Contribution ID: **448** Type: **Oral Presentation**

Numerical modeling to optimize nitrogen fertigation with consideration of transient drought and nitrogen stress

Friday, 4 June 2021 15:30 (15 minutes)

Optimization of nitrogen (N) fertigation is a formidable challenge involving complex interactions between water and N uptake and their effects on crop production. Numerical models can be useful in studying the interaction of multiple variables like those found in mechanistic simulations of N fertigation strategies. The physical aspects can often be accurately represented in soil-plant-atmosphere continuum models, while the biological factors lag due to their oversimplification. When optimizing N fertigation using numerical models, it is essential to consider the effects of N and water stresses on the plant size and corresponding feedback on potential transpiration and N uptake.
The HYDRUS (2D/3D) model was modified to allow for active uptake and decay of multiple solutes and reduce potential transpiration due to a limitation in N uptake. Subsequently, we calibrated and validated the model with a dataset that consisted of 3 nitrate (NO3-) concentration and 6 irrigation levels: a total of 18 distinct treatments used to fertigate cucumber plants grown in lysimeters. The calibration was based on the treatment that received the highest N fertigation. The model was validated by testing its ability to accurately reduce potential N uptake and transpiration in water and
N deficiency cases.
Simulations showed that the N stress function could explain 82% of the reduction in transpiration measured in the experimental setup. The sensitivity analysis, evaluating the effects of the root shape and distribution parameters by increasing and decreasing their values by 20%, showed that these parameters had little impact on the results. Following its validation, the model was used to determine the optimal N concentration in irrigation water and the optimal N application amount to obtain maximal yield with minimal N loss. The optimal irrigation water NO3–N concentration and seasonal NO3–N application were determined to be 75 mg L-1 and 40 mg m-2, respectively.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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Session Classification: MS25

Track Classification: (MS25) Subsurface Water Flow and Contaminant Transport Processes –Special Session in Honor of Harry Vereecken