



## Innovative Greenhouse Support System in the Mediterranean Region; Efficient Fertigation and Pest Management through IOT based Climate Control

تحسين منظومة الزراعات المحمية بمنطقة البحر الابيض المتوسط بالاعتماد على الفلاحة الذكية  
واستخدام التقنيات الحديثة

آليات تسيير عملية الري في البيت المحمي خلال التجربة  
تقديم عماد بن عيسى



## Task 2.3

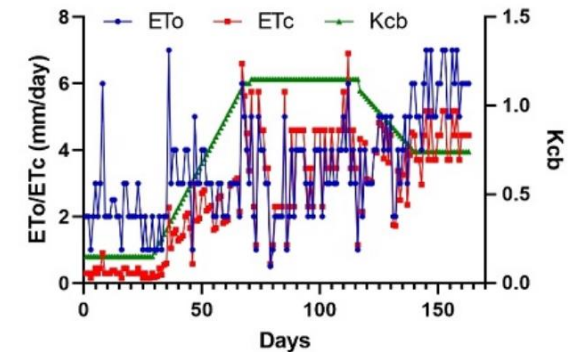
**Models to determine precise irrigation management with conventional and low-quality waters covering all the operational environments and cropping systems of the MED greenhouses**





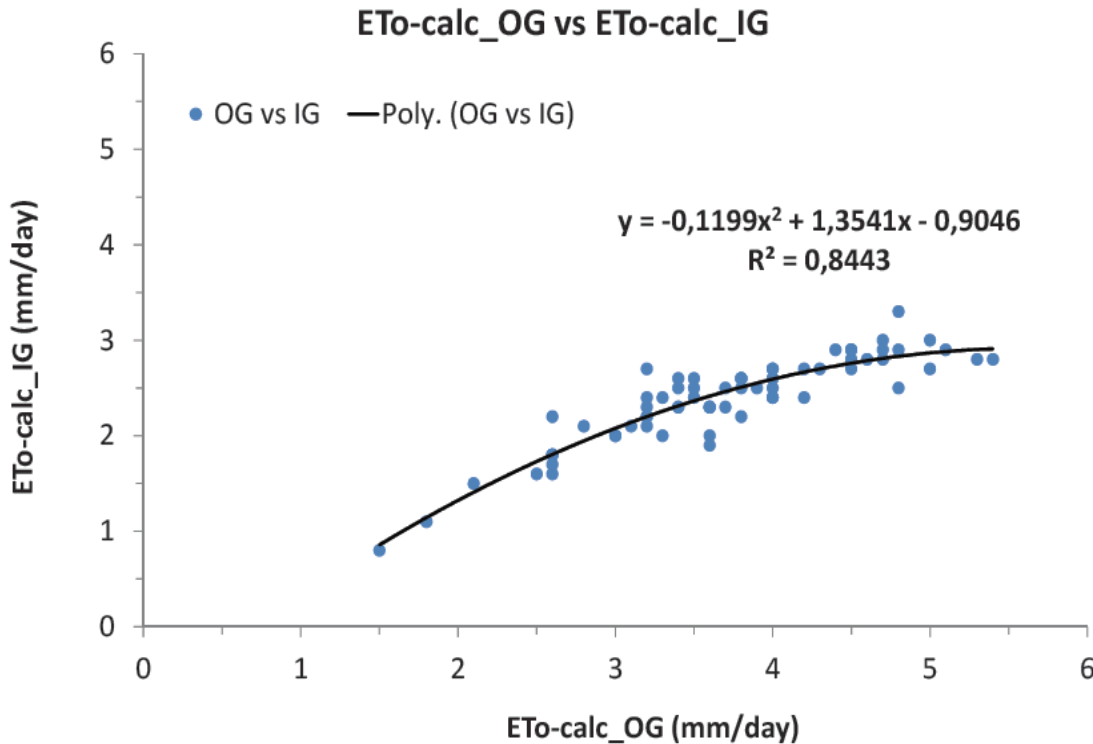
## Background (1)

- To determine ETo inside a plastic mono-tunnel unheated greenhouse, trials have been conducted since 2015
- ETo have been measured with an ETgauge atmometer and a 'class A' evaporation pan.
- 15 agrometeorological models, were used to calculate ETo inside and outside a plastic unheated single tunnel greenhouse.





## Background (2)



ETo FAO56 P-M model, inside and outside of a plastic mono-tunnel unheated greenhouse (Ben Aissa & Ghannem, 2016).



Schéma de fonctionnement du DSS iGUESSmed



# Methodology

- To cope with the task aims, the effectiveness of the PrHo model (part of the DSS) is tested under our climate and cropping conditions.
- The first year, two ways of daily ETo determination will be tested: PrHo-DSS ETo calculated vs FAO56 P-M modified equation ETo calculated with some local greenhouse consideration (wind speed and radiation) as previously shown (2nd background slide)
- Since crop rows are plastic mulched, soil evaporation (Ke) will be neglected and basal crop coefficient (Kcb) will be used as crop coefficient.
- Two irrigation scheduling regimes replicated 3 times were applied.



TOMATE CROP		ENTER DATA IN BLUE CELLS				WHITENING				CROP COEFFICIENT MODEL				Dropper flow(Lin/ha/hour)	
CROP CYCLE		JULIAN (DAY)		START(JD)	FRESH(JD)	TRANSMISSIV	Kc max	1.4 Cum TT	Kcmax	720	Droppers/m2			4.00	
245		01 sept	21 mai	FIRST APPLICATION	245	290	0.6					GREENHOUSE TRANSMISSIVITY		0.65	
151		20 oct		SECOND APPLICATION	46	151									
DATE OF WHITENING		DATE OF 2' APPLICATION		15-fev											
Day	Day of planting	External Solar Radiation(MJ/m2/d)	ETc(mm/d)	Maximal Greenhouse Temperature (°C)	Minimal Greenhouse Temperature (°C)	Average Greenhouse Temperature (°C)	Thermal Time(°Cd)	Cumulative hours	Kc (1.4) (mm/d)	Cond(°C/m)	Irrigation (mm/d)	Irrigation (minutes/dag)			
08/09/20	8	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/09/20	1	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/09/20	2	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/09/20	3	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/09/20	4	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13/09/20	5	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14/09/20	6	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15/09/20	7	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16/09/20	8	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17/09/20	9	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18/09/20	10	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19/09/20	11	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20/09/20	12	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21/09/20	13	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22/09/20	14	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23/09/20	15	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24/09/20	16	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25/09/20	17	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26/09/20	18	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27/09/20	19	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28/09/20	20	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29/09/20	21	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30/09/20	22	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01/10/20	23	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02/10/20	24	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/10/20	25	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04/10/20	26	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05/10/20	27	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/10/20	28	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07/10/20	29	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08/10/20	30	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/10/20	31	0.00	0.00	-10.00	-10.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



## Measures

### We are measuring

- Crop transpiration using sap-flow sensors (ETc ou Tc)
- ETo inside the greenhouse using Etgage atmometer
- LAI of the tomato crop and the intercepted PAR
- Climate conditions inside the greenhouse (T, HR, Rg)
- Outside greenhouse climate conditions (T, HR, Rg, U2)
- Soil water content and EC in the crop root-zone
- ETc (also deduced from soil water balance)
- Plant growth, Yield, fruit quality, firmness, skin color, ...



ATMOS 14



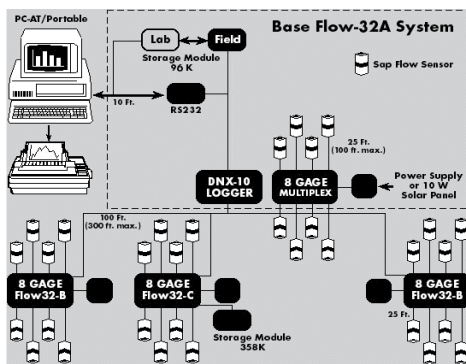
SP-110



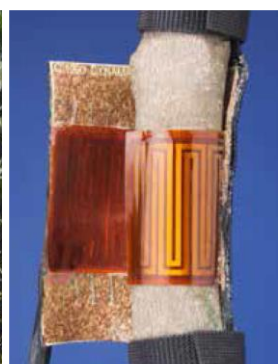
SQ-110/SQ-120



ATMOS 22



Flow32-1K Sap Flow system



EXO-Skin Dynagage



TEROS 12



## ETo determination and irrigation management inside the trial greenhouse

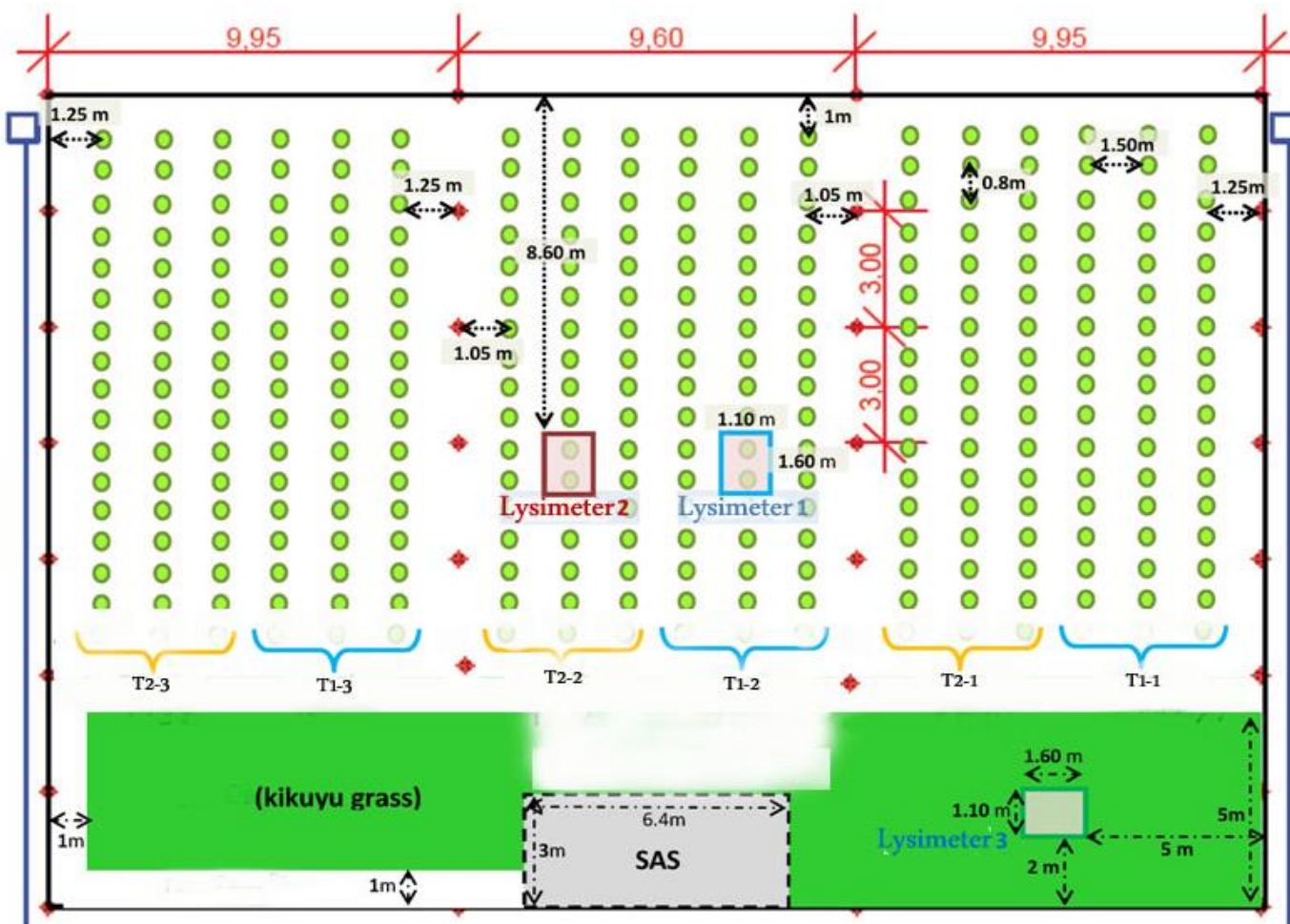
Applying two Water regimes

**PrHo DSS**

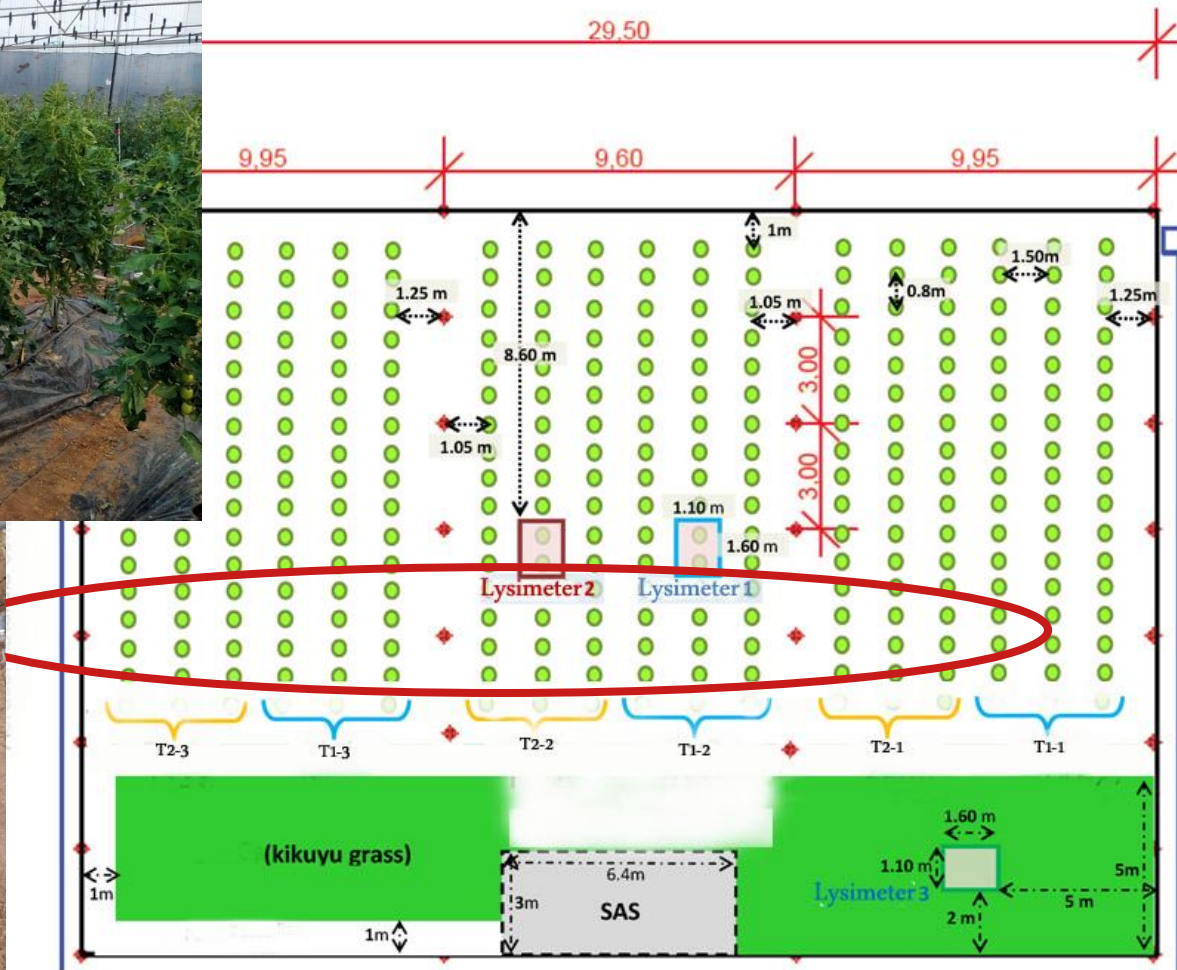
(Cajamar Foundation)

**Modified PM-FAO56**

(Fernández et al., 2010)

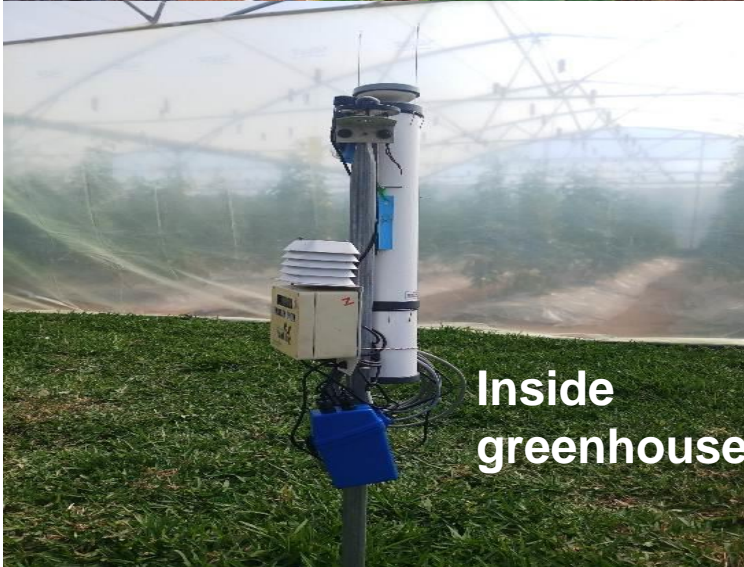


**Trial layout**





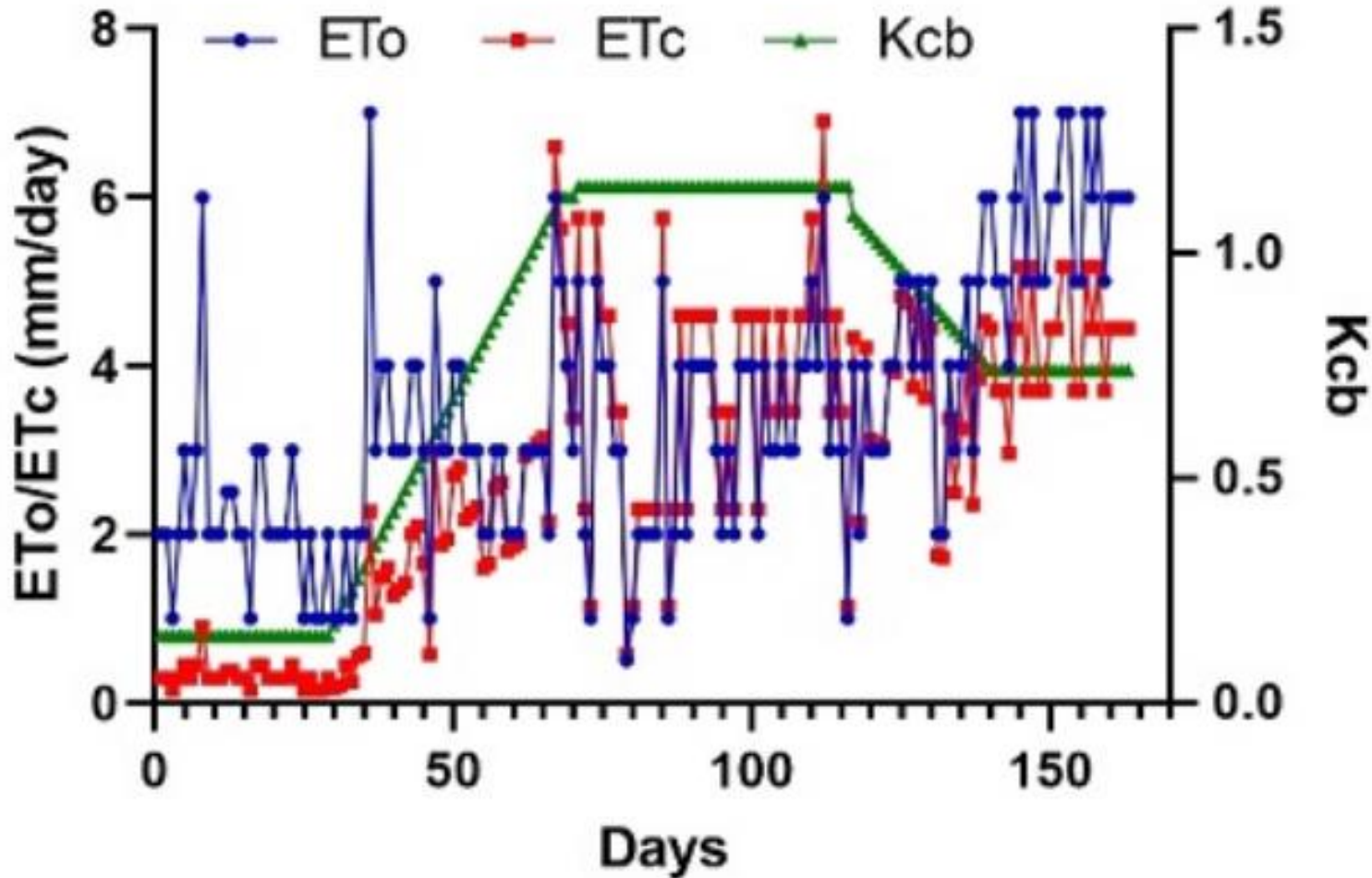
## Measurement and estimation of ETo by ETgage atmometers





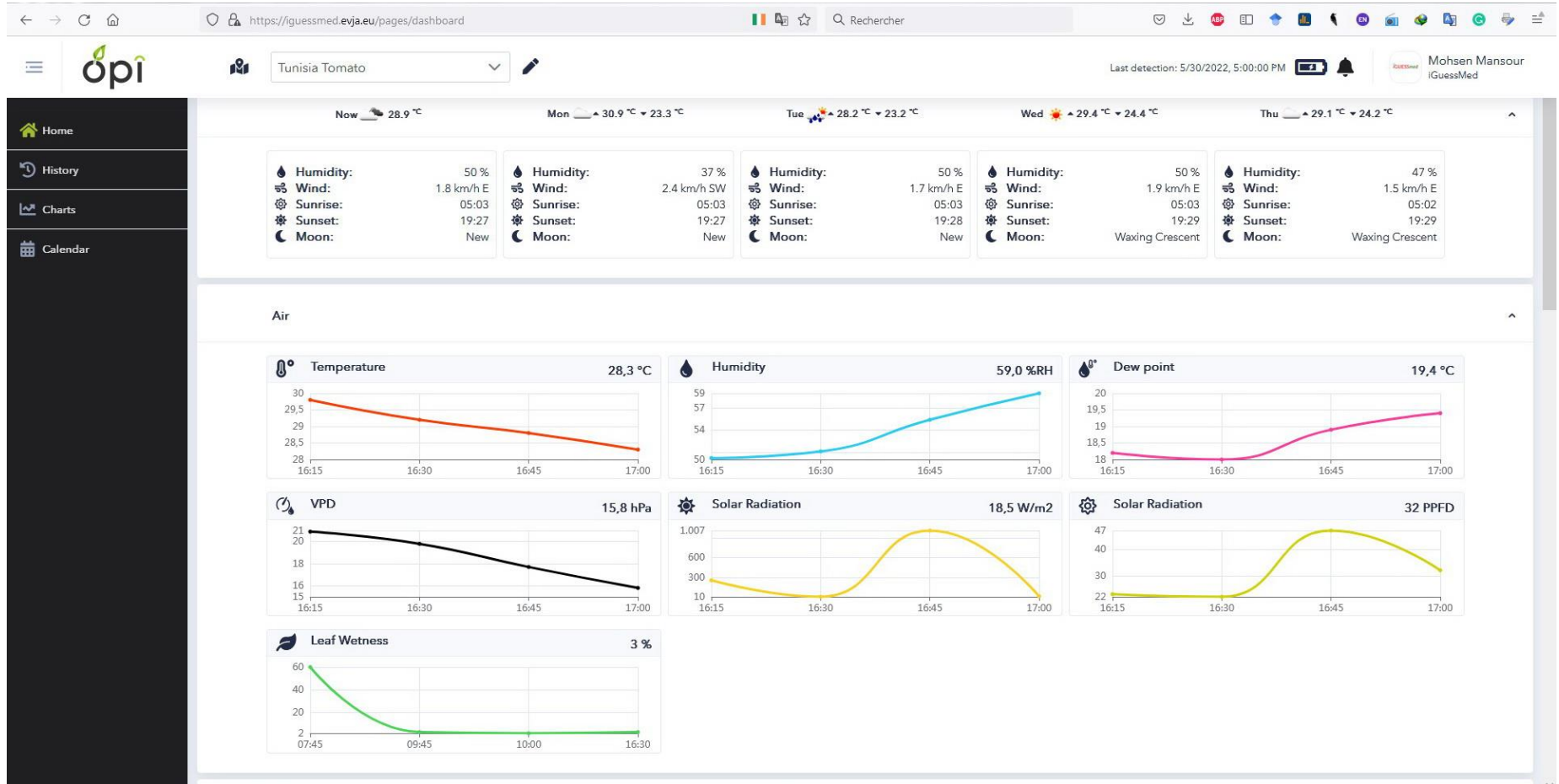
## Measurement and estimation of ETo and ETc by Drainage lysimeters







## Interface de la plateforme OPI





شكرا على حضوركم معنا

