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POPULATIONS AND DISTRIBUTION OF NEMATODES IN SOIL TREATED WITH *MUCUNA PRURIENS* (VELVET BEAN) AS MANURE

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SUMMARY

Research has shown that *Mucuna pruriens* is useful in the management of some plant-parasitic nematodes. However, in Nigeria, *M. pruriens* is still underutilised in that capacity. Consequently, the effect of *Mucuna pruriens* manure on the populations of soil nematodes was examined. Seeds of *M. pruriens* were sown for 2, 4, 6, 8 and 10 weeks in 2m^2 plots, arranged in Randomised Complete Block Design in three replicates. Plots without mucuna served as control. The plants were shredded, and incorporated into the soil and allowed to decompose for three and nine weeks. Soil samples were collected from each 2m^2 plot before incorporation of the mucuna plants and after the decomposition period for the assessment of nematode populations using standard procedures. Data were analysed using ANOVA at $\alpha_{0.05}$. The Relative Importance Value-RIV (%) was determined using the frequency and density of nematodes. The average populations of bacterivores, omnivores, fungivores and predators were 5643.30, 3472.80, 2070.00 and 1302.30, respectively after nine weeks of manure application and were significantly higher than 148.19, 80.83, 59.72 and 40.42, respectively before manure application, respectively. The population of herbivores increased significantly from 39.11 to 195.61 after three weeks of manure application, but reduced to 131.50 after nine weeks of manure application. At nine weeks after manure application, the bacterivores had RIV of 33.1 and the herbivores had the lowest RIV of 10.0. *The results of this study suggests that Mucuna pruriens* manure can be recommended for the management of parasitic nematodes in soil.

Keywords: Cover crop, legume, incorporation, herbivorous nematodes, management

Nematodes are usually categorised based on their feeding habit. These comprise plant feeders, fungal feeders, bacterial feeders, substrate feeders, unicellular eucaryote feeders, predators, omnivores and those at the dispersal stages of animal parasites (21). Zhao *et al*. (22) also grouped nematodes into bacterivores, fungivores, herbivores, omnivores and predators. They exist in almost all environments as parasites and as free living (7). Bui and Desaeger (6) reported plant-parasitic nematodes as a key factor responsible for low crop yield in vegetables and fruit productions. The impact of plant-parasitic (herbivorous) nematodes on arable crops in developing countries is more than what obtains in developed countries. Crop production losses due to nematodes were estimated at 14.6% in under developed and developing countries, compared to 8.8% in developed countries (14).

Mucuna pruriens (velvet bean) is a twining annual plant, belonging to the Fabaceae family. It thrives in tropical and sub-tropical regions of the world (11). Adediran *et al*. (1) reported that mucuna fallow reduced the populations of plant parasitic nematodes by

64-72% in three agro-ecological zones of southwest Nigeria. Furthermore, Blancharta *et al*. (5), reported significant reduction in the populations of *Meloidogyne*, *Scutellonema* and *Criconemella* attributable to the impact of velvet bean as cover crop.

Although, research has shown the efficacy of the legume in the management of some plant-parasitic nematodes nevertheless it is still underutilised in Nigeria. Therefore, the aim of this study was to evaluate the effect soil amended with mucuna has on nematode diversity and populations.

MATERIALS AND METHODS

Experimental site and materials

The field experiment was carried out at the Crop Garden of the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan for a period of five months (February 2020 to July 2020). The Crop Garden lies on latitude 7°27`03.2``N and longitude 3°53`49.0``E. The Department stands on an **elevation of** 692 m above sea level. Seeds of *Mucuna pruriens* were obtained from the International Institute of Tropical Agriculture, Ibadan.

Experimental site and materials

Seeds of *Mucuna pruriens* were sown for 2, 4, 6, 8 and 10 weeks in prepared 2m^2 plots, arranged in randomised complete block design in three replications on the field. Plots without *M. pruriens* served as controls. At the various stages of growth, the plants were shredded, incorporated into the soil and allowed to decompose for three weeks and nine weeks. Soil samples were collected from each 2m^2 plot before incorporation of Mucuna plants and after decomposition for the assessment of nematode populations. Three soil cores (0-30 cm depth) were taken from each plot in a zig-zag pattern and composited to form a sample. The soil samples from each plot were sealed in plastic bags, properly labelled and then taken to the laboratory for further processing, including extraction and nematode identification using standard procedure Department of Crop Protection and Environmental Biology for nematode extraction and identification.

Nematodes were extracted from the soil using the extraction tray method (7). The set up was left for 48 hours, after which water from the plates was poured into labelled beakers and nematodes were identified and counted while observing under the microscope. Identification of nematode groups was done using NEMAKEY (12;13) and Interactive Diagnostic Key (Tarjan *et al*., 1977)

Statistical analysis was carried out using DSAAT and PAST soft-wares. The data obtained were analysed using Analysis of Variance (ANOVA) at 5% level of significance. Means were separated using Tukey HSD test at 5% level of significance.

The relative frequency, relative density and relative importance value of the nematodes were calculated according to Awodoyin *et al*. (4) as follows:

$$\text{Relative frequency} = \frac{\text{Frequency of a species} \times 100\ \%}{\text{Frequency of all species}}$$

$$\text{Relative density} = \frac{\text{Density of a species} \times 100\ \%}{\text{Total density values of all species}}$$

$$\text{Relative importance value (RIV)} = \frac{\text{Relative density} + \text{Relative frequency}\ \%}{2}$$

The nematode for each treatment was computed using Shannon-Wiener and Eveness indices (9).

Shannon-Wiener index (H') = Σ pi. (*ln* pi)

where pi = ni/N

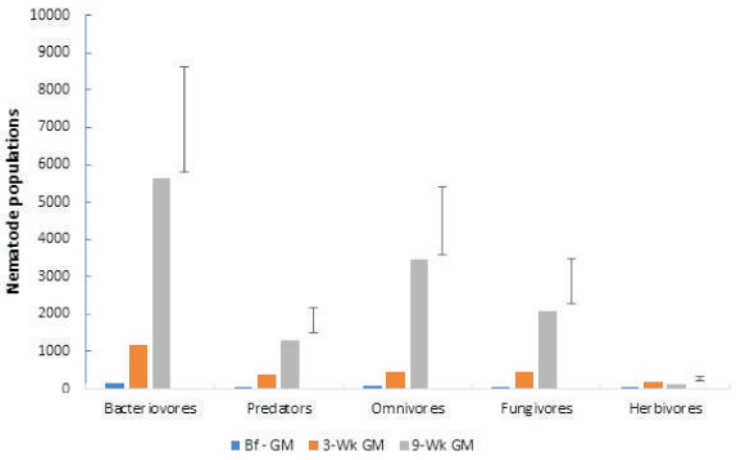
pi = the proportion of individual or the abundance of the *i*th species expressed as a proportion of total cover, ni = Number of

individuals in the *i*th species, N = Total number of individuals in the sample, *ln* = log base n (Naperian log 2.303 x log $_{10}$)
Eveness index (J) = H'/ *ln* S
S = Total number of species in the community.

RESULTS

The population densities of nematodes in the soil before sowing of Mucuna and after manure application are presented in Figure 1. The trophic feeding groups of nematodes were bacterivores, predators, omnivores, fungivores and herbivores. The populations of bacterivores, predators, omnivores and fungivores in the soil increased with increasing period after manure application (Figure 1). Their populations after nine weeks of manure application were not significantly higher than populations after three weeks of manure application but significantly higher than populations before application of manure. However, the population of the herbivores was highest after three weeks of manure application and lowest before the application of manure. The population of herbivores before manure application was significantly lower than populations after three weeks and nine weeks of manure application. In addition, the population of herbivores at nine weeks after manure application was lower than their population after three weeks of manure application (Figure 1).

The effect of age of Mucuna plants used as manure on the populations of nematodes after three and nine weeks of manure application is presented in Figure 2. At three weeks after manure application, 6-week-old Mucuna plants significantly increased the populations of bacterivores, predators and omnivores than the other ages (Figure 2). The population of fungivores was highest in plots incorporated with 6- and 8-week-old Mucuna plants and that of herbivores in plot incorporated with 2-week-old Mucuna plants. Populations of all groups of nematodes were lowest in plots incorporated with 10-week-old Mucuna plants. At nine weeks after incorporation of Mucuna plants, populations of bacterivores, predators and omnivores were highest in plots treated with 10-week-old Mucuna plants and lowest in plots without treatment.



Bf = Before, GM = Manure, WK = Week

Figure 1: Soil nematode populations before and after manure application (after square root transformation)

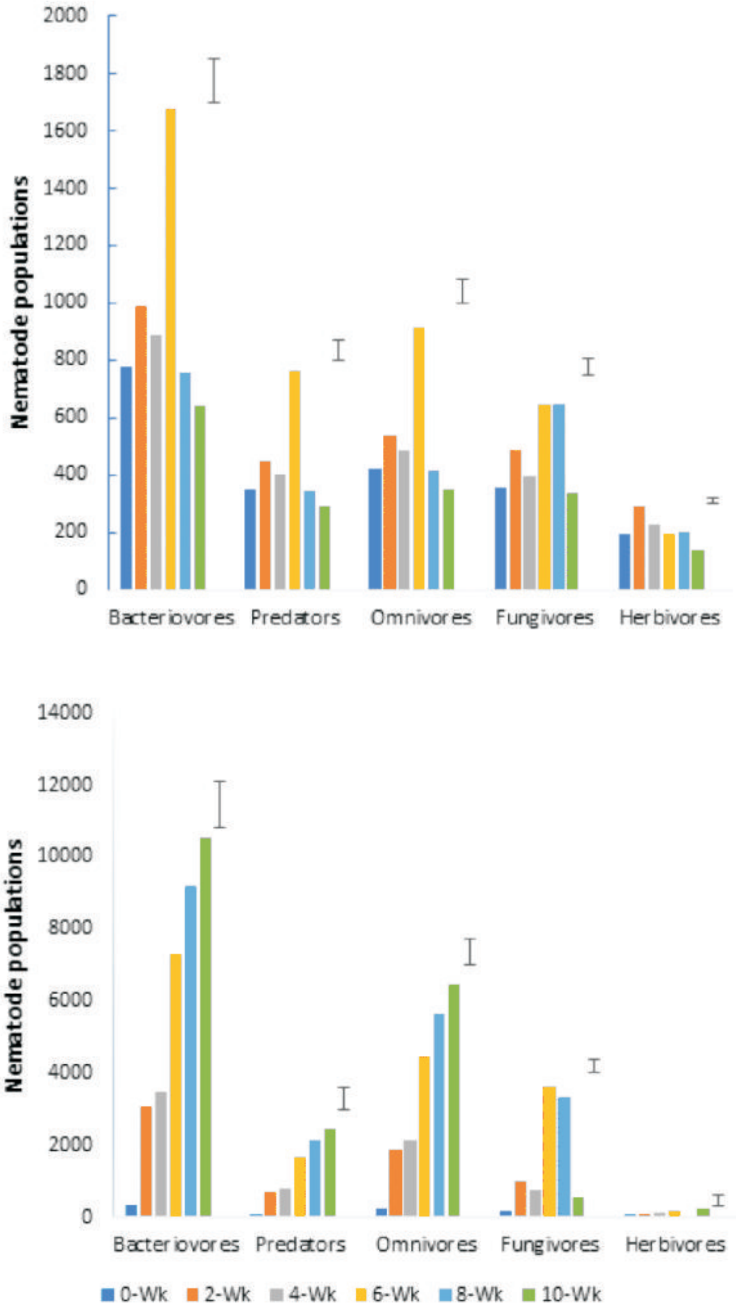


Figure 2: Effect of age of Mucuna plants on the populations of nematodes at three (A) and nine (B) weeks after incorporation (after square root transformation)

The population of fungivores was highest in plots treated with 6-week-old Mucuna plants and lowest in plots without treatment. However, population of herbivores was lowest in plots treated with 8-week-old Mucuna plants and highest in plots treated with 10-week-old Mucuna plants. Furthermore, it was observed that the 6-, 8- and 10-week-old Mucuna plants significantly increased the populations of bacterivores, predators and omnivores than other ages (Figure 2). The population of fungivores was significantly increased by incorporation of 6- and 8-week-old Mucuna plants when compared to other treatments. There was no significant difference in the population of herbivores across all treatment plots (Figure 2).

The relative importance values (RIV) of the trophic group of nematodes is presented in Table 1. The bacterivores had the highest RIV before application of manure, three weeks and nine weeks after application of manure. The RIV of the herbivores decreased over time.

Table 1: Relative importance values (RIV) of nematodes in the manure duration treatment plots

	Relative importance values (%)		
Nematodes	Initial	After 3 Weeks	After 9 Weeks
Bacterivores	30.5	28.2	33.1
Predators	15.8	18.3	15.4
Omnivores	21.3	19.9	24.3
Fungivores	17.9	19.5	17.1
Herbivores	14.5	14.1	10.0

Table 2 shows the diversity indices of the group of nematodes before and after manure application. Population of individual nematodes was highest at nine weeks after application of manure and lowest before application of manure. There were five trophic groups of nematodes (taxa) before and after application of manure. The Dominance, Shanon-wiener and Evenness indices were highest at three weeks after application of manure and lowest at nine weeks after manure application (Table 2).

Table 2: Diversity indices of nematodes enumerated in the manure duration treatment plots

Indices	Initial	After 3 Weeks	After 9 Weeks
Number of individuals	6629.00	40045.00	191206.00
Taxa	5.00	5.00	5.00
Dominance_D	0.26	0.24	0.32
Shanon_H	1.48	1.51	1.28
Evenness_e^H/S	0.87	0.90	0.72

DISCUSSION

The results showed that incorporation of *Mucuna pruriens* as manure increased the populations of predators and fungivores over a period of three weeks, while populations of bacterivores and omnivores increased over a period of nine weeks. The increase in the populations of bacterivores and fungivores nematodes may be credited to increased fungal and bacterial activities in the decomposing incorporated Mucuna. According to Morriien (15), most non-plant-parasitic nematodes are bacteria or fungi feeders, hence secondary consumers. In a soil amendment study, incorporation of biochar and manure treatments increased the populations of bacterivores nematodes significantly (10). Liu *et al*. (10) reported that fungivore nematodes thrive when there is availability of organic matter from plant residues. Furthermore, Blancharta *et al.* (5) reported that application of velvet bean as a cover crop increased the population of some free-living nematodes. The increase in the populations of omnivores and predators may be linked to the increase in the populations of bacterivores and fungivores nematodes. The balance in the predator-prey fluctuation can be attributed to sufficient food resource from bacteria and fungi (20).

Furthermore, at three weeks after manure application, the significant increase in the populations of bacterivores, predators and omnivores in plots treated with 6-week-old Mucuna plants when compared to those in plots treated with 8- and 10-week-old Mucuna plants may be attributed to the fact that decomposition and mineralisation was faster in young and succulent plants compared to old plants. The lowest population of herbivores recorded in plots treated with 10-week-old Mucuna plants at three weeks after manure application may be credited to the release of some allelochemicals in the process of decomposition of the plants. This is supported by the earlier account of Sano (17), who listed velvet bean as one of the nematode-antagonistic plants whose extracts have been reported to reduce the population of plant parasitic nematodes inside plant tissues and in the soil. Incorporation of 6-, 8- and 10-week-old Mucuna plants increased the populations of bacterivores, predators and omnivores significantly at nine weeks after manure application. This shows that Mucuna will improve the populations of bacterivorous, predatory and omnivorous nematodes if it is planted at least six weeks before being utilised as manure.

The relative important values of nematodes in the manure treatment plots showed that the predominant groups of nematodes were the bacterivores. Also, incorporation of Mucuna plants as manure reduced the populations of herbivorous nematodes. This is consistent with the findings of Adediran *et al*. (1) that Mucuna fallow reduced the populations of some herbivorous nematodes by 64-72% in three agro-ecological zones of south-western Nigeria. Similarly, Blancharta *et al*. (5) reported that application of *Mucuna pruriens* as cover crop reduced the populations of some plant parasitic-nematodes. In a fluted pumpkin garden, application of gateway organic fertiliser reduced the populations of herbivores nematodes in the soil significantly **(3).** The reduction in the population of the herbivorous nematodes may be attributed to the increase in the population of antagonistic organisms (fungi, bacteria and predatory nematodes) and allelochemicals released during decomposition of Mucuna plants. Timper (19) reported that antagonistic organisms such as fungi, bacteria and predatory organisms are effective in the management of plant-parasitic nematodes.

It was observed that while the groups (taxa) of nematodes were constant over time, the number of individual nematodes increased over time. The Shanon-wiener values showed that nematode diversity was low throughout. Furthermore, the Dominance indices over time revealed that there was no complete dominance of a group of nematodes. It was also observed that the nematodes were moderately distributed based on the trophic groups over time.

CONCLUSION

From the study, application of manure

enriched the diversity of beneficial nematodes in the soil. Even though there was a non-significant reduction in the population of herbivores at nine weeks after manure application, the trends indicate that there is a possibility of continuous reduction of the population of these herbivores with greater exposure to the effect of decomposing manure.

Therefore, application of *Mucuna pruriens* manure can be recommended for management of plant parasitic (herbivores) nematodes.

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