WP4: Sustainable Water Re-use with Innovative Purification and Sensing system for the agri-food supply chain

Presenter Rim WERHENI AMMERI

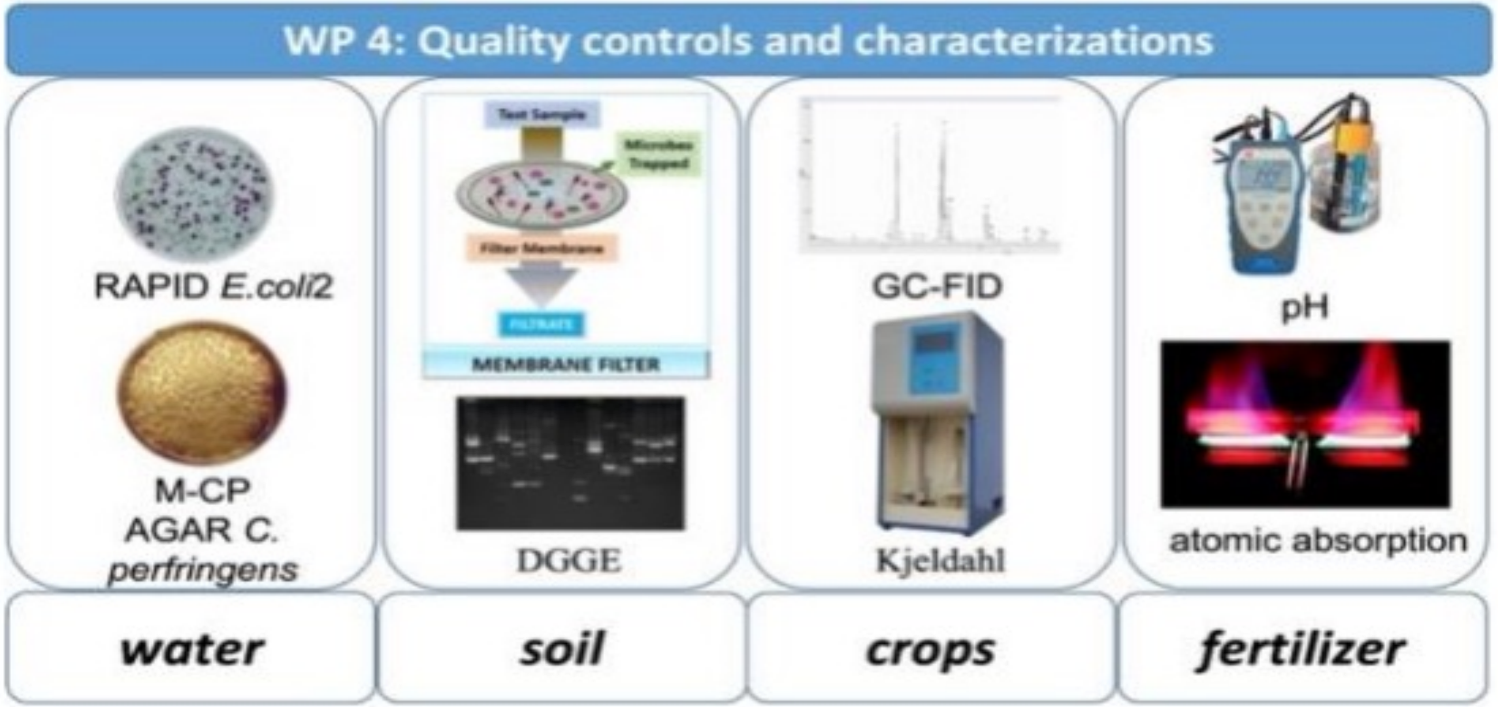
Second SWRIPS General Meeting

Palermo 07-08 October 2024

PRIMA programme is supported by Horizon 2020, the European Union's Framework Programme for Research and Innovation.

WP4 aims

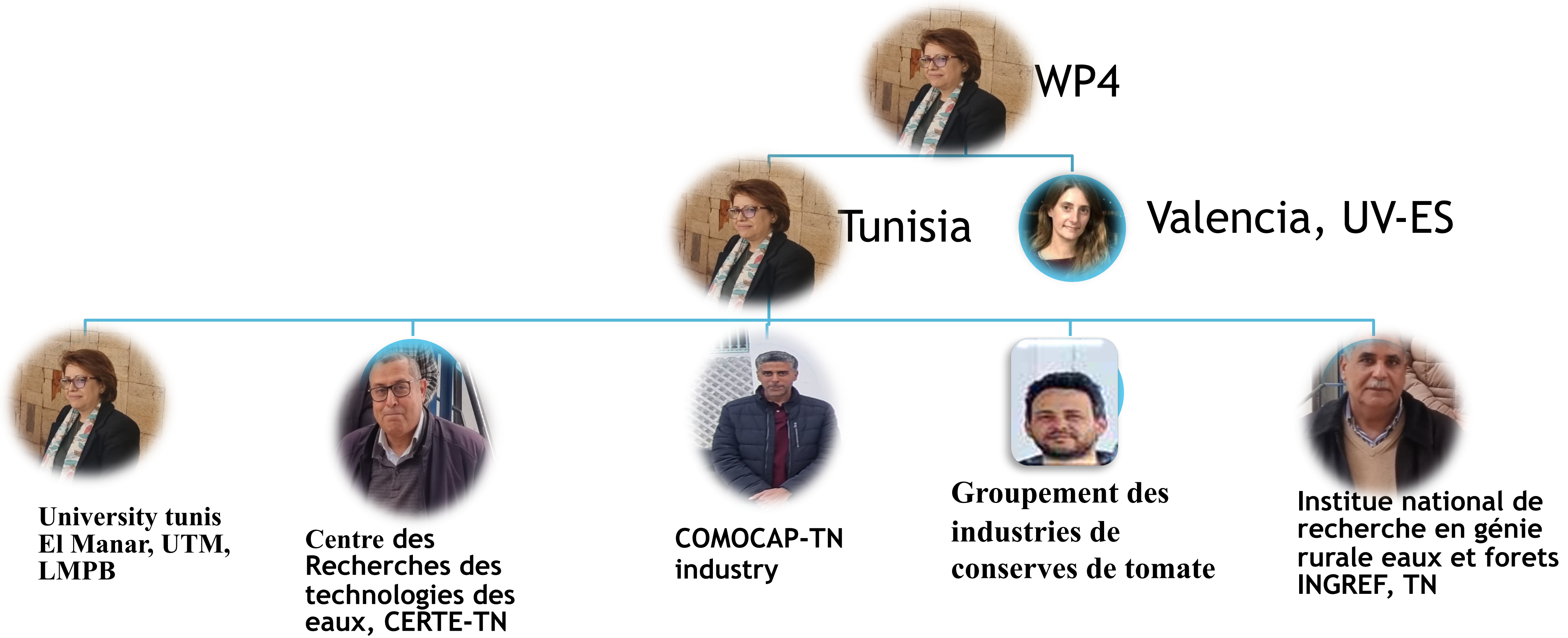
- Analyses of the products of the whole chain: water, sludge soil, crops to measure the effects produced by the system (WP4) in terms of environmental impacts (water and soil) and agriculture and human health impacts (crops).



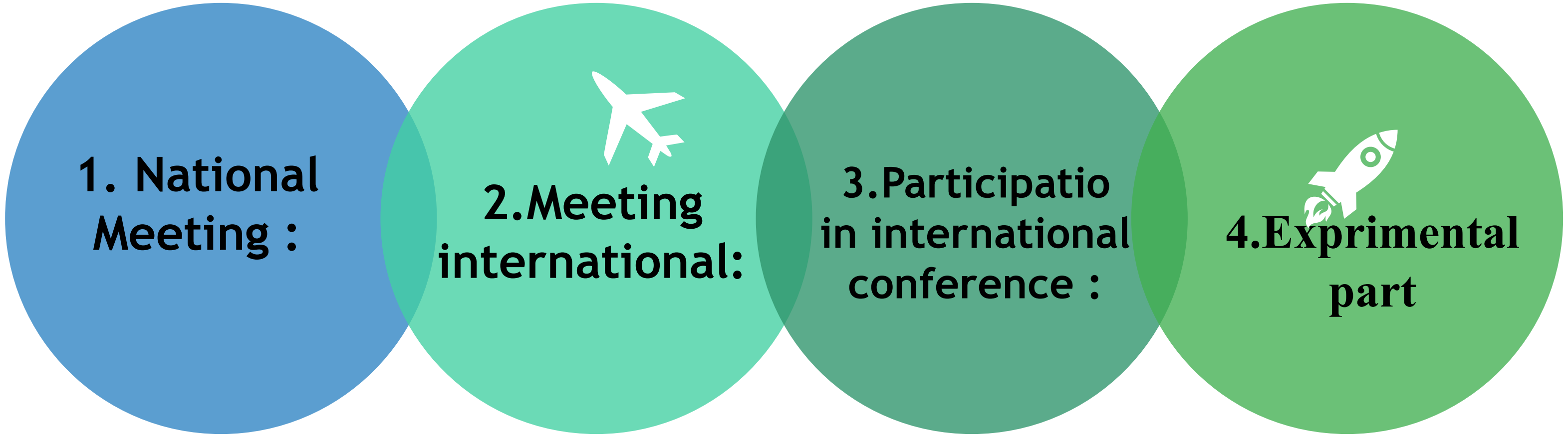
WP4 Tasks

- Task 4.1 Microbiological water quality test (UNITU-TN, CERTE-TN, UV-ES) M16-M24
- Task 4.2 Soil Quality test (UV-ES, ENSA-DZ, UNITU-TN, INRGREF-TN, GICA-TN, ENSCR-FR) M16-M32
- Task 4.3 Crop Quality test (UV-ES, ENSA-DZ, UNITU-TN, GICA-TN, COMOCAP-TN,AGRUCOR-IT) M18-M36
- Task 4.4 Water characterization as Fertilizer (ENSA-DZ, UV-ES, UNIPA-IT, AGRUCOR-IT, INRGREF-TN, GICA-TN, ENSCR-FR) M18-M36
- Task 4.5 Sludge characterization and re-use as Fertilizer (UNIPA-IT, ENSA-DZ, UNITU-TN)- M16-M36

WP 4 Participation



WP4 Activity during the first year



01 **National Meeting :**

Ingref
Certe
UTM
COMOCAP

02 **Meeting international:**

Catania (December 2023)

03 **Participatio in international conference :**

SIDISA 2024

04 **Exprimental part**

Meeting

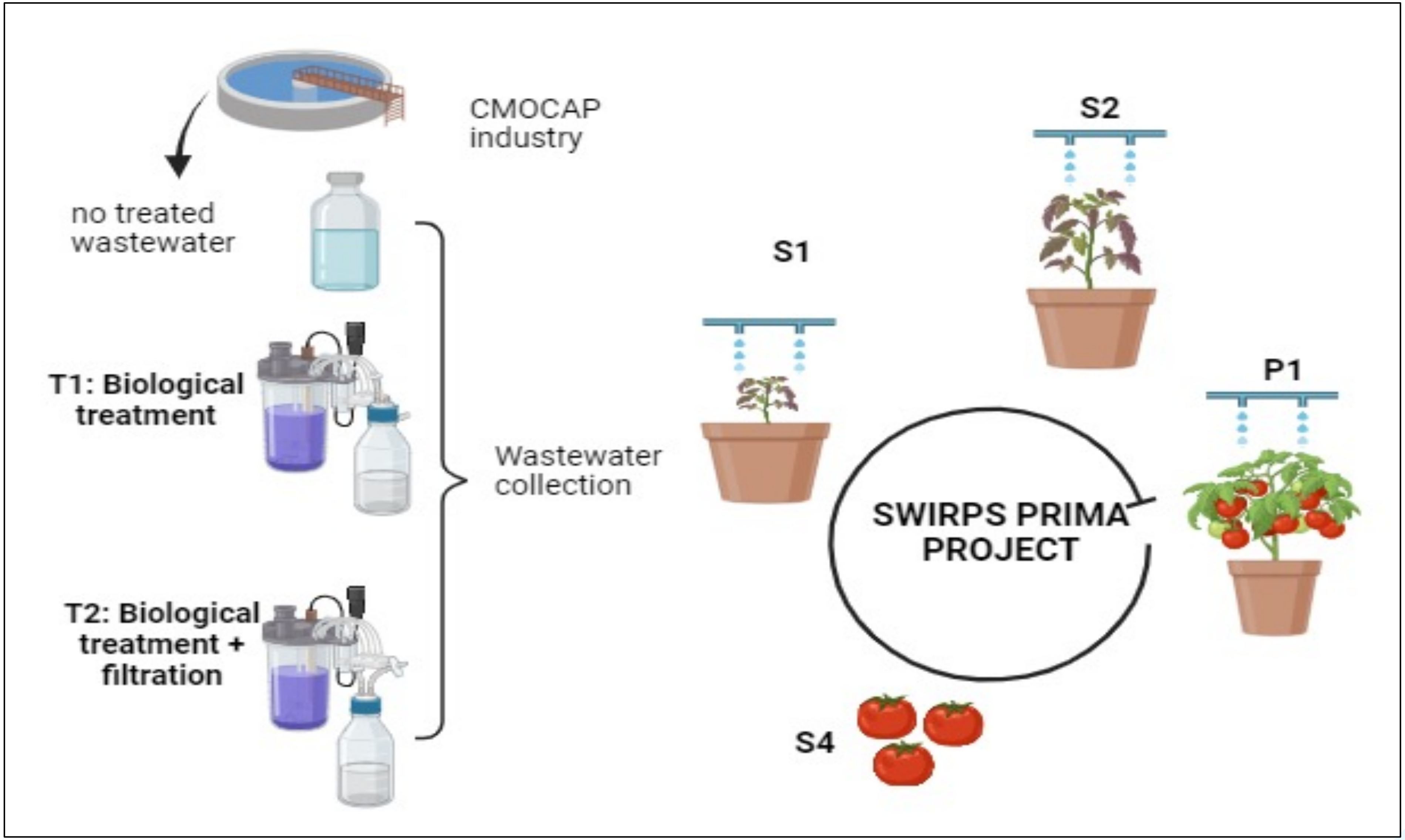
CERTE

COMOCAP

INGREF

UTM manar

WP4 aims



CMOCAP
industry
no treated
wastewater
T1: Biological
treatment
T2: Biological
treatment +
filtration
Wastewater
collection
S1
S2
P1
SWIRPS PRIMA
PROJECT
S4

CERTE Participation

Automatic sampling raw comocap wastewater

sampling

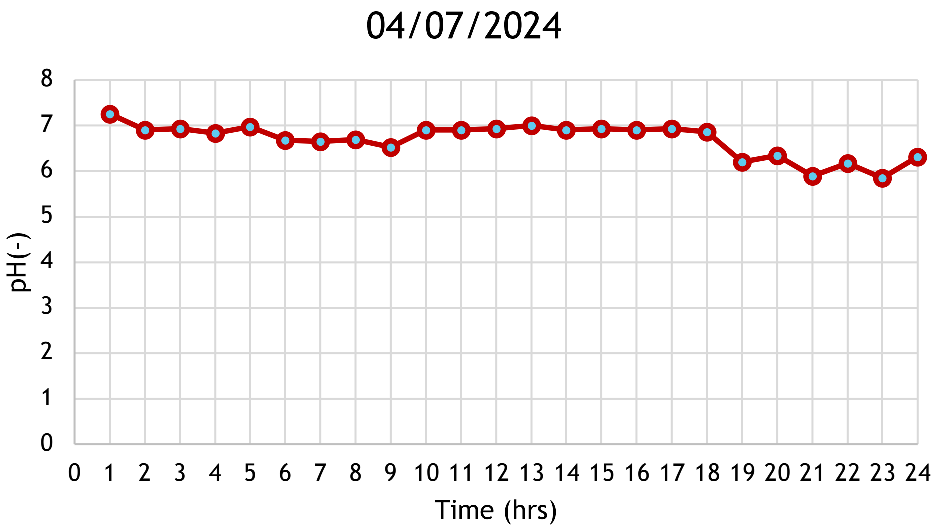
04/07/2024

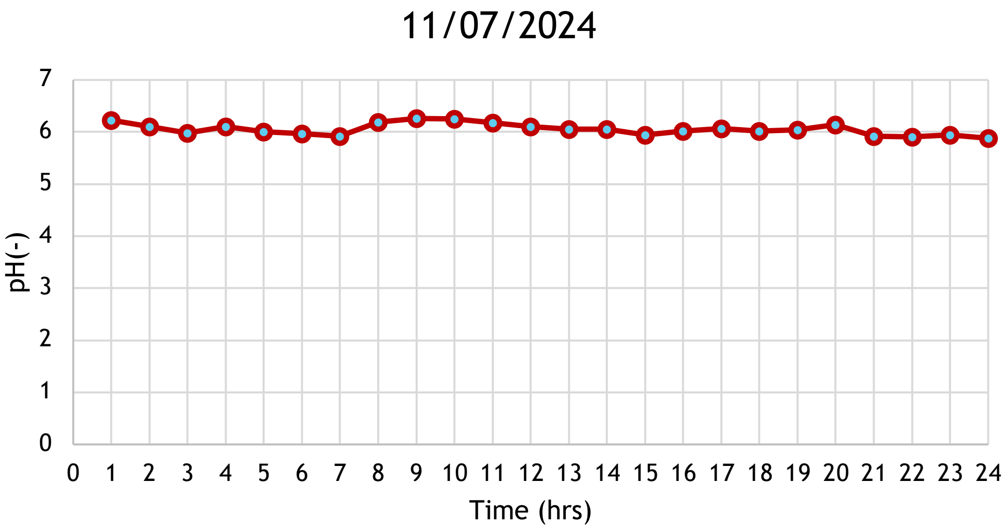
11/07/2024

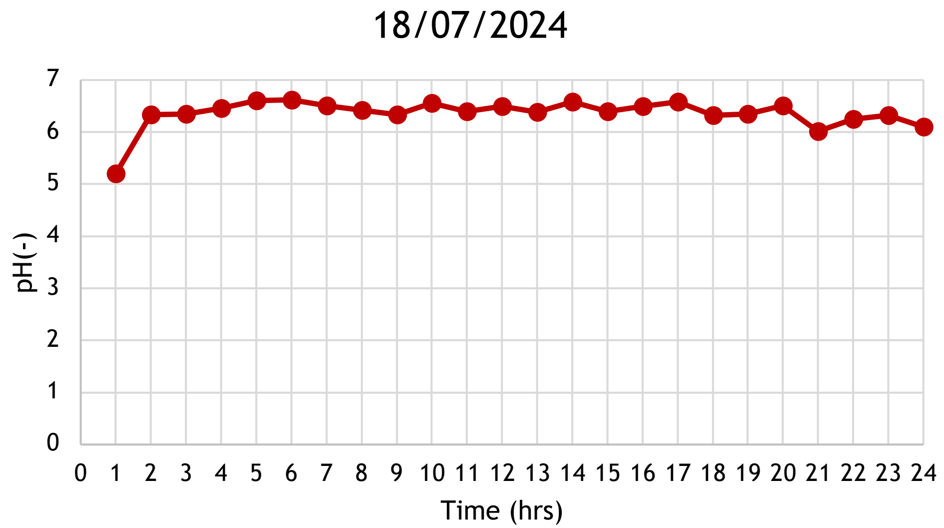
18/07/2024

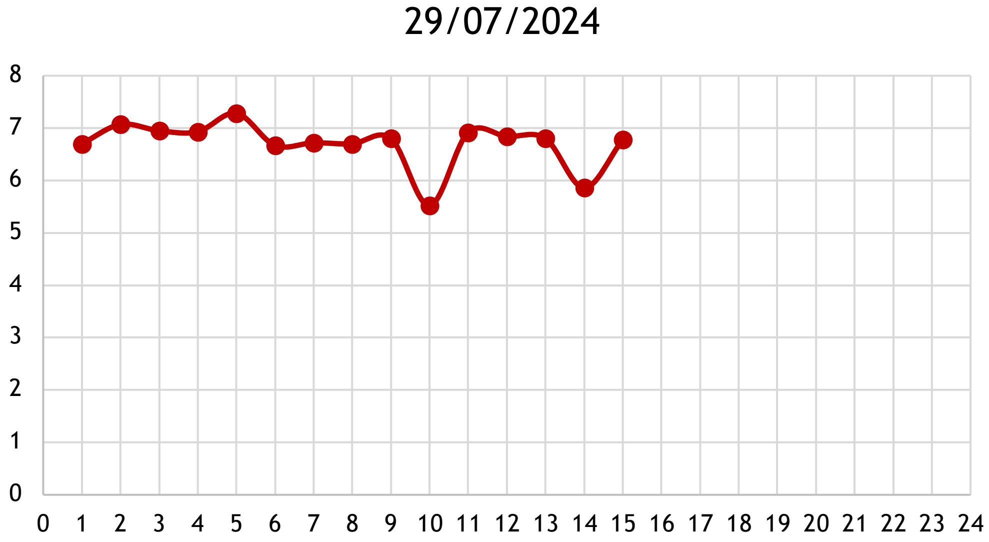
29/07/2024

❑ Variation of comocap's raw wastewater within 24hours (four samples were taken)



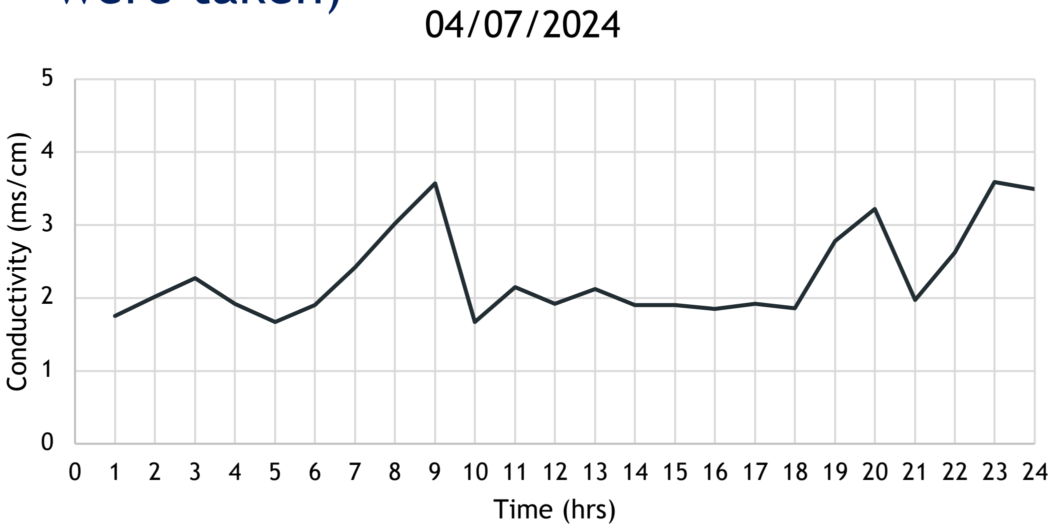


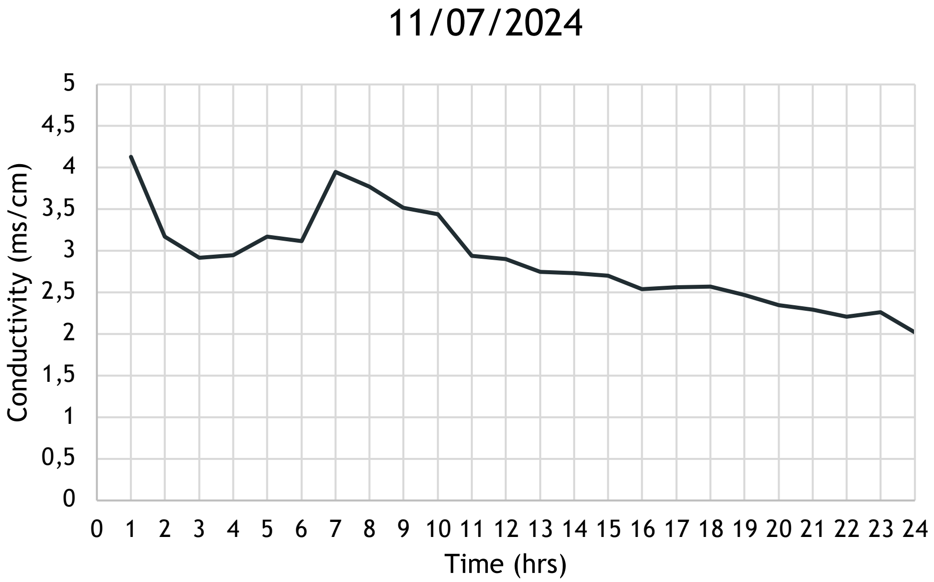


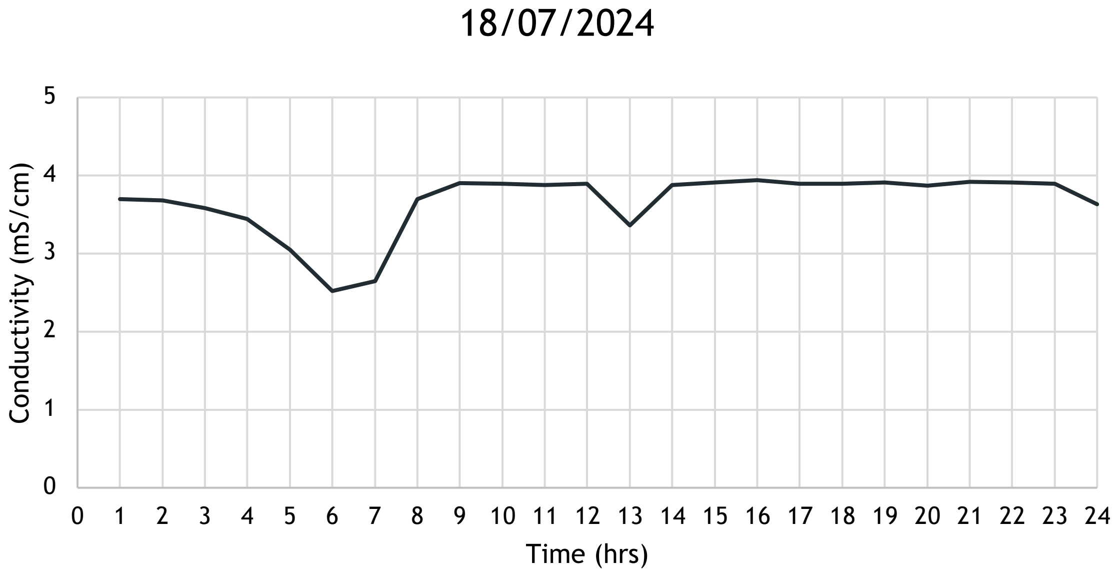


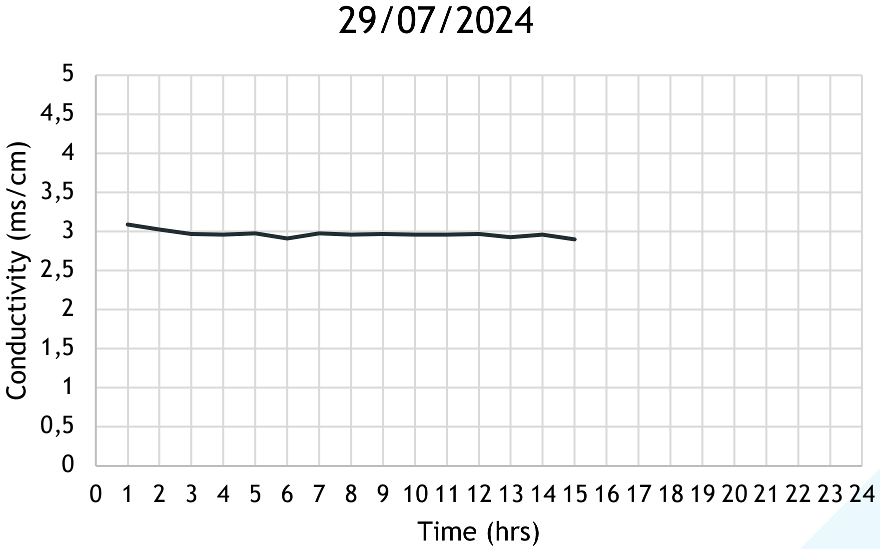
pH varied from 5,2 to 7,3

❑ conductivity variations of comocap's raw wastewater within 24hours (four samples were taken)









CERTE Participation

❑ Characteristiques of Comocap 's wastewater

Parameters	Range
pH(-)	5,2 - 7,3
Conductivity (mS/cm)	2,5 – 4,2
Suspended solid (mg/L)	1100 - 2500
COD (mg/L)	**9600-28800**
BOD_5 (mg/L)	3200- 9600
TKN (mg N/L)	138-148
TP (mg P/L)	70-110

CERTE participation

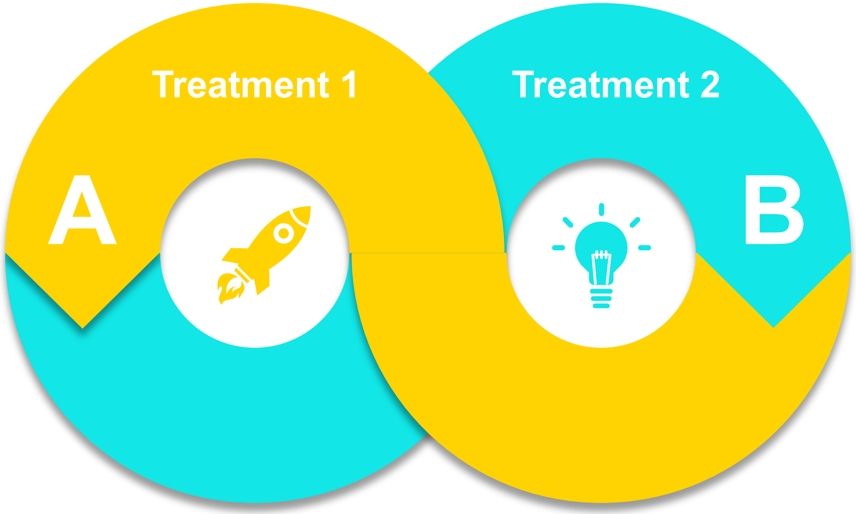
Granular Activated carbon

Start : 17/07/2024

Height (cm)	74,5
Diameter (cm)	28,5
Air flowrate (L/min)	10
Mixing (rpm)	0-200
Sludge volume	1/6 Volume of reactor
pH	7-9 no adjustment of pH
Temperature (°C)	Ambient temperature

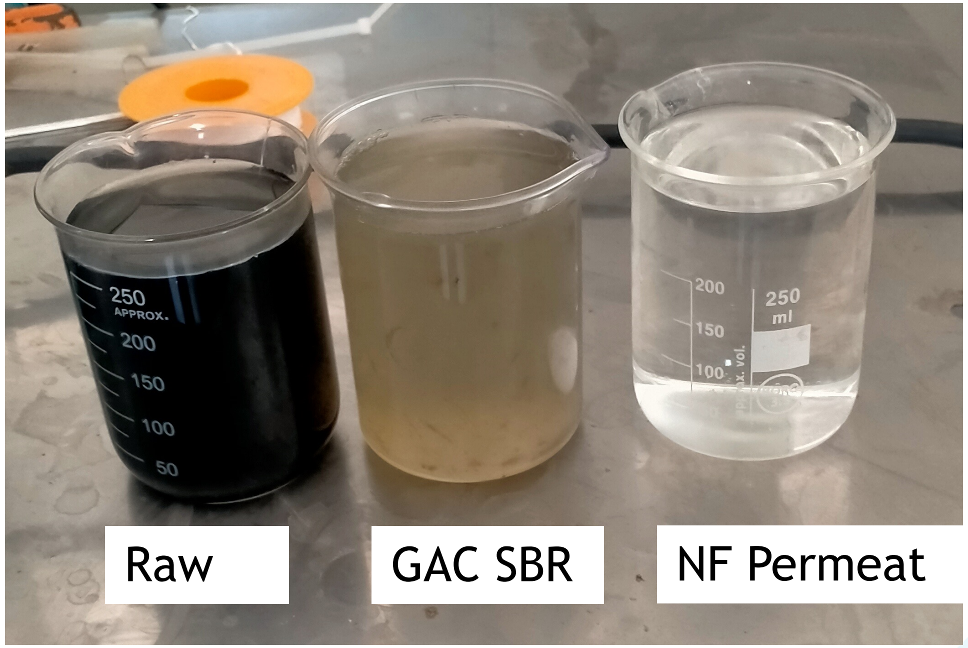
Feeding 20L of raw wastewater/ day

CERTE participation



- GAC SRB at CERTE
- Nanofiltration Unit (Filmtech NF40-40)

Wastewater treatment results



Tunisia

INRGREF Work Packages

- **WP1**: Technical analysis of the water/land/agro-ecosystem degradation
    - Task 1.1 Characterization of water/soil/agri-food product
- **WP2**: Development of Innovate Integrated Water Purification System
    - Task 2.1 Development of innovative agri-food wastewater first stage of treatment based on AGSB
- **WP4**: Quality Control on Water, Soil and Crop
    - Task 4.2 Soil Quality Test
    - Task 4.5 Fertilizer characterization

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA
Co-funded by the European Union

Tunisia

WP1: Technical analysis of the water/land/agro-ecosystem degradation

- **Task 1.1 Characterization of soil**

- Physico-chemical analysis of the soil used for to produce COMOCAP tomato plants (Physical and chemical characterization)

Tunisia

WP2: implementation of an experimental tomato cultivation protocol an study of the effect of irrigation by treated waste water

- **implementation of an experimental tomato cultivation protocol and study the effect of treated wastewater**

- Three classes of waters (T1:raw waste water, T2: waste water treated by mini-bioreactor and T3:bioreactor water treated by Nano filter) are used for to grow tomato plants in soil took from COMOCAB exploitation

WP2: implementation of an experimental tomato cultivation protocol and study of the effect of irrigation by treated waste water

Morphologicals , Physiologicals and biochimicals variables determined

Morphological variables :

- growth in height
- number of leaves
- number of flowers
- leaf area
- leaf size
- biomass of aerial and root parts

WP2: implementation of an experimental tomato cultivation protocol and study of the effect of irrigation by treated waste water

Physiological variables:

- relative water content
- Fluorescence
- Electrolyte leakage
- chlorophyll content.3.3

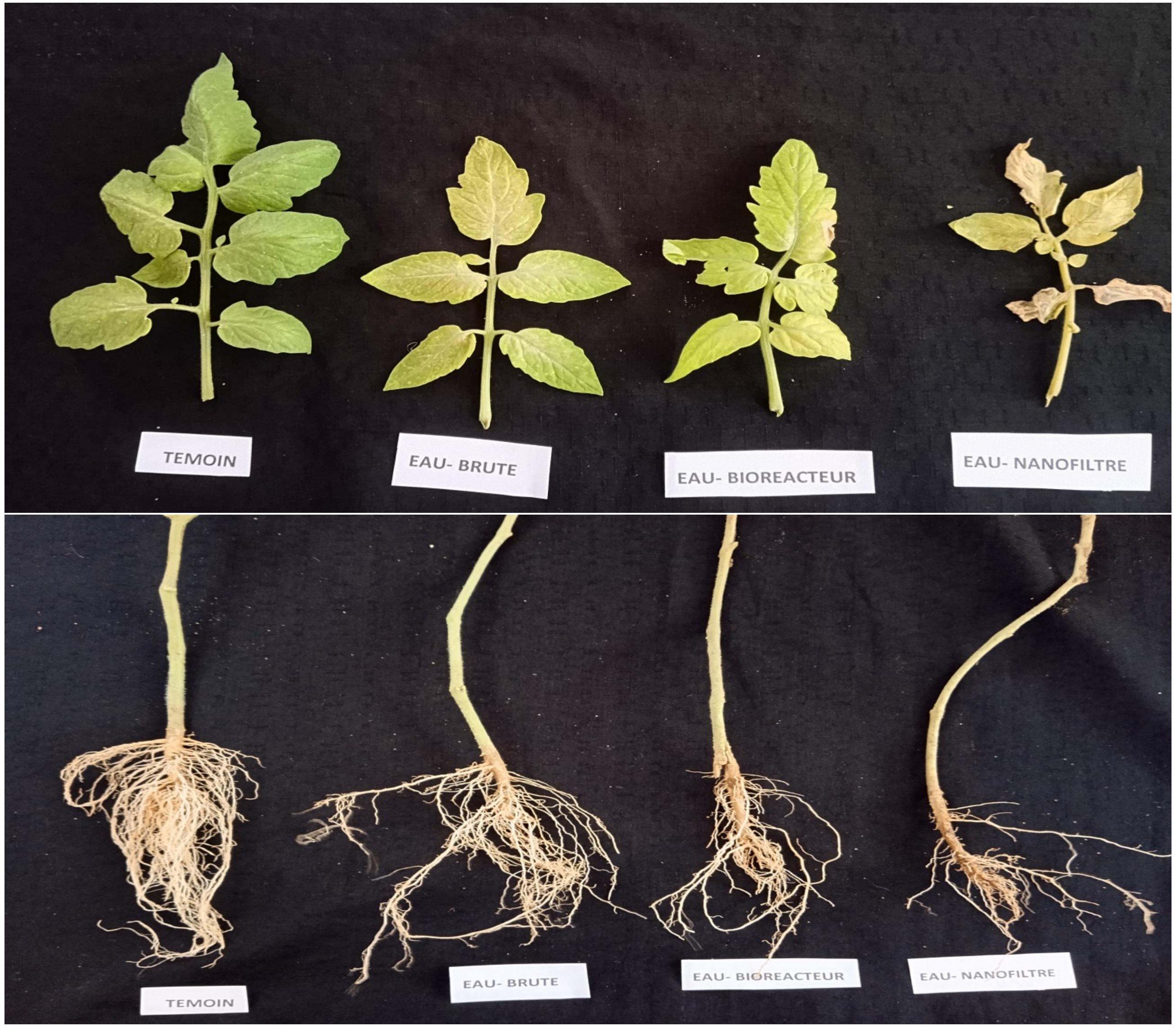
Biochemical variables:

- MDA, proline
- soluble sugars
- phenolic compounds (polyphenols, flavonoids and tannins).

Tunisia

❖ preliminary results

- Plants treated with bio water have the largest leaf areas
- Plants treated with nano water show the smallest leaf area
- Plants treated with raw water developed roots better than the other treatments
- Plants treated with nano water showed the least root development,.



Effect of Water classes on Tomate growth

Interpretation:

- ✓ **Treated water: G**lobally favorable for stem growth and leaf production, but performs less well in terms of flowering.

- ✓ **Raw water:** It may seem less refined, raw water showed excellent results for stem, leaf production, especially for flowering**.**

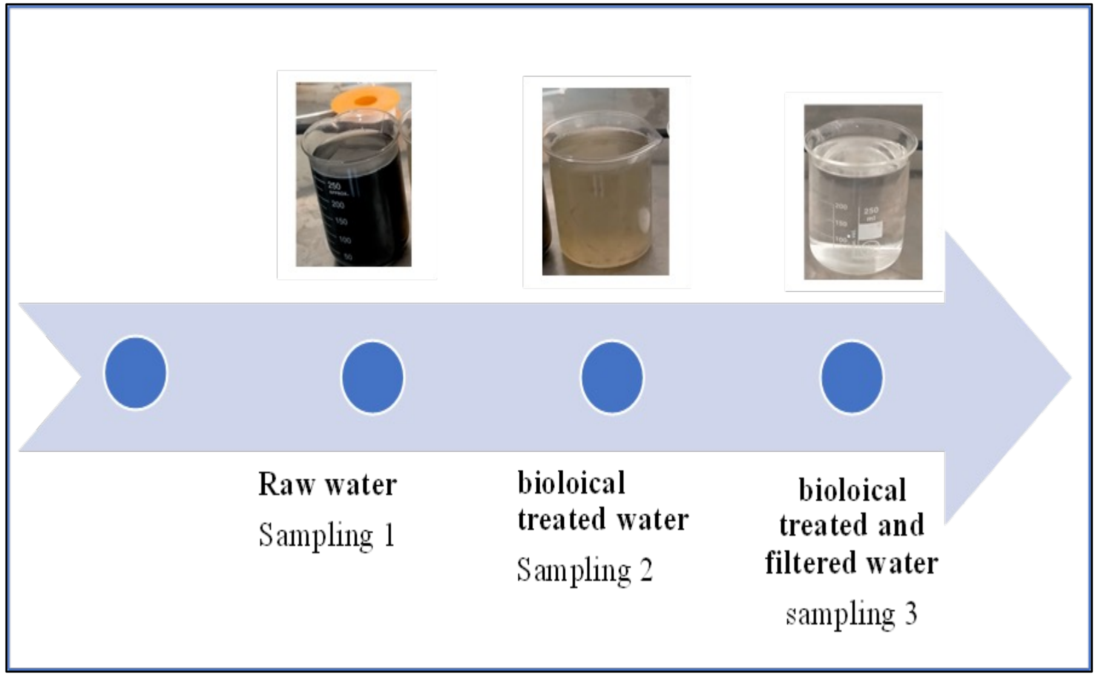
- ✓ **Nano water: N**ano water showed decent initial growth, it did not promote flowering or a noticeable increase in the number of stems.

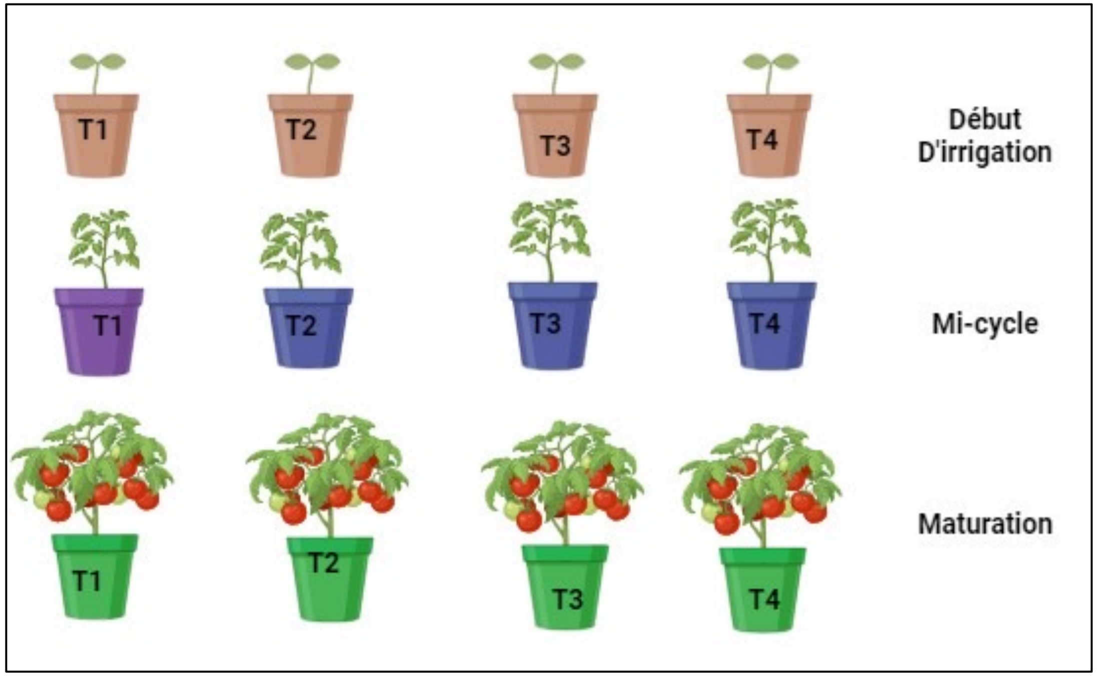
WP4 Participation

- Micribioloical analysis of Water:
- Enumaration in solide medium:
  - ✓ Total Coliform
  - ✓ Mesophll
  - ✓ Clostridium sp,
- Molecular analysis
  - ✓ 16 S sequencing
  - ✓ ERIC PCR and RTpcr

- Micribioloical analysis of soil:
- Enumaration in solide medium:
  - ✓ Total Coliform
  - ✓ Mesophll
  - ✓ Clostridium sp,
- Molecular analysis
  - ✓ 16 S sequencing
  - ✓ ERIC PCR and RTpcr
- Carbon and nitrogen Biomass

WP Implementation

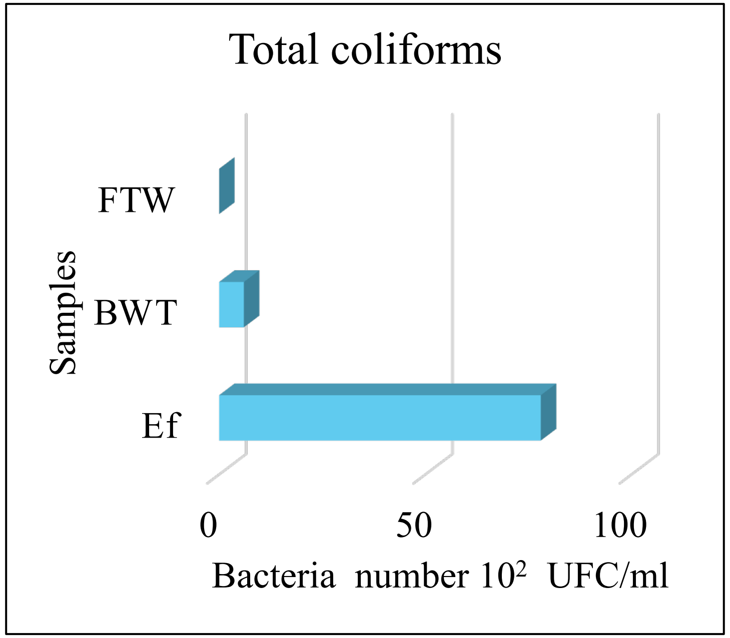


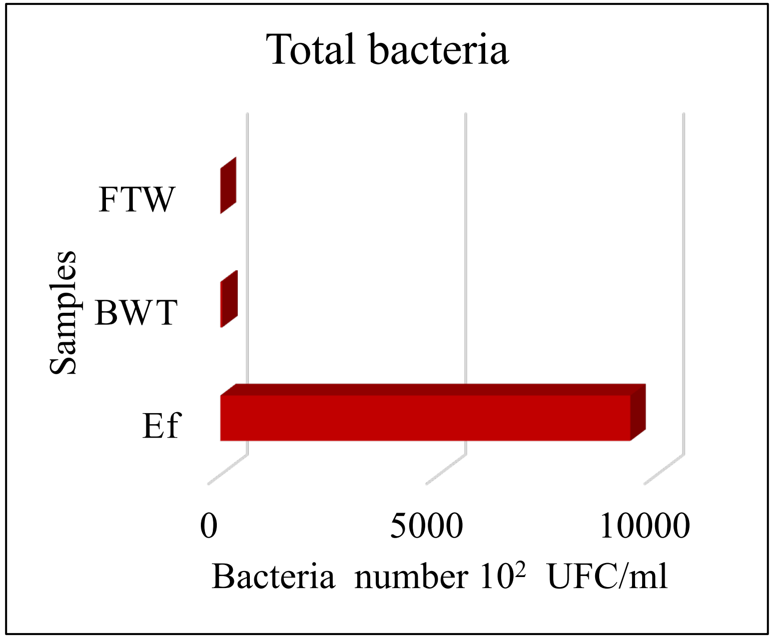


WP4 Results

Wastewater analysis:

- Microbiological analyses of raw effluents revealed inadequate sanitary quality.
- The combined treatment of biological process and nanofiltration proves to be the most effective in achieving the desired objectives.





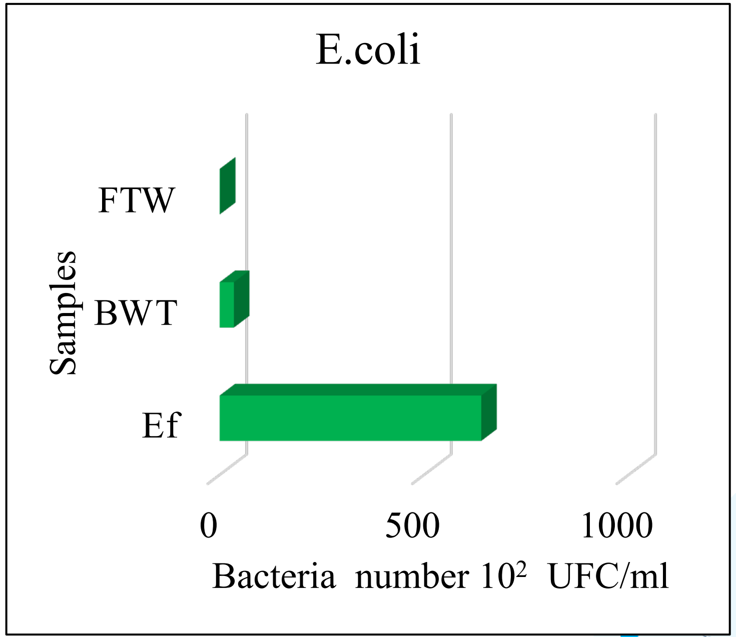


Figure 3. Results of bacterial wastewater analysis

WP4 Results

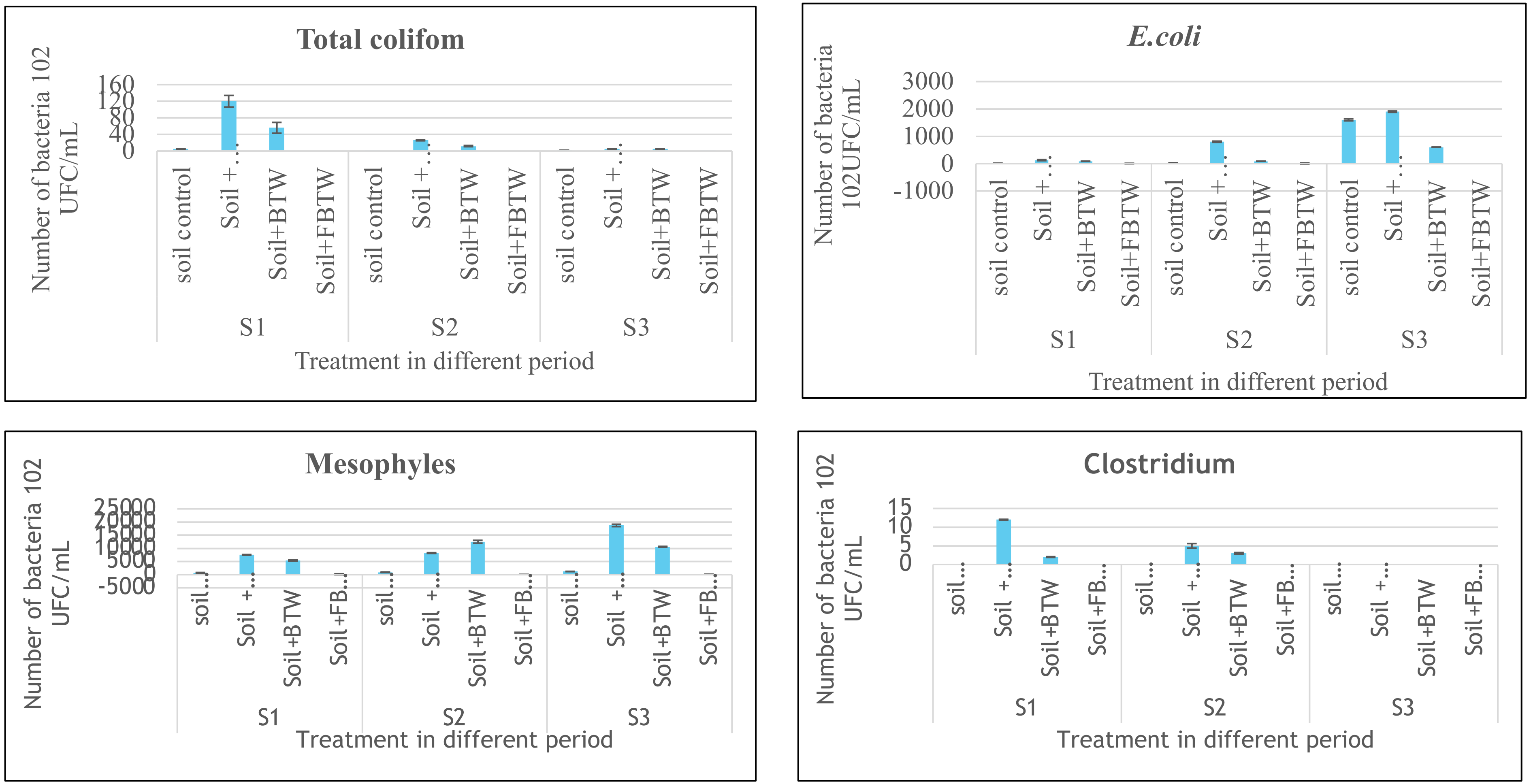
Soil microbial analysis:

- The bacterial load in the soil increases during the growth cycle of the tomato plant, especially with irrigation using raw effluent.

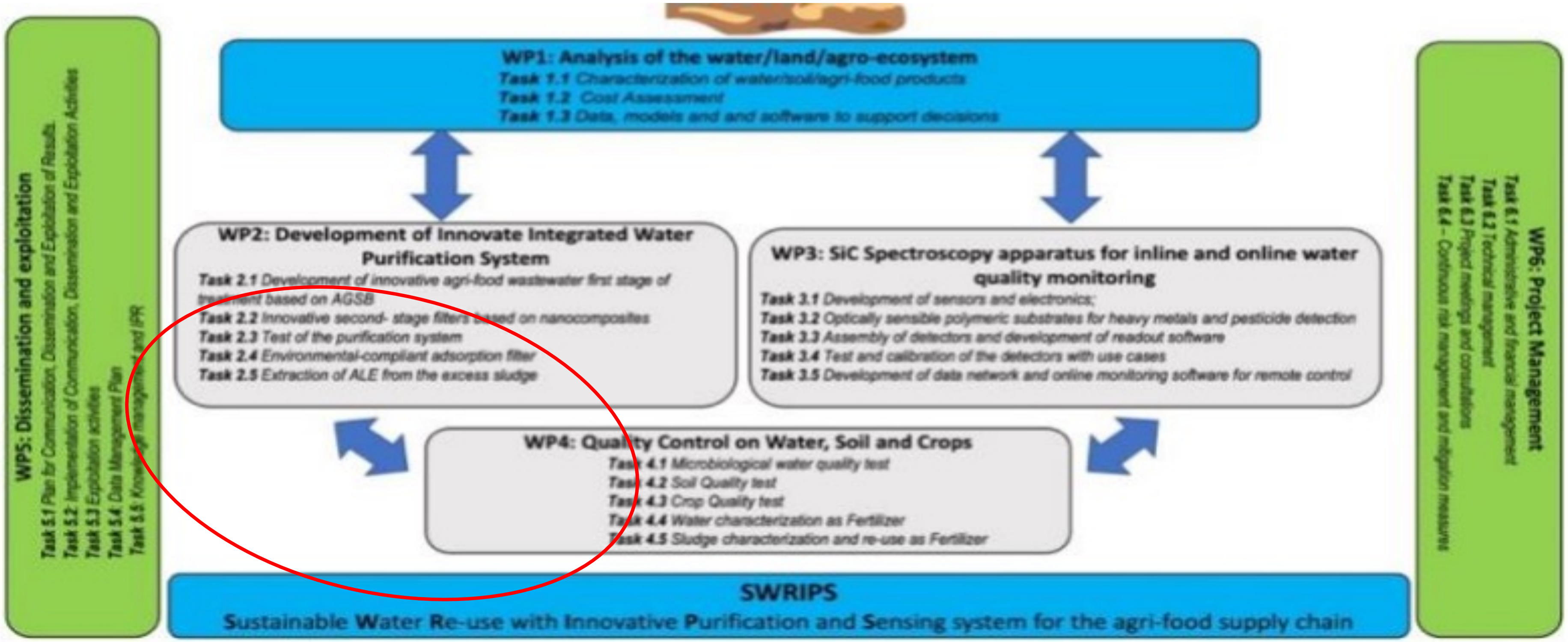
- Therefore, irrigation with non-conventional water increases the load of total coliforms and consequently *E. coli*.

WP4 Results

Figure 4. Results of bacteriological analyses (10^2 UFC/mL): total coliforms (A), *E. coli* (B), mesophiles (C), *Clostridium* (D).



WP interaction with other WPs



WP4 UTM Participation

Protocol Water

PRIMA Full Proposal Template

Title	Sustainable Water Re-use with Innovative Purification and Sensing system for the agri-food supply chain
Acronym:	SWRIPS

Task 4.1 Microbiological water quality test (UNITU-TN)

1. **Description of work**

This task is aimed to ensure that the microbiological property of the purified water is compliant with the EU and International standards.

2. **Experimental part**

2.1. **Water sampling**

Microbiological analyses were conducted to assess the sanitary quality of the COMOCAP water. Samples were collected from raw effluents, water treated by a biological reactor, and water that underwent biological treatment followed by nanofiltration. Each sample was collected in sterile glass bottles and stored at a temperature of 4°C during transport.

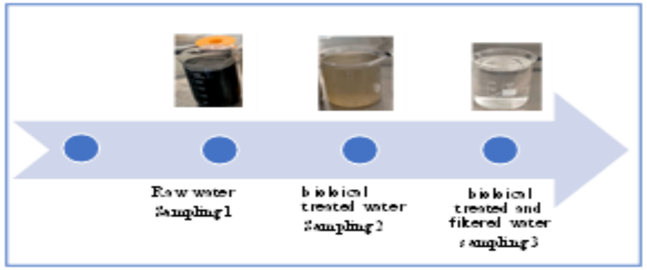


Figure. Representation of different step of water sampling

Protocol soil

Title	Sustainable Water Re-use with Innovative Purification and Sensing system for the agri-food supply chain
Acronym:	SWRIPS

PRIMA Full Proposal Template

Specific objectives of WP4 are:

microbiological water control; soil quality control; crop quality control; water characterization for fertigation purpose sludge characterization for agriculture purpose.

soil quality control;

I. **Soil Sampling:**

As part of the SWIREPES project, we will collect soil samples throughout the tomato growing season. Samples will be taken from both control plots (not irrigated with treated wastewater) and plots irrigated with treated wastewater. We will collect samples at three key points: the beginning, middle, and end of the cultivation period. To collect representative soil samples from agricultural fields irrigated with treated wastewater at two depths (0-20 cm and 20-40 cm) for both microbiological and molecular analysis.

Different samples immediately place the sample bags on ice within a cooler to maintain a cool temperature (ideally 4°C). This helps preserve microbial communities. The various samples will be taken in triplicate.

II. Microbial enumeration in soil

1. Enumeration of sulfite-reducing clostridium

The enumeration of sulfite-reducing clostridium is done by culture on agar meat-liver agar, Diagnostics Pasteur (meat-liver base 30g, glucose 2g, starch 2g, agar 11g, distilled water 100 ml), a standard medium for the detection of these germs (Marchal et al., 1987). Once

WP4 Participation

- Water and soil Simpling:

Title	Sustainable Water Re-use with Innovative Purification and Sensing system for the agri-food supply chain
Acronym:	SWRIPS

PRIMA Full Proposal Template

Sampling plan for microbiological analysis

Experimental design (5 repetitions)

Wastewater sampling :

	Type	Sampling date
E_1	Raw water	05 August 2024
E_2	Water treated by the biological reactor	
E_3	[illegible] and [illegible] water	

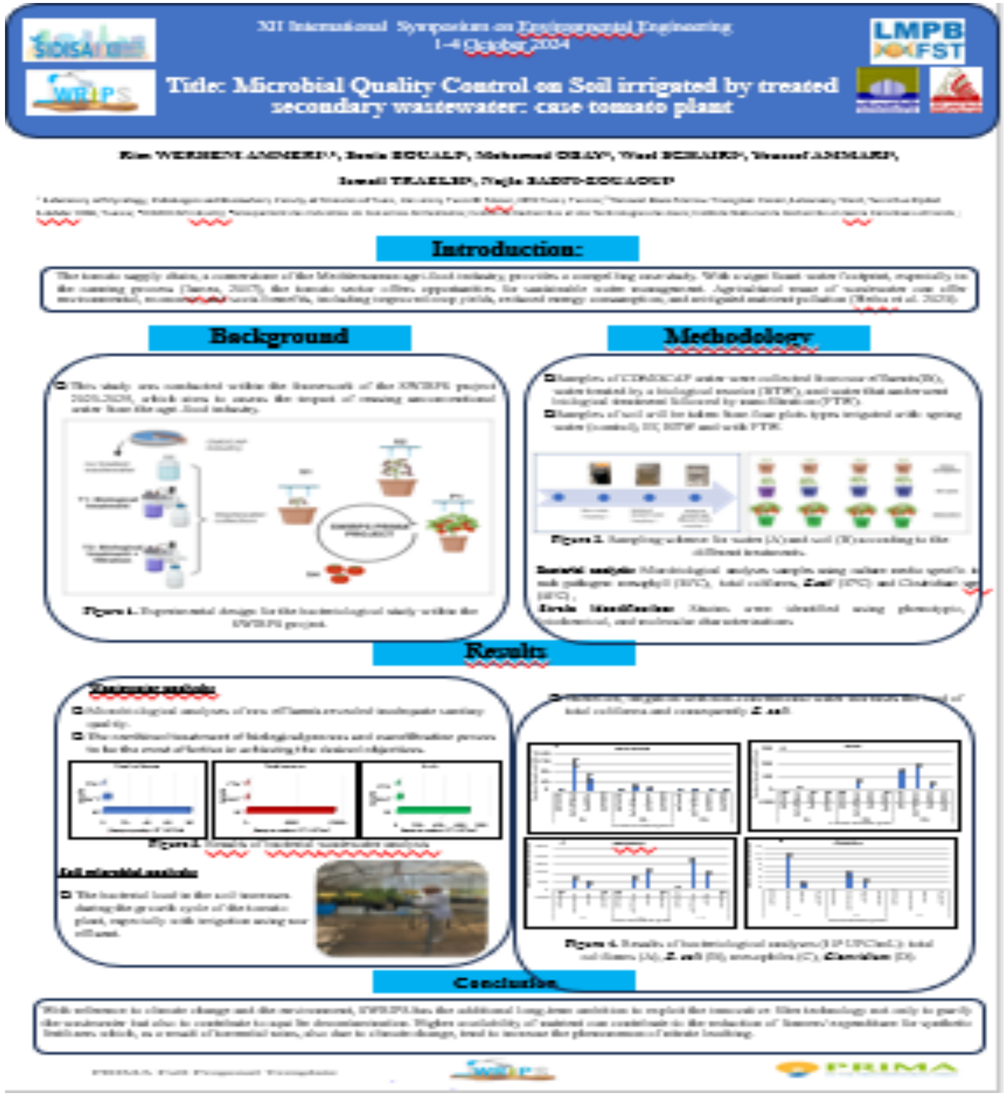
Soil sampling:

	Period	Sampling date
T_1	[illegible] 3 [illegible] of irrigation	05 August 2024
T_2	15 [illegible] irrigation	17 August 2024
T_3	40 [illegible] irrigation	02 September
T_4	60 [illegible] irrigation	[illegible]

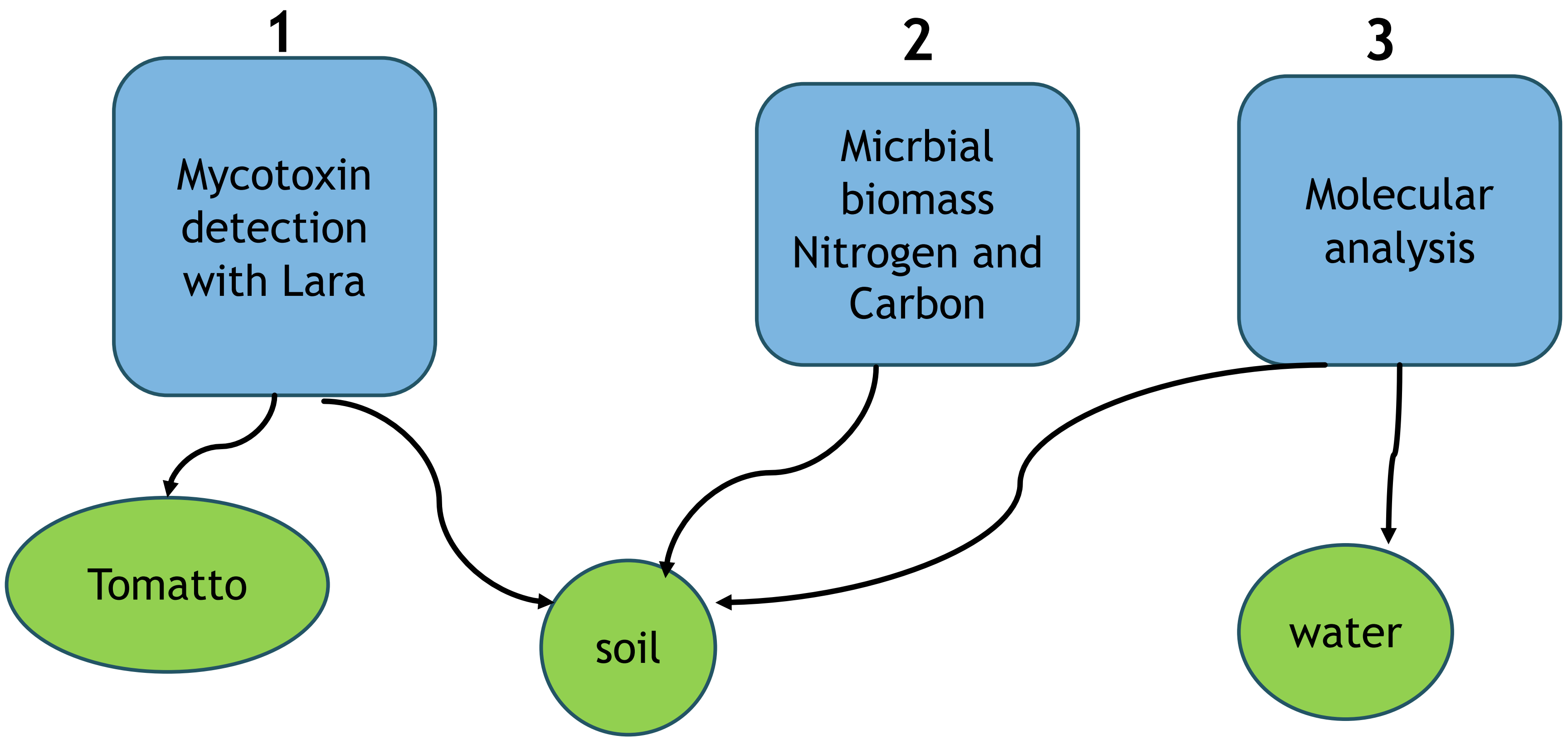
Plant sampling

	Type	Sampling date
T	T ([illegible])	05 August 2024
P_1	Start of irrigation	17 August 2024
P_2	mid-cycle	02 September
P_3	End of cycle to maturity	[illegible]

Poster participation :3 October 2024



WP4 going on

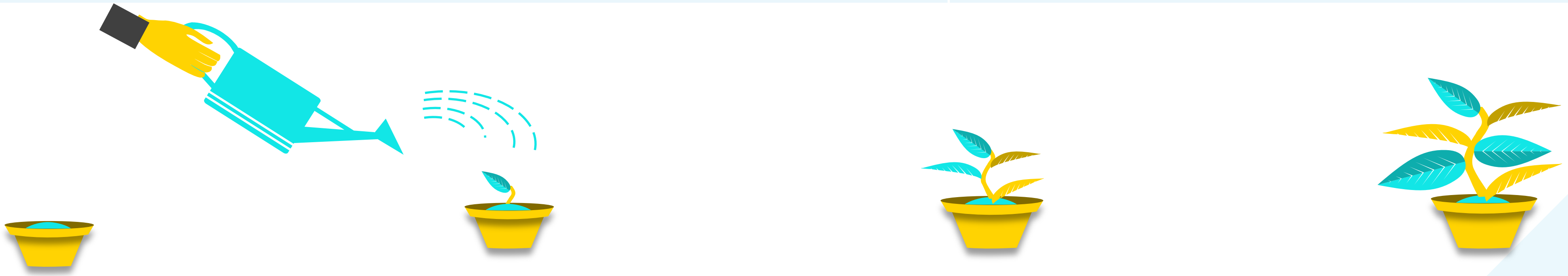

1
Mycotoxin detection with Lara
2
Micrbial biomass Nitrogen and Carbon
3
Molecular analysis
Tomatto
soil
water

On going activities

- ❑ In-person GICA meeting
- ❑ Dissemination through national and international conferences
- ❑ Preparation of the first scientific article
- ❑ Phd student with prof Lara

Risk and contingencies

Exprimental risk	Other risk
Sample Collection: ❑ **Container:** Sterile flasks ❑ **Storage:** 4°C for short-term storage ❑ **Sampling times:** Before and after treatment ❑ **Minimum volume:** 50-100 mL	❑ The exchange of protocols ❑ The similarity of types of analysis
❑ Soil sample collected in a sterile plastic bag or container. ❑ Sampling schedule: at the beginning, middle, and end (harvest time) of the irrigation period using the tested water.	



WP Deliverables

Deliverables (brief description and month of delivery)

- D4.1 Report on the presence of microorganisms in water (M30)
- D4.2 Report on the presence of E. coli, and Clostridium spp. in water (M30)
  D4.3 Report on soil and crop quality (M34)
- D4.4 Report on ALE characterization as fertilizer (M36)

THANK YOU!

LMPB FST

INRGREF

CERTE

UTM
جامعة تونس المنار
UNIVERSITÉ DE TUNIS EL MANAR

Gica

COMOCAP

WRIPS