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RESEARCH ARTICLE

POPULATION DYNAMICS OF EARTHWORM IN RELATION TO SOIL PHYSICO- CHEMICAL PARAMETERS FROM PANDHARPUR TEHSIL, DIST-SOLAPUR (MS)

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Abstract

The present study investigates the population dynamics of earthworms in relation to key soil physico-chemical parameters across various locations in Pandharpur Tehsil, District Solapur, Maharashtra. Earthworms, being crucial indicators of soil health and fertility, were sampled from multiple agricultural and non-agricultural sites over a seasonal cycle. Simultaneously, soil samples were analyzed for parameters including pH, moisture content, temperature, organic carbon, nitrogen, phosphorus, and texture. The study revealed significant correlations between earthworm abundance and certain soil properties, particularly organic carbon content and moisture levels. Earthworm populations were observed to fluctuate seasonally, with peak densities occurring during the monsoon season. Species diversity and richness varied across habitats, reflecting the influence of local soil conditions and land use practices.These findings underscore the ecological significance of earthworms and their sensitivity to environmental changes, emphasizing their potential as bioindicators in sustainable soil management strategies. The data also provide a valuable baseline for future ecological and agricultural planning in the region of Pandharpur.

Introduction:-

Earthworms are known to playimportant role in soil profile development, Nutrient cycling & Plant Productivity where their population densities are high. Earthworm are theecosystem engineer because they significantly modified the physical, chemical & Biologicalproperties of soil. Earthworms along with Bacteria & Fungi decompose organic material. Driving soil structure & nutrient dynamics & their importancein soil ecosystem has long been recognized. Earthworm change soil porosity, water infiltration. Earthworms are most important components of soil formation, maintenance of soilstructure &fertility.(Bhadauria&Saxena 2010). Earthwormcanbe divided into three broad functional groups Epigeic Earthworm, Endogeic earthworm, Anecicearthworm.

Earthworms are important soil invertebratesbelonging to the phylum Annelida & class Oligochaeta. Earthworms have been known as Farmer's friend, nature's "best fertilizers" and "Intestine of earth". Earthworm includes 3 orders, 4 suborder, 7 super families,27 families and 8 sub families. (Murali et al). Oligochaetaare bilaterally coelomate invertebrate withinternal & external metameric segmentation throughout the body. Earthworm biomass is a suitable indicatorto determine soil pH, soil moisture & organic layer (Granval 1997). There are several factors affecting earthworm

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population dynamics positively & negatively. The importance of this is to study the population of earthworm in soil as help to make soil fertile. Earthworms give many benefits to the soil by increasing nutrient availability,better drainage & more stable soil structure, allof which help improvefarmproductivity. It also helps the farmers inthe cultivation of land.The technology has become so advanced that farmers are using the new methods of cultivation to increase their productivity but due to that soil is becoming infertile, so to make the soil fertile earthworms are the best biological component of soil & can help in making the soil fertile. Among numerous macro-invertebrates in the soil, earthworms are the most important components of soil biota in terms of soil formation and maintenance of soil structure and fertility Earthworms are known to constitute more than 80% of the soil invertebrate biomass in subtropical and tropical, as well as in temperate zones (Kale, 1997; Nainawat and Nagendra, 2001). Earthworms have the abilitytoimprove soil physical structure, contribute tothe breakdownof organic matter and release plant nutrients (Edwards and Bohlen, 1996).

Approximately 4400 species have been identified in the world. however, few species are used in the process of vermicomposting. Exotic species of earthworms have also been used in India for vermicomposting.International three species of have received acclaim for vermicomposting, they being Eisenia fetida,Eisenia andrei&Eudriluseugeniae, which are exotic and periong excavators, which is endemic. Earthworms is found in every dry and acidic soil (Elaigwu et al.,2007) Nitrogen fixing bacteria are common in guts & casts of earthworms (Satchell, 1967; Edward, 1980). The resinous substance excreted by earthworms help to increase the water retaining capacity of soils. Population dynamics of earthworm was significantly correlated with rainfall and physical characters of thesoil. Earthwormbiomass was significantlyaffected byrainfall and moisture content of the soil. The earthworms' can specifically affect soil fertility that may be of great importance to increase sustainable land use in naturally degraded ecosystems as well as agroecosystems.

Proper earthworm management may sustain crop yields fertilizer inputs could be reduced. Since farming can involve many soil disturbing activities, the understanding of the biology and ecology ofearthworms'swill help devise management strategies that may impact soil biota and crop performance. Earthworm'shavea potentialto contributetothemanagementofsoilfertilityforplant growth, enhanced farming efficiency and agricultural sustainability. For this to be realized, it is important to understand the roles they play in driving soil-based processes, their biology and ecology. The distribution of earthworms fluctuates in connection with the abiotic factors and land pattern. The distribution of earthworm is heterogeneous (Guild, 1952; Satchell, 1955; Svendsen, 1957). There are many researches works carried out across the globe which investigate the relationship between the activity earthworms, the soil properties and environmental factors and have reported the increasing importance of earthworms.

Material and Methodology:-

StudyArea

The Study area was selected from different area's of Pandharpur. This place is situated in Solapur district, Maharashtra, India. Pandharpur Tehsil is subdivision of pune district of state Maharashtra in India. It's geographical co-ordination is of Latitude 17.67375 Longitude 75.2941and about 450m above sea level on the western margin of the Deccan plateau. It falls under the tropical dry deciduous forest, exceptionally along river Bhima has mixed deciduous vegetation with growth and low density is dominant.

Agriculture is predominant in Pandharpur.Sugarcane is the important crop in the Tehsil, then besides this the other important crops are Jawar, Onion etc. The Farmers are generally reluctant in cultivation of pulses, gram and vegetables. The main irrigation in Pandharpur tehsil is Bhima river, Main river, besides wells, tanks and ponds lift irrigation is available along south bank of Bhimariver. Soil is light brown and deep black soil. It has a capacity to hold moisture for long period and contain calcium carbonate which is useful for cultivation.

Methods:-

Thestudyareawas selectedfromthefivedifferentarea'sof PandharpurTehsil. Five area selected was studied:
Location 1st:Sarkoli,Pandharpur-RanzaniRoad.
Location 2nd:Ambegav,Pandharpur-RanzaniRoad.
Location 3rd:ShivajinagarSarkoli–PandharpurRoad.
Location 4th:PulujgavTakliRoad.
Location 5th:KoliVastiRanzani-PandharpurRoad.

Agriculturalareaisselectedforsoilsampleandforcountingtheearthworms. Quadrate method was used for counting the earthworms in 1sq meter.

CountingOfEarthworm
The earthworms'collected from different study area's are counted by hand sorting method.The Soil below 10cm to 15 cm examined for earthworms' tunnels to assess the presence of deeper burrowing earthworms. The earthworms from juvenile to adult were counted. The earthworms collected intothe plastic vials withrecording date & time.

Earthworms are preserved into the 4% Formalin.

SoilSampling
Soil samples (0-15cm) were removed from the side of each earthworm's pit.During each sampling occasion the soil from each quadrate soil sample was collected in polythene bags and numbered and taken to the laboratory for Different soil parameters analysis.

Soil Analysis is doing at Shri Pandurang SahkariKarkhanaSupant Soil & water Testing Lab VakhariPandharpur.

Thelocalearthwormsweresimplyobtainedbydiggingupthesoil.

ParametersOfSoils:
SoilpH
ItismeasuredbyElectrometricMethod(GlassElectrodepHMeter).

Take 10g of soil and add 25 ml in distilled water in a 100 ml beaker, shakeit for 5 min by a magnetic stirrer. Let the soil suspension stands for about 20to 30min. Adjust the pH meter with solution of 4.0, 7.0. Before inserting glasselectrode into the soil suspension and the reading are taken.

OrganicCarbon:
OrganicCarbonismeasuredbytitrationmethodusingconc.H_2SO_4,Orthophosphoricacid,Mohr Salt Solution.

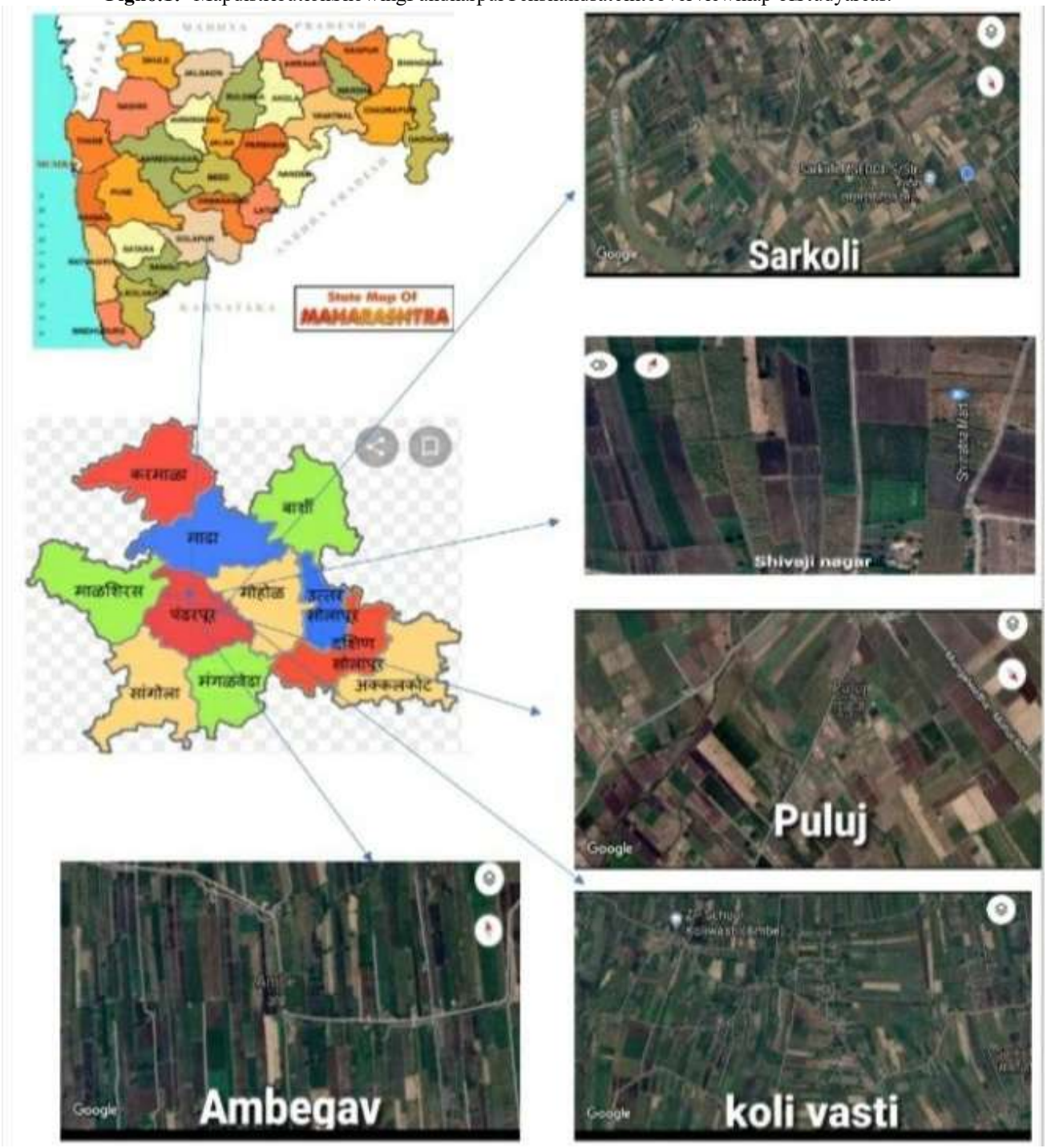
Nitrogen:
Most of thenitrogen in soil is in organic farm. The Kjeldahl method is used for determination of nitrogen. In thistheir steps Digestion, Distillation, and titration. In digestion and decomposition of nitrogen in organic sample usinga concentrated. In distillation method base is added to acid digestion.

Phosphorus:
Phosphorusisdeterminedcolorimetricmethod.Osmondmethodinwhichmolydophosphoricblue colour developed by selective reduction of j6 Molybdophosphoric acid has been extensively adapted. (Osmond, 1887). In this method Chlorostannous – Reduced Molybdophosphoric blue colour method in sulphuric acid system. (Bray and Kurtz, 1945).

Sulphur:
It is determined by heat -soluble S and 0.15% $CaCl_2$ extractable S method (William's and Steinberg's, 1959). Weight a 5gm of soil in silica basin and add 20 ml distilled water.Place the basin on a gently boiling water bath and evaporate to dryness. Then, heat it un a hot-air -oven at102ºc for 60 min. After cooling, transfer the soil to a 50 ml centrifuge tube and extract it with33ml of 1% NaCl. 25 ml aliquot is pipette into silica basin and evaporated to dryness with 2 ml of 3% H_2O_2. The basin is then heated in a hot air oven at 102ºc for 60 min. To ensure the removal of excess H_2O_2 After cooling, the residue is taken up in 25 ml water, transferred to a centrifuge tube and centrifuge to remove suspended matter. Sulphur id then determined by taking a suitable aliquot. Pipettes 10 ml extract in a 150 ml Erlenmeyer flask and add 20 ml of H_2O_2, thus bringing the volume to 30 ml. Add 2.5ml of stabilizing solution and 0.2- 0.3 g of $BaCl_2$ Crystal's by a spatula to the standard and extract. Shake the flask for 1 minute each at constant rate. After 1-3 min, measure the turbidity in a colorimeter using a blue filter. Turbidity can be more accurately measured at 340nm on a spectrophotometer. The turbidity remains constant spectrophotometer.

Sodium(Na):
Determination of Na by flame photometry. Take 5gm soil sample and add 25ml 1N ammonium acetate and shake on mechanical shaker. Then filter it through what man no1 and dilute it to 100ml atomize the sample on flame photometer. By graph of emission intensity against concentration, calculate percentage of sodium sample.

Figno.1: -MapdistributionShowingPandharpurTehsilandsatelliteoverviewmap ofStudyareas.



Iron(Fe):

It is micronutrient. It is detected by using Atomic Absorption Spectroscopic method. In this method EDTA or ammonium acetate used as extractant. DTPA (diethyl thiamine Penta acetic acid) is act as stable cheating agent. Take 10 gm soil sample and add 20ml DTPA (extracting solution) Shake bottle for two hours at room temperature. Filter it through Whitman 1 or 42. Collect filtrate and dilute it to 50ml. Prepare blank solution of DTPA. Aspirate solution at 248.3nm. By the graph of concentration against absorption ironis determined.

Zinc(Zn):
Take 10 gm soil sample in 100ml narrow bottle. Then add 20 ml DTPA (extracting solution) shake bottle for two hours at room temperature.Filter the solution through what man5 1 and 42. Collect filtrate and dilute to 50ml Prepare a blank solution (DTPA). Then aspirate soil extract to 213.8nm. Then atomize it in AAS. By the graph of concentration and absorbance zinc is calculated

Copper(Cu):
It is determined by AAS method. Take 10gm soil sample in 100ml narrow bottle. Then add 20ml DTPA. Shake bottle for two hours at room temperature. Filter it through What man 1 or 42. Then collect the filtrate and again dilute it to 50ml. Prepare blank solution of DTPA. Plot a graph of concentration against Absorption. By calculation Copper is determined.

Potassium(K):
Prepare two kinds of extraction per soil sample, one by adding 20 ml of 1mol/L CH_3COONH_4 to one beaker, and 20ml of 0.01mol/L CH_3COONH_4 to another beaker. Shake the beakers around 1 hour to extract K+ from the soil using a bench top shaker. CalibrateLAQUA twin B-731 with 150mg/L and 2000mg/L K+ standard solutions included in the product. Measurepotassium ion concentration of the filtrated solution with calibrated B-731 and with ICP-OES (e.g. HORIBA Jobin Yvon. Model ULTIMA2).

Manganese(Mn):
AnUltrasonicLeachingMethod (ULM)wasdevelopedfortheanalysisof manganeseandleadon roadside soil samples in order to assess the pollution from motor vehicle exhaust.

Lime:
Manysoil-testing laboratoriesuse thesoil-bufferpHmethodtodeterminethe limerequirement. This method is essentially a titration of an acid, the soil, with a base, the buffer solution.

Result & Discussion:-

TheStudyshowed whiledoingthesurveyfromdifferentfivelocationinPandharpur area,therewas the presence of earthworm in agricultural area. Total number of earthworms present in five location is shown in the table.

Tableno.1:- ListofnumberofEarthwormsaccordingtoselectedlocations.

Location	NumberofEarthworms
AgriculturalareaI- Sarkoli	**39**
AgriculturalareaII- Ambegav	**48**
AgriculturalareaIII- Shivajinagar	**42**
AgriculturalareaIv- Pulujgav	**61**
Agriculturalareav-KolivastiAmbegav	**52**

TableNo.2: -AnalysisofsoilonthebasisPhysico-ChemicalParametersisshowninthetable:

Soil Parameters /Locations	Agricultural area - I	Agricultural area- II	Agricultural area – III	Agricultural area -IV	Agricultural area- V
pH	8.13	8..10	8.08	7.95	8.01
Salt	0.29	0.24	0.76	0.26	0.63
Organic Carbon	0.27ppm	0.39ppm	0.21ppm	0.42ppm	0.33ppm
Nitrogen	140.4ppm	154.2ppm	166.8ppm	169.3ppm	149.2ppm
Sulphur	01.17ppm	01.11ppm	03.27ppm	01.53ppm	04.15ppm
Sodium	1.41ppm	2.02ppm	1.35ppm	1.38ppm	1.05ppm
Iron	6.01ppm	6.96ppm	5.22ppm	10.93ppm	6.49ppm
Zinc	1.19ppm	1.05ppm	1.05ppm	0.89ppm	1.09ppm
Copper	1.16ppm	1.04ppm	1.74ppm	1.91ppm	1.21ppm
Lime	02.75ppm	03.50ppm	04.25ppm	01.50ppm	02.50ppm
Potassium	1359ppm	254ppm	740ppm	253ppm	492ppm
Manganese	8.85ppm	8.72ppm	11.90ppm	7.52ppm	4.99ppm
Phosphorus	09.12ppm	08.19ppm	05.77ppm	07.93ppm	02.65ppm

Tableno.3: -TableshowsCorrelationofSoilparameters(pH,Salt,OrganicCarbon,Nitrogen) with Earthworm number:

Location	pH	Salt	Organic Carbon	Nitrogen	Number of earthworms
1	8.13	0.29	0.27ppm	140.4ppm	39
2	8.10	0.24	0.39ppm	154.2ppm	48
3	8.08	0.76	0.21ppm	166.8ppm	42
4	7.95	0.26	0.42ppm	169.3ppm	61
5	8.01	0.63	0.33ppm	149.2ppm	52
CorrelationWith Population	- 0.9316	-0.2555	0.8189	0.5266	

Tableno.4: -TableShowsCorrelationofsoilparameters(Sulphur,Sodium,Iron)with Earthworm number.

Location	Sulphur	Sodium	Iron	Number of Earthworms
1	01.17ppm	01.41ppm	06.01ppm	39

2	01.11ppm	02.02ppm	06.96ppm	48
3	03.27ppm	1.35ppm	5.22ppm	42
4	01.53ppm	1.38ppm	10.93ppm	61
5	04.15ppm	1.05ppm	6.49ppm	52
Correlationwith Population	0.03853	-0.1248	0.8861	

Tableno.5: -TableShowsCorrelationofsoil parameters(Zinc,Copper,Lime)withthe numberof earthworms.

Location	Zinc	Copper	Lime	Number of Earthworms
1	1.19ppm	1.16ppm	02.75ppm	39
2	1.05ppm	1.04ppm	03.50ppm	48
3	1.05ppm	1.74ppm	04.25ppm	42
4	0.89ppm	1.91ppm	01.50ppm	61
5	1.09ppm	1.21ppm	02.50ppm	52
Correlationwith population	-0.8498	0.44443	-0.7356	

Tableno.6: -TableShowsCorrelationofsoilparameters(Potassium,Manganese,Phosphorus) with number of earthworms.

Location	Potassium	Manganese	Phosphorus	Number ofEarthworms
1	1359ppm	8.85ppm	09.12ppm	39
2	254 ppm	8.72ppm	08.19ppm	48
3	740 ppm	11.90ppm	05.77ppm	42
4	253 ppm	7.52ppm	07.93ppm	61
5	492 ppm	4.99ppm	02.65ppm	52
Correlationwith population	-0.7928	-0.5781	-0.1831	

FromcorrelationofsoilPhysico-Chemicalparametersandpopulationofearthworms.

The distribution of earthworms mainly depends on the soil Physico-Chemical parameters of the soil. When soilis generallyneutral sonumber of earthworm'sare present. The resultshowsthepopulation of earthworm's depend on organic Carbon concentration in the soils. Earthworm's depend upon organic matter for food. The soil which is poor in organic matter shows decrease in number of earthwors.

The pH value is near neutral to basic. pH shows Negative correlation with the population of earthworms. Salt showing negativecorrelation with the population of earthworms. Organic Carbon also shows higher positive correlation with the population of earthworms.

In the present study the Nitrogen shows positive correlation with with population of earthworms. Sodium shows negative correlation with the population of earthworms. More amount of sodium concentration may result in the decrease in the number of population of earthworms.

The metals like Zinc, Manganese, Potassium shows negative correlation with the population of earthworms and present in high concentration they are very sensitive for earthworms.

Lime concentration is also low they show moderate number of earthworms, it has no effect in the population of earthworms Lime show negative correlation with the earthworm numbers.

Phosphorus concentration is also low due to that Phosphorusshowing negative correlation with the number of earthworms.Iron showing Positive correlation with the earthworm population. Sulphur arealso showing positive correlation with the earthworm number. Copper shows positive correlation with the earthworm population.

The human Agricultural activities likeirrigation, tillage, pesticide use, drainage, & crop rotation can have harmful for earthworm biomass & activity. Use oforganic fertilizer obtained from plants &animalsforthe increasethe numberof earthworms. The pHis also important factorforearthworm distribution as earthworm can survive only in neutral soil but also in slightly acidic to slightly alkaline soil conditions. Earthworms can survive into the pH range of 5.0 to 8.0 & an abundance of earthworms increase as pH was shifted from acidic or basic to neutral.

Organic Carbon content is more in soil increase in biomass & population of earthworms. In the present studyobserved that the cattle dung as organic manure like in gardens, have more earthworm species than agricultural land the organic manure beneficial for soil quality which helpful for increasingearthworm number into the soil.

Discussion:-

Earthworms are usually recorded in high no. during rainy season. Higher population of earthworms during June (Beginning of monsoon). (Dash and Senapati, 1980; Rosen, 1982; Bhadauria and Ramakrishanan, 1989, 1991; Blanchart and Julka, 1997; Valle at al., 1997 Josh and aga, 2009; Koirala et al., 2011).

The distribution of earthworms mainly depends upon the soil Physico-Chemical parameters of the soil. Soil pH is generally neutral so no. of earthworms are present. The result shows the populationof earthworms depend on organic Carbon and nitrogen content in the soils. Earthworms are depending on organic matter for food. The soil which is poor in organic matter shows decrease in number of earthworms.More amount of sodium concentration may result in the decrease in number of population of earthworms. And gives the positive significance in the population of earthworms.

The pH value is nearneutral to basic. pH shows Negative correlation with the population of earthworms. Salt is having negativecorrelation with the population of earthworms. Organic Carbon also shows higher positive correlation with the population of earthworms. In the present study the Nitrogen shows positive correlation with population of earthworms. Sodium shows negative correlation with the population of earthworms. More amount of sodium concentration may result in the decrease in the number of population of earthworms. The metals like Zinc, Manganese, potassium shows negative correlation with the population of earthworms and present in high concentration they are very sensitive for earthworms. Lime concentration is also low they show moderate number of earthworms, it has no effect in the population of earthworms Lime show negative correlation with the earthworm numbers. Phosphorus concentration is also low due to that Phosphorusshowing negative correlation with the number of earthworms. Iron showing positive correlation withtheearthwormpopulation. Copper&SulphurarealsoshowingPositivecorrelation with the earthworm number.

Earthworms respire through skin which needs to be kept moist so it helps to dissolve oxygen. Fecundityof earthworms is greatlyinfluenced bysoil moisture (Edward and Lofty, 1972). (Tiwari et al., 1989)

Conclusion:-

The study area characterized the distribution of earthworms in the Pandharpur Tehsil, Dist- Solapur. The occupation of people is mostly agriculture as it is near to the bank of river Bhima. There is availability of water through various sources. Due to the cultivation of land the population of earthworm is more. The population is large in numbers during the rainy season as the moisture content is large amount. Among the different soil Physicochemical parameters, the pH of soil, Organic carbon, Phosphorus, as influenced more in the number of population of earthworms.Proper knowledge of theimportance of earthworms may help in the cultivation of land. More the increase in number of earthworms through various soil parameters will help in increase of fertilityof soil. It can be helpful to minimize the use of chemical fertilizers. From the observations it isconclude that physicochemical properties of soil have some effect on the population of earthworms.

The pH value is near neutral to basic & salt is having negative correlation with the population of earthworms.Salt is having negative correlation with the population of earthworms. Organic Carbon also shows higher positive correlation with the population of earthworms. In the present study the Nitrogen shows positive correlation with population of earthworms. Sodium shows negative correlation with the population of earthworms. More amount of sodium concentration may result in the decrease in the number of population of earthworms. The metals like Zinc, Manganese, Potassium shows negative correlation with the population of earthworms and present in high concentration they are very sensitive for earthworms. Lime concentration is also low they show moderate number of

earthworms, It has no effect in the population of earthworms Lime show negative correlation with the earthworm numbers. Phosphorus concentration is also low due to that phosphorusshowing negative correlation with the number of earthworms. Iron showing positive correlation with the earthwormpopulation. Copper&Sulphur arealsoshowing Positive correlation with the earthworm number.

Some soilparameters showing positive correlationwiththe earthwormnumber or populationwhich means the concentration of that soil parameter is increase or good then number of earthworms or population of earthworms are increasing.& When the concentration of soil parameterslow or not proper then theyshow negative correlation with the earthworm population, earthworms' number are decrease.

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