Regional differences in water use by corn under different cropping systems

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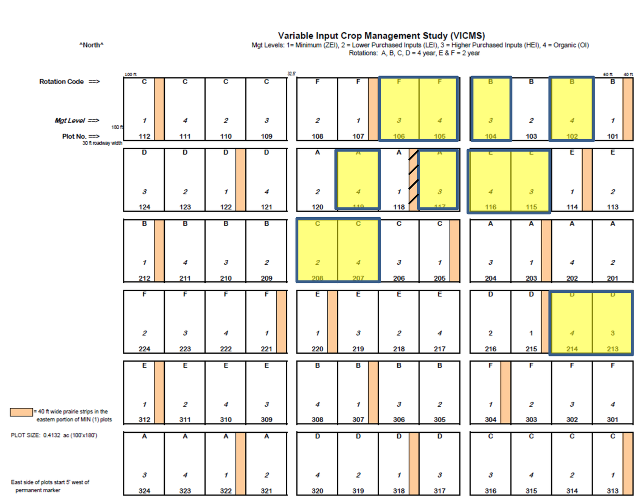
INTRODUCTION

Climate patterns in the central US are expected to become increasingly variable with changes in rainfall intensity, seasonality and available moisture. The soil water balance 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 was to use direct and indirect methods for quantifying crop water use in short- (two-year) and intermediate-term (three- or four-year) organic and conventional cropping systems*.


Figure 1. Experimental sites: Minnesota (left) and Ohio (right).

MATERIALS & METHODS

This project was conducted at two locations: southwest Minnesota and east-central Ohio. In Minnesota, comparisons included 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. In Ohio, comparisons include reduced tillage and cover crop treatments to an extended corn-soybean-wheat/red clover rotation. Three watersheds were planted in an organic system and four others were nonorganic to assess the impact of these systems on water balance components.




Soil moisture measurements were collected using TDR probes for measuring soil volumetric water content (5TM, Decagon Devices, Inc. Pullman, WA). These measurements were made at depths of 4, 8, 16, 24, and 39 inches in each plot. The Minnesota location also include a sensor at 78 inches. A spreadsheet was used to calculate weekly change in soil water storage and a weekly soil water balance.

MATERIALS & METHODS (continued)

Meteorological data were collected at weather stations located near each experimental site. Experimental units in Minnesota, at the Southwest Research and Outreach Center (SWROC) near Lamberton , MN, consisted of 13 plots with dimensions 100 by 180 ft. Experimental units in Ohio, at the North Appalachian Experimental Watershed (NAEW) near Coshocton, OH, consisted of 7 small watersheds. The TDR installation location varied from plot to plot. In order to develop a more in-depth understanding of the interactions between water balance components, local soil characteristics, inter-annual weather variability, and their effects on field-scale water budgets the SWAT model will be used to simulate the cropping systems present at the field sites (not presented).

RESULTS

Inherent in this method are the assumptions that all cropping systems received the same amount of precipitation, similar amounts of runoff have occurred, cropping systems have been exposed to the same evaporative demands, and water extraction by specific crops from all rotations in a given year is the same. Preliminary results for 2014 from April 1 through June 30 are shown.

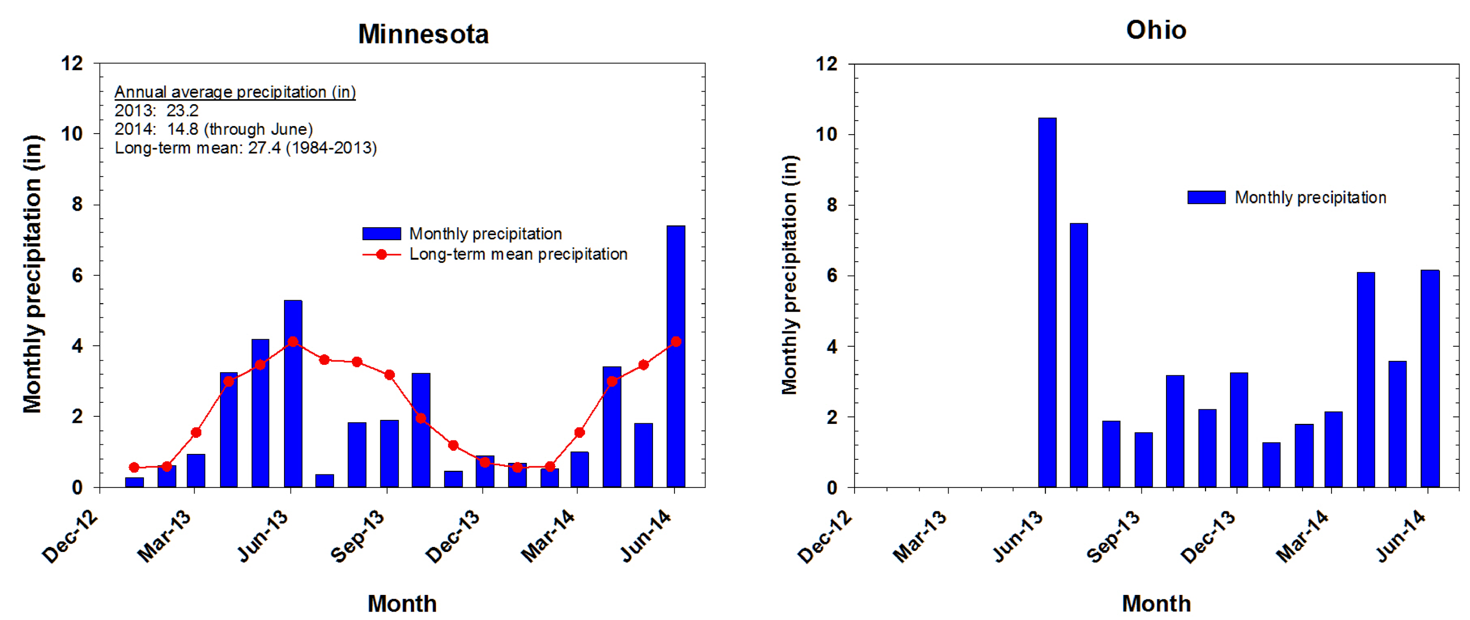


Figure 1. Variation in monthly precipitation from 2013 through June 2014 affected changes in soil water storage and components of the soil water balance (runoff, ET, drainage, etc) at both the Minnesota and Ohio locations.

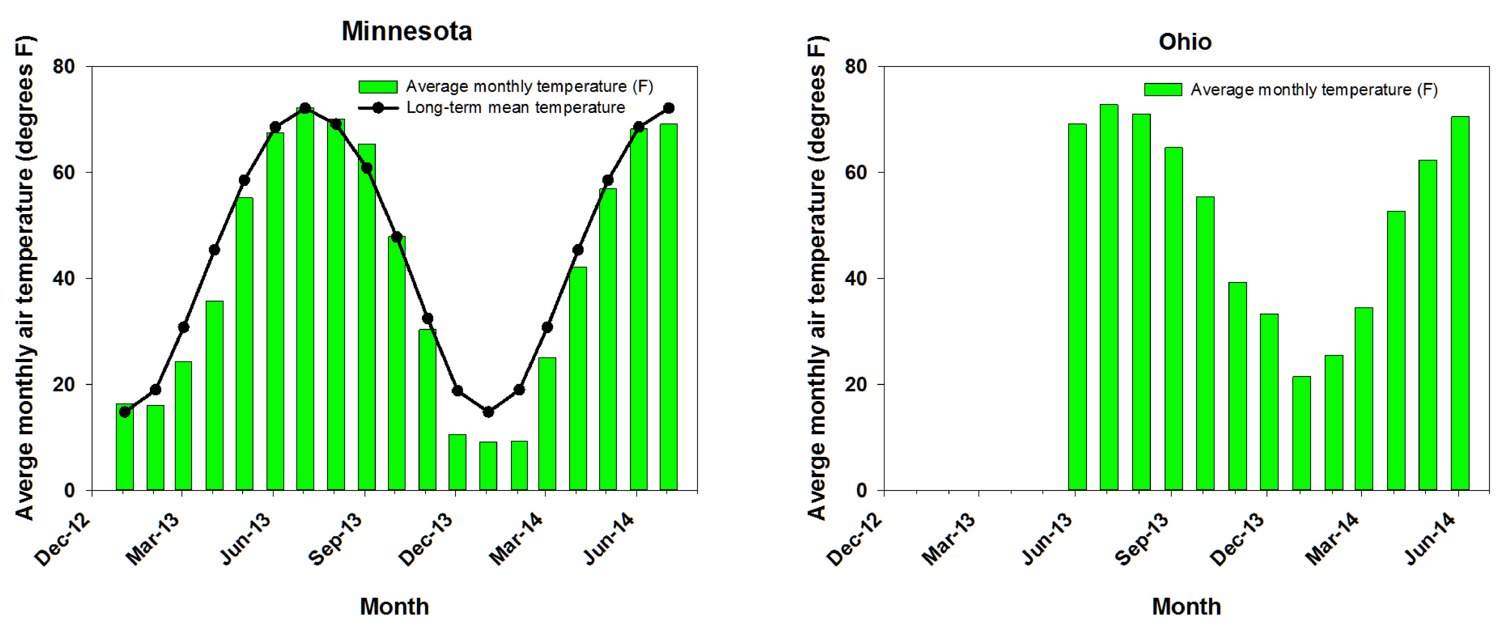


Figure 2. Variability in average monthly air temperature was small during the growing season during both 2013 and 2014 compared to long-term data from Minnesota. The Ohio site was noticeably warmer than the Minnesota location during the observation period.

RESULTS (continued)

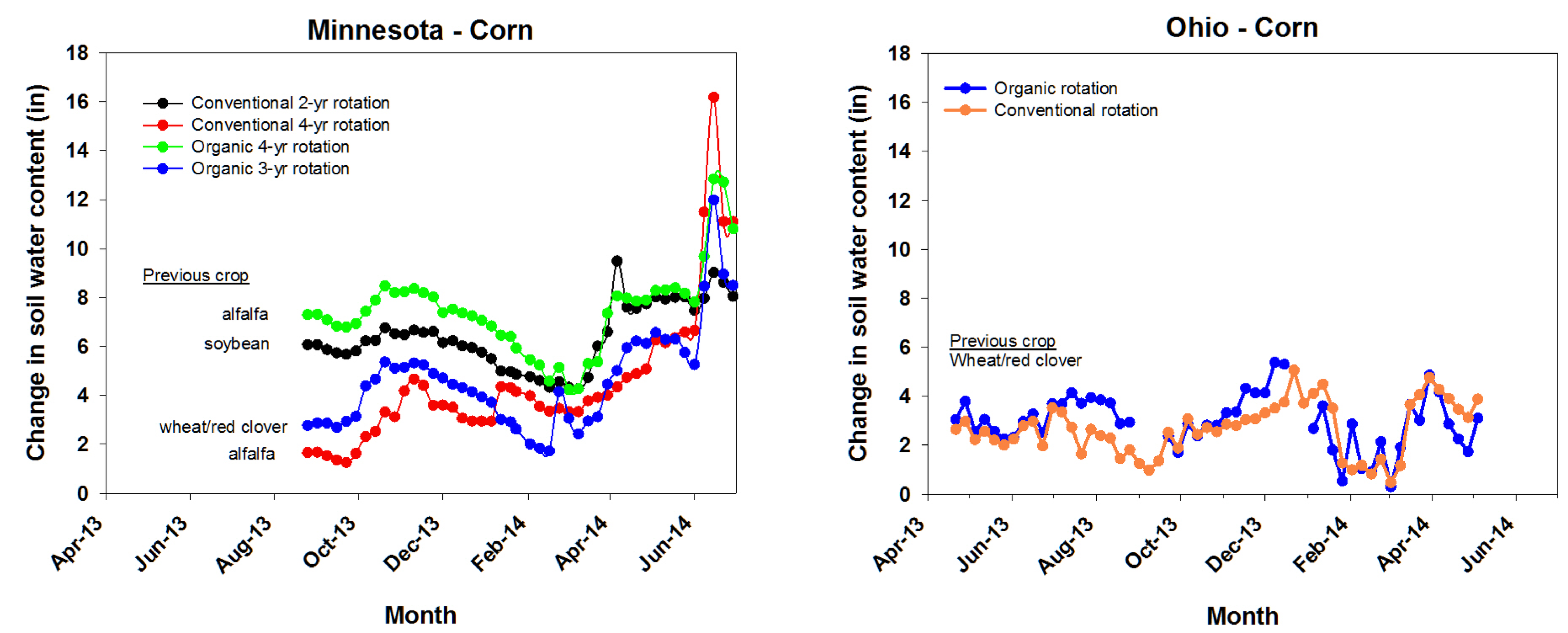


Figure 3. Weekly differences in the change in soil water content for corn were greater in Minnesota than Ohio likely due to differences in precipitation and the runoff component of the water balance. The landscape at the experimental site in Minnesota is relatively flat (<2% slope) and less prone to runoff whereas the landscape at the experimental site in Ohio has greater slope (>12%) and more prone to runoff. The different rotations exhibited differences in soil water content likely related to previous crop and soil storage capacity. Interestingly, the 3-year rotations at both locations had similar water contents at the start of monitoring following wheat interseeded with red clover.

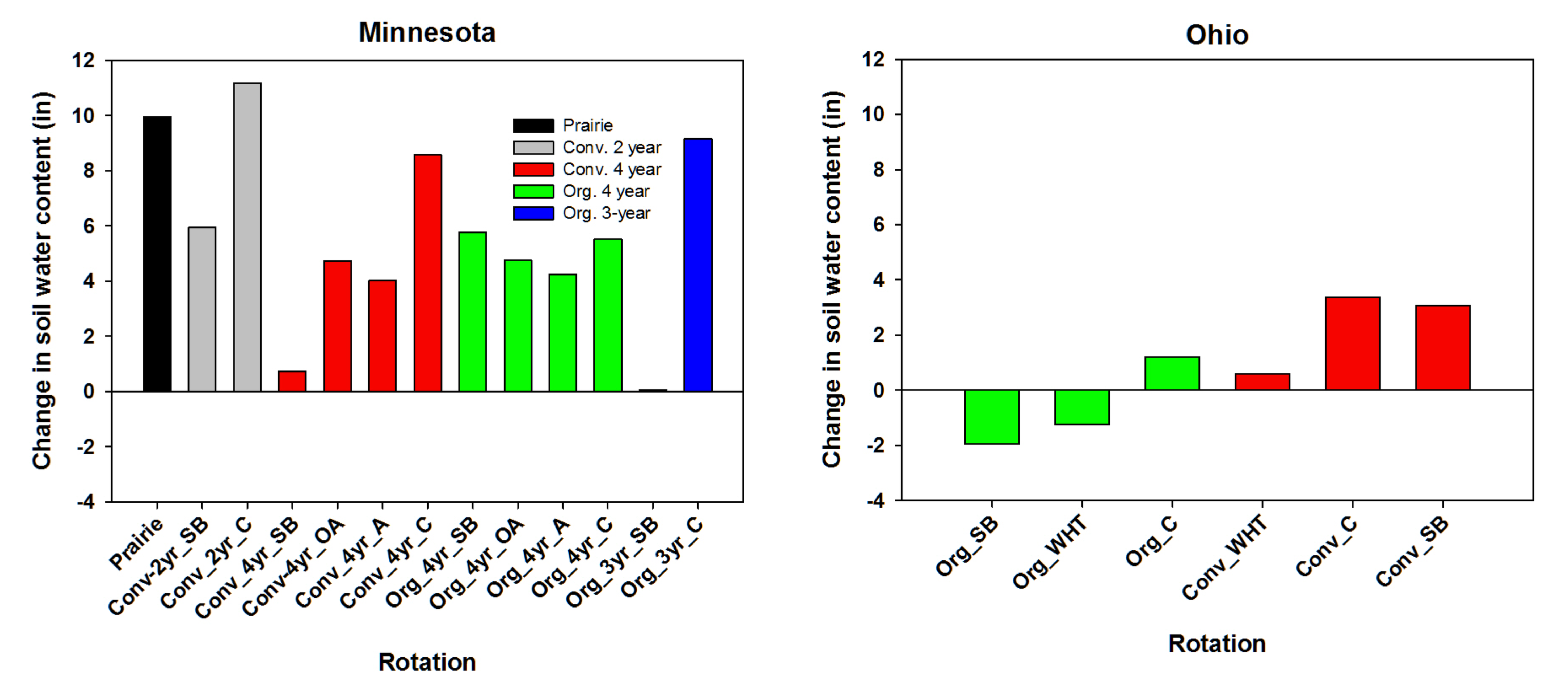


Figure 4. Cumulative difference in soil water content between April 1 and June 30, 2014 for Minnesota and January 1 and April 30, 2014 for Ohio. Data indicate differences in soil water storage and crop water use among crops and among rotations at both locations.

SUMMARY

Results from this work will provide important information that will allow farmers to design cropping systems in a way that is both effective for production and environmentally responsible. Further, results from this work will also help to provide more detail and insight into the strength of the linkage between field-scale management decisions and watershed-scale hydrologic responses.

- Cropping system diversity resulted in much variability in soil water storage between the two experimental locations.
- Previous crop affect changes in soil water content and changes in soil water storage for corn.
- Differences in landscape topography likely resulted in differences in the runoff component of the soil water balance.

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