Biochars in the Desert Southwest: Challenges and Opportunities

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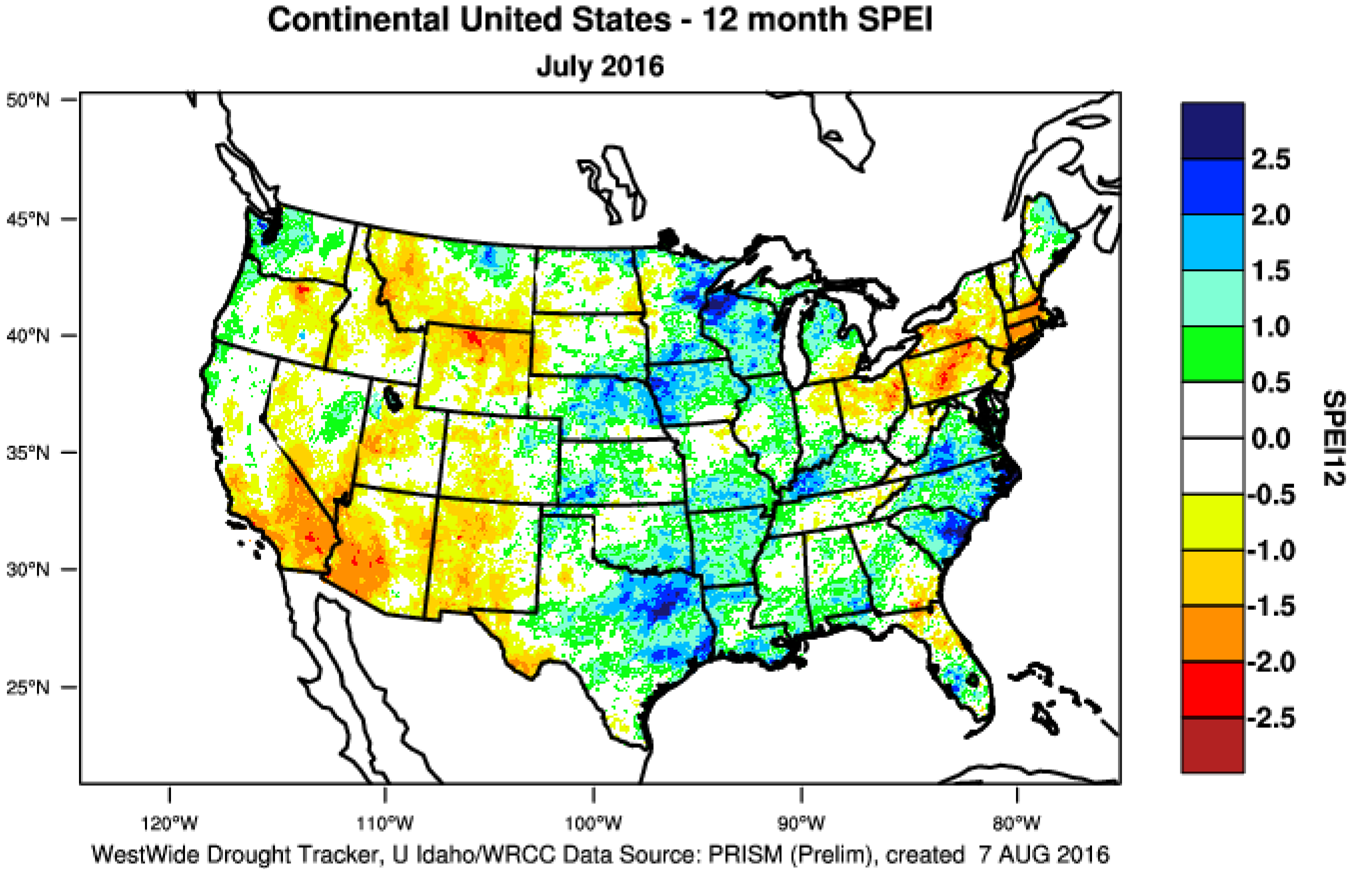
Outline

- Introduction to Desert Soils
- Completed Study: Biochars from Four Local Feedstocks
- New Study: Halophytes, Salts, and Biochars

Desert Soils: Evapotranspiration vs. Precipitation

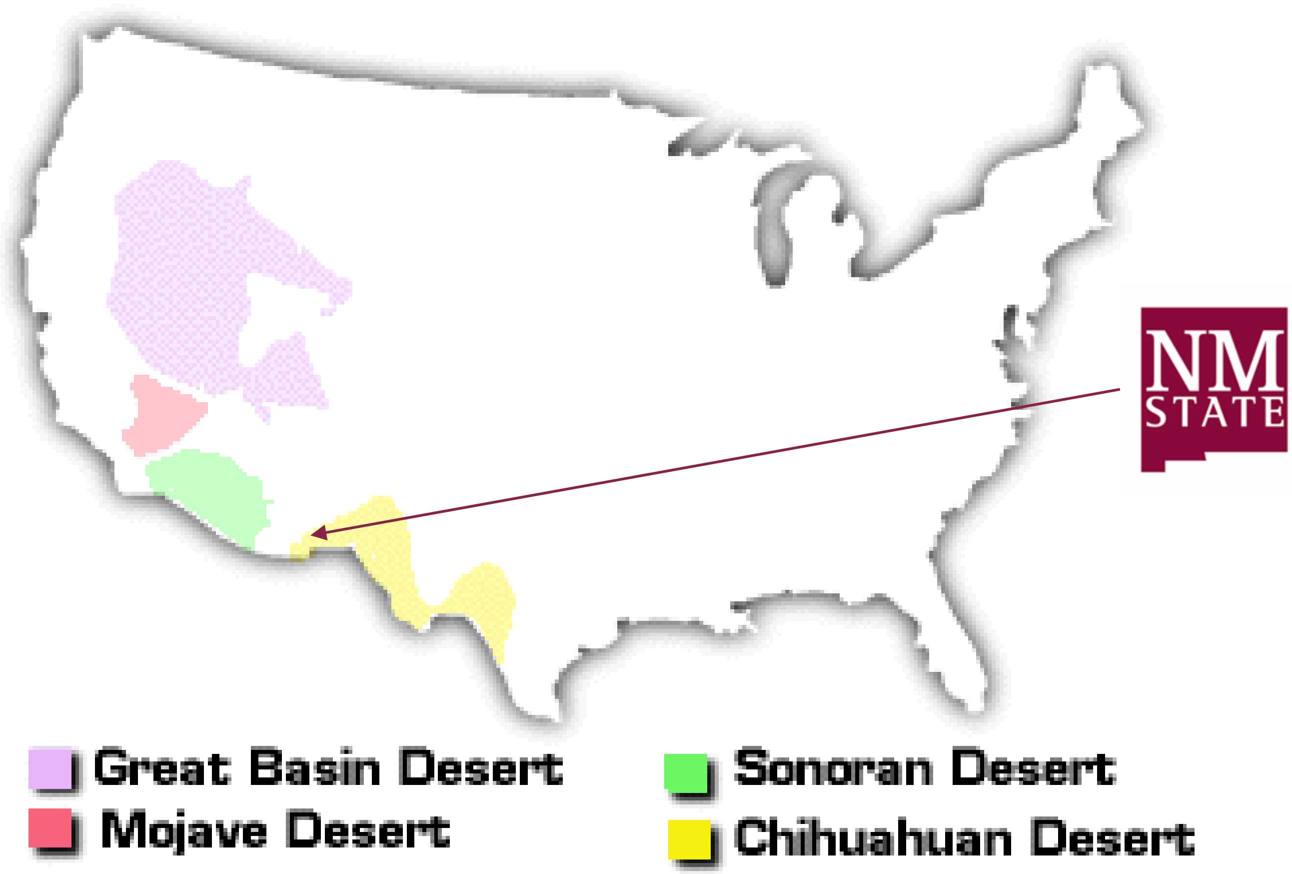


https://www.ncdc.noaa.gov/monitoring-content/sotc/drought/2016/07/noaa-wrcc-prism-spei-us-jul16-12m.png

Desert Soils:
Salinity, pH and SAR

- Saline soil = soil where electrical conductivity (EC) > 4 dS/m
- Sodic soil = soil where sodium adsorption ratio (SAR) > 13 and pH > 8.5
- pH usually alkali (> 7)

Mesilla Valley, New Mexico



http://www.desertusa.com/buttons/usamap.gif

Available Biomass

15,000 tons/year

2,000 tons/year

35,000 tons/year

725,000 tons/year

∞

Slow Pyrolysis

Agricultural Soils

Soil	pH	Electrical Conductivity ($dS \cdot m^{-1}$)	Soil Organic Matter (wt. %)	Sodium Adsorption Ratio
Sandy Loam	7.3	1.49	0.08	1.03
Clay Loam	7.1	5.94	0.11	3.43

Zhang, Y.; Idowu, O.J.; Brewer, C.E. *Agriculture* **2016**, 6, 10; doi:10.3390/agriculture6010010.

Biochar Properties (450° C, 1 hour)

Biochar	Yield (%)	pH	EC ($dS \cdot m^{-1}$)	C (%)	Ash (%)
Pecan Shell	28	8.2	3.0	76	4
Pecan Pruning	35	9.5	2.7	72	11
Cotton Gin Trash	42	8.4	44.6	55	32
Yard Waste	32	9.7	2.0	83	19

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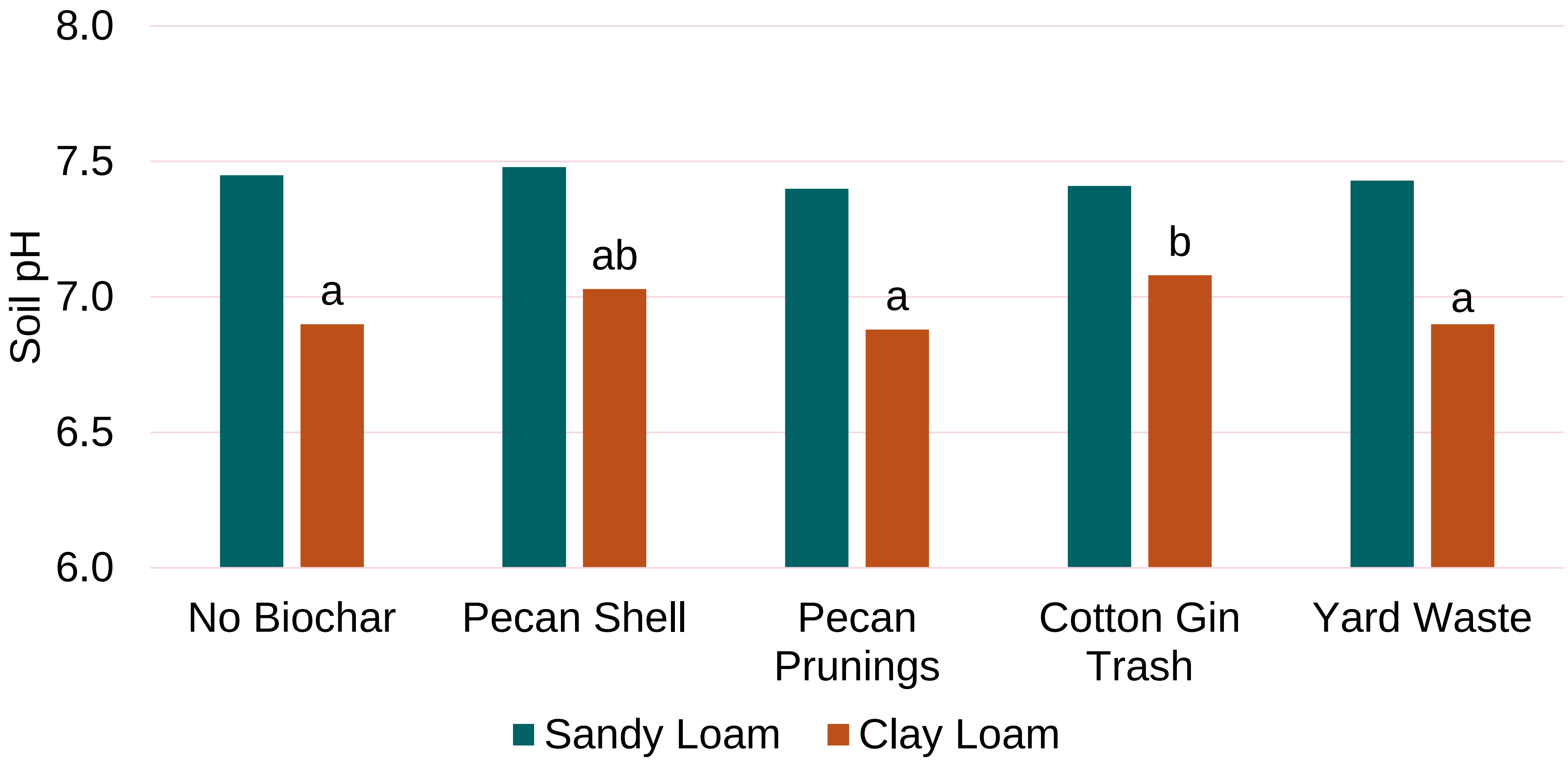
Biochar addition did not affect soil pH much—not a concern here.



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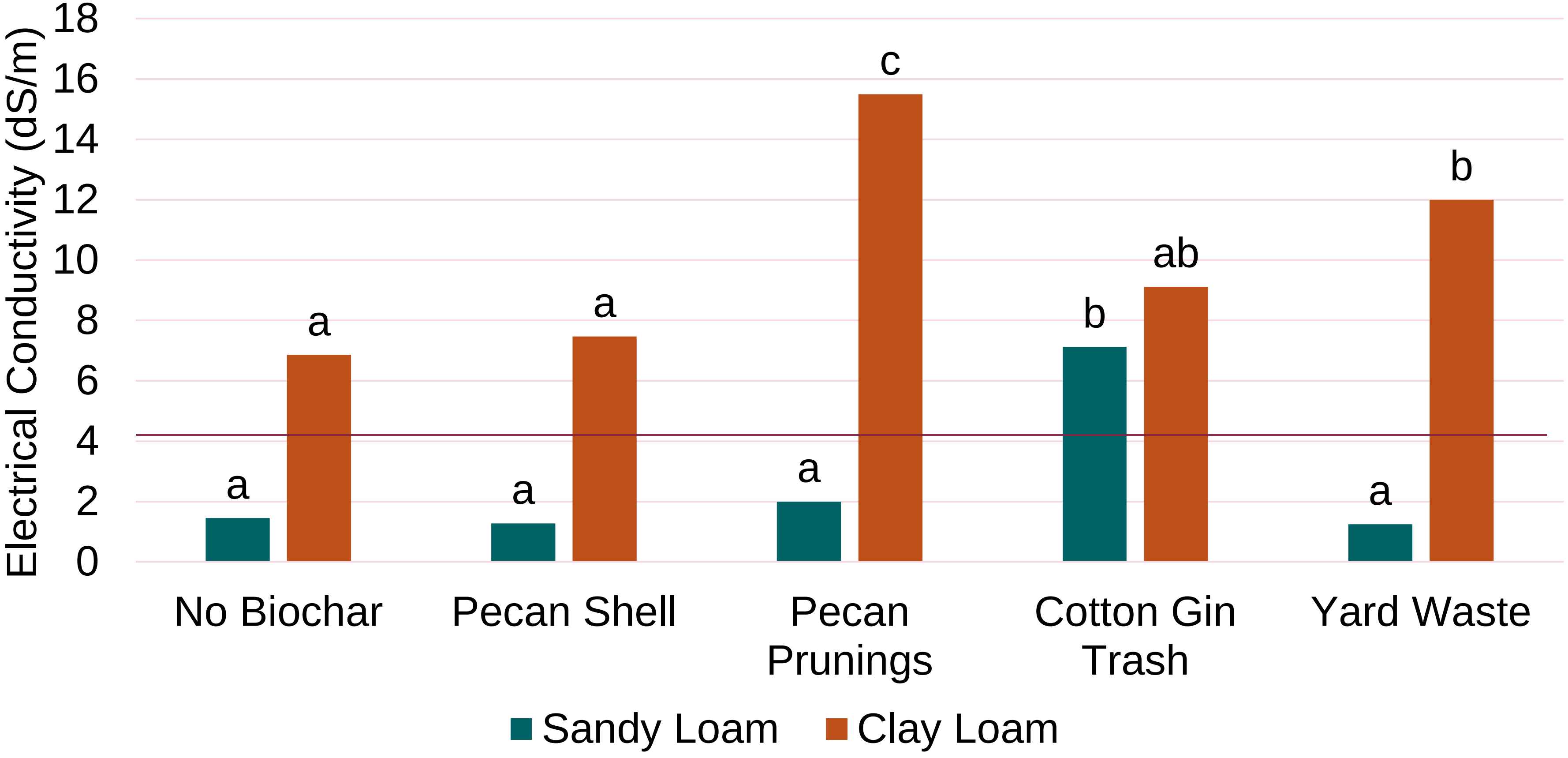
Some biochars did increase soil—this is a concern.



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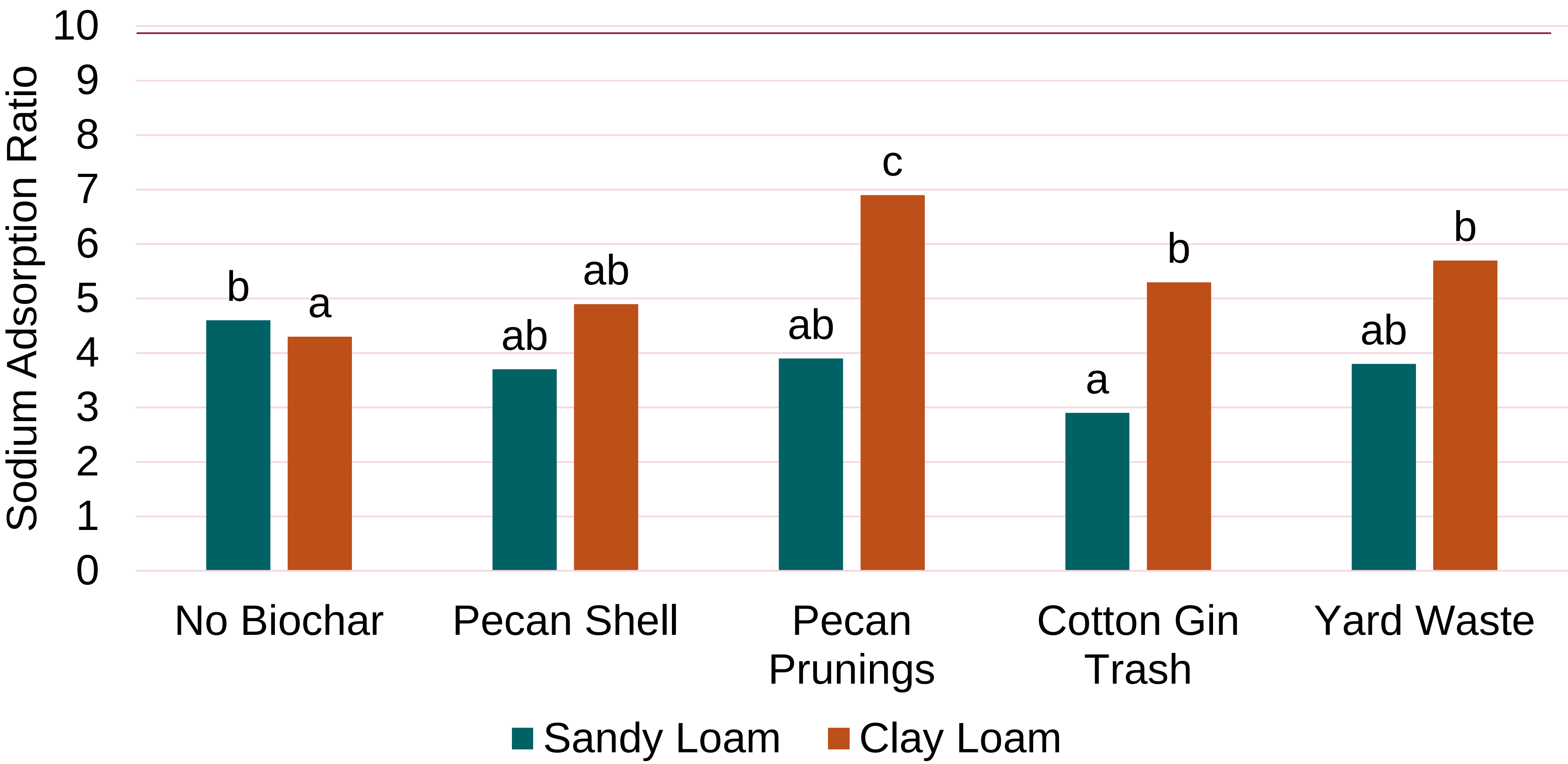
Biochar increased SAR for clay loam soil—not a concern here.



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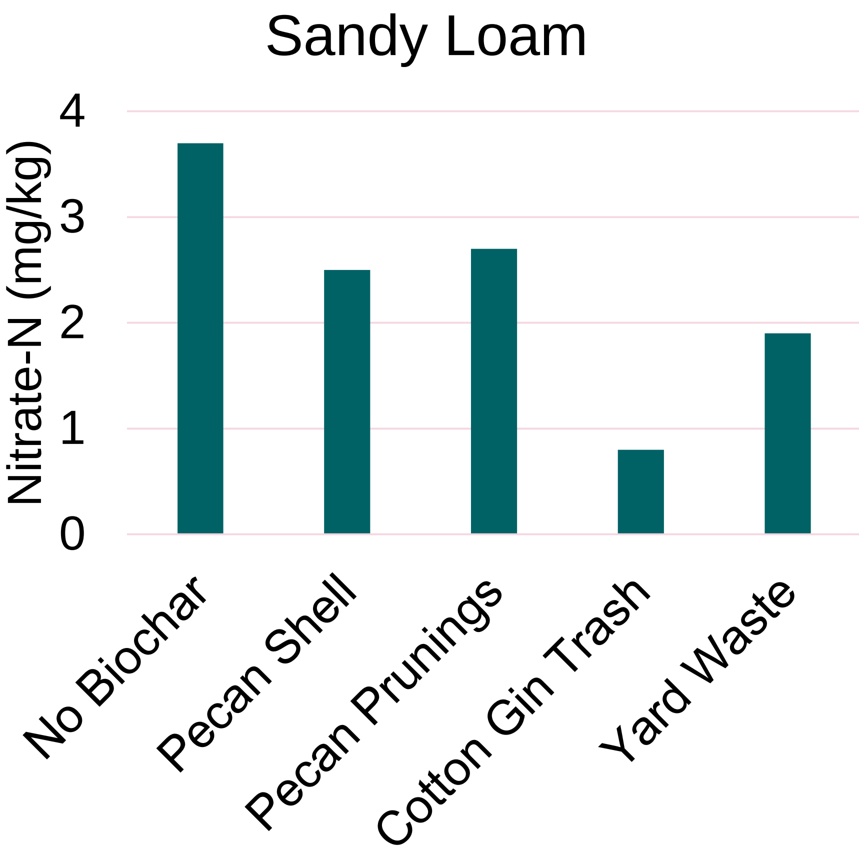
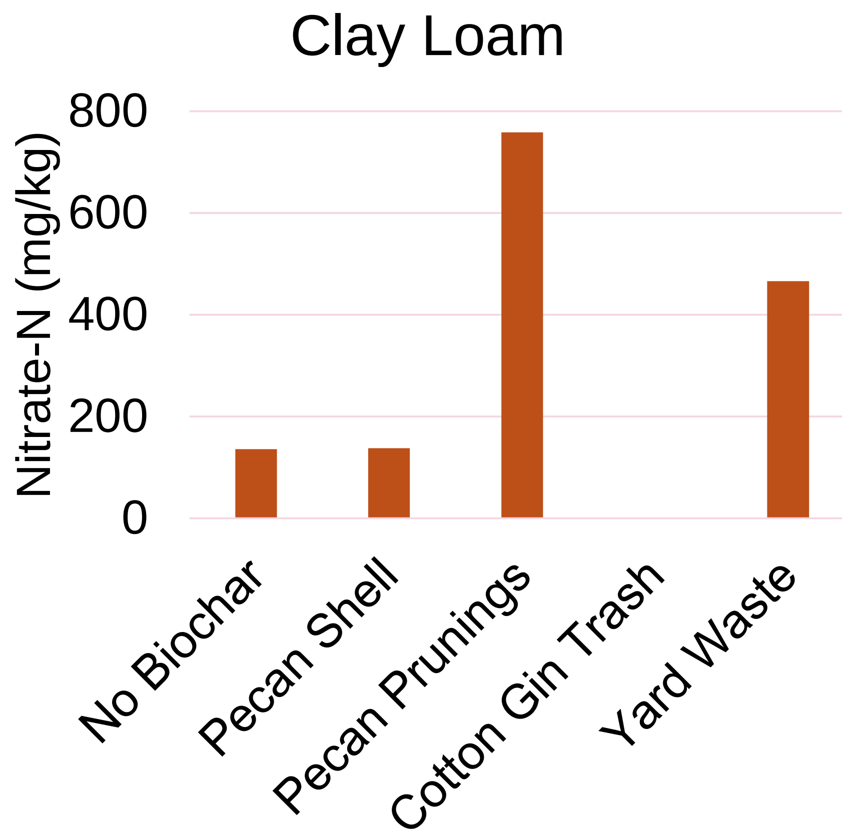
Nitrogen immobilization showed that cotton gin trash biochar was under-baked.





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Take Away Messages

- Desert soils are usually low in organic matter; biochar additions may improve aggregate stability and soil moisture retention.
- Biochar effects on soil pH, salinity and sodium adsorption ratio must be considered; there is not enough water to leach out excess salts.
- More research is needed with plants…

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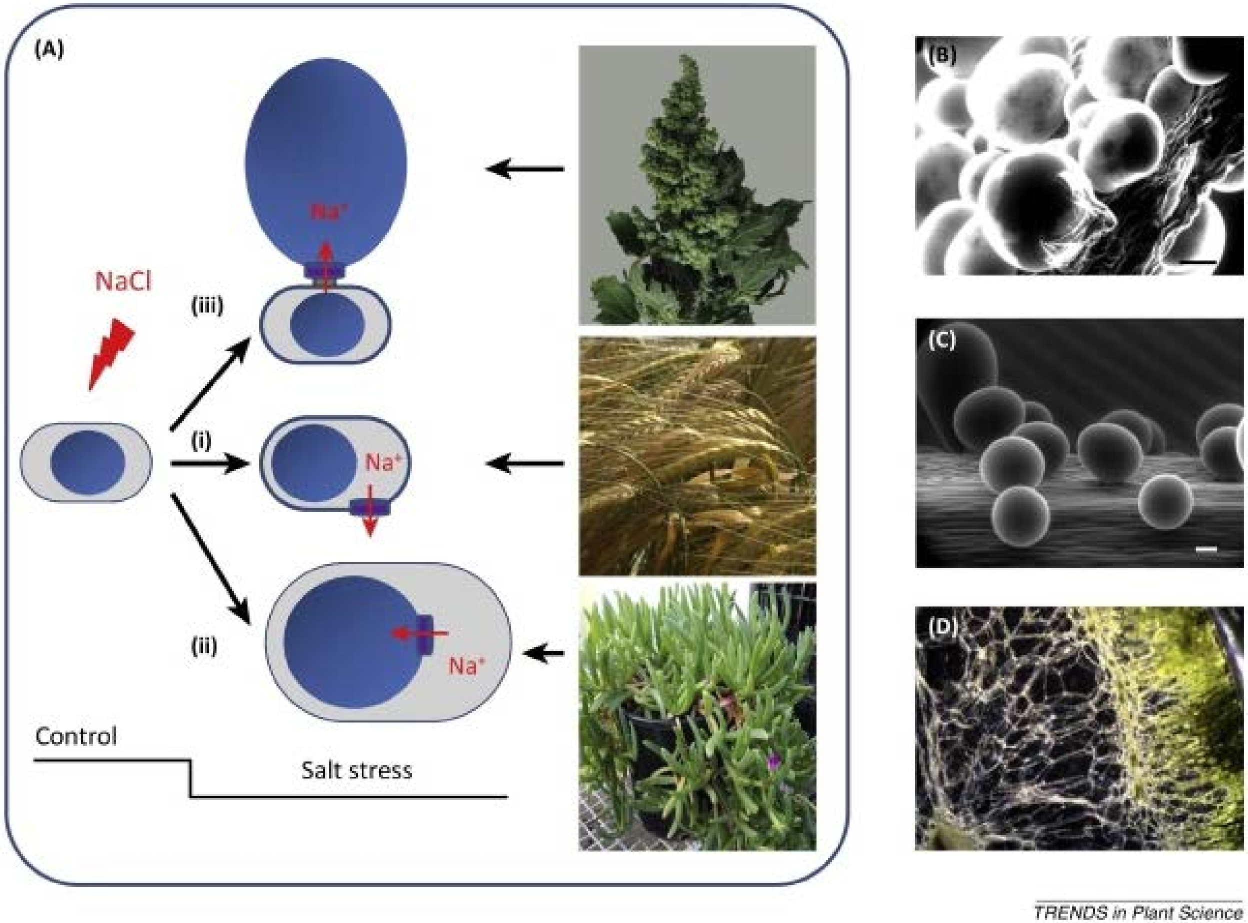
New Study: Salt Immobilization through Halophytes and Pyrolysis

Water dissolves soil minerals, making salts transportable and available to plants.

Irrigation with salty water, combined with evaporation >> precipitation, creates high salt concentrations in soils.

Halophyte Biomass



Shabala, et al. *Trends in Plant Science* **2014**, *19 (11),* 687-691.

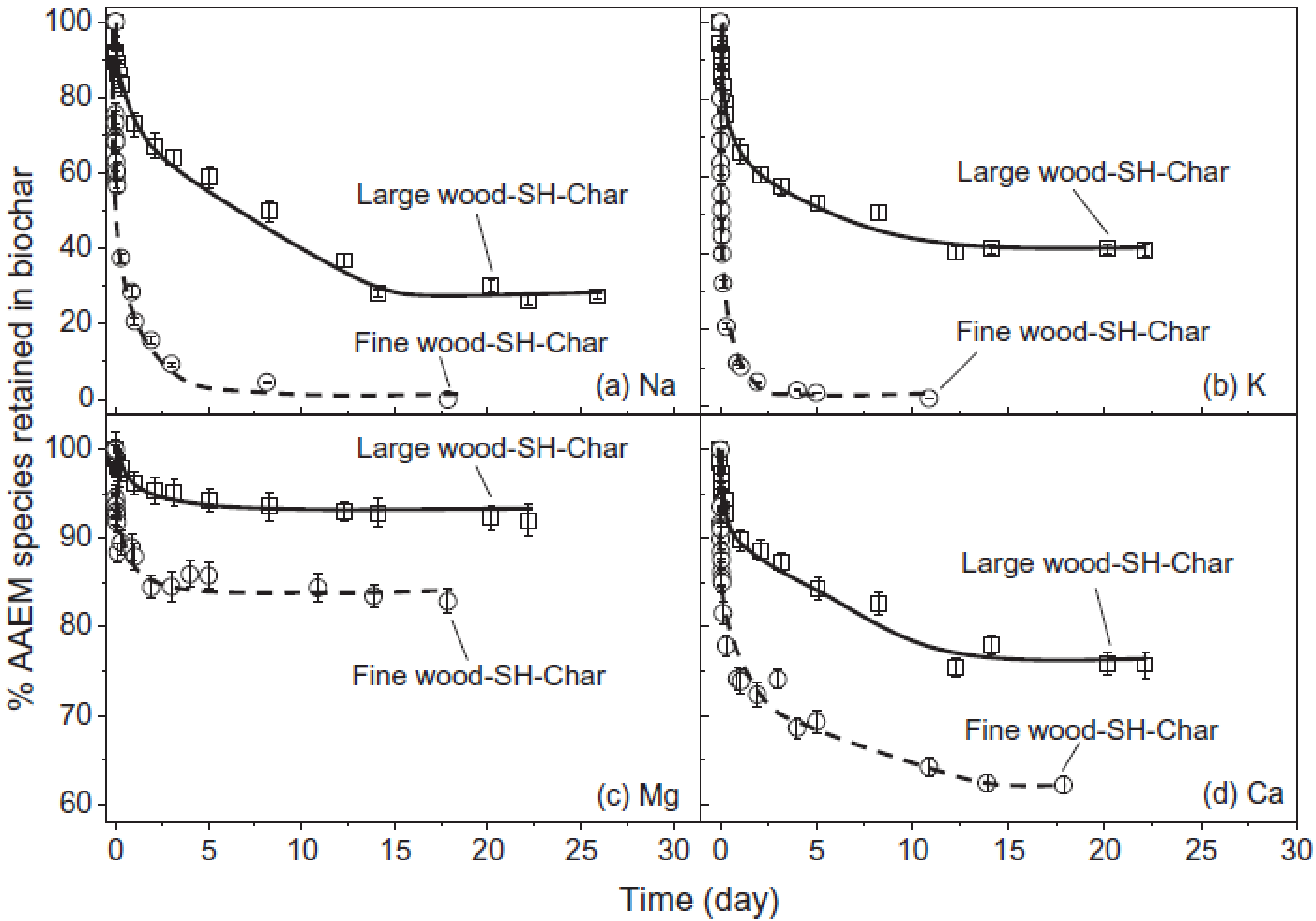
Halophyte Biomass

Atriplex canescens

Four Wing Saltbush

Atriplex lentiformis

Big Saltbush



Kong, et al. *Fuel* **2014**, *128*, 433-441.

What if…

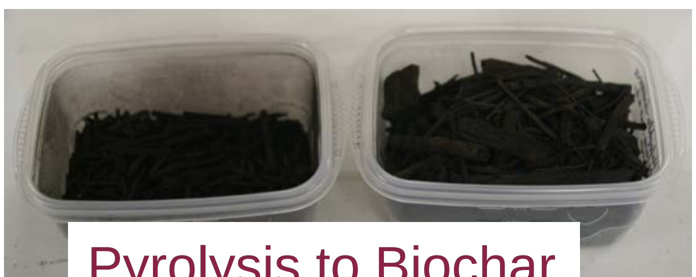
Salts could be removed from the soil into halophyte biomass…

And that salt could be trapped in mineral form by making biochar out of that halophyte biomass?

Constructing Salt Balances Across the Pyrolysis Process

Growth

Collection



Pyrolysis to Biochar

Leaching

Analysis

First Mass Balances

A canescens 400° C Biochar

Element	Before Leaching (mg/kg)	After Leaching (mg/kg)	% Leached
Ca	4361	3984	9
Mg	4162	3339	20
K	20863	15483	26
Na	762	661	13

A lentiformis 400° C Biochar

Element	Before Leaching (mg/kg)	After Leaching (mg/kg)	% Leached
Ca	21370	9330	44
Mg	9322	4292	46
K	46320	29890	65
Na	29525	19610	66

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Questions?
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