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Einsatz von Kupfer als Pflanzenschutzmittel-Wirkstoff: Ökologische Auswirkungen der Akkumulation von Kupfer im Boden

English-language Summary

von

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Ecological effects of the accumulation of copper in soil: Results of a literature review[φ]

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1 Introduction

Since 1885, copper (i.e. five copper-salts) is used as a fungicide in European agriculture. Currently, these compounds are under review whether they can be included in the positive list of active substances authorised for use in plant protection products in Europe (Annex 1) of the EU Council Directive 91/4141 [1]. Knowing that copper is not degradable and that many agricultural soils (vineyards, hops fields and orchards) already contain high levels, a literature review summarising the ecological effects of copper pesticides in soil was conducted. The aims of this review can be summarised as follows:

- Compilation, analysis and critical evaluation of available data on the environmental risk of copper in the soil compartment
- In particular, assessment of the results of field tests and monitoring studies on the adverse effects of copper accumulation to sensitive soil organisms, especially earthworms
- Derivation of general conclusions and recommendations concerning the environmental risk of copper pesticides to the soil compartment.

2 Materials and methods

Using information sources not available to the public like the Draft Assessment Report (2007) prepared during the review programme according to EU Concil Directive 91/4141 as well as information from open literature the review was divided in two parts: Firstly, data on the anthropogenic input of copper in soils, soil background contents and fate in soil as well as results of laboratory tests were used as a starting point for this evaluation. Secondly, the review focussed on the effects of copper on soil organisms (mainly earthworms but also nematodes and microarthropods) in field tests and monitoring studies. The results of these investigations were compiled including data on soil and site properties, copper concentrations and biological information on the studied organisms (preferably on the species level). In total, 86 potentially useful publications were identified, but only 10 publications yielding 14 individual studies and 47 data sets (=i.e. those including both data on measured copper soil concentrations and data on the abundance or diversity of organisms from a comparable contaminated and control site) were useful for further assessment. Since the results of the

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individual studies are difficult to compare due to differences in application and sampling methods, study durations and endpoints measured, it was decided to divide them into three effect classes, which – using five classes – were originally developed for aquatic studies [2].

3 Results and discussion

3.1 Background information

In the year 2000, about ten percent of the whole copper input into German soils was due to pesticides (about 300 t/a). Organic agriculture was responsible for about 20 t/a of this amount, while the majority of copper was applied in conventional agriculture. Soil background values varied, mainly depending on the geological region, between 13 and 45 mg/kg soil dw (all concentrations given as total content Cu) [3]. Much higher values were frequently reported from agricultural soils like vineyards, orchards and hops fields.The mobility of copper is generally low, meaning that most of the input is adsorbed in the uppermost mineral soil layers. Since copper is an essential micronutrient its uptake and elimination can, to some extent, be regulated by most organisms. Therefore, no simple correlation between soil properties and accumulation or between body content and toxicity in soil organisms was found. However, at pH-values below 4.5 the availability and, thus, toxicity of copper increases considerably [4]. On the laboratory level, copper is one of the best-studied chemicals. Based on species sensitivity distributions (NOEC/EC10 or EC50 values of 20 – 40 soil living species), hazardous concentrations (HC5) of 28 and 55 mg/kg soil dw have been calculated, respectively [5].

3.2 Results from field studies

The results of the individual field studies expressed as effect classes are compiled in Fig. 1. As already know from the availbale laboratory data, earthworms are the most sensitive organism group. Largely, pronounced effects (= effect class 3) were observable at about 50 mg/kg soil dw and above. This observation is supported by the interim results of an on-going, state-of-the-art earthworm field study, too. Moreover the upper limit of HC5 values derived from laboratory data (basis: EC10/NOEC values) is almost identical. Compared to earthworms, all other soil organisms tested so far reacted less sensitive. However, it must be noted that some of them like enchytraeids have not been tested so far at relevant concentrations (about 10 – 100 mg/kg soil dw).

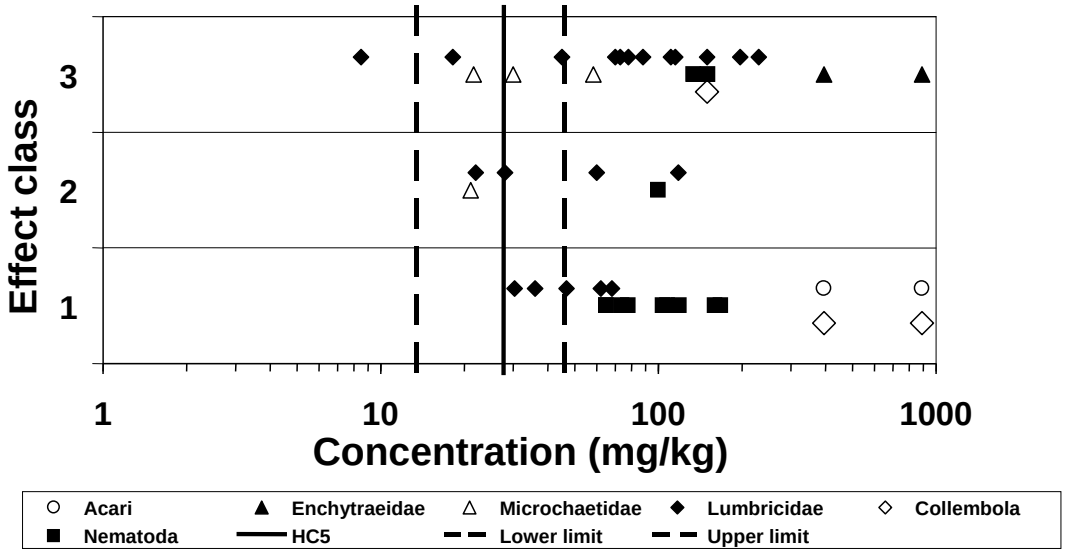

Fig. 1: Effects of copper on soil invertebrates in the field in comparison to an HC5 derived from laboratory NOEC/EC10 values

4 Conclusions

In view of the available information on the concentrations of copper in German agricultural soils, the application rates of copper pesticides currently proposed as well as the knowledge on the fate and effects on soil organisms under laboratory and field conditions the following conclusions can be made:

- Copper concentrations in many agricultural soils (especially permanent crops like vineyards, orchards, hops) are higher than the background levels known from comparable soils with non-agricultural land-use.
- Under laboratory conditions, copper significantly harms soil organisms (Oligochaeta are sensitive, in particular) at concentrations of about 55 mg/kg soil dw and above (HC5 derived from EC50 values).
- This review reveals, that at about the same total soil concentration (50 mg/kg soil dw) clear effects on earthworms are also reported in the field.
- Thus, the pluriannual and long-lasting input of copper into agricultural soils from the application of copper pesticides harbours clear environmental risks.

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