lowest nematode population (464, 369 and 289) larvae/ 200g soil at 30, 60 and 90 days respectively when compared with the corresponding untreated plots (control) (565, 583 and 596). The reduced nematode population recorded on plots amended with combination of poultry manure and neem leaves might be attributed to their chemical compositions which might be toxic to the root-knot nematode. Ismail, et al. [14] reported that application of different organic composts significantly suppressed the population of plant parasitic nematodes on the test crops. Dongre and Simon [15] also reported that plant extracts were found to

significantly decreased root galls in higher concentration. Similarly, Pakeerathan, et al. [16] reported that organic amendment ameliorated the root-knot nematode infection in different ways such as acting as physical barrier to nematode movement, changing the diversity of root micro flora and their population and changing physical and chemical properties of soil.

Effect of mixture of poultry manure and some botanicals on some cowpea growth parameters and root-galls are presented in Table 2. The combination of poultry manure and neem leaves on Ife brown cowpea varieties plots recorded the highest number of leaves (44.3) and least root -gall (0.38) when compared with Oloto brown variety plots and the control plots. These differed significantly ($p < 0.05$) from the control plots where Oloto brown varieties were planted which produced the least cowpea number of leaves (13.10) and were highly galled (3.93). The combination of poultry manure and neem leaves must have improved the soil conditions and attributed to greater root-growth, thereby enhancing the utilization of soil nutrients and water, or might have changed the biotic and abiotic environment of the plants. These ultimately altered the host- parasite relationship, thereby minimizing root-knot nematode damage on the susceptible plant. The nutritional properties of poultry manure and nematicidal properties of neem in the mixture had been reported by several authors [17-19].

The results on the effect of mixture of poultry manure and some botanicals on cowpea plant height are presented in Table 2. All cowpea varieties on amended plots produced significantly ($p < 0.05$) taller plants than the control plots. However, plots amended with the combination of poultry manure and neem leaves produced the tallest plants (99.10 cm), followed by mixture of poultry manure and siam weeds (74.50 cm). The control plots recorded shortest plants (40.5 cm) and had increased nematode damage when compared with amended plots. The interaction between Ife brown variety and mixture of poultry manure and neem leaves produced the tallest plants while shortest plants were obtained from the interaction between Oloto brown and the control plots.

Cowpea peduncle length followed the same trend as number of leaves and plant height. These results were similar to those of Cookey, et al. [19] who reported that cowpea plants treated with different botanicals had higher plant heights and vine lengths and reduced nematode damage than the control plots. Tariq and Siddiqui [20] had also reported that the release of toxic compounds from plant tissues reduced plant parasitic nematode infection and that several plants terpenoids and phenolic compounds are known to have nematicidal properties.

In this study, it was revealed all cowpea varieties on amended plots produced significantly ($p < 0.05$) higher number of pods, pod length and fresh pod weight and lower root galls than the corresponding unamended plots Table 3. The highest number of pods (72.25) and lowest root gall formation (0.50) were obtained on plots amended with mixture of poultry manure and neem leaves. However, this was followed by plots amended with mixture of poultry manure and siam weed which were rarely galled (1.01) and consequently produced higher number of pods (46.75). The control plots had severely galled roots (3.59) and produced the lowest number of pods (25.63) when compared with the others. In terms of the varieties Ife brown produced the highest number of pods (54.92) while Oloto brown produced the least (41.50). The increase in root-gall nematode population as reflected by the number of root-galls produced on the control plots might be the reason for the reduction in the number of cowpea pods produced. Abad, et al. [21] had reported that root-knot nematodes cause giant cells to form in the roots, and this disrupts the root vascular system thereby reducing the uptake of water and nutrients and their transport from the roots to vegetative organs.

The soil amendment, variety and their interaction showed significant effect on cowpea pod length and root-gall index Table 3. The interaction between control and Oloto brown recorded the shortest and the highest pod length (7.17 cm) and root-gall index (3.93) respectively while longest and the lowest pod length and root-gall index were recorded under the interaction between poultry manure and neem mixture and Ife brown (16.82 cm and 0.38)

respectively. The reduced pod lengths obtained from Oloto brown variety on the control plots might be attributed to the severe damage caused by the nematode on their roots which hampered adequate transportation of nutrients by the damaged roots. This result is in line with the reports of Ismail [22] who reported that the antagonistic action of organic composts against *M. javanica* caused remarkable reduction in the nematode developmental stages and roots and their build-up and consequently all treatments showed improvement in all plant growth parameters as compared to unamended plants.

All cowpea varieties on plots with organic amendment recorded significantly ($p < 0.05$) lower root-gall index and higher fresh pod weight. The presence of the soil amendments must have improved the soil conditions which benefited the cowpea plants on one hand and were detrimental to the soil inhibiting nematode on the other hand. Ismail and Hasabo [23] also reported that organic composts increased the amount of macro and micro nutrients over the control. Ife brown variety on plots amended with mixture of poultry manure and neem had lowest nematode damage and produced the highest fresh pod weight when compared with the control plots.

Table-1. Synergistic effect of different soil organic amendment on root-ga nematode population at different intervals.

Nematode population/200g Soil									
	30 days			60 days			90 days		
	VARIETIES								
SOIL AMENDMENT	Ife brown	Oloto brown	mean	Ife brown	Oloto brown	mean	Ife brown	Oloto brown	mean
Control	568	562	565	586	580	583	578	617	597
PM + Siam weed	445	663	539	361	540	450	287	457	372
PM + Neem leaves	441	518	464	304	433	369	194	384	289
Mean	475	571		417	513		358	486	
LSD $_{0.05}$ (Soil amendment)			**90.6**		62.8			77.4	
LSD $_{0.05}$ (Varieties)		**74.0**			51.3			63.2	
LSD $_{0.05}$(Soil amendment x Varieties)			**128.1**		88.9			109.5	

Initial nematode population: 588 larvae/200g soil.
PM + Siam weed = Poultry manure + Siam weed.
PM + Neem weed = Poultry manure + Neem leaves.

Table-2. Effect of mixture of poultry manure and some botanicals on some cowpea growth parameters and root-gall.

	Number of leaves			Plant height (cm)			Penduncle length (cm)			Root-gall index (0-4)		
SOIL AMENDMENT	Ife brown	Oloto brown	mean	Ife brown	Oloto brown	mean	Ife brown	Oloto brown	mean	Ife brown	Oloto brown	mean
Control	13.4	13.1	13.3	45.4	35.7	40.5	5.45	5.28	5.36	3.25	3.93	3.59
PM + Siam weed	32.8	26	29.4	79.2	69.8	74.5	11.22	7.5	9.36	0.53	1.5	1.01
PM + Neem leaves	44.3	34.9	39.6	103.9	94.2	99.1	14.55	10.8	12.68	0.38	0.63	0.5
Mean	30.2	24.7		76.2	66.6		10.41	7.86		1.38	2.02	
LSD $_{0.05}$ (Soil amendment)				7.10				1.54			0.41	
LSD $_{0.05}$ (Varieties)				5.80				1.2			0.34	
LSD $_{0.05}$ (Soil amendment x Varieties)				10.14				2.18			0.58	

PM + Siam weed= Poultry manure + Siam weed.
PM + Neem weed = Poultry manure + Neem leaves.

Table-3. Effect of mixture of poultry manure and some botanicals on some cowpea yield attributes and root-gall.

	Number of pods			Pod length (cm)			Fresh pod weight (g)			Root-gall index (0-4)		
SOIL AMENDMENT	Ife brown	Oloto brown	mean	Ife brown	Oloto brown	mean	Ife brown	Oloto brown	mean	Ife brown	Oloto brown	mean
Control	32	19.25	25.6	9.22	7.17	8.2	18	13.9	15.9	3.25	3.93	3.59
PM + Siam weed	48.75	44.75	46.8	14.1	11.82	12.96	38.2	23.1	30.6	0.53	1.5	1.01
PM + Neem leaves	84	60.5	72.3	16.82	14.72	15.77	42.4	27.9	35.1	0.38	0.63	0.5
Mean	54.92	41.5		13.38	11.24		32.8	21.6		1.38	2.02	
LSD $_{0.05}$ (Soil amendment)				4.78		2.14			5.25			0.41
LSD $_{0.05}$ (Varieties)				5.80		1.75			4.29			0.34
LSD $_{0.05}$ (Soil amendment x Varieties)				6.76		3.02			7.43			0.58

PM + Siam weed= Poultry manure + Siam weed.
PM + Neem weed = Poultry manure + Neem leaves.

4. CONCLUSION AND RECOMMENDATIONS

The present study clearly indicated that the mixture of poultry manure and neem leaves used as a soil amendment has the potential to reduce root-gall nematode infection on cowpea and therefore it can be used as an alternative control measure to chemical nematicides.

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