IMPACT OF MAIZE PLANT RESIDUE ON SOIL TEMPERATURE DYNAMICS IN A DRYLAND ENVIRONMENT

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BACKGROUND

- In dryland conditions, soil temperatures often rise significantly, especially in cleared and tilled soils. These elevated soil temperatures accelerate the decomposition of soil organic matter, resulting in increased CO_2 emissions, reduced soil fertility, and higher evaporation rates.
- The behavior of soil temperature is influenced by various dynamic factors, including air temperature, precipitation, shortwave radiation, soil moisture, and soil cover.
- The aim of this study was to utilize continuous soil and meteorological data to evaluate the influence of maize stover mulching on soil temperature in a dryland environment

METHODS

- The experimental site was located in dryland conditions in Maktau, Kenya.
- A 1 cm thick layer of maize stover mulch (equivalent to 5 t ha^{-1}) was applied and left on the soil for a period of 100 days (Fig. 1).
- Soil volumetric water content and temperature were monitored at depths of 5, 10, 20, 30, and 50 cm, with data collected every 20 minutes. To align with the on-site weather station's data collection interval, these measurements were interpolated to a 30-minute timestep.
- Soil thermal properties were analyzed in a laboratory setting using a thermal properties analyzer to validate the values derived from continuous on-site data.

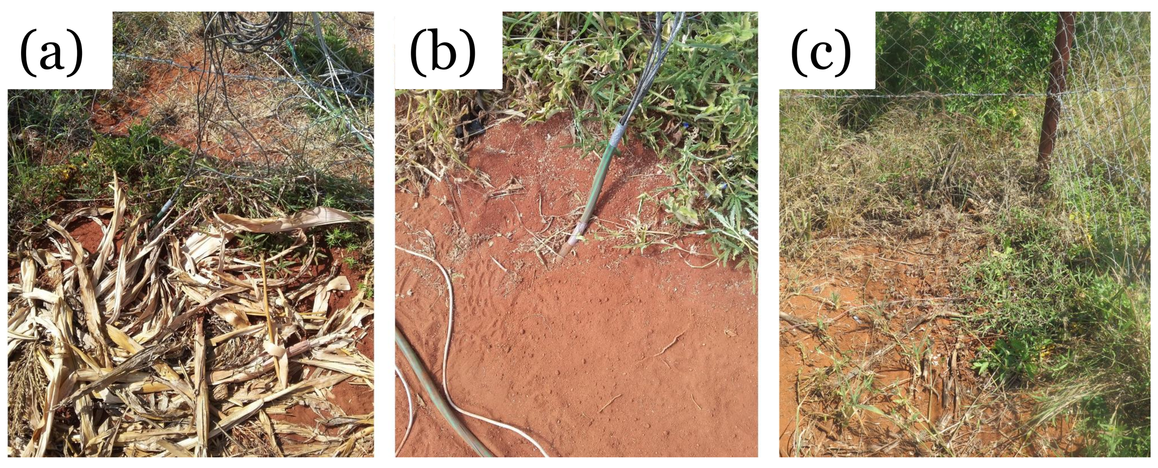

Figure 1. Mulch (a) and no mulch (b) soil surfaces established in February 2016. The plant residue mulch on the Mulch surface was decomposed by the end of the experiment (c).

RESULTS

- Mulch significantly reduced the mean soil temperature between 0 – 30 cm (Fig.2).
- Mulch reduced the diurnal fluctuation of measured soil temperature compared to bare soil (Fig. 3).
- Mulch conserved soil moisture, thus increased the heat capacity and conductivity of the soil (Fig. 3).
- In laboratory conditions at 23°C, air-dry soil had the following thermal properties: volumetric specific heat capacity, $C = 1.201 \pm 0.006$ MJ m^{-3} K^{-1}, and thermal conductivity, $\lambda = 0.234 \pm 0.001$ W m^{-1} K^{-1}. Values are means ($n = 10$) ± standard error of the mean.

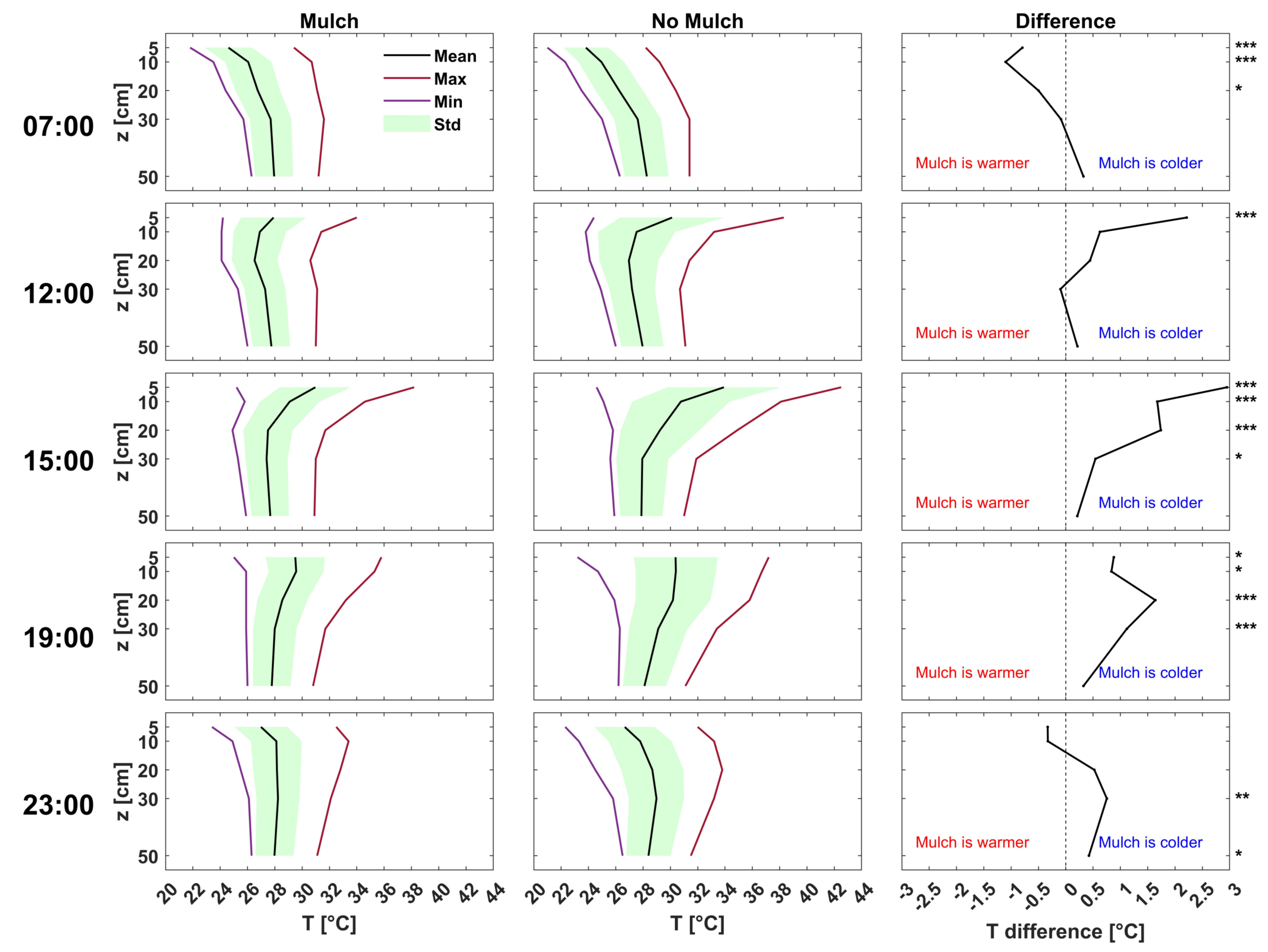

Figure 2. Soil temperature profiles during the 100-day measurement period at 7, 12, 15, 19, and 23 hours. The black line represents the mean (n = 100), the shaded green area depicts the standard deviation, and the outermost lines denote minimum and maximum values. Asterisks indicate significance levels: * for p < 0.05, ** for p < 0.01, and * for p < 0.001.**

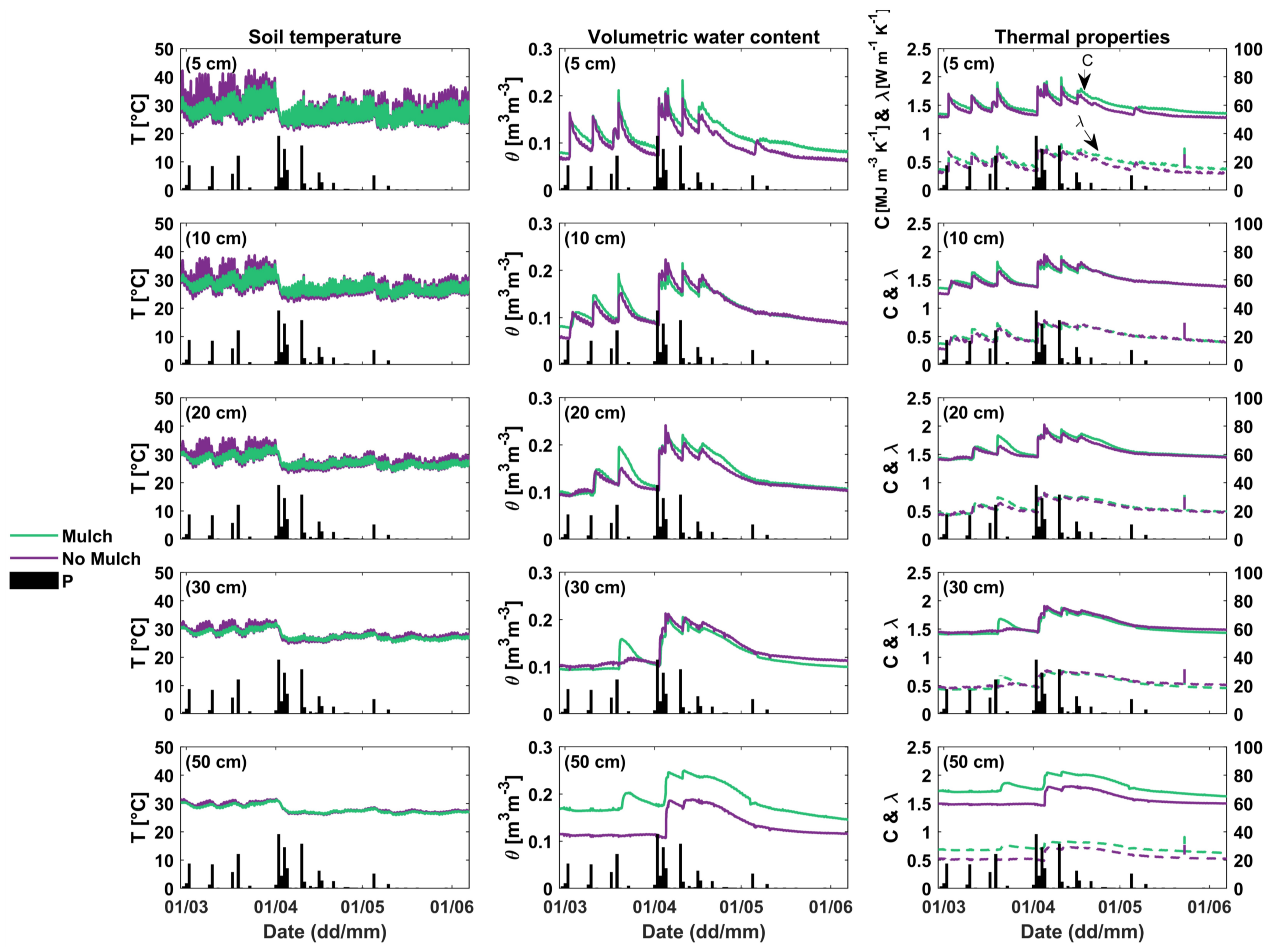

Figure 3. Time series of measured soil temperature (T), soil volumetric water content (θ), calculated soil thermal conductivity (λ), and soil volumetric specific heat capacity (C) at the measured depth nodes for every 30 minutes. Daily precipitation (P) is shown on the right-hand axis.

CONCLUSIONS

- Reduction in temperature fluctuations under mulch was due to decreased radiation interception and increased soil heat capacity and conductivity resulting from preserved soil moisture.
- While smallholder farmers in the study area use plant residues also as forage and fuel, it may be worth considering plant residue mulching as a method to mitigate high-temperature effects and conserve soil moisture in similar dryland conditions.

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