

Biobeds for environmental protection from pesticide use – A review

M. d. P. Castillo, L. Torstensson and J. Stenström, *Journal of Agricultural and Food Chemistry*, 2008, **56**, 6206-6219.

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Use of pesticides at farms

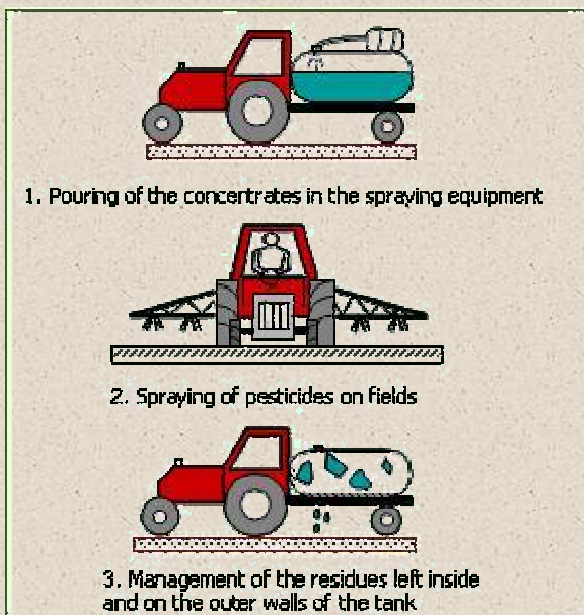


Photo: Tom Bowman, Virginia Tech Pesticide Programs
<http://www.vtpp.ext.vt.edu>

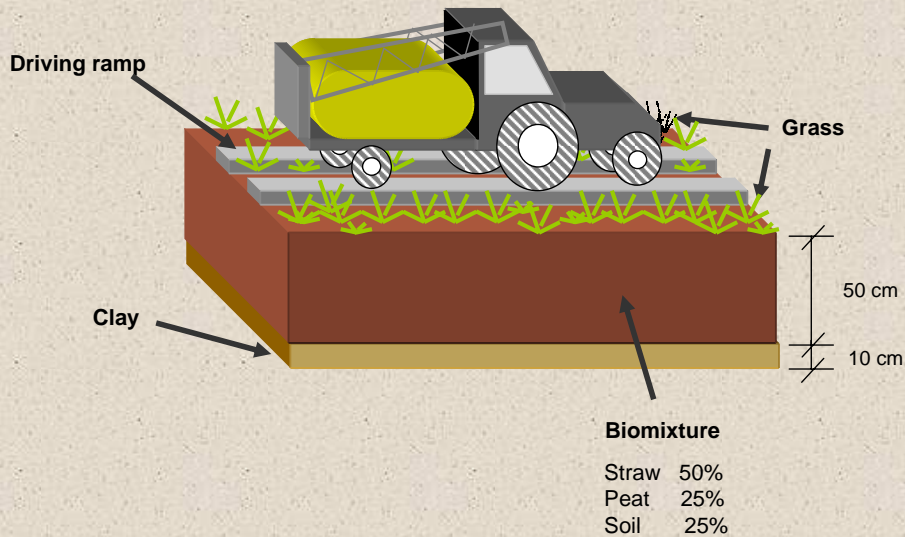
Castillo, et al, 2008

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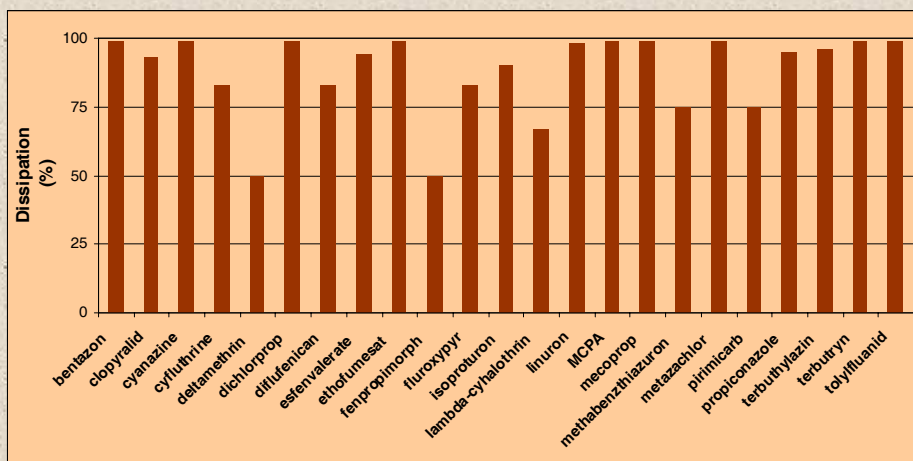
Biobed

Construction intended to retain and degrade spillage of pesticides



Studies of biobeds in Sweden

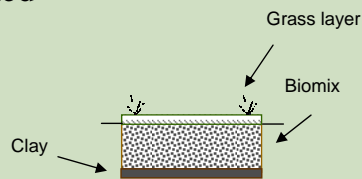
- First biobeds built in 1993
- Effective, simple, inexpensive way to mitigate pesticide leaching
- Pesticides are mainly retained in the upper part of the biobed and most of them are dissipated within one year
- Intended to be used for handling pesticide concentrates



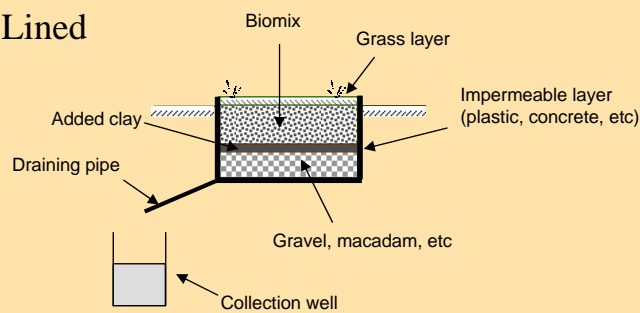
Dissipation of pesticides in biobeds after one year

Types of biobeds

Unlined



Lined



M. d. P. Castillo, L. Torstensson and J. Stenström, *Journal of Agricultural and Food Chemistry*, 2008, **56**, 6206-6219.

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Biobeds in Sweden



More than 1500 units

M. d. P. Castillo, L. Torstensson and J. Stenström, *Journal of Agricultural and Food Chemistry*, 2008, **56**, 6206-6219 and references therein.

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Implementation of biobeds in other countries

Intensive research to adapt them to the special conditions of the particular country

- Climatic conditions
- Agricultural practices
- Treatment of large volumes of water
- Availability of substrates (use of local organic materials)

Biobeds in Europe



www.biobeds.info

Biobeds in the UK



Biofilter in Belgium



Debaer, C. et al 2006

Biomassbed in Italy



Fait, G., et al 2007

Phytobac - Bayer, France



Guyot, C., et al 2006

Biobac in France



www.biotisa.com

Biobeds in developing countries

Biobeds in Lima, Peru



Biobeds in Guatemala



Biobed

Photo: Agreguima



Biotable

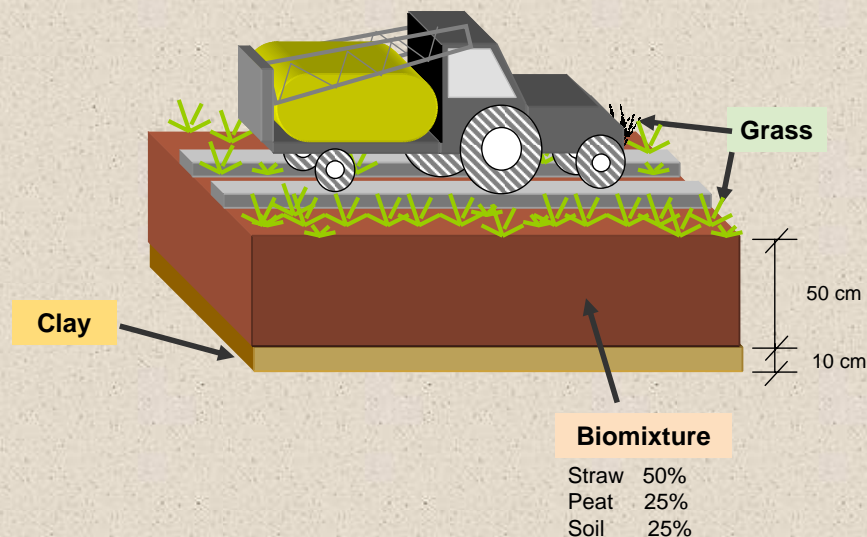
M. d. P. Castillo, L. Torstenson and J. Stenström, *Journal of Agricultural and Food Chemistry*, 2008, **56**, 6206-6219.

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Factors affecting the efficiency of the biobed

- The performance of a biobed is measured by its ability to retain and degrade pesticides
- An efficient biobed implies that all of its three components, (the clay layer, the biomixture, and the grass layer), are functioning correctly



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Biomixture

A good biomixture promotes pesticide binding and an efficient and robust microbial flora that give durable pesticide degradation.

- Composition
- Homogeneity
- Age
- Temperature
- Moisture

Biomixture composition

- Components
- Proportion of the components

Stimulates microorganisms with specific catabolic activities

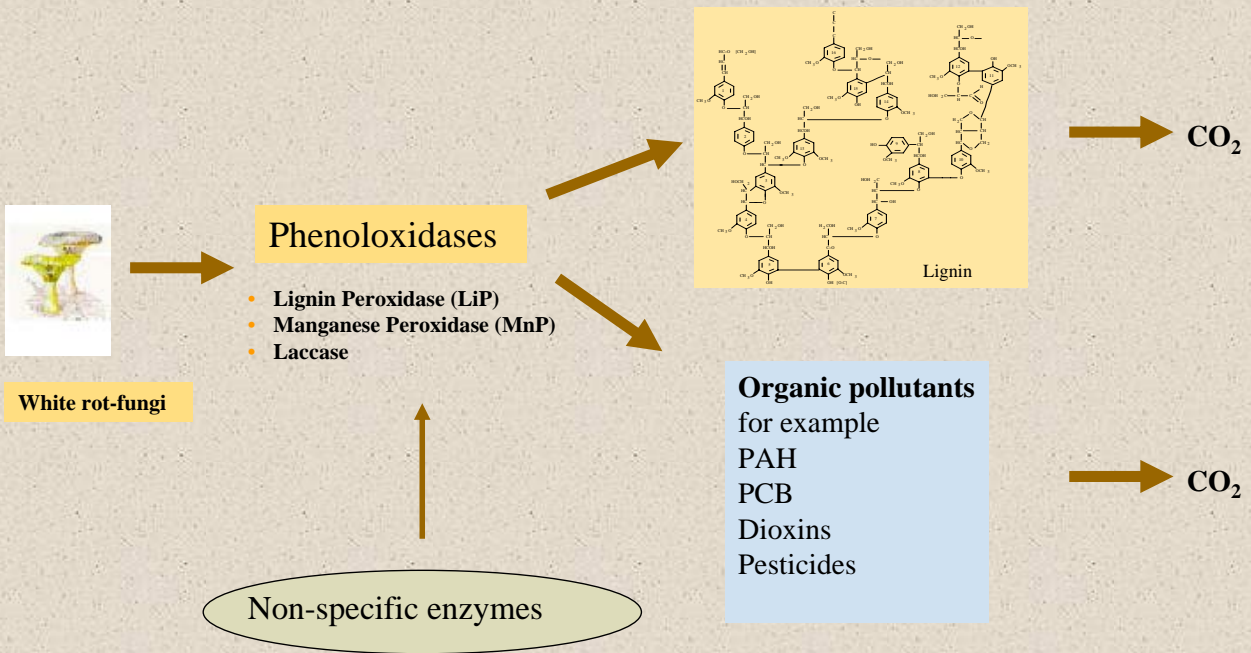
Swedish Biomixture { Straw : Soil : Peat
50:25:25 % vol

High lignin content
C/N > 30 (low N)
pH < 6

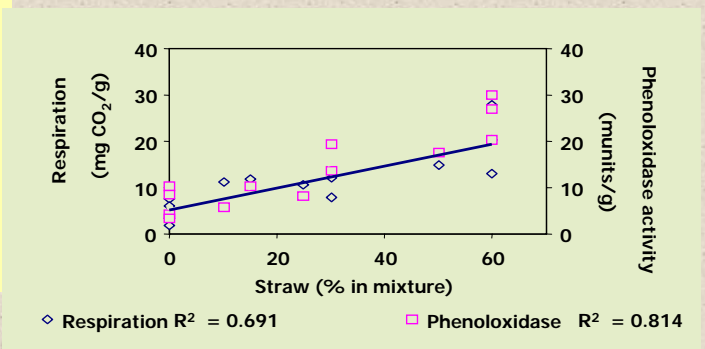
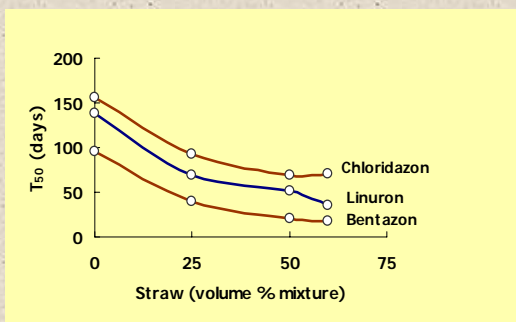
Conditions suitable for lignin degrading fungi
as white rot fungi

Cometabolic degradation of pesticides

Lignin degradation and degradation of organic pollutants



Straw degrading fungi – the driving force



White-rot fungi in biobeds



- Lignin Peroxidase (LiP)
 - Manganese Peroxidase (MnP)
- Isoproturon
Bentazon
Chlorpyrifos

Degradation of glyphosate (a) and a mixture of pesticides (b) by MnP under *in vitro* conditions

a)

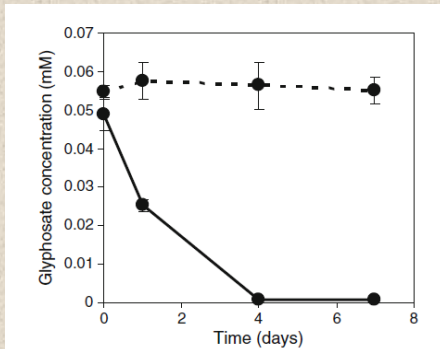
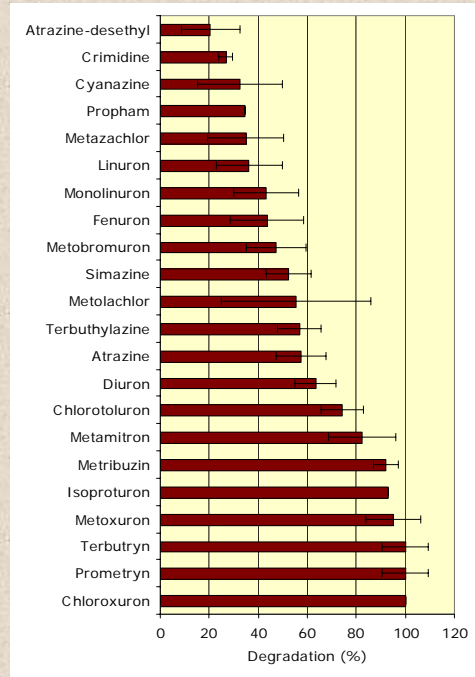


Fig. 1 Concentration of glyphosate, added as formulated Roundup® Bio, in a reaction mixture with 0.15 U ml^{-1} MnP (solid line) and without enzyme (dashed line) under *in vitro* conditions during 7 days incubation at 35°C and 150 rpm. Values are means \pm SD ($n = 2$). The reaction mixture contained 0.06 mM glyphosate, 1 mM MnSO_4 and 1% Tween 80 in 50 mM Na acetate buffer (pH 4.5)

b)



Poster – Pizzul, *et al*

L. Pizzul, M. Castillo and J. Stenström, *Biodegradation*, 2009, DOI 10.1007/s10532-009-9263-1.

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Biomixture composition

- Components
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Cometabolic degradation of pesticides

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Clay layer

- Impermeable layer
- Decreases the water flow downwards
- Increases pesticide retention time



No cracks to avoid preferential flow

Grass layer

- Regulates moisture
- Can produce root exudates to support cometabolic processes
- Can exudate peroxidases
- Reveals pesticide spillages

When grass layer absent



- Poor evapotranspiration
- Can generate a hydrophobic crust
- Can promote transport of water to the bottom
- No pedagogic indicator of pesticide spills

Research needs

- Effects of replacing the components of the biomixture on the efficiency of the biobed
- Better practices for achieving a homogenous biomixture
- Effect of maturity of the biomixture on the efficiency of the biobed
- More active grass types
- Increase efficiency of bottom layer

Conclusions

- Biobeds are effective and simple systems to minimize pesticide contamination
- In Sweden, biobeds are exclusively intended for treatment of pesticide spills when filling and storing spraying equipment
- The biobed should be considered as a unit consisting of three components: clay, biomixture and grass layers
- The replacement of some of the original materials of the biomixture may change its performance

Thank you for your attention!

Acknowledgments

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