SUBSURFACE DRIP IRRIGATION MODELING UNDER OASES CONDITIONS

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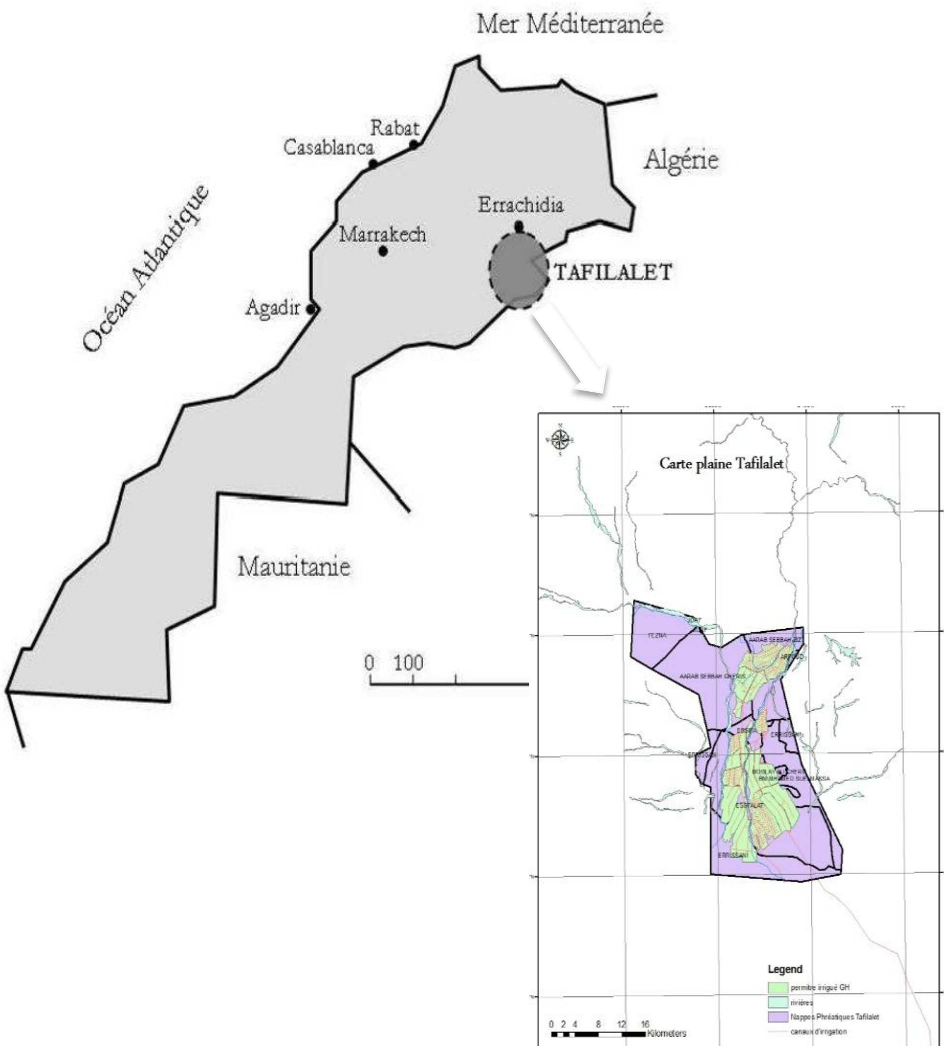
Tafilalet Oasis presentation



- South eastern of Morocco; Pre-Saharan region
- SAU 21300 ha ; 98% Irrigated
- Saharan Climat with high continental influence
- Pluviometry 86 mm/year,
- Evapotranspiration 2500mm/year; 1200mm/year inside palm groves,
- Border Irrigation
- Inter-cropping System

Problematic

Constraints

High Evaporation

Low Rainfall

Limited surface water resources

Groundwater Degradation

Extension of cultivated areas

Less Labors (Immigration)

rainfall regime and water resources could not satisfy crops water requirements

Using innovative technology, i.e. subsurface drip irrigation SDI: application of water directly to the root zone (ASAE Std. 1999)

objectives

As in many parts of the world, the interaction of climate, soils, and crop production presents unique combinations that require local research to fine-tune the production systems.

- Assessment of how the variation of the installation depth of SDI system surrounding date palm can affect soil moisture distribution
- Suitability of using an axisymmetric two-dimensional geometry.
- Better understanding of soil water distribution in subsurface drip system for young date palm in oases areas where an appropriate design and irrigation management of this system has to be proposed to farmers.

Methodological approach

Understand the hydraulic transfer of subsurface drip in dry conditions

Modelisation

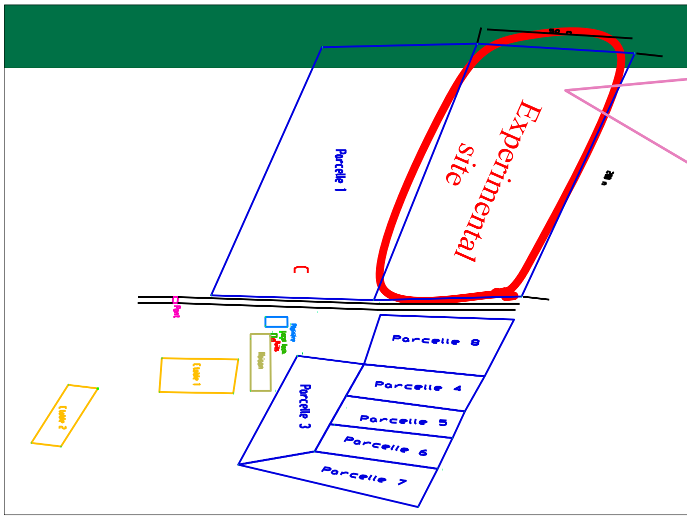
Database & Calibration

Experimentation

modeling the water flow in a variably saturated conditions (Hydrus-2D)

Evaluate the SDI performance in real conditions

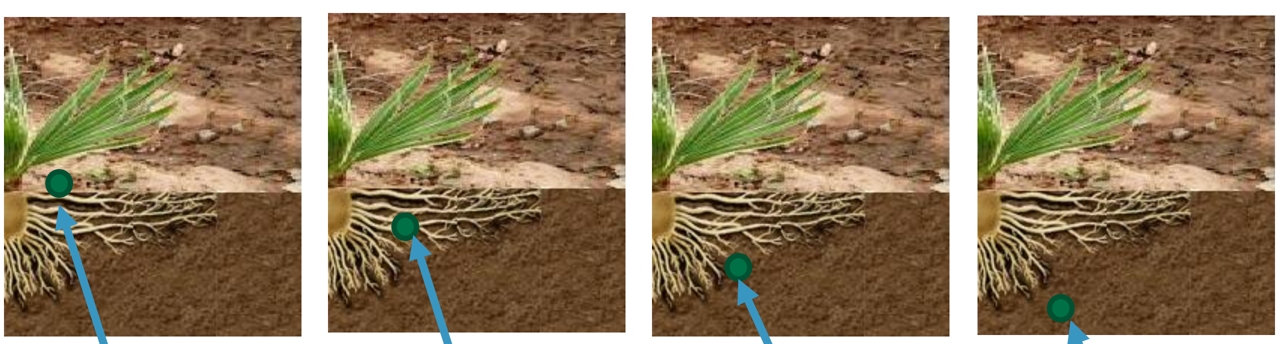
Conduct of experiment



- Field location 31°22'38"N 4°17'7"W
- 2 Plots: 1ha
- Soil: silty, BD= 1.17 g/cm^3 ,
- k= 0.05 cm/h

Irrigation water :

- ✓Well : Flow rate = 5 l/s
- ✓Salt water (CE(mS/cm)=8),
- ✓Flood water of Gheris river



Pipe at 0cm

Pipe at 15cm

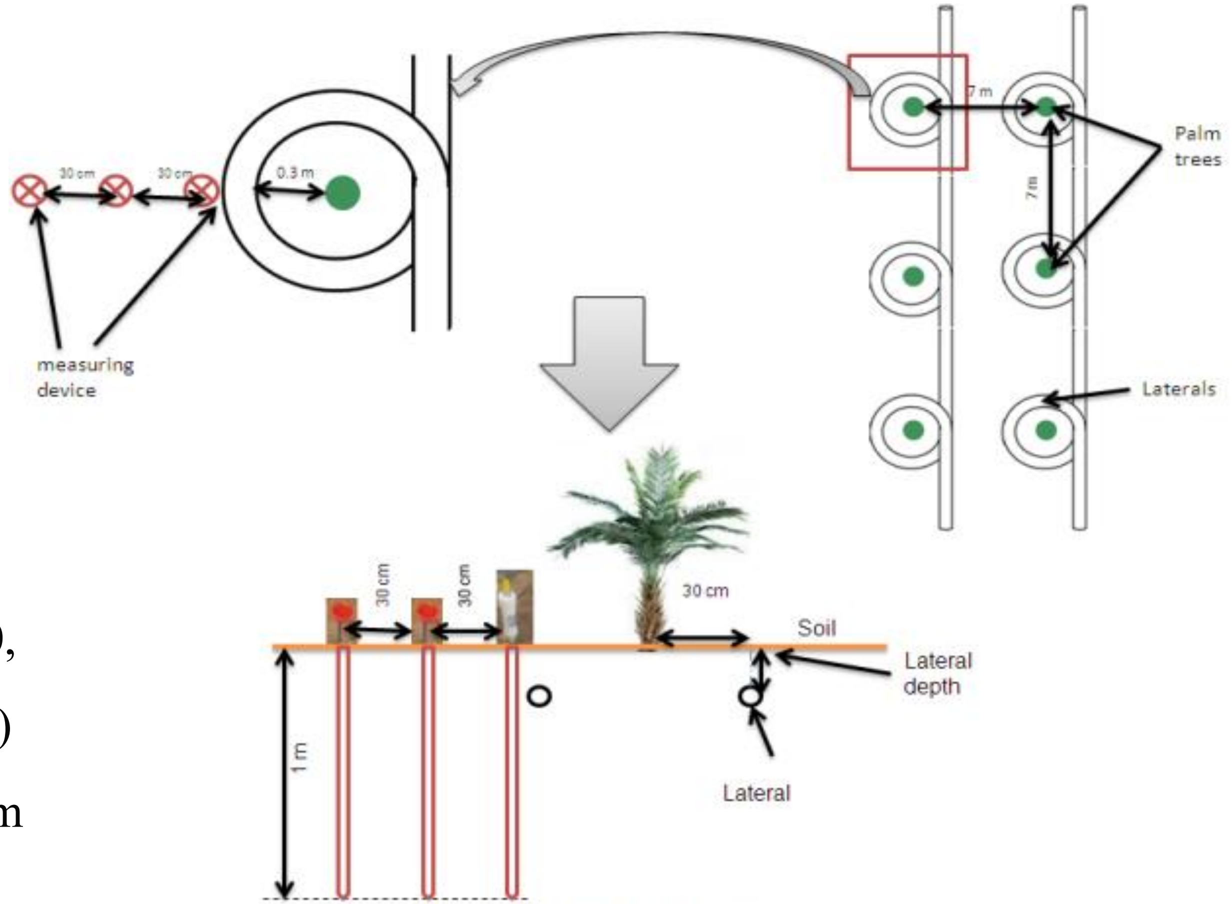
Pipe at 25cm

Pipe at 35cm

- Emitter discharge 2 l/h
- Pressure1 bar
- Spacing between drippers: 0.4 m

SDI Installation Scheme

- To evaluate the soil moisture in deep and laterally, we used 3 capacitive probes
- At different depths we measure water content (10, 20, 30, 40, 60 and 100 cm)
- Spacing between date palm trees is 7m*7m



Installation scheme of Delta-T probes

Modeling Parameters

Genuchten-Mualem equation (Mualem 1976 ; van Genuchten 1980) :

$$\theta(h) = \theta_r + \frac{\theta_s - \theta_r}{(1 + |\alpha h|^n)^m} \qquad (1)$$

$$k(\theta) = k_s S^{1/2}[1 - (1 - S^{1/m})^m]^2 \qquad (2)$$

θr et θs : residual and saturated water content (m^3/m^3)
ks : saturated hydraulic conductivity (m/s)
S : effective saturation à (θ-θr)/(θs-θr)
m, n, l et α (m^{-1}) : shape parameters with m=1-1/n.

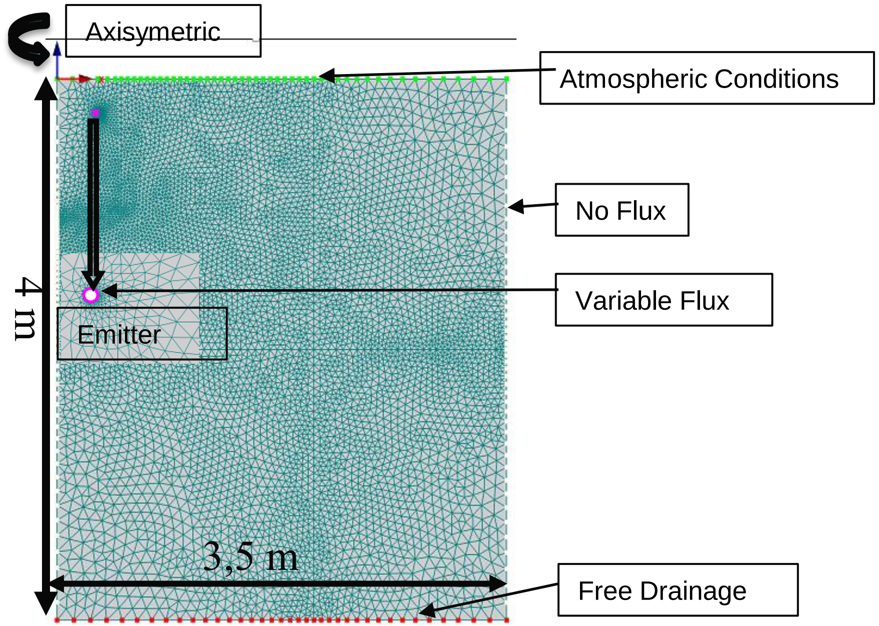
Observed soil water in the soil profile was taken as initial water content.

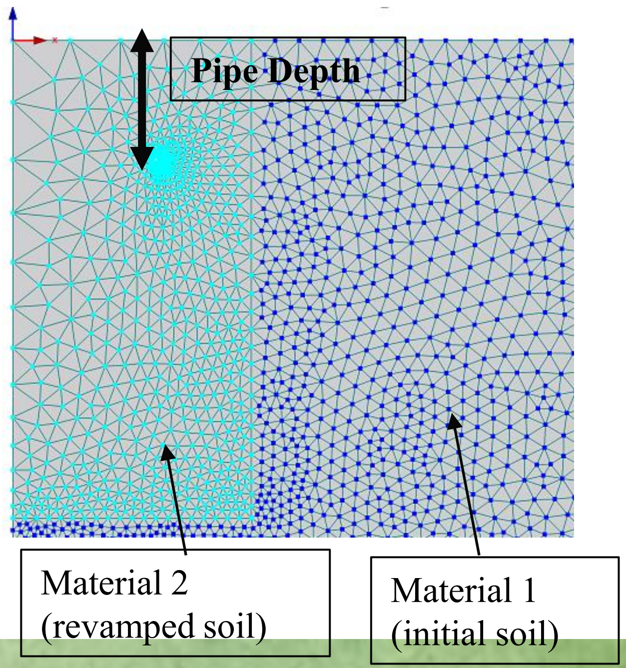
Hydraulic Parameters of van Genuchten-Mualem Model for Considered Soil obtained after calibration are :

Soil material	θr (m^3/m^3)	θs (m^3/m^3)	α (m^{-1})	n (-)	Ks (m/j)	L (-)
Mat. 1	0.0369	0.31	1,825	2,1204	0,4648	0.5
Mat. 2	0,0526	0,34	2,428	1,925	0,9589	0.5

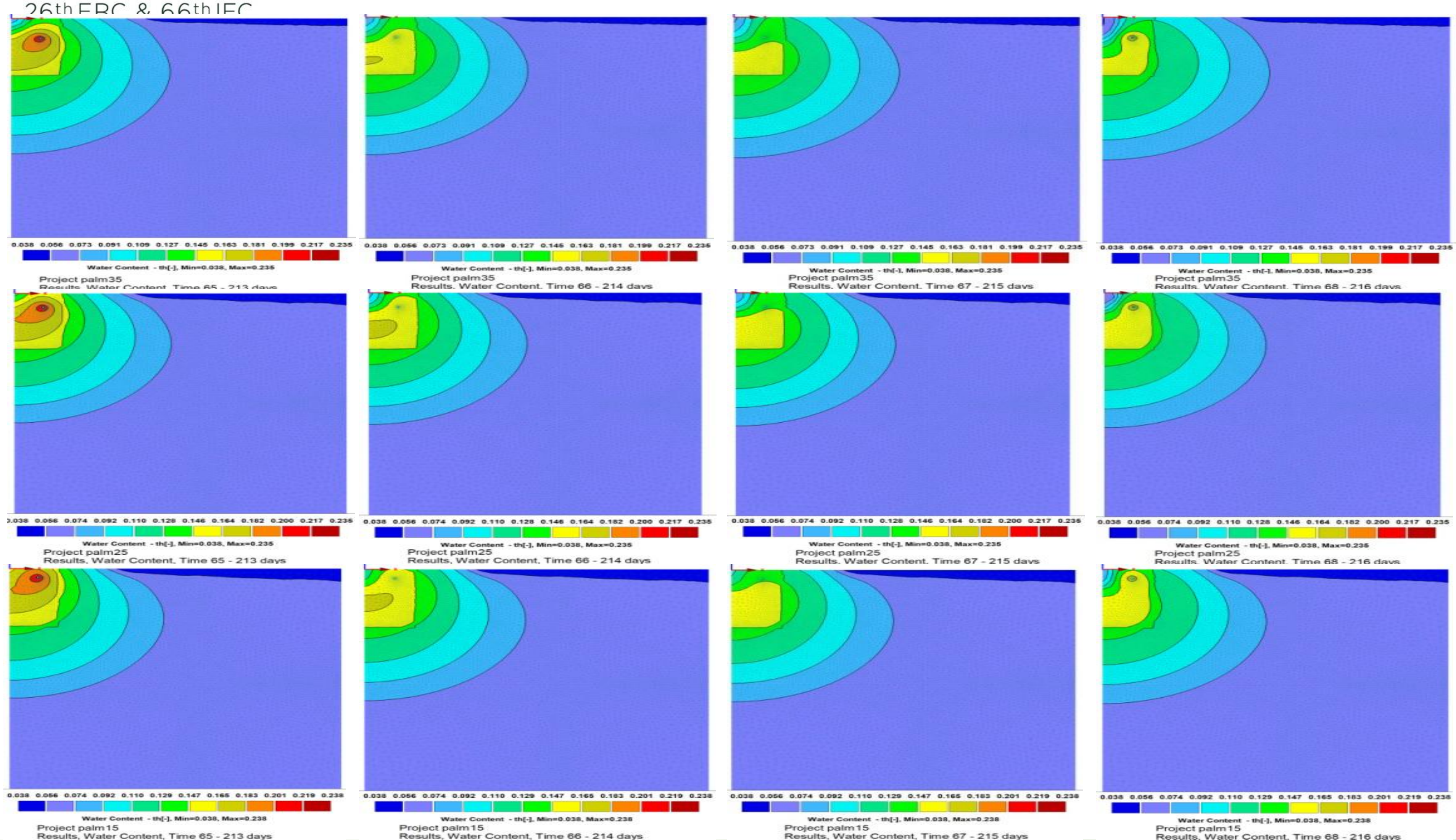
Modeling Parameters

- ✓ No-flux boundary was used on the vertical side boundaries of the soil profile because the soil–water movement will be symmetrical along these boundaries.
- ✓ Flux type boundary condition with variable volumetric application rate of dripper was considered to account the dripper discharge during irrigation.
- ✓ During no irrigation period, flux was kept as zero.
- ✓ the bottom boundary was defined by a unit vertical hydraulic gradient, simulating free drainage from a relatively deep soil profile
- ✓ The Ep (% of ETc) and Tp (% of ETc) were given as inputs in F(t) time variable boundary condition table





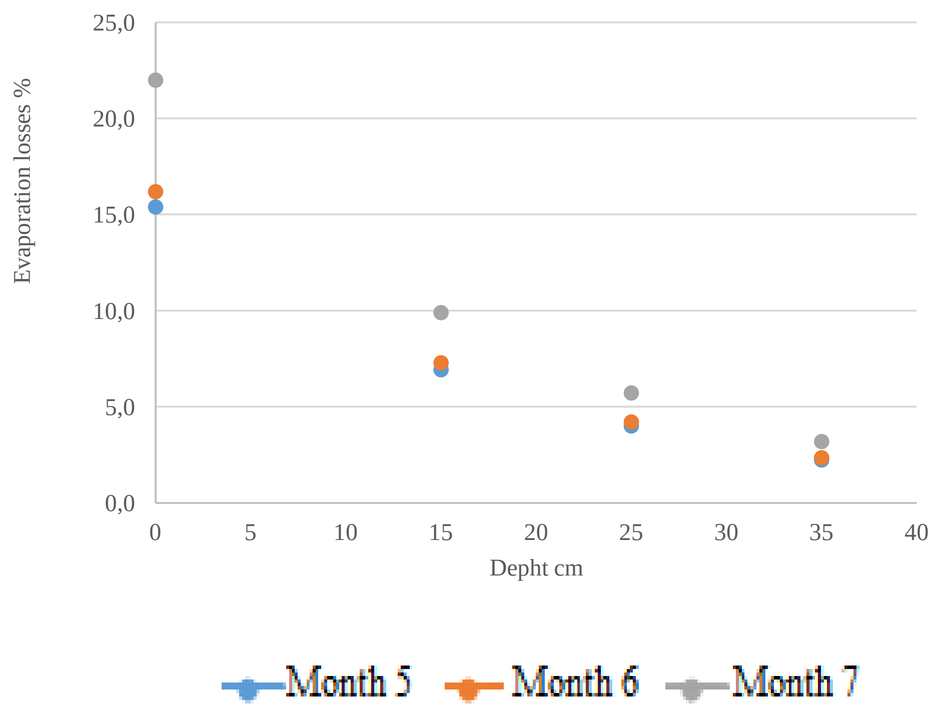
Modeling results



Modeling results

- ✓ As expected, when the depth of emitter increases then the depth (vertically downwards) of water movement increases
- ✓ Close to the surface, when the installation depth of the drip line increases, the extent of wetting (water content and wetted width) decreses
- ✓ For times equal to irrigation duration, the irrigation water never reaches the soil surface for deeper installaion (35 cm).
- ✓ The vertical spread of the water was greater than the horizontal spread du to the effect of gravity
- ✓ The temporal variation of soil moisture surrounding emitter is greater for 15 cm than for 25 and 35 cm due to the evaporation water losses.

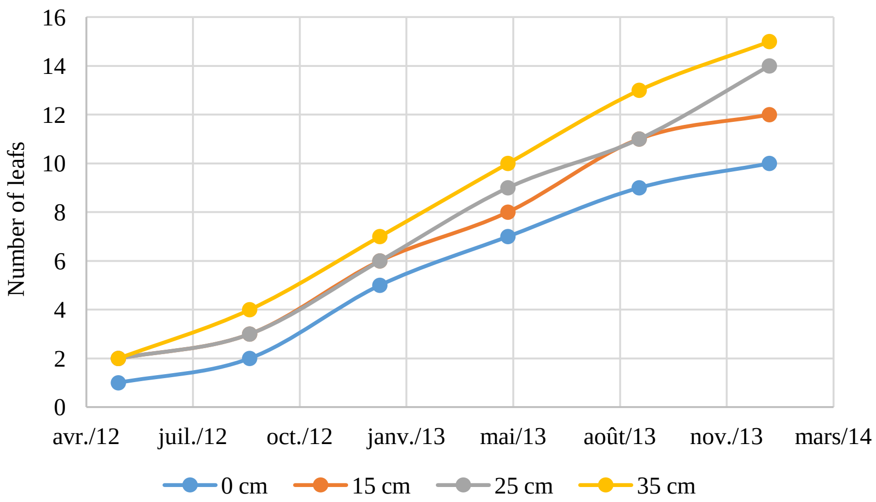
Evaporation water losses



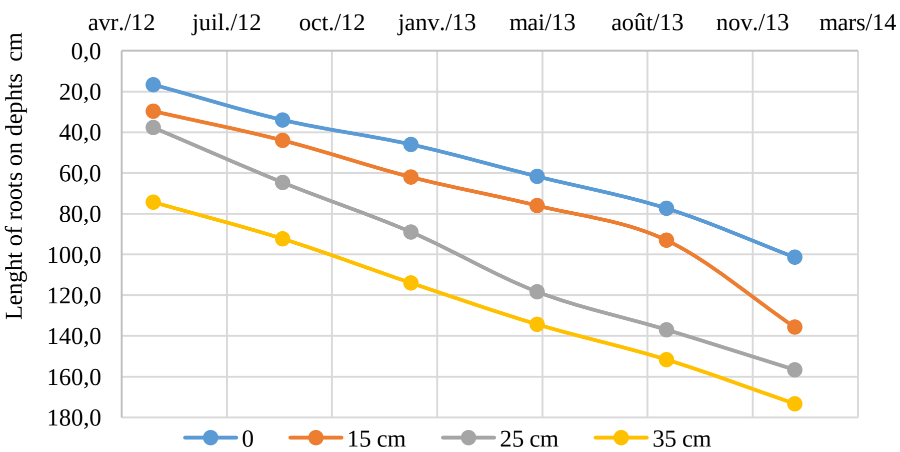
The reduction of water loss by evaporation for the buried laterals is caused by the less availability of water on the soil surface during the evaporation process.

the transmission of water in the soil is limited to the surface as long as the surface is dry; this results in smaller losses by evaporation in case of deeper water source as mentioned in modelling results

Irrigation Effect on Date Palm Growth



Effect of Buried Drippers Depth on the Number of leafs Grown Up for Young Palm Trees



Effect of Buried Drippers Depth on the Maximum Vertical Length of the Roots of Young Date Palms

- The greater the depth of buried laterals is, root development and leafs increase
- The development of roots increases more vertically downwards than horizontally downwards.
- Root growth is more developed in the first two years of study, since the plant needs more to get fixed before getting developed on the surface

Conclusion

- ✓ The comparative study, between simulation results using an axi-symmetrical two-dimensional model (Hydrus 2D) and field measurements carried out in a farmer's plot where SDI was installed at different depths, showed the suitability of the model to well simulate infiltration processes around a dripper line during irrigation.
- ✓ The results have shown that the soil moisture is relatively more steady with SDI at 35 cm depth (T3) than SDI at 15 (T1) and 25cm (T2) respectively,
- ✓ An increase in volumetric soil water content is enregistred for T3 than for T1 and T2
- ✓ Close to the surface, when the installation depth of the drip line increases, the extent of wetting (water content and wetted width) decreses
- ✓ For times equal to irrigation duration, the irrigation water never reaches the soil surface for deeper installaion (35 cm), this could be the main advantage of SDI.
- ✓ SDI promotes optimal root development and surface growth of plants and subsequently an improvement of water use efficiency


Thank you