Drought experiments in alley-cropping systems, from concepts to field reality: lessons learnt at Restinclières, France

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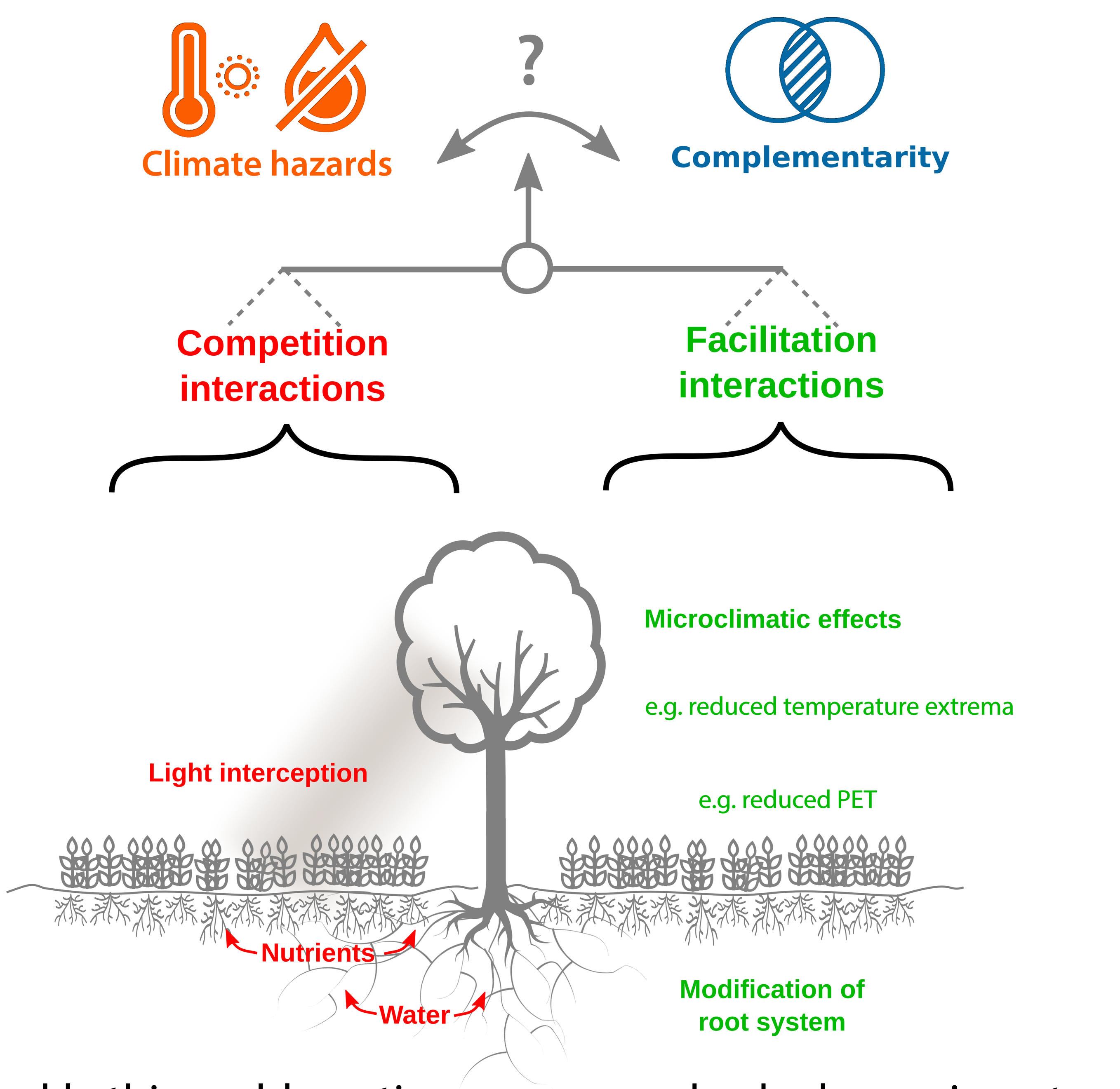
Introduction

In the context of climate change, the Mediterranean region will be more frequently prone to climate hazards, such as drought and heat waves. Given this context, the sustainability of agroecosystems in those regions is at stake.

In mature alley cropping systems (ACS), understory conditions might buffer adverse conditions encountered by intercrops during drought events. However, it is still undecided whether facilitation processes will prevail or not on competition interactions.



To tackle this problematic, we proposed a dual experiment :

- on the field, drought experiment is carried out by means of rainout shelters
- field data are used for modelling purposes in order to obtain deeper understanding of ecological processes at play

Objectives of the study

► To perform total rain exclusion in both monocropping and (mature) alley-cropping systems

► To monitor and assess the impacts of (artificial) drought on annual crops in both agroecosystems. An emphasis is given on :

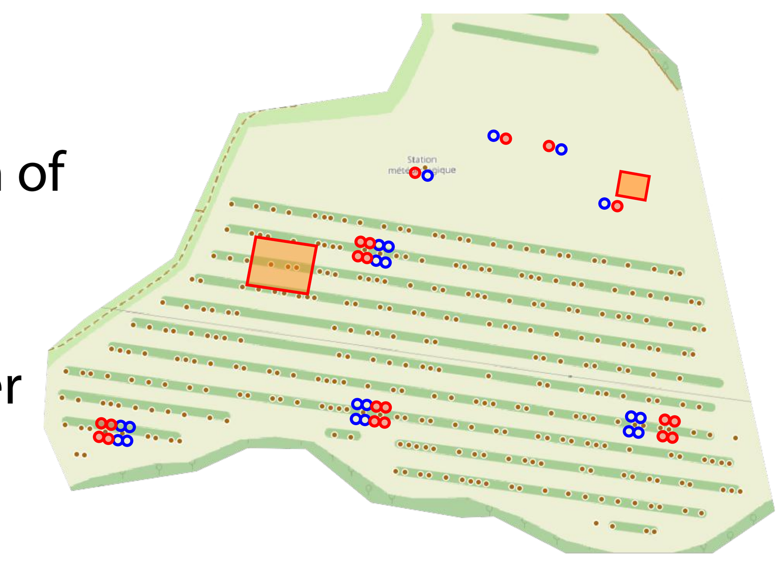
- Soil water availability
- Atmospheric evaporation demand
- Crop water stress (instantaneous and integrated)
- Growth dynamics and crop yields

Experimental site

Domaine de Restinclières, south of France

24 year-old hybrid walnut

3 year-rotation based on winter crops (2018-2019 : Winter Pea)



Feedbacks from the field

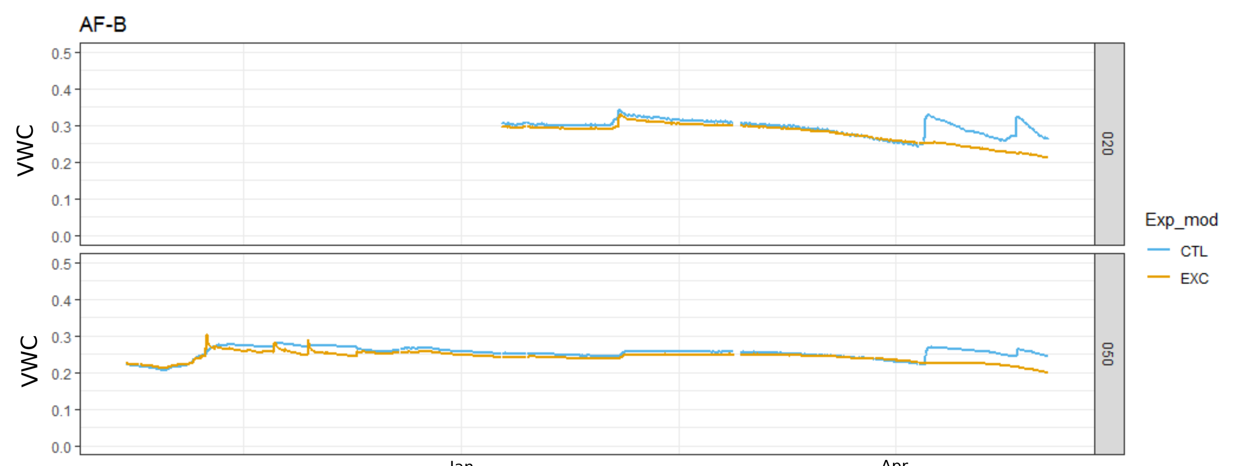
Performing drought experiment in ACS appears to be challenging in terms of implementation and logistics. In particular, a critical aspect concerns the ideal size of rainout shelters, which appears to be a matter of compromise between scientific, technical, organisational and financial aspects. 2 low-cost designs were experimented and compared.

	1st design	2nd design
		
Typology of rainout shelters	Cable structure with folding tarpaulins. Covers 2 alleys (over ~800 m^2).	Tubular structure with removable roof. 4 rainout shelters around a tree (~4x15m^2).
Scientific aspects		
Experimental design	Single block design	Paired design
Artefacts	Lower risk of split-root artefact Modified tree growth in presence of cables ?	High risk of split-root artefact
Edge effects	Significant in the central part of the alley / Irregular according to wind conditions	Regular : about 0.5 m along the edge of the shelter
Technical aspects	Issues in case of strong wind gust and heavy rain events. Important failure risk with consequences on the whole experiment	More stable in case of strong wind gust. Low risk of water evacuation issues. Reduced experimental risk (shared among the 20 rainout shelters)
Organisational aspects	Installation time : ~3h for 2 tents Regular surveillance when set up Moderate maintenance	Installation time : ~2h for 20 shelters Relative autonomy when set up Low maintenance

Preliminary results

► Previous growing season (2017-2018) pushed to its very limits the 1st design of rainout shelter, leading to the development of the 2nd design.

► Experiment is currently on-going (2018-2019) and successful so far (115 mm intercepted). The use of both rainout shelters led to contrasted soil water availability up to 50 cm depth as revealed by TDR sensors.



Visible effects regarding crop biomass, phenology and physiology are already observed.

Perspectives

► Evaluation of the ability of the Hi-sAFe agroforestry model (Dupraz et al., 2019 - see posters L24.P.06 and L24.P.17) to simulate crop growth dynamics and yield under drought in ACS.

Projet soutenu par Fondation de France

UMR System — Fonctionnement et conduite des systèmes de culture tropicaux et méditerranéens

4th World Congress on Agroforestry

20-22 May 2019

Le Corum Conference Centre

Montpellier, France