Bioavailability of atrazine in char-amended soils

Yucheng Feng[1], Vijay Loganathan[1], Daniel Sheng[2], and Prabhakar Clement[1]

[1]Auburn University &

[2]Zhejiang University of Technology

Introduction

- Black carbon production:
  - Biomass burning: 50-260 teragrams C/year
  - Fossil fuel combustion: 12-24 teragrams C/year (Masiello & Druffel 1998)

- Biomass burning
  - Forests
  - Grasslands
  - Crop residues

Late-winter burn of mixed native grasses, Americus GA (Courtesy of Mary Goodman)

Introduction

- Black carbon materials: charcoal, soot, char
- Black carbon contents in agricultural soils:
  - Australia: < 8 gC/kg soil, < 30% of SOC
  - U.S.: 1.8 - 13.6 gC/kg soil, < 35% of SOC

(Skjemstad et al. 2002)

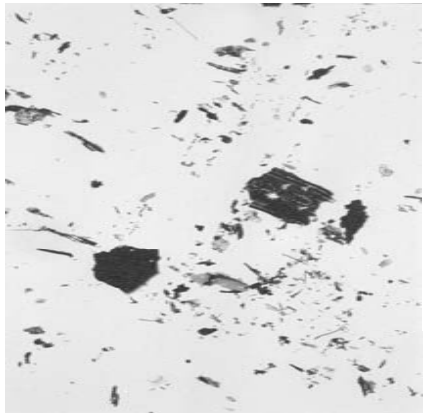
- Char ⟶ Sorption capacity ↑
  Bioavailability ?

Objectives

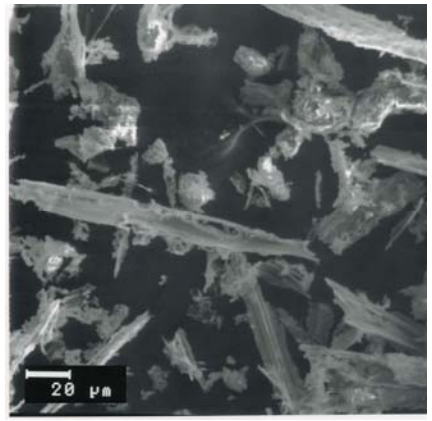
- Examine the impact of char on sorption, desorption, and bioavailability of atrazine in soils.

Wheat char

Char image under light microscope (80x)



Scanning electron micrograph of char (500x)



- Prepared by burning in the field
- Characteristics:

	Wheat char	Activated carbon
Composition (wt%):		
C	12.9	87.6
Carbonate C	1.4	
Si	19.5	
K	20.9	
Ca	3.4	
Surface area (m^2/g)	10.1	776

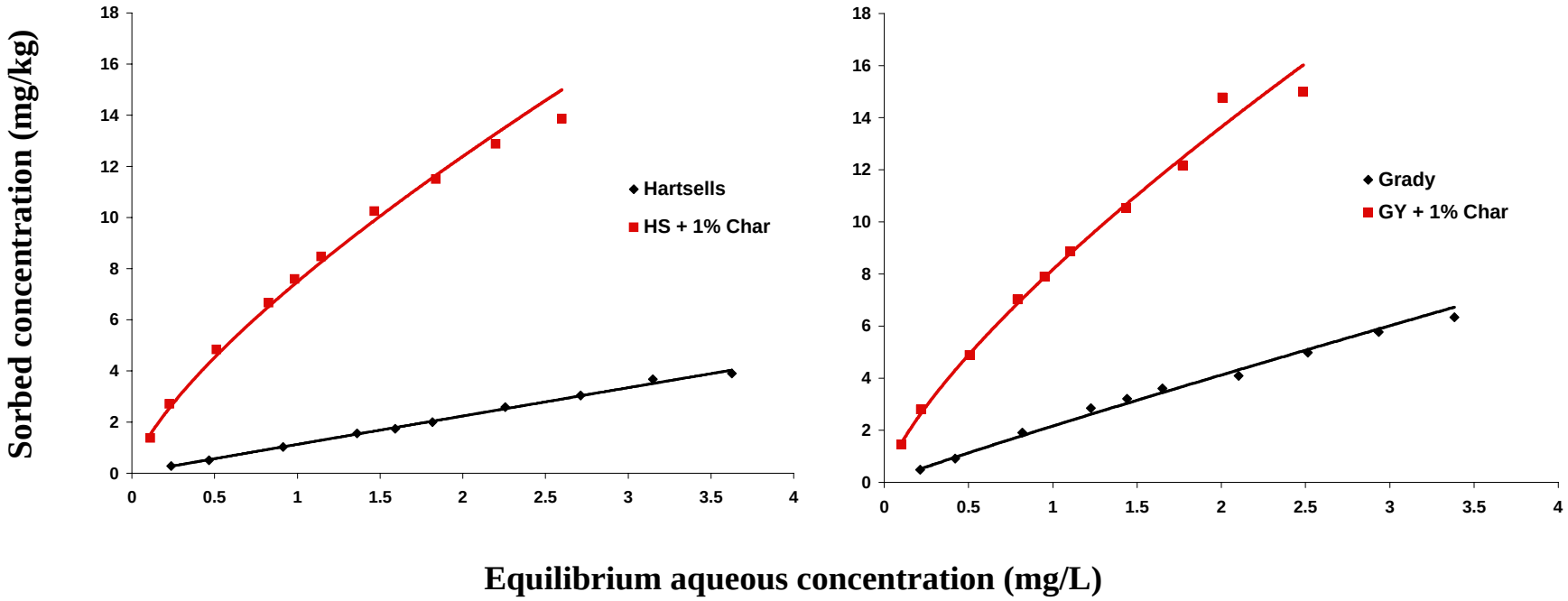
Soils used in the study

	Hartsells (HS)	**Grady** (GY)
Organic Carbon, %	1.3	2.1
pH	5.3	5.7
Texture	Sandy loam	Clay loam
Sand, %	59.1	24.7
Silt , %	32.1	42.8
Clay, %	8.8	32.5
Mineralogy		
Kaolinite, % clay	60	45
Hydroxy-interlayered vermiculite, %	15	35
Quartz, %	15	10
Mica, %	5	-

Methods

- Sorption
  - 1:10 soil to solution ratio
  - 1% char
  - 48-hr equilibration in phosphate buffer (pH 7)
- Desorption
  - Decantation and refill
- Biodegradation
  - Initial atrazine concentration: 2 mg/L
  - *Pseudomonas* sp. strain ADP
  - $^{14}CO_2$ production

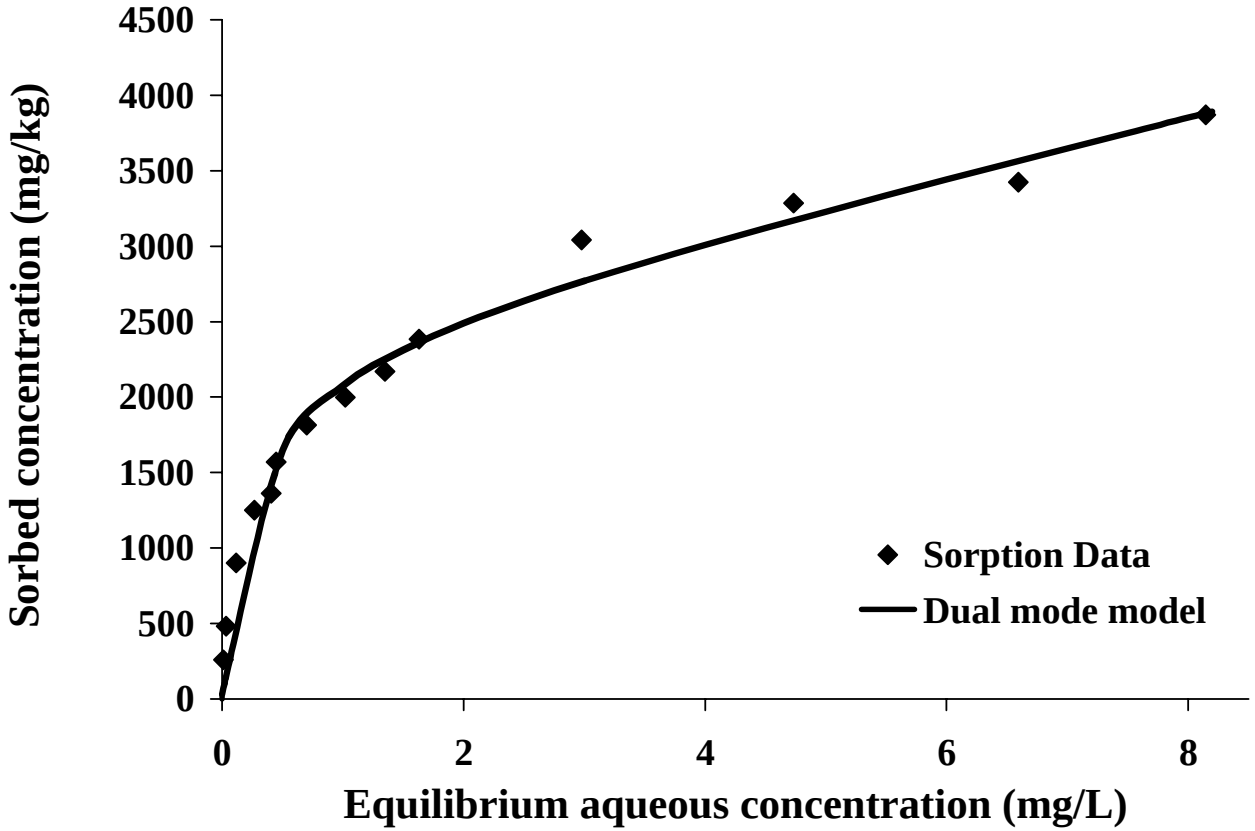
Atrazine sorption by soils and char-amended soils



	K_f	n	r^2
Hartsells	1.49	0.96	0.997
HS+char	7.51	0.72	0.995

	K_f	n	r^2
Grady	1.92	0.88	0.990
GY+char	8.19	0.73	0.997

Sorption of atrazine by char



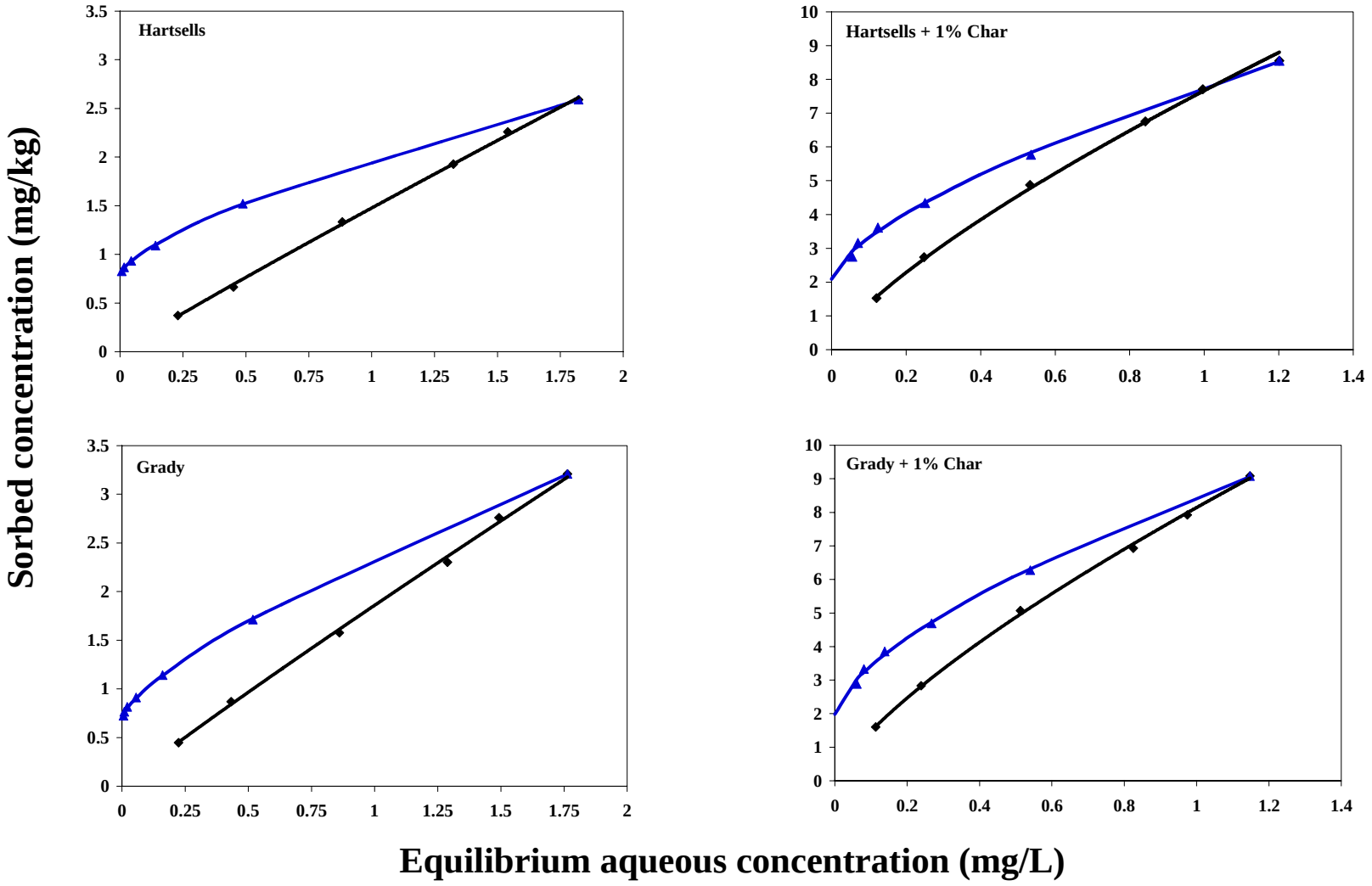
$$q_e = \frac{Q_{max} b C_e}{1 + b C_e} + K_p C_e$$

(Zhao et al. 2001)

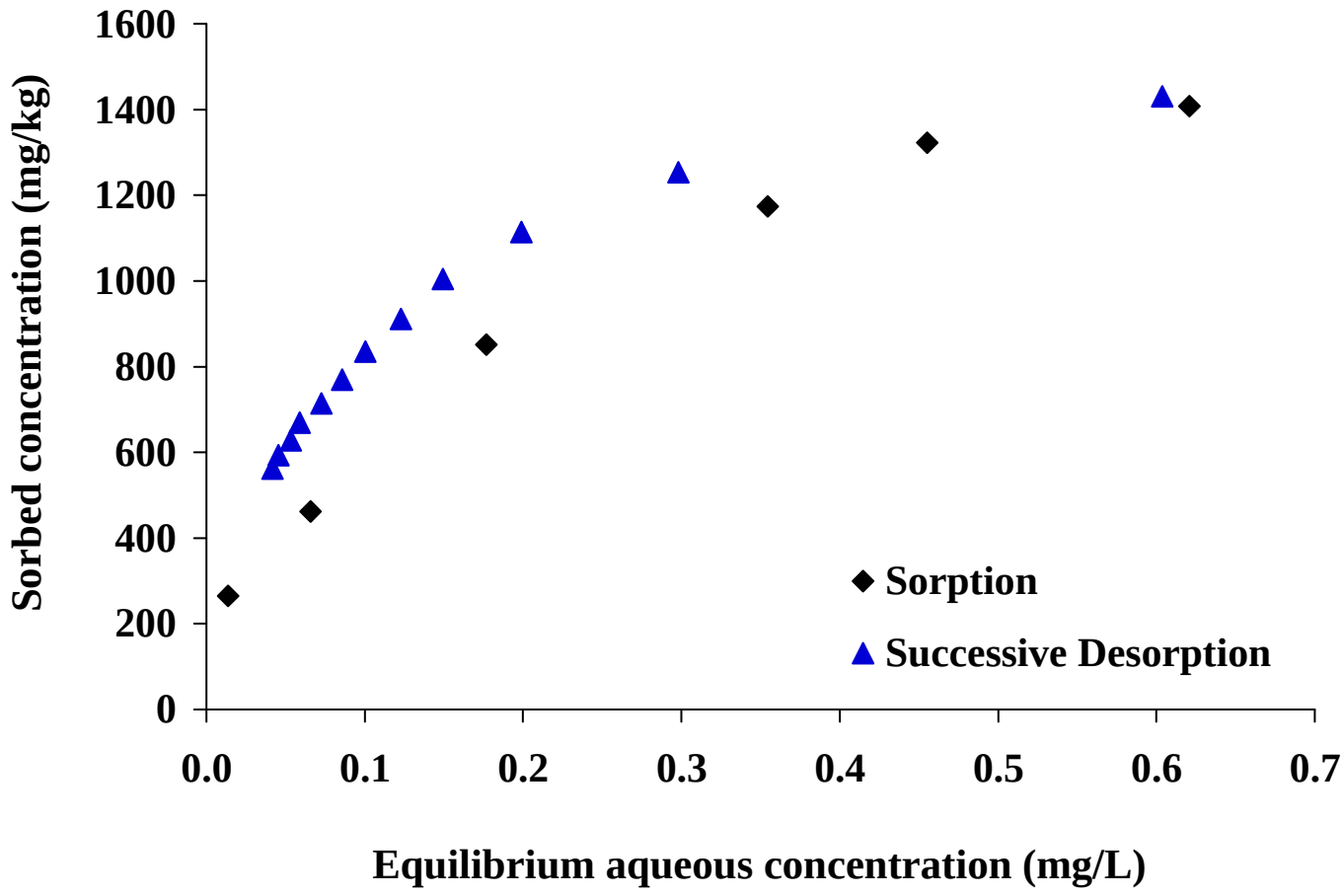
Q_{max}: 2385 mg/Kg
K_p: 194 L/Kg
b: 3.8 L/mg

$r^2 = 0.997$

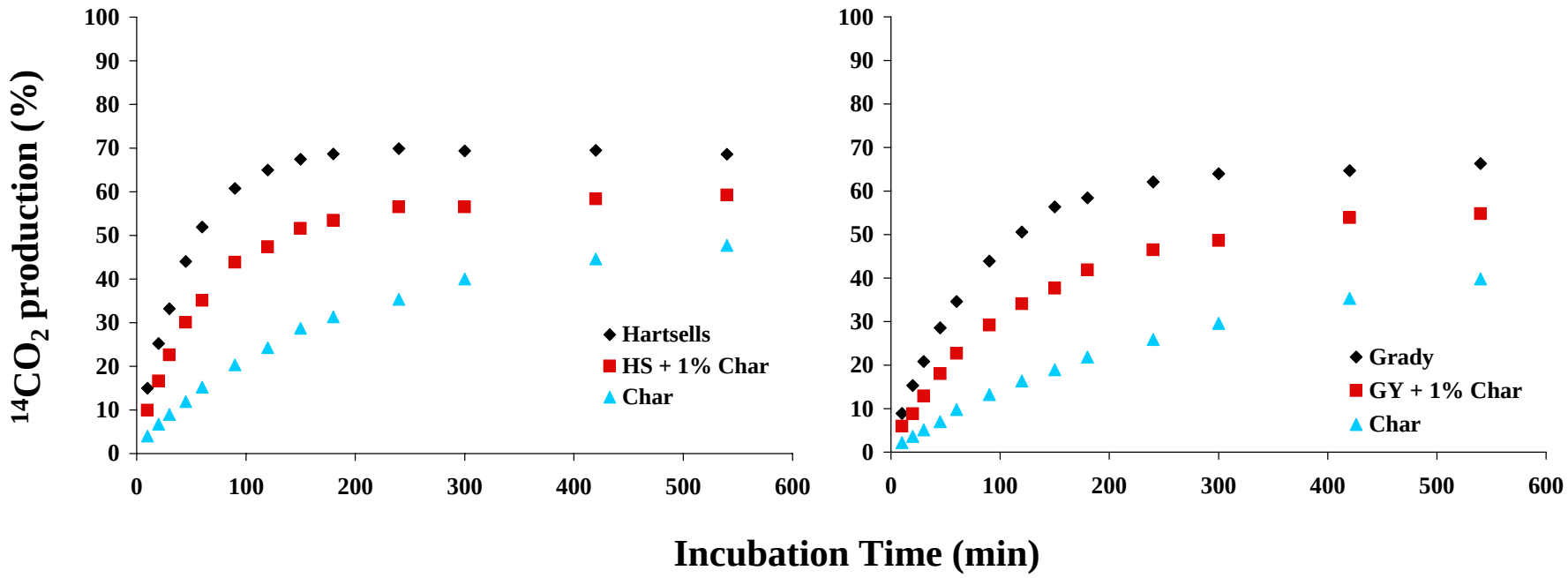
Successive desorption of atrazine



Successive desorption of atrazine from char

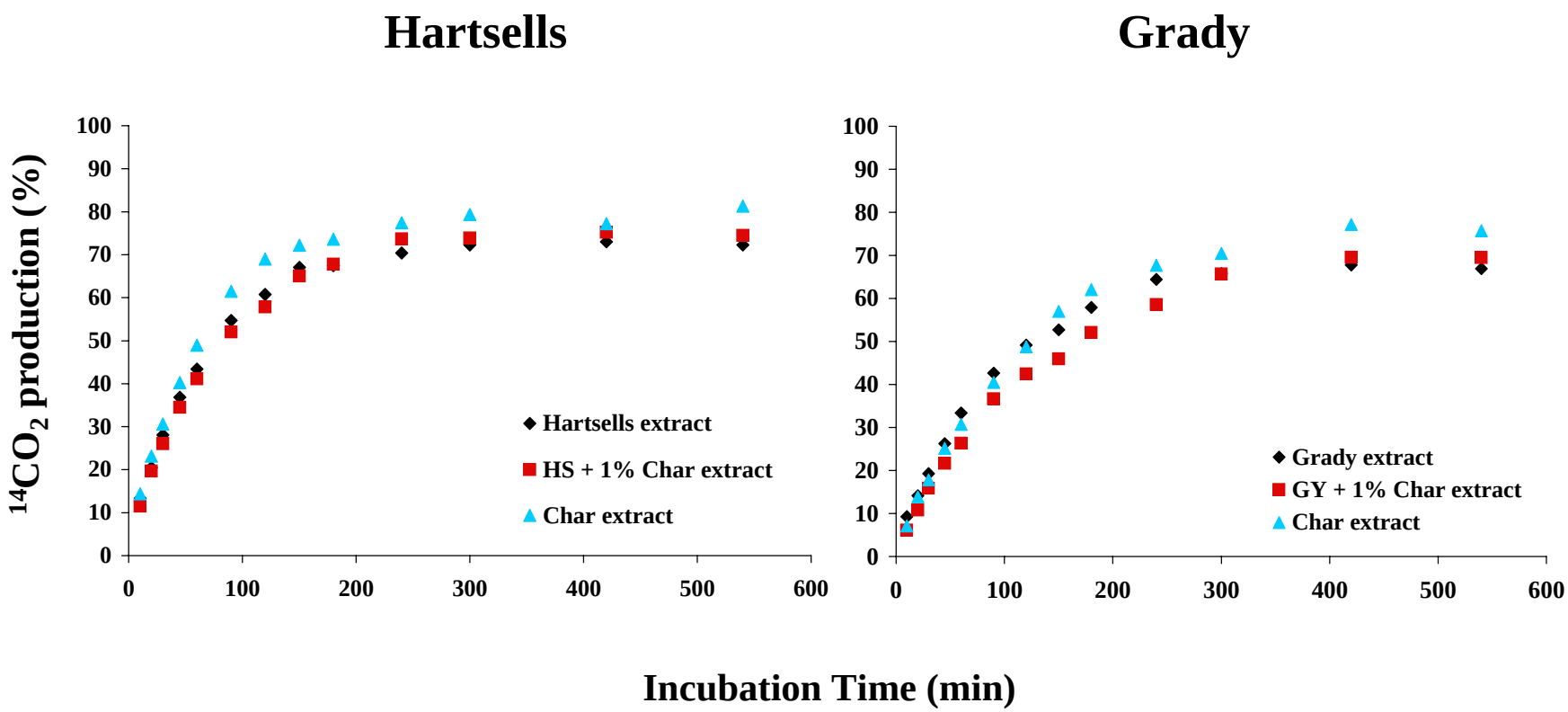


Mineralization of atrazine by *Pseudomonas* sp. ADP



	Hartsells	HS+char	Char^{HS}	Grady	GY+char	Char^{GY}
P_{max}, %	69.4	57.6	48.7	65.5	54.4	45.3
k (min^{-1})	0.0225	0.0159	0.0059	0.0126	0.0084	0.0037

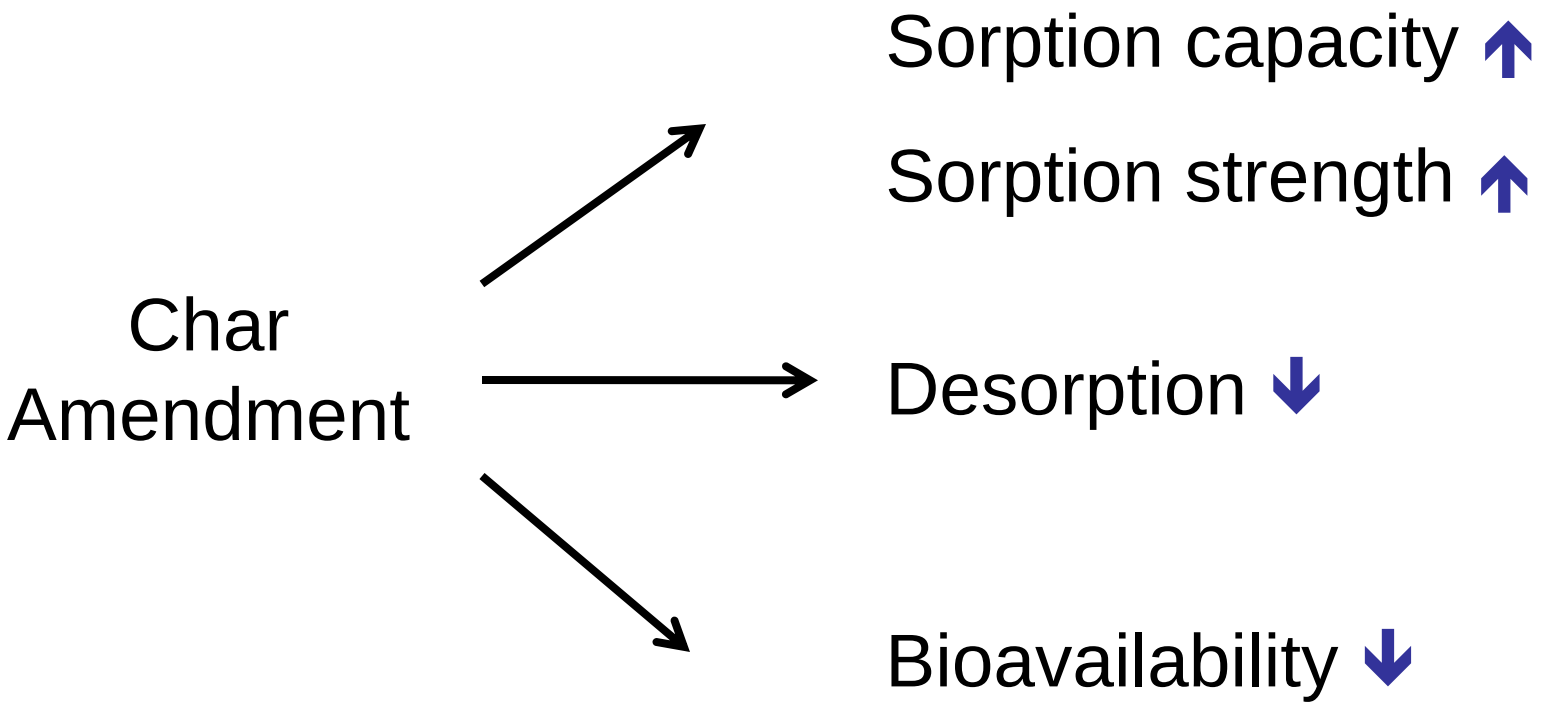
Mineralization of atrazine in sorbent extracts



Initial ^{14}C remaining (%) in sorbents after biodegradation, desorption, and extraction

	Biodegradation	**Desorption**	**Extraction**
Hartsells	6.4 ± 1.9	4.5 ± 0.5	3.2 ± 0.5
HS+char	28.1 ± 2.2	21.9 ± 0.2	5.3 ± 0.1
Grady	5.1 ± 0.3	5.3 ± 0.1	3.5 ± 0.04
GY+char	19.3 ± 4.8	25.8 ± 0.02	6.5 ± 0.5
Char	10.4 ± 8.1	NA	NA

Summary


Char
Amendment
Sorption capacity ↑
Sorption strength ↑
Desorption ↓
Bioavailability ↓

Acknowledgements

- USDA National Research Initiative
- Alabama Agricultural Experiment Station