Biochar Research for the Urban Forest

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Bartlett Tree Research Laboratories (West)

BARTLETT Tree Research Laboratories

SCIENTIFIC TREE CARE SINCE 1907

Canadian Urban Forest Conference

Urban Forests by Design

What is biochar?

- Product of pyrolysis of organic matter
  - Source of energy from exothermic heat
  - Oils and gasses collected and used as fuel
- Mimics ancient practices discovered in nutrient poor tropical soils.
  - Terra preta soils (Dark earth), 2,000+ years
- <u>Not all biochar is the same!!</u>

Properties of Biochar will vary depending on…

- Parent Material
  - Forestry slash, crop residue, chicken waste
- Cooking Temp and Duration
  - Remaining volatiles
  - Ash content

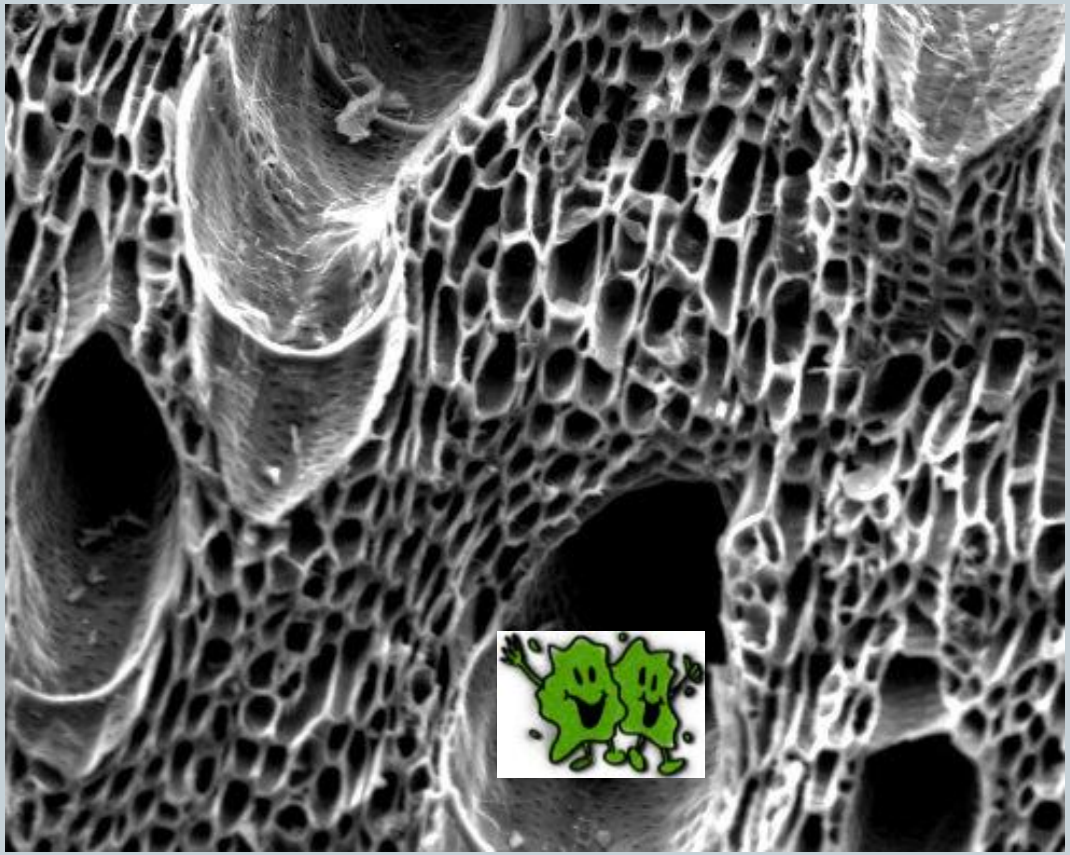
www.biocharproject.org
www.biochar-international.org/biochar/soils

Ancient cultures burned organic waste and buried ‘biochar’

- Small patches of fertile soil in otherwise low-productive areas
- Linked to soil content of “black carbon” or biochar particles
- Remains in soil for many HUNDREDS or THOUSANDS of years

www.biochar-international.org/biochar/soils

Variable surface texture and high porosity are two key attributes



Habitat for beneficial microbes

An incomplete list of potential benefits….

- ↑ Overall plant growth
- ↑ Nutrient retention
- ↑ Cation Exchange
- ↑ Soil drainage (heavy)
- ↑ Water holding (sand)
- ↑ Beneficial bacteria
- ↑ Mycorrhizal assoc.
- ↑ Carbon sequestration
- **↑ Disease Resistance**

- ↓ Nutrient run-off
- ↓ Pesticide run-off
- ↓ Chemical input
- ↓ Soil bulk density
- ↓ Atmospheric CO_2
- ↓ Other GHG's
- **↓ Pest Management**

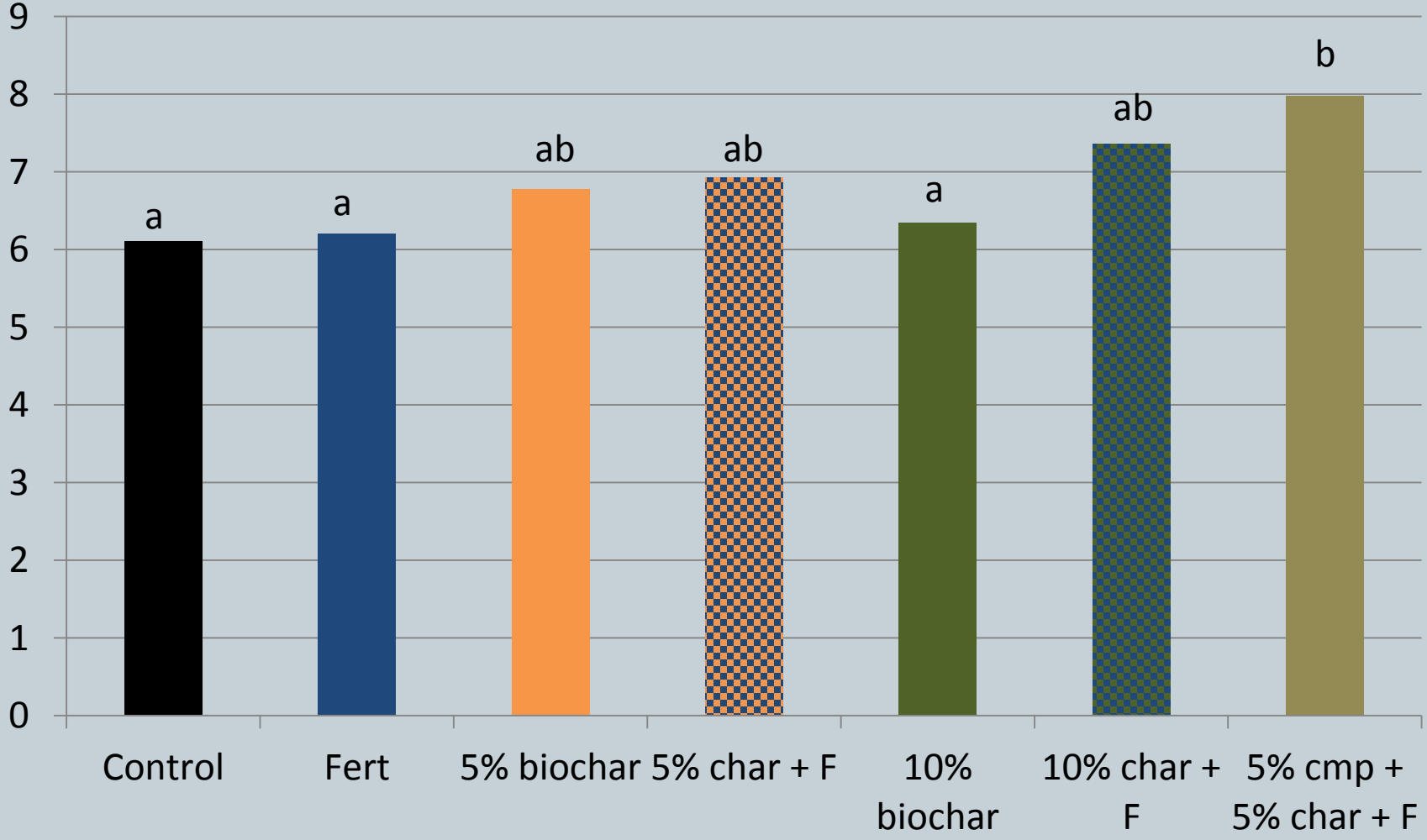
Current / Recent research on Biochar and landscape plants

- Planting, survival and growth
- Street tree soil amendment
- Simulated “tree pit” experiments
- Green roof applications
- Disease resistance (systemic)


Biochar trials at Bartlett Research Labs
Charlotte, NC
Simulated planting pits of approx. 144 cu ft. – cherry, azalea, sneezeweed.


Early benefits seen in soil nutrient retention
No major growth or condition differences after two years.

CEC highest in char+compost+fert



UK Reasearch- Planting Trials

Horse Chestnut Trial: plot after ground preparation and biochar application

Transplanting selected trees and partial removal of root systems

Planting

After planting

Year 1 results

Treatment	Application rate (kg/m²)	Crown Coverage
Grow char	0.25	4.5cd
Grow char	0.5	4.3bc
Grow char	1	4.0b
Bamboo biochar	0.25	4.7d
Bamboo biochar	0.5	3.3a
Bamboo biochar	1	3.3a
Control	0	3.5a

Biochar

Control

- Similar results were seen in a different trial using Flowering Pear.

Another on-going study with real tree pits in Chicago

The Morton Arboretum

BARTLETT Tree Research Laboratories
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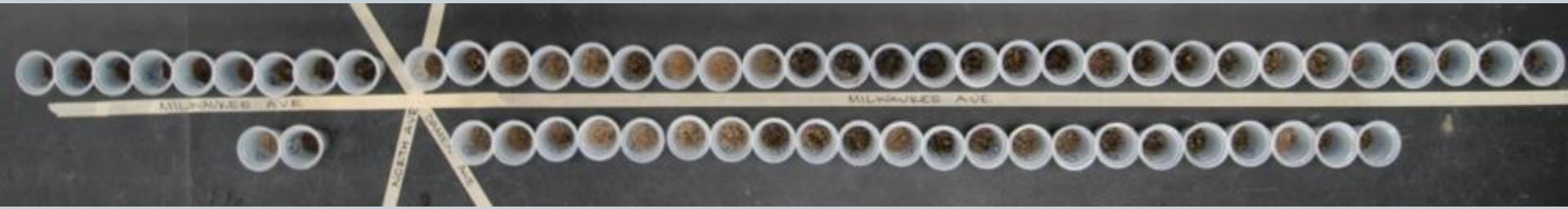
TREE FUND
Tree Research & Education Endowment Fund

Hyland Johns grant

Urban site: City tree pits in Bucktown neighborhood in Chicago

BIOCHAR BUCKTOWN SOIL (0-20 CM) ON 04/04/11

1319 to 1643 N. Milwaukee Avenue, Chicago IL (Wicker Park)



- Auger used to drill holes for amendment.


Parking
Non Verizon Wireless customer will
be towed at owners expense

Tree growth

24-months following treatments (2013)

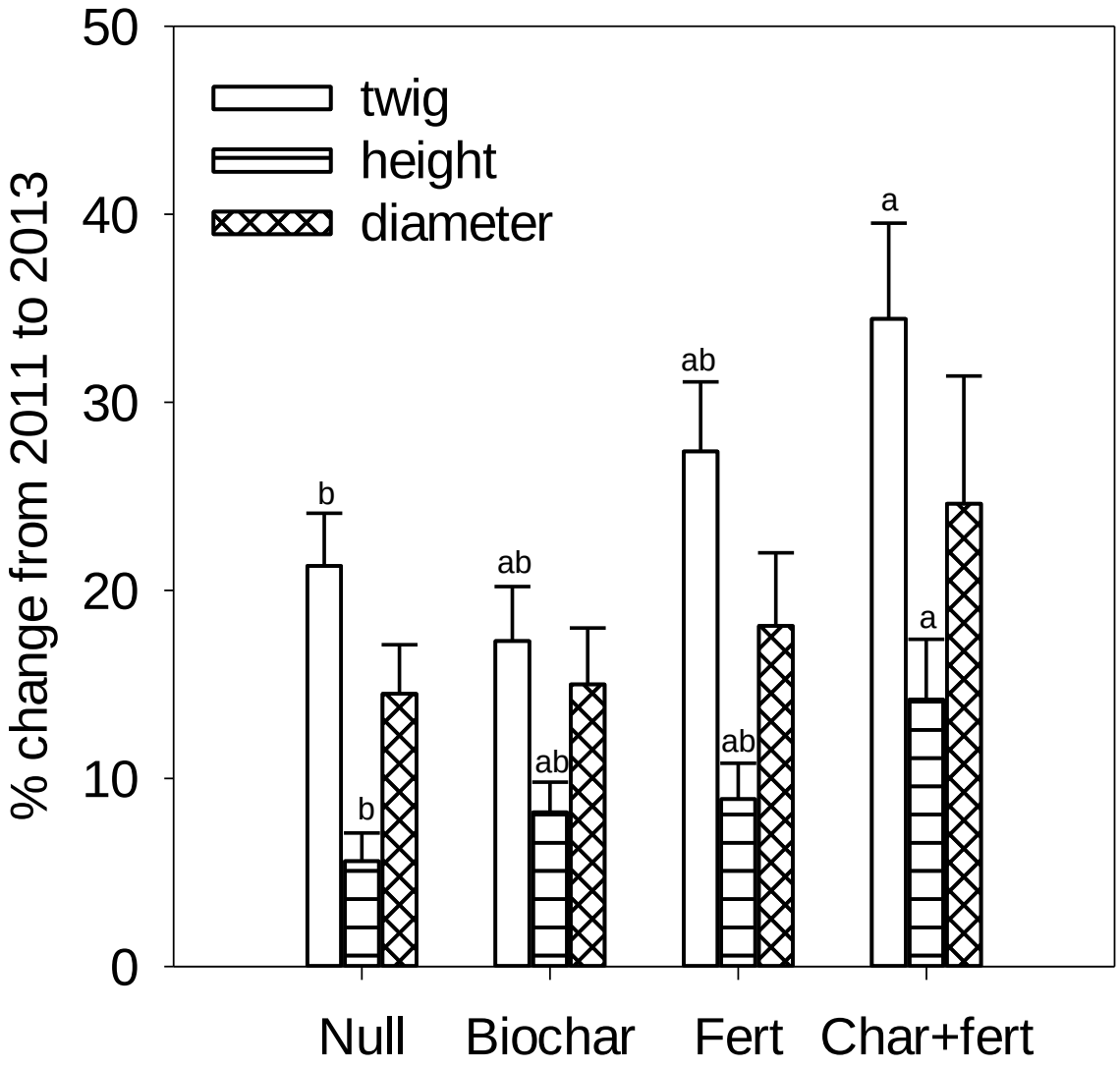
Twig (*P*=0.0118):

Char+fert > Null

Height (*P*=0.0416):

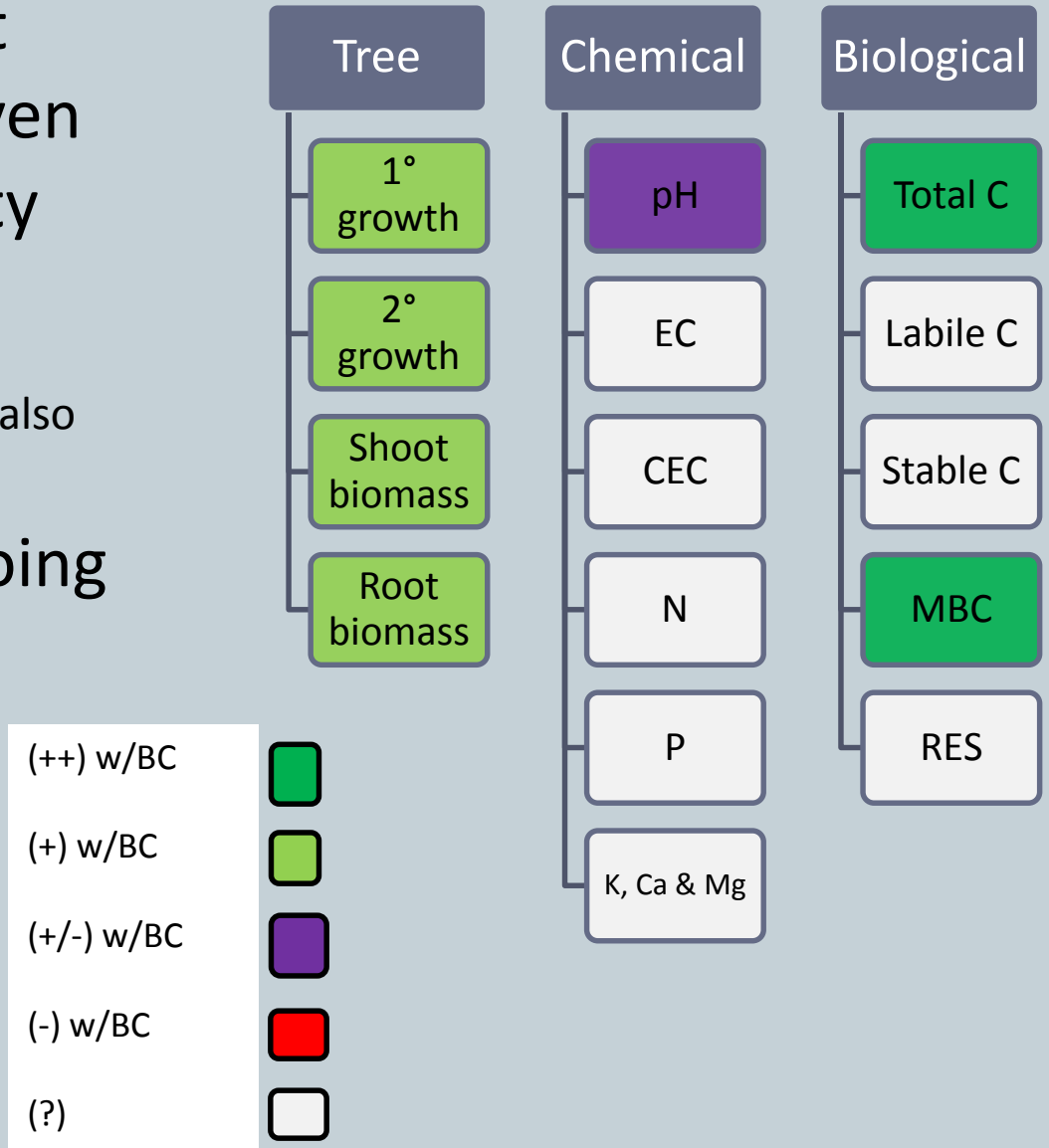
Char+fert > Null

Diameter (*P*=0.3448)



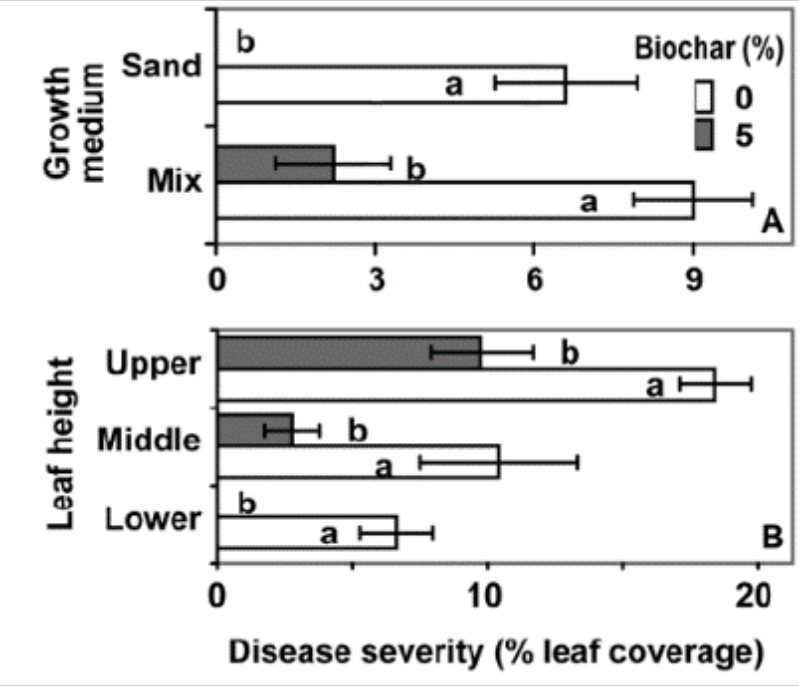
Results from Dr. Bryant Scharenbroch

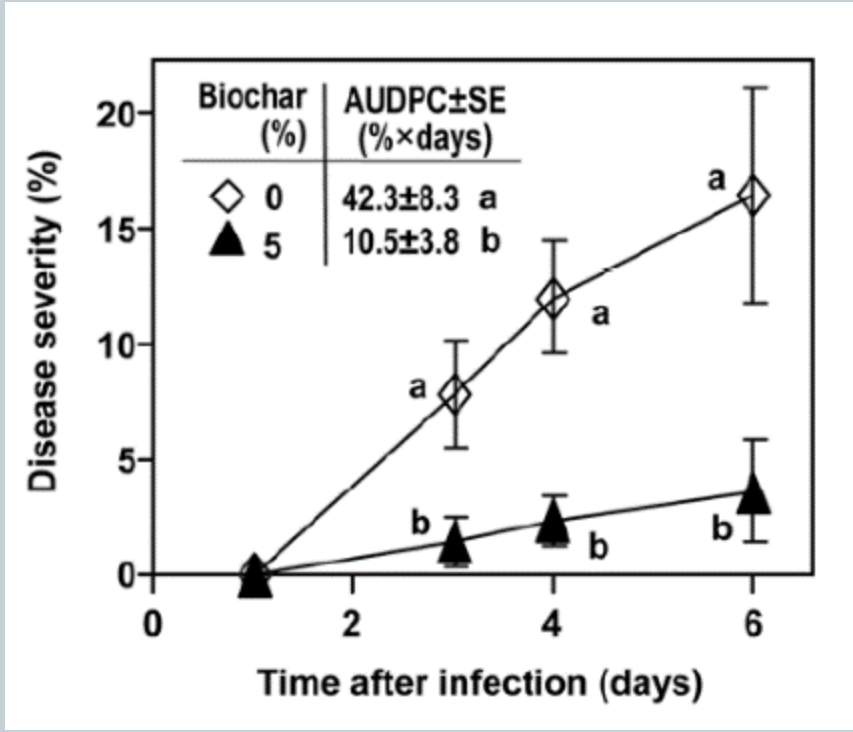
- Early results suggest improved growth even with major variability
  - height and twig elongation improved
  - Several soil characteristics also improved
- Data collection ongoing



Biochar and plant disease

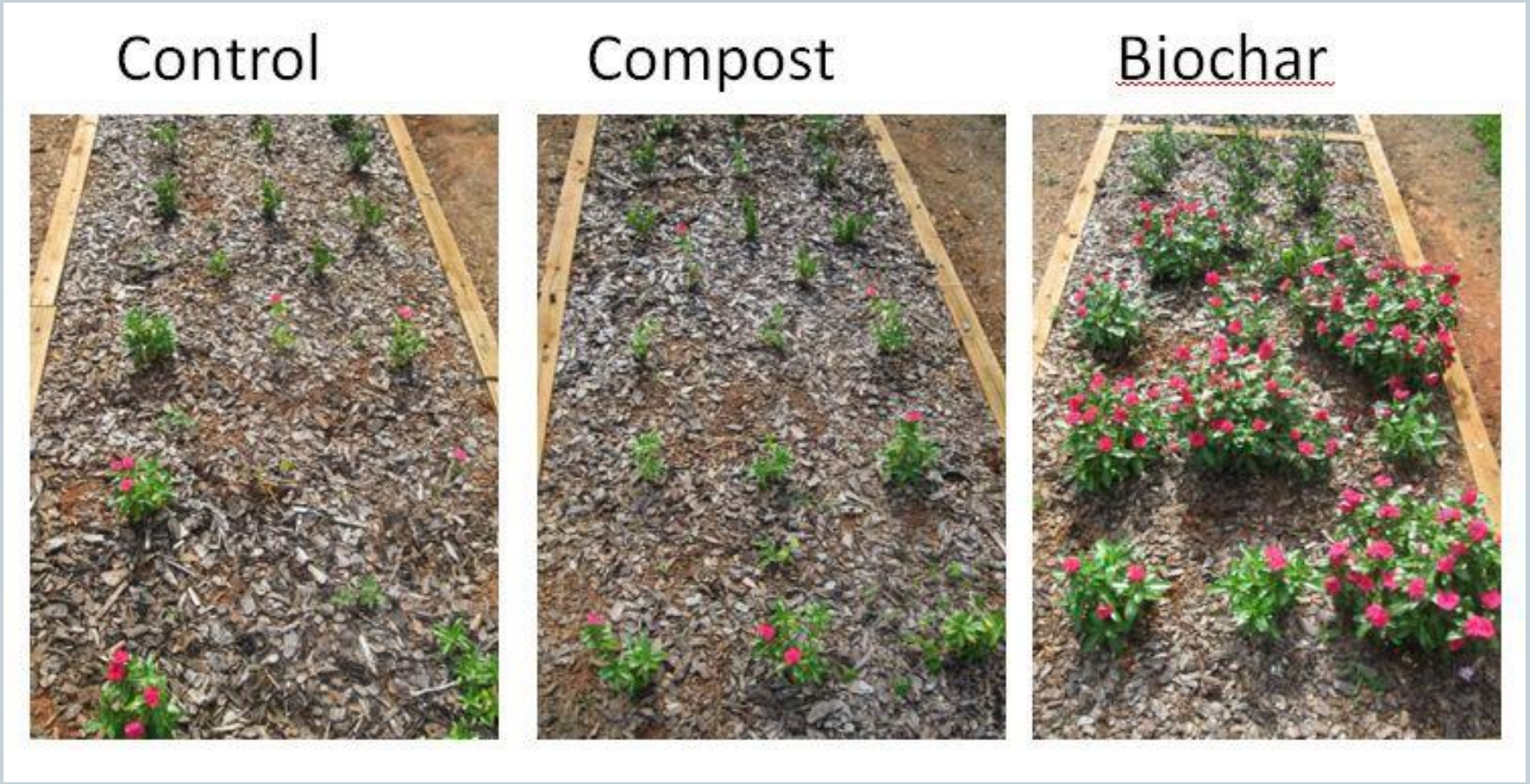
- Soil amendment has been shown to reduce disease in several situations





Elad et al (2010) Phytophathology

Biochar amendment appears to be helping in field trials w/ *Phytophthora*




After tilling


Biochar
No Amendment


No Amendment
No Amendment
Biochar + Compost

Biochar and Disease Resistance

- Controlled research: *Can biochar amendment reduce Phytophthora cankers on landscape tree species?*

- Oak Trial: *P. cinnamomi* on Red Oak
- Maple Trial: *P. cactorum* on Red Maple

Experimental procedure

- Tree seedlings planted in soilless potting mix with:
  - 0, 5, 10, or 20% biochar by *volume*, stem inoculated
  - 0% biochar + Agrifos® at drench rates, stem inoculated
  - 0% biochar, mock inoculation (control).
- Irrigated and Fertilized regularly to eliminate differences in nutrient retention, drainage and water holding capacity

Results: Can biochar reduce disease progression or effects on physiology?

HortScience 47(12):1–5. 2012.

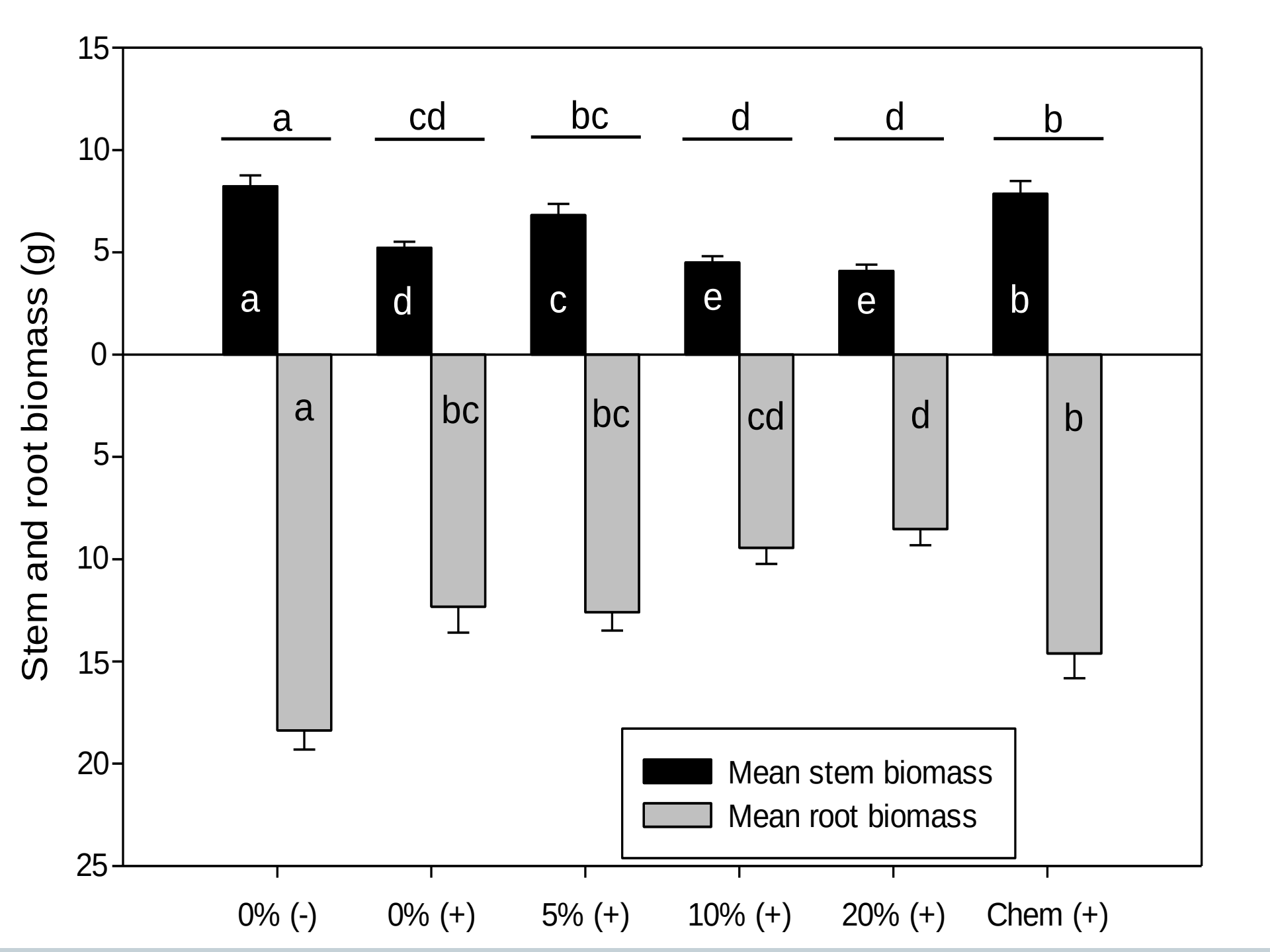
Biochar Amendment Increases Resistance to Stem Lesions Caused by *Phytophthora* spp. in Tree Seedlings

Drew C. Zwart and Soo-Hyung Kim[1]

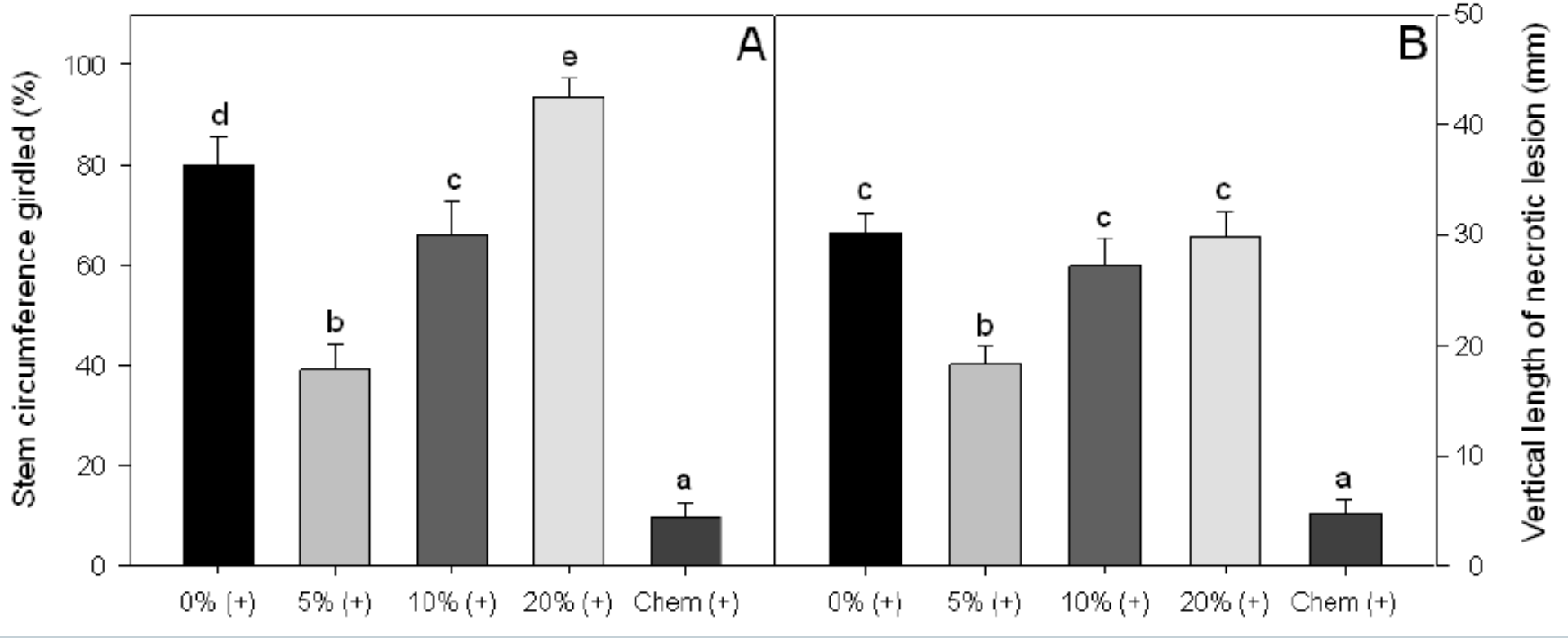
Center for Urban Horticulture, School of Environmental and Forest Sciences, College of the Environment, University of Washington, 3501 NE 41st Street, Box 354115, Seattle, WA 98195

Maple

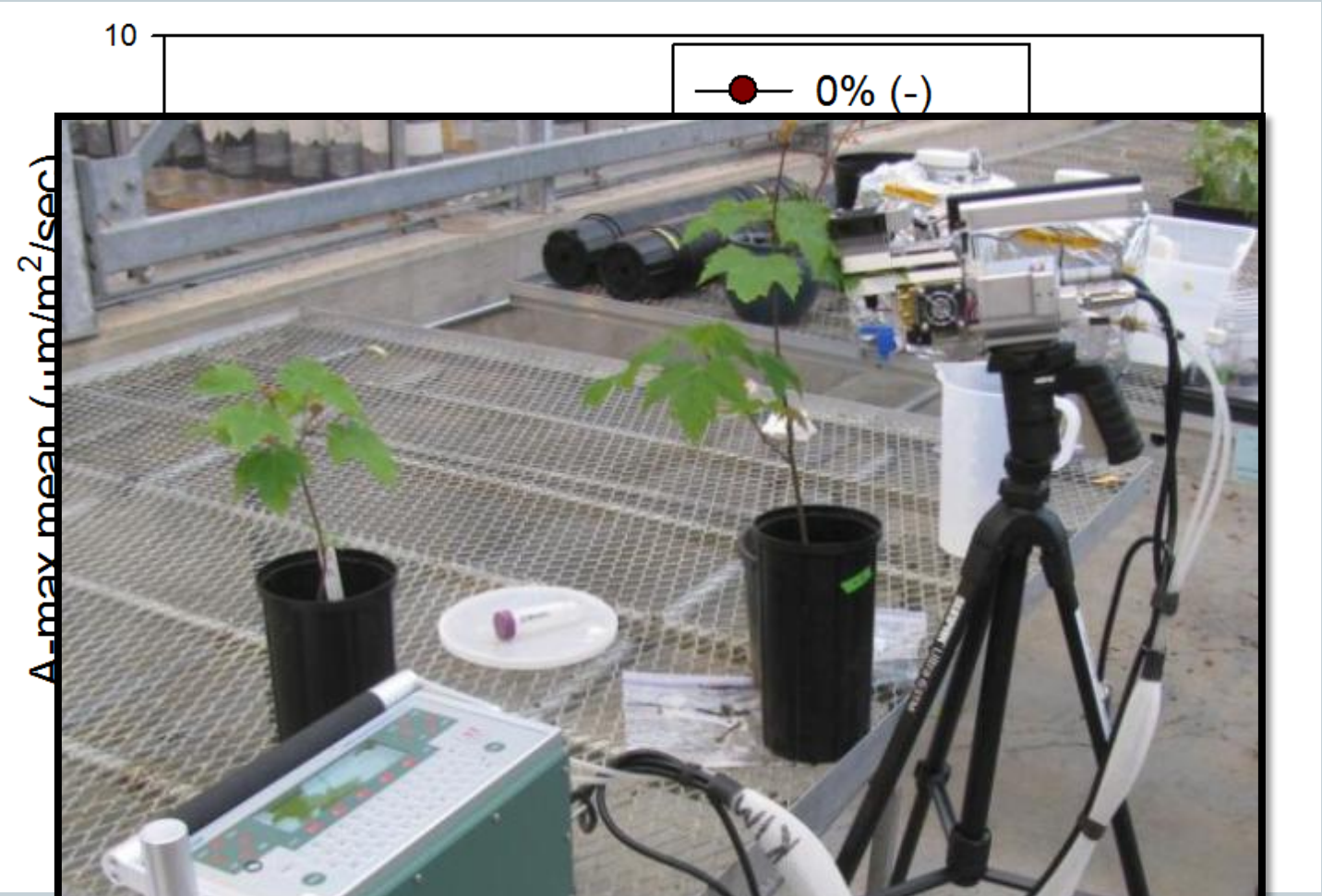
- Biomass:
  - Control > Chem. > 5 % > Inoc. > 10 + 20 %
- Lesion size:
  - Vertical growth: Chem. > 5 % > 10 %, 20 %, 0 %
  - Horizontal growth (girdling %): same


15
10
5
0
5
10
15
20
25
Stem and root biomass (g)
a
cd
bc
d
d
b
a
d
c
e
e
b
a
bc
bc
cd
d
b
Mean stem biomass
Mean root biomass
0% (-)
0% (+)
5% (+)
10% (+)
20% (+)
Chem (+)

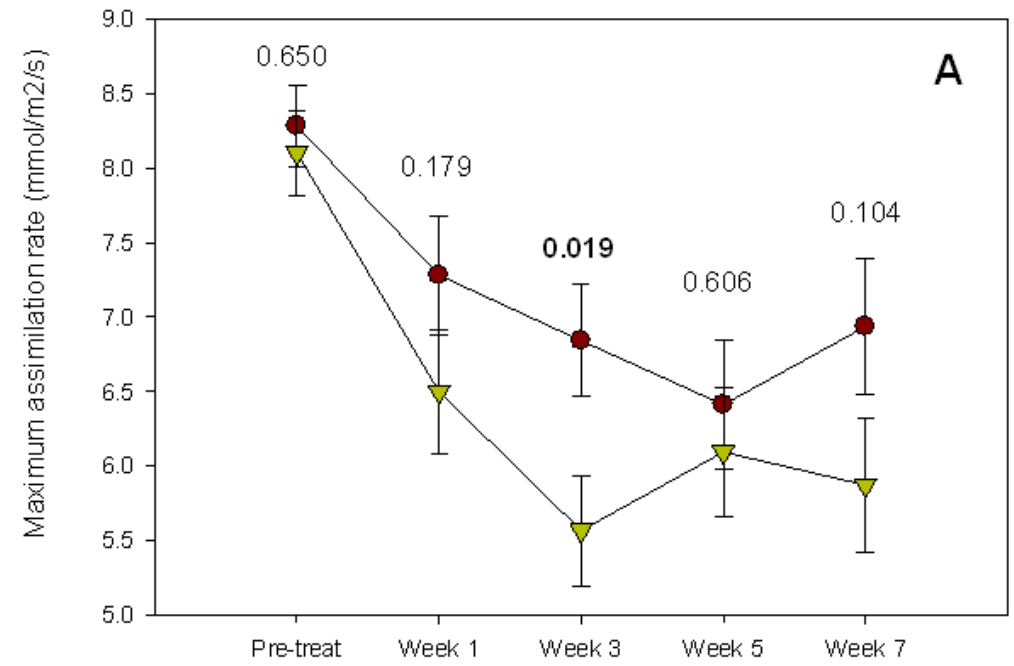
Girdling % and total vertical length were reduced by biochar compared to non-amended treatment

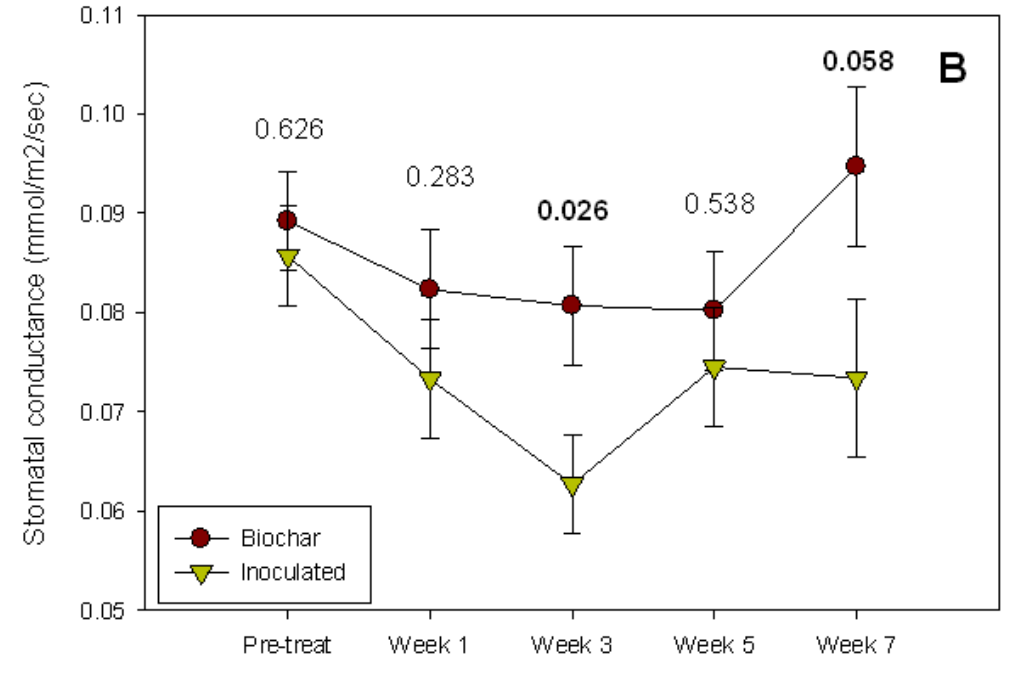


- Biochar did not reduce lesions as much as industry standard SIR material (Agrifos®, salts of phosphous acid)



- Photosy eatment were **int** ed





2011-2012 combined data:

- Same treatment, species, and conditions in **Biochar** and **Inoculated** groups.
  - 2-way ANOVA accounts for experiment year and treatment
- Clear trends in Assimilation and Conductance
- Photosynthetic performance in inoculated plants is **Improved** by **5 % Biochar** amendment of potting media

Oak- stem water potential

- **5 % biochar** reduced girdling growth of pathogen
- **5 % biochar** amendment resulted in least negative stem water potential
- No difference in biomass

Green-roof research

- Focused primarily on nutrient retention and run-off water quality.

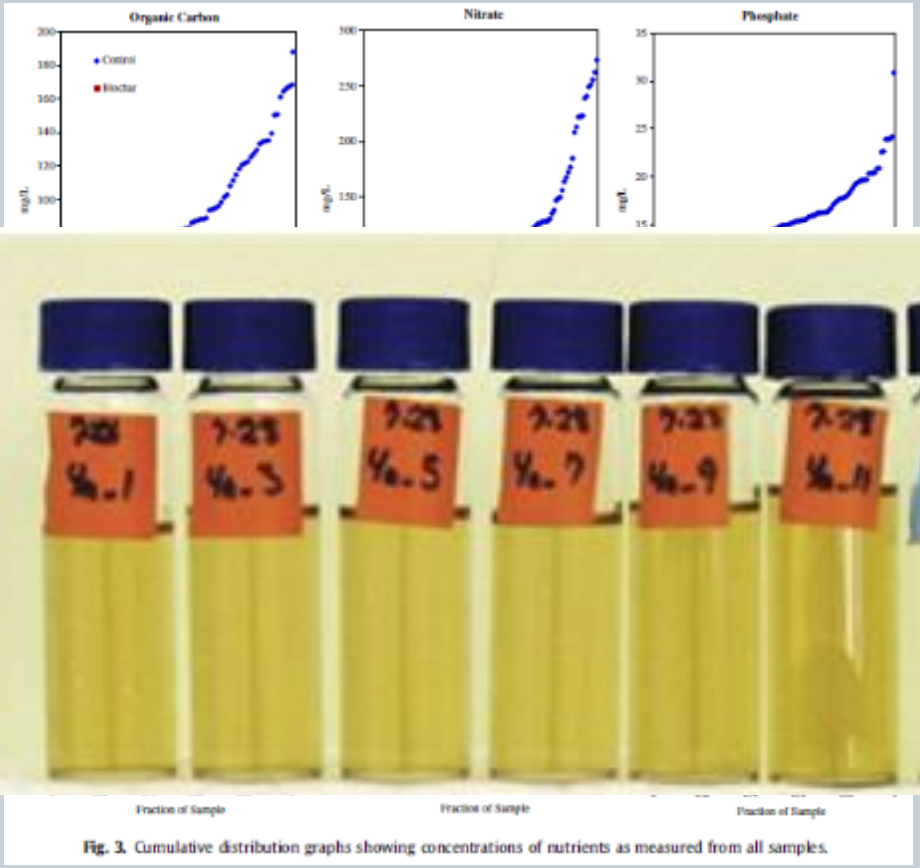
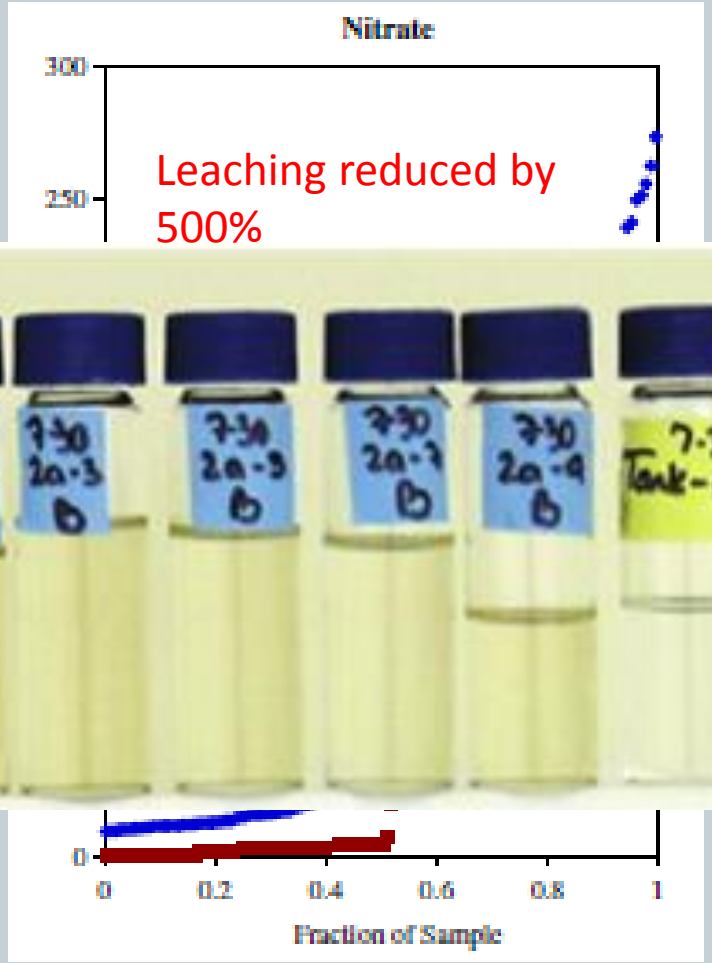


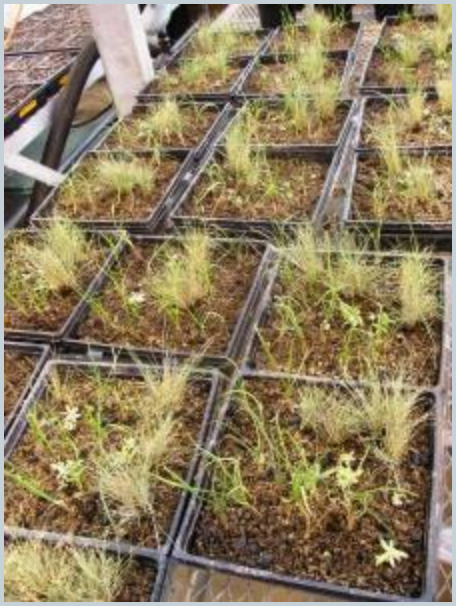
Fig. 3. Cumulative distribution graphs showing concentrations of nutrients as measured from all samples.

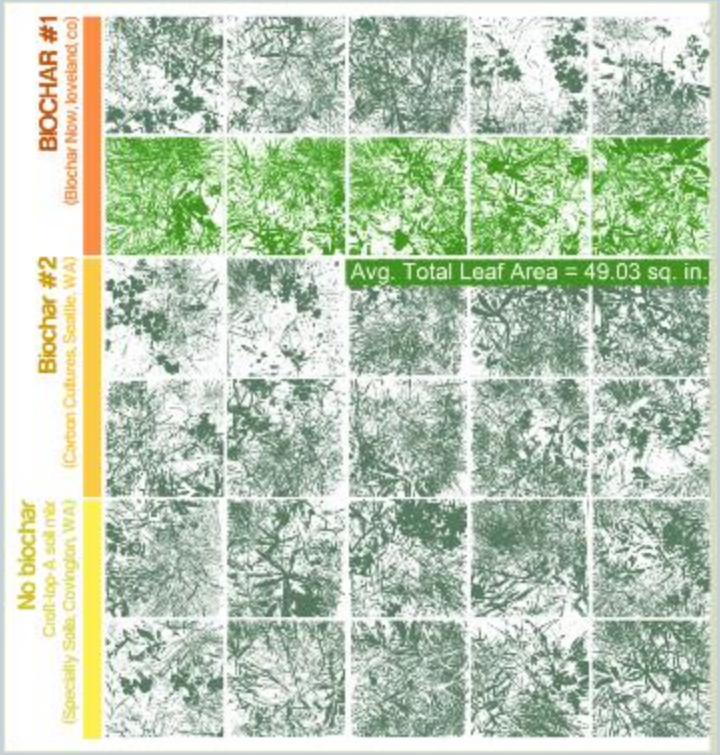


Beck et. al. (2011). Environmental Pollution 159: 2111-2118

Project at U.W. – CUH (Gar-yun Ho)

- Comparing 2 different biochars with 3 plant species and bare soil.
  - Looking at nutrient retention and water holding
- **Results:**
  - Reduced EC of leachate (fertilizer retained in media)
  - Increased plant leaf area





Summary

- Early results are promising
- We are seeing positive responses
  - Soil factors
  - Woody plant response will be slower
  - Disease resistance

- MUST be mixed with compost if OM is less than 5%