Aminocyclopyrachlor sorption to biochar-amended soils.

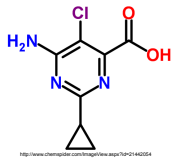
Jennifer L. Rittenhouse, Pamela J. Rice, Kurt A. Spokas, William C. Koskinen

USDA-Agricultural Research Service, Saint Paul, MN 55108

INTRODUCTION

Aminocyclopyrachlor is a new herbicide active ingredient, classified as a "pyrimidine carboxylic acid". It is approved for use to control broadleaf weeds and brush on non-cropland and turf. There is interest in amending soils with activated charcoal or biochar to reduce off-site transport of aminocyclopyrachlor, due to its potential mobility in some soils. Aminocyclopyrachlor adsorption to biochar and biochar-amended soils has not yet been evaluated. This study examined the adsorption of aminocyclopyrachlor to biochar and biochar-amended soils using the batch-equilibrium method. The adsorption was determined by liquid scintillation counting of radio-labeled aminocyclopyrachlor. This analysis included surface (0-15 cm depth) and subsurface (15-30 cm depth) soils from three sites in Minnesota. The soils were amended with biochars from seven different feed stocks.

Aminocyclopyrachlor structure and properties

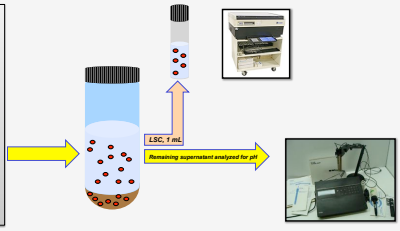


Chemical class: pyrimidine carboxylic acid

Property	Value
Molecular weight	213.6 amu
pK_a	4.65
Log K_{OW}	-2.48
Water solubility	3.13 - 4.20 g L^{-1}
Vapor pressure	6.92 × 10^{-6} Pa at 20°C

MATERIALS & METHODS

10 g dried, 2 mm sieved soil + 1 g biochar + 20 mL of 0.30 mg L^{-1} ^{14}C-Aminocyclopyrachlor in 0.01 N $CaCl_2$



CONCLUSIONS

- Aminocyclopyrachlor adsorption to biochar-amended soils was driven more by biochar selection than soil type (Figure 1).
- Sorption was greater in surface soils than in subsurface soils, in general (Table 2).
- Sorption to biochar varied due to differences in biochar characteristics (Table 1).
- Biochars from pinewood, cornstover, wood chip, and wood pellet feed stocks sorbed less aminocyclopyarachlor than when they were added to soil.
- Steam-activating wood chip biochar doubled adsorption capacity.
- Biochar from olive mill waste feedstock was the only biochar to adsorb more aminocyclopyrachlor than soil.
- Activated charcoal adsorbed 100% of aminocyclopyrachlor.
- Aminocyclopyrachlor sorption is not impacted by low-temperature, non-activated biochar amendments.
- Further studies are suggested to understand desorption of aminocyclopyrachlor from activated charcoal amendments.

^{14}C-Aminocyclopyrachlor kindly donated by DuPont

RESULTS

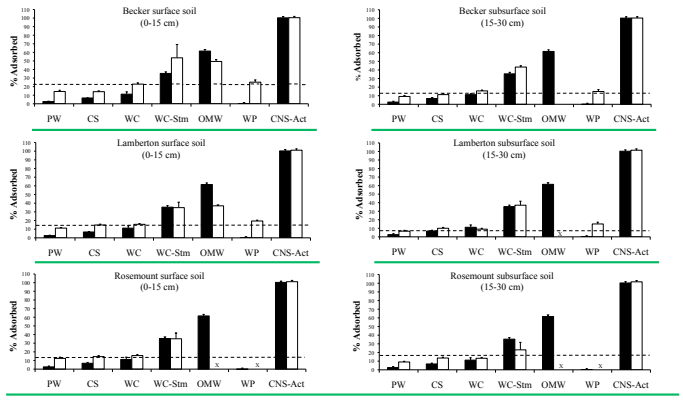


Figure 1. Percent aminocyclopyrachlor adsorbed to non-amended soil (dashed line), biochar-only (black bar), and biochar-amended soil (white bar). "X" denotes no data. Biochars arranged from lowest to highest surface area (Table 1).

Table 1. Characteristics of black carbons (biochar, activated biochar, activated charcoal).

Biochar ID	Biochar feed stock	Production temp (°C)	Surface area (m^2 g^{-1})	Carbon content (%)	O:C molar ratio	Ash content (%)	pH
PW	Pine wood	490	0.52	35	0.11	58	7.3
CS	Cornstover	490	0.82	37	0.08	57	9.0
WC	Wood chip	~500	1.6	74	0.18	5.0	6.6
WC-Stm	Wood chip (steam activated)						
OMW	Olive mill waste	700	34	16	0.28	77	11.2
WP	Wood pellet	650	62	73	0.19	6.4	6.8
CNS-Act	Coconut shells (activated charcoal)	450/1100	956	88	9.0 × 10^{-5}	14	6.9

Table 2. Soil properties and aminocyclopyrachlor sorption coefficients.

Soil type	Soil pH	%OC	% Clay	Texture	K_d	K_{OC}
Becker, MN surface (0-15 cm) soil	5.6	1.6	10	Sandy loam	0.63 ± 0.03	39 ± 2.1
Becker, MN subsurface (15-30 cm) soil	5.7	1.2	8	Loamy sand	0.28 ± 0.00	23 ± 0.21
Lamberton, MN surface (0-15 cm) soil	6.4	2.7	36	Clay loam	0.34 ± 0.03	13 ± 0.95
Lamberton, MN subsurface (15-30 cm) soil	7.0	2.1	30	Clay loam	0.17 ± 0.00	8.0 ± 0.18
Rosemount, MN surface (0-15 cm) soil	7.0	3.2	18	Silt loam	0.31 ± 0.10	9.8 ± 3.0
Rosemount, MN subsurface (15-30 cm) soil	7.2	2.8	10	Silt loam	0.40 ± 0.08	14 ± 3.1

For further information please contact ***Jennifer.Rittenhouse@ars.usda.gov***