International workshop for farming systems design
31/10/2022

Effect of cover crops on the eco-hydrological functioning of Mediterranean fruit agrosystems: Case of citrus farming in Tunisia

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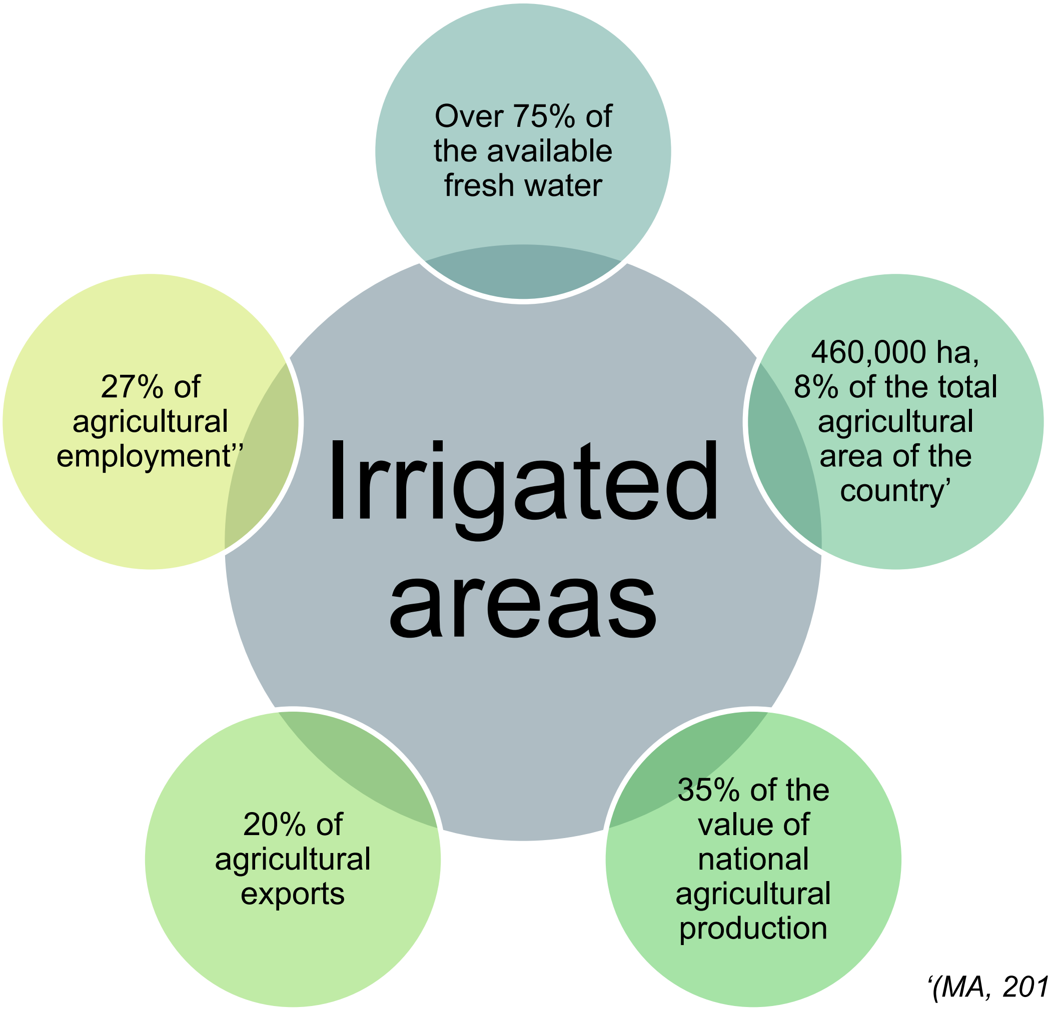
Introduction

Water represents a key element for global socio-economic development.

The largest pressure on water resources generally occurs in developing regions (Central Africa, India, Northern Africa, Middle East) due to the importance of irrigation in their economies (*Nechifor and Winning, 2017*).

- Tunisia suffers from high water scarcity
- The increase in water demand will decrease the ratio of conventional resources per capita per year from 467 m^3/capita/year in 2010 to 359 in 2030. *(Tunisian Institute for Strategic Studies,2019)*

Groundwater is over-used:
31% of all groundwater in the country has an exploitation rate of over 110%
(National Water Report, 2002)



‘(MA, 2018), ‘’(Dhehibi et al., 2014)

- Water scarcity is increasing under **Climate change conditions** => reduces irrigation water availability

- Climate change conditions ; Extreme events (drought and flood) => Aggravate the soil degradation / erosion

Challenge to preserve soil and water!!

Agroecology; alley cropping

Sowing of vegetation cover between trees (farmer at Cab Bon)

(ATAE, 2018)

Flooding 2018 (300 mm in one day), no erosion in these plots

- The intercrop enhanced the infiltration of winter rainwater, probably by limiting surface runof (vine, tall fescue) *(Celette et al, 2005)*

Plant and Soil (2005) 276:205–217
DOI 10.1007/s11104-005-4415-5

Belowground interactions in a vine (*Vitis vinifera* L.)-tall fescue (*Festuca arundinacea* Shreb.) intercropping system: water relations and growth

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Received 21 October 2004. Accepted in revised form 23 March 2005

Key words: intercropping, interspecific competition, root systems, shoot growth, soil water dynamics

Abstract

In the Mediterranean area, the introduction of cover crops in vineyards is hampered by the risk of severe competition for water. Belowground interactions are still not very clear in this perennial-herbaceous association. This work was aimed at characterizing the development of the root systems of associated crops and the soil water dynamics. It also investigated whether water competition could be the cause of vine vigour and yield reductions. Experiments were conducted in a 4-year-old association (vine – tall fescue) and in a weed controlled vineyard. Water transfers in the soil were estimated on the basis of the soil water potential and soil hydrodynamic properties. The vine root system was concentrated in the soil under the row, whereas the intercrop highly colonized a soil compartment under the inter-row to a depth of approximately 1 m. Despite this spatial complementarity in root distribution, intercropping reduced the amount of soil water available for the vine crop. The low soil water content reduced soil water conductivity thereby limiting water transfers, despite a significant gradient in the soil water potential. This conductivity did not differ significantly between treatments but the intercrop enhanced the infiltration of winter rainwater, probably by limiting surface runoff. There was temporal complementarity in this association since the period of intense water uptake by the intercrop occurred earlier than noted for the vine under bare soil conditions. Nevertheless, the competition for water was limited by better refilling of the soil water profile during winter in the intercropped treatment. The intercrop clearly interacted with the vine and decreased its vegetative vigor. Since predawn leaf water potential

- Improves growth - provides environmental services *(Rivest et al, 2009)*

ELSEVIER
Journal of Environmental Management
Volume 91, Issue 2, November–December 2009, Pages 432-440

Tree-based intercropping systems increase growth and nutrient status of hybrid poplar: A case study from two Northeastern American experiments

David Rivest [a], Alain Cogliastro [b], Alain Olivier [a]

- Cost effective and reduces the risk of crop price volatility (mandarin + purpurea + feverfew)(Martin-Gorriz et al 2022)

agriculture
MDPI

Article

Intercropping Practices in Mediterranean Mandarin Orchards from an Environmental and Economic Perspective

Bernardo Martin-Gorriz [1], José A. Zabala [2], Virginia Sánchez-Navarro [3], Belén Gallego-Elvira [1,*], Víctor Martínez-García [2], Francisco Alcon [2] and José Francisco Maestre-Valero [1]

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Abstract: Crop diversification is becoming increasingly important for preserving soil and ecosystems' health and, subsequently, crop productivity and sustainability. Intercropping practices adopted in monocultural woody crops, with herbaceous crops covering the otherwise bare alleyways, foster ecological interactions and can provide both environmental and economic advantages. In this study,

- Balances soil water distribution and improves several ecosystem services
-Bacterial diversity (rubber tree + ginger**)***(Wen et al, 2022)*

ELSEVIER
CATENA
Volume 217, October 2022, 106426

Implementing intercropping maintains soil water balance while enhancing multiple ecosystem services

Zhi Wen [a], Junen Wu [b], Yanzheng Yang [a], Ruonan Li [a], Zhiyun Ouyang [a], Hua Zheng [a, c]

Scientific issues

- In a semi-arid Mediterranean context, the introduction of MSIC* in fruit agrosystems:

(i) Does it save water or, on the contrary, compete with fruit trees?

(ii) Are MSIC efficient under water scarcity condition? what are the compromises?

(iii) can cover characteristics (e.g., seeding density) and management characteristics (e.g., mowing methods) be identified to improve the water use trade-offs of MSIC?

(iv) if MSIC are harvested (e.g., forages), do they represent a productivity and water efficiency gain for fruit agrosystems?

*Multi services intercrops

Objectives

- Study the influence of MSIC* on the eco-hydrological functioning of Mediterranean fruit agrosystems, using **irrigated citrus as a case study**.

- Quantify the impact of MSIC on the water balance of citrus orchards, by evaluating soil evaporation and total evapotranspiration of the orchards;

- Identify the compromises between different services provided by MSIC* based on indicators measured on plants and the environment

*Multi services intercrops

Scientific approach

The Bibliographic Part
- Bibliographic research
- Revision and reformulation of the problematic

→

The experimental part
- Data collection
- Modeling

→

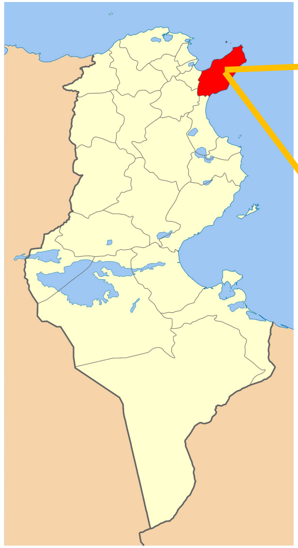
Data analysis part
- Data treatment
- Modeling
- Choice of the adequate model
- Evaluation
- Comparison
- simulation

→

Writing articles

Writing of scientific articles

Experimental site



https://fr.wikipedia.org/

Control
Field crop

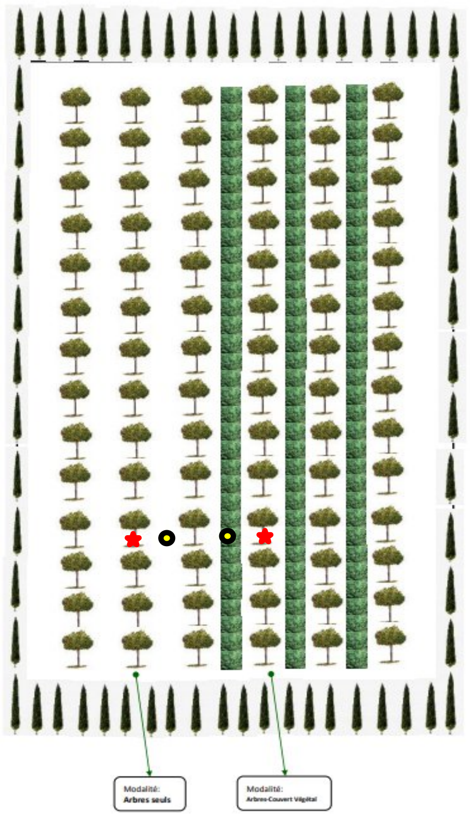
Alley with
crop

Alley
without
crop

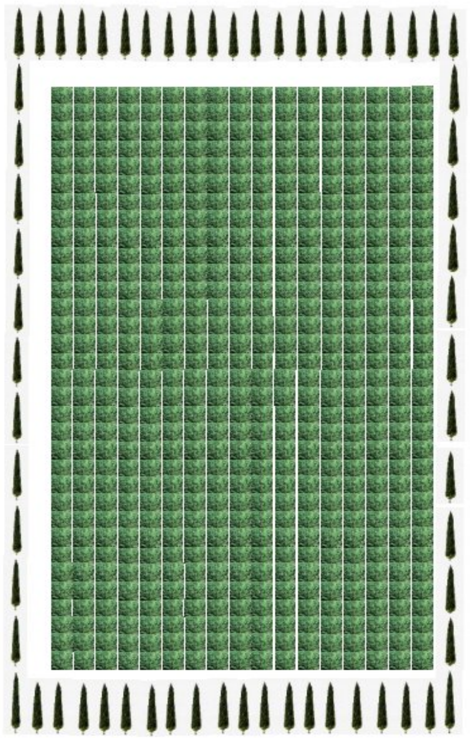
- ✓ North east Tunisia
- ✓ Land area ≈ 2400 m2
- ✓ Annual precipitation (2021/2022) : 445.4 mm
- ✓ Soil texture : sandy loam

Experimental layout

Intercropping:Triticale, oats, vetch



Parcelle Témoin - Couvert Végétal seul

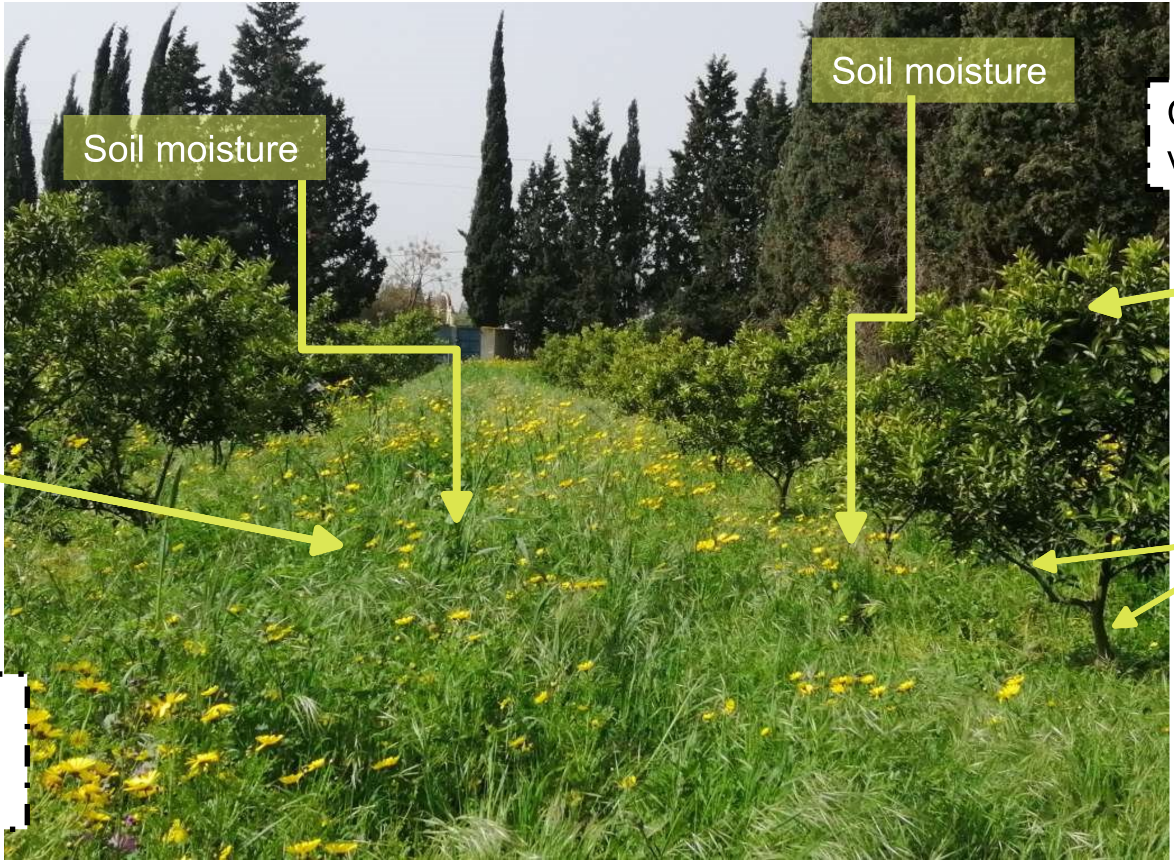


Planting density : 4*5
Drip irrigation system :
Water applied 294 mm

Soil moisture (drill and drop)

Capteur CS616

The measured variables



Citrus variety (Nova/ volkameriana)

Identification of the present species

Plant Biomass

Stem water potential

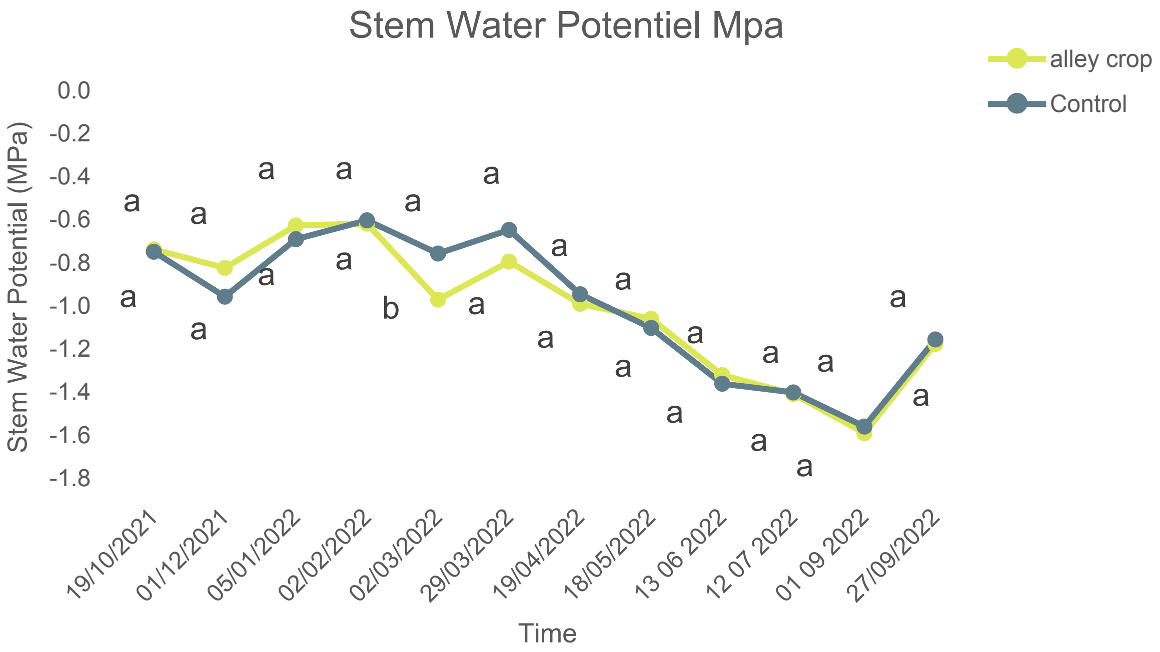
Plant growth (branches, trunk diameter)

Intercropping: Triticale, oats, vetch

Soil moisture

	Alley with and without crop		Field crop
	On the line	Between the line	
Gravimetric method	5 measures 1 measure / month from December 2021 to April 2022	5 measures 1 measure / month from December 2021 to April 2022	5 measures 1 measure / month from December 2021 to April 2022
Drill and Drop probe	Two probes to measure up to 90 cm		
CS616 sensor		Two sensors that measure each 30 and 50 cm	

Stem water potentiel



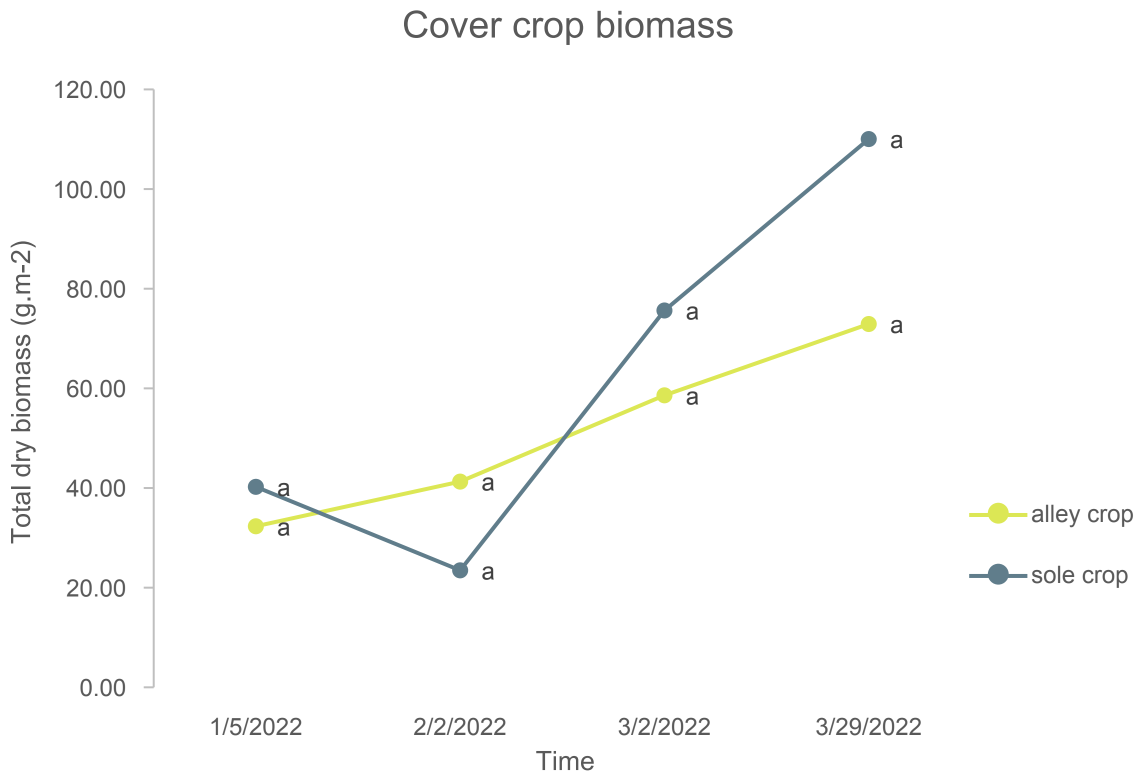
At the beginning of March we recorded a significant difference between the two systems

From April to September, no significant difference between the two models.

A strong stress during September < -1.4 Mpa

(Van Leeuwen et al. (2009), Célette (2007), Ojeda (2007))

Plant growth



Citrus trees combination with service crop didn't affect understory crop growth.

Preliminary result

- No significant differenceof the stem water potential between the intercropping system and the control but just at the beginning of March we recorded a significant difference between the two systems

- Citrus trees combination with service crop didn’t affect understory crop growth.


Thanks for your attention
19 01 2022