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Assessing Synthetic Fertilizers and Compost as Control Measures for Agronomic Parasites and Techniques for Crop Improvement in Nigeria

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Abstract
The activities of soil emanated parasitic worms also called plant parasitic nematodes have continually put the farmer under pressure, exploiting the best possible strategy to cope with its detriment and improve crop production and enhance food supply. However, the propagation sequence for agronomical parasites and affluence in the soil can often time be checked on the employment of distinct strategies with the aim of agricultural improvement and pest control. This study tested the relevance of synthetic fertilizers and compost as control choices for phyto-parasites and techniques for crop improvement to avert food insecurity. The study was conducted to test the prospects of artificial and compost (organic fertilizer) in the control of agronomical parasites in soil and serve as a technique for improving the yield performance of crops. Soil and roots were collected from plots with urea, NPK fertilizer, compost and a conventional farm. Nematode extraction was carried out using the modified sieve plate method. Soil assessment post application of urea, NPK fertilizers and compost revealed a total nematode richness of 1,625 occurring at 30 days (24.4%), 60 had 43.7 % and 90 days 31.9%. The infectivity rate was minimal in plots with synthetic fertilizers and compost while the plot with no treatment showed a high rate of nematode infectivity. The result opined that synthetic fertilizers and compost are suitable control tools for the control of agronomical parasites in soil. Crop growth was encouraging with the use of synthetic fertilizers and compost, which is indicative that they are capable sources for crop improvement and can aid food security.

Keywords: Agronomical Parasites, Compost, Synthetic Fertilizers, Food Security

Introduction
The quest for food security increases on a daily basis as the human population doubles exponentially coupled with the current economic saga in Nigeria. However, the activities of soil emanated parasitic worms also called plant parasitic nematodes have continually put the farmer under pressure to exploit the best possible strategy to cope with its detriment improve crop production and enhance food security. The farmer's effort is targeted at sustainable food availability and the soil parasitic worms portray a serious obstacle to this dream, antagonizing the farmer's effort at all times and seasons. In view of this scenario, the present study evaluates the prospects of synthetic fertilizers and compost in subduing nematode infectivity on crop plants and batten crop performance to forecast the most preferred and affordable practice for rural farmers to subdue the effects of these parasitic worms and quench food insecurity.

Crop farming aside from food production, constitutes a major factor in every rural economy in Nigeria. Nevertheless, the menace castrated by the soil-borne parasites, phyto-parasitic nematodes had many times devastated speedy development due to poor crop performance and low supply in the market. Therefore, it becomes expedient for agro-ecological remedies for these pathogens. Nematode-infested crop plants including ornamentals may appear bald and impact their market value (Ezenwaka & Ekine, 2024; Ozdemir et al., 2021; Nzeako et al., 2016). Ekine and Ezenwaka, (2024) found that nematode invasion on vegetation can mean famine on the land if urgent management strategies are not employed. Plant pathogenic nematodes can damage crop plants in a non-conspicuous manner and impede the farmer's quest for food production (Orluoma et al., 2023; Ekine & Ezenwaka, 2023).

Organic fertilizers which include plants and animals reside when incorporated into the soil with the aim of parasite and pest control, tend to augment soil basic nutrients, better its quality or composition and propel crop

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chances of survival against the activities of incumbent parasitic worms in the soil. These wastes can also stir biodiversity and improve organic interactions in the soil in favour of crop plants scoring the potential of phyto-parasitic nematodes (Ekine & Ezenwaka, 2024; Han et al., 2016). Farahat et al. (2012) report that fertilizers can influence nematode survival sequence and crops exonerated of severe infections in certain cases.

Biodiversity is a significant regulatory factor in every ecosystem. However, it can be influenced by soil management practices (Herren et al., 2020) on the addition of organic or inorganic fertilizers or by cultural practices such as fallowing. The populations of soil organisms are responsive to every activity aimed at stirring nutrient composition. In soil wellness practice, synthetic fertilizers have proven to impact nematode community composition by decreasing fungivorous nematode abundance (Herren et al., 2020; Zhang et al., 2017). Therefore, this study is aimed at evaluating the use of synthetic fertilizers and compost as remedial practices for soil-borne parasites and a measure for crop improvement to quench food insecurity.

Materials and Methods

Study area: This study was carried iout ona piece of land measuring 30 cm by 30 cm within the West campus of the federal University Otuoke. Otuoke is in Ogbia Kingdom, 25 meters from Yenagoa the capital of Bayelsa state. Otuoke is located 21º 27'17 E, 20º29’31N.

Experimental design: The research adopted the complete randomized block design of four treatments and four replicates for the study. The research site was divided into four plots and four beds were made in each with ten planting points 21 weeks old pepper was transplanted after the application of synthetic fertilizers and compost.

Fertilizer application: The portioned land was designated A-D. Plot A was treated with 2kg of urea, in B 2kg of NPK was added, C had 5kg of compost and D was left untreated to serve as control and was allowed to mineralize before transplanting of 21 days seedlings of pepper.

Nematode infectivity assessment: The crop was morphologically evaluated for foliar symptoms of nematode affiliate. Underground symptoms of nematode-initiated injuries such as root knots were also assessed and classified.
Evaluation of crop Performance: At each time of sampling, growth parameters such as plant girth, length, number of branches and fruit number were correlated.

Sample collection
Soil collection: soil was collected in all the plots at 30, 60 and 90 days post-transplant. In each bed, the soil was collected at 0-20 cm core depth.

Root collection: Concurrently, roots were also collected and both roots and soil were carried in specimen bags to the laboratory for bioassay.

Nematode extraction: In the laboratory, the modified Barman’s method was employed for the extraction as described in Imafidor and Ekine (2016) and the nematodes were identified to genus level using nematode pictorial keys and atlas.

Data analysis: Tables were presented on simple percentages and the test for significance was done in SPSS version 23 using ANOVA.

Results

Populations of soil nematodes

Soil assessment at 30, 60 and 90 days post application of urea, NPK fertilizers and compost revealed a total nematode richness of 1,625 across the surveyed plots. These nematodes were extracted at 30 days (24.4%) post-soil treatment with synthetic fertilizers and compost. However, soil sampling at 60 had 43.7 % and sampling at 90 days post soil treatment with synthetic fertilizers and compost was 31.9% nematode abundance.
The assemblage of pathogenic nematodes in the root of pepper was relatively insignificant in this study. Nevertheless, higher percentages of soil and root nematodes were reported in plot D with no treatment of either synthetic fertilizers or compost (Table 1 and Fig 1).
Symptoms relating to nematode infectivity were reported in this study and were more in plot D with no manure treatment when compared with the observation in plot A and C treated with synthetic fertilizers and compost respectively.

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Table 1: Populations of soil nematodes

Sampling duration		Plots/treatment				
	Nematodes	2kg urea Plot A (%)	2kg NPK-plot B (%)	5kg compost Plot C (%)	No treatment Plot D (%)	Total (%)
30 days sampling	*Meliodogyne*	12 (17.4)	38 (35.5)	19 (19.8)	25(20.0)	**94 (23.7)**
	Pratylenchus	9 (13.0)	0	30 (31.3)	11(8.8)	**50 (12.6)**
	Helicotylenchsu	20 (29.0)	11 (10.3)	0	20 (16.0)	**51 (12.8**
	Heterodera	0	38 (35.5)	4 (4.2)	41 (32.8)	**83 (20.9)**
	Hoplolaimus	9 (13.0)	0	7 (7.3)	0	**16 (4.0)**
	Hoplolaimus	17 (24.6)	20 (18.7)	13 (13.5)	9 (7.2)	**59 (14.9)**
	Tylenchus	2 (2.9)	0	23 (24.0)	19 (15.2)	**44 (11.1)**
	Total	**69 (17.4)**	**107 (27.0)**	**96 (24.2)**	**125 (31.0)**	**397 (24.4)**
60 days sampling	*Heterodera*	4 (5.3)	0	9 (3.7)	36 (13.8)	**49 (6.9)**
	Meliodogyne	9 (12.0)	7 (5.3)	13 (5.4)	33 (12.7)	**62 (8.7)**
	Pratylenchus	6 8.0)	11 (8.3)	18 (7.4)	29 (11.2)	**68 (9.6)**
	Rhabditis	18 (24.0)	20 (15.0)	27 (11.2)	0	**65 (9.2)**
	Aphelenchus	20 (26.6)	16 (12.0)	31 (12.9)	5 (1.9)	**72 (10.1)**
	Aphelenchoides	15 (20.0)	27 (20.3)	34 (14.0)	37 (14.2)	**113 (18.7)**
	Longidorus	9 (12.0)	0	15 (6.2)	21 (8.0)	**45 (6.3)**
	Radopholus	7 (9.3)	21 (15.8)	29 (11.9)	40 (15.4)	**97 (13.6)**
	Monochid	0	11 (8.3)	32 (13.2)	6 (2.3)	**49 (6.9)**
	Tylenchorynchus	2 (2.6)	13 (9.8)	25 (10.3)	31 (11.9)	**71 (10.0)**
	Ditylenchus	0	7 (5.3)	9 (3.7)	22	**38 (5.4)**
	Total	**75 (10.6)**	**133 (18.7)**	**242 (34.1)**	**260 (36.6)**	**710 (43.7)**
90 days **sampling**	*Aphelenchus*	6 (15.0)	0	19 (15.3)	9 (3.0)	**34 (6.6)**
	Aphelenchoides	9 (22.5)	9 (16.1)	0	23 (7.7)	**41 (7.9)**
	Longidorus	4 (10.0)	20 (35.7)	6 (4.8)	31 (10.4)	**61 (11.8)**
	Radopholus	0	0	9 (7.0)	38 (12.8)	**47 (9.1)**
	Monochid	4 (10.0)	9 (16.1)	18 (14.5)	6 (2.0)	**37 (7.1)**
	Meliodogyne	1 (2.5)	0	14 (11.3)	46 (15.4)	**61 (11.8)**
	Panagrolaimus	8 (20.0)	5 (8.9)	0	0	**13 (2.5)**
	Paratylenchus	4 (10.0)	11 (19.6)	21 (16.9)	28 (9.4)	**64 (12.4)**
	Pratylenchus	1 (2,5)	0	18 (14.5)	39 (13.1)	**58 (11.2)**
	Helicotylenchus	0	2 (3.6)	8 (6.5)	32 (10.7)	**42 (8.10**
	Heterodera	3(7.5)	0	11 8.9)	46 (15.4)	**60 (11.6)**
	Total	**40 (7.7)**	**56 (10.8)**	**124 (24.0)**	**298 (57.5)**	**518 (31.9)**
	G Total					**1,625**

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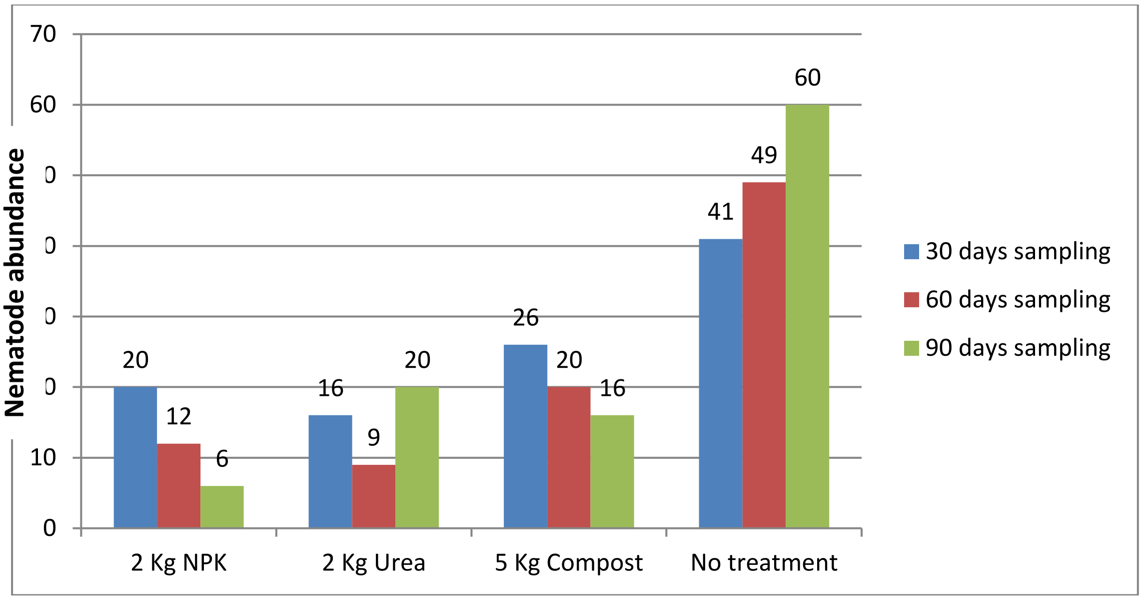

Fig 1: Nematode assemblage in root tissue **Treatments**

Assessment of gall index for agronomical parasites

Root examination revealed limited gall index which implies light or no infection in plots treated with 2 kg urea and compost while the plot with 2 kg NPK had no infection at all. However, server infection was seen in Plot D with no treatment (Table 2).

Table 2: Nematode gall index in pepper

Treatment	Gall index	Interpretation
2 kg urea	2	Minimal infection
2 Kg NPK	5	No infection
5 Kg compost	10	Minimal infection
No treatment	45	Server infection

Growth performance of pepper in fertilizers and compost-treated soil

The overall crop examination shows the improved general performance of pepper crops across plots A-C with the treatment of synthetic fertilizers and compost. However, crop performance in plot D with no manure treatment showed variations contrary to the observation in plots A-C.

Table 3: Pepper plant growth performance

	Treatment	Stem height (cm)	Plant girth (cm)	Leaf number	Wet root weight (g)	Fruit number	Fruit weight (g)
30 days	2 kg urea	25.9	2.0	28.0	27.6		
	2 kg NPK	27.4	1.8	25.0	32.3		
	5 kg compost	23.7	1.9	25.0	29.0		
	No treatment	23.7	0.9	21.0	23.0		
	2 kg urea	53.0	4.1	32.0	30.1		
	2 kg NPK	57.5	4.4	32.0	32.0		
60 days	5 kg compost	48.2	3.0	30.0	32.0		
	No treatment	32.6	2.4	27.0	20.7		
	2 kg urea	63.4	5.2	32.0	33.0	97.0	14.2
90 days	2 kg NPK	67.0	5.8	32.0	35.2	109.0	20.0
	5 kg compost	54.8	3.6	30.0	32.6	94.0	16.0
	No treatment	32.6	2.4	27.0	16.3	37.0	9.4

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Discussion

Propagation sequence for (removing the)agronomical parasites and affluence in the soil can often time be checked on the employment of distinct strategies on the aim of agricultural improvement and pest control. This study tested the relevance of synthetic fertilizers and compost as control choices for phyto-parasites and techniques for crop improvement to avert food insecurity. The study revealed a total of 397 (24.4%) nematodes from soil at 30 days of sampling across the treatments and replicates. Replicate A and B with urea and NPK (synthetic fertilizers) had 17.4% and 27.0% respectively. Replicate C with compost had 24.2% and nematode richness in replicate D with no treatment was 31.0%. The pattern of nematode occurrence as seen here was influenced by the use of synthetic fertilizers and compost and the presence of pepper crops. The result is in conformance with Adamou et al. (2013) who reported a lofty assemblage of the parasites in yellow pepper. During this sampling period, plant-infecting parasite species like *Meloidogyne* species (23.7%), *Heterodera* species (20.9%), *Hoplolaimus* species (14.9%), and *Helicotylenchus* species (12.8%) were prevalence. This observation is indicative that the pepper plant is at high risk of agronomical parasite infectivity and should be checked to prevent extinction in the area.

Sixty days of soil sampling saw a total population of 710 (43.7%) for the agronomical parasites. However, there was a reduction in parasite (nematode) richness from replicates A (10.6%) and B (18.7%) with synthetic fertilizers. The manifestation of a slightly low assemblage of the agronomical parasites as seen in this stage of sampling depicts that the synthetic fertilizers demonstrated potential action effectual in inhibiting the profusion sequence of the phyto-parasites. Farahat *et al*. (2012) reported that NPK fertilizer was effective in inhibiting the developmental stages of soil-borne parasites in biochemical alteration studies. Nevertheless, there were population increases in replicate C with compost with fungi and nematode-feeding species like *Aphenchoides* species (14.0%), *Monochid* species (13.2%) and *Aphelenchus* species (12.9%) prevalence. This scenario is indicative that the plant-feeding parasite species are endangered and the threat imposed by nematode infectivity can be subdued by adequate incorporation of compost. The inclusion of organic manure can propel soil biota among which are nematode consumers causing depopulation of phyto-parasitic species and achieving good management for the soil-borne pathogens (Ekine & Ezenwaka, 2023; Herren et al., 2020; Zhang et al., 2017). In replicate D with no treatment had 36.6% occurrence. This result summits that the propagation and profusion of the agronomical parasites in soil ecosystem with no mechanism of check can propel rapid increase. Elsewhere, İmren et al. (2017) reported a lofty population of *Pratylenchus thornei* on the continuous availability of wheat with no management measure for the parasite.

The decline in nematode actual incidence continues at 90 days of soil sampling in replicate A (7.7%) and B (10.8%) with synthetic fertilizers and the populations of free-living species increase in replicate C with compost. This result implies that synthetic fertilizers do not support nematode quiescence and can successfully control the parasites in cultivated soil. In this study, compost influences nematode community structure and species composition, displaying high grazing species compared to plant-feeding species as sampling is prolonged. This observation suggests that the use of compost can effectively serve as a management measure for nematodes in agro-nematology for the agronomical parasites. Steel et al. (2018) reported that synthetic fertilizers can impact nematode occurrence and cut populations below the threshold. The result here depicts that compost exhibits the potency to improve soil health stir microbial interactions and increase inter-specific competition in the soil ecosystem which is not favorable for nematode propagation. The nematode population can be checked with conditions that increase environmental stressors in soil (Ekine & Ezenwaka, 2024; Hu & Qi, 2010).

Nematode population in pepper roots was limited in replicate A (12.0%) B (15.3%) and C (21.0%) compared to the observation in D (50.8%) with no treatment. These variations further connote that synthetic fertilizers and compost are viable as nematode control possibilities. The gall index was also very low showing no infection and minimal infection. However, assemblage in pepper roots and gall index was very high in replicate D with no treatment, an indication that nematodes are factual pests of pepper and should be checked for sustainable production. Elsewhere, Ekine and Ezenwaka (2023) report that compost are viable control media for plant parasites and can adequately end food insecurity if properly incorporated in agriculture.

The average crop performance in plots with urea and NPK fertilizers was better compared to the observation in plots with compost. However, the yield performance in plot D with no fertilizer amendment at all was not appreciable. This scenario depicts that the use of fertilizers either organic or artificial can serve as a control measure for soil parasites and a technique for crop improvement in Nigeria if properly harnessed. Elsewhere, Han et al. (2016) reported improved crop yield on the application of organic and inorganic fertilizers.

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Conclusion

The study revealed that fertilizers, either artificial or organic possess the required energy influx to adequately control the activities of agronomical parasites and improve yield performance of crops. The study further indicates that farming with fertilizers can practically manages crop pest in soil and boost yield and enhance food availability.

Recommendation

Farmers should take the application of synthetic and organic fertilizers as a practice to outweigh the effects of agronomical parasites and pests to enhance food security.

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