

Joanna JARMUŁ-PIETRASZCZYK<sup>1</sup> and Joanna PIASECKA<sup>2</sup>

**EFFECT OF ACTIVE COMPOUNDS  
FROM PESTICIDES APPLIED TO SOIL  
ON THE CALIFORNIA EARTHWORM *Eisenia fetida***

**WPLYW AKTYWNYCH ZWIĄZKÓW ŚRODKÓW DOGLEBOWYCH  
NA DŹDŻOWNICĘ KALIFORNIJSKĄ *Eisenia fetida***

**Abstract:** This study was aimed at estimating the effect of selected pesticides on the California earthworm *E. fetida* its survival and reproduction. Parameters that were taken into account included:

- 1) changes in the density, mortality, biomass and hampered life activity after application of pesticides as compared with the control,
- 2) the number of laid cocoons and hatching.

Selected pesticides contained the following active chemical compounds: dichlobenyl (herbicide), diazinon (insecticide) and carbendazin and tiuram (fungicide). Earthworms responded to soil pesticides in different ways. Diazinon caused remarkable loss of body weight. Most toxic was fungicide which resulted in 100 % mortality of *E. fetida* after 48 h contact.

**Keywords:** *Eisenia fetida*, pesticides, soil

Soil oligochaetes are important for proper functioning of the soil fauna. They play a role in the production and transport of humus and in the improvement of water and air relations in the soil [1, 2]. Natural occurrence of oligochaetes is affected by the activity of man and his desire to obtain maximum income from farming. Chemical treatments result in changes of the proportion of particular trophic groups of animals due to application of new plant protection chemicals. Side effects of pesticide treatments are not always obvious.

Earthworms became one of the basic ecotoxicological study objects to evaluate environmental changes [3] focussed particularly on various herbicides which are now inseparable part of agricultural production [4–7].

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<sup>1</sup> Department of Zoology, Chair of Biology of the Animal Environment, Warsaw University of Life Sciences SGGW (WULS-SGGW), ul. J. Ciszewskiego 166, 02–786 Warszawa, Poland, phone: +48 22 593 66 28, email: joanna\_jarmul@sggw.pl

<sup>2</sup> Student of Department of Zoology, Chair of Biology of the Animal Environment, Warsaw University of Life Sciences SGGW (WULS-SGGW).

## Material and methods

Plant protection chemicals applied to the soil in concentrations recommended by the producer to control weeds, insects and for seed protection were used in the study.

a) Herbicide – dichlobenyl (Casoron 6,75 GR) (a compound from the benzonitriles group) at a concentration of 6–7 g/m<sup>2</sup>;

b) Insecticide – diazinon (Basudin 600EW) (a compound from the phosphoorganic group) at a concentration of 4 cm<sup>3</sup>/10 dm<sup>3</sup> water;

c) Fungicide – carbendazin (a compound from benzimidazoles) and tiuram (a compound from the dithiocarbamate group) (Funaben T preparation) at a concentration of 3 g/1 dm<sup>3</sup> water.

Thirty individuals of the earthworm *Eisenia fetida* with well developed clitellum from own culture of the Department of Zoology, Warsaw Agricultural University were placed in sterile soil in laboratory conditions. Animals were left in a box for 24 hours at room temperature to let them disperse freely in the soil and to release them from stress caused by capturing and transferring to the laboratory conditions. After 24 hours the soil was sprinkled with pesticides at a concentration and dose used in practise.

Animal behaviour was observed. Appearance of the body wall and mortality after 1, 24 and 48 hours was adopted as criteria of animal response to herbicides.

The next stage of the study was checking the ability of reproduction and hatching after ca 3 weeks since the beginning of the experiment. Each experimental variant was triplicated. Animals placed in the same conditions but in soil sprinkled with distilled water instead of chemicals served as control. Obtained results were tested with one-way ANOVA and LSD tests.

## Results

Plant protection chemicals affected primarily earthworms' body walls from small changes in their appearance to heavy burns as compared with control animals. Most effective was the fungicide containing carbendazin and tiuram which caused the death of earthworms within 72 hours. Earthworms were observed to move out to the soil surface and release celomic fluid directly after fungicide application.

Diazinon appeared to act less drastically though it also contributed to partial paralysis of *E. fetida* and to damage of its body wall. This insecticide limited also the reproductive potential of earthworms. The number of laid cocoons and hatched young individuals in relation to the control was low (Table 1).

Table 1

The effect of active substances from plant protection products on the number of laid cocoons and hatching in the California earthworm *E. fetida*

	Control	Dichlobenyl	Diazinon	Carbendazin + tiuram
Number of cocoons/ind.	97.7	115.7	18.0	0.0
Number of hatched young/cocoon	112.3	123.3	30.0	0.0

The least toxic was dichlobenyl, though it also resulted in earthworm mortality, decreased mobility and metabolic rates (loss of weight compared with the initial at the same feeding system as in the control) (Fig. 1). However, the preparation had a positive effect on reproduction (mean 2.8 cocoons/ind.) and hatching (mean 0.7 cocoons/ind.) as compared with diazinon (Table 1).

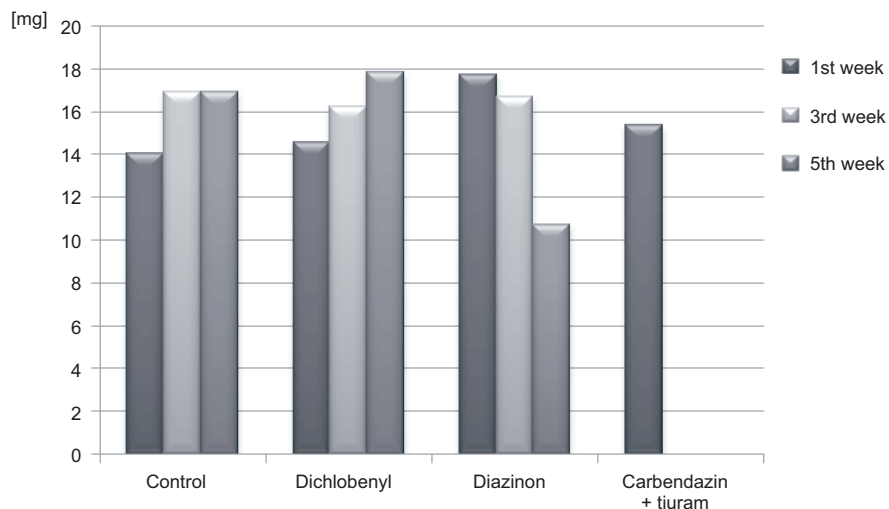


Fig. 1. The effect of active substances from plant protection products on the biomass of California earthworm [mg]

Statistical analysis showed significant differences in the number of laid cocoons and hatched young earthworms between treatments with various active substances from plant protection chemicals ( $p < 0.05$ ).

## Discussion

Reproductive abilities and weight loss of earthworm's body is largely affected by the class of toxicity of a given pesticide and the time of its persistence in the soil. *Lumbricus terrestris* treated with diazinon (from Basudin 10G) by Kostecka and Wojcikiewicz [8] first decreased their body weight but later an increase in animal weight was observed. In our experiment, however, systematic loss of the body weight was observed regardless of the treatment (Table 1). This was caused by permanent contact of the California earthworm *E. fetida* with active substances and by application of the latter in dissolved forms. Reproductive potential of animals is used as a response indicator. Pesticide treatment first of all decreased population density since applied preparations made earthworms produce less cocoons (Fig. 1, Table 1). The time of production of one cocoon under such circumstances is longer [9]. Many studies on the effect of various insecticides, fungicides or herbicides demonstrated remarkable influence of these chemicals on various species of soil oligochaetes [10–13]. Zablocki et

al [14] showed that preparations persisting long in the soil at high concentrations exerted stronger effects. Earthworms being soil animals of limited ability to migrate are sensitive to various chemicals [1, 3].

An important aspect of the studies on mesofauna is to estimate how the chemicals introduced to the environment during agrotechnical works affect mortality and, first of all, an ability to reproduce and migrate [7, 10, 11].

## Summary

Plant protection chemicals (dichlorobenzyl, diazozon and carbendazyn with tiuram) applied to soil showed significant impact on mortality, biomass and reproduction of the California earthworm *E. fetida*. These substances acted both externally and internally causing burn of the body walls and partial paralysis of earthworms. Body weight loss and the flow of coelomic fluid of the body segments were also observed.

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### WPLYW AKTYWNYCH ZWIĄZKÓW ŚRODKÓW DOGLEBOWYCH NA DŹDŻOWNICĘ KALIFORNIJSKĄ *Eisenia fetida*

<sup>1</sup> Katedra Biologii Środowiska Zwierząt, Zakład Zoologii,  
<sup>2</sup> Student Katedry Biologii Środowiska Zwierząt, Zakład Zoologii  
Szkoła Główna Gospodarstwa Wiejskiego

**Abstrakt:** Celem przeprowadzonych badań było określenie wpływu wybranych środków ochrony roślin doglebowych na dżdżownicę kalifornijską *E. fetida* na jej zdolność do przeżywania w środowisku oraz reprodukcję. Pod uwagę wzięto takie parametry jak:

1) zmiany w liczebności po zastosowaniu środka chemicznego w stosunku do kontroli (śmiertelność, wpływ na biomasa, ograniczenie aktywności życiowej),

2) liczbę składanych kokonów i wylęg.

Jako materiał chemiczny wybrano związki ochrony roślin zawierające następujące substancje czynne: dichlobenyl (herbicyd), diazon (insektycyd) oraz karbendazyn i tiuram (fungicyd).

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Reakcja dżdżownic na zastosowane pestycydy dogłębowe była różna. Zaobserwowano znaczne zmniejszenie masy ciała po wpływie diazynonu. Najbardziej toksyczny był fungicyd, który spowodował 100 % śmiertelność *E. fetida* po 48 godz. kontakcie.

**Słowa kluczowe:** *E. fetida*, gleba, pestycydy