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TESTING THE VIABILITY OF POULTRY DROPPINGS AS AN OPTION IN THE MANAGEMENT OF SOIL NEMATODES ON *CAPSICUM ANNUUM* PLANT

Ekine, E. G. and Ezenwaka, C. O.
Department of Biology, Federal University Otuoke, Bayelsa State, Nigeria
Corresponding author email:emmanuelgreen95@gmail.com

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ABSTRACT

A survey to evaluate the viability of poultry droppings as a management option for the control of plant parasitic nematodes was tested on Capsicum annuum. Bell pepper monoculture farms cultivated conventionally and another with poultry droppings as fertilizer were surveyed. Soil samples were collected using a hand trowel while roots were collected by means of kitchen knife. Plant parasitic nematodes extraction was done by using sieve plate method. Nematodes were identified using the light microscope of x4 and x10 objectives, and identification was done using a pictorial key. Roots assay from the conventional far revealed a total of 175 endophytic nematodes from 10 genera while 56 nematodes from 6 genera were extracted from the farm with poultry droppings. Nematode dynamics in diversity was observed such that certain nematode genera such as Meliodogyne, Radopholus, Pratylenchus, Ditylenchus, Hoplolaimus, Rhaditis were reported in both plots. Phyto-parasitic species were predominant at the conventional farm plot whereas nematodes predatory species recorded higher populations in the farm plot with poultry droppings, an observation which depict that parasitic nematodes could be inhibited by the presence of free living species. This observation further suggests that poultry droppings can adequately fit in as a management of nematodes management if properly harmonised.

Keywords: Conventional farm, Farm plot, Management option, Poultry droppings, Viability

INTRODUCTION

A tangible way out of the looming food insecurity among developing nations of the world remains a challenge especially in Nigeria where crop cultivation is fast becoming a norm for survival because many Nigerian farmers lack adequate knowledge of the role biotic factors play in the improvement of soil and forecasting of crop yield hence had continually become victims of the activities of parasitic nematodes in soil. Parasitic nematodes in the soil have been reported as significant factors obstructing crop production in Africa promoting food insecurity (Imafidor and Nzeako, 2008). About twenty percent of total crop lost observed in cultivated fields within West Africa sub-Region is believed to have occurred due to high prevalence of pathogenic nematodes in soil (Coyne *et al*., 2003; Imafidor and Ekine, 2016). The activities of these soil inhabiting worms could sometimes predisposes crops to opportunistic injuries and disorders which in-turn impair crop growth, reduce yield and facilitate food shortage (Imafidor and Nzeako, 2008; El-Sheriny, 2011; Orluoma *et al*., 2023).

Because of the detrimental effect of soil dwelling nematodes on food supply and the necessity for food production, a variety of control measures have been employed against the parasites to minimized its effects, improve crop yield and curb food insecurity. However, a management strategy for the parasites that would not have detrimental effects on the crops and retain the beauty of nature has remained a significant challenge in agro-nematology. This is because the strategies so far exploited occasionally results in crop distortion or contamination of the environment (Abduzor and Haseeb, 2010; Orluoma *et al*., 2023); therefore a good knowledge on the advantages of poultry droppings as an organic fertilizer with the potency to suppress phyto-parasitic nematodes as well as enhance local crops yield and ameliorate food supply is very vital. Among the variety of options employed for nematode control, the use of nematicides has often been reported. Considering the harm in using chemicals as pests control materials and the inability of the local farmers to get such chemicals and the necessity of maintaining the beauty of nature, it became significant that an alternative measure in nematode management strategy that would be affordable and retain the natural ecosystem be introduced to the locals farmers who often suffer losses due to the detrimental activities of soil parasitic nematodes.

Reports have emerged on the use of organic manure to achieve low populations of nematodes in fields and enhance crop productivity but it has been an integrated combination of plants and animal manure. For instance, Treonis (2010) used composited animal dung from Cow and poultry alongside green yard manure and recorded a positive increase in crop yield. In his study, Han *et al*. (2016) used a mixture of green manure in combination and feces from different animals and recorded positive impact on crop yield. Agu (2008) employed composited poultry filters mixed with fresh leaves and also reported improved crop yield with increase nematode population density. Therefore, this survey is aimed at testing the viability of raw poultry droppings as an option in the management of soil inhabiting nematodes.

MATERIALS AND METHODS

Study location

This study was conducted in Abua, Rivers state, Nigeria. It is 92 km from Port Harcourt, the capital of Rivers State. Abua is located at 4°49.502^{l}N, 6°39.067^{l}E (Otto, 2000) and its vegetation is typical tropical rainforest types. The indigenes are commercial farmers that concentrate mostly on vegetables crops such as pepper, okra and tomato (Otto, 2000).

Designation of research sites

Two plots of land measuring 20 by 30m each designated P_A (plot A) and P_B (plot B) were selected, cleared and cultivated for the study. Plot A (P_A) was cultivated conventionally without any form of fertilizers and in plot B (P_B), raw poultry droppings was employed as organic fertilizers. Both farms were bell pepper monocultured. The two farms were cultivated on a distance of 4 kilometres apart to achieve some level of homogeneity of sampling quality.

Sampling Procedure

Collection of soil

A sun total of two hundred soil samples were collected for examination. In each farm plot, P_A and P_B, a total of one hundred soil samples were collected from the root region of the bell pepper at 0-15 cm depth with a modified soil auger. These soil samples were packed into white labeled white waterproof bags and were conveyed to the Biology laboratory, Ignatius Ajuru University, Port Harcourt for nematodes extraction.

Collection of bell pepper roots

One hundred bell pepper stands were uprooted from farm P_A and P_B, fifty from each plot. The roots were taken at the same time from the soil with the aid of a sterile kitchen knife. The samples were properly packed into white waterproof bags, and were

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taken to the Biology laboratory, Ignatius Ajuru University, Port Harcourt for nematode extraction.

Nematode Extraction Procedure

Nematodes were extracted using the sieve plate method as described in (Ekine *et al*., 2018). Soil samples in each sample bag were poured into a rubber plate and were thoroughly mixed and formed a bulk samples from which a measure of 5g soil was taken. The 5g of soil were spread evenly on a circle of tissue paper supported on a plastic sieve standing in a plastic plate. Water was added to the extraction plate gently until the soil become wet but not immersed. The extraction set-ups were left undisturbed in the laboratory for two days. After the two days, the soil was removed. The nematodes aliquot were emptied into clean specimen bottles and allowed to sediment and fixed with 5% formalin and stored for viewing under microscope. 0.1ml of the nematodes aliquot were taken with a pipette placed on glass slides and observed using x4 and x10 objectives of light microscope.

The roots of bell pepper were thoroughly washed in running water to remove soil particles, and cut into 2cm segments before removing a 5g fresh mass sub-sample. The 5g sub-sample of the root sample was macerated in an electric blender (BLG450) for 10-20 seconds at low speed. Each macerated sub sample of the root was spread evenly on a piece of tissue paper supported on plastic sieve standing on a plastic plate and procedure as was observed for the soil was followed.

Identification of nematodes

Nematodes were examined using the x4 and x10 objectives of light microscope, and identification was done using a pictorial key according to Southey, (1986) and Mekete *et al*., (2012).

Data analysis

The paired and independent t- test was used to test for different in the abundance of nematodes between farm plots and significant influence of poultry droppings on nematode population dynamics.

Results

Table 1: Nematode population in plot A (P_A (Conventional farm)

From the soil and roots of bell pepper in plot A (P_A) with conventional farming system, a total of 426 nematodes from 11 general were identified as bell pepper pest. Among the 426 nematodes recovered in plot A; 59% were extracted from the root rhizosphere of the bell pepper, while 41% were obtained from the root tissue of the bell pepper. The most identified nematode genus in roots rhizosphere of bell pepper in plot A (P_A) was *Pratylecnchus* (13.1%) and *Helicotylenchus* (16.3%) had the highest assemblage while *Radopholus* (22.3%) took the lead in the root tissue. Integrated occurrence in both soil and roots saw *Meliodogyne* (13.8%) as the most reported in the plot. However, the occurrence of nematodes between the root rhizosphere and root tissue of bell pepper plant was statistically significant ($p<0.05$) (Table 1).

Table 1: Nematode population in plot A (P_A) (Conventional farm)

Nematodes spp	Soil (%)	Root (%)	Overall abundance (%)	t
Hemicyclophora	18 (7.2)	21 (12.0)	39 (9.2)	
Paratylenchus	27 (10.7)	19 (10.8)	46 (10.8)	
Ditylenchus	5 (0.2)	31 (17.7)	36 (8.5)	
Meloidogyne	38 (15.1)	21 (12.0)	59 (13.8)	
Pratylenchus	33 (13.1)	17 (9.7)	50 (11.7)	
Tylenchus	37 (14.7)	12 (6.9)	49 (11.5)	
Helicutylenchus	41 (16.3)	2 (1.1)	43 (10.1)	
Rhabditis	25 (9.9)	0	25 (5.9)	

Hoplolaimus	12 (4.8)	4 (2.3)	16 (3.8)	
Radopholus	0	39 (22.3)	39 (9.2)	
Scutellonema	15 (5.9)	9 (5.1)	24 (5.6)	
Total	**251 (59.0)**	**175 (41.0)**	**426 (100)**	**4.299**

Nematodes population in P_B (farm plot with poultry droppings)

From the plot B (P_B) farm with poultry droppings, 390 nematodes were recovered from soil and roots of bell pepper plant. The root tissue of the plant in plot B recorded 14.4% occurrence of nematodes. Both free-living and plant feeding genera and species of nematodes were recorded, although free-living were the most frequently occurring nematodes in plot B (Fig 1). Nematodes recovered in the plot included *Aphelenchoides, Ditylenchus, Dorylaimus, Meloidogyne, Radopholus,Monochus, Heterodera, Rhabditis, Pratylenchus, Rotylenchus, Paratylenchus, Xiphenema, Aphelenchus, Hoplolaimus and Arolaimus.* Meloidogyne species (12.0%) occurred most among the recovered nematodes in plot B (P_B) (Table 2).

Table 2: Nematode population in P_B (farm plot with poultry droppings)

Nematodes spp	Soil (%)	Root (%)	Overall occurrence (%)
Aphelenchoides	18 (5.4)	0	18 (4.6)
Ditylenchus	23 (6.8)	3 (5.4)	26 (6.60
Dorylaimus	28 (8.4)	0	28 (7.2)
Meloidogyne	31 (9.3)	16 (28)	47 (12.0)
Rotylenchus	19 (5.7)	21 (37.0)	40 (10.0)
Monochus	33 (9.8)	0	33 (8.5)
Heterodera	20 (5.0)	0	20 (5.1)
Rhabditis	12 (5.6)	0	12 (3.1)
Pratylenchs	9 (2.7)	12 (21.4)	21 (5.4)
Radopholuss	27 (8.1)	0	27 (6.9)
Paratylenchus	16 (4.8)	0	16 (4.1)
Xiphenema	34 (10.2)	0	34 (8.7
Aphelenchus	31 (9.3)	0	31 (7.9)
Hoplolaimus	12 (3.6)	4	16 (4.1)
Arolaimus	21 (6.3)	0	21 (5.4)
N = 15	**334 (85.6)**	**56 (14.4)**	**390 (100)**

Population dynamics of nematodes in relation to trophic affiliation and diversity

Plant-feeding nematode genera such as *Meloidogyne, Pratylenchus, Tylenchus, Radopholus, Scutellonema, Pratylenchus, Hemicyclophora, Ditylenchus, Helicotylenchus* exhibited high prevalence in plot A (P_A) with no poultry droppings.

Nevertheless, free living genera like nematode predators, bacteria and fungi feeders such as *Rhabditis, Monochus, Dorylaimus, Aphelenchoides, Aphenchus* and *Arolaimus* were peculiar to plot B (PB) with raw poultry droppings as organic fertilizer (Fig 1 and 2)r. Yet, nematodes dynamics in diversity was observed such that certain nematodes genera such as *Meloidogyne, Radopholus, Pratylenchus, Ditylenchus, Hoplolaimus, Rhabditis* were reported in both plots (Fig 2).

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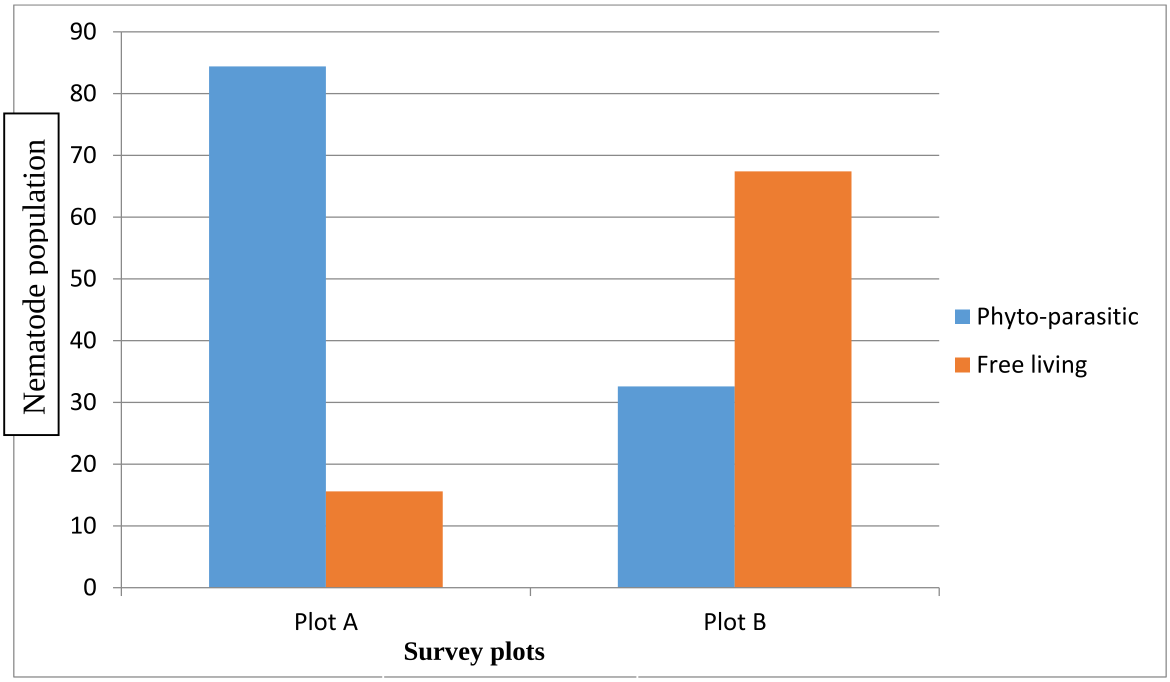

Fig. 1: **Populations of nematodes in relation to trophic affiliation**

Key: Plot A (P_A) = conventional farm plot
Plot B (P_B) = farm plot with poultry droppings as fertilizer

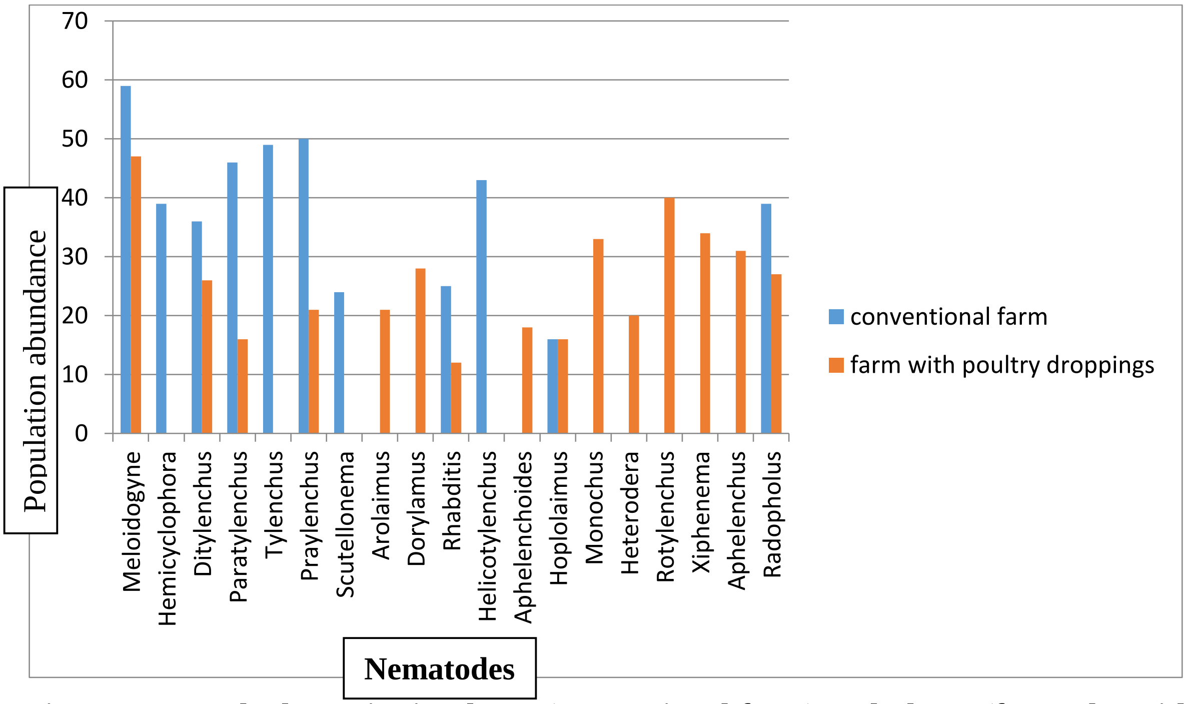

Fig. 2: Nematode dynamics in plot A (conventional farm) and plot B (farm plot with poultry droppings)

DISCUSSION

This survey examined the potency of raw poultry droppings in suppressing nematode abundance and compared nematodes assemblage in a conventional farm and organic farm with poultry droppings as fertilizers. The study reported a total nematode abundance of 516 from 20 genera and species. The population of nematodes in this study is relatively high compare to the 6 genera reported from organic farming system in Egypt (Adam *et al*., 2013). This disparity could be ascribed to environmental conditions of the research locations which are determining factors on nematodes assemblage. The relatively high assemblage of soil nematodes noticed in this study suggests that bell pepper is susceptible to infestations of parasitic nematodes.

The relatively high prevalence of nematodes (334) from the root rhizosphere of bell pepper plant in plot B when compared with plot A (125) is indicative that poultry droppings do not exhibit the potency to drastically reduce nematode populations in the soil. The poultry droppings rather improve soil nutrient and stir up rapid growth and proliferation of latent species in the soil environment. However, these species are mostly composed of free living species. The result further established that poultry droppings enhance soil basic mineral requirement and makes the soil environment more conducive for the propagation nematodes, predominantly predatory species. On the contrary, Farahat *et al*. (2012) reported that all sorts of organic fertilizers could reduce nematode populations in the soil and may not entirely eliminate severe infestations of phyto-parasitic nematodes. This dichotomy could be attributed to the nematode species dominant in the research locations, the kind of crop under review and season of research. The result of this survey also depicted that population suppression could be achieved with poultry dropping on an extended application over a period of time.

Roots assay from the conventional farm revealed a total of 175 endophytic nematodes from 10 genera while 56 nematodes from 6 genera were extracted from the farm with poultry droppings. Nematode assemblage was high in the conventional farm when compared with the populations observed in the farm plot B with poultry droppings. The increased number of nematodes recovered from the conventional farm (plot P_A) suggests that nematodes are true pests of bell pepper in the study area. The reduced populations of species reported from the root tissues of bell pepper plant in plot PB with poultry droppings implied that nematodes never find it easy to pierce through the root tissues because of improved cuticle confer by nutrient absorption made available in the soil by poultry droppings. This result further suggests that poultry manure boost bell pepper rigidity against penetration by soil microbes including nematodes; hence could serve as a management measure for soil nematodes. Bulluck *et al.* (2002), and Farahat *et al.* (2012) reported that root crops surviving in soil rich in organic matter often recorded limited injuries with nematode infestations than crop roots in soil with limited content of organic manure.

In the conventional farm (plot P_A), nematode populations were composed mainly of phyto-parasitic species. This observation could be attributed to the presence of bell pepper plant. This remark further submits that nematodes are actual parasites of bell pepper in Abua. Ekine *et al.* (2020) opined that phyto-parasitic nematodes thrive well in the presence of a suitable host and could show hypobiosis in environments with intense competitions. However, high grazing nematodes like *Dorylaimus, Aphelnchus, Monochus, Ditylenchus, Aphlenchoides, Arolaimus, Rhabditis* and *Xiphinema* which constitute free-living and omnivorous species dominated organic farm (P_B) with poultry droppings. The disparity in nematode community composition noticed in plot P_A and P_B could be traceable to the farming system employed in the research plots,

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implying that the poultry droppings used in P_B had effects on nematode community composition. The limited population of plant-feeding species in P_B suggests that the outbreak of omnivorous species due to the use of poultry droppings may have suppress their populations in the soil. This observation depict that poultry droppings can adequately fit in as a management strategy for nematode control. Ahmad and Siddiqui (2009) and Farahat *et al.* (2012) reported that the application of manure from animals in soil could promote active parasitism with free-living species of nematodes and bring about reduction of plants-feeding species. The actual populations of nematodes observed in this study was statistically significant ($p<0.05$) which signified that the farming pattern observed at both study plot had influence on the actual incidence and richness of nematodes.

CONCLUSION

From the result of this study, it can be deduced that poultry droppings could serve as a viable option for the management of phyto-parasitic nematodes. The study further opined that the presence of high grazing nematode such as the omnivore or fungivore inhibits the activities and populations of phytophytic species.

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