Semi-field methods are a useful tool for the environmental risk assessment of pesticides in soil

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1. Introduction

Only few validated higher tier laboratory or semi-field methods are available to assess structural and functional effects of pesticides in soil. In this context, the SETAC workshop PERAS (Semi-field Methods for the Environmental Risk Assessment of Pesticides in Soil) was organized in Coimbra, Portugal, 08-10 Oct. 2007, to present and discuss the state of the art with a focus on semi-field methods such as Terrestrial Model Ecosystems (TME). 55 experts from academia, industry and authorities, e.g. EFSA, OECD, and national pesticide registration agencies, were invited from Europe, Brazil and the US.

The potential for the use of TME in pesticide risk assessment was mentioned in the EPPO risk assessment scheme for soil organisms and functions in 2000 and also in the Guidance Document on Terrestrial Ecotoxicology under Council Directive 91/414/EEC (SANCO/10329/2002). Whilst TME were proposed as a potential higher tier refinement step, it was not clear precisely how such methods would 'fit' into a tiered risk assessment scheme. This potential for their use may gain importance with the forthcoming revision of Directive 91/414/EEC, regardless of whether the focus of soil risk assessment is on soil 'structure' (i.e. community structure & biodiversity) or soil 'function' (e.g. microbial respiration, litter breakdown) - or both. TME may also fit into the proposed Dutch decision tree for persistent pesticides as a method for higher tier assessment.

The aims of the PERAS Workshop were:

- To highlight the current state of knowledge regarding semi-field methods and to identify most appropriate methods to assess the 'impact' of chemicals on soil community structure and function.
- To give a particular focus on higher tier laboratory and semi-field methods which may be employed between 1st tier laboratory tests and full scale field studies.
- To discuss technical aspects of the TME method in order to agree, as far as possible, on a standardised test method.
- To identify key gaps in knowledge and areas for further research and development in soil effects testing and risk assessment.

2. Experimental approaches

2.1. Comparing systems

A set of different tests is available: single species tests, microcosms, mesocosms, enclosures, and field tests, each with a typical combination of experimental design and ecological relevance (Figure 1). Experimental parameters discussed referred to the use of intact soil cores vs columns with sieved soil, soil with natural communities vs those with added species, open vs closed systems, and systems kept indoor and outdoor.

In the next step systems were compared in terms of their potential to include various ecological levels and processes, i.e., whether they address the population or the community level, reflect the intrinsic recovery and natural recolonisation, and allow a sensitive detection of effects. Finally, performance criteria of the various systems were discussed, such as the time and effort needed, the reproducibility, experience and guidance available, the state of standardization, the control of environmental variables (e.g., light regime, irrigation), and the ecological relevance.

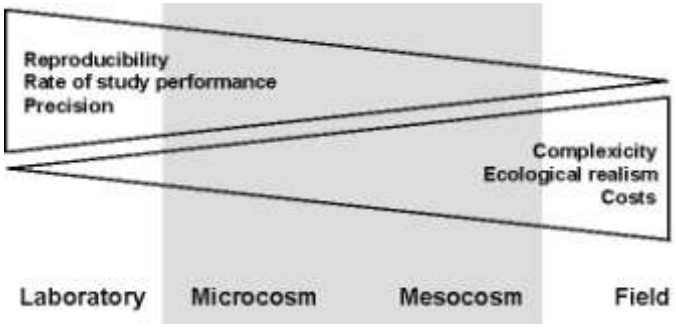

Figure 1: Comparison of test systems

2.2. Terrestrial model ecosystems (TME)

Terrestrial model ecosystems were considered a suitable tool at the semi-field level to assess structural effects on the soil community. The TME should contain undisturbed soil cores, e.g., from an established grassland, containing natural communities, e.g. microarthropods, enchytraeids, nematodes, microorganisms. Efforts should be made to link and quantify exposure and effect in the TME systems, e.g. by chemical analyses and modelling.

However, technical guidance is needed considering fate and exposure of the test substances (e.g. different application techniques for persistent and readily degradable pesticides; pre-equilibrium of soil systems; control of enviromental conditions, e.g., by irrigation, light regime) and for a proper effect assessment (definition of suitable soils; endpoints, e.g., community structure of mesofauna, optionally functional tests; use of positive controls; consideration of intrinsic recovery).

General requirements were defined regarding the proper use of TME:

- sufficient abundance of sensitive organisms in the soils used (pre-screening for species homogeneity);
- measurement of soil moisture (key importance);
- optimized TME size;
- sampling frequency mainly driven by the fate of the test substance;
- statistics: uni- and multivariate methods (PRC); dose-response design to derive ECx and NOEC at community and population levels; consideration of power, minimum detectable difference (MDD) and number of replicates.

3. Conclusions

- TME are an appropriate higher-tier test system to investigate the impact of pesticides and chemicals on the structure of the soil community and biodiversity.
- TME comprise various trophic levels of the soil community and reflect direct and indirect effects.
- TME allow for the investigation of the intrinsic recovery of the soil mesofauna.
- Field studies allow for the investigation of re-colonisation and are ecologically even more relevant.

4. Research needs

- Further research is required for the extrapolation of results across soil types, climatic and edaphic regions, biological communities, etc.
- Develop classification scheme for magnitude and duration of effects (recovery), relevant to protection goals.
- Perform comparative studies, i.e. determine variability within and between TMEs and between TME with field tests; investigate the effect of subsampling vs sacrificial sampling.
- Compare sensitivity of in- and off-crop communities (if a regulatory distinction is to be made).

5. References

[1] Workshop proceedings are being prepared
[2] Workshop description: http://www.gaiac.rwth-aachen.de/peras

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