International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133, Print ISSN: 2664-7125
Received: 28-12-2021, Accepted: 12-01-2022, Published: 28-01-2022
Volume 4, Issue 1, 2022, Page No. 31-34

Earthworm as a bioindicator for soil pollution

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Abstract
In Thailand, biological assessment of contaminated soil using an earthworm bioindicator in combination with chemical analysis should be practical and appropriate. The page includes research undertaken by several Indian scholars on many aspects of night crawler population elements and species diversity, as well as their interactions with other soil fauna and microflora. It investigates the impact of night crawler development on the physicochemical properties of soil, with a focus on India and other tropical countries. There is a wealth of opportunity in the subject of night crawler evaluation to explain the significance of these crucial soil macrofauna from the biological to the atomic level. Worms are a common organic organism used to investigate soil toxicity. They have been widely used to investigate the environmental impact of heavy metal contamination. Our understanding of pesticides' damaging effects on these animals is quite limited. *Lumbricus terrestris* was used as a bioindicator to investigate the effect of human activities on soil quality. Pb in the worm *P. corethrurus* may be utilised as an integrated evaluation to screen for significant metal traffic pollution since it has a high BAF and strongly correlates with traffic volume. Metallic mercury's interaction with natural acids present in residue and dull water frameworks is a fundamental pathway for Hg bioavailability. Drilling mud in soil is toxic and can cause serious damage to earthworm tissues and organs. Earthworms' clitellum, heart, and blood vessels were investigated for histological abnormalities. We discovered mild to severe necrosis and a brownish deposit, which worsened as the drilling mud concentration increased. Organic pesticides are the most efficient means of preserving soil fertility.

Keywords: earthworm, bioindicator, soil pollution, bioaccumulation, biomagnification

Introduction

The earthworm can act as a soil bioindicator, allowing for the measurement and monitoring of soil pollution, soil health, and ecosystem function under a wide range of land use regimes and management strategies. Chemical testing of contaminated soil can be excessively expensive and offers little information about the environmental hazards associated with polluted soil. When used to assess hazardous agrochemical contaminated regions, biomonitoring provides a direct, inexpensive, and thorough assessment of the contaminant's impact on the ecosystem. Thus, using an earthworm bioindicator in combination with chemical analysis to evaluate contaminated soil should be possible and suitable in Thailand. However, more research and genuine data are necessary. The cost-benefit analysis and comparison to other monitoring strategies may provide important data for scaling up the proposed methodology. [1].

Heavy metal contamination of the soil and ecosystem has become a global problem as a result of the detrimental effect heavy metals have on living creatures when they come into touch with them. They are frequently poisonous and have a negative effect; this is due to their tendency to bio-accumulate in the bodies of living creatures, interfering with the food chain. To summarize, the study reveals that earthworms collected some quantity of heavy metals from the soils in the examined areas [2].

The study revealed a high degree of significance for both dynamic and more stable variables impacting earthworms in soil. Sufficient water content has an effect on these soils. Only on agricultural land were relationships between earthworms and certain chemical (pH, available nutrients) and physical (penetration resistance) variables found. The observed biotic relationships suggest that earthworms and arthropods have trophic interactions, implying that land use management may have a top-down influence on the trophic interactions that form earthworm communities. Additional study is required to establish a connection between biotic and abiotic variables, as well as activities such as land management, and more complex ecosystem services [3].

Type of pollutant in soil and how they inter soil-

Overall, polluted dredging sediment-derived heavy clay soils have four times the earthworm biomass of alluvial soils, whereas sandy loam DSDS have similar earthworm biomass to alluvial soils. The reduced earthworm population at the contaminated heavy clay DSDS partly offsets the risk of subsequent poisoning. But not all earthworm ecological groups are equally vulnerable to predation [4].

Plastic contamination in the environment is gaining global attention at the moment. Improper disposal of discarded or abandoned plastic trash pollutes the environment. The disposal of municipal wastewater effluent, sewage sludge landfills, and plastic mulch from agricultural operations is a significant issue and a source of concern for soil pollution. In comparison to plastic contamination in marine and freshwater environments, soil pollution has received comparatively less attention. We examined plastic pollution in the soil environment and reviewed research on the impact of plastic wastes, particularly microplastics, on the soil ecosystem in this paper. We discovered that the majority of research on the impact of soil plastic contamination on organisms has utilised earthworms as the test species. As a result, more study into the impacts of plastic pollution on other species models (invertebrates, plants, microbes, and insects) is necessary to fully comprehend the consequences of plastic pollution on the whole soil ecosystem. Additionally, we recommend additional study directions for future investigations on plastic pollution and the soil ecotoxicity of plastic wastes [5].

What are bioindicators?

The use of bioindicators is not novel, it is a novel technique for analysing different forms of environmental mismanagement, such as pollution, high input farming, improper waste disposal, and contamination. This technique makes use of biological animals (particularly invertebrates, the subject of this volume) and biodiversity to analyse current environmental conditions. While laboratory work is required, bioindicator-based studies depend heavily on field evaluation of a small number of species [6]. Owagboriaye et. al. evaluated the biochemical response and vermiremediation potential of three indigenous earthworm species; namely *Alma millsoni*, *Eudrilus eugeniae* and *Libyodrilus violaceus* in GBH Glyphosate-Based Herbicides treated soils. After being exposed to GBH, earthworm species (*A. millsoni*, *E. eugeniae*, and *L. violaceus*) showed changes in their enzymatic activity and antioxidant defense system. These changes might be utilized to track the health of soils that have been contaminated with GBH [7].

Bioindicators play an essential role in discovering the variables that govern Hg toxicity and bioavailability, and they can eventually be utilized to assess risks in areas where Hg contamination is present. The development of simple, low-cost, less complex techniques can help with the fast detection of potentially dangerous conditions, especially in poor nations where resources are scarce and pollution is widespread. Earthworms (*E. foetida*) may accumulate Hg and other metals, and there is a positive link between Hg concentrations in worm tissues, the substrate they consume, and the duration of exposure (a dose–response relationship). The earthworm approach provided below is simple to implement in a short amount of time and at a minimal cost. As a result, this technique may be used to test the bioavailability of Hg and other metals in contaminated soil, sediments, and tailings [8].

Important characteristics of earthworm that make them eligible as a bio indicator

Pollution of the terrestrial ecosystem is a major environmental issue all over the world. The earthworm is classified as a soil domain creature. It has been suggested that test species be used to assess soil pollution in terms of acute toxicity. Pollution has a significant impact on earthworm population and biomass. The findings highlighted the fact that agriculture soils acquired a disproportionately high amount of anthropogenic heavy metals, probably due to the usage of agrochemicals and other soil amendments in order to achieve high yearly crop yields [9].

This research found that earthworm activity in sewage sludge improved soil characteristics and accessible nutrients like N and P. Earthworm activity increased cabbage biomass and decreased Cd absorption by cabbage. The distributions of Cd and Cu among fractions in sewage sludge with and without earthworm treatment were similar. Thus, earthworm treatment improves sewage sludge by decreasing Cu and Cd bioavailability and increasing nutrient availability [10].

Bioindication is a technique used in various environments to assess biodiversity and environmental quality. Invertebrates, particularly earthworms, are usually good bioindicators in soils. Floodplains are characterized by a complex mosaic of topsoil composition, which results in a high degree of variability in terms of possible homes for earthworms. The existence of some species is very difficult to determine due to the paucity of research on this little-studied habitat. Additionally, earthworm communities are dependent on numerous parameter interactions, including stress, competition between species and/or ecological categories, colonization time, fluvial dynamics, and, most importantly, material inheritance. This research may serve as a first step in establishing a bioindication reference condition for natural and undisturbed subalpine areas in the context of restoration efforts or other environmental effects [11].

Toxicity of Growth Regulators

Buprofezin, triflumuron, and lufenuron were all toxic or fatal to earthworms when administered acutely. After four weeks of exposure, lufenuron was more hazardous than buprofezin and triflumuron. All pesticides had a substantial influence on earthworm development and activity of enzymes. The decrease in the development rate of pesticide-treated earthworms (*A. caliginosa*) was accompanied by a drop in the activities of AChE and GST. These findings suggest that changes in weight growth and enzyme activity during sublethal exposure periods may be sensitive parameters for determining the extent of pesticide injury, as they provide early warning responses at sublethal doses and are closely related to those found naturally in the environment. Thus, by determining the growth rate and particular activity of various enzyme systems in earthworms, they may be used

as biomarkers for pesticide-contaminated soil [12]. Zavala-Cru et. al. studied biomarkers' response to organic contaminant in that they concluded that, Earthworm population and biomass largely depended on the pollution gradient and soil texture and nutrient content [13].

A sub lethal dose of four arsenic species in artificial soils was investigated using three biomarkers: lipid peroxidation, metallothioneins, and membrane integrity. The results demonstrated that the three biomarkers could detect inorganic arsenic in soil. Comparatively, trivalent arsenic has a greater impact on biomarker responses in earthworms (*E. fetida*) than pentavalent arsenic. The results of biomarker responses could be utilised to monitor the environment and design intervention measures to protect earthworms and promote ecosystem health [14].

Effects of Pesticides on the Growth and Reproduction of Earthworm

Earthworms are significant soil macroinvertebrates that are often employed to evaluate the overall effect of pesticide contamination in soil [15]. It is now recognized that, although larger pollutant concentrations may be easily measured using the acute (mortality) test, polluted soils with lower (sub lethal) pollutant concentrations require more sensitive risk assessment approaches such as reproduction testing [16].

Earthworms are well-known in agricultural activities. The growing use of pesticides and chemicals in agriculture has negatively impacted soil flora and fauna. Studies on the influence of pesticides and heavy metals on the activity of major enzymes from different tissues in earthworms are increasing in popularity as possible markers of xenobiotic pollution in soil. Various studies on pesticides and earthworms revealed that pesticides altered the activities of enzymes involved in neurotransmission, energy metabolism, oxidative system, and amino acid metabolism. These enzymes might be used to detect pesticide toxicity. However, additional research is needed to identify sensitive earthworm biomarkers that may be utilized to detect soil contaminants [17].

Role of Earthworms in the Biomagnification

It is well acknowledged that earthworms play an essential role in the biomagnification of heavy metals in terrestrial environments. Differences in earthworm biomass between locations are seldom taken into consideration in ecological risk assessments. These variations might be significant depending on soil characteristics and pollution levels [18].

This study established that drilling mud in soil is poisonous and can result in significant harm to earthworm tissues and organs. The clitellum, heart, and blood arteries of earthworms were examined for histopathological abnormalities. We noticed mild to severe necrosis and brownish deposit that became more severe as the drilling mud concentration increased. The findings of this study indicate that drilling mud may cause *Aporrectodea longa* to develop histopathological diseases [19]. Organic insecticides are the most effective way to save our soil fertility. It will be demonstrated further by a comparison of organic and inorganic pesticides on different tissues and biochemical activities of earthworms [20].

Conclusion

Biological assessment of contaminated soil using an earthworm bioindicator in combination with chemical analysis should be practical and appropriate. The page includes research undertaken by several Indian scholars on many aspects of night crawler population elements and species diversity, as well as their interactions with other soil fauna and microflora. It investigates the impact of night crawler development on the physicochemical properties of soil, with a focus on India and other tropical countries. There is a wealth of opportunity in the subject of night crawler evaluation to explain the significance of these crucial soil macrofauna from the biological to the atomic level. Worms are a common organic organism used to investigate soil toxicity. They have been widely used to investigate the environmental impact of heavy metal contamination. Our understanding of pesticides' damaging effects on these animals is quite limited. Lumbricus terrestris was used as a bioindicator to investigate the effect of human activities on soil quality. Pb in the worm *P. corethrurus* may be utilized as an integrated evaluation to screen for significant metal traffic pollution since it has a high BAF and strongly correlates with traffic volume. Drilling mud in soil is toxic and can cause serious damage to earthworm tissues and organs. Earthworms' clitellum, heart, and blood vessels were investigated for histological abnormalities. We discovered mild to severe necrosis and a brownish deposit, which worsened as the drilling mud concentration increased. Organic pesticides are the most efficient means of preserving soil fertility. However, earthworms are natural bioindicator of the soil pollution but, different species accumulates the metal at different rates. Therefore, it is difficult to recommend single species as a pollution indicator.

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