Second European Biobed Workshop

Pesticides degradation in organic substrates used in biobeds

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CleanRegion

North East South West INTERREG IIIC

BIOBED

ENVIRONMENTAL ISSUES

TECHNOLOGY

REGULATORY PROCEDURES

EFFECTIVENESS IN ADSORBING PESTICIDES
(cleaning water)

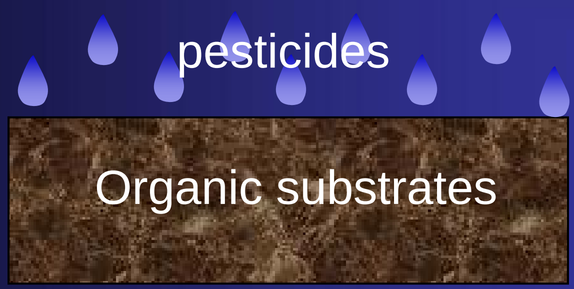
EFFECTIVENESS IN BIODEGRADING PESTICIDES
(exhausted biofilter free of pesticides and metabolites)

EFFECTIVENESS IN BIODEGRADING PESTICIDES

1. Individuating organic residues performing high pesticides biodegradation

→ Pesticide degradation in several different organic mixtures

→ Effect of initial concentration, co-application and repeated application of pesticides



2. Individuating modifications induced by pesticides on the metabolic activity of the biofilter

→ Biochemical Parameters

LAB CONDITIONS

Pesticides Analysis ⟵ Organic mixtures ⟶ Biochemical Properties

DEGRADATION KINETICS

Pesticides half-life

MINERALIZATION

% of pesticides completely degraded

(Collaboration with Microbiology Department of SLU)

2 mm; 60% WHC; in the dark at 20°C

Addition of cold + labelled pesticides

Untreated organic mixtures used as control

BASAL RESPIRATION

MICROBIAL BIOMASS CARBON CONTENT

METABOLIC QUOTIENT

Influence of pesticides on the metabolic activity of the microbial community

SPECIFIC ENZYMATIC SYSTEM

Biochemical process involved

(Collaboration with Microbiology Department of SLU)

Pesticides	Chemical Group	Koc mL/g	Solubility (H_2O) mg/L	DT50 (soil) Field dose	
INSECTICIDES					
Chlorpirifos (CH) TCP (CH metabolite)	organophosphate	6925	1.4	50	Moderately persistent
HERBICIDES					
Isoproturon (IPU)	phenylurea	139	70.2	12	No persistent
Bentazon (BEN)	benzothiazinone	51	570	13	No persistent
Chlorotoluron (CHT)	phenylurea	141	74	45	Moderately persistent
FUNGICIDES					
Metalaxyl (M)	phenylamide	165	7100	42	Moderately persistent
Epoxiconazole (EPX)	triazole	1802	6.6	354	Very persistent
Azoxystrobin (AZX)	strobilurin	423	6.7	70	Moderately persistent

FOOTPRINT pesticides database:http://www.herts.ac.uk/aeru/footprint/it/Reports/54.htm

TESTED ORGANIC SUSTRATES		Composition (% v/v)	C (%)	N (%)	C/N	pH
Urban compost	U	100	30.2	2.40	13	7.97
Urban compost + citrus peel	U+C	87.5:12.5	32.4	2.60	12	6.73
Urban compost + vine branches straw	U+S	50:50	39.4	1.96	20	7.44
Garden compost	G	100	32.8	2.34	14	8.18
Garden compost + citrus peel	G+C	87.5:12.5	31.8	2.26	14	6.41
Garden compos+ vine branches straw	G+S	50:50	32.3	1.43	23	6.87
Vine branches straw + soil + peat	B1	50:25:25	18	0.35	51	5.66
Vine branches straw + soil + peat	B2	25:50:25	7.3	0.23	32	5.94
Vine branches straw + soil + peat	B3	12.5:625:25	3.8	0.18	21	6
Vine branches + garden-urban compost + soil	IB	40:40:20	26.6	2	13.3	7.6
Urban-garden compost						
(3 months age)	C3M	100	30	2.4	12.6	7.8
(12 months age)	C12M	100	29	3.1	9.3	8.4

Results:pesticides degradation

(DT50 & % of mineralized)

Organic substrates		*CH 100ppm DT50	*CH 100ppm %	*TCP % accumulated	**IPU 100ppm DT50	**IPU 100ppm %	BEN 100ppm DT50	BEN 100ppm %
urban compost	**U**	46	5	42	76	2	47	-
urban compost + citrus peel	**U+C**	44	10	42	50	2	-	-
urban compost + vine branches straw	**U+VBS**	52	20	55	25	3	81	-
garden compost	**G**	**39**	**30**	**30**	**35**	**5**	**22**	-
garden compost + citrus peel	**G+C**	43	17	36	33	5	-	-
garden compost + vine branches straw	**G+VBS**	**37**	**28**	**14**	**20**	**5**	**15**	-
vine branches straw + soil + peat	**B1**	53	16	12	68	7	54	4
soil + vine branches straw + peat	**B2**	47	15	28	51	11	57	4
soil + vine branches straw + peat	**B3**	51	14	25	61	11	55	4

Preliminary results		EPX 100ppm DT50	AZX 100ppm DT50	CHT 100ppm DT50
Urban-garden compost (3 months age)	**C3M**	315	57	182
Urban-garden compost (12 months age)	**C12M**	433	433	277

Lignino-cellulosic substrates and compost at 3 months seem to better degrade tested pesticides

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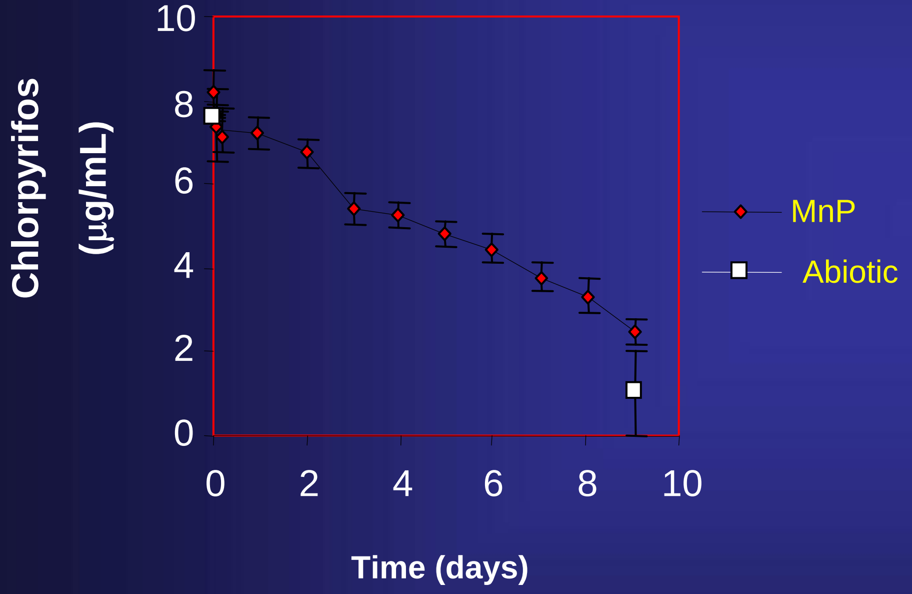
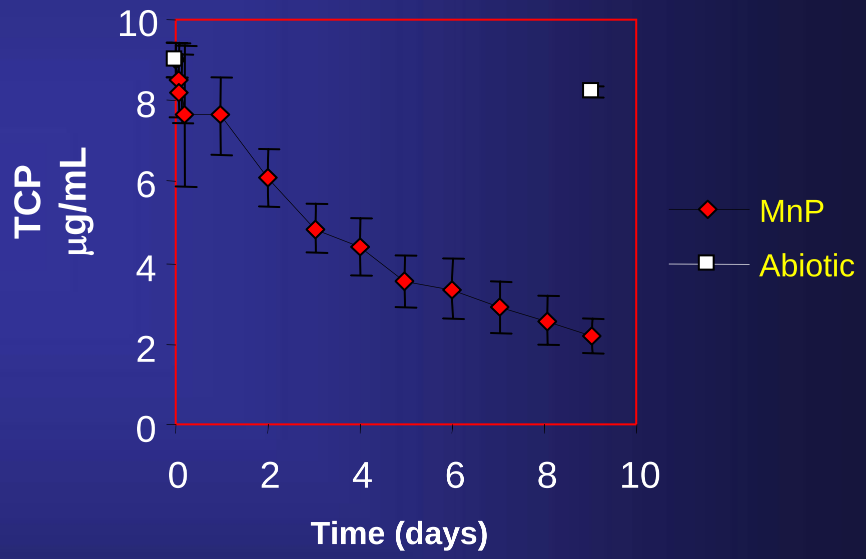
An experimental evidence of lignino-lytic enzimatic activity (manganese peroxidase MnP)

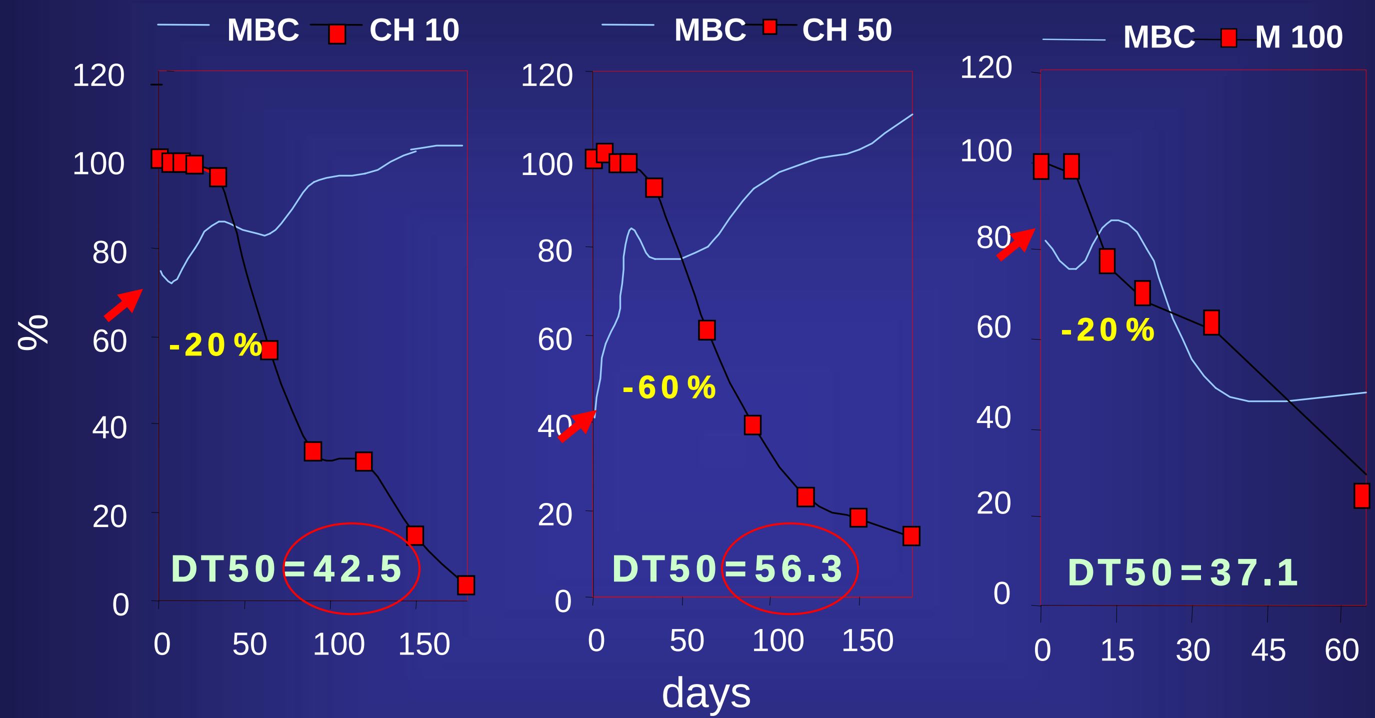




Biomix:vine-branches straw (40%) garden-urban 3M compost (40%) soil (20%)

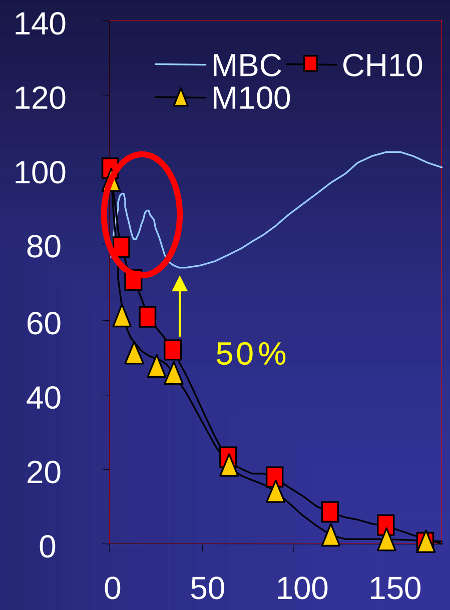
Addition of M (100ppm) and CH (10 and 50 ppm) in single and in co-application

% Pesticides Residues versus % Microbial Biomass Carbon Content (MBC, *it is considered 100%* *the MBC value found for the untreated biomix*)



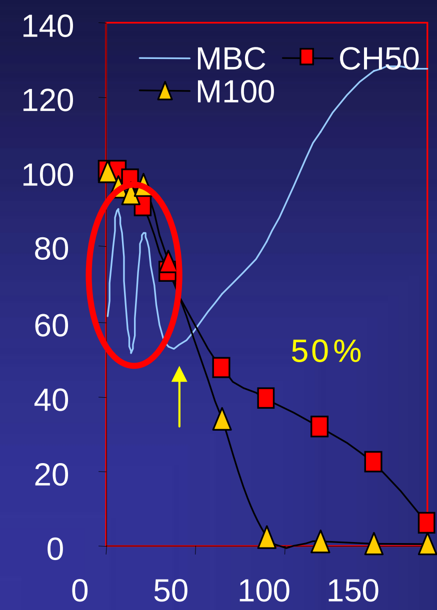
- Effect of CH initial concetration on CH DT50

- Initial toxic effect of CH and M on MBC. In CH treatments MBC gradually recovered, while in M treatments gradually decreased untill about 50% of the initial value



CH10(DT50)=43.6

M(DT50)=22.6



CH50(DT50)=51.3

M(DT50)=19.0

- Synergic effect of the co-application versus M degradation

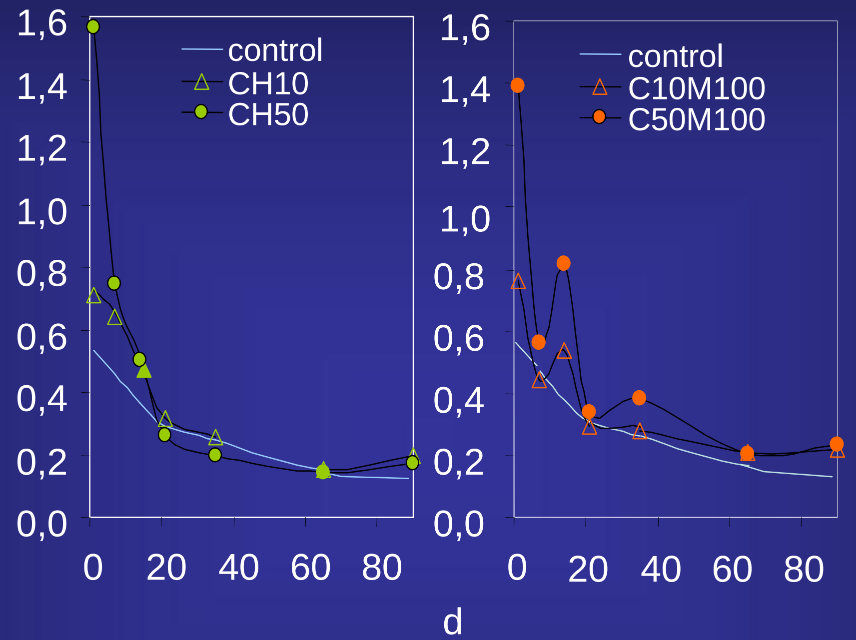
- Toxic effect of CH and M against two different groups of microorganisms of the biomix microbial community

- MBC started to recover when CH residue were about 50% of the initial concentration

Metabolic quotient qCO_2

Repiration actvity (CO_2 evolved) per unit of MBC

(qCO_2 of the treated biomix was compared to qCO_2 of the untreated biomix)



Metabolic stress (hypothesis: shift in the microbial community towards tolerant/degrading microorganisms)

- single application 20 days (CH)

- co-application 40 days

Conclusions

- Lignino-cellulosic substrates showed a good pesticide degradation

- The aging of compost generally reduces degradative efficiency (especially against fungicides)

- Microbial biomass of the biomix has to be varied enough to allow the selection towards tolerant/degrading microrganisms

Future Research

-Design a biofilter with the following characteristics:

- highly efficient versus mixture of varied pesticides downloaded at high concentration

-free from pesticides and metabolites and from crops pathogen microflora when exhausted

-Estimating the biofilter turn-over under mediterranean operative and climatic conditions

-Testing the possibility to use part of the exahusted as inoculum

-Testing the possibility to download pesticides directly on a farm made composter

Study of degradation pathways in different organic substrates to individuate pesticides transformation products (HPLC, GC, GC-MS)

Study of the population dynamics of fungal and bacteria species involved in pesticides degradation (DGGE, genus specific Real Time PCR assay) and of the biochemical finger printing (PhenePlate, MBC, basal respiration metabolic quotient) of the microbial community to evidence specific enzimatic systems involved in pesticides biodegradation.

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THANK YOU FOR YOUR ATTENTION