Changes in Soil Thermal Properties Under Corn Stover Removal and Cover Crops

Michael Sindelar[1], Humberto Blanco[1], Virginia Jin[2], and Richard Ferguson[1]

[1]Department of Agronomy & Horticulture, University of Nebraska-Lincoln, Lincoln, NE, USA
[2] Agroecosystem Management Res. Unit, USDA-ARS, Lincoln, NE, USA

BACKGROUND

- Removing corn stover and using cover crops (CCs) can alter soil thermal properties (Blanco-Canqui et al., 2011; Kenney et al., 2015)
- Changes in soil thermal properties affect energy fluxes, climatic fluctuations, seed germination, and others.
- There is little information on how CCs can mitigate changes in soil thermal properties after corn stover removal.
- Knowledge of changes in soil thermal properties can be important for developing sustainable management practices.

OBJECTIVE

To assess the impact of corn stover removal and CCs on soil thermal properties (thermal conductivity, specific heat capacity, and thermal diffusivity) through the growing season on a 6-yr irrigated no-till continuous corn in south central Nebraska. We also correlated soil thermal properties with other soil properties.

METHODOLOGY

- We used an ongoing experiment at the University of Nebraska-Lincoln's South Central Agriculture Laboratory located east of Hastings, NE
- The experiment was established in spring 2010 on a silty loam (*fine, smectitic, mesic Udic Argiustolls*) with < 1% slope.
- Treatments were: 1) control (no stover removal without CCs), 2) no stover removal with CCs, 3) corn stover removal without CCs, and 4) stover removal with CCs (Fig. 1).

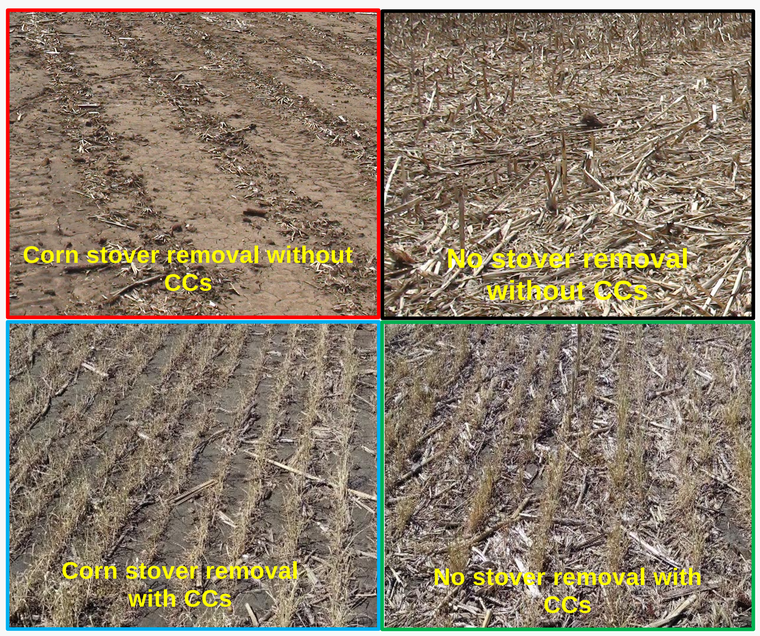

Fig. 1. Experimental treatments.

- Stover was mechanically removed each fall prior to CC planting. The average rate of removal across 6 yr was 56±3%.
- Winter cereal rye CC was planted after corn harvest and terminated 3 wks prior to planting of corn in spring.
- Two soil cores (5 cm x 5 cm) were sampled from each treatment plot in May 2016 for the determination of thermal properties in the laboratory.
- The thermal properties were measured using a KD2 Pro with SH-1 sensor on soil cores equilibrated at -0.033 MPa (field capacity) and -1.5 MPa (permanent wilting point) matric potentials.
- In the field, thermal properties were measured every 15 d for the first two months after corn plating and then every 30 d.

RESULTS

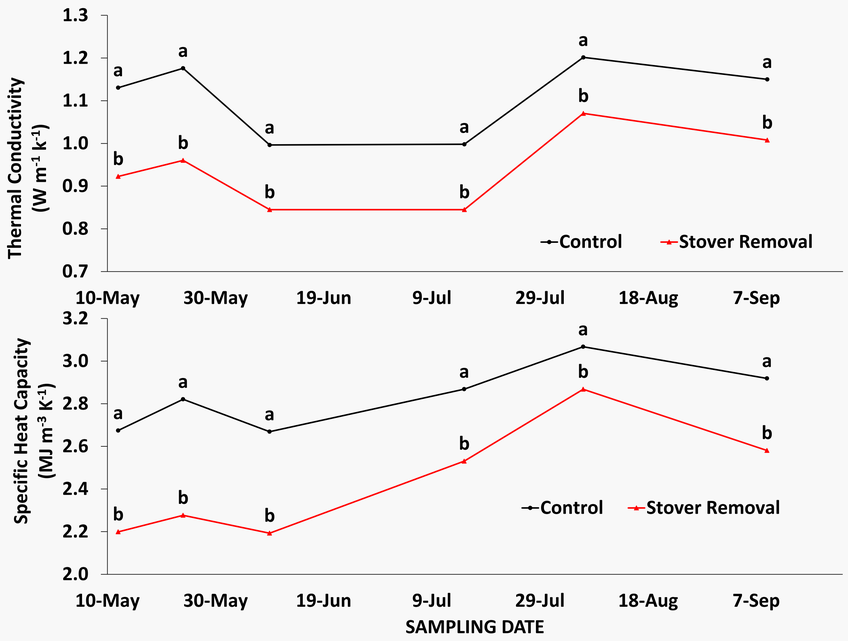

Fig. 2. Soil thermal properties measured in the field.

- Stover removal had an effect on thermal conductivity ($p<0.05$) and specific heat capacity ($p<0.05$) in both field and laboratory.
- Cover crop affected specific heat capacity in the laboratory ($p<0.05$) but not in the field.
- Interaction between CCs and corn stover removal was not significant for any soil thermal property ($p>0.10$).
- In the field, corn stover removal reduced thermal conductivity by 11-18% and soil specific heat capacity by 12-18% compared to no removal through the growing season ($p<0.05$; Fig. 2).
- In the laboratory, corn stover removal reduced thermal conductivity by 21% at field capacity and by 22% at permanent wilting point (Fig. 3a).
- Similarly, in the laboratory, corn stover removal reduced soil specific heat by 18% at field capacity and by 20% at permanent wilting point (Fig 3b).
- Cover crop reduced specific heat capacity by 17% in the laboratory at permanent wiling point (Fig 3b)
- Soil thermal properties were not correlated to any soil property except thermal conductivity, which was correlated with volumetric water content at the 0.1 probability level (Fig 4).

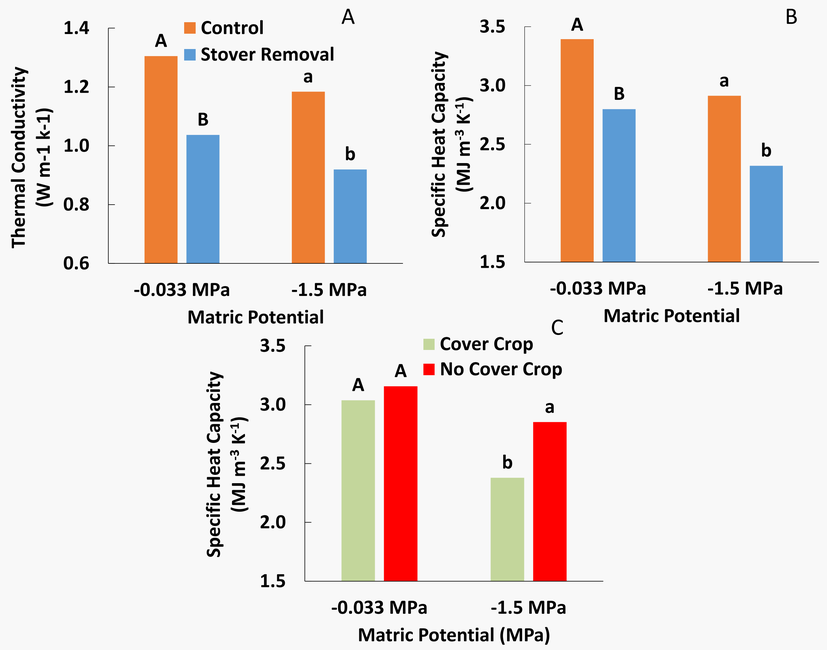

Fig. 3. Thermal properties measured in the laboratory at -0.033 and -1.5 MPa.

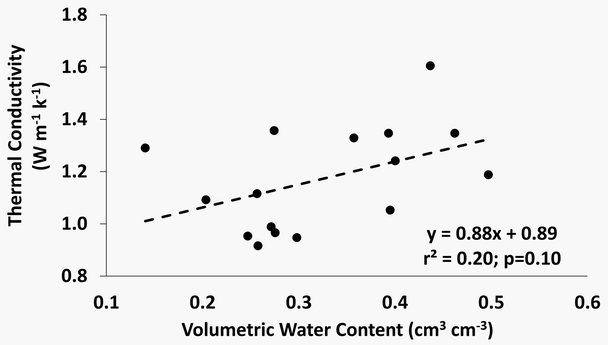

Fig. 4. Relationship of thermal conductivity with soil water content.

DISCUSSION

- Results show that corn stover removal reduces thermal conductivity and specific heat capacity.
- Results also show that cover crops can reduce the specific heat capacity of soil at low water contents, but this warrants further analysis to fully understand the extent to which cover crops affect soil thermal properties in the long term (> 6 yr).
- Changes in soil water content can be the most sensitive indicators of changes in thermal conductivity.
- Thermal conductivity appears to be more responsive to stover removal compared with specific heat capacity.
- Other soil properties (i.e., pore-size distribution) may influence changes in thermal properties more than soil organic C and bulk density in this study.

CONCLUSIONS

- This study suggests that stover removal can reduce the amount of heat flow and exchange through the surface layers and can have implications for crop establishment and climatic fluctuations.
- Removing approximately 50% of corn stover can impact soil thermal properties.
- Cover crops may not mitigate the negative impacts of corn stover removal on soil thermal properties.
- Further long-term monitoring is needed, particularly under cover crops, as the magnitude of change in soil properties could increase with time (> 6 yr).

REFERENCES

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- Kenney, I., Blanco-Canqui, H., Presley, D. R., Rice, C. W., Janssen, K., & Olson, B. (2015). Soil and crop response to stover removal from rainfed and irrigated corn. GCB Bioenergy, 7(2), 219-230.