

8-20-2017

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Recommended Citation

Maren Oelbermann, "Effect of biochar addition on carbon dioxide and nitrous oxide emissions from a temperate agricultural soil" in "Biochar: Production, Characterization and Applications", Franco Berruti, Western University, London, Ontario, Canada Raffaella Ocone, Heriot-Watt University, Edinburgh, UK Ondrej Masek, University of Edinburgh, Edinburgh, UK Eds, ECI Symposium Series, (2017). <http://dc.engconfintl.org/biochar/30>

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Effect of biochar addition on carbon dioxide and nitrous oxide emissions from a temperate agricultural soil

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INTRODUCTION

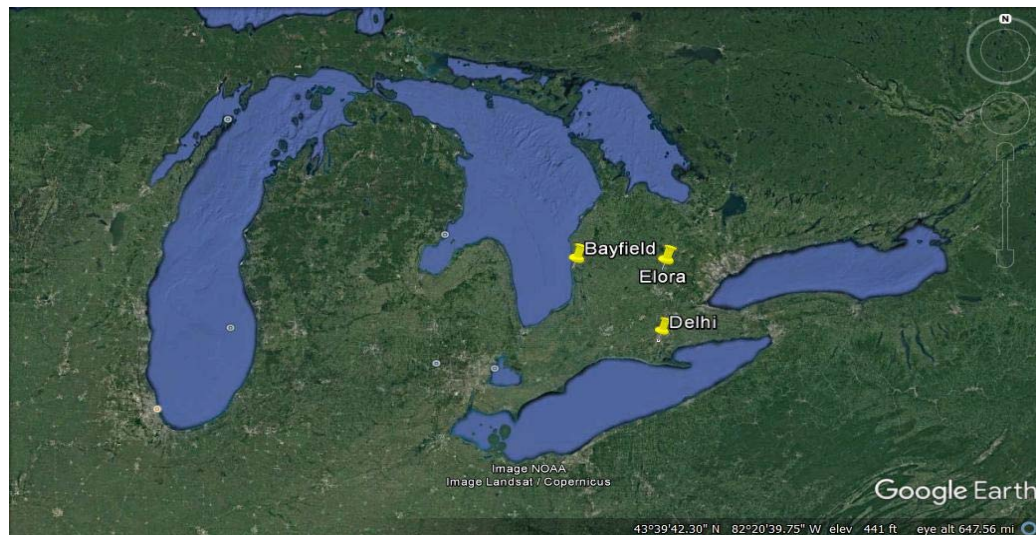
- Amending agricultural soils in temperate locations with biochar is a more recent approach
- Research still in its infancy
- Knowledge gap remains on the effect of biochar on GHG emissions
- Most GHG emissions studies to date conducted over the short term (4 months or less)
 - Field and laboratory
- Short-term studies do not capture temporal variation in GHG emissions

OBJECTIVES

To evaluate soil CO₂ and N₂O emissions in a conventional agricultural production system amended with biochar and under a maize (*Zea mays*) crop in southern Ontario

STUDY SITE

- Bayfield, ON
 - 43°34'45"N, 81°39'48"W
- Commercial poultry farm
- Maize-soybean rotation
 - Addition of poultry manure on 3-year rotation
 - Poultry bedding: switchgrass
 - Addition of 135 kg N/ha in years maize is produced



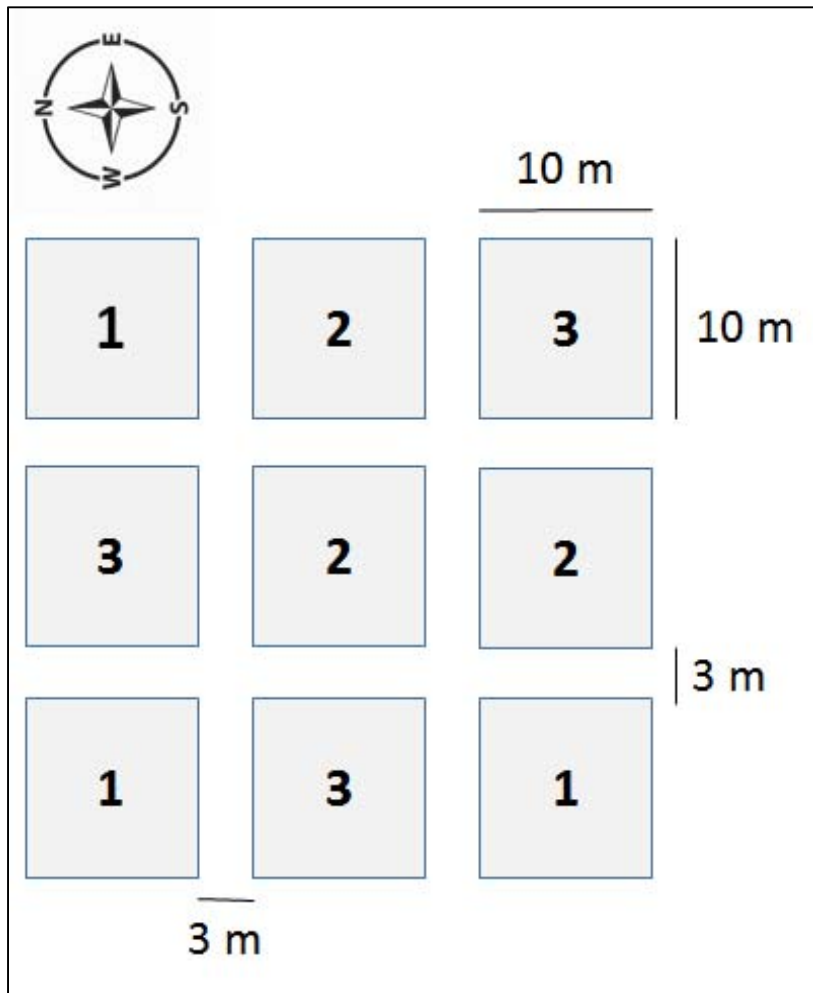
Soil

Grey-brown Luvisol
(Light) loam texture

Site

247 masl
1.5 % slope

Experimental Design



Randomized complete block design with three treatments and three replications.

Treatment 1 (M+N): 6t/ha poultry manure plus 150 kg/ha N fertilizer.

Treatment 2 (M+B): 3t/ha poultry manure plus 3 t/ha biochar.

Treatment 3 (M+N+B): 3t/ha poultry manure, 3 t /ha biochar, 150 kg/ha N



METHODS



- Bi-weekly GHG collection
 - May to November 2016
 - Static chamber (2 chambers per treatment replicate)
 - T=0, 15 & 30 mins
- Bi-weekly
 - Soil temperature
 - Soil moisture
 - Soil samples (NH_4 & NO_3)
- GHG analysis on Agilent gas chromatograph
- Soil moisture & temperature using WET sensor
- N-fraction analysis using UV-Vis Spectrophotometry

BIOCHAR USED IN THIS STUDY

- Mayan Gold Biochar
 - Titan Carbon Smart Technologies
 - Spruce-Pine mix

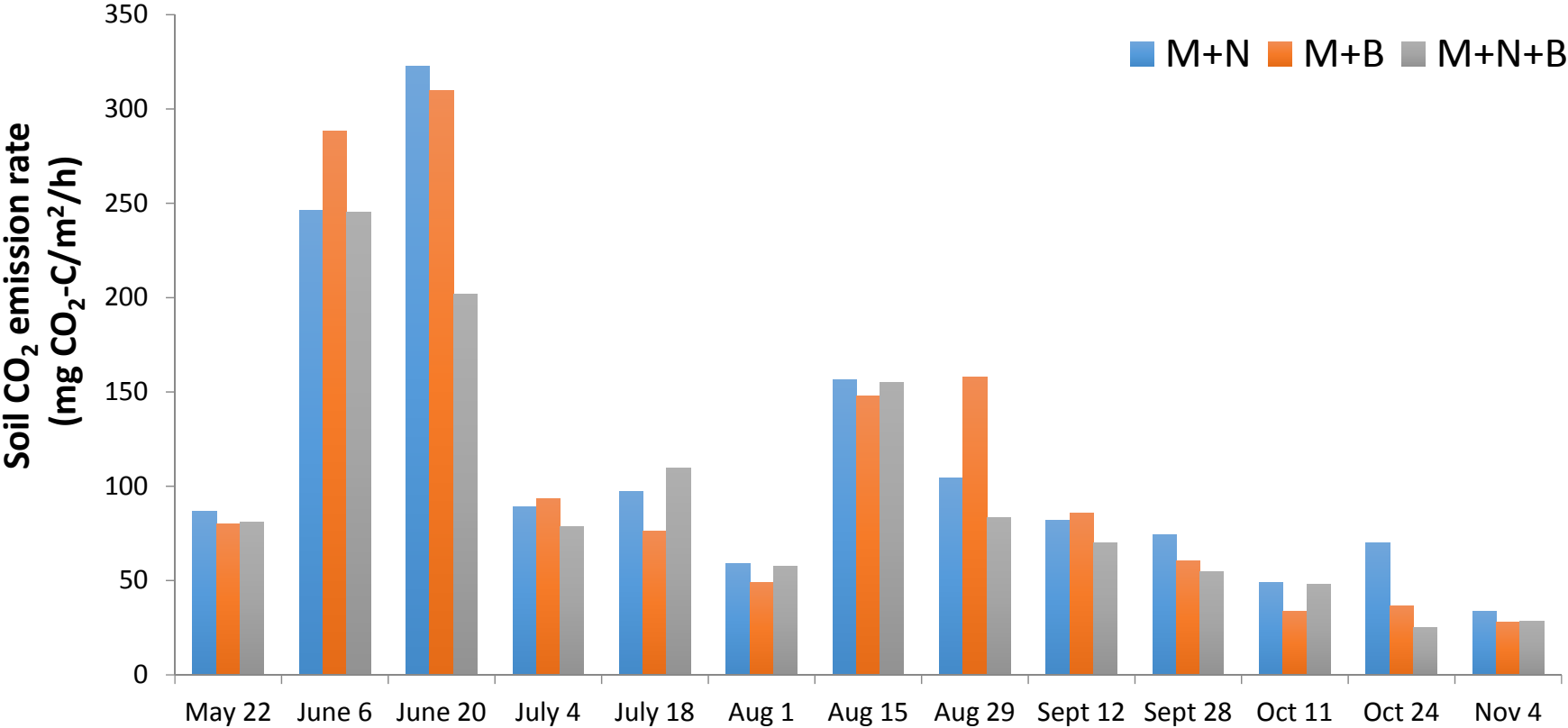
Biochar Composition

| | |
|-----------------------|-----------|
| Carbon Content | 80% |
| Ash Content | 12% |
| pH | 7.2 |
| Nitrogen | 1500 ug/g |
| Phosphorus | 500 ug/g |
| Potassium | 7000 ug/g |

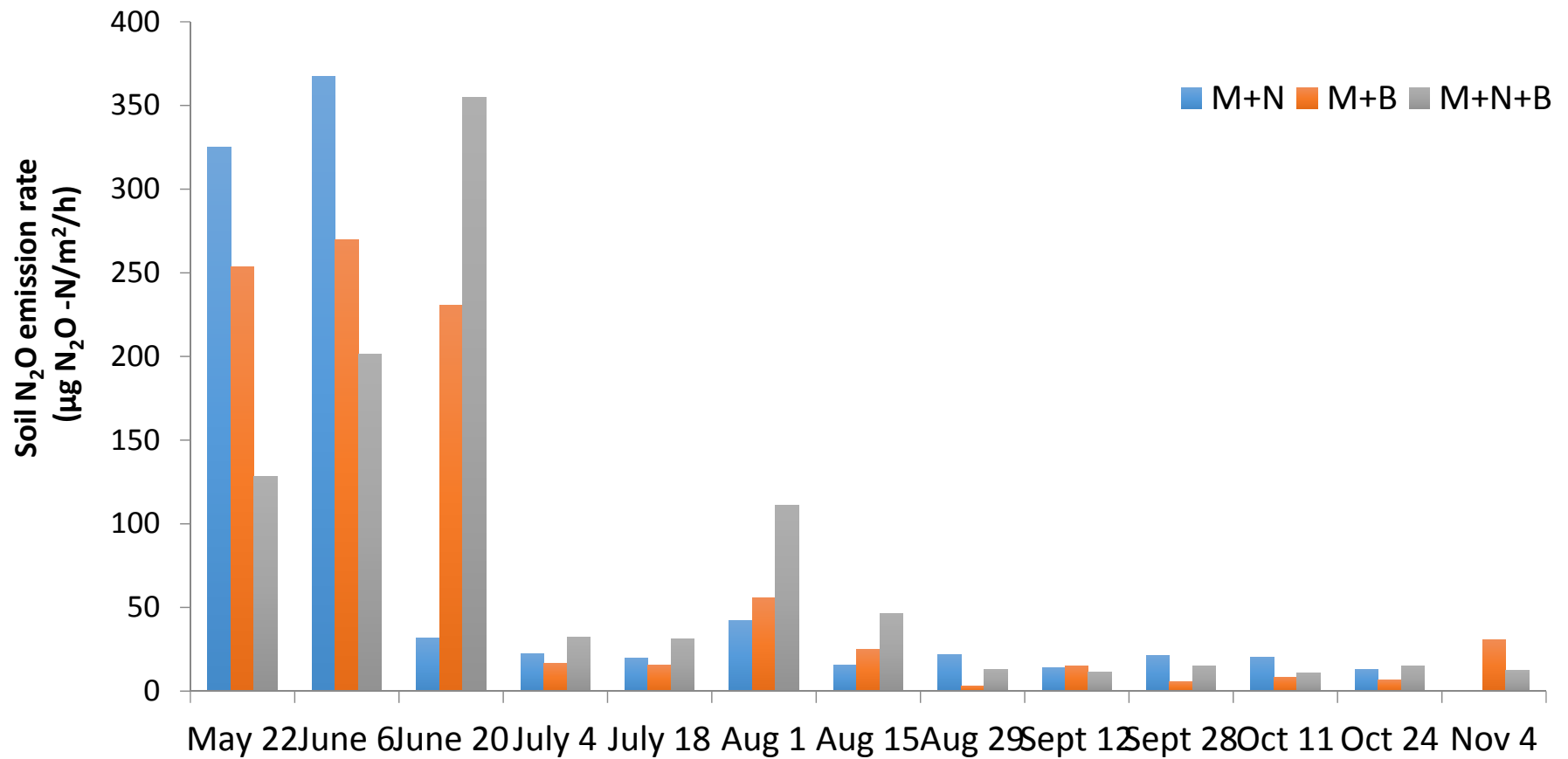
Non-toxic, neutral pH, high carbon content, high surface area, low nutrients, trace metals and micro-nutrients, user friendly (low dust).



Results: CO₂ Emissions



Soil N₂O Emissions



Mean CO₂ and N₂O emissions from May to November 2016

| Treatment | CO ₂ Emissions (mg CO ₂ -C/m ² /h) | N ₂ O Emissions (μg N ₂ O-N/m ² /h) |
|-----------|--|---|
| M+N | 113 | 76 |
| M+B | 111 | 57 |
| M+B+N | 95 | 71 |

No significant differences among treatments

Correlations

| | Moisture | Temperature | NH ₄ | NO ₃ |
|------------------|----------|-------------|-----------------|-----------------|
| CO ₂ | -0.240** | 0.482** | | |
| N ₂ O | 0.433* | 0.364* | 0.386** | 0.360** |

*Significant at p=0.05

**Significant at p=0=0.01

Conclusions

- Biochar addition did affect GHG emissions
 - Treatments containing biochar showed a trend of lower GHG emissions (but was not significant)
- Significant correlation for all treatments
 - Very strong correlation between CO₂ emissions and soil moisture for all treatments
 - Strong correlation between N₂O emissions and soil moisture for all treatments
 - Very strong correlation between N₂O emissions and soil NH₄ and NO₃ content
- Further sampling (second season) currently underway
 - This study will have three years of GHG data once completed (2016 under corn, 2017 under soybean and 2018 under corn)
- Long-term studies necessary to determine temporal variation in GHG and how this correlates to fluctuations in soil temperature and N

Acknowledgements



Ontario

Ministry of Agriculture,
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