Comparison of models that include salinity and matric stress effects on plant growth

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Abstract
Steady-state models provide the means to evaluate potential effects of the amount of applied water and its salinity on crop yields. These models have been in use since about 1950. Because of the inherent limitations of steady-state models, transient-state models have been under development by several research groups since about 1980. The objective of this research was to determine how the models handle matric and osmotic stress effects on relative crop ET and consequently relative crop yield.

In transient-state models, crop water use and crop yields account for the continually changing soil salinity (osmotic potential) and soil water contents (matric potential) that occur throughout the rootzone resulting from changes in irrigation water salinity, amounts of applied water, rainfall, and climate. Under conditions where crop water use is not limited by either matric or osmotic potentials or hypoxic conditions, these models assume that relative crop ET, and relative yields for forage crops, increase linearly with increasing amounts of crop water use in the range from zero to maximum potential ET. The models account for changes in this linearity if either matric or osmotic potential exceeds threshold levels.

Key Words
Salinity, modeling, relative yield, matric stress, osmotic stress

Introduction
The majority of the transient-state models evaluated in this research use Richards and the convection-dispersion equations to simulate water and salt transport (ENVIRO-GRO, SALTMED, UNSATCHM, SWAP); while others use variations of what is commonly called the 'tipping bucket' to account for water movement into and through the rootzone (SWAGMAN/WALKABOUT). One allows for preferential water flow through the rootzone (TETrans). Root and water uptake distributions in the root-zone and crop coefficients may be dependant on the stress levels within the rootzone (ENVIRO-GRO, WALKABOUT), and the effects of matric and osmotic stresses on crop water uptake can be additive or multiplicative.

Methods
For the purpose of model simulation and comparison, the same set of crop and soil data were used as inputs for the models. These were: forage corn (ECe threshold = 1.8 dS/m and slope = 7.4 %/(dS/m); moderately sensitive), and the physical properties of a Panoche Clay Loam. Meteorological data from California Irrigation Management Information System (CIMIS) at the Westside Research and Extension Center were used to schedule irrigation for irrigation options that ranged from 0.8 to 1.3 times potential crop ET. A root depth of 1 m with free drainage lower boundary condition was used in the simulations. Different EC values ranging from less than the threshold salinity to at least twice the threshold were chosen as inputs. The simulated results from various models were compared in terms of relative ET and yield of forage corn, leaching fraction, and salinity of the soil- and drainage-water.

Anticipated Results
Transient state models are useful tools that allow accounting for the effects of changes in osmotic and matric potentials on relative ET and crop yields where supplemental irrigation is practiced in monsoonal, humid, and semiarid climates. In the future, use of such models is likely to increase as irrigation water becomes more scarce and the salinity of water available for irrigation increases.

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