ECOTOXICOLOGY OF MULCH FILMS

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antonia.weltmeyer@rwth-aachen.de

Antonia Weltmeyer[1], Christoph Kämpfer[1], Thomas-Benjamin Seiler[1], Hennert Hollert[1,2], Martina Roß-Nickoll[1]

[1] RWTH Aachen University, [2] Goethe University *Frankfurt*

BACKGROUND

- Mulch films are applied worldwide due to their **positive effects** (e.g. humidity, temperature, weed growth limitation) on agricultural farming
- Commonly applied polymers are polyethylene (PE) and the bio-based poly lactate acid (PLA) with addition of multiple, often **unknown additives**
- Despite the environentally friendly seeming labelling of bio-based and biodegradable, PLA can be even **more toxic** than petroleum based plastics[2] and only degraded under very harsh conditions[3]
- Degradation and later accumulation of mulch films in soil is fascilitated by their low thickness due to rising removal difficulty and generally high disposal costs[4]
- Plastic mulching is a **relevant source of microplastics** (MP) in the terrestrial environment with up to 324.5 kg/ha[5] which lies in the same magnitude of earthworm mortality[6]
- Impact of accumulation in soil is yet unsufficiently determined and requires further investigation[7]

The main applications, greenhouse and mulch flm, account for almost **75%** of the total market, with more than one million tons being produced for each.[1]

Plasticulture market growth is **5% annually** depending on region and application.[1]

We aim to investigate the effects of mulch film microplastics and their constituents on the living environment with focus on soil organisms.

Furthermore, we want to investigate the influence of sorbed pesticides on the toxicity of mulch film fragments.

This work is part of the iMulch project funded by the European Fond for regional development (EFRE).

iMulch – An investigation of the influence of polymers on a terrestrial ecosystem using the example of mulch films used in agriculture

OBJECTIVE

- Assessment of toxicity mechanisms of mulch film constituents and potential synergistic effects
- Determination of MP toxicity on representative soil organisms
- Determination of the interaction of mulch film fragments and selected pesticides
  - Influence of mulch films on pesticide toxicity
  - Availability of pesticides in plastic spiked soil
- Determination of the baseline toxicity of pesticide active substances and products

Thiacloprid, Atrazine, Tebuconazole, Quinoxyfen

→ Comparison of petroleum- and biobased mulch films conderning biological effects

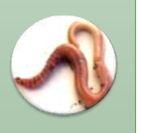
WHERE DO WE GO FROM HERE?

In vitro

- Establishment of beta-Naphtoflavone as micro EROD induction standard
- Investigation of sorption behaviour in microtiter plates for extracts and pesticides

In vivo

- Comparison of effects of new and aged mulch film
- Deduction for further testing with *Eisenia fetida* in chronic exposure scenarios (OECD 222, in soil) and decision on biomarkers
- Comparison between sensitivity of *Eisenia fetida* and *Lumbricus terrestris*



Other project partners are also presenting at the SETAC 2020: Check out poster 2.08P.11 for information on biodegradability and poster 4.14P.1 for more information on the iMulch project and first results.

METHODS

Details

Extraction

- 500mg polymer cut into 1x2cm

Worst case scenario

- Per solvent 2x30min UAE

Solvents PE: acetonitrile/dichlormethane
Solvents PLA: acetonitrile / isopropanol

Realistic scenario

Shaking extraction: 24h, Millipore Water, 20±2°C, 100rpm

- Solid phase extraction
  - Solvent: ethyl acetate, methanol
- Analysis with GC-MS

Extracts & pesticide screening

- Extract testing
  - In vitro screening for dioxin-like activity, genotoxicity and endocrine/androgene activity
  - Application of glass-coated microplates to prohibit sorption
  - Determination of acute toxicity to earthworm *Eisenia fetida (*OECD 207, filter paper test)
- Pesticide testing
  - In vitro assays to narrow down substances
  - Active substances and products in comparison

Microplastic in soil

Refesol

Reference soil 01-A to approximate to natural conditions

Scenarios

Pesticide loaded MP
vs.
MP + pesticide

- Exposure monitoring (soil, earthworm)
- Acute toxicity on *E.fetida* (OECD 207)
- OECD 232: realistic and worst case MP concentrations on *F. candida* reproduction

Details on MP production:

PRELIMINARY RESULTS

*results should be interpreted as trends

- In vitro pesticide screening: positive, negative, unclear

	Endocrine activity	Genotoxicity	Dioxin-like activity
Atrazine	✓	✓	?
Tebuconazole	✓	✗	✓
Quinoxyfen	✓	?	✗

- 2,3,7,8-TCDD not usable in assay with glass coated plates (Fig. 1)
- OECD 207: Filterpaper test with EC50 [mg/mL]
  - Tebuconazole (49±2), solvent extracts (no toxicity), water extracts (no toxicity)
- OECD 207: Acute toxicity test with active susbtance and EC50 [mg/mL]
  - Folicur (Tebuconazole, 116±27), Biscaya (Thiacloprid, <50)

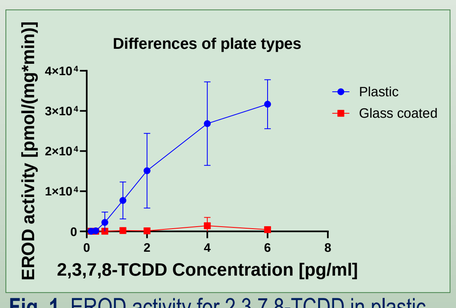


Fig. 1 EROD activity for 2,3,7,8-TCDD in plastic plates (blue, n=5) and glass plates, n=4)

Details

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Picture: Source: https://www.basf.com/global/en/products/plastics-rubber/fairs/BASFatK2016/must_sees/ecovio_m.html (last access: 19.04.2020)

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