Crop rotation diversification, water balance and soil organic carbon in organic production systems in southwest Minnesota

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INTRODUCTION

Climate patterns in the central US are expected to become increasingly variable with changes in rainfall intensity, seasonality and available moisture. Evapotranspiration (ET) plays a key role in the water cycle, affecting the water balance from local up to regional scales and causing feedback between soil, plants and the atmosphere. *The objective of this research is to use direct and indirect methods for estimating ET for determining soil water balances and WUE in short- (two-year) and intermediate-term (three- or four-year) organic and conventional cropping systems*.

This presentation contains information about the experimental layout and methodologies used to characterize ET. Knowledge of ET is crucial for design and management of water management infrastructure (e.g. irrigation; subsurface drainage system design), quantifying the effect of changes in land use and management on water balances (diverse crop rotations, perennials, cover crops), and as an important tool to calculate vegetation/crop water requirements under a given set of climatic and management conditions. Evapotranspiration can be determined through the use of direct and indirect methods. In this experiment, the indirect Penman-Montieth method along with the direct soil water balance method for estimating daily ET will be compared for organic and conventional cropping systems. Weather data for calculating ET using the Penman-Monteith method will be measured with an automated weather station located at the research site. Estimates of ET, using the water balance method, will be determined by measuring various components of the soil water balance. Soil moisture measurements will be collected using probes for measuring soil volumetric water content (5TM, Decagon Devices, Inc. Pullman, WA). These measurements will be made at depths of 0.05, 0.1, 0.2, 0.4, 0.6, 1.0 and 2.0 m in each plot. A daily spreadsheet will be used to calculate ET and a daily soil water balance during frost free periods.

MATERIALS & METHODS

The scenarios for global environmental change suggest a future increase in aridity and in the frequency of extreme events in many areas of the world. Evapotranspiration (ET) plays a key role in the water cycle, affecting the water balance from local up to regional scales and causing feedback between soil, plants and the atmosphere. At the farm level, under rain fed conditions, the process of water loss has two main components: one due to evapotranspiration losses, and the other including the losses resulting from the percolation of water beneath the root zone and to subsurface drainage systems in drained landscapes.

Reliable estimates of ET are crucial for agronomic and hydrological studies because ET links two fundamental definitions; the soil water balance and the surface energy balance. The soil water balance may be defined as:

$$DS = (P + I + U) - (\mathbf{ET} + D + R_o) \qquad [1]$$

Where DS is change in soil water storage, P is precipitation, I is irrigation, U is upflux or capillary rise of water from shallow groundwater, *ET is evapotranspiration*, D is deep seepage or drainage, and R_o is surface runoff.

The surface energy balance in its simplest form is defined as:

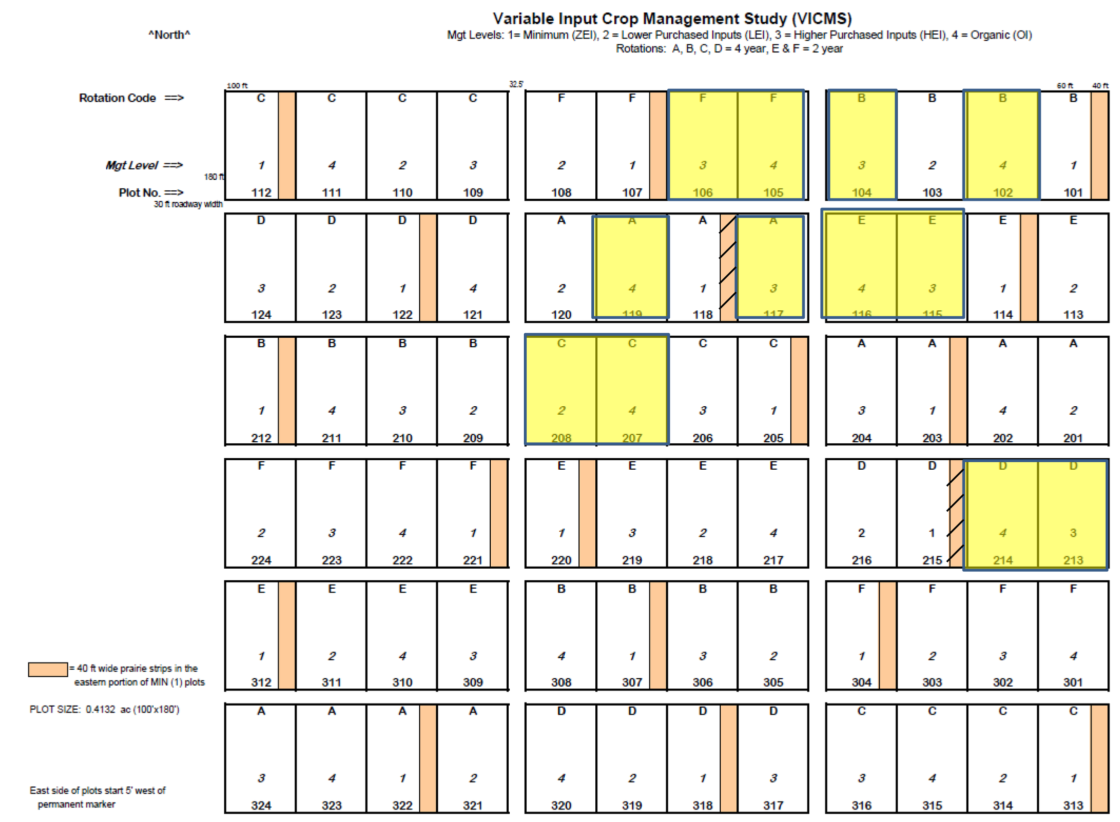
$$R_n + G + \mathbf{LE} + H = 0 \qquad [2]$$

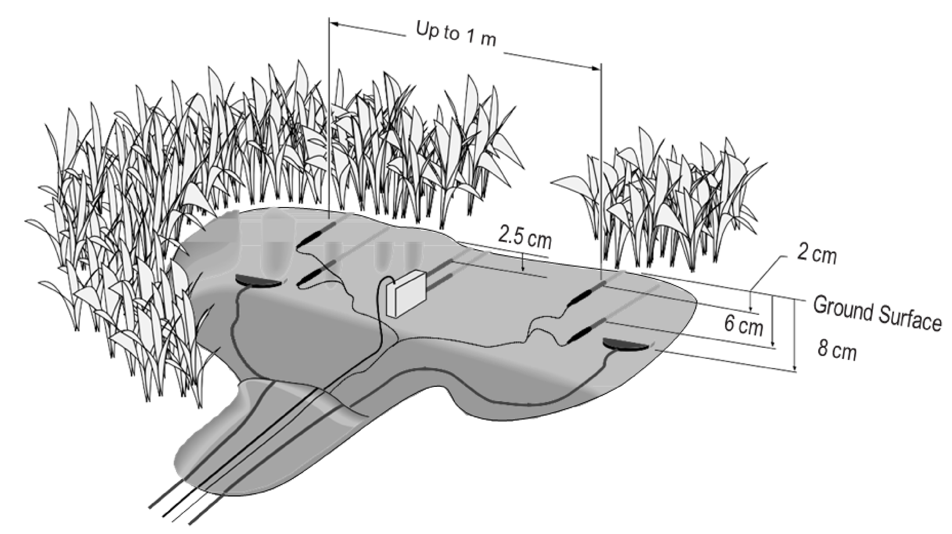
Where R_n is net solar radiation, G is soil heat flux, H is sensible heat flux, and *LE is latent heat flux or more generally known as ET.*

TREATMENTS

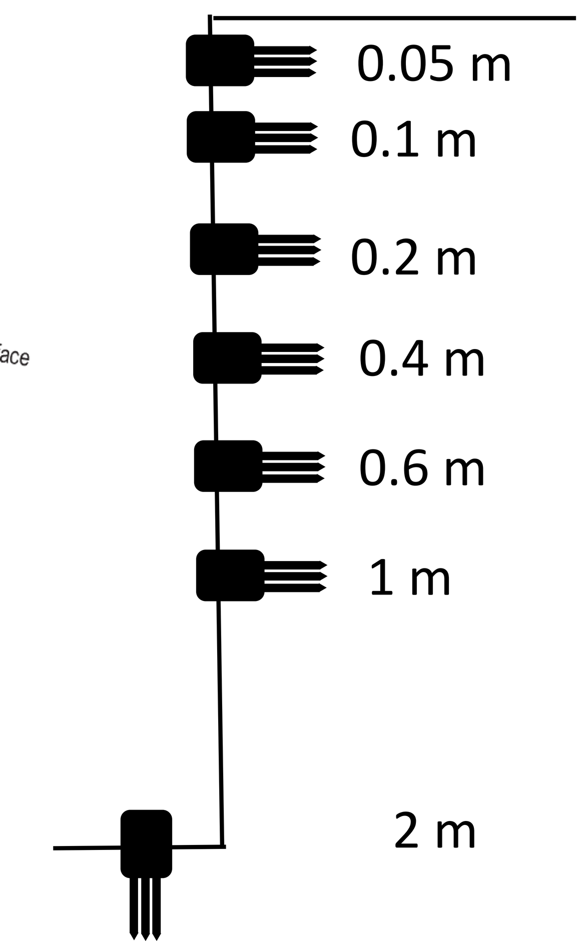
In Minnesota, comparisons will include a two-year conventional rotation of corn following soybean, a four-year conventional and a four-year organic rotation of corn, soybean, oat-alfalfa, alfalfa, a three year organic rotation of corn, soybean, wheat-red clover and a perennial native grass.

MATERIALS & METHODS (continued)





Heat flux sensor network



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