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Effect of poultry manure mixed at different rates of jatropha leaf powder on root-knot nematode (*Meloidogyne* spp.) infecting onion (*Allium cepa* l.) in Ishiagu, Southeast, Nigeria

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Abstract:

Costly and sometimes very harmful chemical pesticides to humans and the environment are the main means of combating root-knot nematodes available to farmers in Ishiago, southeastern Nigeria, and elsewhere. The uses of animals and plants waste give positive results in sustainable control programs. This study assessed the effect of poultry fertilizer mixed with different levels of jatropha leaves in controlling the infection of root node nematodes on onions at the Research and Teaching farm of the Federal College of Agriculture Ishiagu, Ebonyi State, Nigeria in 2020 and 2021 cropping seasons. The treatments used were: 10 t/ha of poultry manure (PM) + 5 t/ha of Jatropha leaf powder (JLP), 10 t/ha of PM + 10 t/ha of JLP, 10 t/ha of PM +15 t/ha of JLP, 10 t/ha of PM and Carbofuran (Control) at l00g/ plot. Experiments were designed in a Randomized Complete Block Design (RCBD) and replicated three times. Data were taken on growth measurement indicators (Plant height and number of leaves), crop characteristics (Number of bulbs and weight of bulbs at harvest), and characteristics of nematodes infection (Number of galled roots and root gall index at harvest). Treatments significantly ($P<0.05$) reduced root galling and gall index with the application of 10 t/ha PM + 15 t/ha JLP with a significant increase in growth and yield parameters of onion. Since 10t/ha of PM + 15t/ha of JLP significantly (PO.05) reduced nematode infection and promoted the growth and yield of onion, farmers in Ishiagu community are therefore advised to adopt this manure integration.

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Introduction

Onion (*Allium cepa* L.) also known as the bulb onion or common onion belongs to the family of *Alliaceae*. It is a vegetable that is the most widely cultivated species of the genus *Allium* (Ndon *et al.*, 2015). Onion is grown in many tropical countries, including Ghana and Nigeria, but the production in Nigeria is concentrated in the northern states.

Onion can be planted at any season of the year, but it is mostly a warm-weather loving crop. Best results have been reported when grown through irrigation. Survey showed that drip irrigation system performed superior over surface irrigation on onion according to Begali *et al.* (2015). Onion is normally propagated through seed. However, some farmers have been reported to propagate onion through the bulb or set. On cultivation, nursery practice management is the most important practice to produce healthy seedlings (Choudhary, 2018).

All the plant parts are edible but the bulb and the lower stem sections are the most popular as seasonings or as vegetables in stews. It can also be used as a condiment and extensively in flavouring of processed meat, spicing of various food preparations and also used for medicinal purposes (Alabi, 2014).

Effective production of onion is however hampered by action of nematode infections. Wide array of nematodes poses serious problems in the cultivation of onion, which have therefore caused tremendous setbacks in the production of this important vegetable crop (Ellis, 2016 and Mbaukwu *et al*., 2016). Parasitic nematodes, especially the root-knot nematodes (*Meloidogyne* spp.) are the most destructive parasitic nematode pests hampering world agricultural production in general and vegetable production in particular (Taylor *et al*., 2016). *Meloidogyne* species pose significant threats to crop production especially in Africa and other developing countries and account for the huge losses in a wide range of agricultural crops.

Onion is one of the sensitive crops to root-knot nematodes. *Meloidogyne* species is an obligate parasite which is regarded as one of the most important parasitic genera (Crichley, 2011). Gowda *et al*. (2019) reported that root-knot nematodes can cause 50 – 60 % loss in vegetable crops. The market value of most economic crops is drastically reduced as a result of root-knot nematode attacks resulting in disfiguring quality of the crop produce, including onion. Nematodes are difficult to control because of their wide host range and high rate of reproduction, with the female capable of reproducing up to thousand eggs per female (Netarajan *et al.*, 2016).

To protect the crops from pest attacks, farmers usually rely on quick pest management options, mainly synthetic chemicals like carbofuran. Despite the efficacious attribute of synthetic pesticides, continuous usage has its challenges such as development of pesticide resistant pests. Overuse and misuse of synthetic pesticide can result in harmful effects on humans and the environment and toxicity to non-target organisms, thus impacting negatively on biodiversity (Geraldin *et al*., 2020). Constituent compounds of synthetic pesticides have been attributed to chronic human ailments either due to consumption or exposure. Most of the synthetic pesticides are not easily biodegradable thus accumulate in the environment and cause pollution to soil and ground water in addition to depletion of the ozone layer.

One of the alternatives to the use of chemical pesticides in controlling pests and improving soil fertility as well is the use of organic or botanical materials. Soil amendment using organic or botanical manure sources have been reported to reduce nematodes infections and population, increase growth and yield through the release of nutrients into the soil (Ogwulumba and Mba, 2016). The use of organic manure especially poultry manure is preferred in this regard because it can provide a sustainable and environmentally acceptable soil management at little or no direct cost to the poor farmers in

developing countries, who cannot afford costly imported chemical pesticides. The use of organic materials for soil amendments do not only control nematodes population but also add nutrients to the soil thereby enhancing yield. Poultry manure supplies other essential plant nutrients and serves as a source of soil organic matter that improves soil properties and nutrient retention (Mijindadi and Erhabor 2016 and Ogwulumba and Mba, 2016). Although poultry manure is common in most localities, its nematicidal properties have not been fully exploited by vegetable farmers (Mcsorley *et al.*, 2014).

Jatropha curcas L., a member of the family Euphorbiaceae, is a large drought-resistant multipurpose shrub with several attributes and considerable potential and has evoked interests all over the tropics as a potential bio-fuel crop (Takeda, 1982; Martin and Mayeux, 1984 and 1985 and Jones and Miller, 1991). The leaves, latex, roots and seed oil have medicinal, insecticidal and nematicidal properties (Aminul-Islam *et al*., 2011).

The main aim of the study is to determine or evaluate the effectiveness of poultry manure amended with different levels of *Jatropha* leaves in the management of root-knot nematodes infecting onion.

Materials and methods

The experiment was carried out at the Research and Teaching farm of the Federal College of Agriculture Ishiagu, Ebonyi State, Nigeria in 2020 and 2021 cropping seasons. Ishiagu is located in the derived savannah zone of the South Eastern Nigeria and lies within latitude 05° 56 **I** N and longitude 07° 41 IE. It has mean annual rainfall and temperature of 1350 mm and 29°C, respectively.

1. Experimental materials:

Seeds of red onion variety were obtained from Ishiagu local market and used for the experiment. Poultry manure was obtained from the battery cage of Federal College of Agriculture Ishiagu farm, while *Jatropha* leaves were sourced from Ishiagu community.

2. Experimental design and treatments:

2.1. Design:

Experiments were designed in a Randomized Complete Block Design (RCBD) and replicated three times that giving a total of fifteen plots with each plot measuring 2m by 2m.

2.2. Treatments:

The five treatments used in the experiments were:

Poultry manure 10 tons/ha amended with 5tons/ha, 10 tons/ha, 15 tons/ha of *Jatropha* leaves; 10 tons/ha of poultry manure only and Carbofuran, a synthetic nematicide used as the control.

2.2.1. Nursery preparation/transplanting:

Seedlings were raised in sterilized soil under a shade for three weeks before transplanting the vigorous and healthy ones to the field.

2.2.2. Land preparation:

The experimental site was cleared, ploughed and harrowed, marked out, and subsequently prepared into beds.

2.2.3. Preparation/application of treatments:

The *Jatropha* leaves were dried at room temperature and ground to powder and added to the well cured poultry manure at the stipulated levels accordingly. The treatments were randomly applied to the plots and worked into the soil using a garden fork three days before transplanting of the onion seedlings.

2.2.4. Plant spacing/ population:

A plant spacing of 50 cm by 50 cm was used, thereby giving a population of 16 plants per plot and 240 plants for the experiment. This would give 40,000 plants per hectare.

3. Data collection:

i. Plant height (cm): This was determined by measuring the height of the plant from the base using a meter rule at 3, 6, and 9 weeks after planting.

ii. Number of leaves: This was determined by counting the number of leaves per stand at 3, 6, and 9 weeks after planting.

iii. Number of bulbs at harvest: This was determined by counting the number of bulbs per plot at harvest.

iv. Weight (g) of bulbs at harvest: This was determined by weighing the bulbs according to plots at harvest using Camry digital weighing balance.

v. Number of galled roots at harvest: This was determined by counting the number of roots with galls at harvest

vi. Number of galls per root at harvest: This was determined by counting the number of galls on every root, scaled according to Ogwulumba and Okonta (2015) below:

Rate	Number of galls	Infection level
0	No galls	No infection
1	1 – 10	Mild
2	11 – 20	Moderate
3	21 – 30	Moderately high
4	31 – 40	High
5	41 – 50	Very high
6	51 and above	Severe

4. Data analysis:

Collected data were analyzed using analysis of variance according to the procedure for randomized complete block design (RCBD). Significant treatment means were separated and compared using Fisher's Least Significant Difference (F- LSD) and all inferences were made at 5% level of probability according to Obi (2002).

Results and discussion

Data are shown in Table (1) reveal that there is not have any significant (P>0.05) effect on the plant height of onion at 3 weeks after planting (WAP). However, the treatments significantly (P<0.05) affected the plant height at 6 and 9 WAP. The highest plant height of 54.14 cm and 55.01cm respectively in 2020 and 2021 were obtained from the plots treated with 10 t/ha of poultry manure (PM) + 15 t/ha of Jatropha leaves (JLP), while the plants treated with carbofuran (control) gave the lowest plant height of29.19 cm and 29.92 cm respectively at 9 WAP. lots treated with 10 t/ha of PM + 15 t/ha of JLP significantly differed from other treatments except 10 t/ha of PM + 10 t/ha of JLP at 6 and 9 W AP. Plots treated with 10 t/ha of PM + 10 t/ha of JLP did not differ significantly from 10 t/ha of PM + 5 t/ha of JLP, 10 t/ha of PM + 1 0 t/ha of JLP, and carbofuran.

Table (1): Effect of poultry manure mixed with different levels of *Jatropha* leaves on plant height (cm) of onion plants at intervals of 3, 6, and 9 Weeks after planting during 2020 and 2021 growing seasons.

Treatment	3WAP		6WAP		9WAP	
	2020	2021	2020	2021 2020	2020	2021
PM at 10tlha + JLP at 5t/ha	28.72	27.98	34.23ab	33.89b	37.18 b	37.56 b
PM at 10tlha + JLP 10t/ha	31.81	32.01	37.33bc	38.12b	41.04 b	42.01b
PM at 10t1ha + JLP at 15 t/ha	40.11	39.76	49.84d	50.87d	54.34 c	55.01 c
PM at 10t/ha	26.23	25.78	30.52a	32.32b	34.06 b	33.98 ab
Carbofuran (Control)	20.37	21.32	25.93a	27.04a	29.19a	29.92 a
LSD (0.05)	NS	NS	5.22	5.07	7.15	5.76

Key: PM = poultry manure JLP = *Jatropha* leaf powder NS = Not significant

Results in Table (2) showed that there was no significant effect on the number of leaves by the treatments at 3 WAP. The treatments significantly

affected the number of leaves produced by the plants at 6 and 9 WAP. The highest mean value of leaves of9.51 and 9.92 respectively in 2020 and 2021 were recorded from plots treated with 10 t/ha of PM + 15 t/ha of JLP, while the lowest mean value of 5.12 and 5.33 were obtained from carbofuran at 9 WAP in 2020 and 2021 respectively. Plants treated with 10 t/ha of PM + 15 t/ha of JLP significantly differed from other treatments at 6 and 9 W AP. Plants treated with 10 t/ha of PM + 10 t/ha of JLP did not differ significantly from that one's treated with 10 t/ha of PM + 5 t/ha of JLP, 10 t/ha of PM, and carbofuran at 6 and 9 WAP.

Table (2): Effect of poultry manure mixed with different levels of *Jatropha* leaves on onion plants leave number at intervals of 3, 6, and 9 Weeks after planting during 2020 and 2021 growing seasons.

Treatment	3WAP		6WAP		9WAP	
	2020	2021	2020	2021	2020	2021
PM at 10tlha + JLP at 5t/ha	4.05	4.17	6.27c	6.09b	7.1b	7.25c
PM at 10tlha + JLP 10t/ha	4.43	5.72	6.84c	7.01c	7.21bc	7.19bc
PM at 10t1ha + JLP at 15 t/ha	5.05	7.74	9.11d	9.42d	9.51d	9.92d
PM at 10t/ha	3.19	4.53	5.71b	5.91aba	6.1ab	6.43ab
Carbofuran (control)	3.81	4.11	4.28a	5.02 a	5.12a	5.33a
LSD (0.05)	NS	NS	1.16	1.22	1.38	1.41

Key: PM = poultry manure JLP = *Jatropha* leaf powder NS = Not significant

Results in Table (3) showed that there was a-significant effect on number of bulbs of onion by the treatments. There was enhanced yield on the plots treated with poultry manure at 10 t/ha amended with Jatropha at 15 t/ha, which gave the highest mean value of 34.31, while plots treated with Carbofuran gave the lowest mean value of 12.04. 10 t/ha of PM + 15 t/ha of ILP significantly (P<0.05) differed from other treatments.

Table (3): Effect of poultry manure mixed with different levels of Jatropha leaves on onion plants bulbs' number during 2020 and 2021 growing seasons.

Treatment	2020	2021
PM at 10tlha + JLP at 5t/ha	18.17 bc	18.09bc
PM at 10tlha + JLP 10t/ha	20.12 c	20.23c
PM at 10t1ha + JLP at 15 t/ha	34.31 c	35.21d
PM at 10t/ha	15.31 bc	15.41ab
Carbofuran (control)	12.04 a	12.14a
LSD (0.05)	5.19	5.21

Key: PM = poultry manure JLP = *Jatropha* leaf powder NS = Not significant

Results in Table (4) showed that there was a significant (P < 0.05) effect by the treatments on the weight of bulbs of onions at harvest. 10 t/ha of PM + 15 t/ha of JLP gave the highest mean value of 806 g and 809 g respectively in 2020 and 2021 while Carbofuran gave the lowest mean value of 273.3(g). The treatments were significantly (P<0.05) differed from each other.

Table (4): Effect of poultry manure mixed with different levels of *Jatropha* leaves on onion plants weight bulbs (g) at intervals of 3, 6, and 9 Weeks after planting during 2020 and 2021 growing seasons.

Treatment	Weight (g)	
	2020	2021
PM at 10tlha + JLP at 5t/ha	416 b	423 b
PM at 10tlha + JLP 10t/ha	460b	471 b
PM at 10t1ha + JLP at 15 t/ha	806 c	819 c
PM at 10t/ha	300 a	297 a
Carbofuran (Control)	273 a	272 a
LSD (0.05)	50.16	51.01

Results in Table (5) showed that the treatments significantly (P<0.05) reduced the number of galled roots and galls per root at harvest. 10 t/ha of PM + 15 t/ha of JLP gave the highest reduction rate on both the number of galled roots and the number of galls per root respectively.

Table (5): Effect of poultry manure mixed with different levels of *Jatropha* leaves on galled roots and the number of galls per root of onion at harvest during 2020 and 2021 growing seasons.

Treatment	No. of galled roots		No. of galls/root	
	2020	2021	20202020	2021
PM at 10tlha + JLP at	28.33 b	27.13b	4.33 d	3.92 d
PM at 10tlha + JLP 10t/ha	27.33 b	25.22 b	4.04 c	3.83 c
PM at 10t1ha + JLP at 15	8.67 a	6.32 a	2.03a	1.89 b
PM at 10t/ha	30.04 c	33.12 c	4.64 e	4.11 e
Carbofuran (control)	6.43 a	5.78 a	2.67 b	1.34 a
LSD (0.05)	2.35	2.41	0.21	0.18

Treatments did not show any effect on the plant heights or the number of leaves after three weeks from planting, but the effect was appeared after 6 and 9 weeks from planting. These results agree with Ayed (2002), who mentioned that the mixture had not decomposed well enough at 3 WAP for plant fertilization., to gives its effect on onion growth. The results also agreed with the works of Falodun and Peters (2019) which stated that there was a significant relationship amongst the treatments on growth parameters at 6, 8, and 10 WAP on onions. Michigan State University's report published in SFGATE Newsletter in 2020, mentioned that Organic fertilizers, take about 5 to 9 weeks to break down into the soil depending on the nature of the organic fertilizer.

Plots treated with poultry manure at 10 t/ha mixed with *Jatropha* at 15 t/ha produced significantly better leaves. This could be due to the high level of nutrients added to the soil due to high level of *Jatropha* leaves mixed with poultry droppings. The highest yield values was obtained with the treatment (PM at 10 t/ha + JLP at 15 t/ha) carbofuran (Control) gave the lowest yield mean values in each case because carbofuran contains only nematicidal properties while the decomposition of poultry and *Jatropha* leaves added more nutrients to the soil for the plant absorption and utilization. These results are in line with Ehigiator *et al*. (2013), Sonbeer *et al*. (2017) and Falodun and Egharevba (2018) who reported that enhanced growth and yield attributes of onion, carrot, and beans were obtained due to the application of *Jatropha* leaves at 15 t/ha and poultry manure at 10 t/ha. Funda *et al*. (2019) found out that application of chicken manure significantly improved number of bulbs, bulb weight, bulb height, number of shoot tip, number of dried leaves of onion compared to control.

Using of poultry manure combined with *Jatropha* leaves showed a significant reduction on nematode infections on the crop (Onion). The mixture of poultry waste and *Jatropha* leaves works as a nimatodic pesticide, which reduces the incidence of infection. When this fertilizer mixture is used with in rate of 10 tons/hectare of poultry waste with 15 tons/hectares of *Jatropha* leaves, it led to a reduction in nematode numbers and enhancing growth and parameters returning to the crop. These results are in agreement with Ogwudire *et al*. (2019), who stated that root extracts of *Jatropha* was statistically significant on the control of *Meloidogyne incognita*. The results also agreed with Agu *et al*. (2013), whose

study indicated that root-gall nematode diseases of okra were significantly affected by *Jatropha curcas* and the consequent pod proximate composition were achieved. Poultry manure had been proven to have nematicidal properties in treatment of nematodes infections, but combination (Amendment) with other organic/botanical manure sources such as *Jatropha* gives best results (Sonbeer *et al*., 2017, Ehigiator *et al*. , 2013 and Falodun and Egharevba, 2018). Also, Ogwulumba and Mba (2016) found out that plant manure sources were effective in the control of root-knot nematode infections and boosting the yield of Bambara groundnut (*Vigna subterranean)* Another study by Ogwulumba *et al*. (2010) indicated that *Meloidogyne javanica* infections on Roma tomato (*Lycopersicon esculentum*) could be controlled under different soil amendments. Poultry manure and *Jatropha* leaves are indicated to improve soil fertility status, soil organic matter, micro-nutrient status and micro-nutrient qualities of the soil (Maerere *et al*., 2001; Adeniyan and Ojeniyi 2003; Akande and Adediran 2004). It also promotes the CEC of the soil (Akinrindi and Obigbesan, 2000). Ogwudire *et al*. (2019) found out that *Jatropha curcas* leaves contain phytochemicals such as alkaloids, saponins, flavonoids and tannins which have shown high mortality rate against the population of *Meoidogyne incognita*.

It is concluded that Based on the findings of this study, application of poultry manure at 10 t/ha mixed with Jatropha leaves at 15 t/ha significantly reduced the activities of root-knot nematodes attacking onion according to the enhancing of the growth and yield characteristics.

It is recommended that Application of poultry manure at 10 t/ha combined with Jatropha leaves at 15 t/ha as soil amendments significantly suppresses the activities of root-knot nematodes, improves growth and yield of onion. This is therefore recommended to onion farmers to mitigate the menace of root-knot nematodes in the farms.

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