International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 29-03-2022, Accepted: 15-04-2022, Published: 30-04-2022
Volume 7, Issue 4, 2022, Page No. 227-231

Study on the density and distribution of earth worms (DDEW) towards In-Situ Vermiculture technology

M Lathasanthi[1], R Umamaheswari[2], S Krishnamoorthy[3]

[1] Assistant Professor, Department of Zoology, Arulmigu Palaniandavar Arts College for Women, Palani, Tamil Nadu, India

[2] Associate Professor, Department of Zoology, Arulmigu Palaniandavar Arts College for Women, Palani, Tamil Nadu, India

[3] Research Scholar, Department of Zoology, Vivekananda College, Tiruvedakam West, Madurai, Tamil Nadu, India

Abstract

The present study aims to understand the density and distribution of earthworms (DDEW) in the chosen habitat sites. To consolidate the list of soil associated and other environmental factors on DDEW. To know and generate the awareness to promote the possibility of introduction of the exotic varieties in the field with an integrated approach by in-situ vermicomposting cum vermiculture by way two novel insitu culture methods experimented at our centre namely pit bed culture and strip bed culture. The in-situ culture system through square pit, circular-cylinder pit and strip bed displays an overwhelming perform with regard to the increase of earthworm population, process and rate of composting. While comparing the in-situ Farm yard manure characteristics, the in-situ Vermicompost reveal higher success rate. Out of various parameters and stations studied, the ideally combined characteristics at S1, S10, S 11 were found to be advantageous.

Keywords: vermicomposting, vermiculture, DDEW, *Drawida mathai*

Introduction

The biosphere constitute the vital Life Support System (LSS) for all organisms. The Biodiversity makes our lives both pleasant and possible. No one knows exactly how many species occur in our planet. Scientists trust that the number of species in earth is between 10 million to 80 million. We have been able to enlist only 1.4 million species till date. But we are also losing the rich accumulated heritage of 600 million years at a very fast rate. The onset of biological poverty or reduction in diversity of life forms is bound to have great consequences for the entire living world. The change in climatic conditions are reflected in the distribution of living organisms and the pattern of biodiversity on our planet. Biological diversity is vital to biosphere's health, stability and proper functioning [1].

The quality of our soil depends heavily on earthworms as they are considered very important in soil organic matter cycling [3]. Earthworms contribute substantially in the process of soil formation, maintenance of soil fertility and in the involvement on organic waste degradation to produce vermicompost [2].

Their distribution and abundance are governed by several ecological and edaphic factors [4]. Earthworms are bioindicators in soil. Earthworms, tunnels through the soil and releases mucus from its body. This reacts with the soil of the tunnel walls and forms a type of cement which keeps the tunnel very stable. These tunnels allow rain water to enter into the soil increasing the infiltration rate of soils, preventing erosion and allowing water to flow to the rooting zones for plant uptake. Earthworms are omnivorous feed on various materials in the soil including plant remains and occasionally animal remains [6, 9-20].

Soil texture plays a crucial role in its water holding capacity. The same is true for various faunal species, which are important for adding the nutrients to the soil by the breakdown of organic matter and making it suitable for the agriculture. In this regard, earthworms are said to play a great role. The diversity of earthworm community is influenced by the characteristics of soil, climate and organic resources of the locality as well as history of land use. The species poor communities are characterized by extreme soil conditions such as low pH, poor fertility, low fertility litter or a high degree of soil disturbance [8]. The most significant soil factors affecting the distribution of different species of earthworm are the C/N ratio, pH and contents of Al, Ca, Mg, organic matter, silt and coarse sand.

Under present day conditions of energy crisis and environmental degradation, it has become essential to develop appropriate technologies for the recovery of energy from non-conventional sources like organic wastes. The concept of resource recycling in particularly relevant to agricultural production, because the natural soil-plant-animal- soil recycling system in remarkably effective in operating the process of bio processing and bio conversion. The two broad approaches in tackling the problem of organic recycling in soil improvement and crop production are improvements in the process of composting by a reduction in the processing period and an enrichment in quality and utilization of the available organic residues and inorganic residues in the natural plant production cycle. India produces about 2,500 million tonnes of organic waste annually, which can be utilized for the recovery of essential resource such as fertilizers, fodder, fuel and food. Earthworm is a known and good biological element for the recovery of Vermi fertilizers and vermiprotein are use in agro ecosystem, aquaculture and poultry [7, 18]. Hence with an intention of promoting in-situ earthworm culture, pit bed culture system and stripped culture system methods have been used by integrating exotic earthworm species and endemic worms.

Although the earthworm can be an indicator of soil changes, not much is currently known about earthworm diversity or biogeography. Increasing our knowledge about earthworm can lead to better decision making on soil improvement and conservation [3, 20]. So the objectives for the present study are: To understand the density and distribution of earthworms (DDEW) in the chosen habitat sites. To consolidate the list of soil associated and other environmental factors on DDEW. To know and generate the awareness to promote the possibility of introduction of the exotic varieties in the field with an integrated approach by in-situ vermicomposting cum vermiculture by way two novel insitu culture methods experimented at our centre namely pit bed culture and strip bed culture.

Materials and Methods

The general protocol is based on the National Worm Watch Programme (NWWP) administrated as part of nature watch. Nature watch provides suites of monitoring protocols which encourage researchers, education centers, naturalists and other organization or other individuals to engage in monitoring, indicators for environmental quality.

So, 12 different stations in Dindigul district were selected for the study. The land from where the soil sample collected are vegetable gardens, flower gardens, green house farm land, grassland, plain barren landscape, paddy fields, sugarcane fields, Farmyard manure tanks(FYM), Banana field, Betel vine yard, tank beds and canal banks. Earthworms were sampled from above referred habitats between September 2020 and February 2021, following the procedure of Baker and Barrett [6].

A plot of 30 cm X 30 cm was measured first within each habitat and a hole of 10 cm deep was dug in the plot and the soil was removed and spread on a white enamel tray. Hand-sorted soil is put back into the hole removing the earthworms. When all the soil was sorted, counted the number of earthworms found, place all earthworms in a small plastic container with original local native soil. Four more holes were dugged in the same way at the same places at 5M apart. Added up the number of worms in five holes and doubled it and expressed as the number of earthworms / m^2. The adult worms sampled from above habitats were identified with the guidance of Zoological Survey of India [8, 16-17]. The temperature (˚c) of the soil at 5cm deep was measured with a soil thermometer. The pH was measured using soil pH meter. The water moisture content of the soil was calculated as the difference between the weights of the initial and oven dried (55˚C) soil and expressed as percentage.

The calcium carbonate, electrical conductivity, Hydrogen ion concentration, Zinc, Copper of the chosen soil samples were determined in the soil testing laboratory, Government of Tamil Nadu, following the standard procedures. After realizing multivarions soil-hydro-minerological-physical factors from seventeen different study stations, as per the objective of the work, the in-situ vermiculture has been designed as a pilot project. The silks, where local worms were low in DDEW, were chosen for this experiment. 30 cm X 30 cm X 30 cm square pits, 30 cm dia x 30 cm depth circular pits and 30 cm x 90 cm x 30 cm (l x b x h) 3 rectangular pits were made and kept open (for a week for soil aeration). Vermicompost residues (containing Juveniles and Cocoons) along with local worms (*Drawida sp.*) and exotic worms (either or both of *Eisenia sp. and Eudrilus.)*. The pits made at shady places at orchards and farms were appropriately moistured and covered with dry leaves, waste gunny bag pieces, coconut husks and fibers. In 45±9 to 61± 13 days time, the population of both local and exotic species were found to be abundant. The species association, and related co-existence were observed. Spearman Rank correlation coefficient [10] was carried out to determine the strength and significance of correlation between different soil factors and the Density and Distribution of Earthworms. (DDEW)

Results

On the chosen project the parameters studied are with reference to the type of soil, presence of calcium carbonates, Electrical conductivity, Hydrogen ion concentration, Nitrogen, Phosphate, Potassium, Iron, Manganese, Zinc, Copper,soil moisture content, soil temperature and the quantum of Earthworm Juveniles adults and cocoons. The types of soil observed in the chosen seventeen sites are specifically different as sandy clay or clay. The soil moisture range among the sites vary from 14% to 48%. The electrical conductivity ranges from 0.1 to 0.32. But majority of soil samples exhibit minimum level 0.1 and only 3 sites exhibit higher electrical conductivity. The hydrogen ion concentration ranges from 7.9 to 8.9. The level of Nitrogen is very very low except S9 site. At most sites the range is between 62 to 150ppm. The phosphorous level is 5 to 15.5ppm. As per the investigation from soil chemistry department, only 5 sites possess required level. Regarding potash, the level is 65ppm and 215ppm. Out of all sites, only 6 sites possess required level. The level of Iron ranges from 1.2 to 142ppm. Except S3 soil site, all other sites possess very less quantity. As far as the manganese is concerned, S10 & S11 soil sites reveal deficiency and other soils exhibit required level. With regard to Zinc the range varies from 0.14 to 2.54ppm. The presence of copper too from various sites exhibits a differential level from 0.02 to 2.8ppm.

Table 1: Status of chosen parameters and DDEW at S1 to S12

S.No	Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
1	Soil type	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay
2	Calcium carbonate (level)	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
3	Electrical conductivity	0.31±0.1	0.1±0.05	0.1±0.05	0.1±0.05	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	0.31±0.1	0.32±0.11	0.1±0.05
4	Hydrogen Ion concentration	8.8±0.1	8.9±0.1	8.8±0.1	8.6±0.2	8.7±0.1	8.8±0.1	8.9±0.1	8±0.2	8.5±0.2	7.9±0.2	8.1±0.2	8.8±0.1
5	Nitrate (ppm)	69±11	64±6	67±7	66±9	63±6	66±3	69±3	70±7	62±8	70±3	150±11	70±11
6	Phosphate (ppm)	6.3±0.8	7.5±1.1	5.0±0.3	7.5±0.4	5±0.2	6.3±.2	7.5±0.1	6.3±0.6	6.3±0.3	14.6±1.3	12.8±1.4	50±8
7	Potassium (ppm)	130±14	215±16	133±11	90±9	70±4	73±4	95±4	150±11	83±8	93±13	75±11	65±9
8	Iron (ppm)	4±4	8.24±1.1	12.8±2.2	24±5	2±0.2	1.2±0.2	1.2±0.3	6.8±0.9	1. 4±0.3	11.2±1.8	1.3±0.3	1.0±0.1
9	Manganese (ppm)	19.4±2.2	12.4±1.6	7.8±0.8	21.2±3.1	20.4±1.8	4.8±0.4	8.0±0.8	19.6±3.1	18.4±1.2	0.4±0.1	0.24±0.09	14.4±3.1
10	Zinc (ppm)	2.54±0.6	2.1±0.3	1.78±0.3	0.86±0.1	0.38±0.1	0.14±0.04	0.32±0.1	1.28±0.1	0.76±0.1	2.48±0.3	1.7±0.3	0.8±0.09
11	Copper (ppm)	2.8±0.3	2.22±0.4	1.46±0.11	1.94±0.3	1.3±0.12	1.6±0.1	0.02±0.01	2.8±0.2	1.12±0.02	0.46±0.1	0.8±1.3	1.84±0.18
12	Soil temperature (˚C)	24.5±1.2	26±1.5	26±2	29±1	23±2	26.5±1.5	23.5±1.5	29±2	26±3	29±1.5	27.5±1.5	29±1.5
13	Soil moisture (%)	19±7	23±15	48±10	32±9	14±10	27±6	26±8	31±12	33±9	26±9	22±8	19±8
14	Earthworm adult (number)	108±12	54±8	48±8	17±11	8±1	28±19	36±9	27±11	11±9	126±18	92±22	18±6
15	Earthworm juvenile (number)	207±18	71±12	76±14	49±17	24±11	42±4	51±14	42±9	36±14	96±11	79±14	26±4
16	Earthworm cocoon (number)	38±8	38±7	29±11	34±8	14±9	46±14	18±8	38±7	14±9	45±12	36±11	34±8

Table 2: Performance of in-situ vermiculture using level and exotic varieties:

Culture System	Age of inoculants	Success rate of Endemic species (%)	Success rate of Exotic species (%)
Square pit system	Cocoons	74±9	72±6
	Juveniles	66±6	64±5
	Young adult	58±8	53±7
	Adults	52±6	46±11
Circular-cylinder pit system	Cocoons	81±11	79±8
	Juveniles	76±8	70±4
	Young adult	61±9	56±9
	Adults	1±9	45±8
Strip bed system	Cocoons	89±9	86±3
	Juveniles	79±8	74±7
	Young adult	69±7	60±8
	Adults	57±11	50±11

The sub-soil temperature too exhibit wide variation from 23.5 to 29.0. In addition to the soil laboratory pH estimation, the field spot test of soil samples were also taken. This factor ranges from 7.2 to 8.8. Out of all these 15 parameters from 12 locations, four sites namely S1, S10, S11 soil types exhibit more earthworm population (Table 1). The results of in-situ culture are highly encouraging. The environmental parameters studied reveal that the worms inoculated in a different soil situation respond differentially, according to these age (cocoon or juveniles or young adult or adult) the acclimatization and associated adaptability to the new soil system of both the species are significant and characteristic. The success and survival rate of the above four age groups are found to be verifying from 25% to 98%. However the in the in-situ culture system, local species exhibit higher survival rate than the exotic varieties. But the significance is not much. With regard to the age of inoculant, the results are significantly high at all culture systems [22]

During the course of field investigation three different earthworm species were collected. One of the three species *Drawida mathai* alone was predominant and ubiquitous at all sites. Regarding the other two species though they are insignificant, they coexist at more than 08 sites. It is characteristic to observe the species association. Species association was predominant at sites where Zinc and Iron with moisture content at optimal level. The population density of earthworms at different sites from plain barren landscape to potent fertile cultivated fields varies from 18/ m^2 to 126/ m^2 [20]. Soil temperature and soil water exhibit a modest correlation 0.62 at 5% with regard to DDEW. Temperature and moisture are usually inversely related and high surface temperatures and dry soils are much more limiting to earthworms than low temperature and waterlogged soils [11, 23, 24].

The hydrogen ion concentration of the soil of the different sites were ranging from 7.2 to 8.9 i.e. slightly alkaline to moderate alkaline. As pH increased, a general decreasing tendency was observed in the abundance of worms. A strong inverse correlation (-0.84 at 10%) exist between soil pH and DDEW. The distribution of 67 taxa of Lumbricidae in relation to the pH of the soil and found most species occurring in soils with a pH range of 7.0-7.4 [12]. However in the soil type at S1 (pH 8.2-8.8) the DDEW is 108 /m^2. Similar reported indicated an increase of pH from 7.25 to 8.25 was associated with a decrease in DDEW of 14 Egyptian soils demonstrating that soils can also be too alkaline to favor earthworms [13].

The soils of different sites with different habitats namely vegetable garden, flower garden, green house, farm land and grass land were loamy sand which accommodated moderate to high numbers of earthworms and the lower DDEW (16/m^2) was noted in silt clay soil found in plain barren landscape [15].

A modest correlation (0.47 at 5%) of the percentage of sand in soil, a modest inverse correlation (-0.66 at 5%) of the percentage of slit in soil, and a very weak inverse correlation (-0.14 at 5%) of the percentage of clay in soil and the number of earthworms sampled were evident. Light and medium loams had greater total populations of worms than heavier clays [14, 21].

Differential population of adult, juvenile and cocoons are exhibited at different sites of varied habitats. Adult mortality is normally high during seasonal extremes of high or low temperatures. But embryos survive in cocoons and populations recover rapidly with the restoration of condition suitable for active life. A period of about two years is generally required for populations to recover upon the return of favorable conditions. Perhaps this may be the reason for differential counts of different age groups at different sites. In few sites, after heavy rain many earthworms are commonly found dead on the ground surface. It is suggested that they are forced to abandon their flooded burrows because of anoxia or perhaps resulting from acidification of the water in the burrows due to accumulation of dissolved CO_2 and are then killed by UV rays of sunlight [19].

The in-situ culture system through square pit, circular-cylinder pit and strip bed displays an overwhelming perform with regard to the increase of earthworm population, process and rate of composting. While comparing the in-situ Farm yard manure characteristics, the in-situ Vermicompost reveal higher success rate. (Table-2) out of various parameters and stations studied, the ideally combined characteristics at S1, S10, S11 were found to be advantageous.

Conclusion

An absolute relation was found to exist between the levels of Zinc, soil moistures, oil temperature and hydrogen ion concentration on DDEW. Out of the three species collected namely *Drawida mathai, D.willsi* and *D.celebi* the first one exhibit 5+ and other two species exhibit 2+. Age composition of collected adults, juveniles and cocoons exhibit a trend in such a way that as temperature raises, the cocoon population is found to be more and as the soil moisture increases the juveniles are found to exist more. With the available and current data on Earthworm biology and distribution, it is strongly possible to promote in situ culture. The in-situ vermiculture technology will largely promote and help the promotion of soil quality.

References

1. Anne Grace, Ismail SA. Impact of earthworm inoculation on soil–A laboratory study. J Soil Bio Ecol, 1995, 140-143.
2. Buchanan MA. In: Earthworms in Waste and Environmental Management. (Edwards, C.A and Neuhausar, E.eds). SPB Academic Publishing, The Hague, the Netherlands, 1988, 241-249.
3. Clapperton J. EMANC Ecological Monitoring and Assessment Network, Environment Canede, 1996.
4. Clapperton J. Earth watch website, 1996. (C.F. http://www. naturewatch. ca/english/wormwatch)

5. Das PK. In: Organic Farming and Sustainable Agriculture, National seminar, G. B. P. U. A. T., Pantnagar, p. 45. Devleeschauwer, P.R. and Lal, L.B. (1981). *Soil Boil Biochem*,1996:24:913-915.
6. Dexter AR. Tunnelling in soil by earthworms. *Soil Boil Biochem*,1978:10:447-449.
7. Dash MC, Senapati BK. Cocoon morphology, hatching and emergence pattern In tropical earthworms. Pedobiologia,1980:20:317-324
8. Edwards CA, Lofty JR. xEffects of earthworm inoculation upon the root growth of direct drilled cereals. *J Appl Ecol*,1980:17:533-543.
9. Ghafoor A, Hassan M, Alvi ZH. Biodiversity of earthworm species from various habitatsof district Narowal, Pakistan. Int. J. Agri. Biol,2008:10:681-4.
10. Gupta SK, Sundraraman V. Correlation between burrowing capability and AChE activity in earthworm, *Pheretima posthuma*, on exposure to carbaryl. *Bull Contain Toxicol*,1991:46:859-865.
11. Ismail SA. Vermitech: The use of local species of earthworms in agriculture. *Changing Villages*, 13: 27-31.
12. Julka, J.M. 1997. Contribution to the Knowledge of the earthworm fauna (Oligochaeta: Annelida) of Meghalaya. *Newsl Zool Surv India*,1994a:3:398-400.
13. Lee KE. Earthworms. Their ecology and relationships with soil and land use. Academic Press, Sydney.
14. Reganold JP, Papendick RI, Parr JE. Sustainable agriculture. *Scientific American*, 1985-1990, 72.
15. Retzchmar A. Burrowing ability of the earthworm *Apporrectodea longa limited* by soil compaction and water potential. Biol Fertil Soils,1991:11:48-51.
16. Sims RW. The Scientific names of earthworms. In: Satchell JE(ed) Earthworm ecology from Darwin to vermiculture. Chapman and Hall, London, 1983, 467-474.
17. Sims RW, Gerard BM. Earthworms: Keys and notes for the identification and study of the species. Synopses of the British Fauna no 31, London, 1985.
18. Sinhaet RK. Al Vermiculture technology: reviving the dreams of Sir Charles Darwin for scientific use of earthworms in sustainable development programs. Journal of Technology and Investment,2010:1(3):155-172.
19. Venter JM. The life-cycle of the compost worm *Esienia fetida* (Oligochaeta). S Afr J Zool,1988:23:161-165.
20. Zheng W, Ma Y, Wang X, Wang X, Li J, Tian Y, Zhang X. Producing high-quality cultivation substrates for cucumber production by in-situ composting of corn straw blocks amended with biochar and earthworm casts. *Waste Management*,2022:139:179-189.
21. Chao H, Sun M, Wu Y, Xia R, Yuan S, Hu F. Quantitative relationship between earthworms' sensitivity to organic pollutants and the contaminants' degradation in soil: a meta-analysis. *Journal of Hazardous Materials*, 128286, 2022.
22. Fleri JR, Martin TG, Rodewald AD, Arcese P. Non-native earthworms alter the assembly of a meadow plant community. *Biological Invasions*, 2021, 1-9.
23. Xiang H, Guo L, Zhang J, Zhao B, Wei H. In situ earthworm breeding to improve soil aggregation, chemical properties, and enzyme activity in papayas. *Sustainability*,2018:10(4):1193.
24. Dekemati I, Simon B, Vinogradov S, Birkás M. The effects of various tillage treatments on soil physical properties, earthworm abundance and crop yield in Hungary. *Soil and Tillage Research*, 2019:194:104334.
25. Chapla J, Prabhaker G, Suresh A, Rajarao P, Sumathi J. Preparation of vermicompost in aerobic conditions.
26. Steckley J. Nightcrawler commodities: A brief history on the commodification of the humble dew worm. *Environment and Planning E: Nature and Space*, 2021. 25148486211031341.