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EFFECTS OF SOIL TYPES AND ENHANCED NUTRIENT LEVELS ON THE PRODUCTIVITY OF EARTHWORM (*EUDRILIUS EUGENIAE*, KINBERG)

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ABSTRACT
The productivity, in terms of ability to reproduce, of the earthworm Eudrilius eugeniae (Kinberg), was studied in the laboratory under three (sandy, loamy and clayey) soil conditions with and without cow dung enrichment, in order to determine their individual suitability for the culture and breeding of the species. Ten earthworms of equal sizes were each introduced into two groups of twelve pots, each subdivided into three groups of four pots each, containing 9500g of ordinary sandy, loamy or clayey soils (served as control), and 300g cow dung enriched sandy, loamy and clayey soils (served as experimental). Experimental and control pots were moistened with 750cm^3 of water every three days for ten weeks. Both sets of pots were assessed for total earthworm population, their weights and lengths. Percentage increases in earthworm population in the control soil media were 72.5%, 92.5% and 170% in clayey, sandy and loamy soils respectively. Experimental pots yielded 560%, 1700% and 3395% increments in earthworm population for clayey, sandy and loamy soils respectively. Population increments amongst the three soil media differed significantly (P<0.05). Nutrient enriched soils produced significantly higher earthworm population than ordinary soils (P<0.05). The study shows superiority of loamy and nutrient enhanced soil in enhancing earthworm productivity.

Keywords: Eudrilius eugeniae, earthworm, productivity, soil types.

INTRODUCTION

The challenges facing aquaculture industry today are numerous, among which are the increasing demand, high cost and scarcity of fish meal. This has led to the aquaculture nutritionists searching for alternative sources of protein other than fish meal in fish feed (Ogbe *et al.*, 2004). Between 40 and 70% of the cost of operations in aquaculture come from feed alone (Ogbe *et al.*, 2004).Thus, reducing feed cost becomes essential in aquaculture nutrition for economic sustainability. Earthworm (*Eudrilus eugeniae*, Kinberg) is one of the readily available substitutes that needs to be investigated as a potential source of cheap protein. According to Tacon et al., (1983), earthworm contains 56% crude protein which comes higher than the 46% for either groundnut or soya bean meals. Sandy and Clayey soils are extreme soil types with the former having low rapidly leached nutrients and the latter with high with high nutrient that are not leached. Loamy soil is intermediate between sandy and clayey, usually with superior nutrient capacity and a porous crumb structure (Green *et al.*, 1995)

The objectives of the present research were to determine the effects of soil types and enhanced nutrient levels on the productivity of the earthworm (*Eudrilus eugeniae*, Kinberg), as replacement for fish meal in fish diet.

MATERIALS AND METHODS

Collection of Soil Samples

Loamy and clayey soil samples were collected from the Botanical Garden of the Department of Biological Sciences, Ahmadu Bello University Zaria, while the sandy soil was obtained from the University dam (Kubanni Lake) in the main campus, Ahmadu Bello University Zaria, Nigeria. The university dam lies on longitude 07°39'E and latitude 1l°08'N, at an altitude of 642.52m above sea level. The soil samples collected were thoroughly sieved to remove any debris using 2mm mesh size sieve (Madge, and Sharma, 1969).

Collection of Earthworms

The earthworms were collected from the muddy and marshy areas along the University dam, by digging, and hand sorting using hand trowel (Ashby, 1976). The earthworms were identified to species level using relevant text material (Edward and Lofty, (1976).

Culture Method

Cultivation of the earthworm was done using three types of soil sample media namely loamy, sandy and clayey soils. Twenty four (24) earthenware pots were used for the culture. Two experiments were set up consisting of control group A and experimental group B. Twelve pots were used in each group (i.e. the control and the experimental groups). Four pots were used for each soil medium in each group. The pots were filled with 9500g of each soil sample and to an average depth of 25cm. Ten earthworms of equal sizes were introduced on top of the soils in each pot, and allowed to burrow down. Exactly 750cm^3 of water was sprinkled on each pot content every three days, so as to keep the culture moistened, but not saturated.

The experimental groups B were treated with organic matter in form of cow dung. While the control group A were not so treated.

Cow dung measuring 300g was spread on top of the culture media every week and cover with one centimeter of the soil sample. Thus, only the experimental groups contain organic matter. The culture lasted for a period of ten weeks, and the harvested earthworms were counted, weighed, measured to determine their individual lengths, bottled and preserved with 5% formalin (Madge and Sharma, 1969).

Physical Parameters of the Earthworms

Body Weight of the Earthworms

The fresh body weights of the earthworms were measured in grams using an electric top loading balance (Metler P163 model). The initial stocking weight of adult earthworms in each experimental and control group, as well as the body weight of individually selected earthworms during harvesting were recorded for each soil sample (Edward and Lofty 1976).

Contracted and Extended Length

The lengths of the earthworms were measured and expressed in centimeters using a measuring board. The contracted lengths of the earthworms were obtained when static, while the extended lengths were recorded when in motion (Lucker and Lucker 1971).

Statistical Analysis

Mean counts of harvested earthworms amongst the three soil samples were analysed by ANOVA.

RESULTS

The percentage increases in the number of earthworms in each of the three soil culture media are presented in Table 1. It indicates that the loamy soil sample has the highest percentage increase in number of earthworms harvested in both the control and experimental groups with 170% and 3395% increase respectively. This was followed by sandy soil with 92.5% and 1700% increase for the control and experimental group respectively. The least increase in the number of earthworms was recorded in clayey soil with 72.5% and 560% for control and experimental group respectively. It also showed that the percentage increase in number of earthworms was more in the experimental group treated with cow dung than the control group.

Figure 1 shows the lengths of the earthworms harvested from each of the three soil types, revealing that the lengths of the harvested earthworms varied with the soil samples with earthworms harvested from the clayey soil having the greatest length. This was followed by loamy soil, while the least length was recorded in the sandy soil. It was also observed that the earthworms in the experimental soil samples treated with cow dung increased more in length, than those in the control soil samples without cow dung.

The mean weights of the earthworms harvested from the soil media were presented in Figure 2. It shows that earthworms from the clayey soil had the highest weight, followed by those from loamy soil, while the least weight was recorded in the sand soil medium. It also indicated that the earthworms in experimental soil samples with cow dung recorded more weight than those in the control soil samples without cow dung.

DISCUSSION

The highest populations of earthworms were obtained in the loamy soil medium, followed by the sandy and lastly the clayey soil. This corroborates the work of Guild (1948), who reported that light and medium loamy soils had higher total population of earthworms than heavier clayey and more open gravelly sand. This can be attributed to the soil structure which influences the ability of the earthworm to penetrate into the soil. This also agrees with the findings of Madge and Sharma (1969), Boston (1986) and Joschko *et al.* (1989), that too compact soils like clay hinder earthworm penetration, while too loose soils such as sand make

the burrows unable to retain their shape, and the earthworm may suffocate due to inadequate aeration in compacted soil like clay. Therefore, earthworms prefer and would multiply faster in loamy soil than either sandy or clayey soil.

The organic matter content of the experimental soil samples were increased over those of the control soil samples, by the addition of cow dung. This provided a better nutrition to the annelids which translated to greater weights. More so, the loamy soil sample had the highest population of earthworm, than the clayey and sandy soils, and this could be attributed to the fact that loamy soil contains more organic matter than the clayey and sandy soils. These results were in agreement with the findings of Edward and Lofty (1976), who reported that soils that were poor in organic matter do not usually support large number of earthworms. Duweini and Ghabbour (1965), also observed that, increase in the organic content of the soil were in association with increase in number of earthworms.

Thus, it can be concluded that earthworms could therefore be cultivated using simple technique of nutrient enhanced soils in earthen pots for feeding fish in ponds. Nutrient enhanced loamy soil supported the highest population of earthworms, than the sandy and clayey soils. Localised moisturisation as done in this study could sustain the production of earthworms in the dry season when natural fish foods are scarce. Thus, constant supply of the earthworms could be maintained throughout the year.

Table1: Productivity parameters of earthworms harvested in different soil samples under experimental and control conditions

Soil sample	Control group				Experimental group			
	INE	FNE	Increase in number of Earthworms	Increase in number of Earthworms (%)	INE	FNE	Increase in number of Earthworms	Increase in number of Earthworms (%)
Loamy soil	40	108	68	170	40	1398	1358*	3395
Sandy soil	40	77	37	92.5	40	720	680*	1700
Clayey soil	40	69	29	72.5	40	264	224*	560
Total	**120**	**254**	**134**	**111.67**	**120**	**2382**	**2262***	**1885**

Key: INE = initial number of earthworms, FNE = final number of earthworms
Significant increase in harvested earthworm populations between control and experimental (P<0.05)

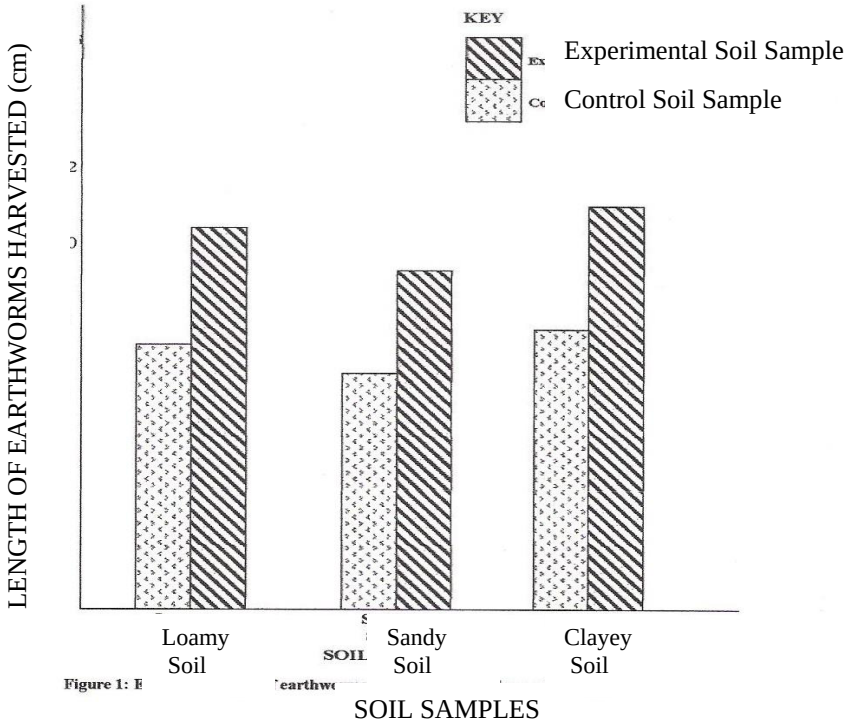

Figure 1: Length of earthworms harvested in the three soil samples

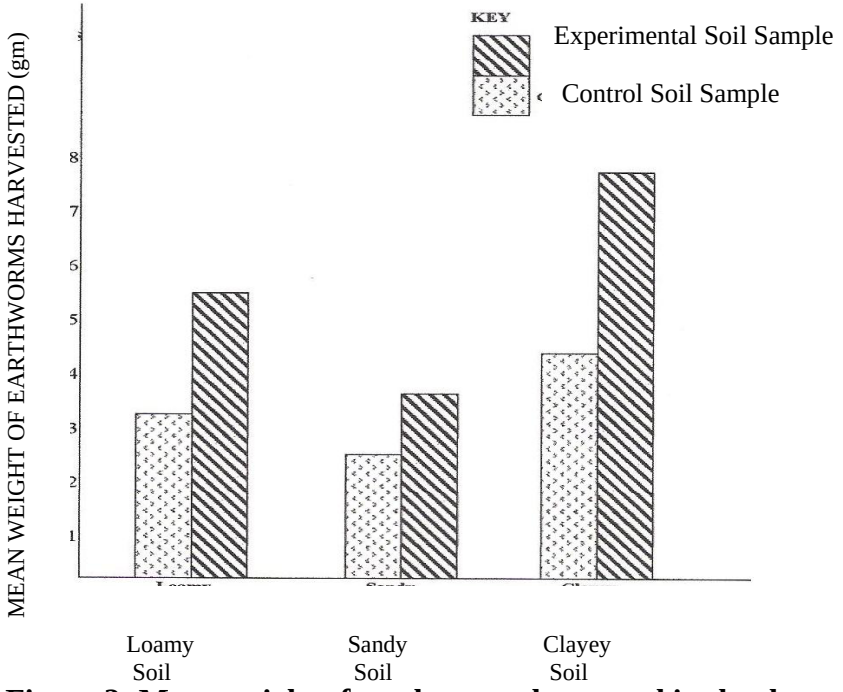

Figure 2: Mean weight of earthworms harvested in the three soil

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