North American Biochar Symposium

BASALT DUST AND BIOCHAR INTERACTIONS AT NEW HARMONY FARM, MASSACHUSETTS

Thomas J. Goreau, Erin Stack, Elaine Senechal, Jim Tang, Rebecca Ryals, Tom Vanacore, & Joanna Campe
Basalt Powder Restores Soil Fertility and Greatly Accelerates Tree Growth on Impoverished Tropical Soils in Panama

Thomas J. Goreau, Marina Goreau, Felix Lufkin, Carlos A. Arango, Gabriel Despaigne-Matchett, Gabriel Despaigne-Ceballos, Roque Solis, & Joanna Campe
THE SITE: PANAMA

- Mitigation for clearance of basalt quarry
- Geology: Pleistocene pyroclastic ashes, volcanic tuffs, with basalt lava outcrop
- Agricultural Soil Capacity: Highly infertile, not arable with severe nutrient limitations
- Vegetation: Secondary pioneer scrub following deforestation for pasture
- Precipitation: 2500 mm/yr
- Elevation: 600 m
THE TREE: ACACIA MANGIUM

- Planted in basalt quarry rock powder, local soil, and transition zone
- No fertilizer added
- Nitrogen fixing tree
- Height measured by video after 19 and 59 months
- Soil samples analyzed
TRANSITION SOILS

19 months

59 months
BASALT POWDER

19 months  59 months
TREE HEIGHT VS TIME

GROWTH RATE OF ACACIA MANGIUM IN BASALT POWDER (GREEN), LOCAL SOIL (RED), AND MIXTURE (BLUE)
TREE SURVIVAL VS HEIGHT

FASTER GROWING TREES HAD MUCH HIGHER SURVIVAL

PERCENT SURVIVAL FROM 19 TO 59 MONTHS

TREE HEIGHT AFTER 59 MONTHS
TREE HEIGHT VS SOIL
BIOMASS VS TREE HEIGHT

ACACIA MANGIUM
D. Torres & J. I. del Valle, 2007

\[ y = 0.0301x^3 - 0.2699x^2 + 1.6077x \]

\[ R^2 = 0.9487 \]
BIOMASS PER TREE VS SOIL

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Graph showing biomass per tree versus soil.
PHOSPHORUS

![Bar graph showing phosphorus levels across different fertility categories: H, M, L.](image)
IRON

![Iron Concentration vs Fertility Graph]

<table>
<thead>
<tr>
<th>Fertility</th>
<th>Iron (Microgram/ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>~250</td>
</tr>
<tr>
<td>M</td>
<td>~150</td>
</tr>
<tr>
<td>L</td>
<td>~50</td>
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</tbody>
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MANGANESE

MANGANESE (MICROGM/ML)

FERTILITY

H
M
L
POTASSIUM

![Bar graph showing potassium levels across different fertility levels.](image)
MAGNESIUM
CALCIUM

![Graph showing calcium levels in different fertility stages (H, M, L)]
COPPER

![Graph showing copper levels across different fertility levels.](image)

- **COPPER (MICROG/ML)**
  - H: Approximately 0.8 - 1.0
  - M: Approximately 0.6 - 0.8
  - L: Approximately 0.4 - 0.6
pH

FERTILITY

H M L
CONCLUSIONS

• Rock powders alone greatly increase plant growth and survival

• They provide a wide range of essential minerals as slow release fertilizers

• Rock weathering by roots provides a sink of atmospheric CO2

• The effects could be greatly increased by addition of Biochar
RECOMMENDATIONS

- Rock powders could be widely used as natural slow release fertilizers
- They can greatly aid restoration of forest and agricultural productivity in poor soils if matched to plant needs
- They can contribute to removal of CO2
- Research is needed to optimize use of various rock powders, plants, soil types, climate regimes, and management practices
LONG TERM BIOCHAR/BASALT POWDER INTERACTIONS

• SITE: NEW HARMONY ORGANIC FARM, WEST NEWBURY, MASSACHUSETTS
• BIOCHAR FROM NEW ENGLAND BIOCHAR, ONE YEAR OLD PINE/OAK MIXED 50:50 WITH OAK/PINE LEAF COMPOST (BOB WELLS)
• BASALT POWDER FROM ROCK DUST LOCAL (TOM VANACORE)
Figure 1. New Harmony Farm.
The plot of the Biochar/Rock Dust experiments is shown in the white rectangle. The Merrimack River is at lower left.
Figure 2a. A portion of William Woods 1634 map showing an island in the Merrimack River. New Harmony Farm is located on the southern channel, which was plugged up by the 1635 Hurricane.
Figure 2b. A perspective view of the New Harmony Farm site. The white dot marks the project site. The approximate boundaries of the Merrimack River channel before the hurricane filled it are shown in the dashed stars, based on the topographic contours of the site.
Figure 3. Merrimack River watershed, with the project site indicated by the arrow.
Figure 4. New Harmony Farm showing the boundaries of New Harmony Farm and of soil types surveyed by the US Department of Agriculture. Soil types are classified in Figure 5. below. Note that the image was taken before the greenhouse (long white structure in Figure 1) was built. At the time this image was taken the land had been ploughed for hay.
Figure 7. Arrangement of subplots used in this experiment. The legends at top and bottom show the relative amounts of biochar or rock dust in each column and row respectively. Plots 1, 5, 17, 21, 28, and 32 were used for the initial greenhouse gas flux measurements.
Figure 8. First crop yields in pounds per plant for beets and radishes as a function of basalt powder concentration. Note an increase with basalt, but an inhibition at the highest levels, indicating that there is an optimal concentration above which benefits decrease. All graphs show means plus or minus standard deviations of replicate plots.
Figure 9. First crop yields in pounds per plant for beets and radishes as a function of biochar concentration. Note that the fresh biochar inhibited growth of beets but not radishes.
Figure 16. Earthworm castings per unit area.
Figure 17. Gas emissions from plots measured between crops.

- **CO₂ flux**:  
  - Control: 2.5*  
  - High Basalt: 2.0*  
  - High Char: 1.5*

- **N₂O flux**:  
  - Control: 0.16*  
  - High Basalt: 0.12*  
  - High Char: 0.08*

- **NOₓ flux**:  
  - Control: 0.04*  
  - High Basalt: 0.006*  
  - High Char: 0.002*

* denotes significance level.
BIOCHAR & ROCK POWDER

• Both provide benefits for years
• Effects take a few years to mature
• Are ideal complements for each other
• Should provide the greatest results in combination
• Should greatly increase crop production, soil fertility, and soil carbon storage, while reducing greenhouse gas emissions
• Seeking funding for long term continuation
GEOTHERAPY: INNOVATIVE METHODS OF SOIL FERTILITY RESTORATION, CARBON SEQUESTRATION, AND REDUCING ATMOSPHERIC CO2

• 38 chapter 2014 CRC Press book edited by Tom Goreau, Ron Larson, Joanna Campe
• Rock powder & Biochar data from many ecosystems, climate regimes, soil types, crops
• Results from every continent except Antarctica
• Supports potential for large scale global soil fertility improvement and carbon sequestration
• CO2 can only be stabilized by soil carbon increase
• Aims to influence UN Climate Change negotiations