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DSSAT modelling for best irrigation management practices assessment under Mediterranean conditions

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Introduction

Sustainable water management in agriculture aims to match water availability and water needs in terms of quantity and quality and in space and time with acceptable environmental impact, especially in arid and semi-arid regions, where irrigation is required to reach a competitive and profitable agriculture. The objectives of this research were to (1) calibrate and validate the DSSAT model for the main crops of a modernized irrigation district located in the Ebro Valley (Spain) after irrigation performance characterization at the farm-field scale and (2) determine the best management irrigation practices under different soil types and crop requirements.

Materials and Methods

This work is performed in the Violada Irrigation District (VID), located in the Ebro River basin (northeast Spain). The VID (5231 ha) was recently modernized (2008-2009) from traditional irrigation systems to pressured irrigation systems. The DSSAT V4.7 software (Hoogenboom et al., 2017) was used to calibrate and validate the main crops in the VID. Data from 54 plots of farmers' fields were used for model calibration and evaluation during two cropping seasons for barley, wheat, maize long season (maize-LS) and maize short season (maize-SS) and sunflower. In the case of alfalfa, the field experiment described by Malik et al. (2018) was used. Two irrigation scenarios were evaluated in the eight principal soil types for both seasons (the current irrigation practices and the irrigation dose adjusted to crop requirement and soil properties).

Results and Discussion

Both DSSAT calibration and validation demonstrated a good performance for all crops. The evaluation of the current irrigation system showed that farmers were not managing their modern irrigation systems adequately. Consequently, yields losses due to drought stress were identified, especially for wheat, barley and alfalfa. In contrast, an excessive irrigation water depth was applied for maize-LS, maize-SS and sunflower. The optimal irrigation schedule can improve the water use efficiency by 22.5%, 22.0%, 86.0%, 35.0% and 26.0% for maize-SS, maize-LS, sunflower, barley and alfalfa, respectively. The reduction in the seasonal irrigation depth was 27% for maize-SS, 18% for maize-LS and 16% for sunflower. In a broader context, adjusted irrigation practices could reduce the amount of deep percolation and leached N losses by 34% (1.2 hm^3) and 31% (4.48 T), respectively, considering the all cultivated crop area in the VID. The spatial distribution of water lost by deep percolation and Leached N under the current and optimal irrigation schedules is presented in Figure 1.

Conclusions

The DSSAT model demonstrated good performance for simulating the main crops in intensive cropping systems under Mediterranean conditions. The water management scenarios considered in this study indicated that the optimal irrigation management significantly improved the irrigation water use by adjusting the irrigation water applied according the actual evapotranspiration needs and the soil holding capacity.

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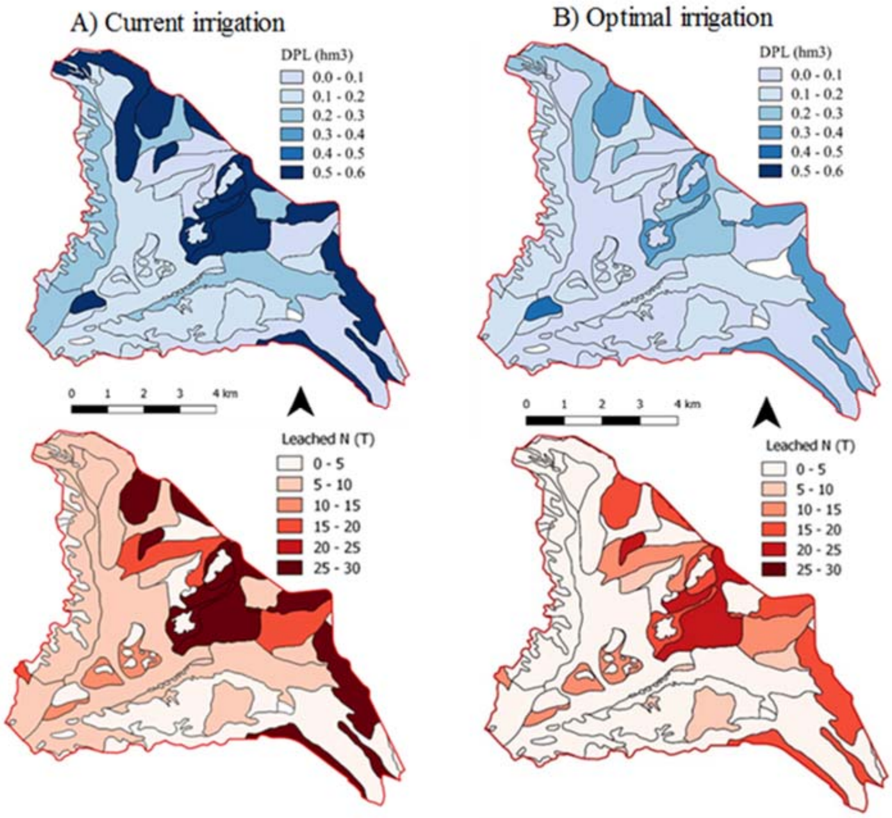

Figure 1. Spatial distribution of average total deep percolation losses (DPL, hm^3) and leached N (T) under current irrigation (A) and optimal irrigation (B) in the VID.

Keywords

Current irrigation, Optimum irrigation, N leaching, Deep percolation losses.

References

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