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Earthworm as Bioindicator of Soil Pollution Around Benghazi City, Libya

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Abstract

Pollution of terrestrial ecosystem is a serious environmental problem worldwide. Earthworm is considered as a domain soil organism. It has been recommended test species to evaluate soil contaminations in acute toxicity. Earthworm density and biomass are strongly influence by pollution. In this study, mortality, biomass, cocoon number of *Eisenia fetida* were examined during 14 days of exposure to series percentage (100, 75, 50, 25%) for each soil of (Bouatni, Hawari, Lowifia, and Jarotha) locations around Benghazi city, under control conditions. The locations soil was mixed with artificial soil to get the desired percentages. Mortality was recorded in Bouatni soil 100%. However, no mortality observed elsewhere. No cocoon numbers were account in all locations at 100, 75% as well as in Lowifia soil 50%. However, Cocoon numbers were significantly reduced in Bouatni, Hawari and Jarothaat50, 25% compared to control. Interestingly, earthworms body weight were increased significantly, in all locations soil (25, 50, 75%) compared to control earthworm. Our results had shown decreased in cocoon number which can lead to decline in earthworm populations and consequence to reduce soil fertility. This study was first investigation of contamination soils around Benghazi city by using biota as well as put more emphasis on using earthworm as bioindicator.

Keywords: Earthworm; Soil pollution; Ecosystem; Environmental

Introduction

Benghazi (32_10¢N, 20_06¢E), the second largest city in Libya, is colonized by many soil invertebrates such as earthworms. Soil pollutions have enormously increased during the last decades due to the intensive use of pesticides and fertilizers in agriculture. The increase in soil pollution levels due to pesticides as well as heavy metals has endangered both the environment and human life [1]. It is becoming increasingly apparent that chemical analysis and the use of chemical-specific trigger values cannot take into account issues such as mixture toxicity and the environmental conditions determining chemical bioavailability. The best integrators of these complex effects are the exposed organisms themselves [2]. Among soil species, earthworms are ubiquitous, abundant, and important for soil processes. Earthworms form the largest part of the invertebrate biomass in most soils Lavelle and Spain, 2001), considered not only as a biofertilizer and composting agent but at the same time nature's plough, aerator, moisture retainer, crusher, and biological agent [3]. It is able to modify soil physical properties [4], through mixing surface litter, casting, and burrowing activities. Earthworms are known to play a major role in the development and maintenance of soil structure, in the incorporation and breakdown of organic residues in the soil, and as a source of food for terrestrial organisms [5]. Assimilation of contaminated earthworm tissue by predators may lead to accumulation of toxic chemicals throughout the food chain. Their survival and behaviour in contaminated soils has implications for their use as biological indicators of soil health and as agents of soil restoration [1].

Earthworm is considered as a domain soil organism. It has been recommended test species to evaluate soil contaminations in acute toxicity. Earthworm density and biomass are strongly influence by contamination. Pollution of terrestrial ecosystem is a serious environmental problem worldwide. The potential hazards of environmental pollutants to soil invertebrates have been assessed in many years by the use of the 'earthworm acute toxicity test' [6]. This 14-day LC_{50} test using the earthworm *Eiseniafetida* has been important for risk assessment and regulation of new and existing chemicals [7]. The end point of the 'earthworm acute toxicity test' is mortality. However, mortality is unlikely to be either the most sensitive or ecologically relevant parameter for predicting effects on field populations. Reproductive and/or growth disturbances are far more likely to mediate population effects [8]. Reproduction is likely to be of particular important in ecotoxicological assessment because of its influence on population dynamics [9]. The aim of this study, to use earthworm as bioindicator to evaluate soil contamination around Benghazi city. Duration of the experiment was 14 days. However, along with mortality, the body weight and reproduction rate by cocoon production were considered.

Material and Methods

Four stations located within the municipality of Benghazi were selected for the study (Figure 1). These stations were (1) Bouatni (2) Hawari (3) Lowifia and (4) Jarotha, they were categorized into four different habitats of earthworms. These were (i) Clayey loam soil, lemon, olive, guava and orange farm (stations 1). (ii) Silt clay soil, plain landscape with wild grasses and olive plants having medium-sized trees forming canopy (station 2). (iii) Loamy sand soil, rose and flower garden (station 3). (iv) Loamy sand soil, rose, flower garden pomegranate and olive plants having medium-sized trees forming canopy (station 4). Soil, were sampled during March 2013, and following certain steps a plot of 20 × 20 cm replicates ten times were measured within the survey site 10 × 10 m, of each station with two substations. A ditch of 10 cm deep was dug in the plot and the 100 g soil were taken from each and spread on a white plastic tray, and hand-sorted removing stones and road as they were found. The soil samples were air–dried and each

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sample was then placed in a mortar, and then sieved per 2 mm mesh to remove the rest of stones and pieces of macro–organic matter for routine analyses.

The temperature of the soil (10 cm deep) was measured by a soil thermometer, relative humidity (%) on the soil surface by a hygrometer, and pH of the soil using a soil pH meter. The water content of the soil was calculated as the difference between the weights of the initial and oven-dried (55°C) soil, and expressed as a percentage. Selected heavy metals were determined in biota samples (microwave digestion with nitric acid and hydrogen peroxide). However, heavy metals in soils for "total" content with aqua-regia extraction (ISO 11466).

Earthworm of the species *Eiseniafetida* was maintained in the laboratory in culture medium according to OECD_222 [10]. Treated soils were mixed with different concentrations of the control soil (100, 75, 50, 25%). These experiments were started by adults with well-developed clitella, for 14 days exposure. The test endpoint were mortality, body weight as well as cocoon production.

Result and Discussion

The result put more emphasis on fact that the agriculture soils received a comparatively high input of anthropogenic heavy metals, possibly related to the use of agrochemicals and other soil amendments for the high annual crop production. Total concentration of heavy metals was always higher in soil collected from Buatany area compared to other. Heavy metals follow two orders, first order Zn>Cu>Pb>Cd inBuatany and Jarotha. Secondly, Zn >Pb>Cu >Cd in Hawari and Lowifia. The average concentrations of Cd, Cu, Pb, and Zn (expressed as mg kg^{-1} dry weight) were shown in Table1. Selected Heavy metals concentrations were always higher in Buatany station than other, which were in different order in between. Heavy metals are strongly bound to soils rich in organic matter or clay [11]. Temperature was 22 ± 2, pH. was 7 ± 1, relative humidity was 70%. High mortality 93% was recorded in Bouatni soil 100%. However, no mortality observed elsewhere.

Body weight was significantly decreased in all soil from different locations at concentration (100%). At concentration 75 body weight was less than control group except 75% Jarotha was higher than control group. However, body weight was increased in all soil from different

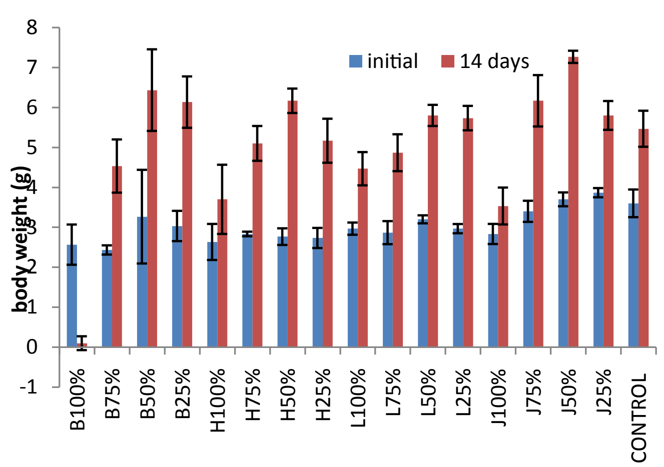

Figure 1: Location of study stations in Benghazi (up to down) (1) Bouatni, (2) Hawari (3) Lowifia, and (4) Jarotha.

Stations	Pb	Cd	Zn	Cu
BUATANY	33.1	0.43	321.8	44.8
Hawari	19.6	0.26	52.3	12
Lowifia	17.6	0.2	87.7	16.1
Jarotha	13.5	0.2	115	15.3

Table 1: Show the mean of selected heavy metal concentrations (mg/Kg) in different soil stations around Benghazi city.

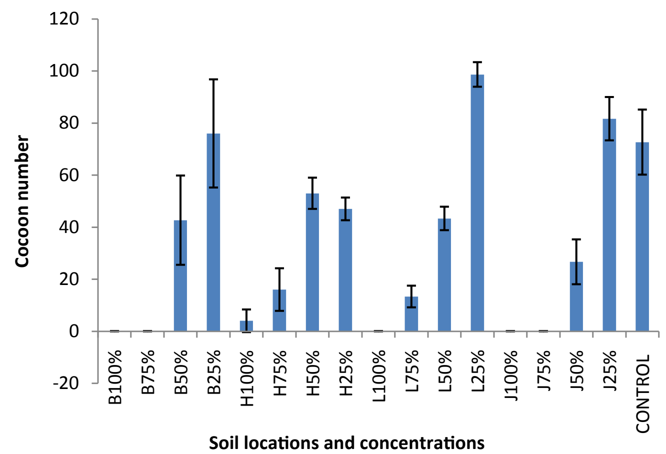

Figure 2: Shown the change in body weight after 14 days at different concentration (100, 75, 50, 25%) of study stations around Benghazi (B) Bouatni, (H) Hawari (L) Lowifia, and (J) Jarotha.

locations at concentrations (50 and 25%) compared to control (Figure 2) with no significant different.

Cocoon production was not recorded in treated soil (100%) in Bouatni, Lowifia, and Jarotha as well as in (75%) treated soil in Bouatni, and Jarotha. However, cocoon number in Hawari soil (100%) was four cocoons. Hawari and Lowifia soil (75%) the number of cocoon were 16 and 13 respectively that are significantly different with control group. In 50% treated soil, Hawari soil were the highest production (53 cocoon) followed by Lowifia and Bouatni (43, 42 respectively). The lowest cocoon production at 50% of treated soil were in Jarotha soil with (26 cocoon), all of them were significantly less production than control group. The cocoon production at 100, 75 and 50% of treated soil were always less than cocoon production in control group (72 Cocoon). However, the cocoon production at 25% of treated soil was almost higher than cocoon production in control group (72 Cocoon). In the 25% treated soil, Lowifia soil were the highest cocoon production (99 Cocoon) with significant different followed by Jarotha and Bouatni (82 and 76 Cocoon) respectively with no significant different with control. However, Howari 25% were shown cocoon production (47 Cocoon) which is significantly less than control group production (Figure 2). This study show high total concentration of heavy metal in Bouatni. Treated soil did not cause mortality in acute toxicity test 14 day exposure except in Bouatni 100%. However, it has clear effect on body weight and cocoon production which should be considered in such experiments. Such change in body weight and cocoon production leads to change in population dynamic.

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References

1. Caroline JL, Trevor GP, Andrew AM, Kirk TS (2001) Survival and behaviour of the earthworms Lumbricus rubellus and *Dendrodrilus rubidus* from arsenate-contaminated and non-contaminated sites Soil Biology and Biochemistry 33: 1239-1244.
2. Svendsen C, Spurgeon DJ, Hankard PK, Weeks JM (2004) A review of lysosomal membrane stability measured by neutral red retention: is it a workable earthworm biomarker? Ecotoxicology and Environmental Safety 57: 20-29.
3. Eguchi S, Hatano R, Sakuma T (1995) Toshio effect of earthworms on the decomposition of soil organic matter. Nippon Dojo-HiryogakuZasshi 66: 165-167.
4. Edwards WM, Shipitalo MJ (1998) Consequences of earthworms in agricultural soils: aggregation and porosity. In: Edwards CA (eds) Earthworm Ecology. CRC press, Florida, USA .
5. Edwards CA, Bohlen PJ (1996) Biology and Ecology of Earthworms. (3rdedn), Chapman & Hall, London.
6. OECD (1984) Guidelines for the testing of chemicals No. 207 Earthworm acute toxicity tests. OECD Adopted 4 April 1984.
7. Becker H, Edwards PJ, Heimbach F, Greig-Smith PW (1992) Ecotoxicology of Earthworms. Intercept Ltd., Hampshire, UK.
8. Moriarty F (1983) Ecotoxicology. The Study of Pollutants in Ecosystems. Academic Press, London, UK
9. Denneman CAJ, Straalen NM van (1991) The toxicity of lead and copper in reproduction tests using the oribatid mite PlaO, nothruspeltiJer. Pedobiologia 35: 305.
10. OECD (2004) Guidelines for testing chemicals, No 222. Earthworms, Reproduction Tests Eisenia Fetida/Andrei Organization for Economic Cooperation and Development, Paris, France.
11. Sauve S (2002) Speciation of metals in soils. In: Allen HE (eds.), Bioavailability of Metals in Terrestrial Ecosystems: Importance of Partitioning for Bioavailability to Invertebrates, Microbes, and Plants. SETAC, Pensacola: 7-38.