CARDBOARD AND CHIPBOARD BIOCHARS

impact on episodic drought and reversing soil contamination

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UMASS BOSTON

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OBJECTIVES AND GOALS

- Clean, minimal harvesting and disassembly
- Production, pre-treatment and a wide variety of applications
- Easy to use metrics
- Social, economic and environmental benefits

SPECIFIC MEASUREMENT OBJECTIVES

- Moisture retention in ag, potting and contaminated soils
- Sprout biomass in ag and contaminated soils
- Inorganic/organic metals and energetics in leaves, soils and effluent

WORKING WITH CRREL

CRREL (Cold Weather Research Laboratory) in Hanover NH comprises scientists in laboratories within the U.S. Army facility in Hanover NH. There they are always looking for new methods and materials related to sustainable solutions for soil decontamination, plant restoration in decontaminated soils and improving plant reintroduction in challenging climates and environmental conditions

Short term experiments described here enable data collection and analysis which can be used to develop longer term tests of a variety of plant species and soil manipulations with biochar

METHODS

Field work

- Double barrel TLUD and Adam retort to make chars
- Chars blended with soils at 10% volume (v/v)
- 8 mm sieves for soils and chars
- 500 mL containers
- Weigh before saturation
- 250-375 mL saturation depending on test
- Reweigh on daily, weekly basis (2 to 4 month tests)

Lab work

- Grind and sieve soils and leaves for spectroscopy
- 66 cm columns to test effluent

ENVIRONMENTAL CONSTRAINTS

Field work

- Requires full sun
- Allow for rain events
- Take advantage of near to peak PAR (photosynthetic active radiation)
- Progress photographs to accompany data
- Irrigate only at onset of morbidity

SOIL MATERIALS

Agricultural soil

Sandy loam (6.8% clay, 51.9% silt, 43.4% sand) Entisol
2.2% dry bulk density, 5.22 pH, 5.2 CEC, Ca=129 ppm,
K=14.67 ppm and P=3.19 ppm

Contaminated soils from 2 DoD (US Army) sites

Loamy sand or sandy clay

BIOCHAR MATERIALS

CB (cardboard) Biochar

.62g/5cc, 7.4 pH, 49.4 CEC, Ca=>1500 ppm,
K=152 ppm and P=59.7 ppm

CH (chipboard) Biochar

.64g/5cc, 6.4 pH, 22.2 CEC, Ca=>1500 ppm,
K=323 ppm and P=21 ppm

Red oak, pine and waste wood chars

Similar dry bulk capacity, pH, elevated CEC (RO and P), similar inorganics (e.g., Ca, K, P, trace elements)

PRIMARY FOCUS

cardboard
waste
biochar

chipboard
waste
biochar

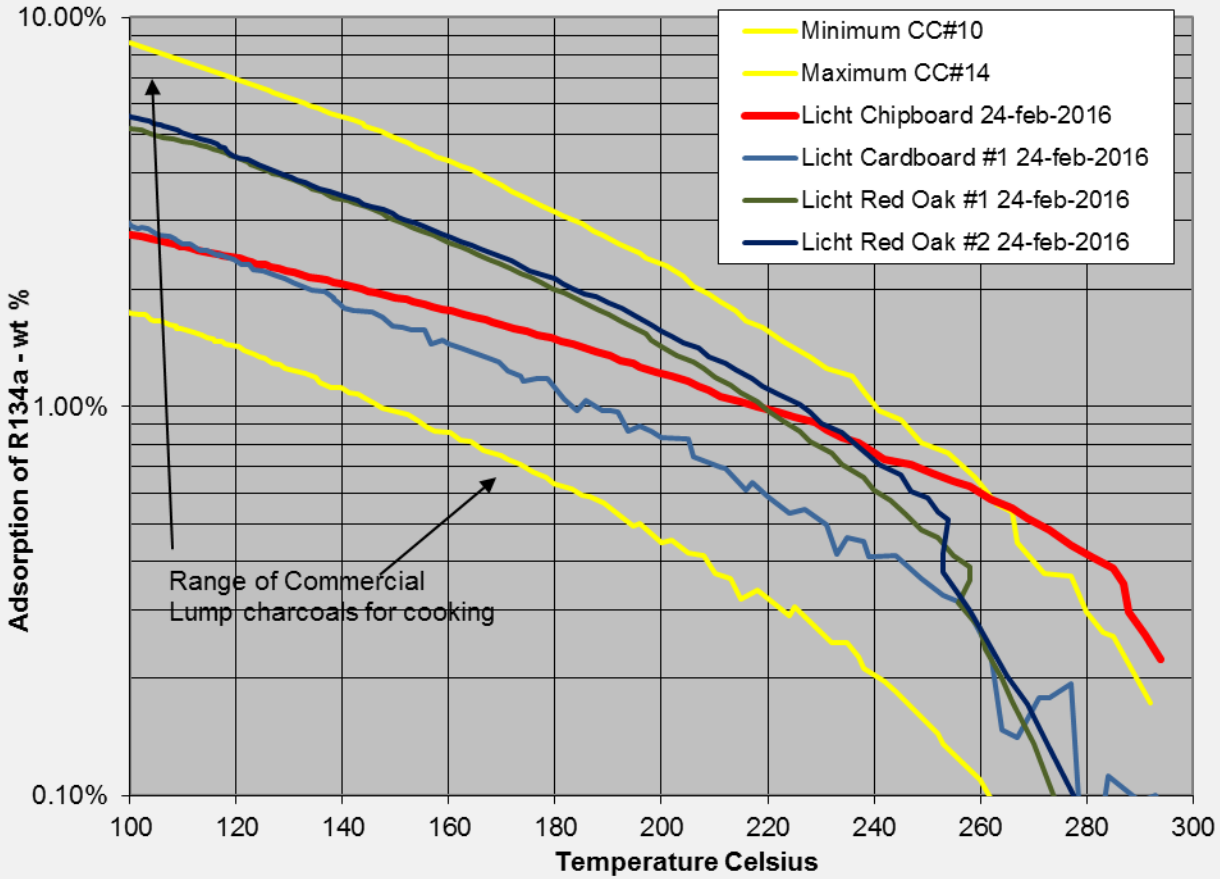
other chars used for comparison

pine
waste
biochar

red oak
waste
biochar

storm debris
wood waste
biochar

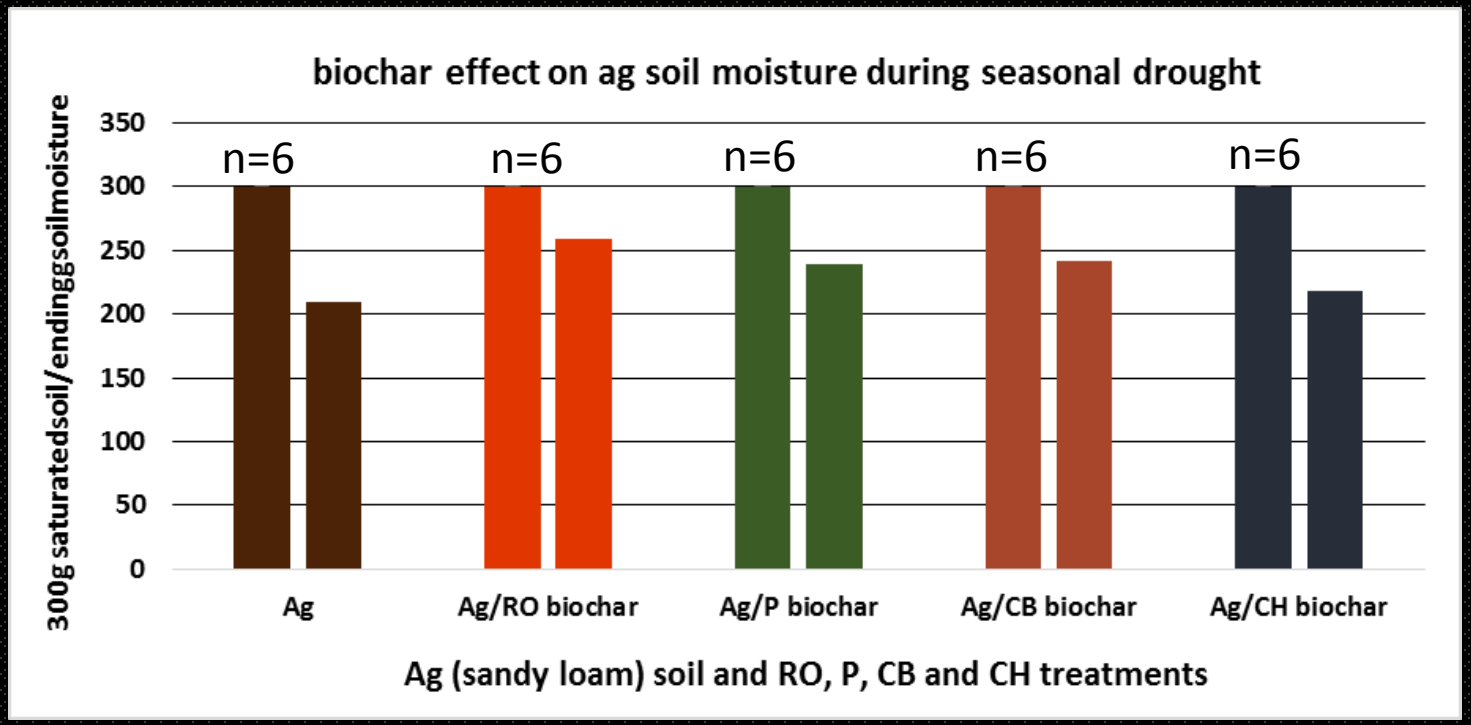
Adsorption capacity in biochars is believed to play a pivotal role in drought



Despite lower adsorption measured by the GACS test, CB and to a lesser extent CH, are nearly as water retentive

SOIL ONLY

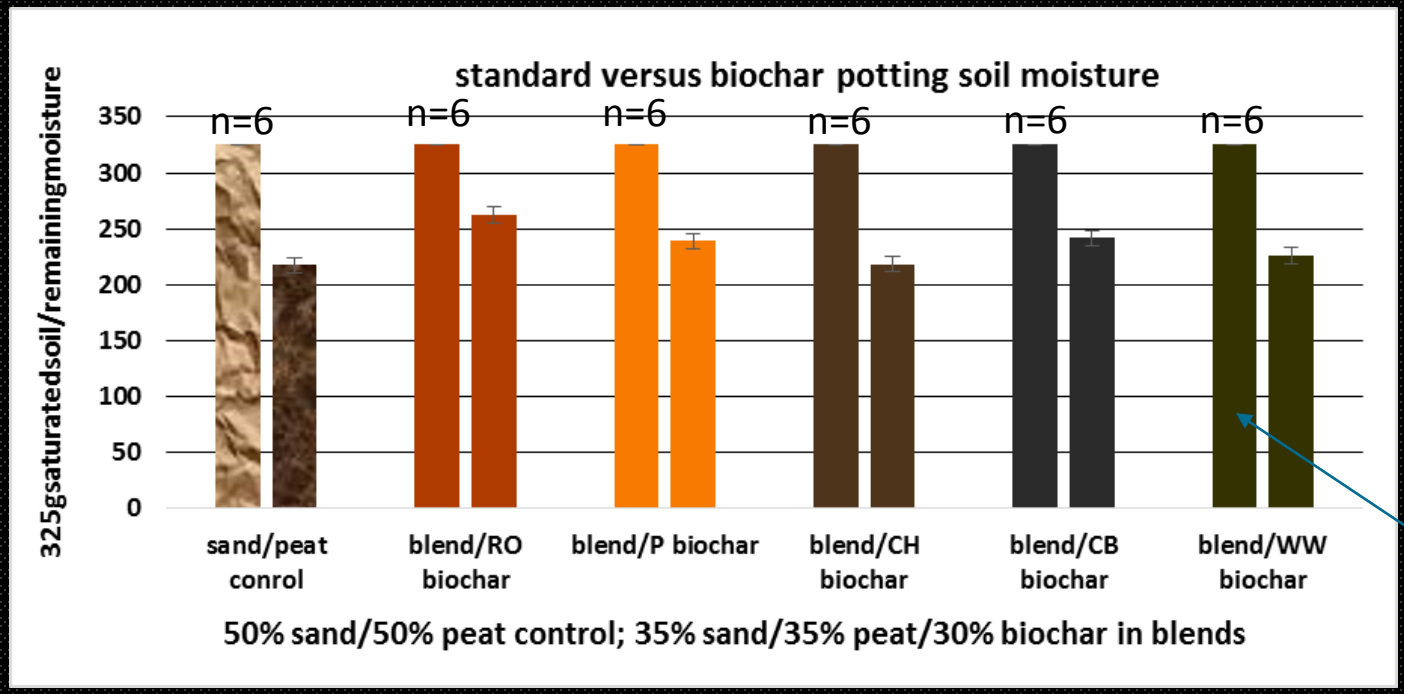
Influence on moisture retention on an Ag soil (sandy loam) representative of local soils



During a 4 month test there was significant drought (rain levels 22.8 cm below normal between May-July). RO, P and CB amendments produced as much as 15% higher moisture retention than Ag control

SOIL ONLY

Biochar influence on potting soil moisture retention



3 month test with intermittent drought episodes. RO and CB yielded a similar effect on potting mixtures compared with soil. Waste wood biochars can also be produced at urban horticulture production centers

TWO CONTAMINATED SOIL TESTS

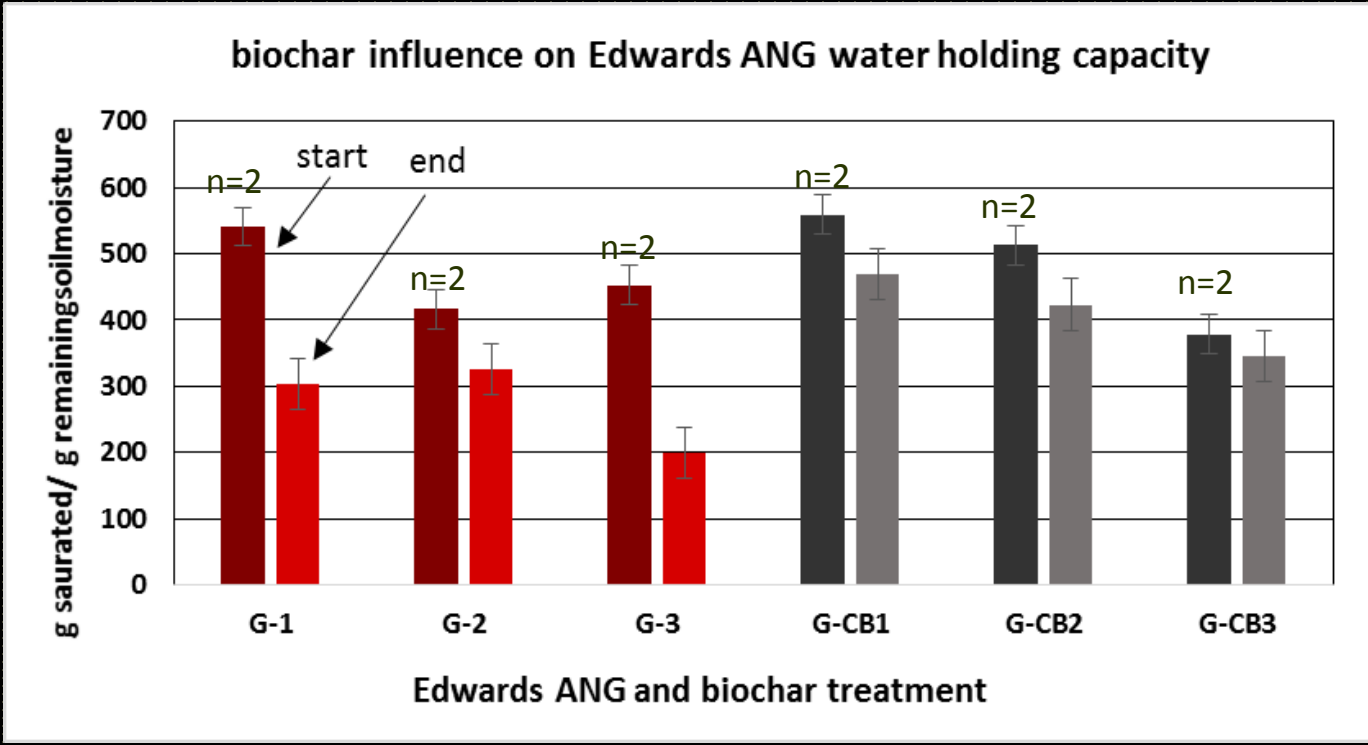
Ft Edwards Army National Guard samples contain substantial levels of Cr, Pb, As, Sb, Cu and Pb. Massachusetts

Joint Base Elmendorf-Richardson (E-R) samples
also contain substantial levels of TNT (.04 mg/kg),
RDX (.04 mg/kg) and HMX (.03 mg/kg) energetics
(used in explosives). Alaska

Contaminated samples were handled with caution and protection; the basic 01 and 03 samples were provided pre-screened and then blended, as required, weighed, saturated and re-weighed. No irrigation was provided to any samples to determine moisture holding capacity in summer heat and episodic drought

SOIL ONLY

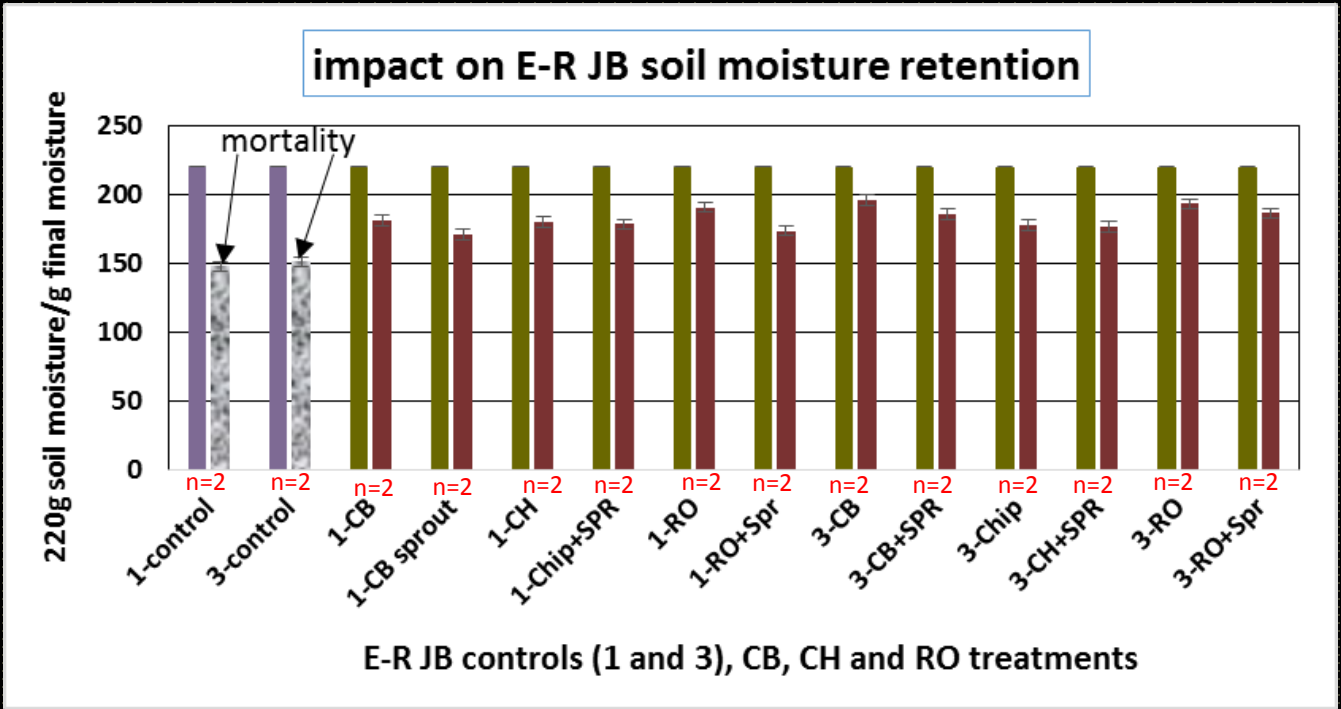
Influence on moisture retention of a representative Edwards Army National Guard (ANG) contaminated soil



During 3 month test CB outperformed contaminated controls (G) by an average of 16% higher moisture retention

SOIL ONLY

biochar influence on moisture retention of E-R Joint Base contaminated soils

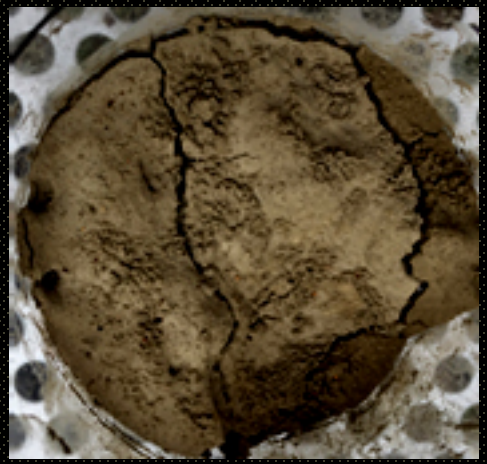


CB and CH amendment overcame 1-and 3-control hydrophobicity, and sufficiently neutralized soil toxicity to allow sprouts to survive in all three biochar treatment conditions. 2 month tests

EFFECT ON SHRINKAGE PROPERTIES OF E-R JB SOILS

Elmendorf-Richardson JB soil hydrophobicity is demonstrated in middle slide—note nearly intact CB treated sample at right

start no treatment



after 2 weeks, cracking, rupture no treatment

after 2 weeks CB treatment

BACKGROUND FOR PLANT AND SOIL TESTS

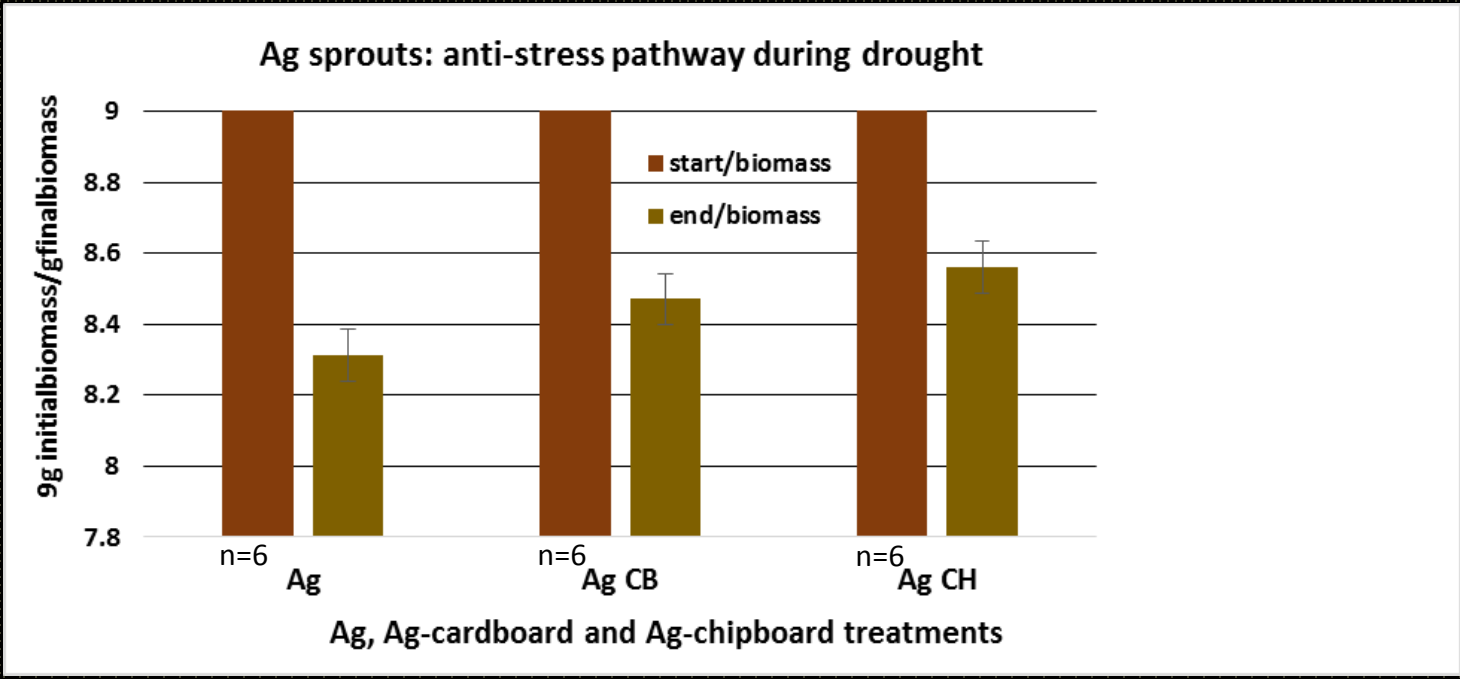
Purpose of testing Brussel sprouts in both Ag and contaminated soils. Goal was to acquire rapid data points of biochar influence on soil response in episodic drought, summer growing

- 500 mL containers in full sun over a 2.5-4 month
- Full sun
- Initial saturation, then no further irrigation
- 16.53 cm of rain between April and July

Metric for measurement based on ascertaining difference between starting and ending biomass

PLANTS AND SOIL

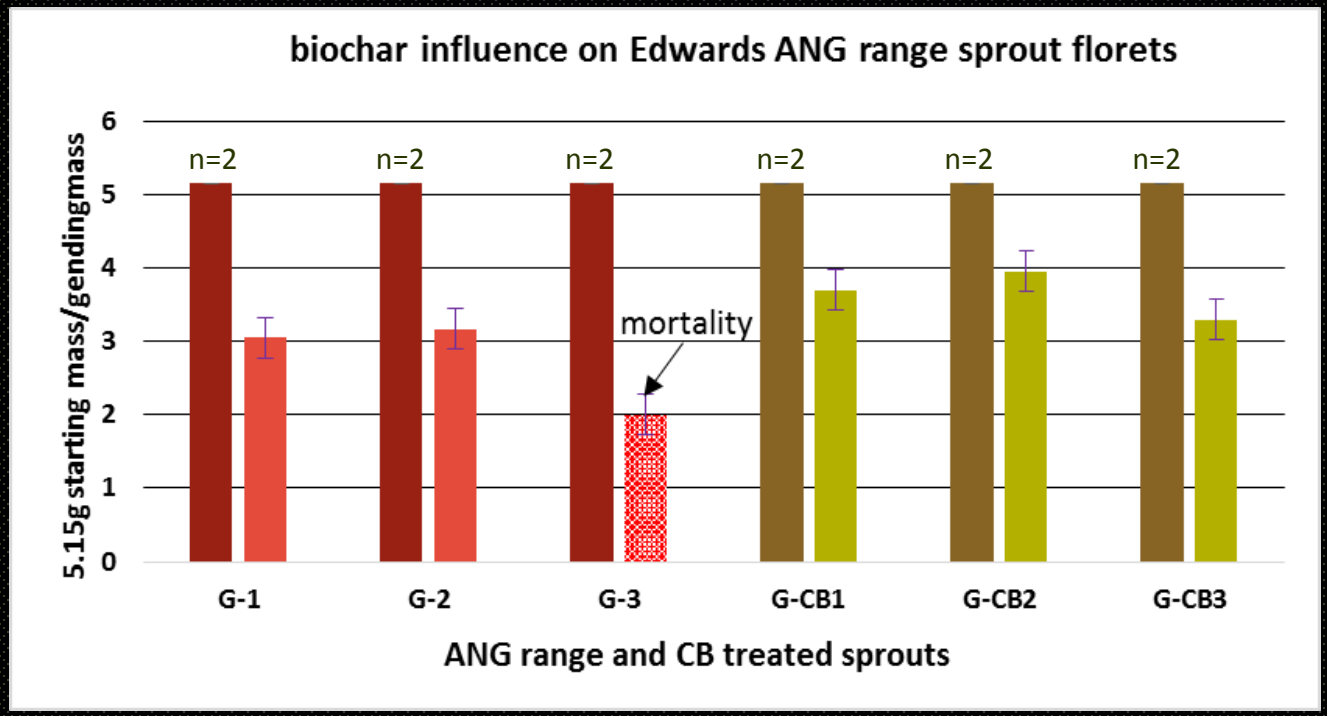
Biochar influence on sprouts in an Ag soil exposed to episodic drought April-end of July



When plants were added to the equation, during a 4 month test, CB and CH biochars limited biomass loss to 4-6%

PLANTS AND SOIL

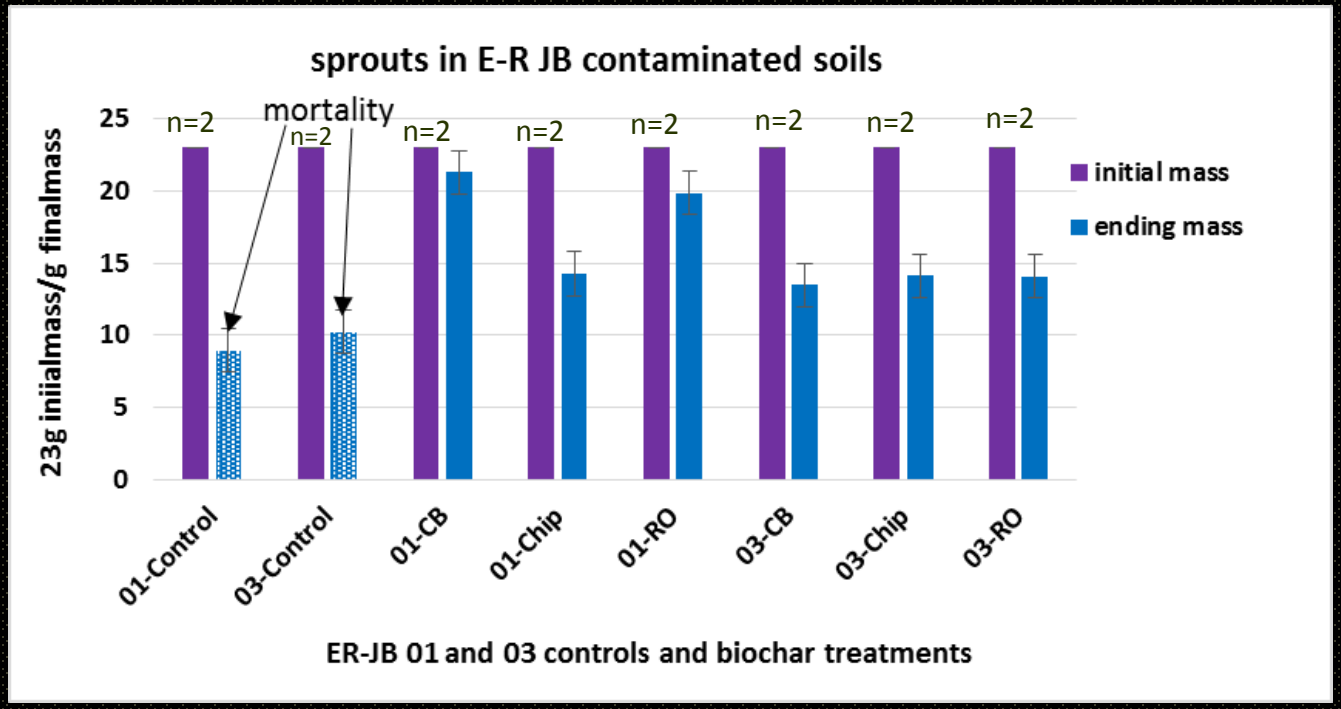
Influence on sprout growth when exposed to episodic drought April-July in Edwards ANG contaminated soil



During 3 month test, CB outperformed ANG controls limiting floret loss to around 30%

PLANTS AND SOIL

Influence on sprout overall biomass exposed to episodic drought May-July in E-R JB soils



During 2 month test, CB and RO limited total biomass loss to around 20%

FURTHER PLANT AND SOIL TESTING

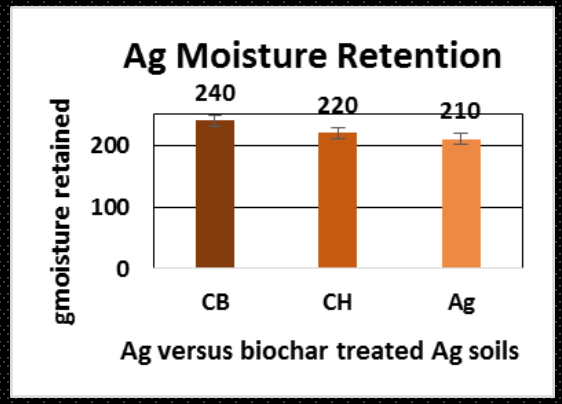
controls (no biochar treatment) suffered mortality within 2 weeks

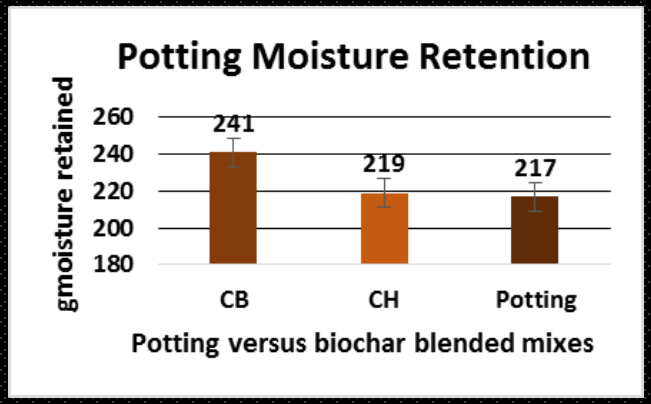
CRREL plans on completing inorganic and organic analysis of 01 and 03 soils, biochar-treated samples, treated and untreated sprout tissue.

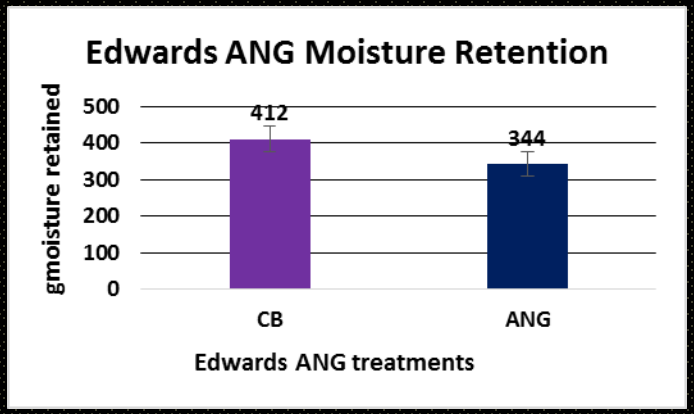
A second analysis set will study effect of CB on 01 and 03 effluent to see to what extent CB and CH filter out toxins

FIGURE SUMMARY

Effects of Biochar on Moisture Retention in Ag, versus Potting and Contaminated Soils







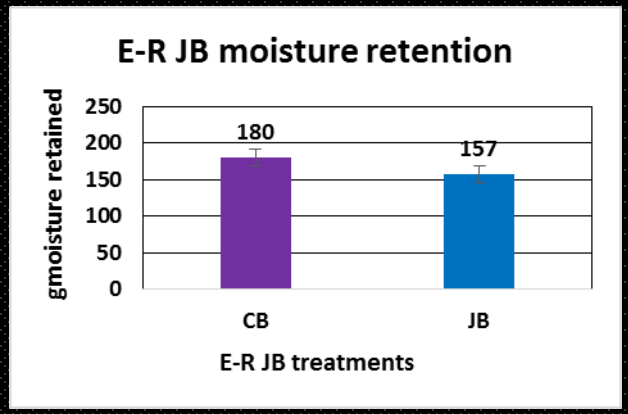
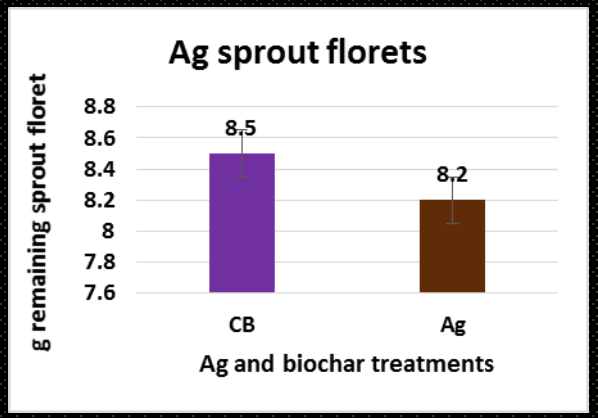
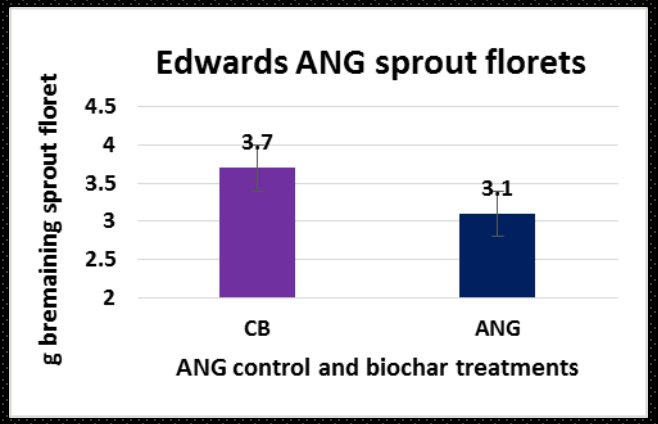
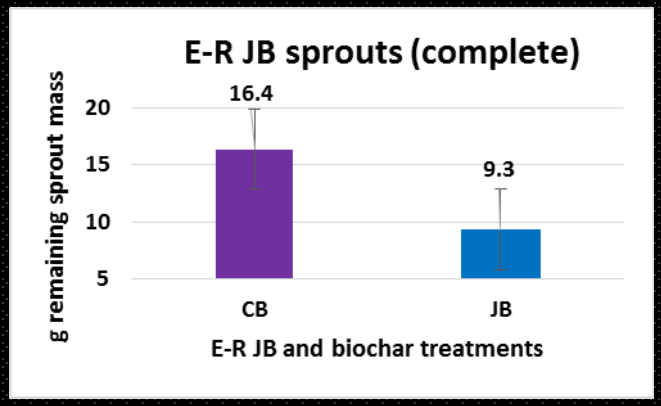


FIGURE SUMMARY 2

Effects of Biochar on Sprout Biomass In Ag and Contaminated Soils







CONCLUSION

- CB AND CH FEEDSTOCKS, LIKE CORN STOVER OR CHICKEN LITTER, ENLARGE THE BIOCHAR PALETTE
- DEMONSTRATED VALUE FOR MOISTURE RETENTION, REDUCING BIOMASS LOSS DURING DROUGHT
- DEMONSTRATED VALUE AS A MEANS OF COUNTERACTING INORGANIC AND ORGANIC TOXINS
- EASILY PRODUCED/USED IN A WIDE VARIETY OF SETTINGS

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QUESTIONS ?

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