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Soil physico-chemical characters of two habitats: Sewage, Garbage areas in urban system and effect on population densities of earthworms

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Abstract
The present study deals with the spatial distribution and population density of earthworms in sewage area and garbage area and is related to the some of physical and chemical characters of soil. To investigate population densities of earthworms in relation to various physico-chemical variables of two municipal-sewage and garbage of urban environment. Certain species of earthworms, *Lampito mauritti, Pontoscolex corethrurus* grow abundant in well-humified soils with high C: N ratio, while some (Perionix excavatus) are most abundant in poorly humified soils with low C: N ratios. In tropical regions N-content is low in soil as compared to temperate regions. Availability of nitrogen appears to be one of the most important factors limiting earthworm's population. The population density of earthworms in soil is regulated by abiotic and biotic factors over the seasons. The effects of various abiotic environmental variables such as rainfall, air temperature, temperature at the soil surface and 15 cm depth, soil moisture, pH available nitrogen, available phosphorus (P_2O_5) and potassium (K_2O) on the seasonal population abundance and vertical distribution of earthworms in these urban sewage and garbage areas.

Keywords: earthworms, abiotic factors, soil, urban system

Introduction

Earthworms are fundamental to the dynamics of an ecosystem. Both physical and organic factors of soils have been known to influence the abundance and distribution of earthworms. Earthworms with no firm body cover have to survive against various physical and chemical changes occurring in their immediate surroundings. Thus, soil type; pH Organic matter content, and any related disturbances can act as limiting factor for their survival. Tropical and sub-tropical soils are predominated by earthworms belonging to megascolecidae (Oligocheta; Annelida). One of the principal functions of the earthworm is to consume available mineral nutrients and by actions of enzymes in their digestive tract, render them water soluble, easily absorbable by the root hairs of plants, to be made available in turn to the cells of plants, animals, and man. As vision point out, without earthworms there would be no civilization. Earthworms are known to produce vermicompost by using any organic waste like agricultural waste, city garbage, industrial waste and sewage waste and helps in reducing noxious gases of a wide variety of organic water, eliminating the bad smell. In India, although some ecological information is available on the earthworms of Bangalore, Madras, Berhampur and Sambalpur, no information is available on the ecology of earthworms of Deccan Peninsula with the semi-arid dry weather and high temperature conditions prevailing most of the parts of the year that being less favorable for earthworm populations, and their growth and multiplication. In 1990's, there was an increasing interest in use of earthworms in land reclamation & soil improvement and in the use of earthworms as bioindicators of environmental contamination by toxic chemicals [1]. Since 1980s, the Indian farmers started taking keen interest in earthworm technology such as vermiculture and vermicomposting. To investigate some aspects of the ecology of earthworms of sewage and garbage of urban systems, which is a prerequisite to research on their role in decomposition, diversity and density in the sewage, and garbage of urban environment, Hyderabad. Earthworms play very important role in decomposing of garbage in soil, which is defined as that nutrient fraction of the soil accessible to plant roots and depends on the chemical and physical status of the nutrients in the soil. Thus, it is important to know the significance of earthworms and also to find out the factors that diminish the earthworms' population in sewage and garbage [2].

Materials and methods

The earthworm population was sampled during January to February in morning hours (0600 to 0800 hours) during the first week of every month. A total of 250 samples (5 replicates from each site in every month) from sewage area 120, from garbage area 120 samples were collected on randomized basis, the distance between the each of the two points of sampling being not less than 5m. The sampling unit was 1 x 1 m^2 area dug to a depth of 45 cm. The earthworms were collected only by hand sorting method from different soil layers: 5-10, 10-20 cm. The earthworms were collected in the polythene bags with some of the moist parent soil. They were brought to the laboratory, washed, and narcotized with absolute ethanol, and identified. They were sorted in to different age groups such as adults (with clitellum), pre-adults (large worms without clitellum) and juveniles (newly hatched and small worms) and were preserved in 80% ethanol.
All the reagents of laboratory grade were used.

Methods

Soil Analysis

1. Estimation of Available Organic Carbon Analysis in Soil

a. Rapid titration method [4].

The organic matter (humus) in the soil gets oxidized by chromic acid (potassium dichromate plus conc. Sulphuric acid) utilizing the heat of dilution of Sulphuric acid. The unreacted dichromate is determined by back titration with ferrous ammonium sulphate (redox titration).

The soil is ground and passed through 0.5 mm sieve. Placed 1.0 or 0.5 g soil into a dry 500 ml conical flask (corning). Added 10 ml of 1N $K_2Cr_2O_7$ and swirled a little. The flask is kept on asbestos sheet. Then added 20 ml of concentrated H_2SO_4 and swirled again two or three times. The flask is allowed to stand for 30 minutes preferably in darkness. Added 200 ml of distilled water, 10 ml of ortho-phosphoric acid. Titrated the contents of the flask with ferrous ammonium sulphate solution till the colour changes from blue-violet to green. Simultaneously, a blank is run without soil.

$$\text{Organic carbon (\%)} = \frac{10\,(B - T)}{B} \times \frac{0.003}{\text{Wt. of Sol}} \times 100$$

B = Volume (in ml) of ferrous ammonium sulphate solution required for blank titration

T = Volume of ferrous ammonium sulphate needed for soil sample

Qualitative method of estimation of organic carbon [5].

The oxidation of soil organic matter is carried out by dichromate-sulphuric acid mixture and the intensity of the green colour of the chromium sulphate formed is measured to give directly the amount of carbon oxidized.

Taken one g. of soil (passed through 0.5 mm sieve in a dry test tube (Pyrex/Corning). Added 2 ml of 1 N $K_2Cr_2O_7$ and swirled a little followed by 2 ml of conc. Sulphuric acid and swirled again. This is kept for 30 minutes without disturbance. Matched the green chromium sulphate colour of the supernatant layer with colour chart and recorded organic carbon:

Low-	Orange to yellow colour – 0.5%
Medium -	Dull Green colour 0.5 – 0.75%
High -	Olive Green to dark green colour > 0.75%

2. Estimation of Available Nitrogen Analysis in Soil Available Nitrogen (NH_4-N)

Alkaline permanganate method [6].

Weighed accurately 5.0 g of soil sample (passed through 2 mm sieve) and transferred it to a distillation Macro test tube of 250 ml capacity. Added 35 ml of 0.32% $KMnO_4$ and connected it to the distillation unit. Measured 20 ml of 2% boric acid containing mixed indicator in a 150 ml conical flask and placed it under the receiver tube. Dipped the receiver tube end in the boric acid. The time was preset for 6 minutes and sodium hydroxide 2.5% for 35 ml. Press alkali addition switch and added 35 ml of NaOH (2.5%). Switched on the timer switch and ran the distillation unit for 6 minutes. After completion of distillation for 6 minutes timer switch goes off automatically. Taken out conical flask after the timer switch goes off. Titrated the contents of the flask against 0.02 N H_2SO_4 till the colour changes from bluish green to brick red. Removed the test tube from the distillation unit and run the next sample as stated above.

$$\text{Available Nitrogen (Kg ha}^{-1}) = \frac{(TVS - TVB) \times 0.02 \times 0.014 \times 10^{6} \times 21.12}{\text{Weight of soil taken}}$$

$= (TVS–TVB) \times 125.44$

Available Nitrogen in Kg $acre^{1}$ = $(TVS – TVB) \times 50.8$

Where

TVS = Titre Value of sample

TVB = Titre value of Blank

Weight of soil taken = 5 g

3. Estimation of available phosphorous in soil

Estimation of phosphorous in the Olsen's extract by ascorbic acid method [7]

Weighed 2.0 g of soil into a 250 ml conical flask, add a little of activated charcoal and add 40 ml of Olsen's reagent ($NaHCO_3$ 0.5 M at 8.5 pH) and shake the contents of the flask on reciprocating shaker for ½ an hour. Filtered through What man No. 1 filter paper into a dry beaker. 5 ml aliquot of Olsen's extract is pipetted into a 25 ml volumetric flask and add 1 or 2 drops of p-nitro phenol indicator. The colour changes to yellow. To bring it to 5.0 pH add 5 N H_2SO_4 till the yellow colour ceases. On adjustment of pH 5.0 it is diluted to 20 ml with dist. Water. Added 4 ml of reagent B and the volume is made up to 25 ml and the contents shaken well after waiting for 10 minutes the intensity of the blue colour is read using a photoelectric colorimeter at 730-840 mu using red filter. Phosphorous content or P_2O_5 is calculated using a standard curve. A blank was run (without soil) along with the sample.

Standard curve for phosphorous

Prepared standard curve of different concentrations of P, pipetted out 1,2,3,4,5 & 10 ml of 2 ppm P solution in different volumetric flasks of 25 ml capacity. To these, added 5 ml of Olsen's reagent, one or two drops of p-nitro phenol indicator and acidified it with sulphuric acid and diluted it with water and added 4 ml of reagent (Dissolved 1.056 g of ascorbic acid (LR) in 200 ml of reagent (Dissolved 12 g of ammonium molybdate (AR) in 250 ml of distilled water and 0.291 g of antimony potassium titrate in 100 ml distilled water separately. Added these two solutions to 1000 ml of approx. 5N H_2SO_4, mixed them thoroughly and made up to two liters with distilled water) and mixed well. This should be prepared fresh as and when required and made up to volume. The colorimetric readings are taken after 10 minutes.

Calculations

$$\text{Available } P_2O_5 \text{ in Kg ha}^{-1} = \frac{KR \times 0.0033 \times \text{Total volume of Olsen's extractant}}{\text{Weight of soil taken}} \; \frac{\times \text{ Total volume made up} \times 2 \times 1.12 \times 2.29}{\text{Extractant taken}}$$

Where

KR = ug P in the aliquot (To be seen from standard curve)

$$= KR \times \frac{0.0033 \times 40 \times 25 \times 2 \times 1.12}{2.0 \times 5} = KR \times 0.9$$

Available P_2O_5 in kg ha^{1} = KR X 1.55

For Spectrophotometric method P_2O_5 in Kg ac^{1}

= (Absorbance sample reading - Blank Reading) X 325.0

4. Estimation of available potassium

To 5 g of soil added 25 ml of neutral normal ammonium acetate and shaken for 4 minutes and filtered it immediately through a dry filter paper (Whatman No.1). Determined potassium concentration in the extract using flame photometer after necessary setting and calibration of instrument.

Standard curve for potassium

From the stock solution of 1000 µg K ml^{1}, taken 1,2,3,4,5 and 6 ml in 100 ml volumetric flasks and diluted with ammonium acetate solution to give 10 to 60 µg ml^{1} of K. After placing appropriate filter and adjusting the gas, recorded the flame photometer reading by setting the blank to zero and 60 µ ml^{1} K to 100 reading. The curve is obtained by plotting flame photometer readings on the vertical axis against the different concentrations (10, 20, 30, 40, 50 and 60 µg ml^{1}) of K taken on horizontal axis.

$$\text{Available } K_2O \text{ (kg ha}^{-1}) = R \times \frac{\text{Volume of the extract}}{\text{Weight of soil taken}} \times \frac{2.24 \times 10^6}{10^6} \times 1.21$$

$$K_2O \text{ (kg ac}^{-1}) = \frac{\text{Flame photometer Reading} \times 25 \times 0.6 \text{ ppm} \times 2 \times 1.12 \times 1.21}{5 \times 2.50}$$

Where

R= µg ml^{1} of K in the extract (obtained from standard curve)

Results and discussion

The distribution of earthworms was mainly depends on the physico–chemical characteristics of the soil. Each habitat of has its chemical composition. Once famous during the era of Nizam, river Musi, which flows through the city of Hyderabad, is today called as cocktail of effluents and sewage, it is no more a river. It is a cocktail of industrial pollution and sewage. The effluents from the factories located along the Musi are diverted into the river and the drainage is let into Musi their by polluting the entire city.

K_20 and P_20_5 are high in both soils of sewage and garbage is not favorable of the earthworm population densities. The percentage of organic carbon and nitrogen give an idea of the nutrients available in soil for earthworms. The organic content was medium in both sewage and garbage soils. It was medium percentage. Where the population density of earthworms was also more of less equal in number in both sewage and garbage soils. It may be because of the availability of organic matter as food material as well as moisture to the earthworms. These findings support the earlier reports that the availability of food is one of the important factors in the determination of earthworm's populations [8, 9].

Table 1: Soil physico-chemical characters of two habitats; Sewage & Garbage areas in urban system.

Area	K_2O	P_2O_5	OC	N
SEWAGE	378.07	72.5	0.5%	180.465
	Kg/ha-1	Kg/ha-1		Kg/ha-1
	high	high	Medium	Low
GARBAGE	1027.7	848	0.75%	200.197
	Kg/ha-1	Kg/ha-1		Kg/ha-1
	high	high	Medium	Low

Sewage soil

The physico chemical factors of the soil were presented in Table 1. K_2O was recorded 378.07 kg/ ha^{-1} P_2O_5 was 72.5 kg/ha, OC 0.5% and N 180.465 kg/ha-1 in sewage soil. The soil contains high K_20 and P_2O_5. Whereas OC was medium and Nitrogen was very low in sewage soil.

Garbage soil

The physico chemical factors of garbage soil were presented. (Table – 6). K_2O was recorded 1027.7 kg/ ha^{-1} P_2O_5 was 848 kg/ha, OC 0.75% and N 200.197 kg/ha-1. The level of these physical factors of the soil. The soil contains high K_20 and P_2O_5. Whereas OC was medium and Nitrogen was very low in garbage soil.

The soils with low organic matter do not support earthworm's population, where as those with higher organic matter showed increased earthworm population abundance [8]. Reported very low earthworm population density in clay soil possessing low quantity of carbon

and nitrogen.

The available nitrogen in sewage and garbage soil ranging between 180.465 kg / ha^{-1} to 200.197 kg / ha^{-1} many investigators reported that nitrogen content in soil had no influence on earthworm population. However, the population densities of earthworms and nitrogen content in sewage and garbage soil are unexplainable with the present data, which may need further investigation. The P_2O_5 content of sewage and garbage soil is 378.7 kg/ ha^{-1} is not favorable to the earthworm population density it is very high range of 9 to 26 kg / ha^{-1} is favorable affects on the earthworm population densities. The physico chemical factors on population density of earthworms in the two sites showed the individual influence on the population densities but also exerted combined influence on them. The available P_2O_5 and K_2Ocontent in soil were responsible 5-32% of sewage and 5-28% in garbage of variation in seasonal abundance of different age group of earthworms. Very little information in available in the literature the effect of various physico chemical factors on the seasonal fluctuation in earthworm population densities to compare with present results. Nevertheless, it may be concluded from the present study that the physico chemical factors influenced the seasonal variation in the population density of different earthworms in sewage and garbage soils.

Conclusion

The physico chemical factors on population density of earthworms in the two sites showed the individual influence on the population densities but also exerted combined influence on them. The available P_2O_5 and K_2O content in soil were responsible for 5-32% of sewage and 5-28% in garbage of variation in seasonal abundance of different age group of earthworms. Very little information is available in the literature the effect of various physico chemical factors on the seasonal fluctuation in earthworm population densities to compare with present results. Nevertheless, it may be concluded from the present study that the physico chemical factors influenced the seasonal variation in the population density of different earthworms in sewage and garbage soils.

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