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EFFECTS OF ALTITUDE, ROOT BIOMASS AND TEMPERATURE OF SOIL ON DENSITY OF EARTHWORM IN SOUTH-EASTERN PART OF SIMILIPAL BIOSPHERE RESERVE, MAYURBHANJ, ODISHA.

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ABSTRACT Earthworm is the most important invertebrate of soil. Since it involved in improving the soil quality, an attempt has been made to test the effects of root biomass and temperature of soil on density of earthworms in different altitudes of South-eastern part of Similipal Biosphere Reserve (SBR) (Balma: 133 mASL, Debkund: 190 mASL, Hadgut: 222 mASL, Katuria: 242 mASL and Nato: 326 mASL). It was observed that the number (density) of earthworms is significantly different among different altitudes and different seasons. More root biomass indicates higher earthworm density. Density of earthworm was highest at moderate temperature, i.e., in rainy season (since temperature of soil in rainy was more than that of winter and less than that of summer season).

KEYWORDS : Earthworm, Density, Root Biomass, Altitude, Temperature

INTRODUCTION

Soil is a treasure house of different type of invertebrates and to lesser extent vertebrates. Earthworms are the most important soil invertebrate. Earthworms are involved in improving the soil quality. It helps in conservation of soil profile. Traditionally earthworms were used in fishing. But now-a-days earthworm has a wide range of application in agriculture and in many more fields. It plays a vital role in the increase of soil fertility. Earthworm has a significant role in soil aggregation and soil porosity (Sharma, 2005).Therefore, Aristotle rightly called them as "Nature's Plough". So, indirectly it also helps in the increase of soil aeration, water infiltration, water-holding capacity, soil tilt and in soil crusting (Edwards et al., 1995). The vermicompost or "Black Gold" produced by the earthworm has an endless demand for consumer, since there are no competitors or manmade factories that can ever duplicate the elements of 'Black Gold'. This product can insulate the plant root from extreme temperature, reduce erosion, control weeds and finally increases the fertility of the soil (Dash and Senapati, 1985). Earthworm can accelerate the rate of decomposition from 25% to 40% (Dash and Senapati, 1980; Edwards and Heath, 1975; Senapati and Dash, 1982, 1984a).

MATERIALS AND METHODS

The study area covers the transition (peripheral) as well as buffer zones of South-eastern part of Similipal Biosphere Reserve (SBR). Similipal Biosphere Reserve is located (latitude 20 0 17'- 22 0 34' N and longitude 85 o 40'- 87o 10' E) in the central part of Mayurbhanj district of Odisha state in India.

The soil samples were collected from five places of each study sites of different altitudes in different seasons (July-October: Rainy season; November-February: Winter season; and March-June: Summer season) for consecutive 3 years from 2013-2016. For collection of samples, soil block of 25 × 25 × 30 cm were dug up by crowbar and ten replicas (for each season of each year) were made for each site of study area (Anderson and Ingram, 1992). Laboratory thermometer was used to measure the temperature (0c) of soil as per Saxena (1990) at each study site during collection of samples (soil and root biomass and earthworm). For plant root biomass analysis, a quadrate of 12 cm x 12 cm x 12 cm size was placed at the site of earthworm sample collection and from that quadrate root was collected and weighed (g) by balance (Saxena, 1990). The soil masses were taken out and from that earthworms observed visually were collected out by handpicked method (Dash and Patra, 1977; Senapati and Dash, 1981). They were kept in small plastic jars which contain 5% formalin for preservation. Then they were counted by hand for density (number) study of each season. To convert the soil block area into one square metre, 16 was multiplied with each data obtained from area of 25 × 25 cm for the density study.

Differences among mean root biomass and temperature of soil in relation to different altitudes of SBR in different seasons of a year were determined by two-way analysis of variance (ANOVA) (Croxton et al., 1982). A difference was considered to be statistically significant if $p < 0.05$.

RESULT AND DISCUSSION

The effects of environmental characteristics (root biomass and temperature of soil) on density of earthworm were studied in three different seasons (summer, rainy and winter) for 3 years at different altitudes of SBR. As there is no significant difference of data between years, the data of three years were pooled together.

It was also observed that mean (average) root biomasses were decreased from lower altitude to higher altitude in all three seasons of the year (rainy, winter and summer). But an exceptional case was observed at study site Katuria and Hadguth in winter season, i.e., mean root biomass at Katuria (23.54 g) and Hadguth (25.31 g) was more than the study site at Debkund (20.08 g), though Katuria and Hadguth are present at higher altitude than the Debkund study site (Table: 1).

Table 1: Average density (number) of earthworm, root biomass (g) and temperature (0c) (3 years) of soil at different altitudes of SBR in different season (Summer, Rainy and Winter).

Study area of different altitudes	Parameter	Summer	Rainy	Winter
Balma (133 mASL)	Density of earthworm	102.39	133.86	115.73
	Root biomass	19.18	32.89	31.06
	Temperature	27.53	24.66	17.96
Debkund (190 mASL)	Density of earthworm	92.26	125.86	107.19
	Root biomass	18.31	30.12	20.08
	Temperature	28.82	30.13	17.56
Hadguth (222 mASL)	Density of earthworm	83.73	120.53	105.59
	Root biomass	16.24	28.56	25.31
	Temperature	29.93	27.06	17.99
Katuria (242 mASL)	Density of earthworm	81.59	111.99	97.06

	Root biomass	15.29	25.98	23.54
	Temperature	29.39	25.59	17.79
Nato (326 mASL)	Density of earthworm	71.46	109.86	93.33
	Root biomass	14.29	35.55	19.71
	Temperature	29.96	26.69	17.46

Table 2: Summary of computations for two-way analysis of variance (F - test) of data of root biomass of soil at different altitudes of SBR in different seasons (Summer, Rainy and Winter).

Source of Variation	Degree of Freedom	Sum of squares	Mean square	Variance ratio (F)
Between Altitudes	r-1=5-1= 4	RSS = 64.76	RMS = 16.19	F_{CR}= 1.39 F = 3.84, at 0.05 level
Between Seasons	c-1=3-1= 2	CSS = 487.36	CMS = 243.68	F_{CC}= 20.96 F = 4.46, at 0.05 level
Error	(r-1)(c-1)= 8	ESS =92.98	EMS = 11.62	
Total	(r c)-1= 14	TSS = 645.11		

Table 3: Summary of computations for two-way analysis of variance (F - test) of data of temperature of soil at different altitude of SBR in different seasons (Summer, Rainy and Winter).

Source of Variation	Degree of Freedom	Sum of squares	Mean square	Variance ratio (F)
Between Altitudes	r-1=5-1= 4	RSS = 7.72	RMS = 1.93	F_{CR}= 1.12 F = 3.84, at 0.05 level
Between Seasons	c-1=3-1= 2	CSS = 361.65	CMS = 180.82	F_{CC}= 105.12 F = 4.46, at 0.05 level
Error	(r-1)(c-1)= 8	ESS = 13.76	EMS = 1.72	
Total	(r c)-1= 14	TSS = 383.143		

It was observed that mean temperature of soil was highest in summer. Then it decreases in rainy and further decreases in winter season at all five study site of study area. An exceptional case was observed at study site Debkund, i.e., mean temperature of soil was more in rainy (30.13 0c) than that of summer season (28.82 0c) (Table: 1). There was no significant difference of mean temperature of soil among different altitudes of study area (Table: 3).

From two-way analysis of variance (ANOVA) study, it was observed that both the temperature and root biomass of soil were significantly different ($p < 0.05$) among different seasons. But among altitudes they were not significantly different (Table: 2 and 3). According to Karmegam and Daniel (2007) earthworm population decreases with increase in the soil temperature at Dindigul district of Tamilnadu, India. The soil temperature plays an important role in the maintenance of earthworm population at Odisha (Senapati and Dash, 1984b) and Madras (Ismail and Murthy, 1985). In the present study there was also a seasonal variation in earthworm population in study sites and peak density was observed during the monsoon (rainy) season due to moderate temperature. As the root biomass increases density of earthworm also increases. Plant root increases the soil moisture and some time dead tissue of root epidermis in soil also increases the organic matter of soil. Both the soil moisture and root biomass favours the growth of earthworms (Lavelle et al., 1994).

CONCLUSION

From the present study it can be concluded that, soil containing more root biomass supports more numbers of earthworm. Since root biomass increases organic matter and moisture content of soil, which support the increase in density of earthworms Again present study indicates amount of root biomass increases from lower to higher altitudes, from summer to winter seasons and from winter to rainy season. So density of earthworm increases along from lower to higher altitudes. Present study provides a conclusion that soil having moderate range of temperature supports more numbers of earthworms. According to this study the temperature of soil in rainy season is in between temperature of soil in summer and winter season. So it can be concluded that rainy season is favourable for increase in the earthworm population than other seasons of the year at SBR.

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