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A new stochastic framework based on evolutionary algorithms for evaluating potential yield and corresponding risks of optimal deficit irrigation strategies

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Abstract The scarcity of water compared with the abundance of land constitutes the main drawback within agricultural production. Besides the improvement of irrigation techniques (e.g. use of micro-irrigation) a task of primary importance is solving the problem of intra-seasonal irrigation scheduling under limited seasonal water supply. An efficient scheduling algorithm has to take into account the crops' response to water stress at different stages throughout the growing season. It is very difficult to solve the highly multi-dimensional and nonlinear optimization problem for finding the schedule with maximum crop yield for a given water volume. The objective of our research is to assess the risk in yield reduction in view of different sources of uncertainty (e.g. climate, soil conditions and management) based on a new global optimization technique and physically-based modelling for reliable, predictive simulation. In this contribution we introduce a stochastic framework for decision support for the planning of water supply in irrigation. This consists of: (i) a weather generator for simulating regional impacts of climate change; (ii) a new tailor-made evolutionary optimization algorithm for optimal irrigation scheduling with limited water supply; and (iii) mechanistic models for simulating water transport and crop growth in a sound manner. As a result, we present stochastic crop water production functions (SCWPF) for different crops which can be used as basic tools for assessing the impact of climate variability on the risk for the potential yield or, furthermore for generating maps of uncertainty of yield for specific crops and specific agricultural areas. A case study of a French site is used to illustrate these methodologies, and the impacts of predicted climate variability on wheat and maize are discussed.

Key words deficit irrigation; crop water production function; optimal scheduling; risk assessment