

Stability of biochar in contrasting soils of Australia

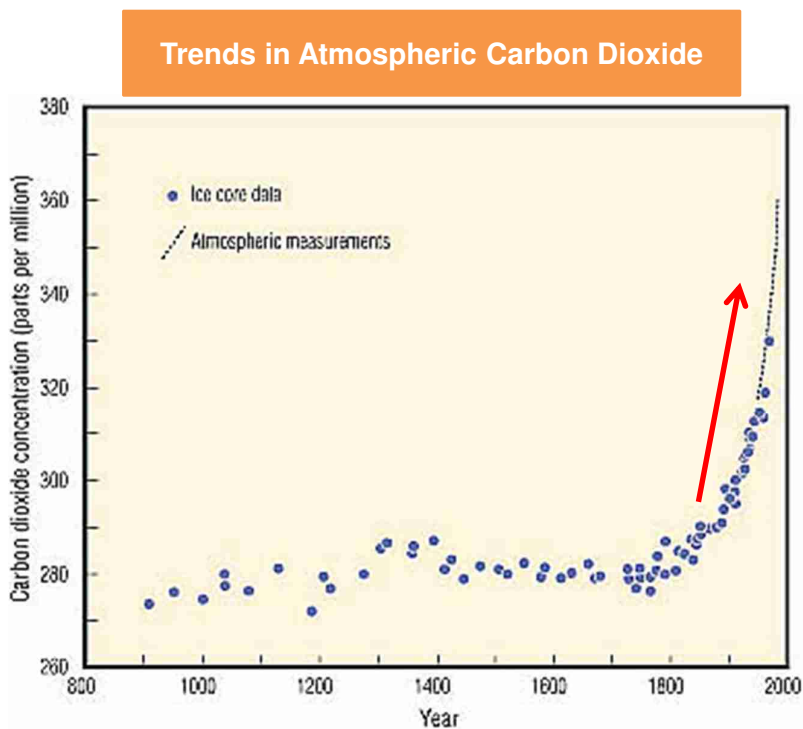
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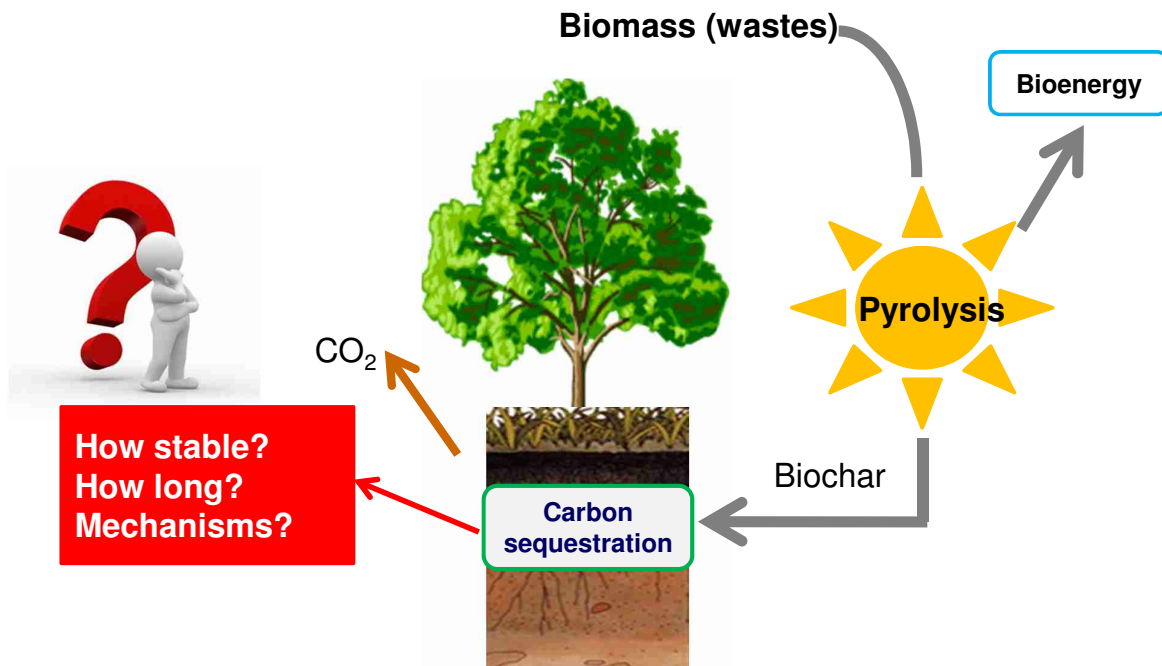


Background



Source: U.S. Global Change Research Information Office

Biochar application to the soil, in conjunction with bioenergy generation, can result in carbon sequestration



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Research questions

- Does the stability of biochar vary with biochar produced at different pyrolysis temperature, soil type and environmental conditions?
- How does biochar presence affect soil organic matter mineralization?
- Can biochar-mineral interactions play a role in enhancing biochar-C stability in soil?

Materials and Methods

Biochars: Wood biochar was produced at 450 and 550°C by slow pyrolysis from a ^{13}C -depleted (-36‰) woody biomass of *Eucalyptus saligna*.



Property	Biochar 450	Biochar 550
pH (1:5 H ₂ O)	8.64	9.96
EC (1:5 mS/m)	89.4	112.7
$\delta^{13}\text{C}$ ‰	-36.3	-36.5
Total carbon (%)	67.4	73.2
Total nitrogen (%)	0.5	0.6
CEC (mmol _c /kg)	11.4	54.0
SSA (m ² /g)	191	228
Pore volume (cm ³ /g)	57	68

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Physico-chemical properties of the experimental soils

Property	WA	SA	Qld	NSW
pH (1:5 H ₂ O)	5.70	8.77	7.89	5.65
EC (1:5 mS/m)	8.2	24.5	13.0	15.0
Clay (%)	1.3	21.5	44.2	44.1
CEC-AgTU	24	99	265	120
OC (%)	0.95	2.53	2.25	4.39
IC (%)	-	6.01	-	-
$\delta^{13}\text{C}$ (‰)	-28.2	-14.1	-17.3	-21.4
TN(%)	0.07	0.16	0.16	0.43
Clay minerals	Kaolinite, quartz, illite	Illite, kaolinite, calcite	Smectite, kaolinite	Goethite, gibbsite, kaolinite, hematite

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Experimental procedures



- Biochars (450 and 550 °C, 2% w/w) was mixed with 300 g (oven dry basis).
- Nutrients solution
- Moisture at 70% WHC
- 4 replications

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Experimental procedures

- The soil samples with or without biochar were incubated in 1.2 L sealed plastic buckets for 6 months at 20° C, 40° C and 60° C.
- Gas sampling and analysis ($^{13}\text{CO}_2\text{-C}$ and total $\text{CO}_2\text{-C}$) performed at 2, 4, 8, 16, 32, 60, 90, 120, 183 days, to evaluate the oxidation of biochar-C.



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Biochar-derived C in the respired CO₂ can be determined using the mass balance approach

$$C_{\text{Biochar}} (\%) = \frac{(\delta^{13}\text{C}_T - \delta^{13}\text{C}_S)}{(\delta^{13}\text{C}_B - \delta^{13}\text{C}_S)} \times 100$$

$C_{\text{Biochar}} (\%) =$ Fraction of biochar-derived C

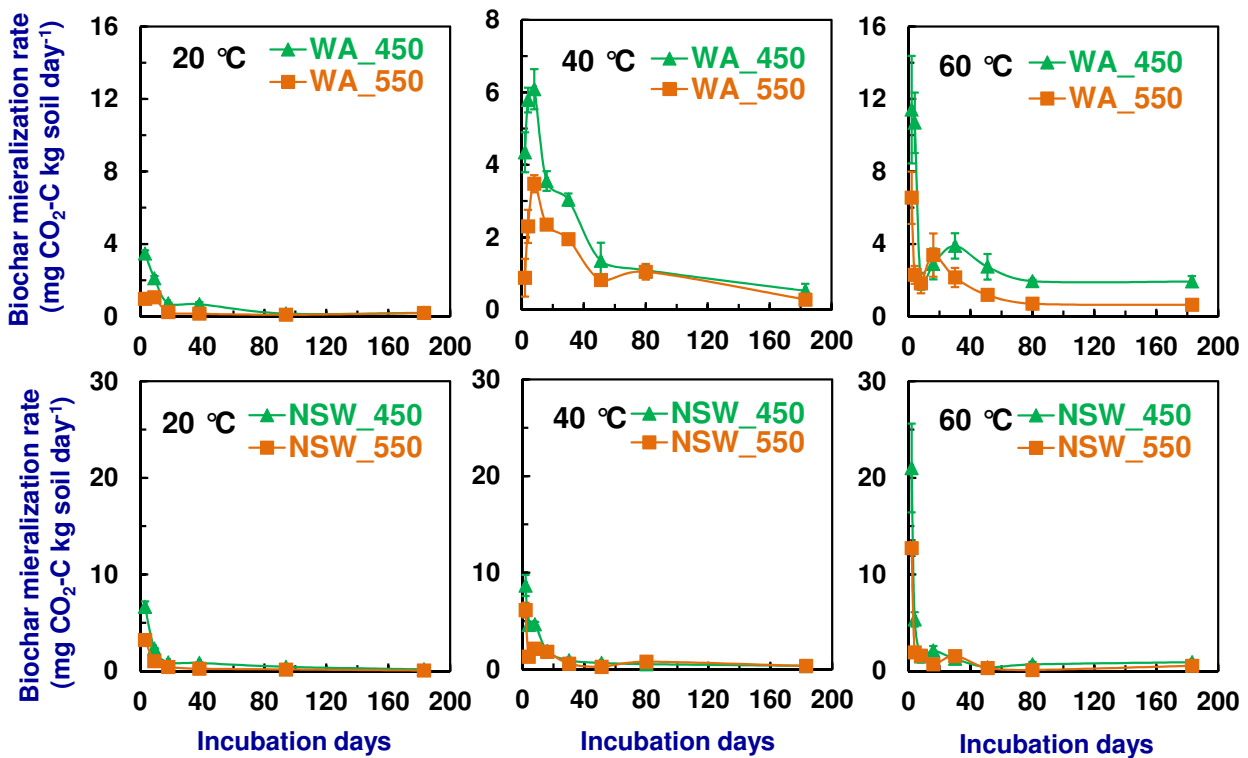
$\delta^{13}\text{C}_T$ = $\delta^{13}\text{C}$ signature of total respired CO₂ from biochar-amended soil

$\delta^{13}\text{C}_B$ = $\delta^{13}\text{C}$ signature of ¹³C-depleted-biochar

$\delta^{13}\text{C}_S$ = $\delta^{13}\text{C}$ signature of control soil-C

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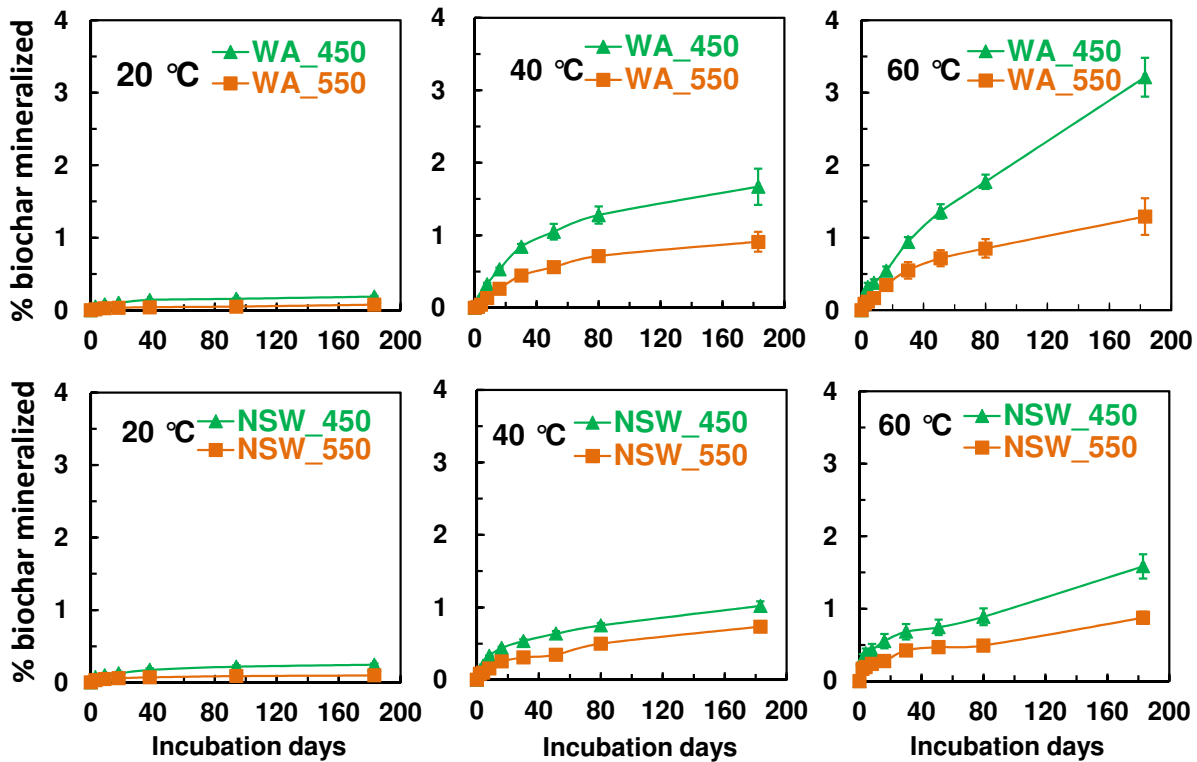
Biochar mineralization rate



60°C > 40°C > 20°C
Initially, NSW > WA
Biochar: 450 > 550

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% biochar mineralized



60 °C > 40 °C > 20 °C

40 and 60 °C: NSW lowest compared other soils

Biochar: 450 > 550

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Biochar priming effect on native soil organic matter mineralization

$$PE = C_{SB} - C_s$$

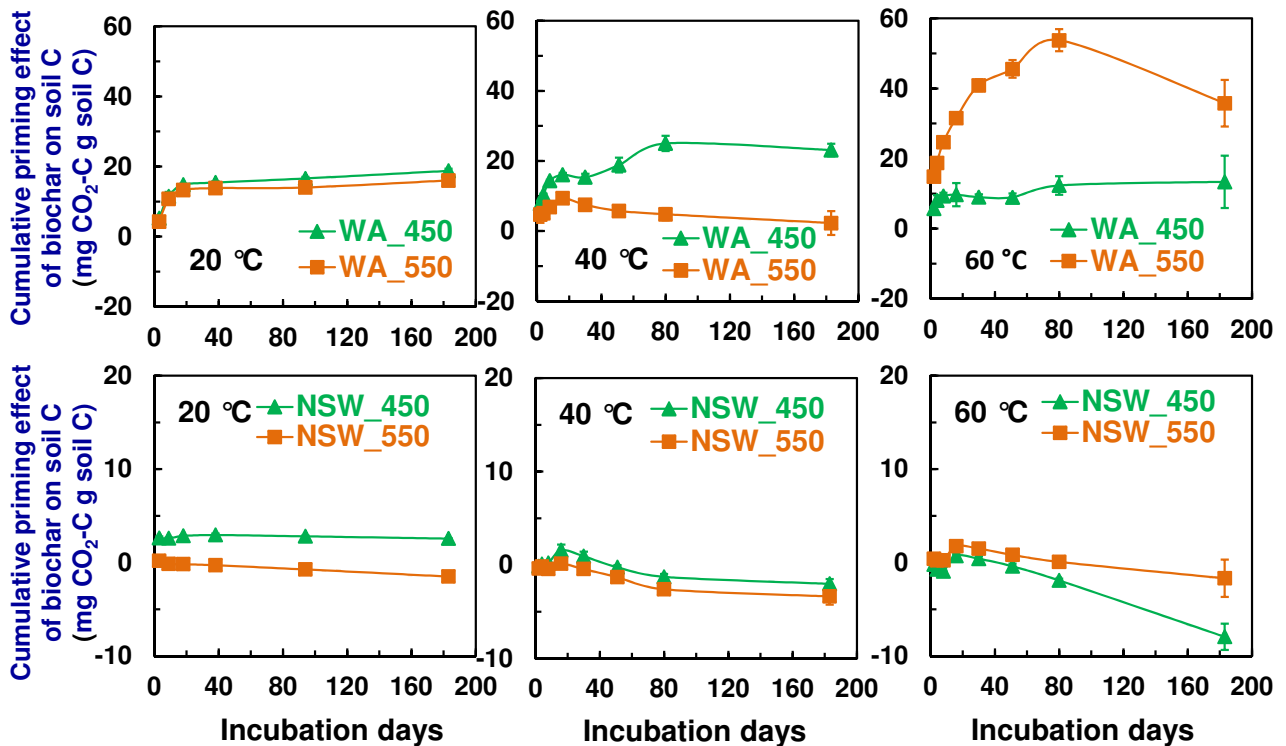
PE = The priming effect of biochar on soil

C_{SB} = Soil-derived CO₂-C in the presence of biochar

C_s = Soil-derived CO₂-C in the absence of biochar

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Cumulative priming effect of biochar on SOC



WA: positive priming on SOC

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Conclusions

- Biochar carbon mineralisation rate increased with increasing incubation temperature;
- Biochars stability is affected by soil type, Ferrosol reduced biochar-C mineralization (more stable) compared to other soils;
- Biochar produced at 550° C is more stable than the 450°C biochar in all soils.
- In WA soil, biochar had a positive priming effect on native SOC

Acknowledgements

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