



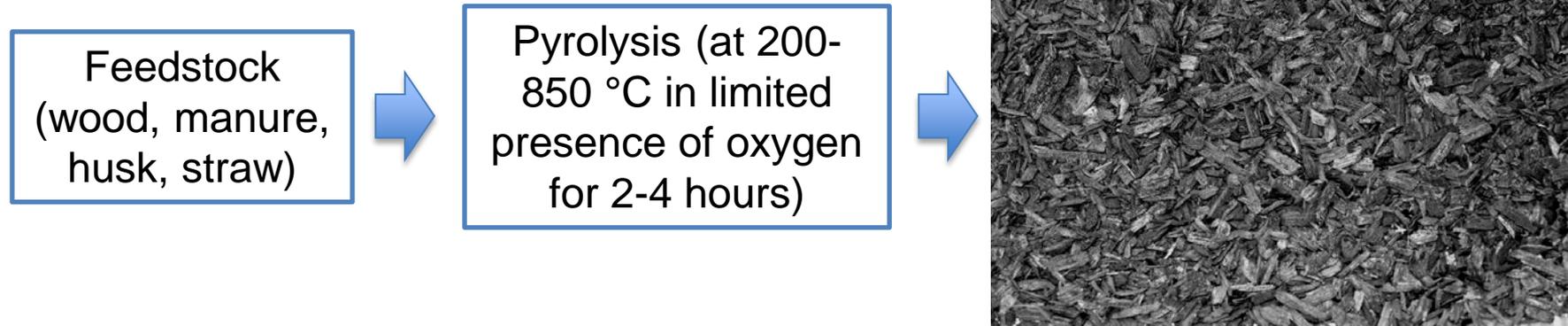
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# Adsorption and degradation of diuron and glyphosate in biochar-amended soils

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Swedish University of Agricultural Sciences

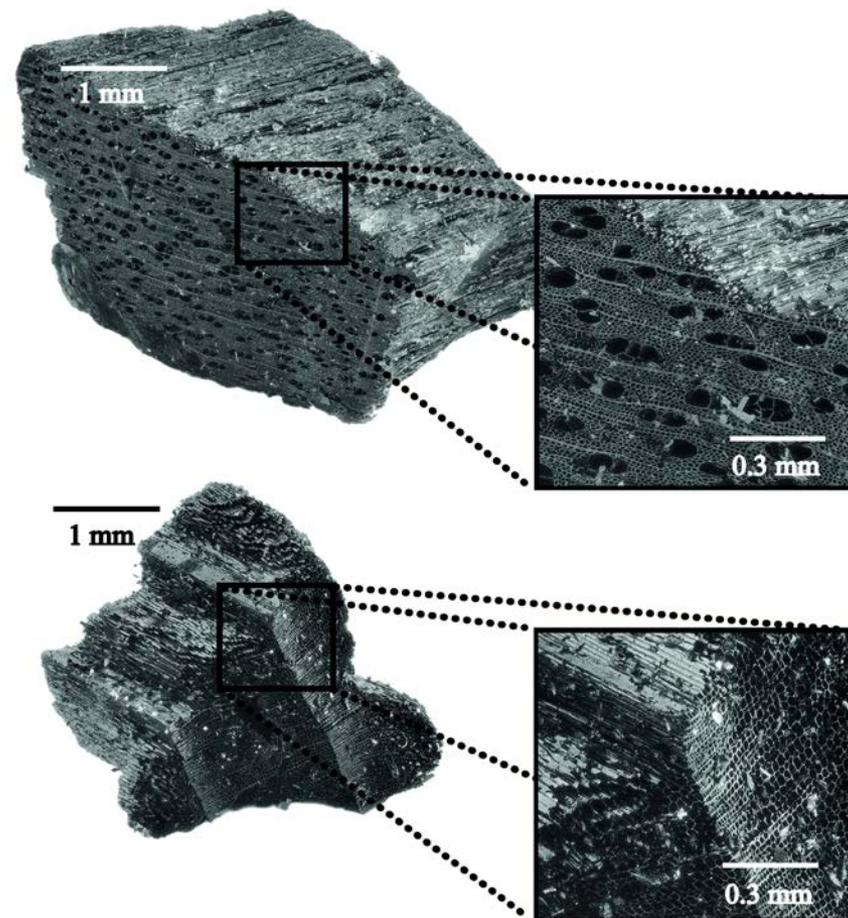
# What is biochar?

- Carbon-rich bioproduct that is produced from feedstock through the process of pyrolysis (heating in oxygen-depleted environment)



# What is biochar?

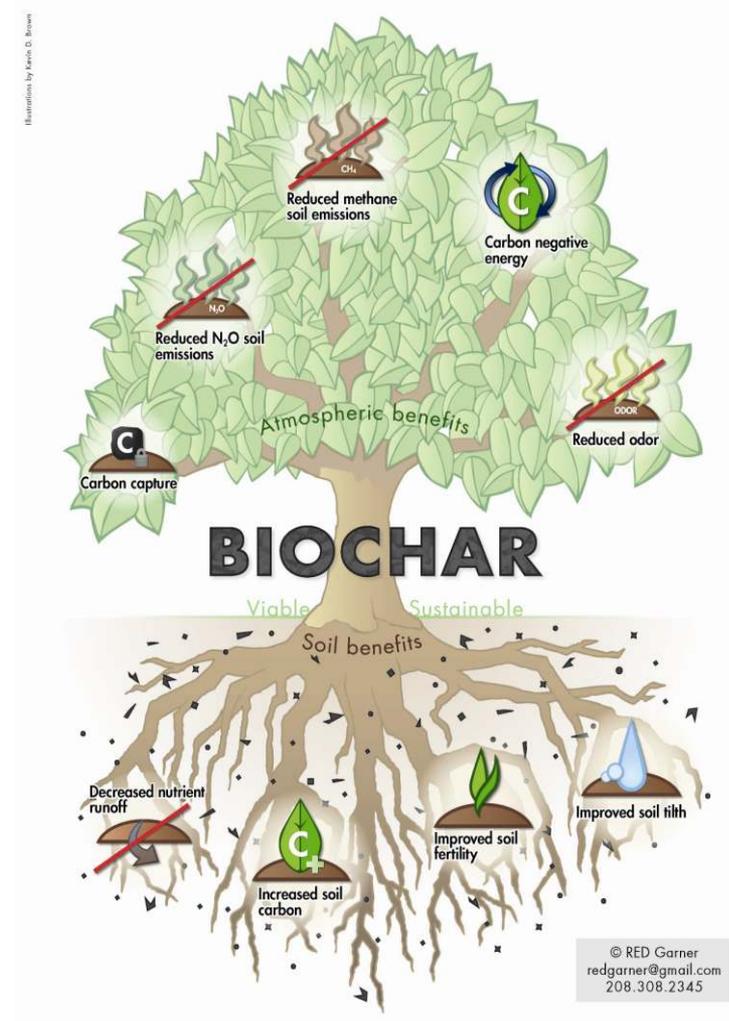
- Stable carbonaceous substance
- High porosity, big surface area
- Nutrient content depend on feedstock



Birch and spruce biochar

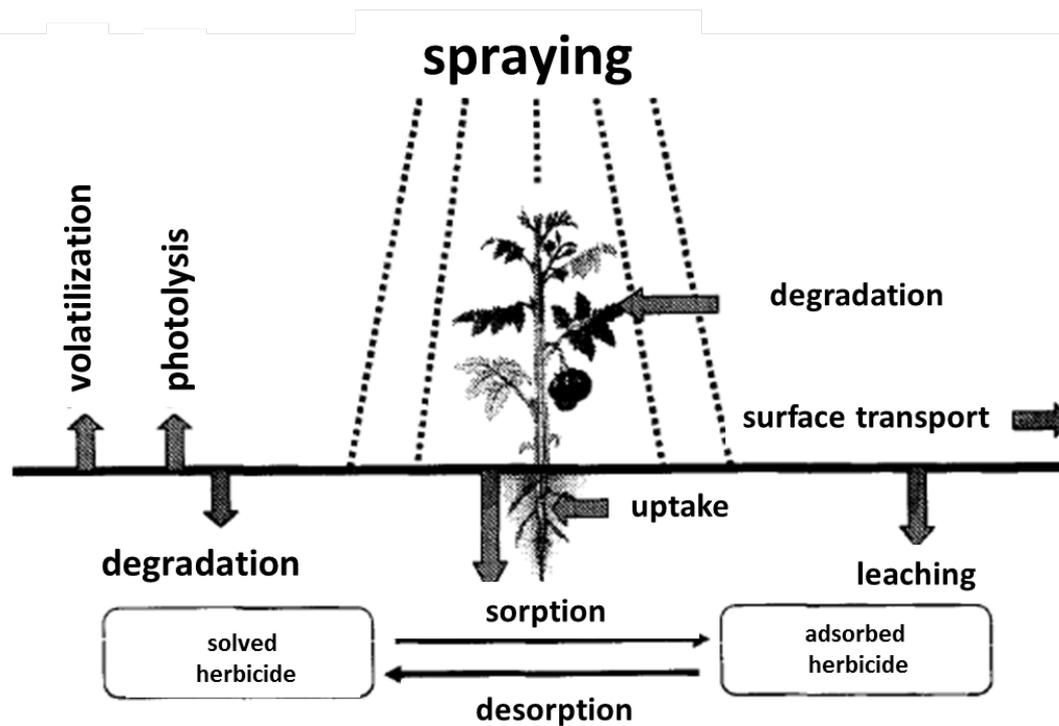
# Biochar – effects

- Alters wide range of chemical, physical and biological soil properties
- Carbon sequestration
- Reduces greenhouse gas emissions
- Sorption of pesticides, organic compounds and agrochemicals
- Side effects: release of toxicants that may be present in biochar, increase of pH



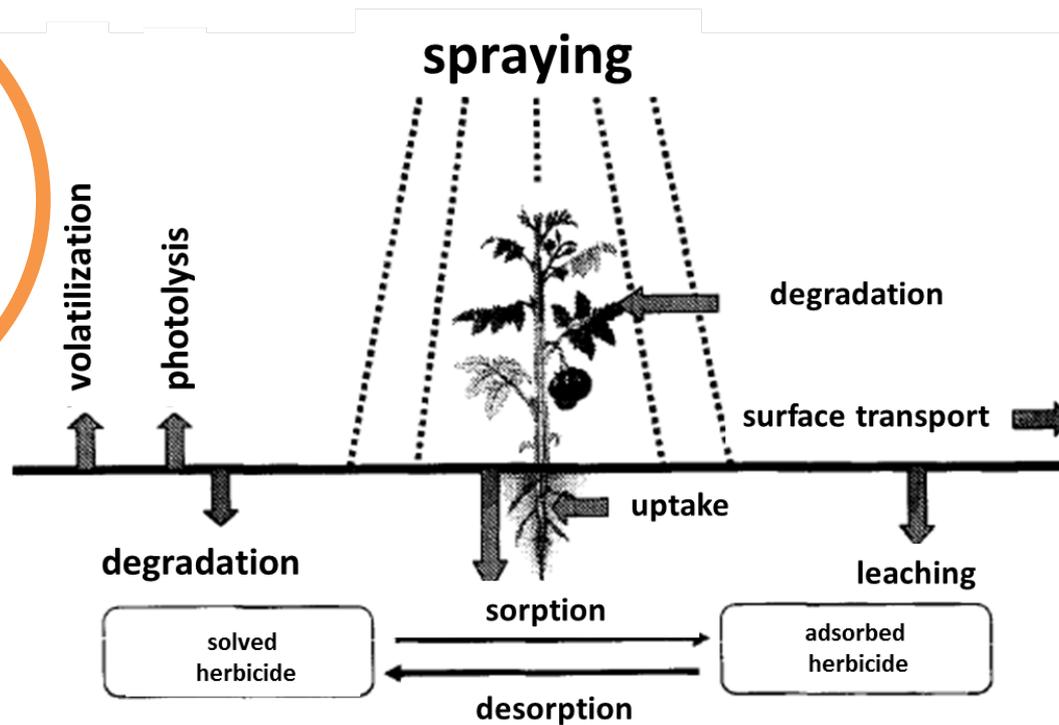
Picture from [www.biochar-international.org](http://www.biochar-international.org)

# Environmental fate of pesticides



# Environmental fate of pesticides

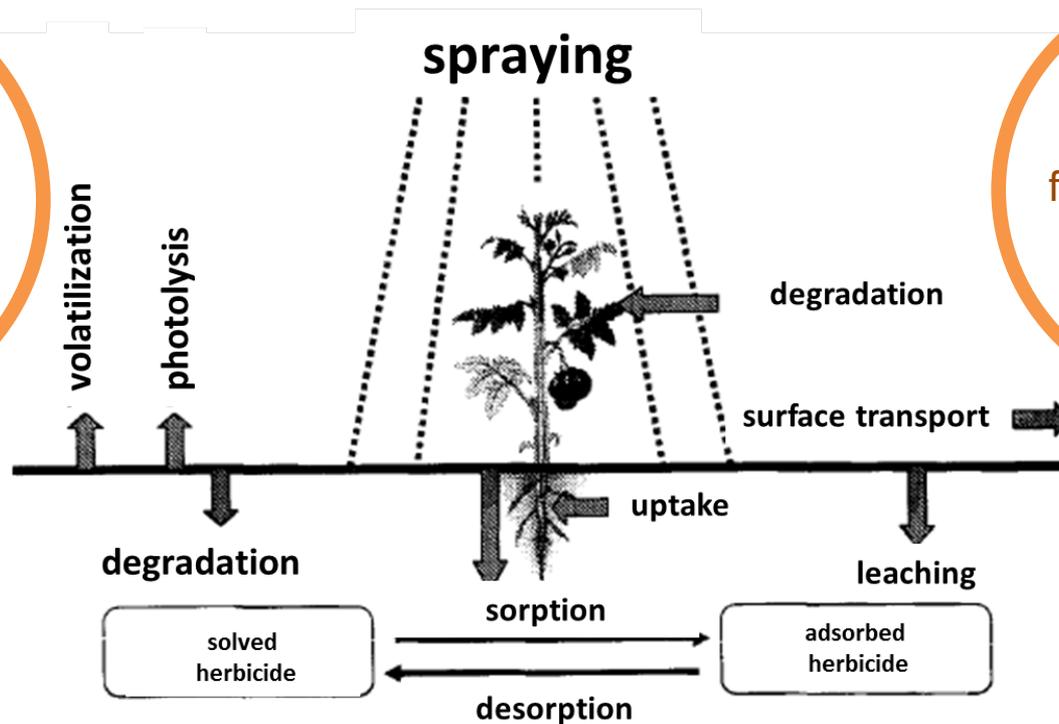
Biochar suggested as soil amendment for storing carbon and to increase soil fertility



# Environmental fate of pesticides

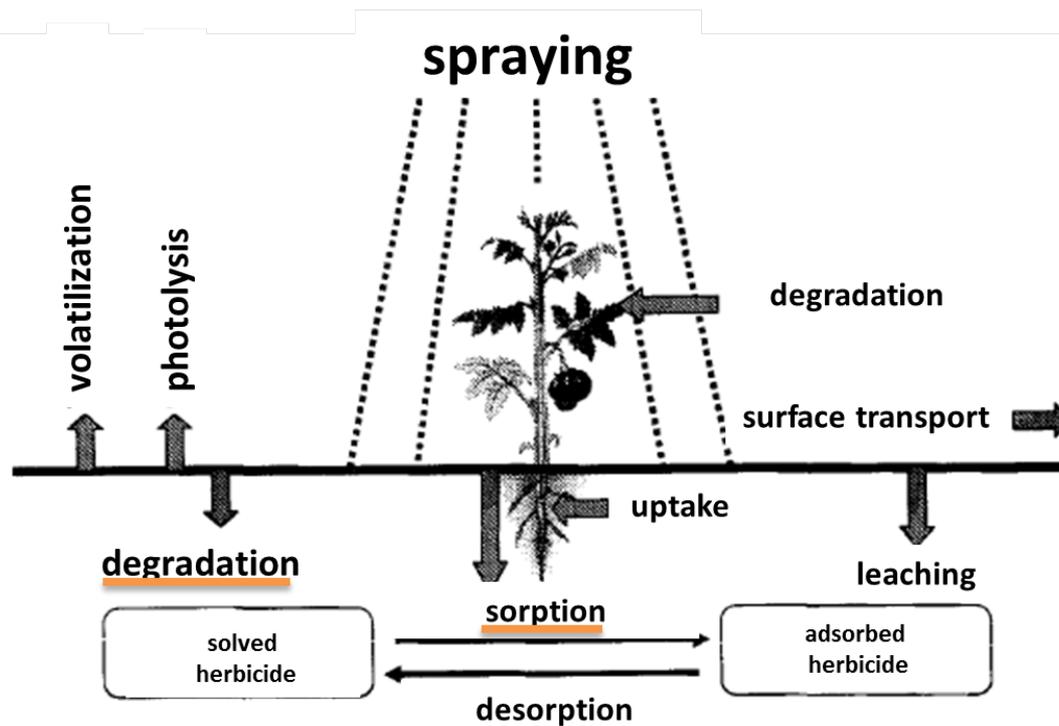
Biochar suggested as soil amendment for storing carbon and to increase soil fertility

But how is the environmental fate of pesticides affected by biochar amendment?



Picture from Kulikova, Lebedeva, 2010

# Environmental fate of pesticides



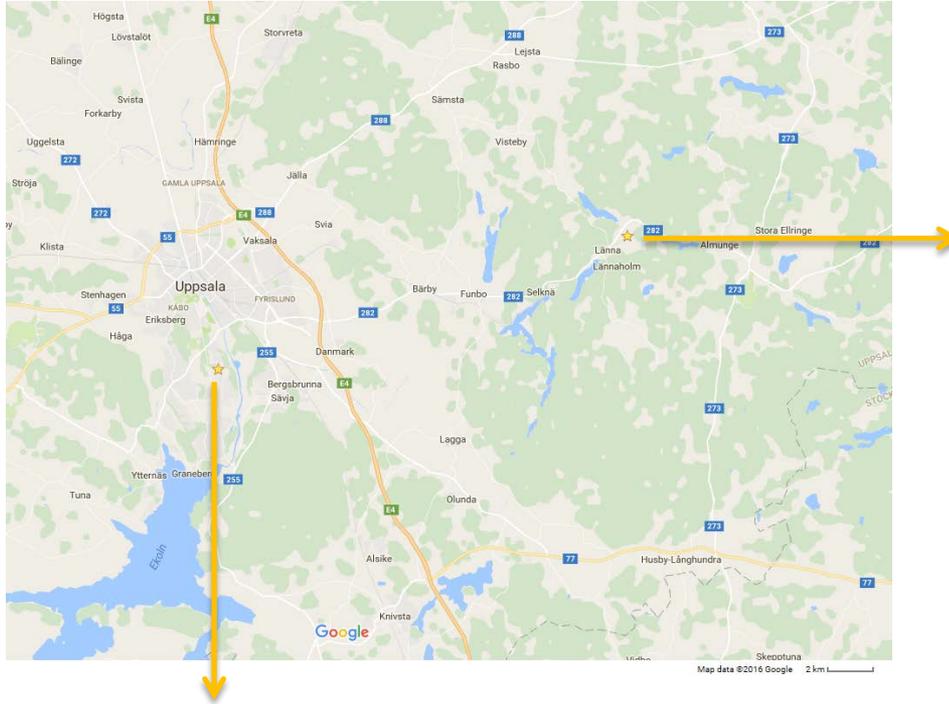
# Studied questions

- How addition of wood-based biochar affects adsorption and degradation of diuron and glyphosate
- Will biochar give the same effects after transformation in process of environmental exposure (ageing)?

# Experimental design

- Two sampling sites: soils with contrasting properties (sandy, clayey and historically charcoal-enriched)
- Soils (clayey and sandy) used for preparation of soil-biochar mixes with different percent of biochar (from 1 to 30 w/w).
- Biochar: *Skogens kol*, wood-based biochar, T of pyrolysis is 380 – 420 °C
- Two herbicides: lipophilic diuron and hydrophilic glyphosate

# Soil sampling



**Ulleråker field – U**  
- sandy soil

- soil amended with charcoal waste from kilns (worked from 1930s to 1950s)
- total C – 17.57 %



**Satellite image of Länna field**

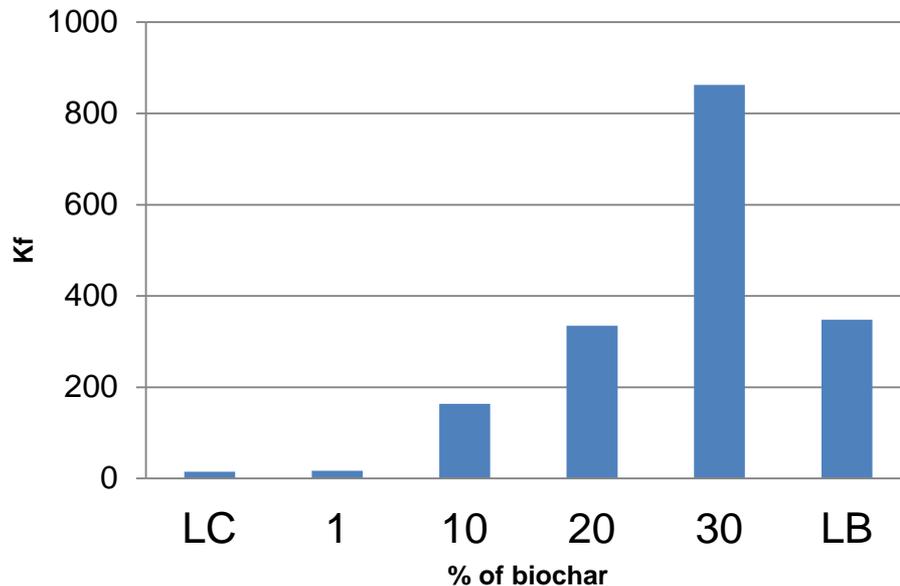
- ❖ - LC (Länna control – clay soil),
- ❖ - LB (historically charcoal-enriched soil).

Picture from eniro.se

# Experimental design

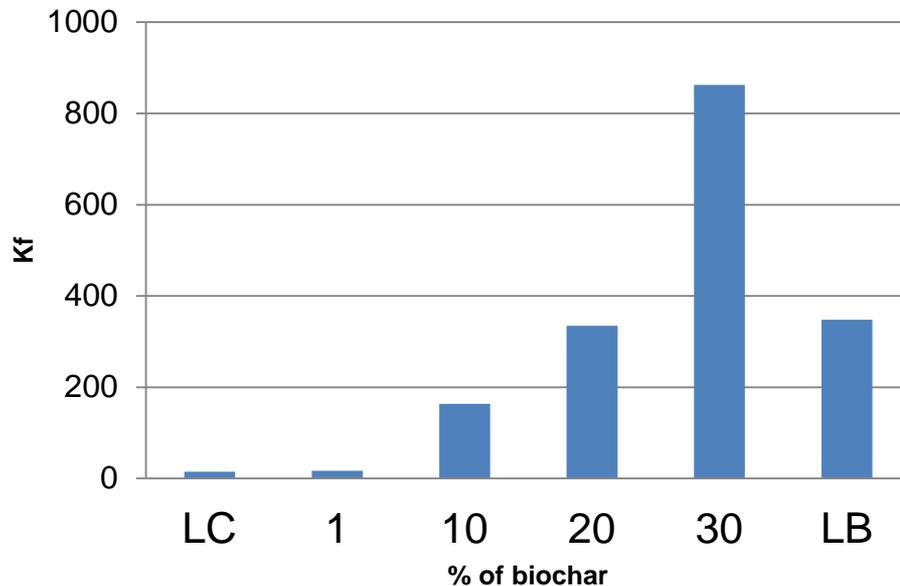
- **Biochar ageing** of soil-biochar mixes was performed in the laboratory conditions for 3,5 months at stable  $t = 20^{\circ}\text{C}$  in the dark room. Moisture content was kept at 55% of WHC
- **Adsorption** was measured according to OECD guideline 106, 2000
- **Degradation** experiment for half-life estimation was done for all soils and soil-biochar mixes

# Adsorption of diuron in clay soil

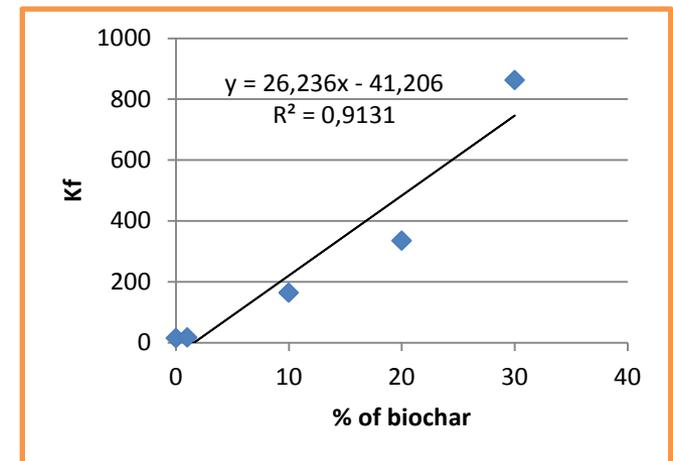


- Biochar addition increases diuron adsorption
- Historically charcoal-enriched soil efficiently adsorbs diuron

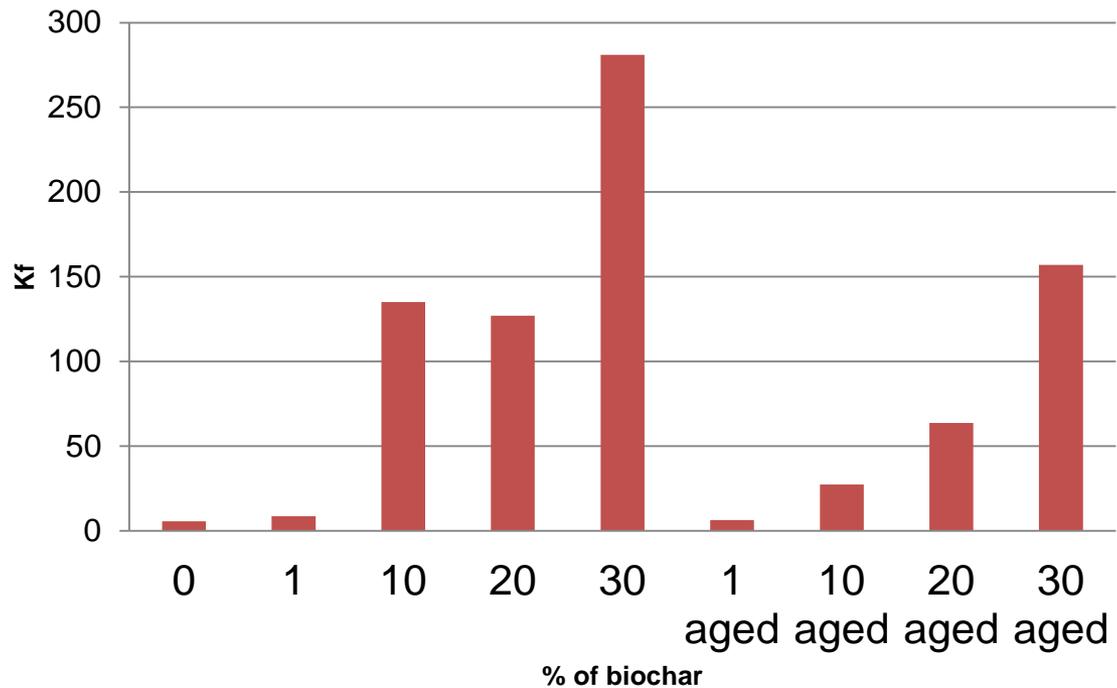
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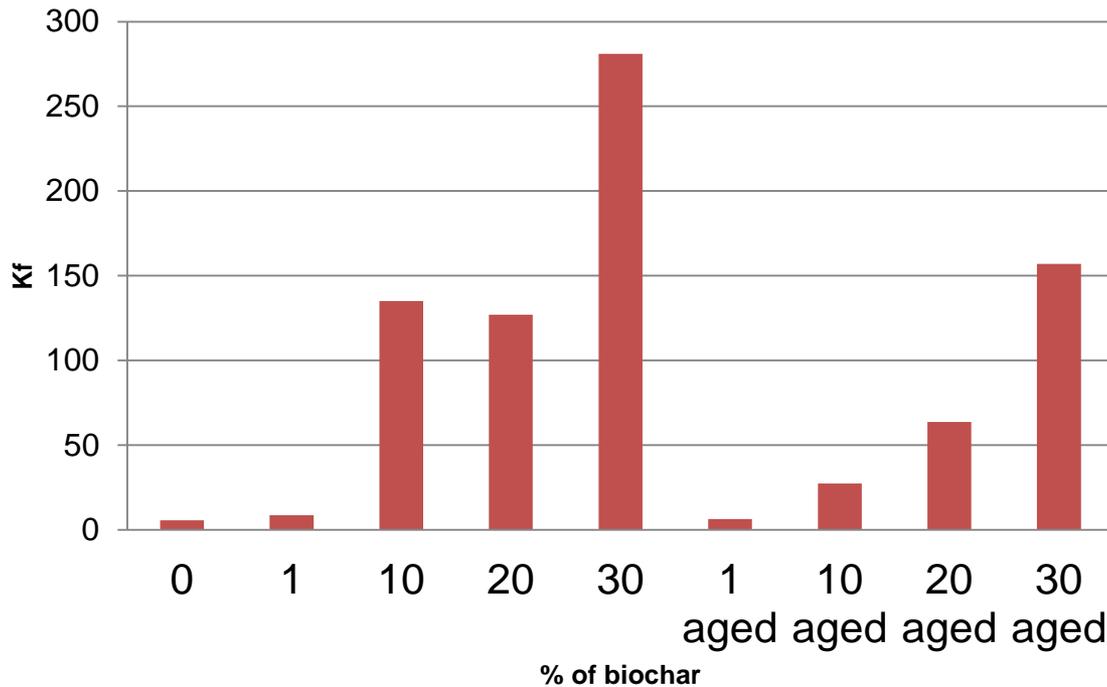


# Adsorption of diuron in sandy soil

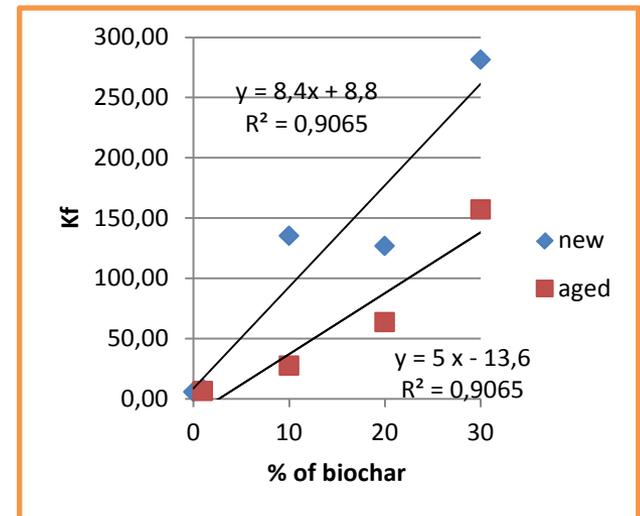


- Biochar addition also increases diuron adsorption
- Biochar ageing leads to decrease in diuron adsorption

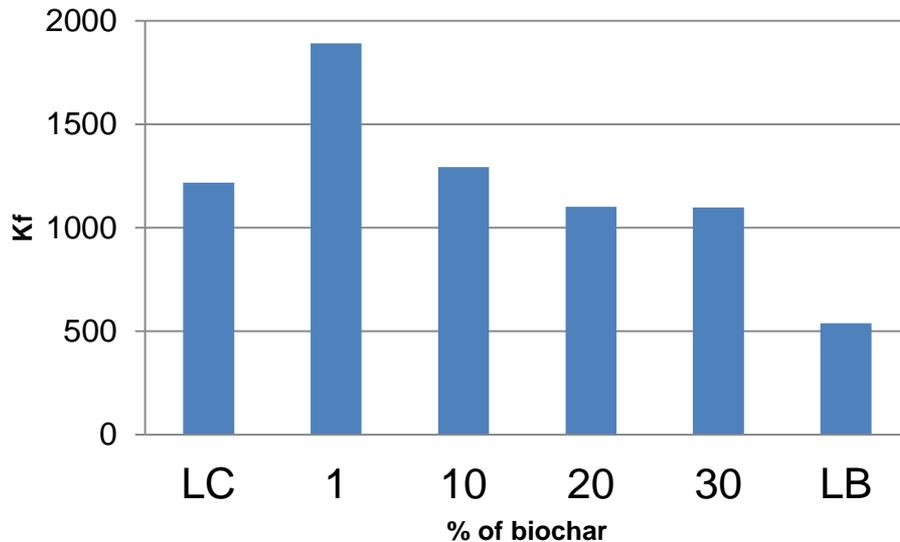
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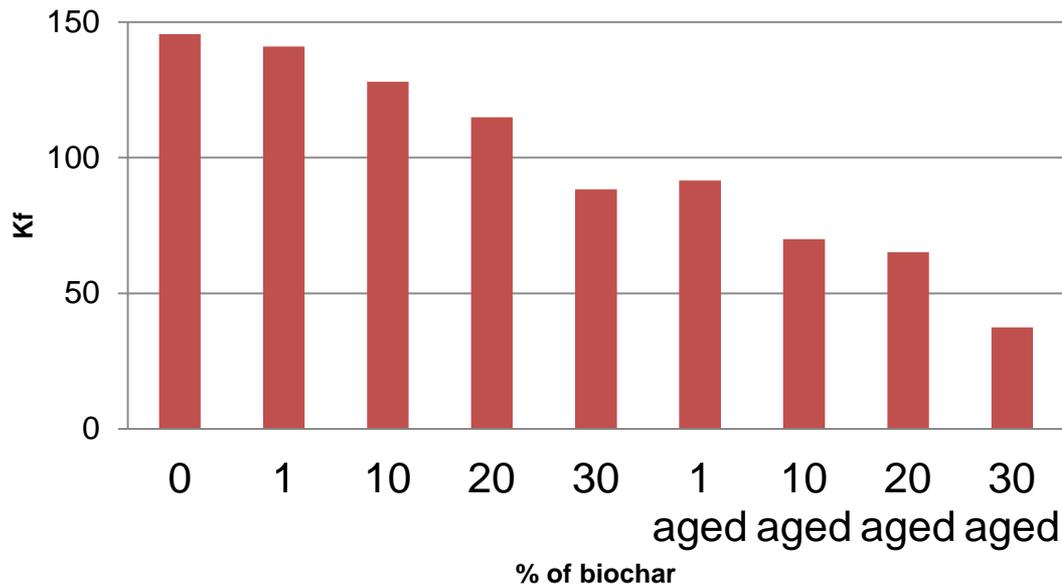


# Adsorption of glyphosate in clay soil



- Glyphosate adsorption in clay soil remains high with any percentage of biochar
- Glyphosate has lower adsorption coefficient in historically charcoal-enriched soil

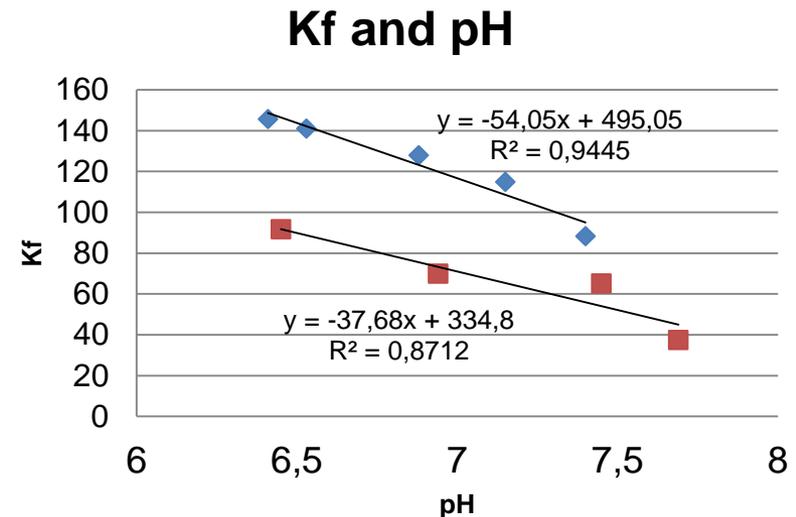
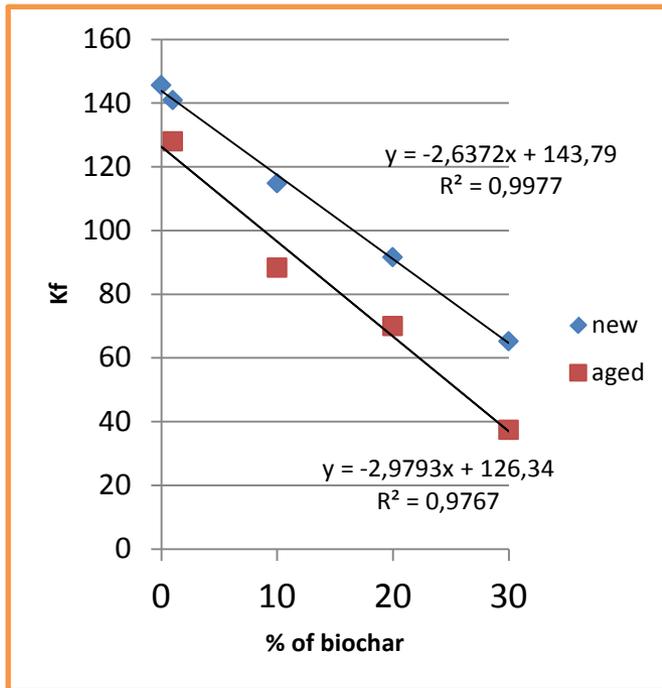
# Adsorption of glyphosate in sandy soil



- Biochar addition reduces glyphosate adsorption in sandy soil
- Glyphosate adsorption reduces with biochar ageing

# Adsorption of glyphosate in sandy soil

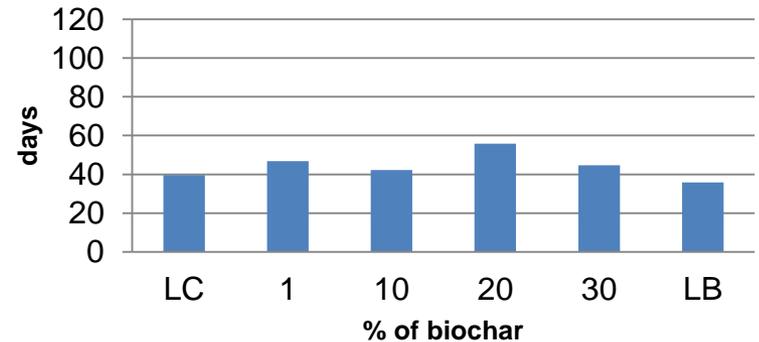
- Biochar addition reduces glyphosate adsorption in sandy soil
- Dilution effect or pH increase consequence?



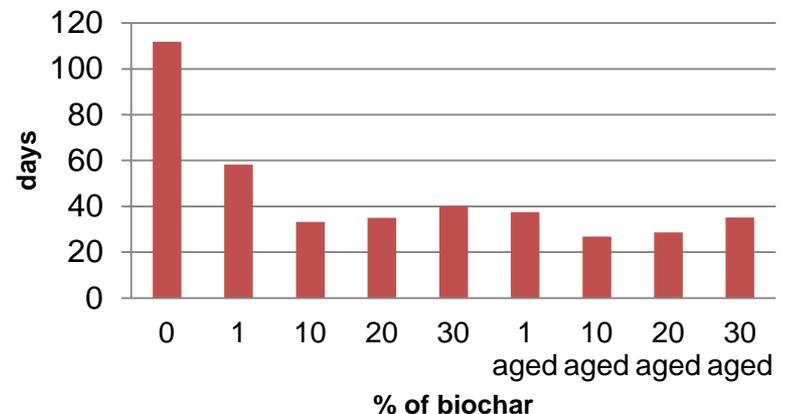
# Degradation of diuron

- In clay soil half-life of diuron varied from 36 to 55 days
- In sandy soil diuron half-life varied from 33 to 58 days
- No consistent effect of biochar amendment on diuron half-life was observed

**clay soil**

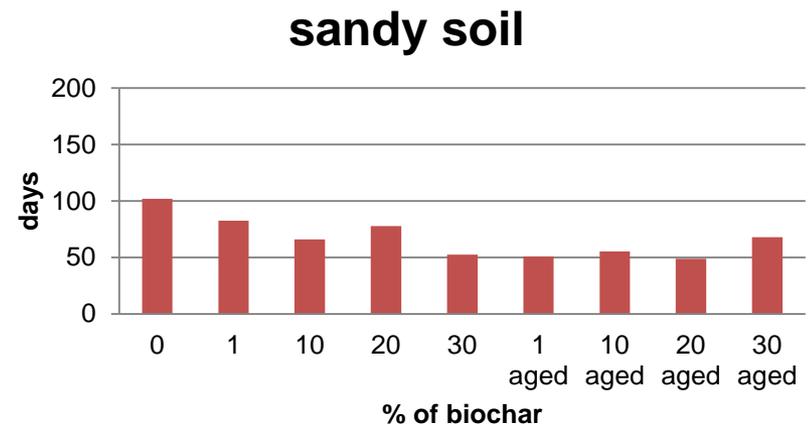
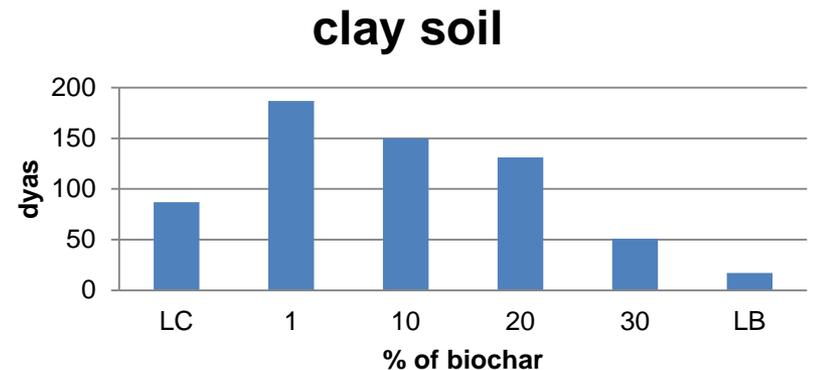


**sandy soil**



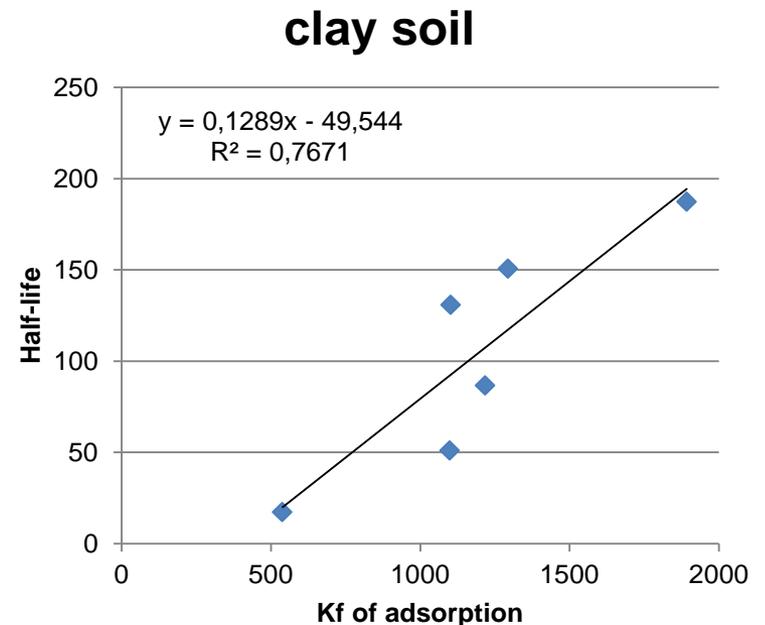
# Degradation of glyphosate

- In clay soil estimated half-life of glyphosate varied from 87 to 187 days
- Glyphosate half-life was short in historically charcoal-enriched soil
- Glyphosate half-life varied from 51 to 102 days in sandy soil



# Degradation of glyphosate

- No consistent effect of different biochar percentage on glyphosate degradation was observed
- However, glyphosate half-life correlated with adsorption coefficient in case of clay soil, but not in sandy soil



# Conclusions

- Biochar amendment increases diuron adsorption in both soils
- Glyphosate adsorption was lowered in sandy soil by biochar amendment
- Biochar ageing decreases adsorption of both herbicides
- There was no consistent effect of biochar on herbicides degradation

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Thank you for your attention