Effects of Different Cover Crops and Tillage on Greenhouse Gas Emissions in Soil Incubation

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Introduction

- Decomposition of cover crops (CC) after termination stimulates microbial activity and can increase the greenhouse gas (GHG) emissions.
- Tillage following CC termination accelerates the decomposition process and may promote the GHG emissions (Abdalla et al., 2014).
- Different cover crops like legumes, brassica, cereal and mix species of CC with residues incorporated or surface applied to the soil may have differential effects on GHG emission.
- However, the carbon dioxide (CO₂), nitrous oxide (N₂O) and methane (CH₄) emissions after cover crop termination and incorporation into the soil is not adequately studied.
- Soil incubation simulating the field condition of CC residues and tillage may help understand the GHG emission dynamics in a cover crop incorporated cropping system.

Research Hypotheses

- Mix species of CC may have higher CO₂ emissions and legume CC would have higher N₂O emissions compared to other CC and no CC treatments.
- Soil incorporation of residues may lead to higher GHG emission compared to surface applied.

Objectives

1. To investigate the effects of CC residues on CO₂, N₂O and CH₄ emissions during incubation of soil core samples collected from an organic cotton field at 29°C.
2. To study different residue management effects (surface applied or soil incorporated) on GHG emissions during the incubation.

Methods

- Study Site: Near College Station, Texas (33.55˚N, 96.43˚W).
- Climate: Humid subtropical.
- Cropping System: Organic cotton with CC treatments.
- Exp. Design: Split plot design with two tillage treatments as main plots and six CC treatments as subplots in three replications.

Treatments

- Tillage (Main plots):
  - Cover crops (Sub plots):
    - Winter pea (Pisum sativum)
      - Winter mix (mix of all three)
      - Winter pea
    - Mustard (Brassica rapa)
      - Mustard
      - Mustard - Weed free
      - Mustard - Winter mix
    - Oats (Avena sativa L.)
      - Oats
      - Oats - Weed free
    - Weed free (no cover crop)
    - Weedy (no CC and no weed control)

Soil Sampling and Incubation

- Undisturbed soil core samples were collected from each plot after CC termination.
- Core size: 5.72 cm inner diameter, 10.2 cm height (Fig.1).
- Soil samples were placed in 250 ml cups and were stored in the refrigerator at <4°C until incubation.
- Incubation jars: Inner volume of 946 ml with air-tight lids (Fig.2).
- Soil water adjustment: 60% WHC.
- Incubation temperature: 29°C.

Greenhouse Gas Emissions

- Sampling days: 0, 1, 2, 4, 6, 10, 14, 22, 30, 45 days of incubation.
- Sampling time: 0 and 4 hours after closing the lids.
- Gas samples were stored in 12 ml evacuated vials.
- Samples were analyzed for CO₂, N₂O and CH₄ concentration using a gas chromatograph.

Results and Discussion

- CC residues were applied just before soil incubation at the rates as in field.
- Poultry litter was applied at a rate of 2.98 Mg ha⁻¹ (0.77 g per soil core).
- Soils were stirred for conventional filled plots and surface applied to mimic no-tillage.

Conclusions

- Balanced C and N availability from mix species CC stimulated the microbial activity and increased CO₂ emissions in both residue management. Legume CC had higher CO₂ emissions while residues were mixed into the soil.
- Mix species CC treatment when residues were incorporated had higher N₂O emissions. Low C:N ratio legume CC treatment didn’t increase N₂O emissions compared to no CC treatments.
- Oats residues increased CH₄ emissions when incorporated with soil but overall CH₄ emissions were very negligible and no difference among CC treatments were found in surface applied treatments.

References


Acknowledgment

Undergraduate student workers Giordano (Bruno) Fontana and Walker Crane