

Simulation of water table depth using DRAINMOD under canola production in the Canadian Prairies

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Objectives

- Calibrate and validate the DRAINMOD model
- Simulate water table depth (WTD)
- Determine hydrological components of the study area

Introduction

- Decision making for sustainable water management requires an understanding of hydrological processes
- Traditional field experiments which are expensive, time-consuming, and tedious compared to modelling
- Canadian prairies are prone to waterlogging and prolonged soil water deficit at the start and mid growing season, respectively.
- Few studies have assessed the performance of the DRAINMOD model under the Canadian prairies weather conditions (Cordeiro and Sri Ranjan 2015, Satchithanatham and Sri Ranjan 2015) for corn and potato respectively.
- We will be looking at the hydrologic processes in Canola.

Materials and Methods

Study Area

- PESAI site, Arborg

Experimental Design

- The total area is about 4.5 Ha, with canola, soybean, and wheat planted in rotation in the North-South direction (Fig. 1). A buffer strip of about 3 m separates each treatment.
- The field is divided into 3, each representing a replicate for each crop..
- Each replicate has drain tiles installed at 0.9m and different spacing of 15, 30 and 45 inch respectively
- Field plots with no drain tile serves as the control
- In 2020, canola was planted on the field plots with drainage spacing of 45 inch

Field data

- Weather data including hourly precipitation, maximum and minimum temperature were obtained from Manitoba agriculture
- Piezometric wells were installed in each plot to measure WTD using the Solinst Levellogger sensor
- WTD was measured every 3 hours and daily average values obtained from the plots

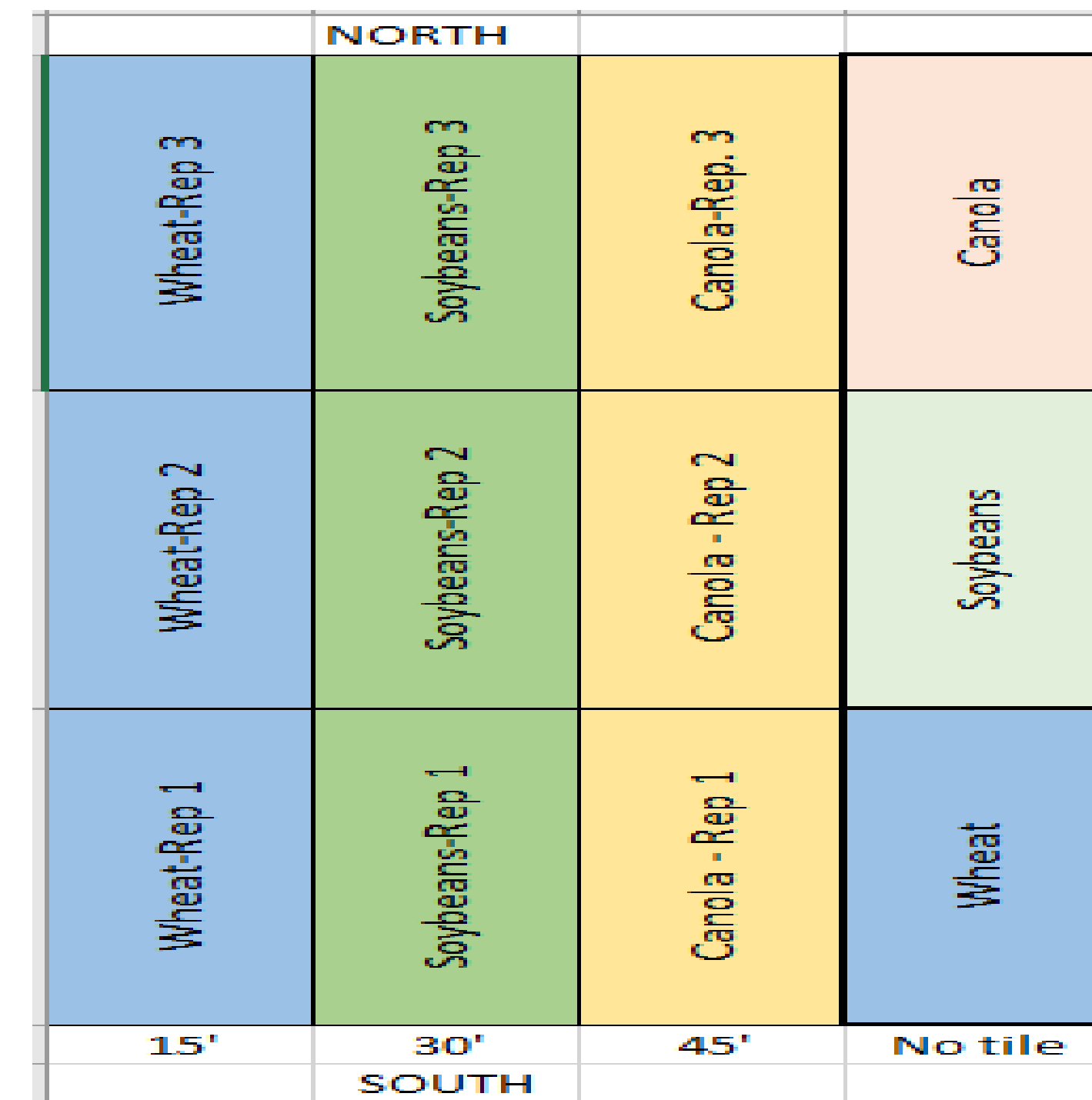


Fig.1: Experimental Design

Model

- DRAINMOD is a hydrological model developed to evaluate the impacts of different water management
- It simulates surface runoff, sub-surface drainage, evapotranspiration, infiltration, crop yield and changes in water table depth
- DRAINMOD performs water balance on a soil profile, midway between two tile drains from the soil surface down to an impermeable layer (Skaggs 1978).
- Numerous studies have reported good performance with DRAINMOD (Skaggs et al. 2012, Dayanni et al. 2009, Cordeiro and Sri Ranjan 2015, Satchithanatham and Sri Ranjan 2015)

Model Inputs

- Soil properties- Rossetta model
- Crop information
- Drainage design variables – drain depth, drain spacing etc
- Weather and ET

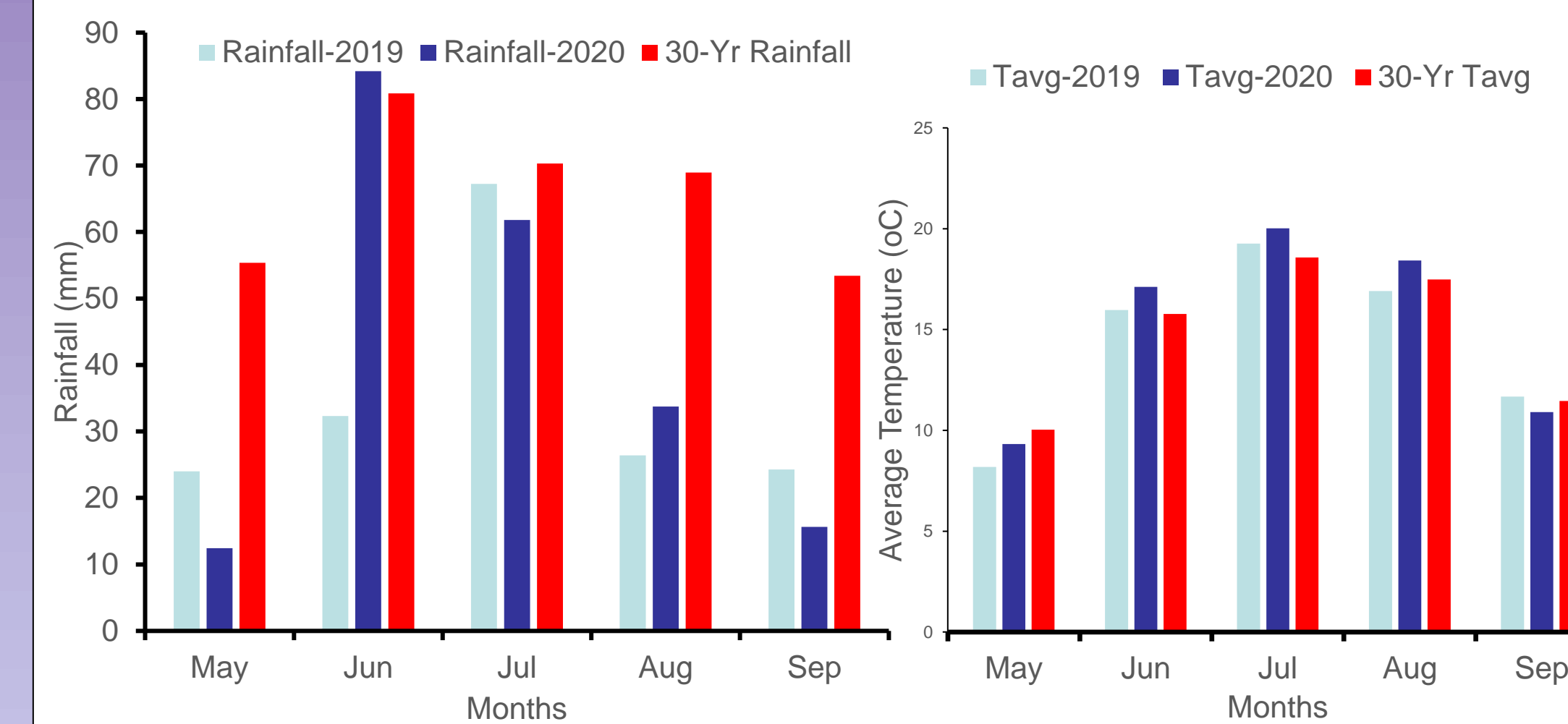
Model calibration and validation

- Observed WTD for 2020 and 2019 were used for model calibration and validation respectively
- Calibration parameters included soil properties (α , n , K_s), ET correction factor

Model performance

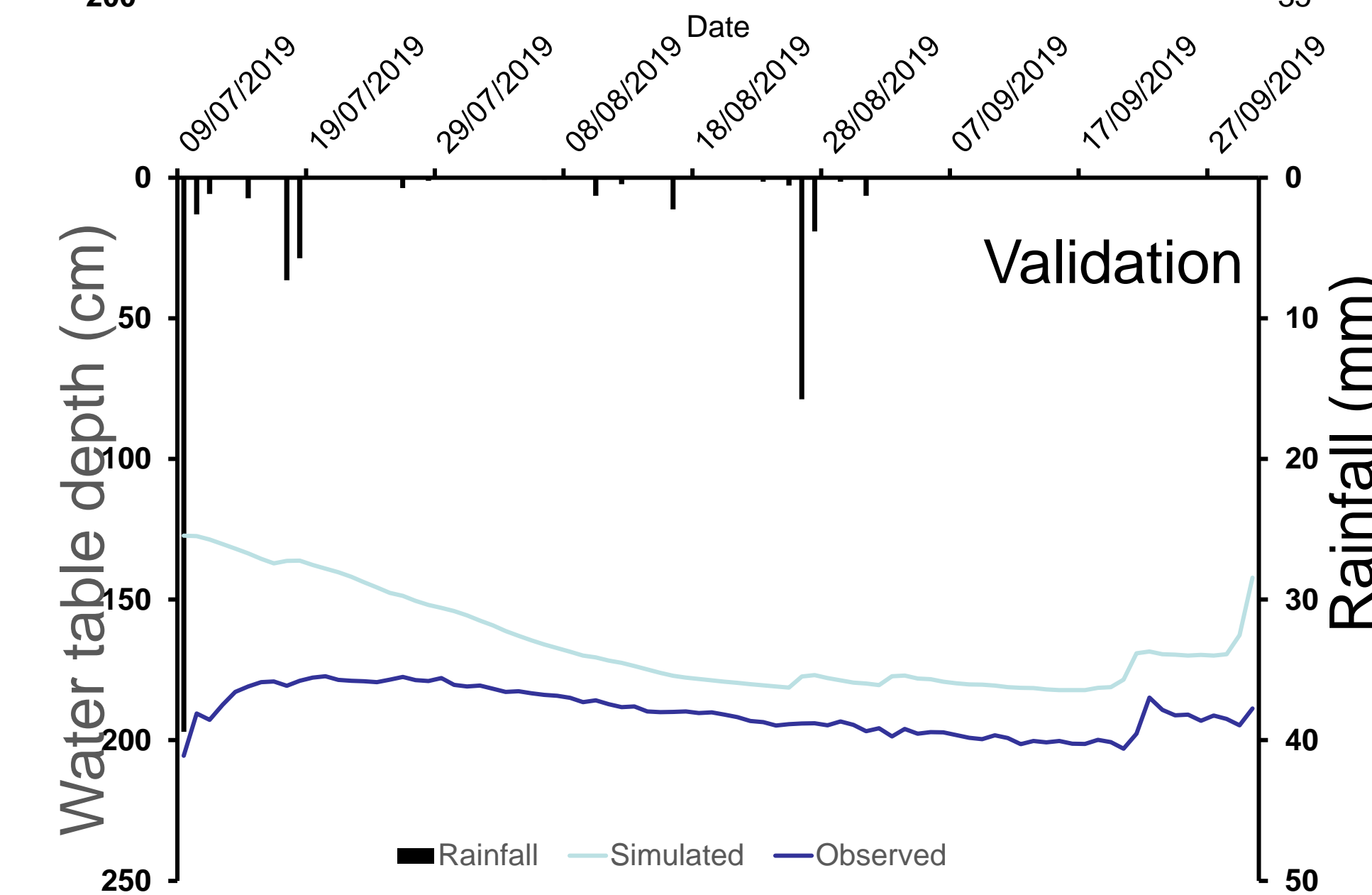
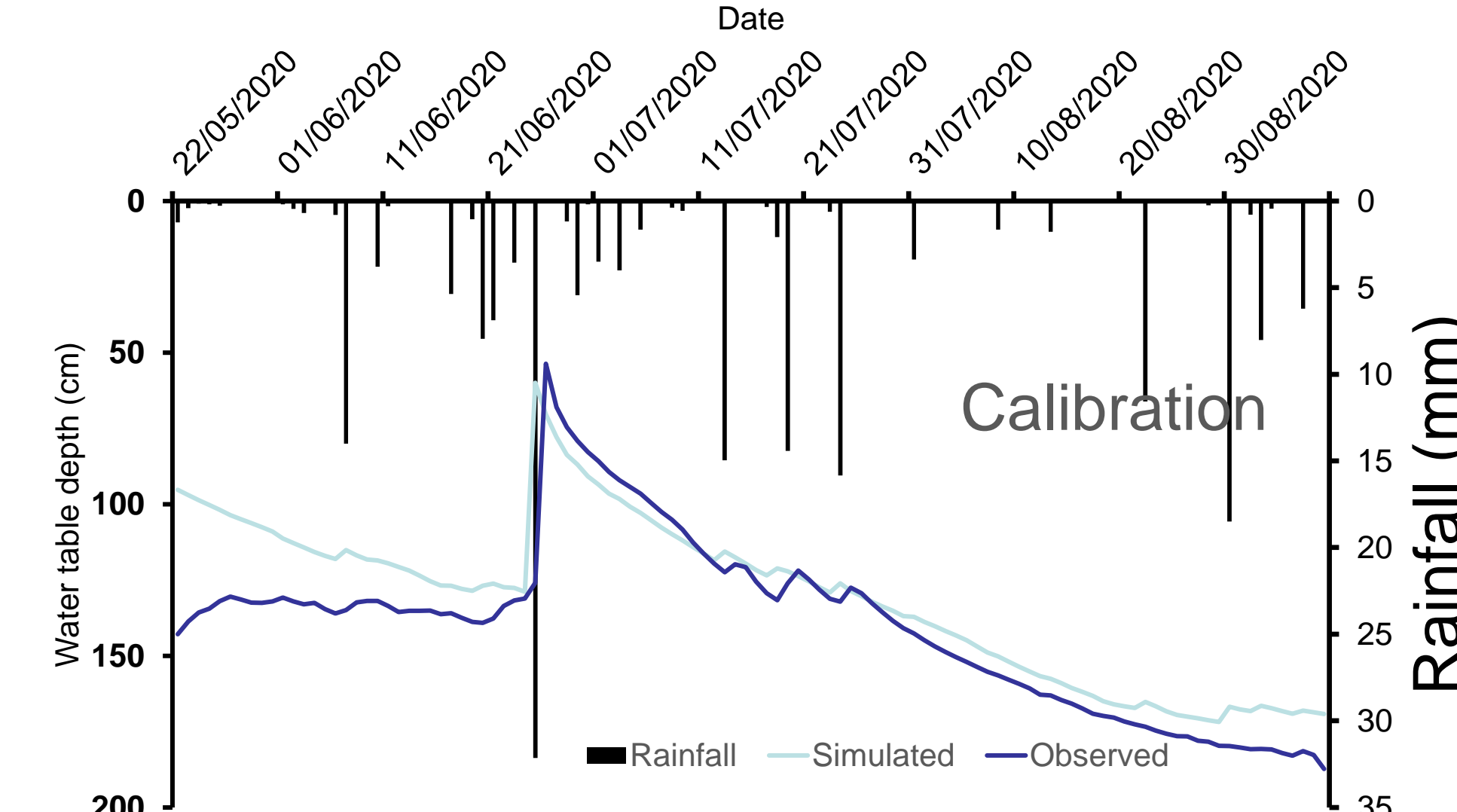
Statistical indices including R^2 , NSE, and MAE were used to compare simulated and observed WTD

Results



- Observed average temperature was close to the long term average
- In both years, rainfall was less than the long-term average for all the month except in June 2020
- Total precipitation was 25% and 18% less than the long-term average

Water table simulation

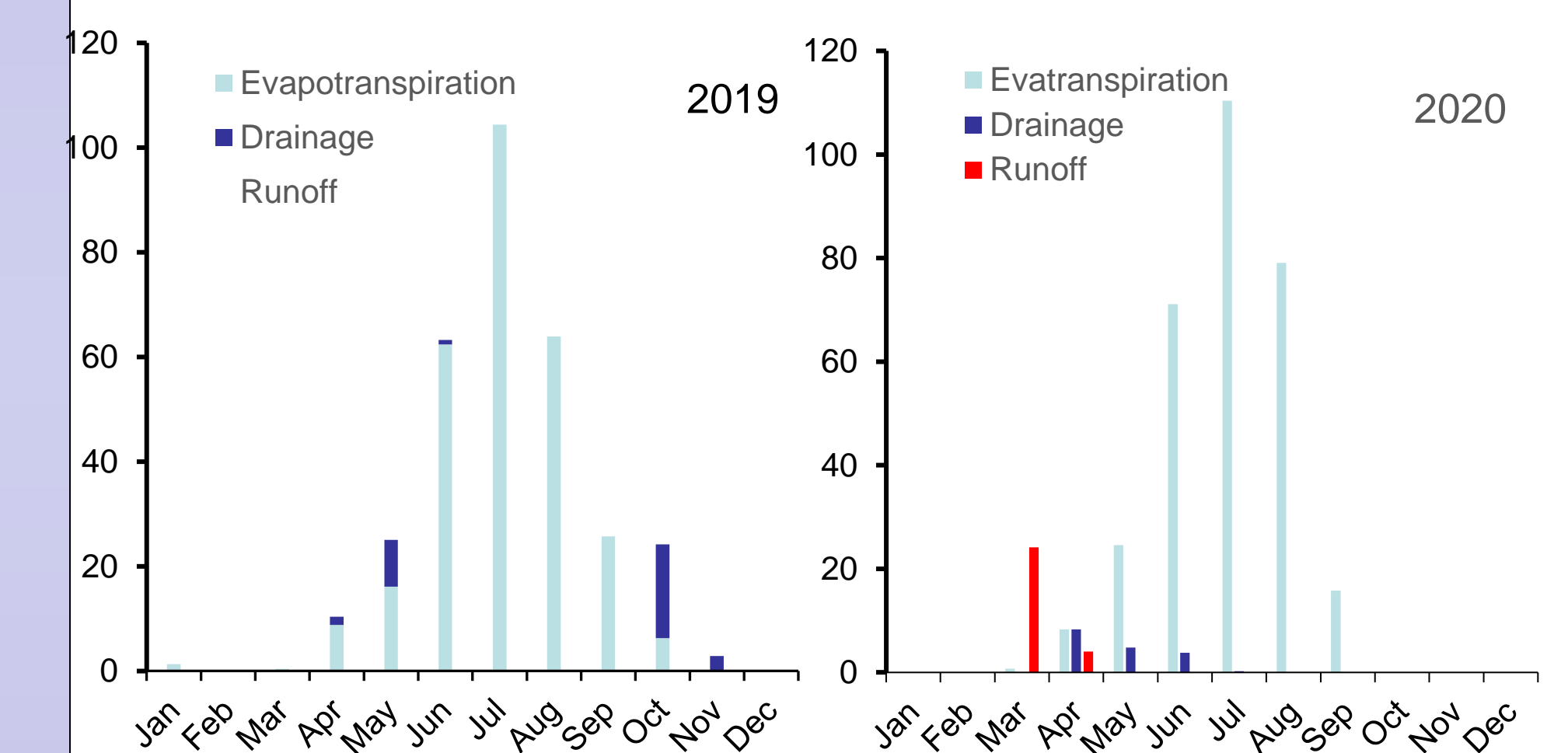


Statistical analysis

	R^2	NSE	MAE
Overall	0.72	0.67	67

Conclusions

- Statistical analysis and graphical plots of observed and simulated WTD showed that the DRAINMOD model performed well
- The DRAINMOD model can be used for guiding water managers and decision makers
- Water balance analysis showed that evapotranspiration constituted a significant amount during the growing season
- In both years, Runoff and Drainage constituted little or no impact. This is due to abysmally low rainfall received during the study period



Acknowledgment

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References

- Cordeiro, M.R.C. and Ranjan, R.S. 2015. DRAINMOD Simulation of Corn Yield under Different Tile Drain Spacing in the Canadian Prairies. Transactions of the ASABE. 58, 6 (Dec. 2015), 1481–1491.
- Dayyani, S., C. A. Madramootoo, P. Enright, G. Simard, A. Gullamudi, S. O. Prasher, and A. Madani. 2009. Field evaluation of DRAINMOD 5.1 under a cold climate: simulation of daily midspan water table depths and drain outflows. JAWRA Journal of the American Water Resources Association 45 (3) (June): 779–792.
- Satchithanatham S, Ranjan RS (2015) Evaluation of DRAINMOD for potato crop under cold conditions. Trans ASABE 58(2):307–317
- Skagg R.W., 1978. A water management model for shallow water Table soils. In: Tech. Rep. 134. University of North Carolina Water Resource Research Institute, Raleigh, NC.