Deficit Irrigation Toolbox: A new tool to improve crop water productivity and food security under limited water resources

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Motivation

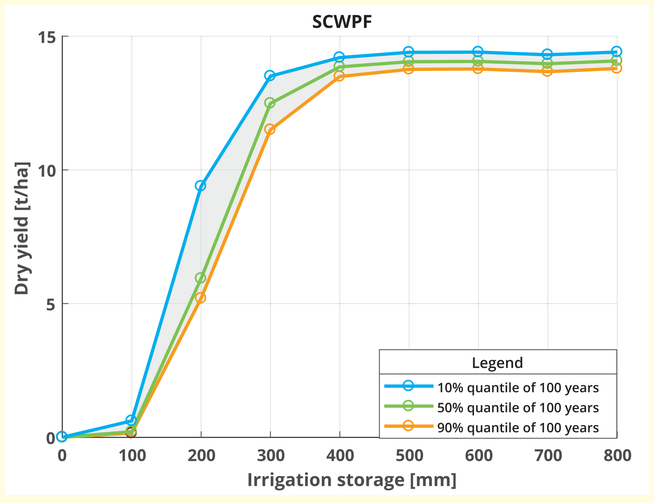
Under conditions of climate change, productive irrigated agriculture with limited water resources is of paramount importance. However, solving the corresponding multidimensional and non-linear optimization problem is computationally hard. Appropriate scheduling strategies may depend on climate and soil variability as well as on irrigation systems.
For this reason, we developed the **Deficit Irrigation Toolbox** (DIT) – an **open-source collection of tools** that provides advanced techniques to simulate, analyze and optimize deficit irrigation systems. **DIT** is implemented as a Matlab® toolbox and efficiently exploits tailor-made evolutionary algorithms and parallel stochastic simulations.

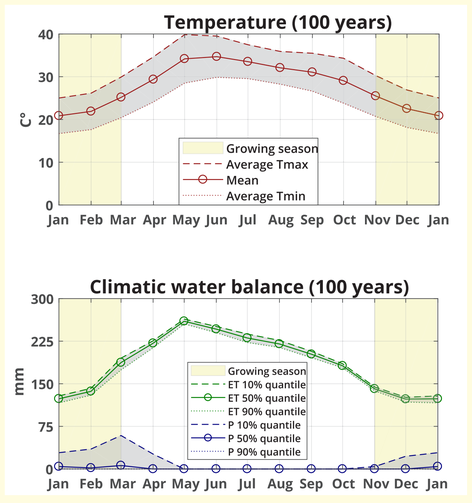
Features

DIT provides routines to describe and analyze many aspects of the scheduling of deficit irrigation systems, including:

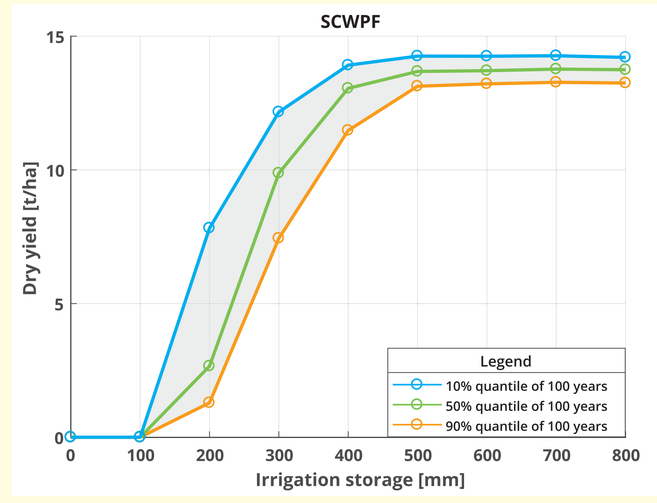
- integration of FAO **Aquacrop-OS** and **Cropwat** models,
- open interface to numerical crop growth models such as **APSIM**, **Daisy**;
- consideration of **climate and soil variability** within one probabilistic framework;
- **visualization tools** for performance analysis of deficit irrigation strategies;
- usage of highly efficient **adaptive and fixed scheduling** strategies;
- **simple tools** (reliable irrigation calendars) for deficit irrigation strategies in practice;
- site-specific stochastic crop production functions (**SCWPF**) which allow for the implementation of food security policies, economic analyses of water productivity and water demand elasticity.

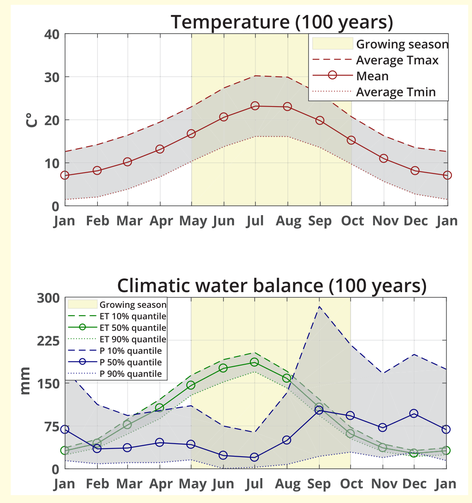
Analysis of climate variability (arid site)



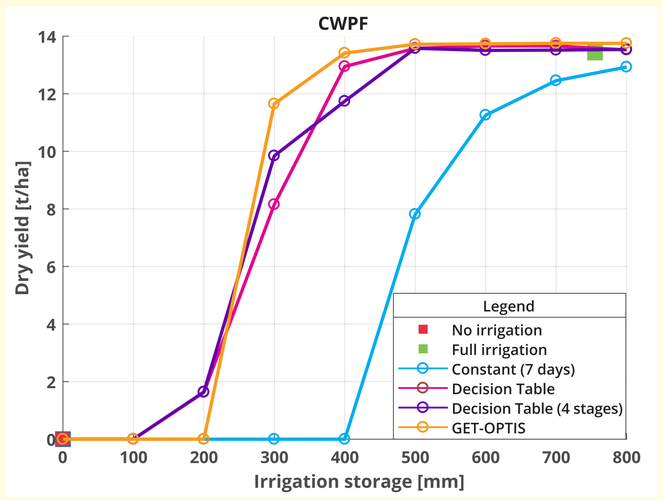


Analysis of climate variability (semi-arid site)





Comparison of irrigation strategies (arid site)

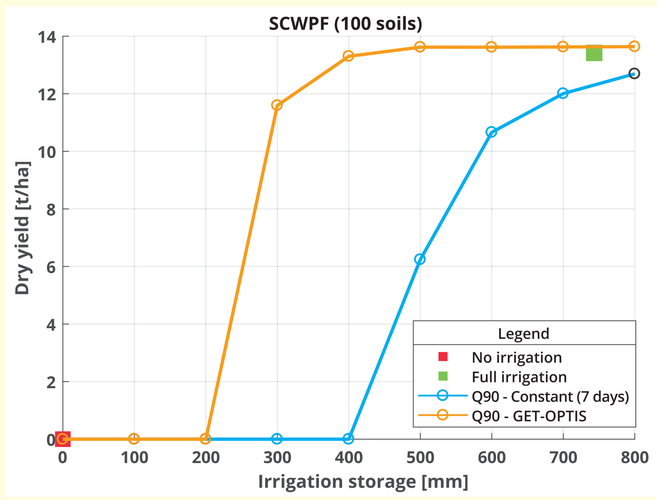


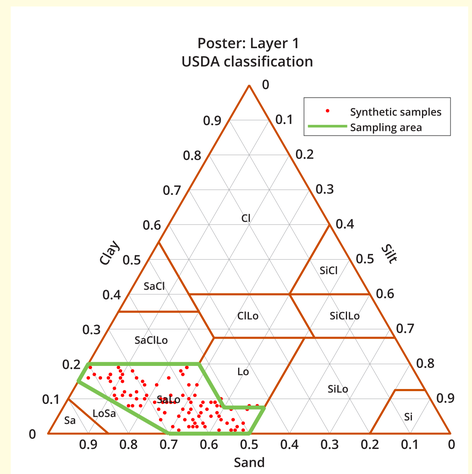
The results are **examples** from the **Deficit Irrigation Toolbox**. Different irrigation strategies were firstly tested for the arid site (left).

The upper figures show the application of the **GET-OPTIS** strategy for a **climate variability analysis** for Seeb, Oman (arid) and Montpellier (semi-arid).

The right figure shows a **soil variability analysis** based on the sandy loam texture class based on the USDA soil classification system.

Analysis of soil variability (arid site)





References:

[1] N. Schütze, M. de Paly, and U. Shamir. Novel simulation-based algorithms for optimal open-loop and closed-loop scheduling of deficit irrigation systems. Journal of Hydroinformatics, 14(1):136–151, 2012. doi:10.2166/hydro.2011.073.
[2] N. Schütze and G. H. Schmitz. OCCASION: New Planning Tool for Optimal Climate Change Adaption Strategies in Irrigation. Journal of Irrigation and Drainage Engineering - ASCE, 136(12):836–846, doi:10.1061/(ASCE)IR.1943-4774.0000266.

Photography encouraged

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