

Adapted Soil Water Balance Model for Irrigation Scheduling in Pear Orchards 'cv. Conference'

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Content

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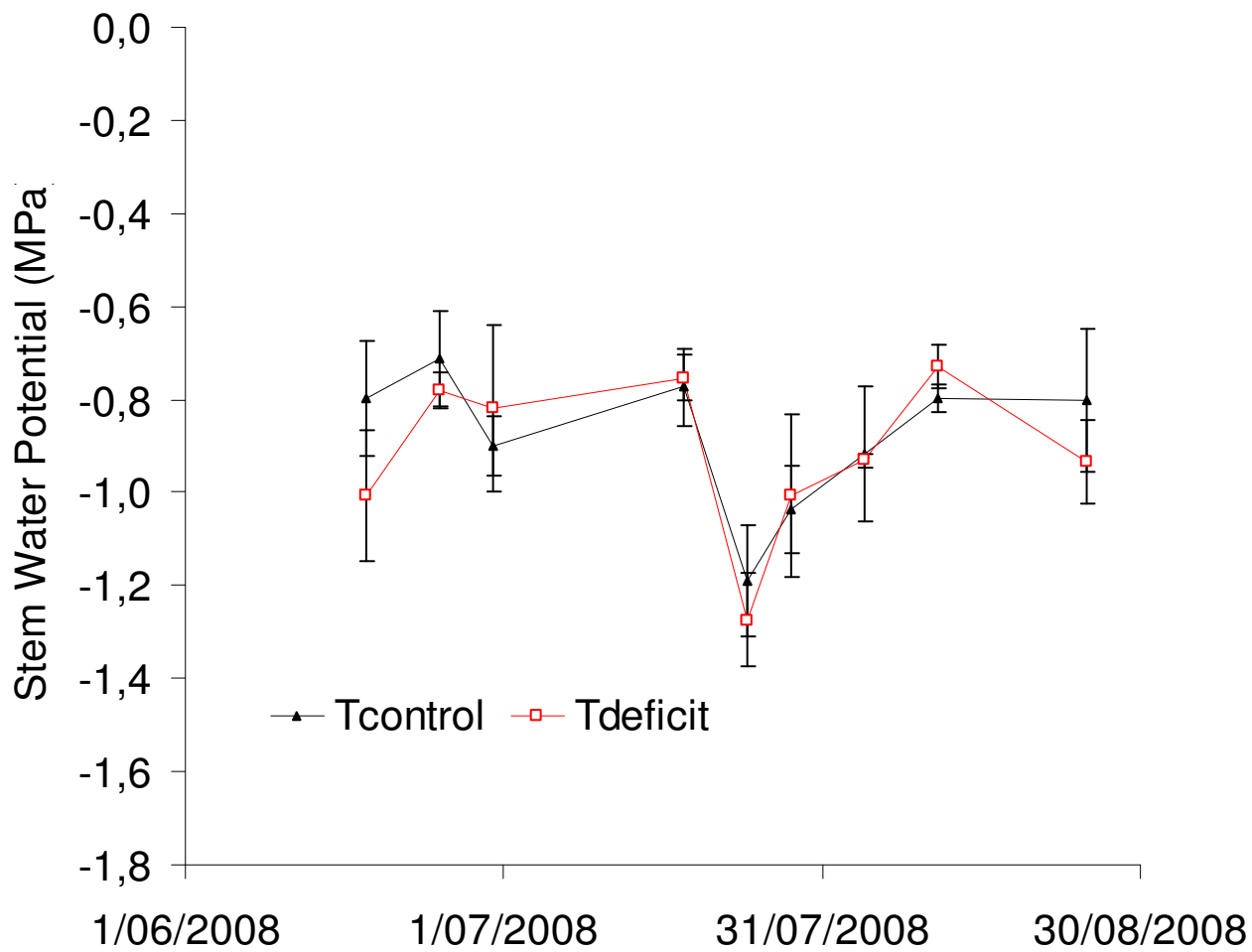
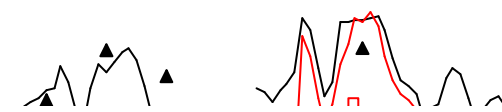
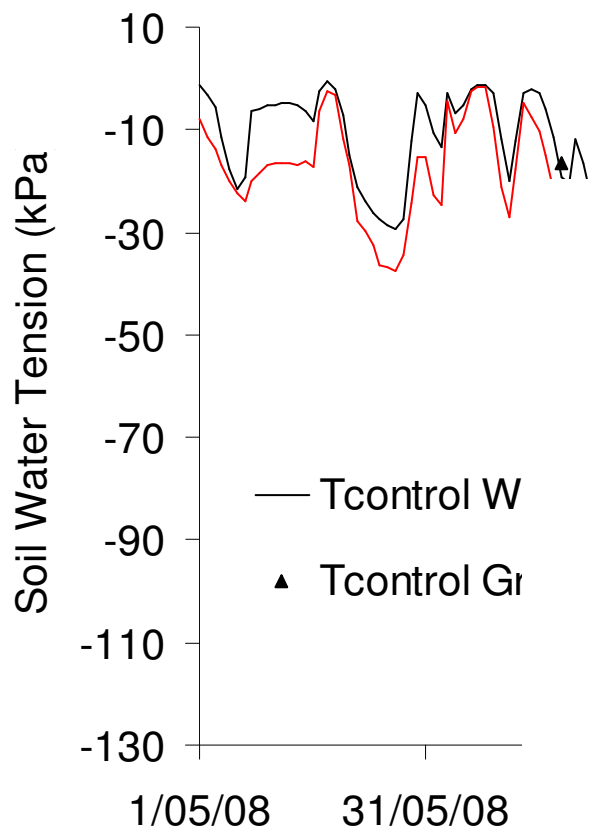
- Introduction
- Pear tree evapotranspiration
- Modelling in orchards conditions
- Model calibration
- Model performance
- Conclusion



Introduction

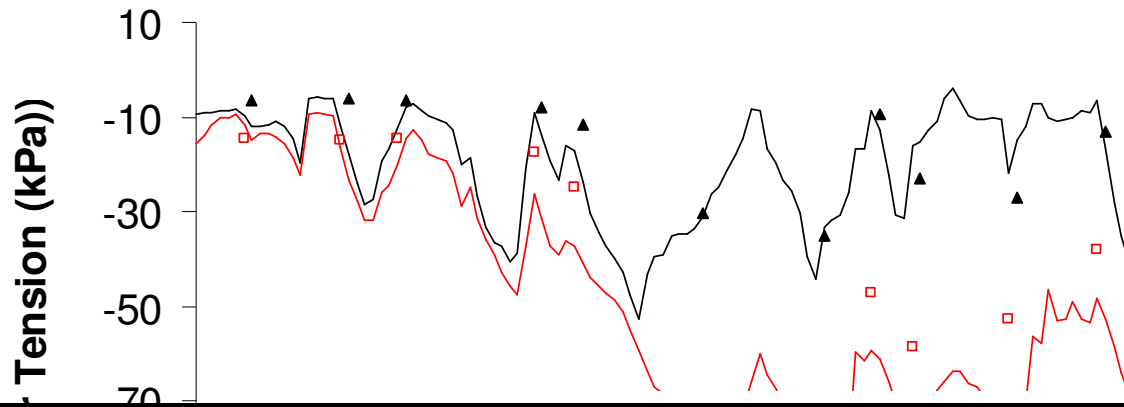
- **Pear ('Conference')**
 - Fastest growing part of horticulture in Belgium
 - 'Conference' production in Belgium
(nr 10 in the world, nr 3 in Europe)
 - Maximal financial result of high fruit sizes
(return +65 mm is twice return price +55 mm)
 - Expected production loss drought stress 10-15 %
(1000-2000 euro/ha)
- **Drip irrigation – root pruning**
- **Irrigation guidelines for pear tree in Belgium**
(silt, loam soils, temperate conditions)
 - Full irrigation during bloom, cell multiplication and fruit maturing:
Soil Water Tension > -30 kPa
 - Deficit irrigation during cell elongation:
Soil Water Tension > -80 kPa





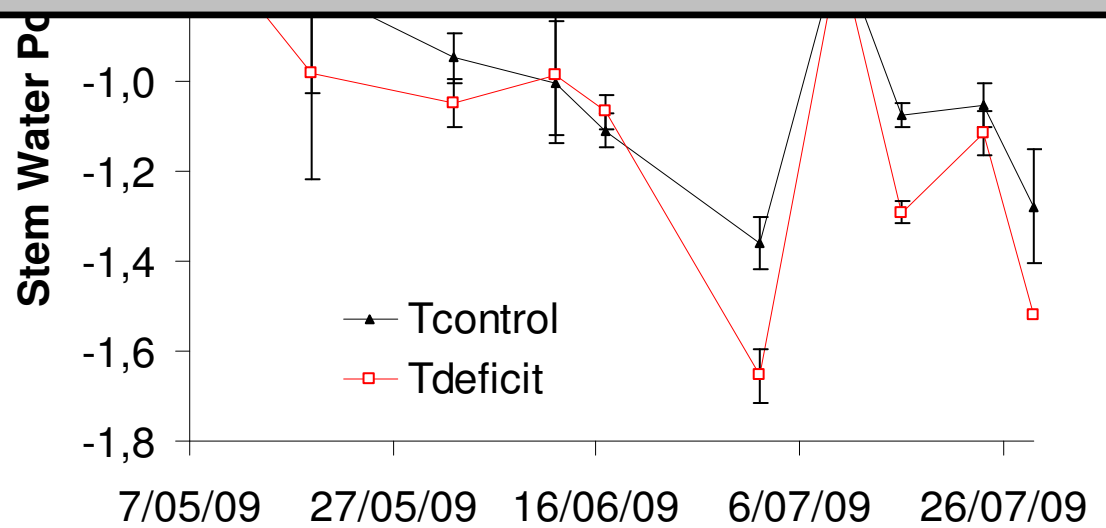
**2008, Meensel
Belgium**





		Fruit weight	Total	Yield (kg/tree)		
				<60 mm	>60 mm	>65 mm
2008	T _{control}	173	23	7	16	9
	T _{deficit}	163	22	8	14	7
2009	T _{control}	160	25	15	36 *	16 *
	T _{deficit}	174	24	39	26 *	7 *

□ control watermark
 ▲ Tcontrol Gravimetric

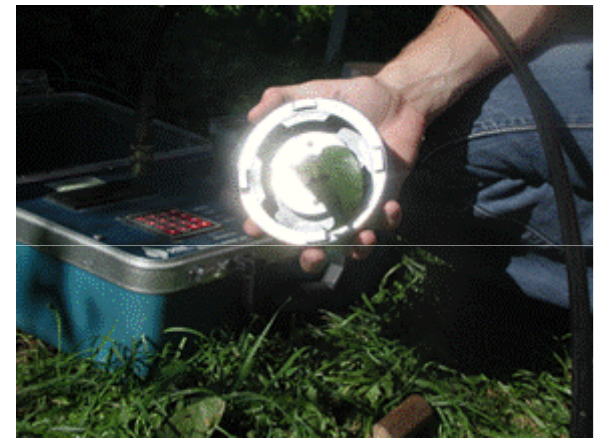


**2009, Meensel
 Belgium**



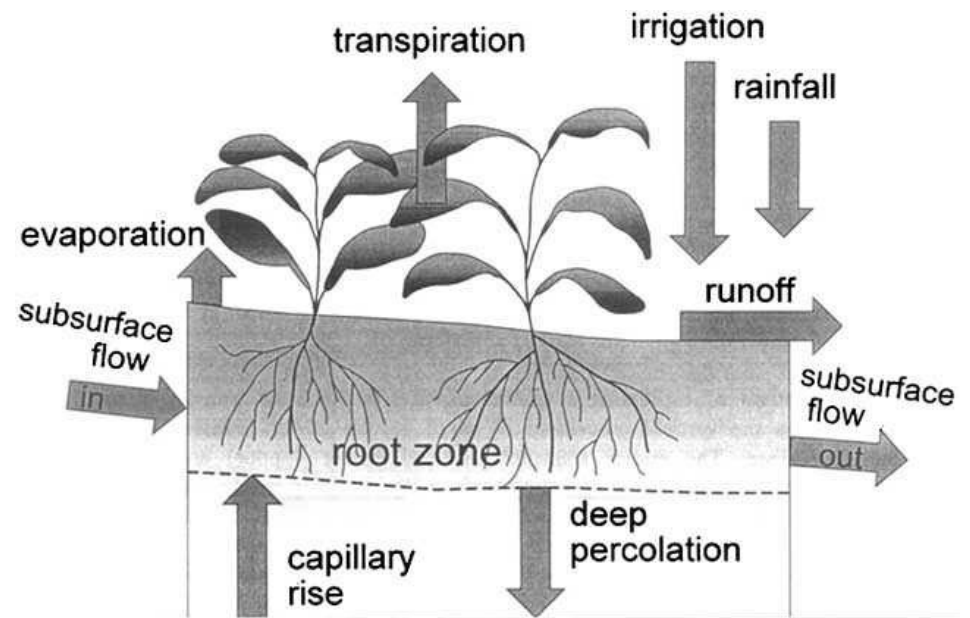
Introduction

- **Methods for Irrigation scheduling**
 - Soil moisture sensors e.g. Watermark
 - Stem water potential or pre dawn water potential
 - Mean daily trunk shrinkage
 - Soil Water Balance model
 - ...



Soil water balance model

- Components soil water balance of the root zone Input parameters:
 - Water Retention Characteristics
 - Crop evapotranspiration
 - Rain, Irrigation events



(FAO 56, 1996)

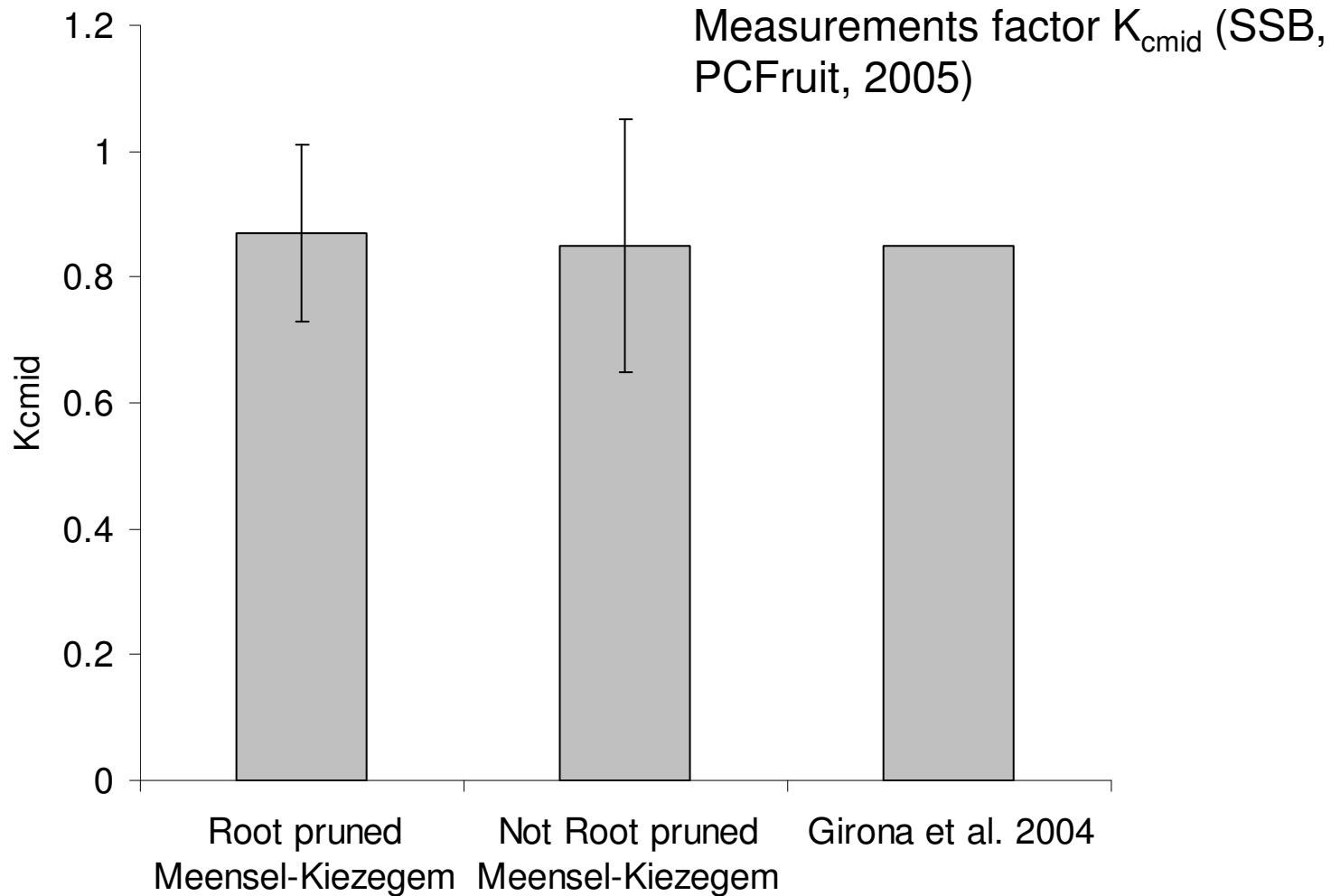


Pear tree evapotranspiration

- $ET_c = K_c * ET_0$
- Lysimeter observations northern Spain 'Conference' pear tree IRTA Kc Girona et al. (2004) $K_{c_{mid}}=0.85$, tree spacing 1.6m, 4 year old, not root pruned.
- Sap Flow measurements Thermal Dissipation Probes Meensel-Kiezegem, Belgium 2008, tree spacing 1.5m, 10 year old.

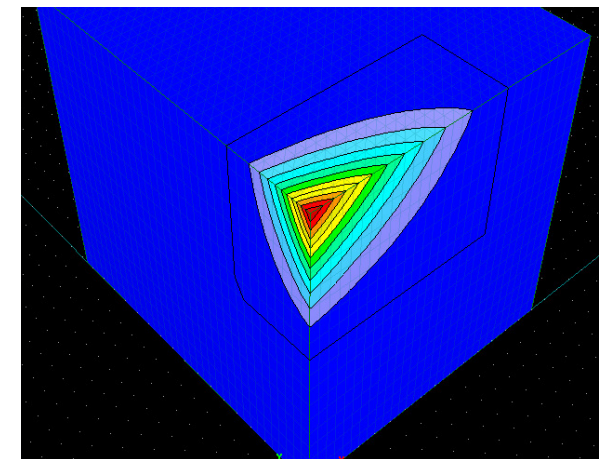


Pear tree evapotranspiration



Modelling in orchard conditions

- Grass strip
- Weed free strip below tree
- Root pruning
- Drip Irrigation
 - > Interaction between grass strip and root zone
 - > Heterogeneous water distribution in root zone
 - > Can be simulated with macroscopic 2D/3D models (ex HYDRUS) but a lot of input parameters.

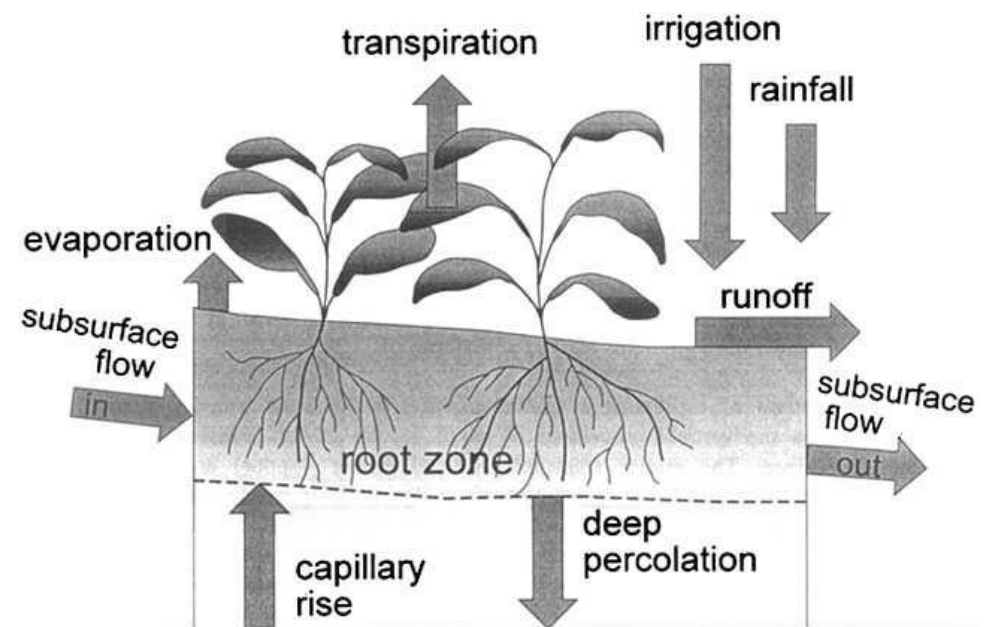


Modelling in orchard conditions

Soil Water Balance Model cover crop

$$D_i = D_{i-1} + CR - DP + R + I - ET$$

- D_i : Root zone depletion day i
- CR: Capillary Rise
- R: Rain
- I: Irrigation
- DP: Deep percolation
- ETm: Tree evapotranspiration



Modelling in orchard conditions

Soil Water Balance Model pear orchard

$$D_i = D_{i-1} + \alpha * CR - \alpha * DP + \alpha * R + I - ET$$

α = Water uptake surface tree roots / total surface

- Influenced by: soil characteristics, management practices (root pruning, ...), Tree properties, ...
- Difficult to measure
- Calibration by gravimetric moisture determination



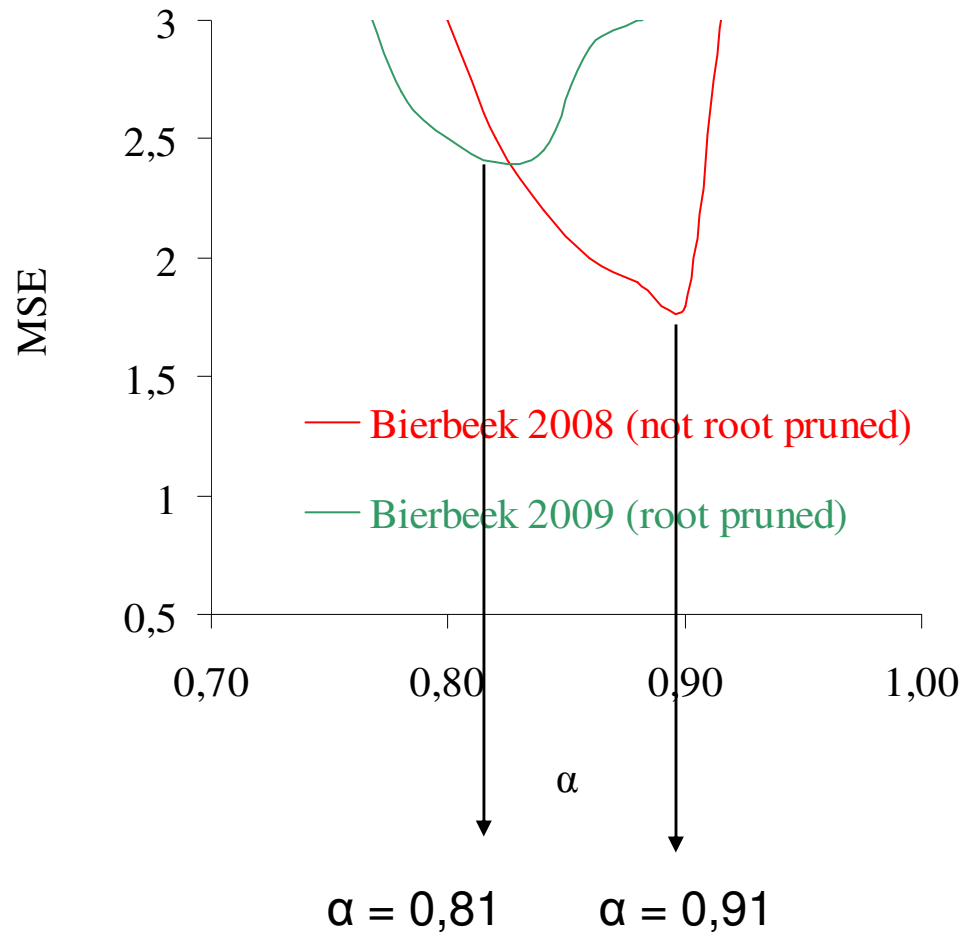
Model calibration

Example:

- Orchard situated in Bierbeek, Belgium.
- Trained in V-system, plant year 2000
- 'Conference pear.
- 2008 not root pruned
- **2009 root pruned.**
- Soil Water Balance model in combination gravimetric moisture measurements



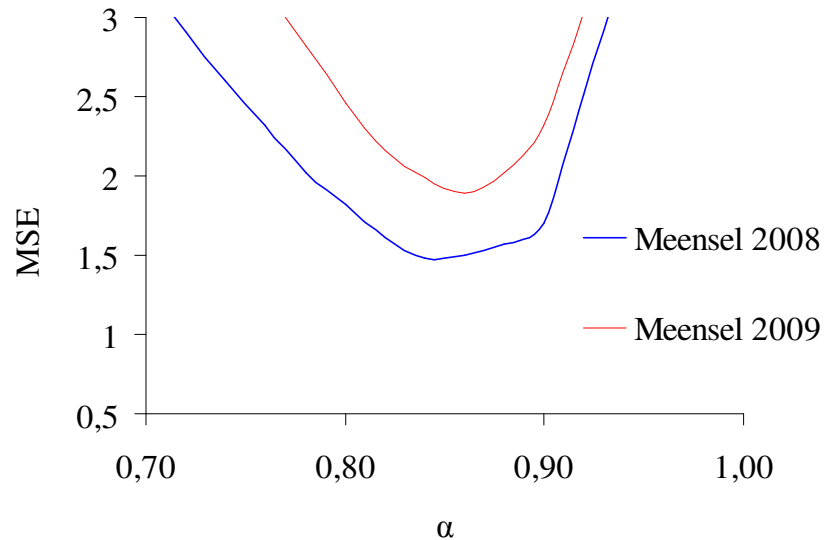
Model calibration



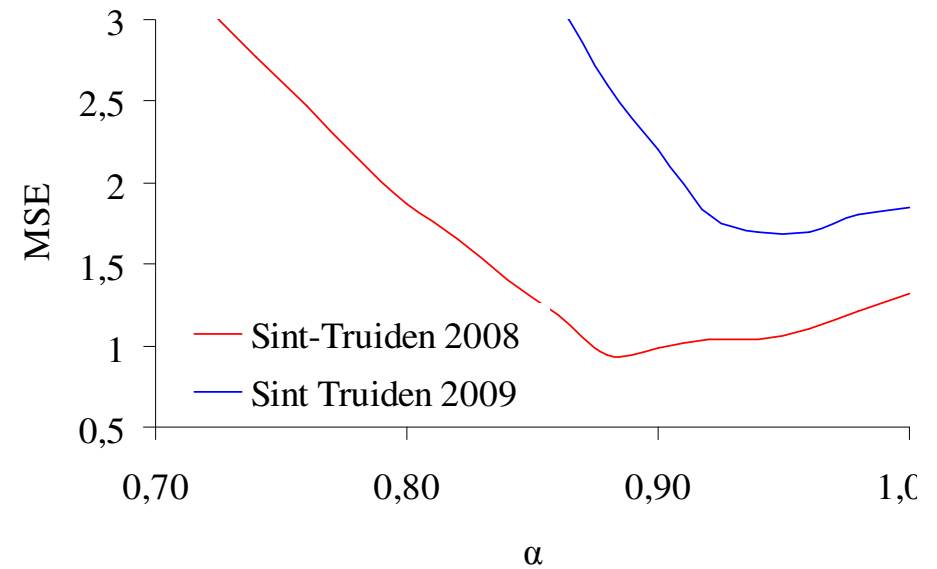
**Mean Square Error (MSE):
Measurement vol. water% 0-60 cm
vs prediction.**



Model calibration



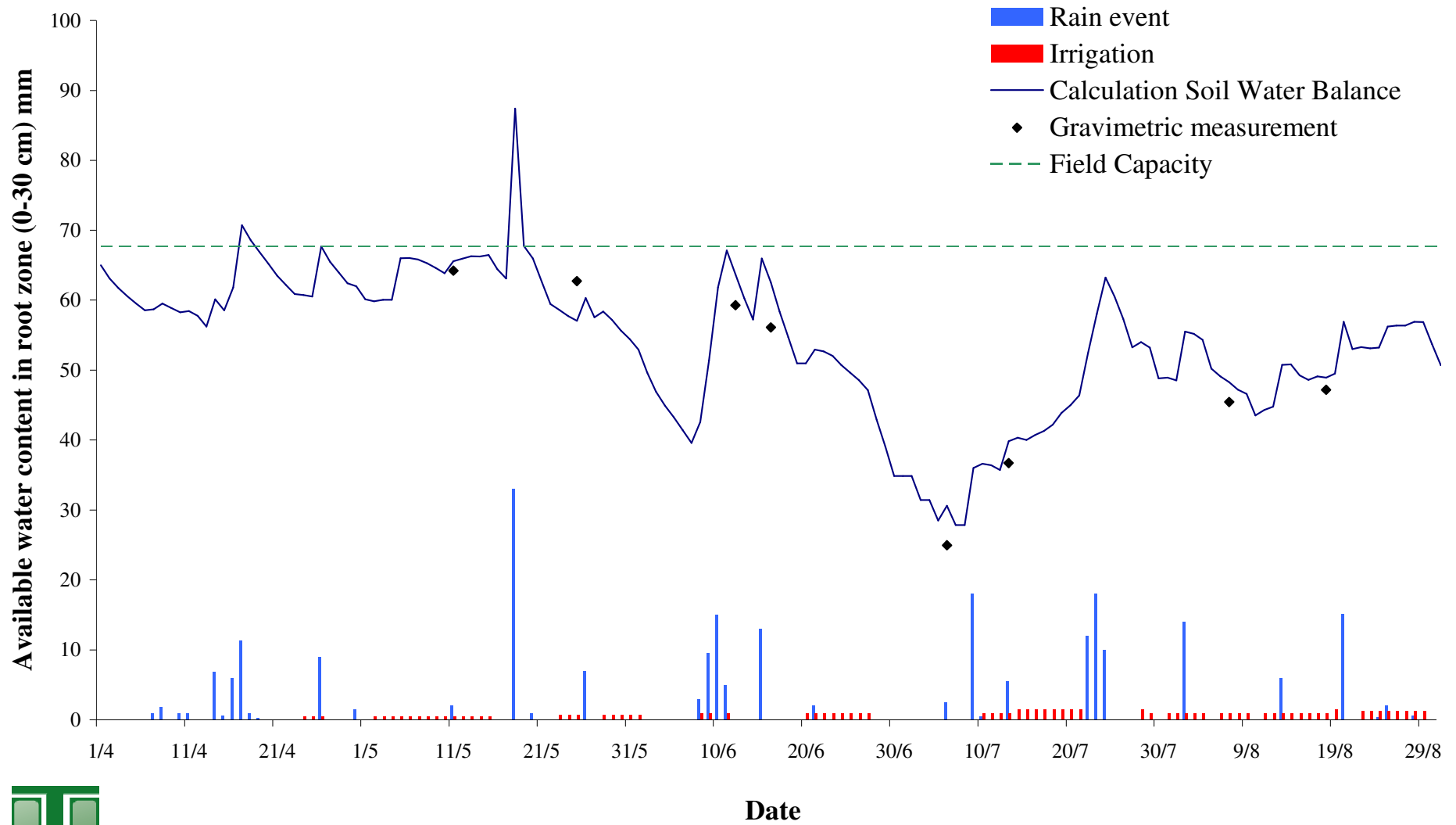
Meensel: Yearly Root pruned



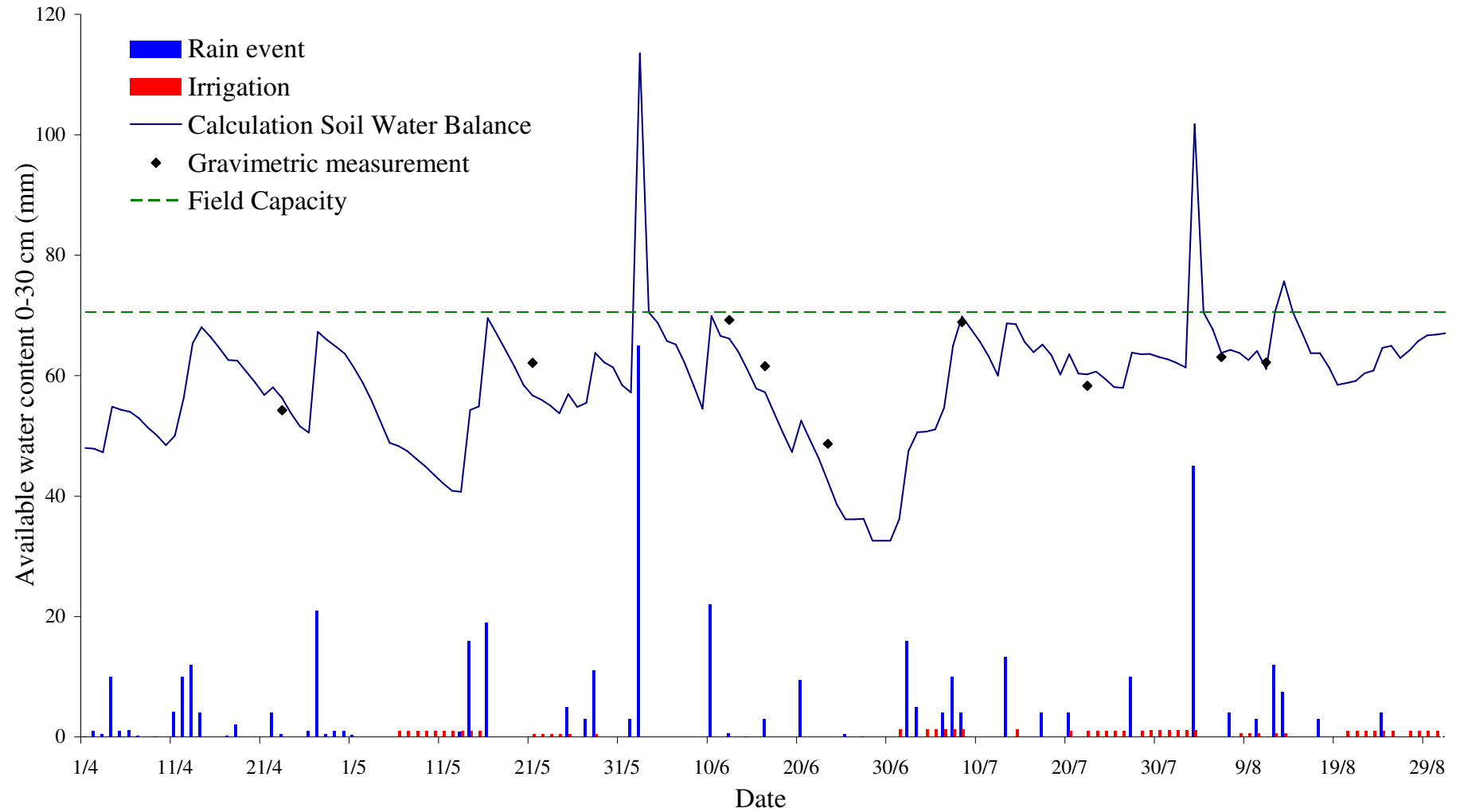
Sint-Truiden: Never Root pruned



2009

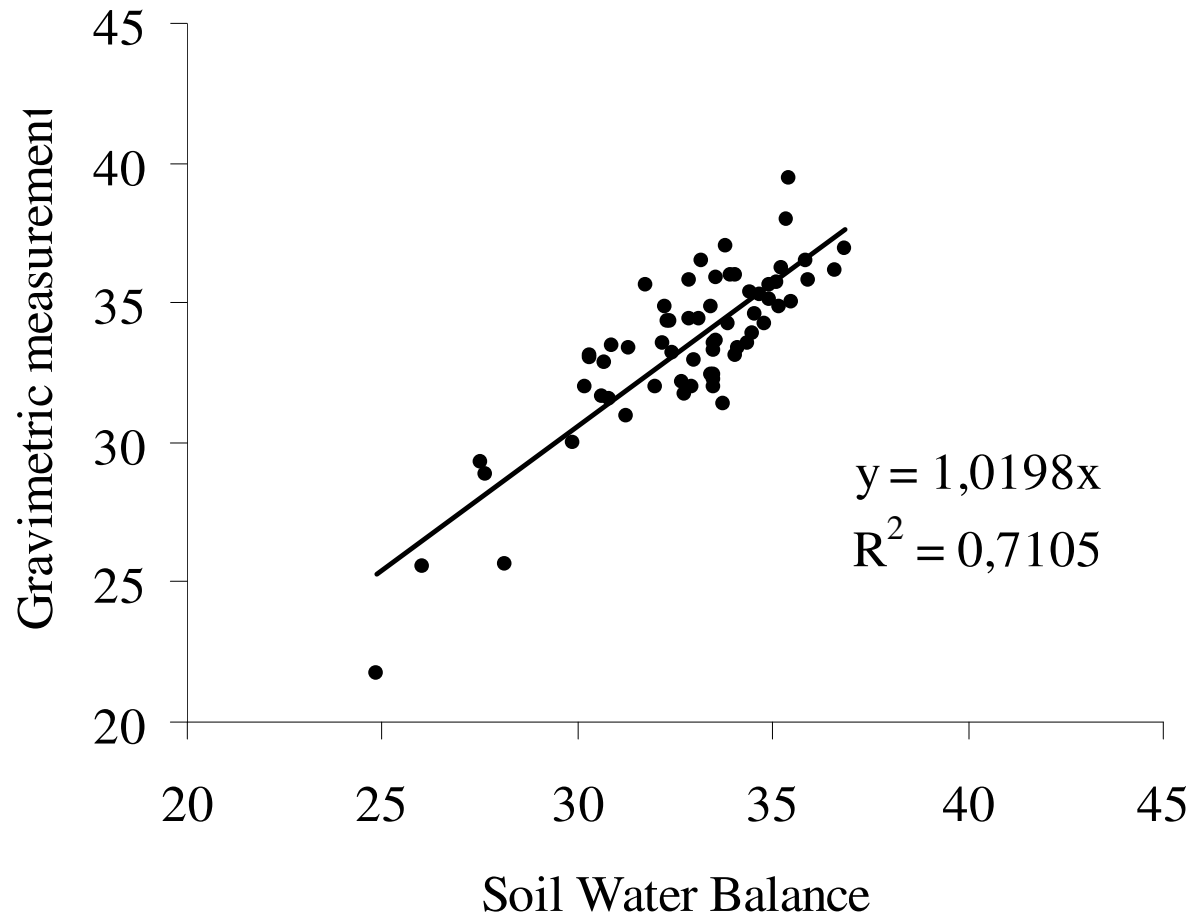


2008

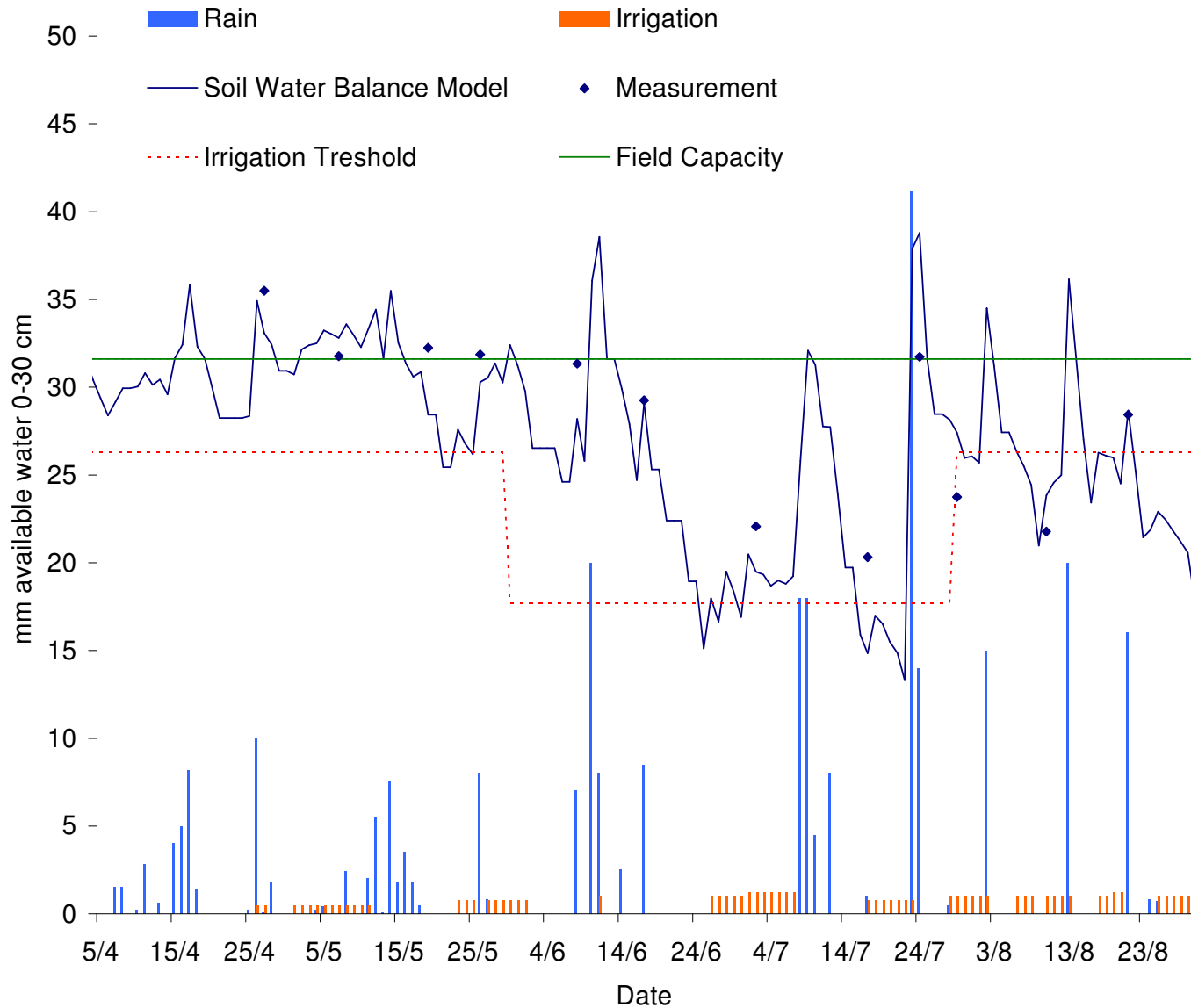


Model performance

Monitoring 3 orchards (Bierbeek, Meensel-Kiezezem, Sint-Truiden) during 2008, 2009 vol water content (0-60 cm)



Conclusion



Soil Water Balance Model + calibration gravimetric measurements:

Accurate way to monitor soil water evolution and valuable for irrigation scheduling in combination with evapotranspiration forecast.

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