SALTMED 2013 model application using greenhouse experiment data from Turkey

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ABSTRACT

The present study investigates the application SALTMED model in predication of dry matter, yield, soil moisture and soil salinity level of greenhouse pepper (Capsicum annuum) experiment from Antalya, Turkey. In the greenhouse experimental study, the effects of different irrigation regime with salinity treatments using drip irrigation system were investigated. Irrigation regimes consisted of four irrigation treatments with four salinity levels. SALTMED model was calibrated using soil moisture data of the control experiment. After the calibration, the model was validated using the other experimental treatments. Results show the ability of the model to reproduce the measured soil moisture at three soil layers 0-20 cm, 20-40 cm and 40-60 cm. The simulated results are also seen to capture the salinity level during irrigation in these soil layers. Preliminary results of total dry matter and yield are showing good agreement.

INTRODUCTION

In many areas in world, farmers encounter soil salinity due to saline ground water or irrigation with available local saline water. In such areas drip irrigation has advantages over irrigation systems such as sprinkle or furrow because it only wets area around emitters which mostly leach out salts and has no foliar damage due to salts during irrigation. It also possible maintains a relative high soil moisture and low soil salinity level over time with the frequent drip irrigation where emitters are placed reasonably well within the plant rows (Malash *et al*. 2008).

Pepper (*Capsicum annuum*) is a high value crop cultivated in warm countries. It is one of the major vegetable crops produced in Turkey. Antalya, located in the Mediterranean coast of Turkey, is the main location for pepper production in greenhouses (Sevik, 2011). It is an important part of the economy on which pepper production depends almost entirely on water management. In the Mediterranean coast, vegetable crops are often irrigated with available saline water which can cause damage to the plant and soil and reduction to the yield. Drip irrigation can be an appropriate water management system in greenhouses in the Mediterranean coast.

The main objective of this study is to calibrate and validate the SALTMED model using greenhouse pepper experiments at Antalya, Turkey which were subjected to four irrigation treatments with four salinity levels.

EXPERIMENTS

The greenhouse experiments were performed in Antalya, Turkey. The pepper was cultivated with four irrigation treatments (different ratios of class A Pan evaporation rate, Ekpc) with four salinity levels as listed Table 1. A drip irrigation system was utilised with discharge of 2 l/hr. The greenhouse layout is show in Figure 1. Plant parameters - crop height, root depth, leaf area index and yield - were measured for each growth stage. The Class A Pan Evaporation was used for measurement of water evaporation within greenhouse. Climate parameters – maximum temperature, minimum temperature, sunshine hours, relative humidity and net radiation - were measured within greenhouse. The irrigation duration, the salinity level and the amount of nitrogen applied were recorded. Soil parameters – saturated moisture content, field capacity and wilting point - were measured for greenhouse soil which has been classified as a sandy clay loam.

	Irrigation treatments (Ekpc)			
dS/m	**0.5**	**0.75**	**1.00**	**1.25**
1.0	Experiment 1	Experiment 2	Experiment 3	Experiment 4
2.5	Experiment 5	Experiment 6	Experiment 7	Experiment 8
3.5	Experiment 9	Experiment 10	Experiment 11	Experiment 12
6.0	Experiment 13	Experiment 14	Experiment 15	Experiment 16

Table 1 Irrigation and salinity treatments

Figure 1 The greenhouse layout

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SALTMED MODEL

SALTMED model is a physically based model using the well-known water and solute transport, evapotranspiration and water uptake equations. It was developed to predict dry matter and yield, soil salinity and soil moisture profiles, salinity leaching requirements and soil nitrogen dynamics and nitrate leaching, soil temperature, water uptake, evapotranspiration (Ragab, 2002, 2010).

RESULTS AND DISCUSSION

The model calibration was carried out first using plant and soil measured parameters along with crop coefficients Kc and Kcb values from FAO56 for experiment 1. Soil parameters such as saturated hydraulic conductivity and pore size distribution index (lambda) were fine tuned in order to obtain a good calibration. Figure 2 shows the measured and calibrated model results for soil moisture for the three layers 0-20 cm, 20-40 cm and 40-60 cm. Figure 3 shows the correlation between the measured and calibrated model results which shows very good fit.
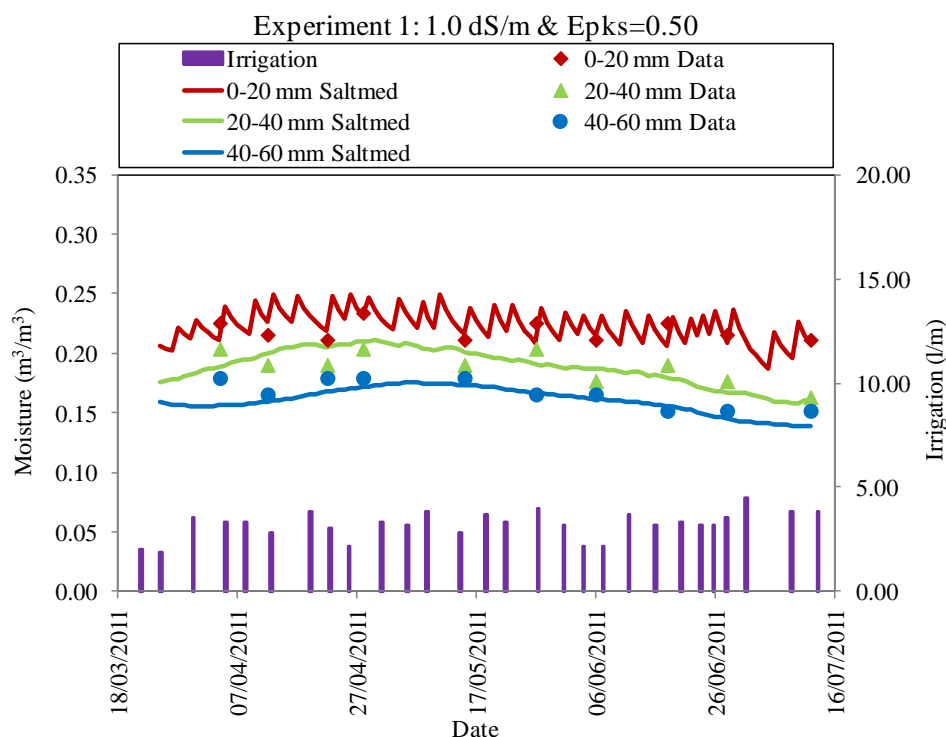

Figure 2 Measured and calibrated model results

Using measured and calibrated parameters with appropriate salinity stress parameter $\pi 50$ values, the validations were performed for other 15 experiments. Figure 4 shows the measured and predicted soil moisture for the three layers 0-20 cm, 20-40 cm and 40-60 cm for experiments 9, 10, 11 and 12. Figure 5 shows the correlation between the measured and predicted soil moisture for all 16 experiments. It can be seen from Figure 4 that the model predicts soil moisture very well in the top 0-20 cm layer and reasonably well in other two

layers 20-40 cm and 40-60 cm. Figure 5 showed a very good agreement between measured and predicted soil moisture for all 16 experiments.
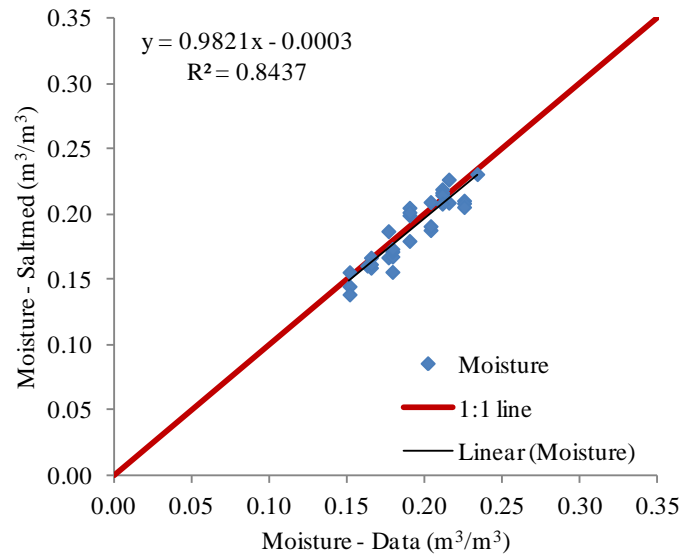

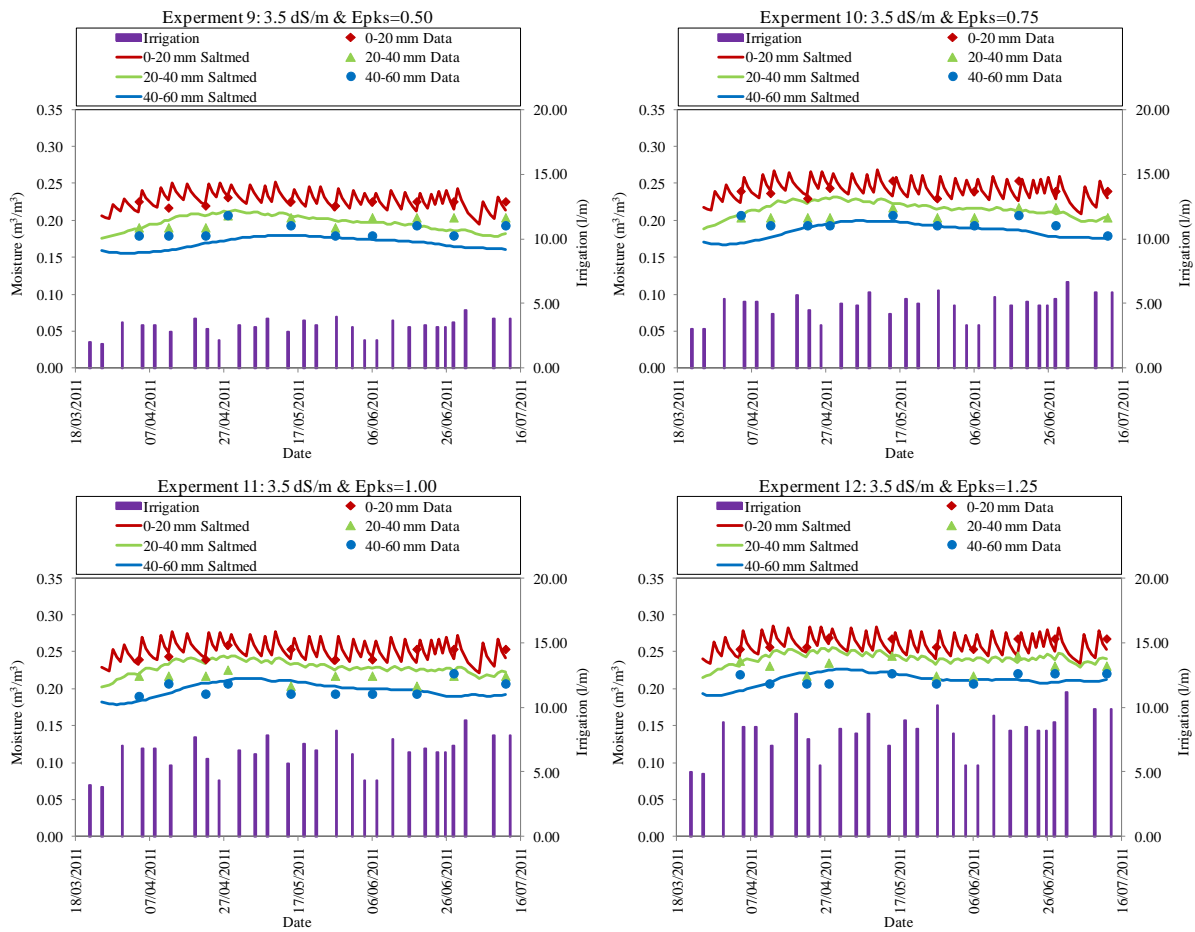**Figure 3**. Correlation between measured and calibrated model results

Figure 4. Measured and predicted soil moisture experiments 9 to 12.
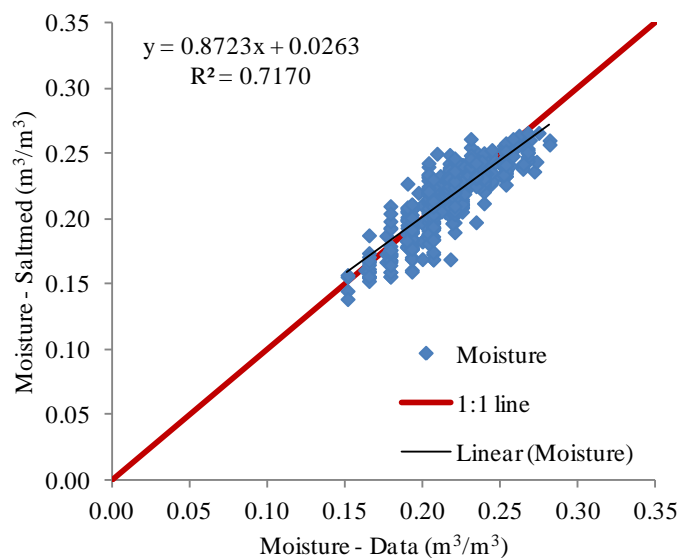
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Figure 5. Correlation between measured and predicted soil moisture for all 16 experiments
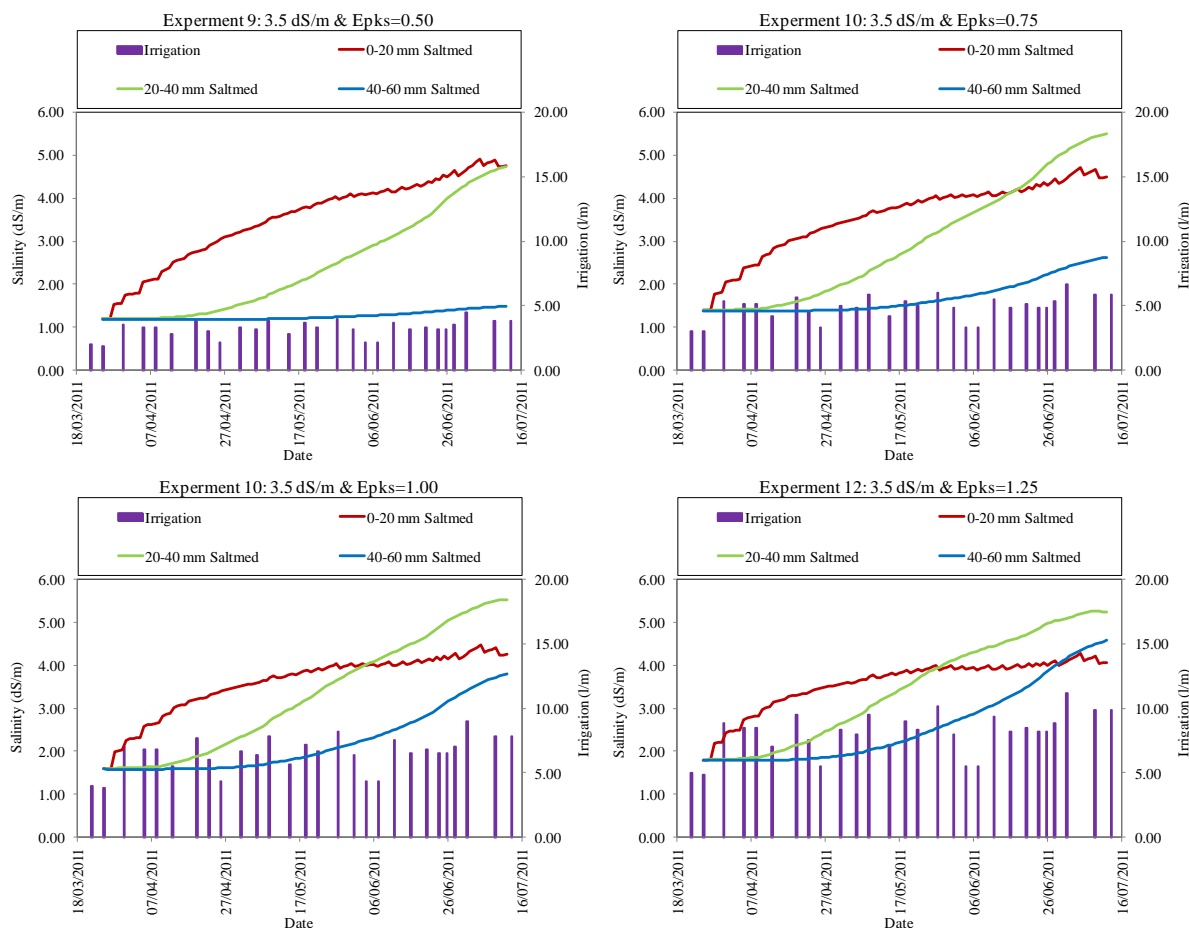

Figure 6. Predicted soil salinity for experiments 9 to 12.

Figure 6 shows the predicted soil salinity for the three layers 0-20 cm, 20-40 cm and 40-60 cm for experiments 9 to 12. It can be seen from the figure that the predicted soil salinity of the top layer 0-20 cm slightly decreases with increases in irrigation while the other two

bottom layers 20-40 cm and 40-60 cm, the soil salinity continuously increases which due to frequent irrigation which leaches the top layer salinity as expected. The rate of increase in bottom layer 40-60 cm is more than 20-40 cm layer as the amount of irrigation increases which due to increase in leaching from top layer to deeper depth where the differences between bottom two layers tend to become smaller with increases in irrigation.

Table 2 summaries the preliminary results of total dry matter and yield for first salinity treatment experiments 1 to 4. It shows that the initial results reasonably match the measured data within 5% difference. Further calibration and validation is on progress.

Experiment	Total dry matter (t/h)		Error %	Yield dry matter (t/h)		Error %
	Data	Model		Data	Model	
1	8.61	8.59	0.22	6.78	6.78	-0.07
2	8.48	8.61	-1.54	6.52	6.63	-1.73
3	8.45	8.62	-2.00	6.36	6.46	-1.57
4	8.23	8.61	-4.64	5.95	6.20	-4.19

Table 2 Dry matter

CONCLUSION

In this study, the SALTMED model is calibrated and applied to greenhouse pepper experiments at Antalya, Turkey. The results show that the model is capable to reproduce the measured soil moisture for different irrigation regime with salinity levels using drip irrigation system. The model predictions are also seen to capture the salinity level during irrigation. The initial results of total dry matter and yield for first salinity treatment reasonably match the measured data.

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