

## Organic Pollutants in Secondary Fertilizers

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### Project sponsored by German UBA

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**Title:**

Limitation of hazardous substances input on agricultural soils due to fertilization  
(part I: fertilizer analysis; part II: soil analysis)

**Partners:**

- Institut für Pflanzenernährung und Bodenkunde, Bundesforschungsanstalt für Landwirtschaft (FAL)
- Gesellschaft für Consulting und Analytik im Umweltbereich
- Bioplan
- Fraunhofer-IME

**Substances:**

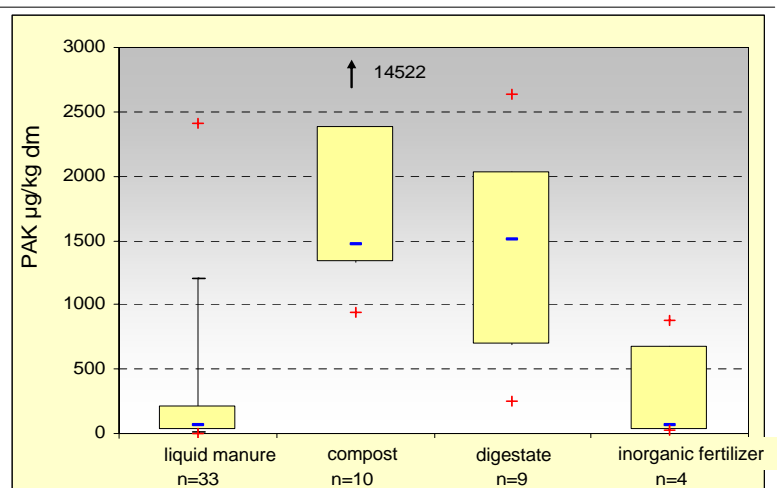
Metals and priority organic substances



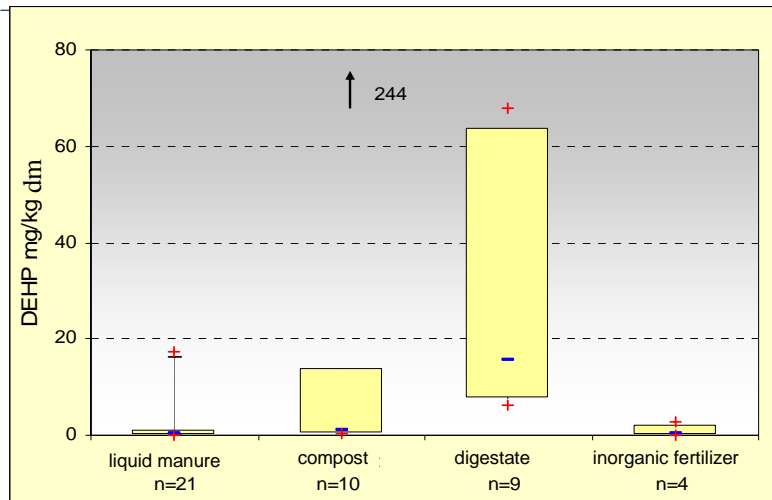
## Criteria for critical organic pollutants in secondary fertilizers

- accumulation potential in soils
- significant effect potential
- significant plant-uptake
- mobility → pollution of surface water or groundwater

## PAH concentrations

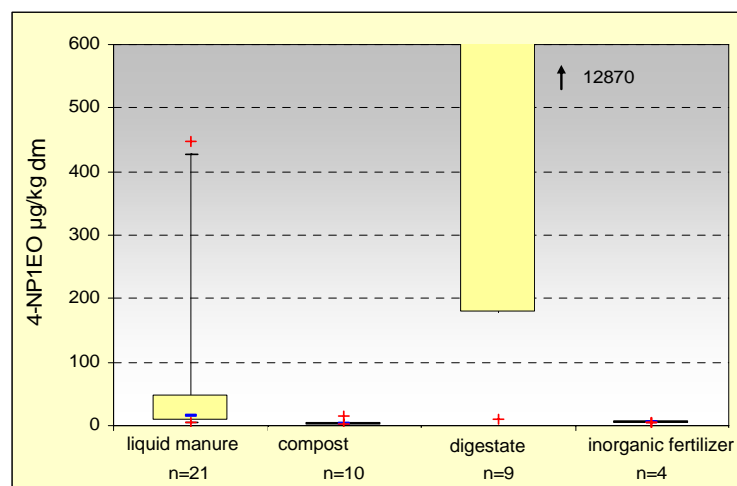


### DEHP concentrations



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### NPEO concentrations



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### Pollutant concentrations [mg/kg dm] in different fertilizers

pollutant	mineral fertilizer	liquid manure	compost	sewage sludge	digestate
PCB	0,001	0,004	0,02	0,05	0,01
PAHs (EPA)	0,26	0,20	3,01	5,5	1,43
NP + NPEO	0,03	0,17	0,03	17,0	4,77
LAS	138	164	42	1390	877
Galaxolid Tonalid				6,3 / 12,8 2,4 / 4,0	
DEHP	0,86	1,79	30,1	27,0	29,70
DBP	0,05	0,07	0,20	0,25	0,81
organotin compounds	<BG	0,21	0,13	0,70	0,43
hydrocarbons	0,5	k.A	0,5	3816	4,6



### Concentrations [mg/kg dm] in sewage sludges compared to „precautionary values“

Parameter	median	maximum	precautionary value	PNEC <sub>soil</sub>	EU - proposal
PCB	0,05	0,1	0,05		0,8
PAH (EPA)	5,5	16,0	3,0		6,0
NP/NPEO	17,0	35,0		0,43	
LAS	1390	2290		4,6	2600
Galaxolid® Tonalid®	12,8 4,0	17,1 5,3		0,31 0,31	-
DEHP	27,0	56,0		10,0 (2,6; ECB 2001)	100
DBP	0,25	0,69		2,0	-
organotin cpd	0,70	1,95		0,008 (TBT)	-
hydrocarbons	3816	6986			-



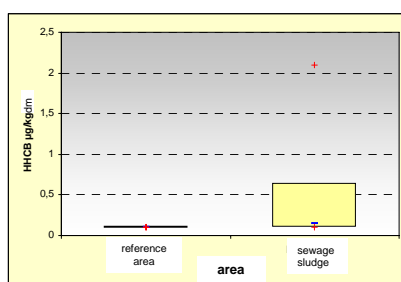
## Selection of sites for soil monitoring

### Criteria:

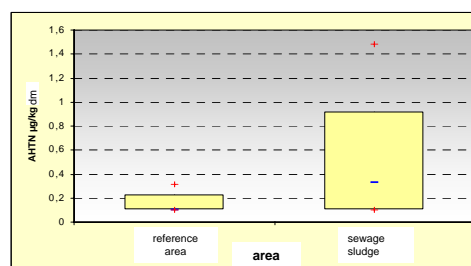
- distribution of sampling sites
- differentiation with respect to soil characteristics
- recording of fertilization regime
- sewage sludge application within the last 4 years before sampling
- applied fields and control areas in direct neighborhood

⇒ 18 fields with sewage sludge application, 14 controls

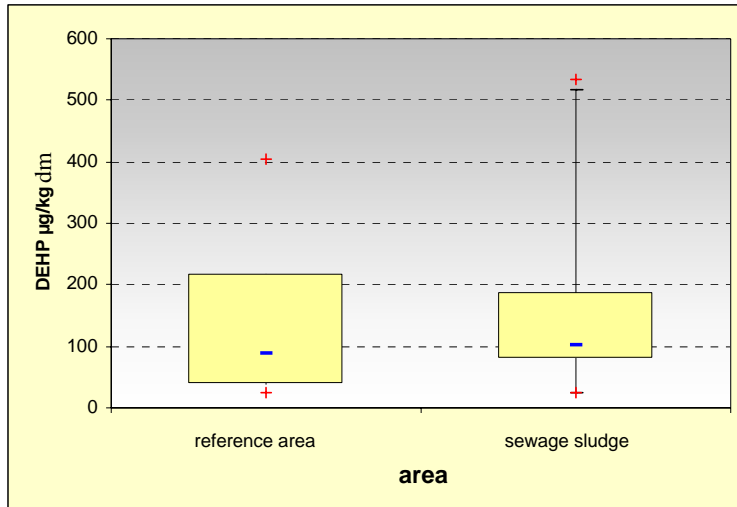
## Concentration ranges of musk compounds (Galaxolid®, HHCB (top) and Tonalid®, AHTN) in fertilized soils



transfer factor soil - carrot:  
HHCB: 0,48  
AHTN: 0,37

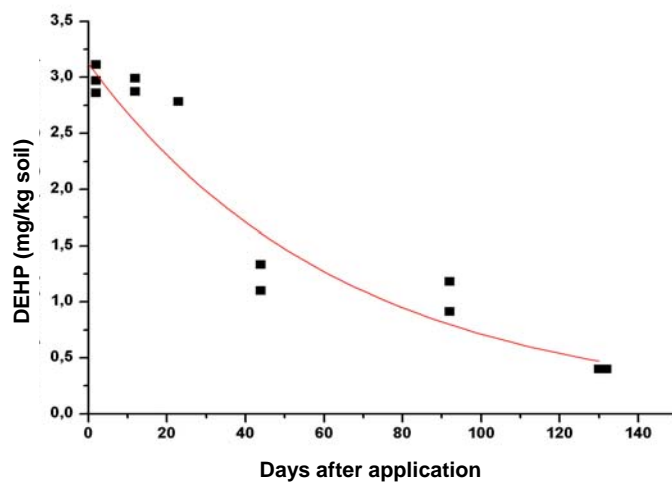


### Concentration ranges of DEHP in fertilized soils



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### Degradation of DEHP in soil



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### Comparison of concentrations in soil with / without sewage sludge application

compound	Concentration (sewage sludge application) > concentration (control)	concentration (sludge application) ~ Concentration (control)
metals		X
PCBs*		X
B(a)P/∑ PAH (EPA)		X
Organotin compounds	X	
LAS		X
NP + NPEO*		X
phthalates		X
musk compounds	X	

\* Concentrations at limit of determination



### Lysimeters for the determination of plant uptake of pollutants



**PFOA and PFOS concentrations in plant material**  
(µg/kg dm for maize, ryegrass and wheat grain; fresh weight for potatoes)  
and calculated transfer factors

	PFOA		PFOS	
	Concentration [mg/kg dm]	Transfer factor	Concentration [mg/kg dm]	Transfer factor
Wheat grain	0,49	0,021	0,10	0,004
Wheat grain	1,12	0,014	0,31	0,001
Wheat grain	42,92	0,147	4,30	0,001
Maize	0,47	0,021	0,53	0,022
Maize	1,56	0,020	14,41	0,031
Maize	6,36	0,022	93,89	0,028
Ryegrass, 2 <sup>nd</sup> harvest	9,51	0,417	1,02	0,043
Ryegrass, 2 <sup>nd</sup> harvest	37,04	0,480	26,41	0,057
Ryegrass, 2 <sup>nd</sup> harvest	254,46	0,872	435,24	0,130
Potatoes, peeled	0,60	0,026	0,16	0,007
Potatoes, peeled	0,70	0,009	0,13	0,000
Potatoes, peeled	3,03	0,010	1,22	0,000

### Evaluative approach I: persistent organic pollutants

principle: avoidance of accumulation in soil  
 ⇒ low level of tolerable concentrations in secondary fertilizers  
 (e.g. precautionary values or PNEC-values)

principle:  $PEC/PNEC > 1$   
 ⇒ less toxic compounds, high accumulation

compromise: no significant long-term accumulation

## Evaluative approach II: slowly degradable pollutants

principle: avoidance of accumulation in soil  
⇒ manageable, as elimination by degradation,  
residues in soils to be considered

principle:  $PEC/PNEC > 1$   
⇒ applicable due to principle degradability

need: elaboration of valid data sets

## Evaluative approach III: degradable pollutants

principle:  $PEC/PNEC > 1$   
⇒ avoidance of short-term effects

testing:

- acute tests sufficient for PNEC-derivation
- plant-uptake unlikely in the case of application prior to cultivation
- consideration of further undesired effects (e.g. mobilisation of other pollutants)

## Summary

- Secondary fertilizers may contain significant amounts of organic pollutants.
- Persistent pollutants will accumulate in soils. A significant accumulation by repeated applications should be avoided.
- Most important are persistent pollutants with a high toxic potential (e.g. organotin compounds) or high mobility (e.g. PFTs).
- A direct comparison of substance concentrations in composts, digestates or sewage sludge is problematic. A risk assessment should include fate and effects in soil.