14th International HCH and Pesticides Forum

BLÁNQUEZ CANO, PAQUI

Associate Professor
Chemical, Biological and Environmental
Engineering Department
Engineering School

Universitat Autònoma de Barcelona

PRELIMINARY STUDIES TO IMPLEMENT A PILOT REACTOR FOR THE BIOLOGICAL REMOVAL OF PESTICIDES FROM AGRICULTURAL WASHING WASTEWATER

Eduardo Beltrán-Flores, Martí Pla-Ferriol, Maira Martínez-Alonso, Núria Gaju, Montserrat Sarrà, Paqui Blánquez.

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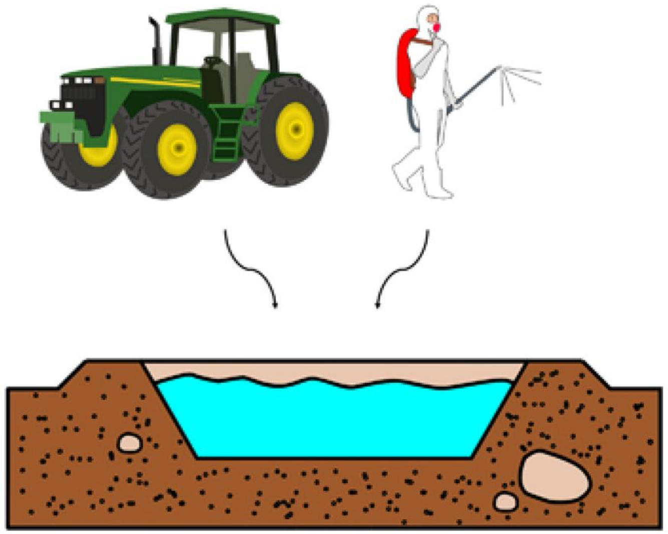
Agricultural washing wastewater

Nowadays, pesticides are needed to guarantee pest control and to meet global food demand

Good practices in the agricultural sector



1) Agricultural washing wastewater (AWW) is generated when cleaning spraying equipment and agricultural machinery.

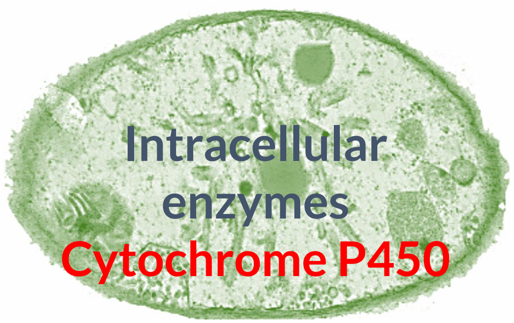
2) AWW is deposited in collection ponds

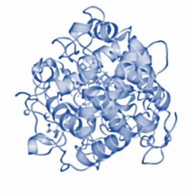
3) AWW should be treated before discharge

Bioremediation by WRF

White-rot fungi (WRF)

✓ Powerful non-specific enzyme system



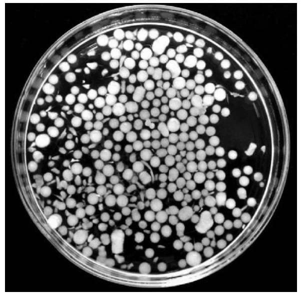


Lignin peroxidase

Manganese peroxidase

Laccase

❖ Bacterial competition



Auto-immobilization (pellets)

Immobilization on lignocellulosic substrate (e.g., wood)

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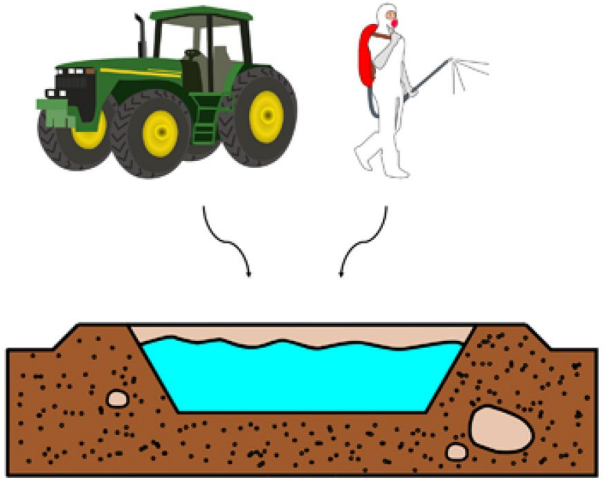
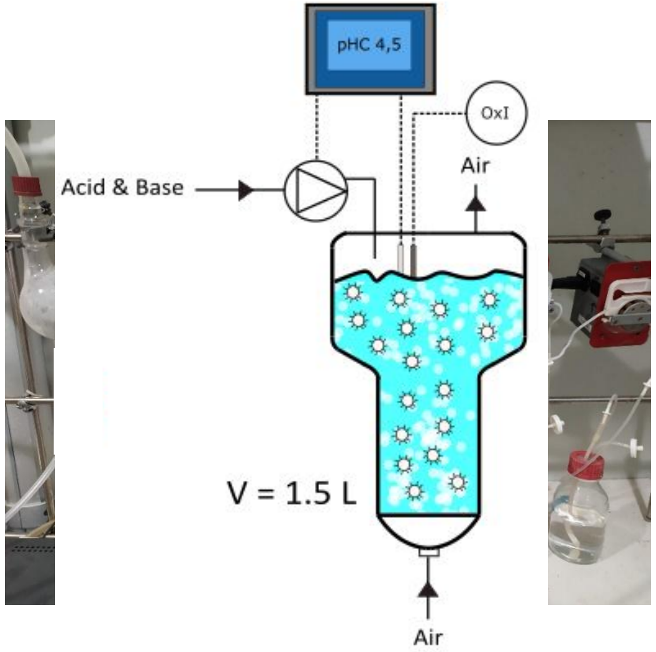
Objective



Agricultural washing wastewater

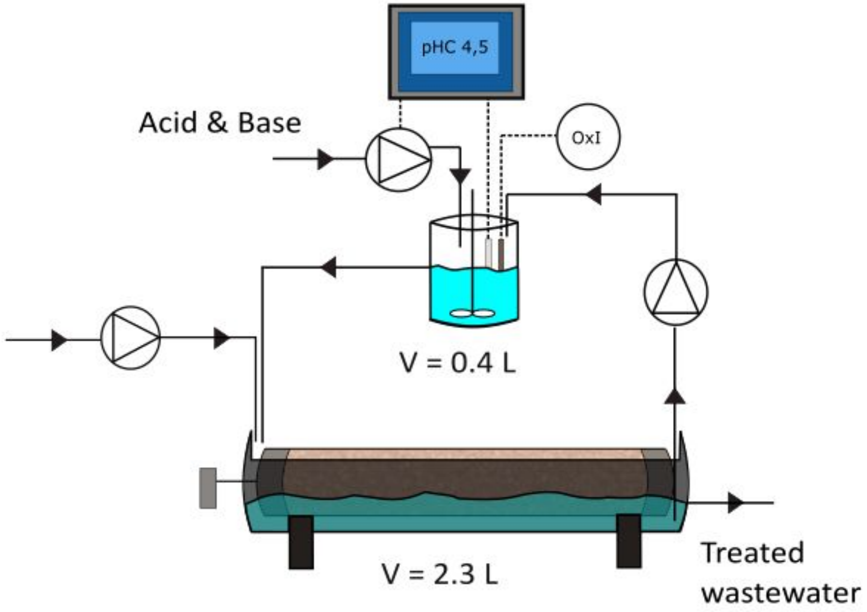
Auto-immobilization (pellets)



Fluidized bed bioreactor (FBB)

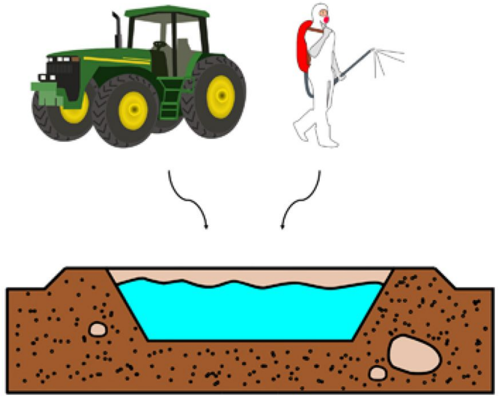
VS

Immobilization on wood



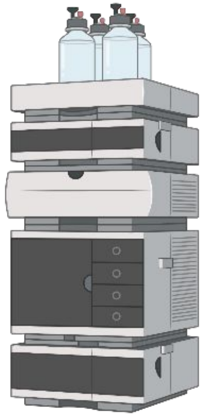
Rotating drum bioreactor (RDB)

AWW origin and characterization



AWW was collected from an artificial pond that accumulates water from several crop fields: rice, apple, corn and tomato

Pesticide identification LC-Q-TOF-MS



Confirmatory analysis and quantification of pesticides HPLC-UV

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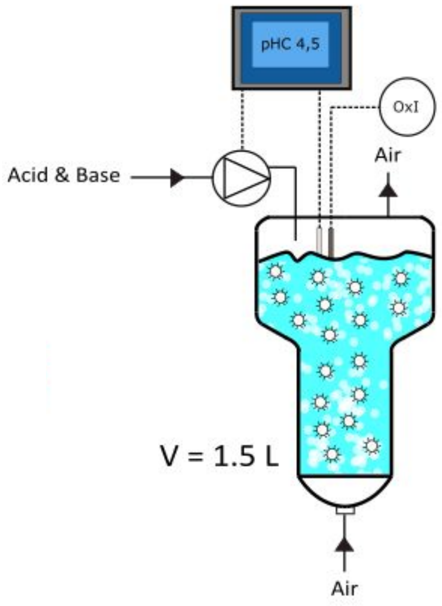
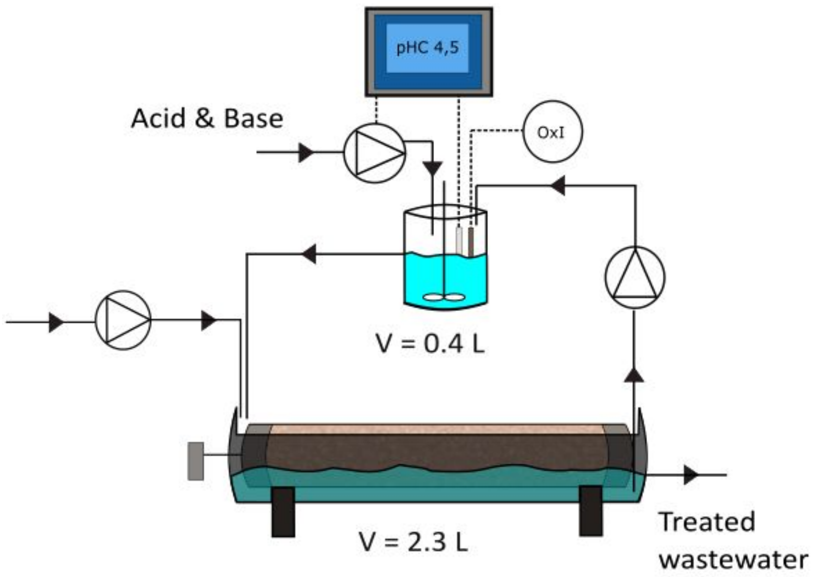
Operational parameters



VS



FBB -> Pellets of *T. versicolor*

- pH 4.5
- Batch (17 days)
- Fungal biomass = 2.2 g DW L^{-1}
- Substrate: Glucose and NH_4Cl
- Sterile and non-sterile conditions
- 1 batch

RDB -> *T. versicolor* immobilized on wood

- pH 4.5
- Batch (17 days)
- Fungal biomass = 2.2 g DW L^{-1}
- Substrate: Wood (initial)
- Non-sterile conditions
- 2 batches

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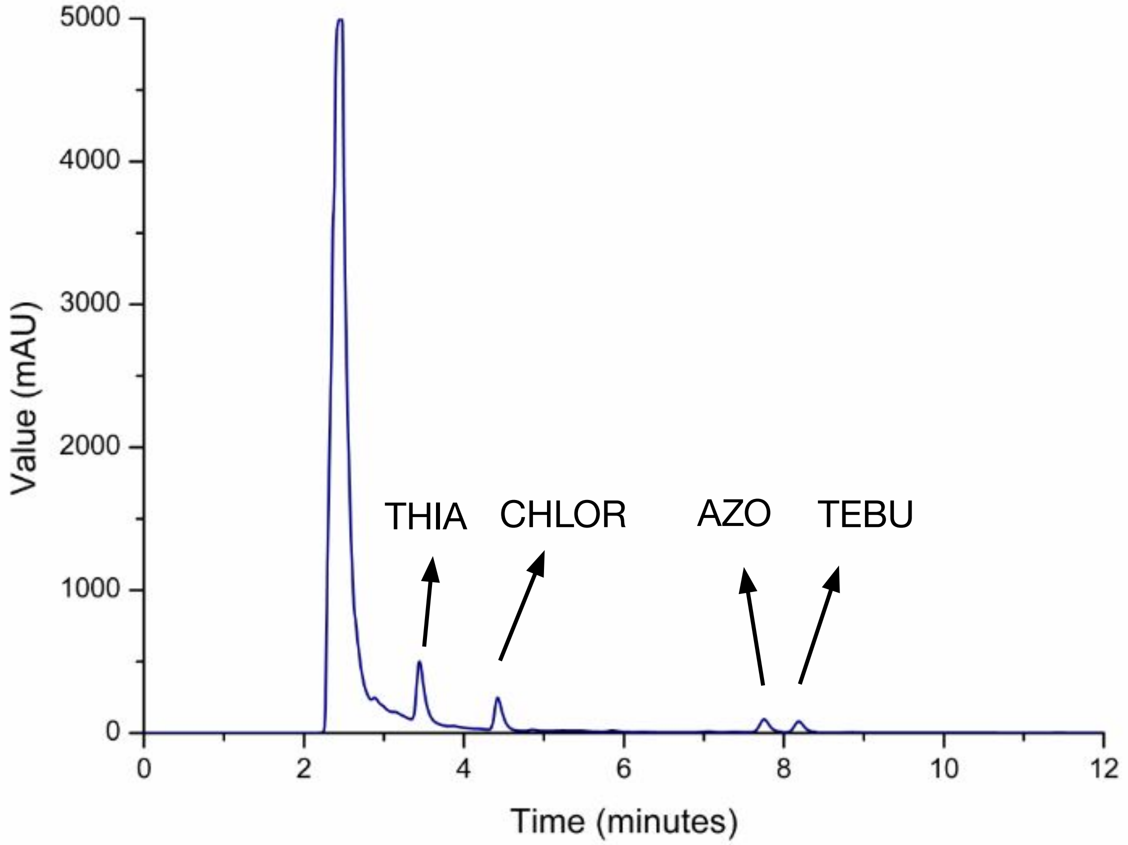
Pesticide identification and quantification

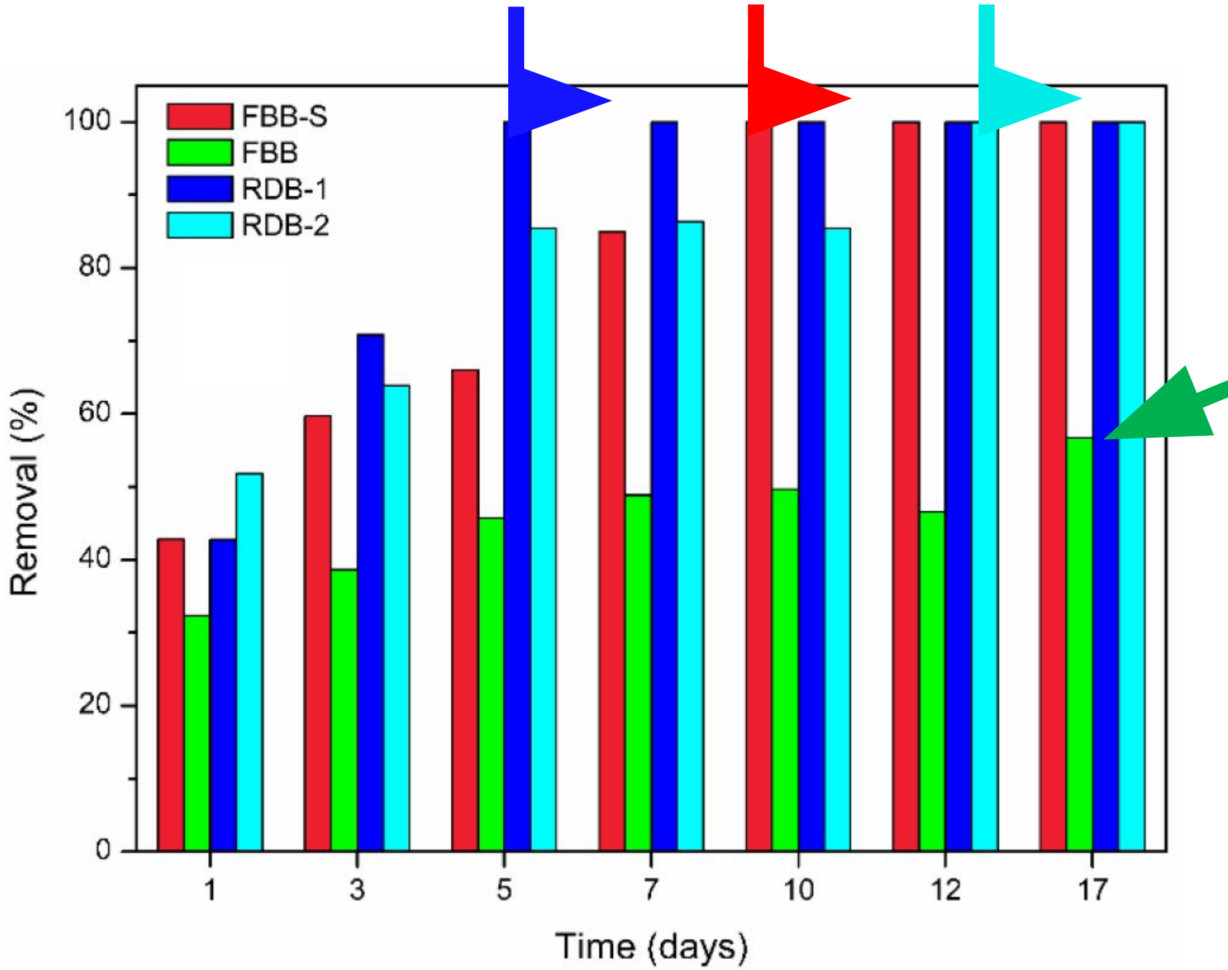


- Four pesticides were identified through exact mass analysis

Pesticide	Type	Group	Concentration (ppm)
Thiacloprid (THIA)	Insecticide	Neonicotinoid	19
Chlortoluron (CHLOR)	Herbicide	Phenylurea	7
Azoxystrobin (AZO)	Fungicide	Strobilurin	5
Tebuconazole (TEBU)	Fungicide	Triazole	10

Pesticide removal

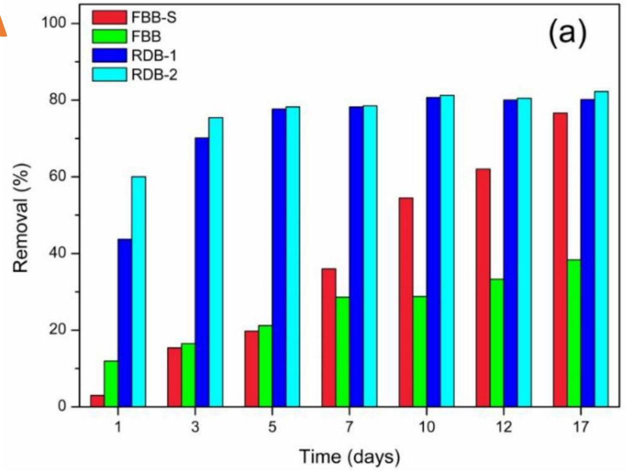
AZO



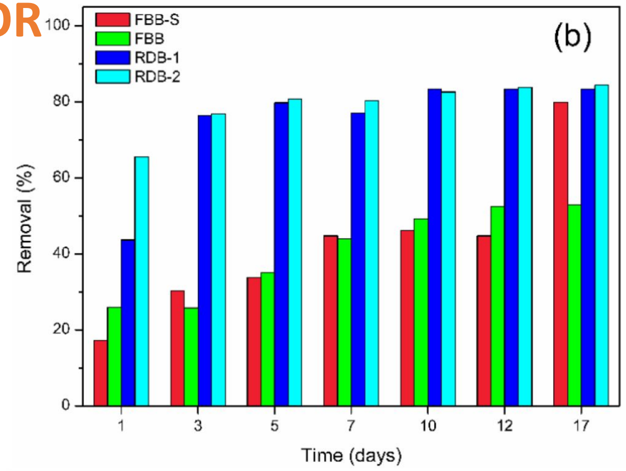
≈ 55 %

Pesticide removal

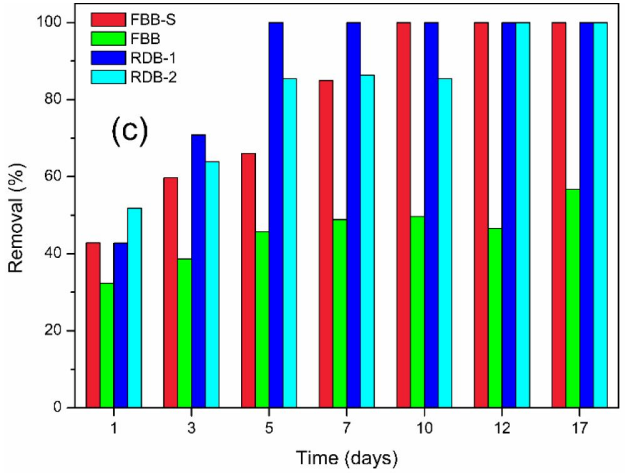
THIA



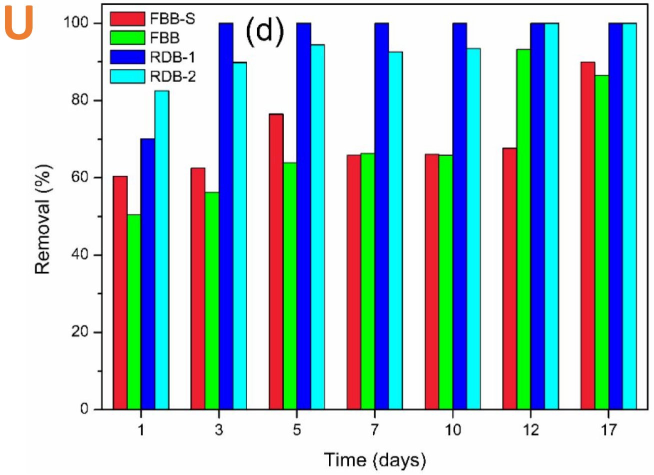
CHLOR

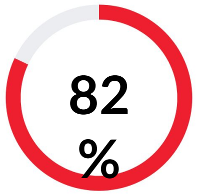


AZO

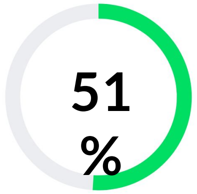


TEBU





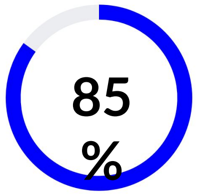
FBB-S



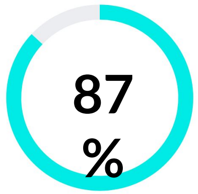
FBB

T. versicolor is involved in the degradation of the detected pesticides

Microbial contamination reduced the FBB performance



RDB-1



RDB-2

Higher removals were achieved in the RDB

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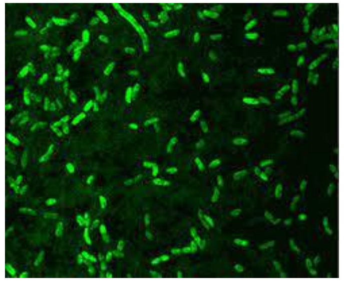
Toxicity and phytotoxicity

Wastewater	Operating conditions	Toxicity (TU)	Phytotoxicity: Relative seed germination SG (%)	Phytotoxicity: Relative root elongation RE (%)	Phytotoxicity: Germination index GI (%)
Pond	-	13.6 ± 1.0	52.9 ± 5.2	69.6 ± 4.7	36.9 ± 3.2
FBB-S	Sterile	6.0 ± 0.3	88.2 ± 20.6	82.28 ± 15.5	72.6 ± 17.8
FBB	Non-sterile	8.6 ± 2.8	76.5 ± 31.8	82.9 ± 11.9	63.4 ± 11.8
RDB-1	Non-sterile	2.2 ± 0.3	111.8 ± 40.9	93.7 ± 20.2	104.7 ± 29.2
RDB-2	Non-sterile	2.9 ± 0.1	61.8 ± 27.0	78.5 ± 1.7	48.5 ± 4.3

The RDB reduced toxicity more than the FBB

The RDB obtained better phytotoxicity results



Other parameters

Operating time (day)	COD (mg O_2 L^{-1})				Absorbance (AU)				Microbial counts [log (CFU mL^{-1})]			
	FBB-S	FBB	RDB-1	RDB-2	FBB-S	FBB	RDB-1	RDB-2	FBB-S	FBB	RDB-1	RDB-2
0	2088	2088	2088	2088	0.171	0.171	0.171	0.171	-	6.47	6.47	6.47
17	10476	8140	7076	4785	0.041	0.372	0.243	0.212	-	6.61	6.54	6.51

- FBB → COD: antifoam
  → Absorbance: dispersed biomass
- RDB → COD & absorbance: organic compounds from the wood

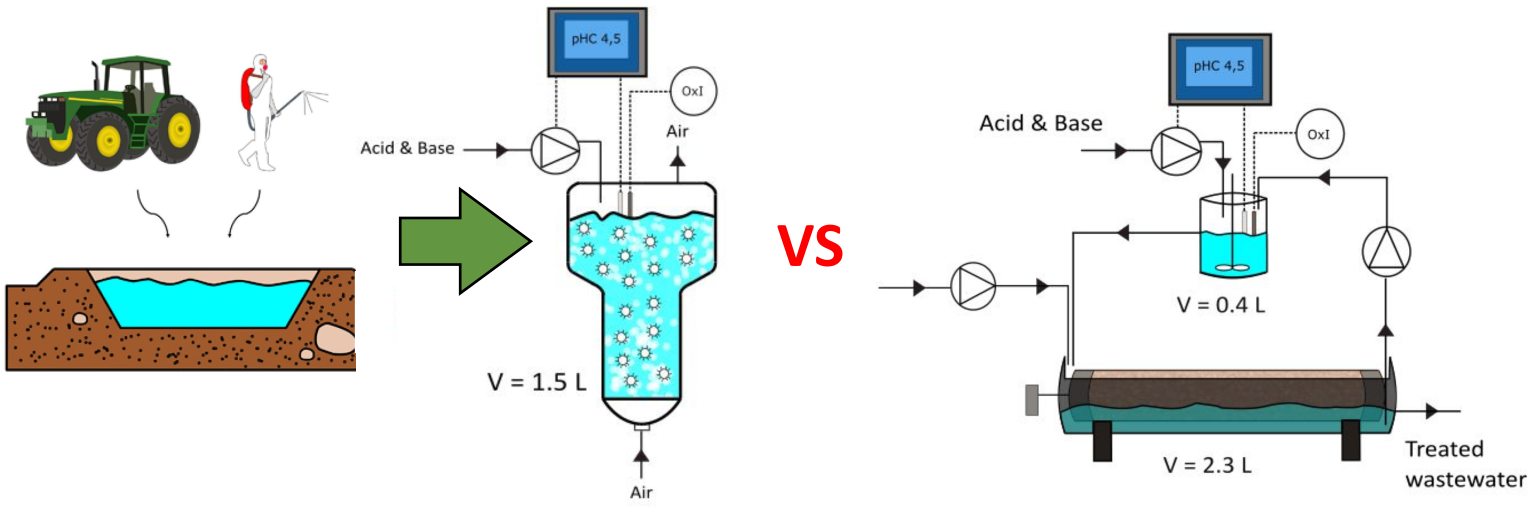
- Bacterial contamination was under control

- Analysis of fungal community

  Predominant: *Trametes sp.* (21-40 %) and *Meyerozyma sp.* (21-40 %)

Better biomass retention was obtained by the wood immobilization strategy

Conclusions



Effluent quality: RDB > FBB

Post-treatment for COD reduction is recommended

The RDB is the most promising treatment for further full-scale applications

Future work

«Proyectos Estratégicos Orientados a la Transición Ecológica y a la Transición Digital» 2021

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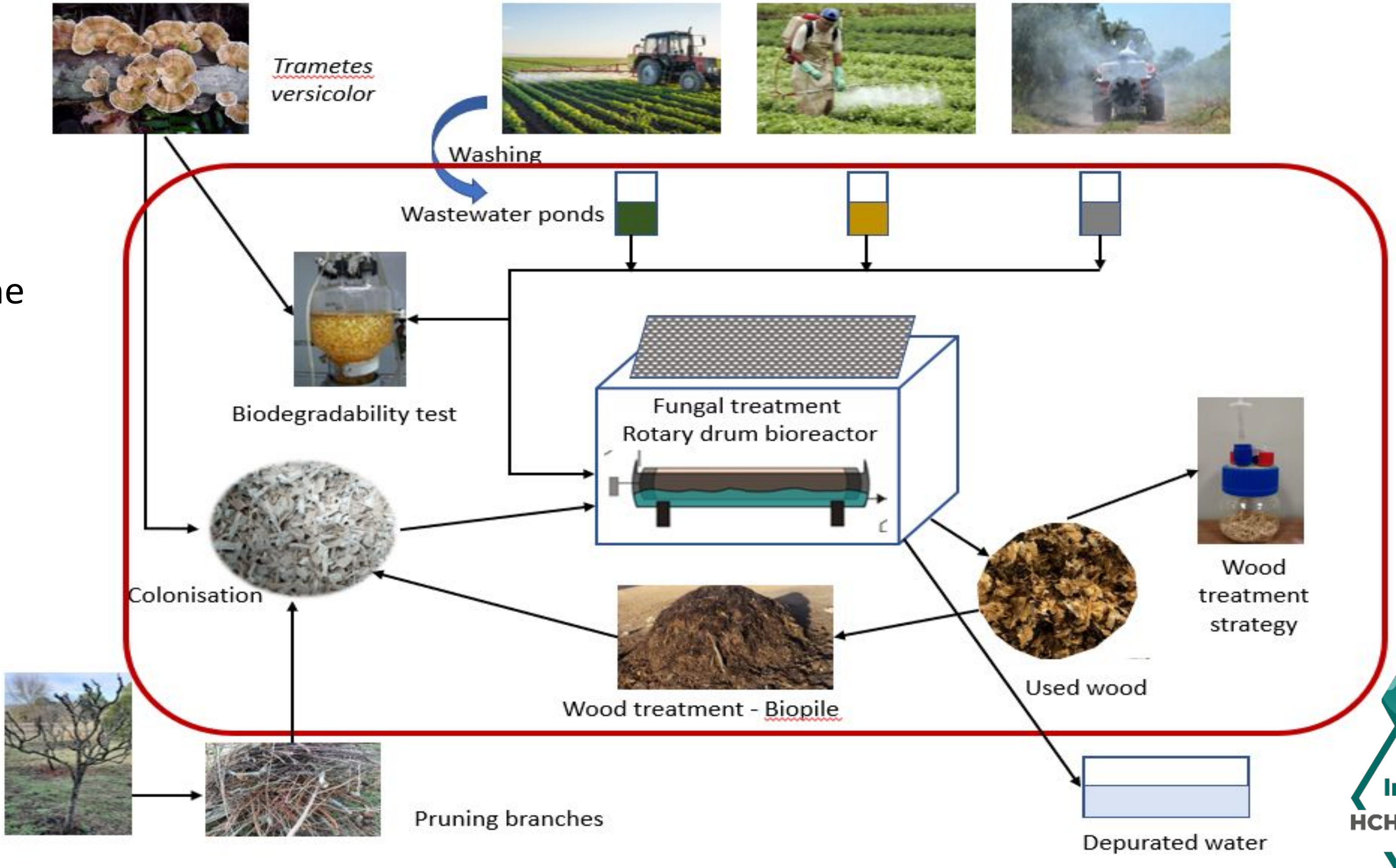
TED2021-130639B-I00. Towards the ecological transition in the agricultural sector by fungal bioremediation of pesticide-containing wastewater.



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Paqui.Blanquez@uab.cat

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