# Carbon content and soil organisms – Trick or Peat?

Thomas Schmidt, Magdaléna Cornement, Bettina Hodapp, Stefan Höger
IES Ltd, Benkenstrasse 260, 4108 Witterswil, Switzerland

SETAC Europe 30th Annual Meeting
Dublin Ireland, May 03 – 07, 2020
Final ID: 4.13P.3

## Introduction

Soil organisms are one of the most important groups within terrestrial systems. The current standard for laboratory testing foresees a set of four test systems to be tested, the three species *Eisenia fetida*, *Folsomia candida* / *fimetaria* and *Hypoaspis aculeifer* within artificial soil (consisting of the three components quartz sand, kaoline, peat) and the soil microbial community within natural soil (organic carbon content 0.5 – 1.5 %).

According to the SETAC Scientific Opinion for in-soil organisms (2017), measuring exposure in soil test systems is crucial. Artificial soil has the advantage that it is relatively well reproducible. However, *Sphagnum* peat has different properties than organic matter in arable soils and the type of the organic matter influences sorption and hence bioavailability. Peat content in artificial soil is 5 or 10 % resulting in approximately 2.5 - 5.0 % organic carbon which is higher than in many agricultural soils. On the other hand, chemical substances are characterized by their capacity to adsorb to organic carbon, expressed as the Koc, the distribution coefficient between organic carbon and water. It has been shown that with increasing Koc the percentage of adsorbed substance increases and the bioavailability of the substance to soil organisms decreases.

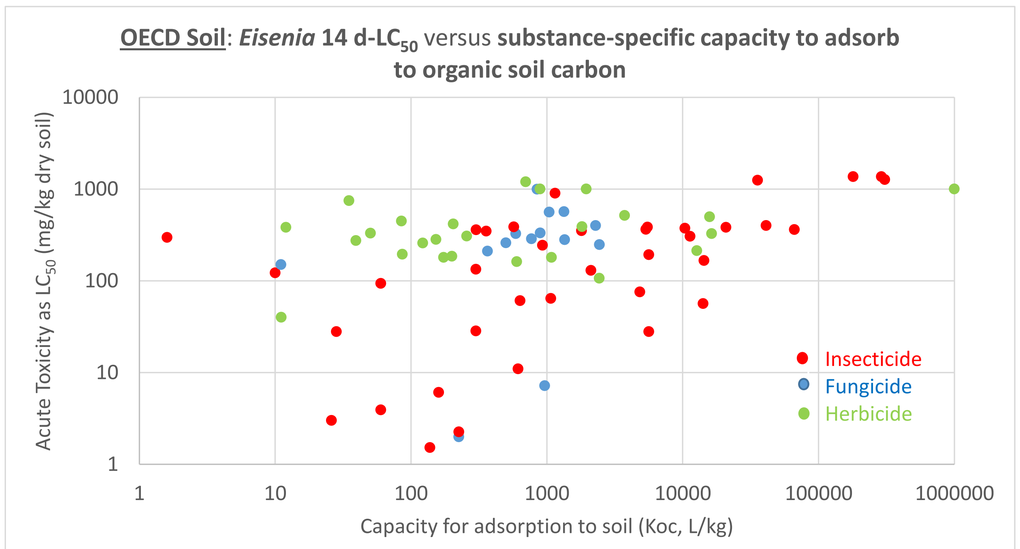
## Question

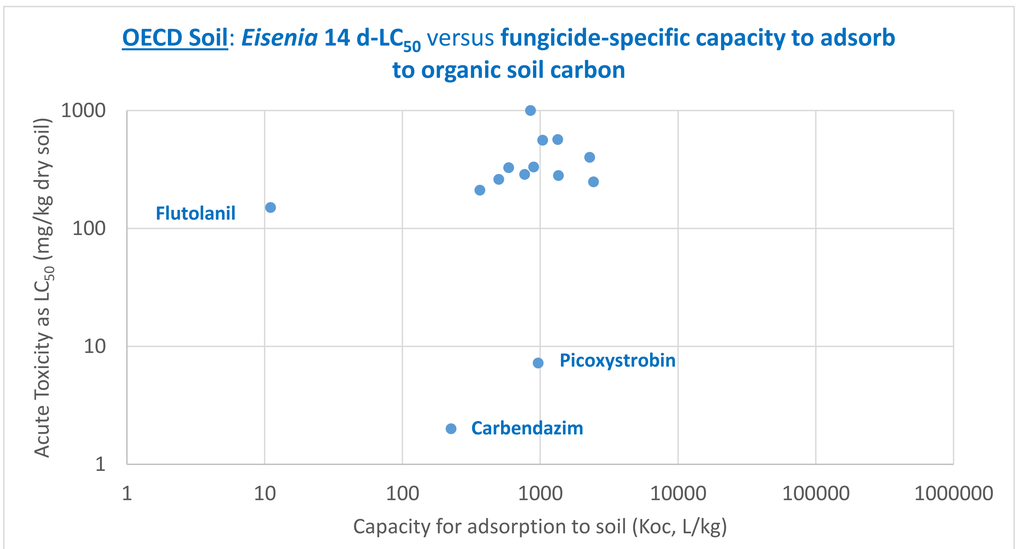
In the acute earthworm test, *Eisenia fetida* is exposed for 14 days to a test substance in artificial soil with 70 % quartz sand, 20 % kaoline and 10 % peat following OECD 207. If the adsorption capacity of a substance does influence its bioavailability to worms in soil, the following is expected:

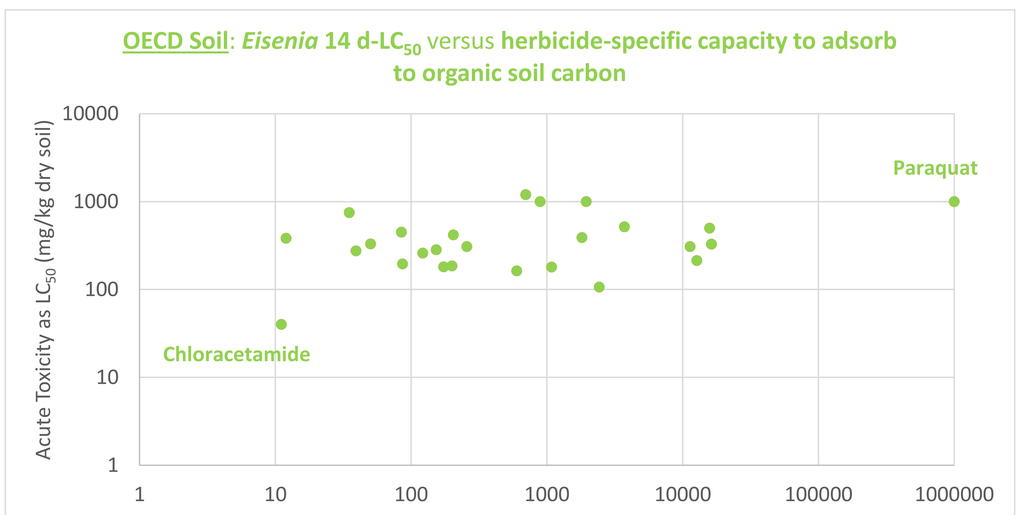
- substances with high Koc
  - ➔ strong adsorption to soil organic carbon
  - ➔ low availability
  - ➔ low toxicity to earthworms (i.e. high $LC_{50}$).
- substances with a low Koc
  - ➔ weak adsorption to soil organic carbon
  - ➔ high availability
  - ➔ high toxicity to earthworms (i.e. small $LC_{50}$).

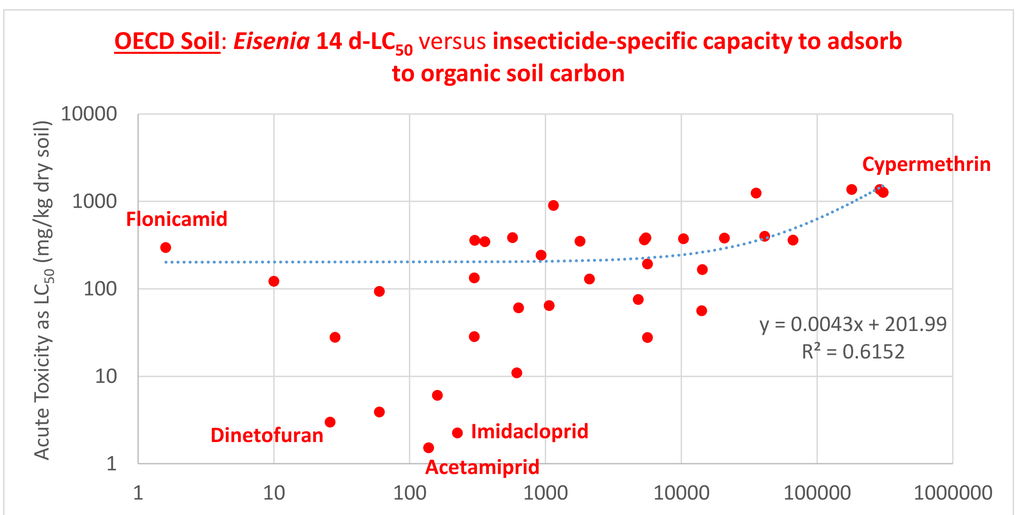
## Data

Data from acute earthworm tests according to OECD 207 come from publicly available data, mainly from Wang et al. (2012ab). For the analysis, 76 active substances (14 fungicides, 26 herbicides, 36 insecticides) were used. Data on adsorption to soil organic carbon are published in the Pesticide Properties DataBase of the University of Hertfortshire or originate from calculations in ChemSpider (five substances).The relation between Koc and LC50 is shown in the figures below.




## Conclusion

- The whole data set does not show any pattern.
- The number of fungicides is too small for further conclusions.
- The majority of herbicides causes 50 % mortality in a band between 100 and 1000 mg/kg dry soil, independent of Koc.
- Insecticides tend to cause 50 % mortality a lower test concentrations with a statistically significantly positive correlation between Koc and $LC_{50}$ (i.e. mortality decreases with increasing Koc).
- High organic carbon content in peat might mask toxic effects for insecticides and fungicides.
- A standardised arable soil with properties closer to the scenarios in the exposure assessment would be preferred over an artificial soil with *Sphagnum* peat. The use of natural soil might be an option as an extended test design.

## Sources

1. EFSA (2017): Scientific Opinion addressing the state of the science on risk assessment of plant protection products for in-soil organisms. ISSN: 1831-4732. DOI: 0.2903/j.efsa.2017.4690. FSA Journal 15, 2:4690.
2. OECD (1984): Test No. 207: Earthworm, Acute Toxicity Tests. OECD Guidelines for the Testing of Chemicals, Section 2. ISBN 9789264070042 (PDF). DOI: 10.1787/9789264070042-en. Adopted 04 Apr 1984. 9 pages.
3. Wang Y., T. Cang, X. Zhaon , R. Yu, L. Chen, C. Wu, Q. Wang (2012a): Comparative acute toxicity of twenty-four insecticides to earthworm, *Eisenia fetida*. DOI:10.1016/j.ecoenv.2011.12.016. Ecotoxicology and Environmental Safety 79 (2012) 122–128.
4. Wang Y., S. Wu, L. Chen, C. Wu, R. Yu, Q. Wang, X. Zhao (2012b): Toxicity assessment of 45 pesticides to the epigeic earthworm *Eisenia fetida*. DOI: 10.1016/j.chemosphere.2012.02.086. Chemosphere 88 (2012) 484–491.

## Acknowledgements

Thanks to Stefan Kimmel for the jumps into deeper soils.

t.schmidtl@ies-ltd.ch I www.ies-ltd.ch