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

Presented by:
Mariem BEN ABDALLAH

Supervised by:
Rim Zitouna-Chebbi, LRVENC/ INRGREF/ Université de Carthage
Karim Barkaoui, CIRAD-UMR ABsys/ Monpellier
Salah Ben Youssef /INRAT (Production fourragère)
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 m³/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)
Irrigated areas

- Over 75% of the available fresh water
- 460,000 ha, 8% of the total agricultural area of the country
- 27% of agricultural employment
- 20% of agricultural exports
- 35% of the value of national agricultural production

‘(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)

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

(ATAE, 2018)
- The intercrop enhanced the infiltration of winter rainwater, probably by limiting surface runof (vine, tall fescue) (Celette et al, 2005)

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

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

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

- 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

https://fr.wikipedia.org/
Experimental layout

Intercropping: Triticale, oats, vetch

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

- Soil moisture (drill and drop)
- Capteur CS616
The measured variables

- Soil moisture
- Stem water potential
- Plant growth (branches, trunk diameter)
- Soil moisture
- Citrus variety (Nova/volkameriana)

Identification of the present species

Plant Biomass

Intercropping: Triticale, oats, vetch
## Soil moisture

<table>
<thead>
<tr>
<th></th>
<th>Alley with and without crop</th>
<th>Field crop</th>
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</thead>
<tbody>
<tr>
<td><strong>On the line</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravimetric method</td>
<td>5 measures 1 measure / month from December 2021 to April 2022</td>
<td>5 measures 1 measure / month from December 2021 to April 2022</td>
</tr>
<tr>
<td>Drill and Drop probe</td>
<td>Two probes to measure up to 90 cm</td>
<td></td>
</tr>
<tr>
<td>CS616 sensor</td>
<td></td>
<td>Two sensors that measure each 30 and 50 cm</td>
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</tbody>
</table>
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 difference of 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