Biochar: Effects on soil microbial activity and soil enzyme activity

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Introduction – Biochar

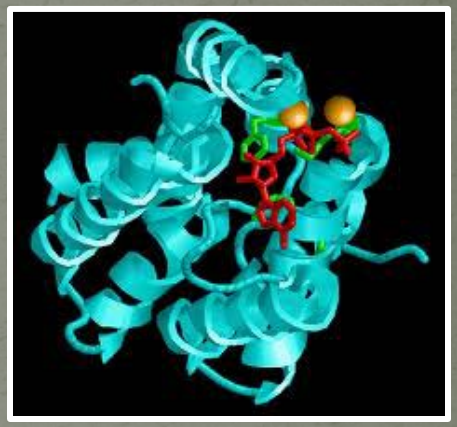
- Biochar
  - By-product of pyrolysis
- Mobile-pyrolysis (in development)
  - Pre-commercial thinning
  - Logging residue
  - Slash → bio-oil
- Biochar
  - Deposited onsite in forests

Introduction – Biochar

- Effects of biochar on forest soil?
- Numerous studies regarding agriculture
- Fewer studies on:
  - Forest soil
  - Forest soil microbiology
    - Critical to forest health

Experiment – Biochar in forest soil

- Objectives:
  - Enzymes – decomposition and nutrient cycling
    - Aminopeptidase, β-glucosidase, Chitinase, Phosphatase, Peroxidase
  - Microbial activity (respiration)
  - Fertilization
    - Urea 46-0-0
  - Forest succession
    - Mature v. ~30 yr plantation
  - Dilution effect
    - Sand v. biochar



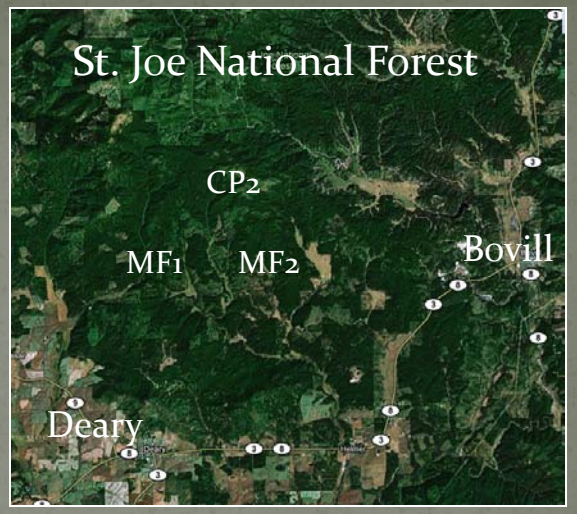
Methods – Installation

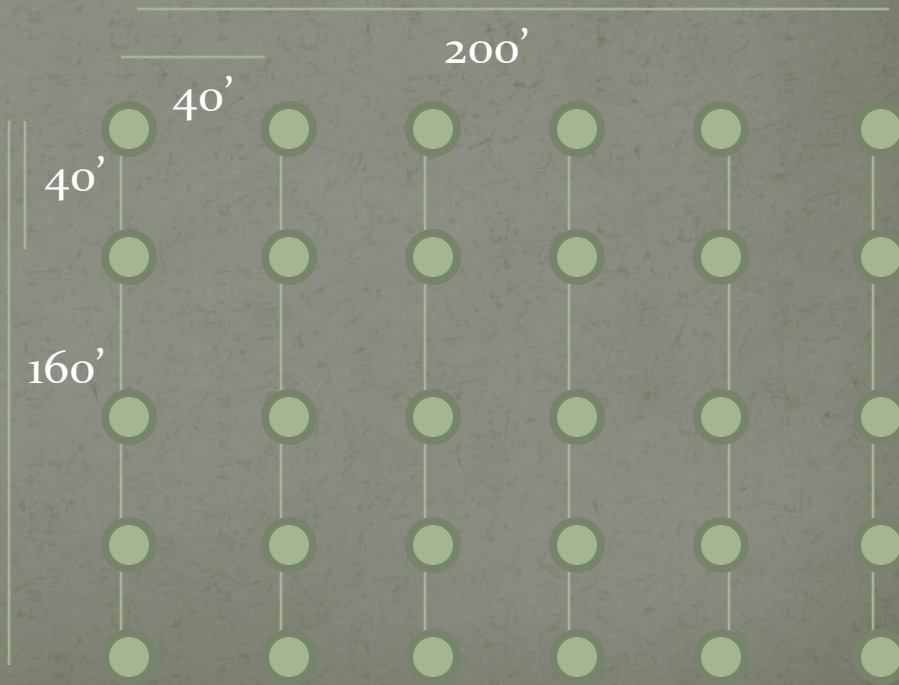
- Field incubation cores
  - 30 cores at 4 forest sites
  - 6 treatments
  - 5 replicates each
- Installed Nov-Dec 2010

Treatments		
Amendment	**Unfertilized**	**Fertilized**
Non-amended	5	5
50% Biochar	5	5
50% Sand	5	5

Methods – Location

- 30 Incubation cores in 4 sites
  - Latah Co. Threebear soil
  - Forest sites
    - 2 Mature forests
    - 2 Plantations
      - Clearcut and replanted ~30 yrs prior
  - 30 cores randomly arranged in grid



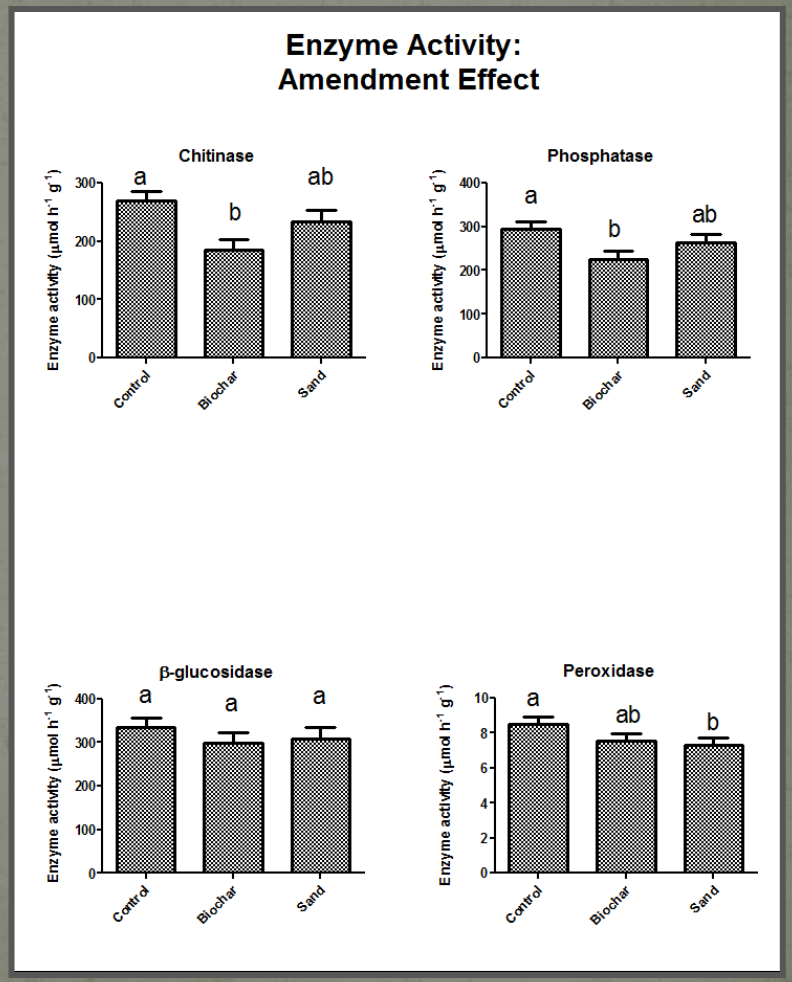


Methods – Harvest and analyses

- Harvested June-Aug 2011
- Enzymes → Fluorimetric
  - Soil + enz substrate → product fluorescence
- Microbial activity → SIR
  - Soil + glucose → CO_2
- Soil moisture, pH, field temp

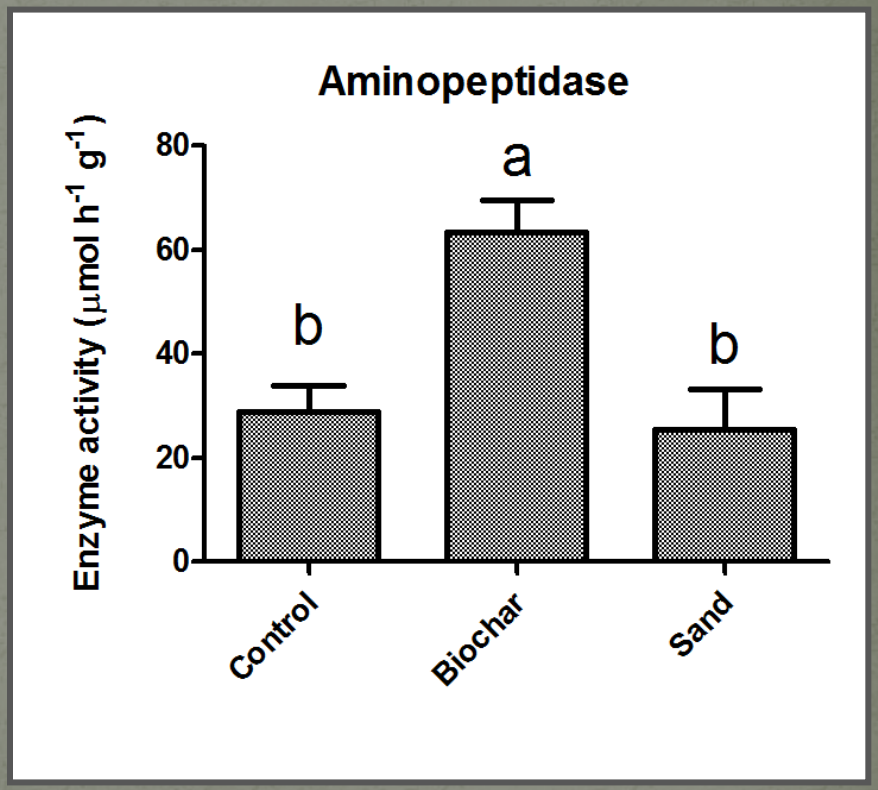
Results – Enzyme activity

- Amendment effect
  - Decrease (biochar)
    - Chitinase
      - ↓ Chitin decomposition
    - Phosphatase
      - ↓ Phosphorus cycling
  - No effect (biochar)
    - β-glucosidase
    - Peroxidase
  - Decrease (sand, NOT biochar)
    - Peroxidase
      - Lignin decomposition



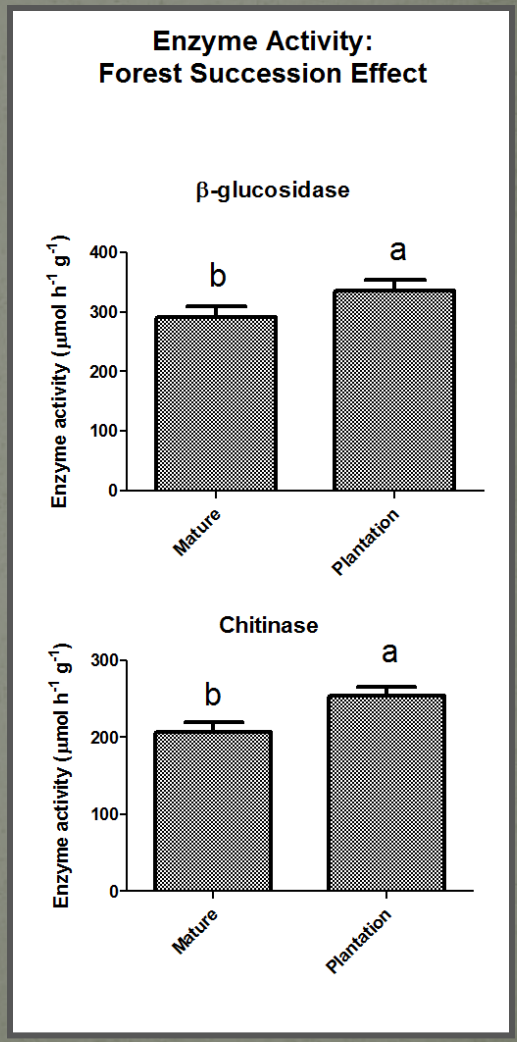
Results – Enzyme activity

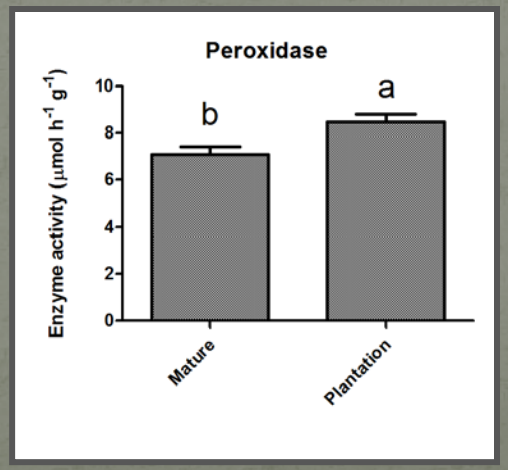
- Amendment effect
  - Increase (biochar)
    - Aminopeptidase
    - Proteins → amino acids



Results – Enzyme activity

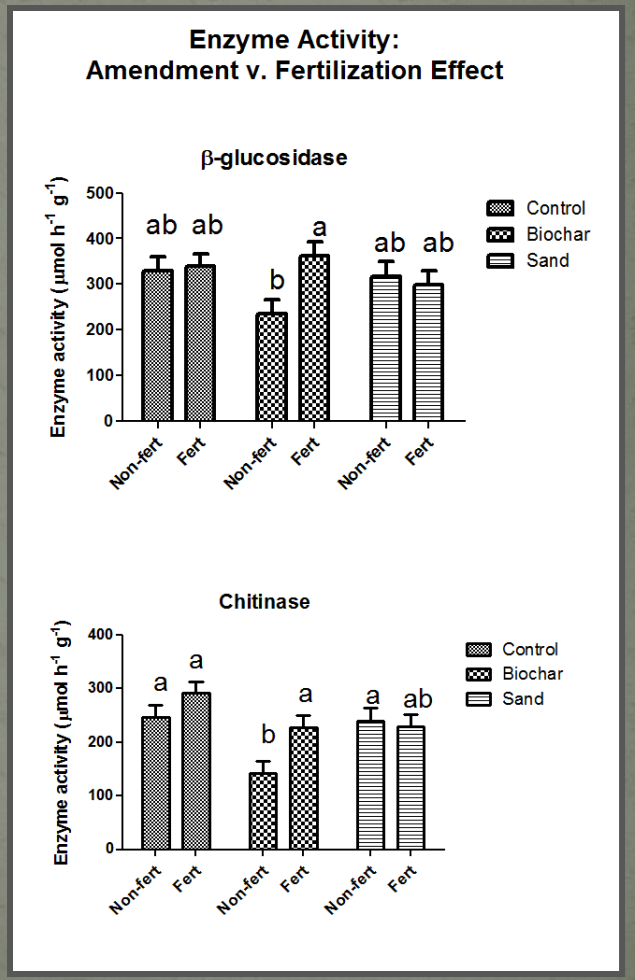
- Forest succession
  - Increase in plantation sites
    - β-glucosidase
    - Chitinase
    - Peroxidase





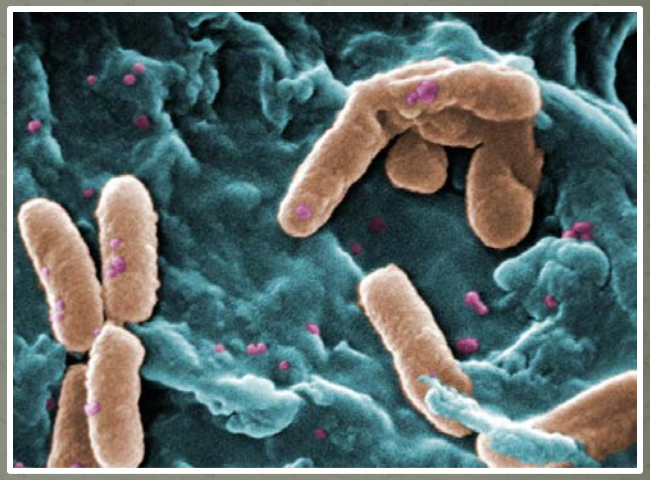
Results – Enzyme activity

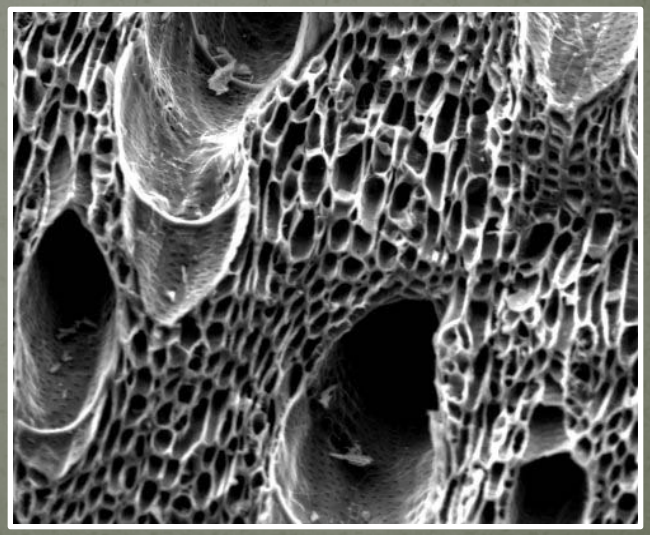
- Amendment v. Fertilization effect
  - Urea fertilizer
    - Compensated for biochar-related activity reduction
      - Chitinase
      - β-glucosidase
  - No other significant correlations with fertilizer and enzymes



Results – Enzyme activity

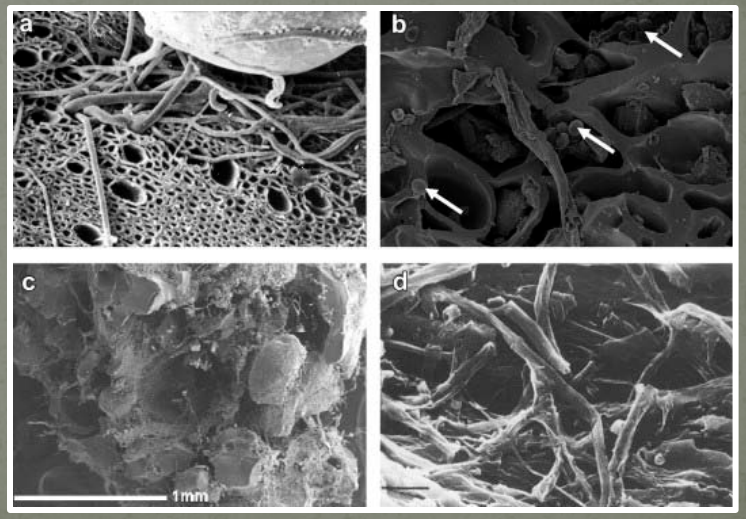
- Enzyme effects – Proposed causes
  - Increase
    - Biochar co-location of enzyme and substrate
      - Field or lab analysis
    - Biochar favoring of exoenzyme producing microbes
  - Decrease
    - Biochar sorption / blocking of enzyme or substrate
    - Lower demand for enzymes





Results – Microbial activity

- Microbial activity
  - No significant effects
    - Amendment
    - Fertilization
    - Forest succession
    - Site
  - Other studies have shown biochar can increase biomass



Conclusions

- Enzyme activity
  - Unique aspects of biochar may influence C, N, and P cycling through alteration of chitinase, aminopeptidase, and phosphatase activity.
  - Changes may be altered by fertilization.
  - Total response of B-glucosidase, chitinase, and peroxidase activity to biochar may differ between plantations and mature forests.
- No significant effects on microbial activity.

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