Prediction of Crop Water Use and Irrigation Requirement with Crop Growth Models

K. J. Boote and J. W. Jones

Dynamic crop growth models have potential use as tools to predict crop water use and irrigation requirement. The mechanistic DSSAT crop growth models contain evapotranspiration equations with options of Priestley-Taylor or Penman-Monteith. The models simulate root depth, root length density, and leaf area index dynamically over time for different crops as a function of weather, thus giving a dynamic crop coefficient approach, rather than static FAO-style coefficients. The dynamic rooting better estimates soil water availability, which allows better prediction of crop water use and irrigation requirement. These crop models have been calibrated to predict growth dynamics of leaf area index, rooting, growth, and yield for crops including maize, peanut, soybean, cotton, bahiagrass, tomato, sweet corn, snap bean, and potato. For plastic mulch crops like tomato, a different type of soil water balance model is needed, because the irrigation is drip or sub-surface. These models can be used in two ways to improve water use efficiency and sustainability. First, they can be used in a strategy-approach, to predict expected water use and irrigation requirement for a given crop and region, when growth is simulated for multiple weather years, using an automated irrigation threshold. A second approach is to use the models as decision-support tools to schedule irrigation, using current weather up to today, plus short-term forecast and historical weather for the rest of the season. Crop growth models have other applications beyond predicting water use and irrigation. For example, they predict crop N uptake and N leaching, two aspects that interact greatly with the amount of rainfall and irrigation water applied. Crop models are valuable decision-support tools for efficient use of water and N fertilizer.
Keywords: evapotranspiration, irrigation, water-use, crop production, crop models