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DISTRIBUTION OF EARTHWORMS IN SOIL RELATED TO DIFFERENT CULTIVATIONS IN WAYANAD DISTRICT

[1]*Raymol K J and* [2]*Sajani Jose*

[1]*Post graduate student and* [2]*Assistant professor*

[1]*PG and Research Department of Zoology, Nirmala College for Women,*

[1]*Coimbatore, Tamil Nadu, India*

Abstract: This study has been undertaken to investigate the distribution of earthworms in soil related to different cultivations in Wayanad district. Distribution of earthworms were analysed for a period of 3 three times a day from 10 different sites and 10 crops cultivations of Wayanad district and evaluated various physico-chemical and micronutrient elements of soil samples. These studies confirmed the maximum distribution of earthworms in Amorphophalous cultivated soil.

***Index terms*- Soil, Earthworms, Crops, Amorphophalous crop, Physico-chemical properties**

I. INTRODUCTION

Earthworms are regarded as the bio-indicators of soil quality. Also, due to several beneficial ecosystem services provided by earthworms, focus has been given to earthworms in agriculture management. So, there is need of knowing the distribution of earthworms, factors affecting their distribution and modification of soil environment due to them. With the aim of characterizing earthworm distribution in different cultivation area, earthworms were sampled from land December to January. Soil sample was also taken to characterize the soil preference of the earthworms. Earthworms are considered to be the most important soil animals in many Indian subcontinental habitats. This consideration is based on their high density as well as their severe contribution to ecological and agronomical important aspects (Sankar and Patnaik, 2018).

Earthworms act on soil structure by creating burrows and casts and by breaking down organic matter. They consume and excrete plant and soil residues, incorporate these into aggregates and contribute formation and stabilization of soil aggregates. Positive and significant correlation between earthworm population and available mineral nutrients (P and K) suggests that earthworms help in mineral nutrient availability to the plants. The presence of earthworms modifies the environment (soil quality) due to their various activities like burrowing and casting which affect the activities of other organisms. So, they are also termed as ecosystem engineers. Further, the geographical distribution of earthworms is very poorly known; and much valuable information can be obtained by sampling various ecosystems and soil types (Edwards and Lofty, 1972). The studies regarding the distribution of earthworms. So, this study is carried out to determine earthworm population density and biomass in different land use types and to determine relation between earthworm population. They produce physical structures through which they can modify the availability or accessibility of a resource for other organisms.

II. METHODOLOGY

2.1 EARTHWORM SAMPLING AND SOIL COLLECTION

Earthworms are collected from different areas of Ambalavayal panchayath, Wayanad district. A plot of 30cm X 30cm was measured first within each station and a hole of 10 cm deep was dug in the plot. Then soil was removed and spread on a tray and hand sorted the soil removing earthworm as they were found. When all the soil was sorted, the number of earthworms found was counted and then they are released back in the soil. Collection was done during 3 different times. Number of earthworms collected during was recorded separately. Soil was collected from the areas where the earthworms were collected. Large pebbles and other rocky parts were removed before analysis. Then it was dried in shade for 3 days.

2.2. SOIL ANALYSIS

ANALYSIS OF PHYSICAL PARAMETERS (pH, Temperature and Moisture)

10 grams of soil is taken in a beaker. Add 25ml distilled water. Stir for 30 minutes. Take the readings using pH meter/pH tester. Soil temperature was measured by using digital thermometer. Soil moisture was determined gravimetrically.

ANALYSIS OF CHEMICAL PARAMETERS (Electrical Conductivity, Organic Carbon and NPK)

Electrical conductivity indicates amount of soluble ions in soil is measured by using conductivity meter. Organic carbon was determined by a modification of Alten's method. An amount of soil containing 30-100 mg of humus, 25 ml 0.25 M K2Cr207 and 40 ml conc. H2SO4 were put into a 400 ml flask. The mixture was kept for 1.5 h on a hot water bath, allowed to cool for 30 min. and 175 ml of water were added. After standing overnight, the solution was measured colorimetrically and the reading compared to standards. Nitrogen is analysed by titration method. 2g soil taken in a conical flask.10 ml potassium dichromate solution is added to the soil. Then add 20 ml concentrated Sulphuric acid. Then add 200 ml distilled water to it. This solution is titrating with ferrous ammonium nitrate by using the indicator ferroin. At the end point the colour of the solution changes from green to wine red colour. Then calculate the amount of Nitrogen by using the intensity of colour in a colorimeter. Phosphorus is analysed by colorimetric method. 2.5g soil is taken in a conical flask.25ml of Brayls extracting solution added to it. Then shake for 5 minutes in heavy rotary shaker. Then the solution is filtered. Take 5ml filtrate into test tube then add 3.5 ml boric acid and 4ml ascorbic acid into it. A coloured solution is obtained. Measure the amount of phosphorous by using the intensity of color in a colorimeter. Potassium is analysed by flame photometer method. Take 5g of soil into a conical flask. Add 25 ml neutral ammonium acetate solution. Shake well for 5 minutes. Filter it. Clear solution obtained, it directly read to flame photometer.

ANALYSIS OF SOIL MICRONUTRIENTS (Mn, Zn, Cu, Fe and B)

Manganese, zinc, copper and iron were analysed by Spectrophotometric method. The acid ammonium acetate-EDTA extraction solution, 0.5 M CH3COONH4, 0.5 M CH3COOH, 0.02 M Na2EDTA, was made by diluting 571 ml 100 % CH3COOH, 373 ml 25 % NH4OH and 74.4 g Na2EDTA to 10 litres with water. The pH was adjusted to 4.65 with acetic acid or ammonium hydroxide. Soil and extracting solution were shaken for 1 h. The suspension was filtered using Whatman No. 42 filter paper. The concentrations of Cu, Fe, Mn and Zn were determined with an atomic absorption spectrophotometer and appropriate standards. Analysis of Boron is done by Berger and Truog method (1939). 25 ml soil sample, 50 ml of water and 0.5 ml of activated charcoal were boiled for 5 minutes in a quartz flask and filtered immediately. 2 ml of the extract and 4 ml of buffer masking agent were mixed and 4 ml of azomethine reagent added. The colour was allowed to develop for 1 h, intensity measured spectrophotometrically at 420 nm and compared to standards varying from 0 to 2 mg boron per litre.

III. RESULT AND DISCUSSION

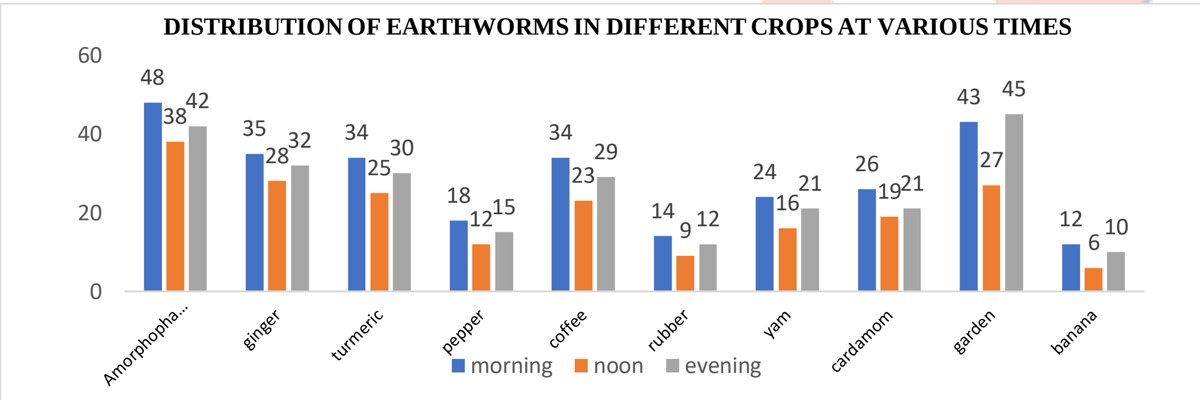

figure 1: Distribution of earthworms in different crops at various times

Figure 1 shows the earthworms collected from 10 various areas. Earthworms collected from different areas and different times (Morning, Noon and Evening) differ in a small range. In which an average earthworm density was more in case of Amorphalous cultivated area throughout the duration of study. 48 earthworms were collected from amorphophalous cultivated soil. The number of earthworms distributed during noon time was very less due to increase in temperature. Highest number of earthworms were identified during the morning time in all the days. This was probably due to less soil temperature and highest humidity during the morning timings.

Bhadauria and Ramakrishnan (1989), reported that different biotic and abiotic forces such as soil properties, surface litter inputs, local or regional climate, dynamic land management history, surface vegetation type, and human pressure at an extent are some of the major causes which effects the regional earthworm biodiversity and species dispersal pattern. In the present study earthworms were abundantly seen on amorphophalous cultivated soil. The distribution of earthworms was mainly dependent on the physicochemical characteristics of the soil.

Table 1: Earthworms identified from different crop cultivated soil

NO	CROPS	FAMILY	ORDER	GENUS	SPECIES
1	**Ginger Yam Coffee**	Moniligastridae	Haplotaxida	Drawida	*D.impertusa* / *D.modesta*
2	**Pepper Rubber Cardamom**	Rhinodrilidae	Opisthopora	Pontoscolex	*P. corethurus*
3	**Yam Banana Pepper**	Almidae	Opisthopora	Glyphidrilus	*G. annandalei*
4	**Garden Amorphophalous Banana Turmeric**	Megascolecidae	Opisthopora	perionyx	*P. ceylanensis*
5	**Amorphophalous Turmeric**	Octochaetidae	Haplotaxida	Dichogaster	*D. Bolaui*

Different species of earthworms were identified from 10 crops. From all 10 sites, 6 species of earthworms belonging to 5 genera and 5 families were identified. The identified earthworms along with classification were listed in Table 1. Earthworm species like *D. impertusa*, *D. modesta*, *P. corethurus*, *G. annadalei*, *P. ceylanensis* and *D. bolaui* were identified from the selected 10 crop cultivated soil. Chandrashekara *et al.*, (2008) and Mohan *et al.*, (2011), reported that *Pontoscolex corethrurus,* is widely distributed 111 India and that it is common in Nilgiri Biosphere reserve in Kerala. In the study of Joseph John et al., (2019), 30 samples and 678 specimens were collected. Among these specimens, 218 were identified with developed clitellum. The study shows the presence of four earthworm families namely, Megascolecidae, Moneligastrida, Eudrilidae, Glossoscolexidae and Olegochaetae, and seven genera namely, Megascolex,Metaphire, Perionyx, Amynthas, Eudrillus,Pontonex and Drawida which represents fourteen species. The family Megascolex represents the highest species diversity with three Megascolex species followed by two Metaphire Perionix and Amynthas species respectively. The genera -*Megascolex* and *Drawida* - have an inherent capacity to adapt to those unfavourable climatic conditions. So, these species became predominant in the study area. The earthworm abundance is directly influenced by the management practices of agricultural lands. Thus, understanding the influence of agricultural management on earthworms and their relationship with soil organic matter dynamics is imperative for the development of sustainable agroecosystems.

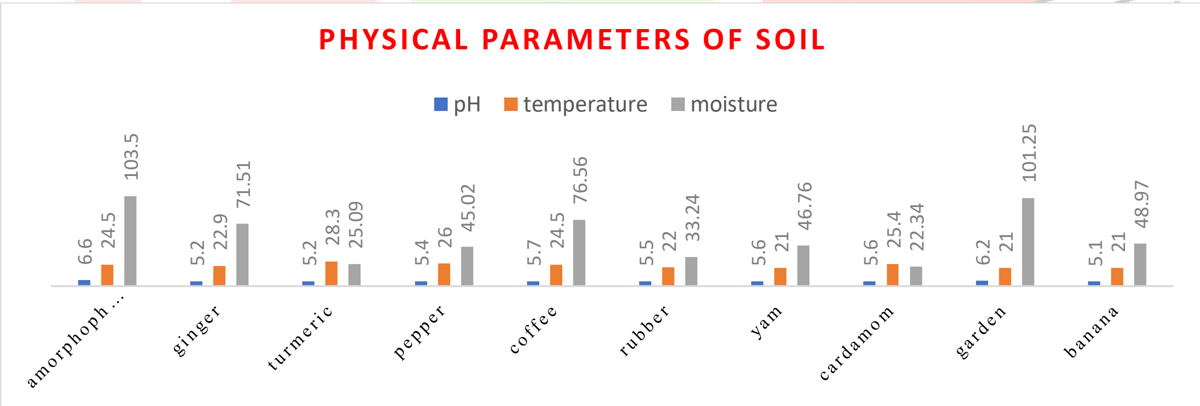

Figure 2: physical parameters of soil

Soil pH were also higher in the amorphophalous cultivated soil. Most of the soil pH ranged between 5.4 - 6. Most acidic soil, is the one collected from the Amorphalous cultivated soil. Staaf (1987), suggested that pH and factors related to pH have very important influences on the distribution and abundance of earthworms in acid beech forest soils in Sweden. Soil pH in this region varied from neutral to slightly acidic. The pH values recorded in the present study are within the range for the distribution of earthworms. In the present study, the pH of the soil varied from 5.1 to 6.6. The study is closely related to the study of Curry and Schmidt (2007), in which earthworm's species respond very quickly to variations in pH at a particular site and they are generally avoiding soil having pH values less than 4.5, favouring pH between 5.0 and 7.4. Chaudhuri and Bhattacharjee, (1999); Najar and Khan (2011), also suggested that earthworms are distributed in a pH range of slightly acid to moderate alkaline. Temperature was higher in turmeric cultivated soil and lesser in yam, garden and banana cultivated soil. Curry (1998), reported that, temperature is a factor of importance for earthworm dispersal in soils and it determines individual metabolic rates and, on a global scale, it can have a major role in determining patterns of earthworm distribution and activity. The present study explained that earthworm communities and their diversity indices are directly correlated with the physico-chemical characteristics of soil at the particular site

Likewise, moisture content was maximum in amorphophalous cultivated soil and minimum in cardamom cultivated soil. The physico-chemical properties of soil directly affect the earthworm abundance and hence diversity indices. Tripathi and Baradwaj (2004), reported that the worms are available from neutral to alkaline pH. Whalen *et al.* (1998), reported that a significant decline in abundance and biomass of earthworms in summer can be attributed to changes in soil temperature and moisture. The Moisture is a critical factor for earthworm distribution due to the cutaneous mode of respiration. Chakravarthy Thejesh (2020), suggested that 60-70% moisture is most favourable for the growth and development of earthworms. Ample moisture with heavy rainfall is lethal to earthworms.

Since anaerobic conditions are created by too much moisture and they occupy the place of dissolved oxygen to survive earthworms move to the soil surface where they are exposed to damaging ultra-violet radiation and predation. In the present study moisture of soil is moderate for earthworm's growth. The soil temperature plays an important role in the maintenance of earthworm population in an ecosystem. This is because the tropical species can withstand higher temperatures.

Table 2: Analysis of chemical parameters

SL.NO	CROPS	EC (µS)	OC (gm/kg)	N (gm/kg)	P (Kg/Ha)	K (Kg/Ha)
1	Amorphophalous	0.039	6.56	2.95	249.00	107.74
2	Ginger	0.050	2.15	1.78	16.80	202.83
3	Turmeric	0.053	3.68	1.86	22.40	120.51
4	Pepper	0.946	2.13	2.34	41.00	135.20
5	Coffee	0.382	2.13	1.77	145.60	759.73
6	Rubber	0.144	1.85	1.23	95.60	478.66
7	Yam	0.084	3.12	1.68	33.60	95.96
8	Cardamom	0.184	2.79	2.12	148.60	89.06
9	Garden	0.378	4.54	1.97	44.32	228.24
10	Banana	0.092	0.02	1.15	18.76	44.86

EC (Electrical conductivity), **OC** (organic carbon), **N** (nitrogen), **P** (phosphorus), **K** (potassium)

Chemical parameters tested includes electrical conductivity, organic carbon, nitrogen, phosphorous and potassium. In which Phosphorous is one which is present in higher amount in all the 10 samples. Amorphophalous cultivated soil possess highest amount of phosphorous content, followed by cardamom cultivated soil. Not only Phosphorous, Electrical conductivity, Organic carbon, Nitrogen & Potassium are also present maximum in the same sample. Most other soils contain lesser amounts of these parameters.

Kale (1998), reported that abundance and diversity of earthworm species affected by carbon and nitrogen content of the soil, and that is why settled ash field gives the lowest diversity. The present study reveals maximum physical parameters in amorphophalous and minimum in banana. The results obtained show that the density of earthworms is dependent on Carbon and Nitrogen content of soils. Chakravarthy Thejesh (2020), suggested that earthworms improve the organic matter mineralization in the soil and consequently increase the amount of nitrogen in the soil, as of superior nitrification in earthworm casts. The nature of the organic matter affects the abundance and species diversity of earthworms. When nitrogen content is high, C/N ratio reduces and earthworm density falls. It is the relative values carbon and nitrogen that affect the earthworm population. The higher nitrogen content, high organic carbon and corresponding high C/N ratio is found at amorphophalous soil. The lower nitrogen content and low organic carbon is found at banana cultivated soil, where the minimum occurrence of earthworms found. The occurrence of most of the earthworms in amorphophalous shows that earthworms prefer to live in soil rich in organic carbon and nitrogen. The present observations are more or less in agreement to the findings of Lavelle, (1974); Edwards and Lofty, (1977); Lee (1985). Achuthan Nair *et al.*, (2017) stated that mineral nutrients showed positive correlations with earthworm density, which indicated the comprehensive roles of earthworms in the process of mineralization.

Various physiochemical factors play a vital role in regulating the distribution of earthworms. Satchell and Martin, (1984) and Satchell *et al.*, (1984), suggested that much of the increase in the availability of phosphorus in earthworm casts relative to that of surrounding soil is due to enhanced phosphatase activity in the casts. Park *et al.*, (1992), reported that it is not known whether the increase in activity is due to earthworm – derived enzymes or to increased microbial activity. Tripathi and Baradwaj (2004), reported that the earthworms prefer to live in soil ecosystems rich in organic carbon and nitrogen instead of phosphorus.

Hendrix *et al.*, (1992), suggested that earthworm population was positively and significantly correlated with organic matter content and high significant correlation between earthworm populations and soil organic carbon content. Organic matter provides food base for the earthworms. Soils that are poor in organic matter do not usually support large numbers of earthworms. The presence of leaf litter in the soil also favors the earthworm population due to the easy availability of organic matter.

Table 3: Analysis of soil micronutrients

SL.NO	CROPS	B (Ppm)	Fe (Ppm)	Cu (Ppm)	Zn (Ppm)	Mn (Ppm)
1	Amorphophalous	0.46	158.44	1.44	0.56	8.76
2	Ginger	0.42	328.64	1.7	1.16	8.52
3	Turmeric	0.22	92.46	2.7	0.12	19.14
4	Pepper	0.2	100.00	3.1	2.78	28.1
5	Coffee	0.12	113.66	1.7	1.58	40.88
6	Rubber	0.14	172.42	2	0.46	30.62
7	Yam	0.38	95.16	2.66	0.04	0.02
8	Cardamom	0.22	89.06	1.72	0.44	33.45
9	Garden	0.16	228.48	3.02	2.82	34.23
10	Banana	0.14	44.86	1.7	0.16	6.22

Boron **(B)**, Iron **(Fe)**, Copper **(Cu)**, Zinc **(Zn)** and Manganese **(Mn)**

Soil micronutrients like boron, copper, zinc, iron and manganese were analysed, in which iron is maximum in all the 10 samples. Boron is higher in amorphophalous cultivated soil. Copper and zinc were maximum in garden soil and manganese were maximum in coffee cultivated soil. Fageria (2008), stated that uptake of micronutrients is affected by the presence of major nutrients due to either negative or positive interaction. Zhang *et al.*, (2004), also stated that practice of different fertilization methods and cropping sequences are responsible for variation in behaviour of Fe, Mn, Zn and Cu in soil and crop. Both the availability of Zn Cu, Fe and Mn in soil as well as their concentration in different crops could be enhanced by application of N, P and K fertilizers. According to Setia and Sharma, (2004), in alkaline soils, higher uptake of Zn, Cu, Fe and Mn were generally associated with increased application of N-fertilizer. This increase can be related to the reduction of soil pH due to N fertilization which further results in increase of the availability of Zn, Cu, Fe and Mn in soil. The combined application of P with N showed a notable increase in Zn and Fe contents in soil while minimal effect was observed in case of Cu and Mn. Dadlich and Somani, (2007); Kizilgoz and Sakin, (2010), said that however, high phosphate content of soils or high fertilization with phosphate may reduce the uptake of Zn and other nutrients.

According to Aulakh and Grant (2008), indiscriminate use of macronutrients may affect uptake of micronutrients in soils. Andres Reyes (2020), suggested that Micronutrient deficiency is one of the most important issues in global crop production. Significant contribution of chemical fertilizers was found effective in nutrient supply for intensive cultivation but the increased use of these fertilizers in an imbalanced manner is also responsible micronutrient deficiency. Organic manures application coupled with application of inorganic fertilizers on the other hand effectively enhances the micronutrient availability in soils. Severe micronutrient deficiencies in plants are accompanied by different symptoms. Deficiencies with no symptoms are also common. Moreover, it is also important to avoid over-application of micronutrients because this can cause severe toxicity. For the maintenance/adjustment of soil factors to an optimum level to get better crop productivity and highest benefit from all possible sources of plant nutrients (i.e., both organic and inorganic) integrated nutrient management is the most suitable option.

In the study of Lamps, (2000), he inferred that organic manures and crop residues applied in conjunction with mineral fertilizers can improve the physical and chemical properties of soil resulting in higher fertilizer use efficiency. According to Berti and Jacobs, (1996); Sekhon *et al.*, (2006), micronutrients occur in different forms and their transformations from one to another are affected by various cropping sequences. Elements like Cu and Zn present in soils were found in numerous physicochemical forms/fractions. In this study all micronutrients are higher in amorphophalous cultivated soil and lower in banana cultivated soil.

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