Nitrogen Management Effects on Soil Water Dynamics and Wheat Evapotranspiration

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Introduction

- Understanding the interaction between crop evapotranspiration and applied nitrogen is essential for crop-water management.
- It remains challenging to quantify the effect of nitrogen on the behavior of crop transpiration and soil evaporation as well as soil water dynamics.
- The influential amount of rainfall has not been clearly determined in which range it affects the interaction between evapotranspiration and applied nitrogen rate.
- Is RZWQM2 an appropriate tool for improving the scientific understanding of the interaction between nitrogen application rate and water dynamics in the field?

Objectives

- Quantifying the effect of N application rates on the soil water dynamics and evapotranspiration behavior.
- How would crop evapotranspiration respond to N rates under different climate conditions, represented here through increased and reduced amounts of rainfall during the growing season?

Materials and Methods

- Winter wheat was grown in no-till management with corn residue 2016-2017.
- Three N fertilizer rates (UAN) were applied with four replications at the UK Research Farm, Lexington, Kentucky.
- The climate is humid subtropical. The soil is a Maury silt loam, classified as a mixed, semiactive, mesic Typic Paleudalf.

- Nitrogen rates
  1. High-N (130 kg N ha⁻¹)
  2. Low-N (70 kg N ha⁻¹)
  3. Zero-N (0 kg N ha⁻¹)

- Measured soil hydraulic property inputs were manually and iteratively calibrated within one standard error of measured values (Table 1).
- RZWQM2 was calibrated for the wheat experiment using experimental data from the N rate of 130 kg N ha⁻¹ under the observed rainfall scenario which is 100% rainfall.
- The model was used for simulating the effects of different nitrogen rates on soil water dynamics, crop evapotranspiration, and crop growth under different rainfall amounts.

- Rainfall scenarios
  • 100% rainfall (Actual rainfall * 1.00)
  • 125% rainfall (Actual rainfall * 1.25)
  • 75% rainfall (Actual rainfall * 0.75)
  • 50% rainfall (Actual rainfall * 0.50)

- RZWQM2 performance statistics
  • Normalized Root Mean Square Error (NRMSE).
  • Root Mean Square Error (RMSE).
  • Mean Bias Error (MBE).

Results

- The model performed satisfactorily in simulating the impacts of nitrogen rate and rainfall on the daily wheat evapotranspiration, soil water dynamics, and crop growth.
- Under the effect of 100% and 125% rainfall scenarios, the High-N rate yielded higher soil water content and soil water flux than the other N rates, but its associated evapotranspiration was lower than for the other N rates; moreover, the Zero-N rate yielded the highest evapotranspiration.
- In the 75% and 50% rainfall scenarios, all N rates showed similar soil water content, soil water flux, and evapotranspiration.
- The impact of nitrogen application rates on the behavior of soil water dynamics and crop evapotranspiration components was differing depending on modeled extent of rainfall.

Conclusions

- Nitrogen application rates were appreciably manipulated the crop evapotranspiration and soil water dynamics under high rainfall amounts. However, under low rainfall amount, soil water dynamics and crop evapotranspiration were not affected by N application rate.
- The results of this study show the applicability of the RZWQM2 for improving the scientific understanding of the interaction between N rate and water dynamics in the field.

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