EVALUTION OF CSM-CROPGRO-COTTON FOR SIMULATING COTTON GROWTH RESPONSES TO IRRIGATION, NITROGEN FERTILIZER, PLANTING DENSITY, AND FREE-AIR CARBON DIOXIDE ENRICHMENT IN CENTRAL ARIZONA

K. R. Thorp
USDA-ARS Arid-Land Agricultural Research Center
Maricopa, AZ
E. M. Barnes
Cotton, Incorporated
Cary, NC
D. J. Hunsaker
B. A. Kimball
J. W. White
V. J. Nazareth
USDA-ARS Arid-Land Agricultural Research Center
Maricopa, AZ

Abstract

Originally developed for simulating soybean growth and development, the CROPGRO model was recently reparameterized for cotton. However, further efforts are necessary to evaluate the model's performance against field measurements for new environments and management options. The objective of this study was to evaluate CSM-CROPGRO-Cotton using data from five cotton experiments conducted at the Maricopa Agricultural Center in Maricopa, Arizona. The field experiments tested ambient atmospheric carbon dioxide (CO_2) versus free-air CO_2 enrichment (FACE) over two growing seasons (1990 and 1991), two irrigation levels and two nitrogen fertilization levels for one growing season (1999), and three planting densities and two nitrogen fertilization levels with optimum irrigation for two growing seasons (2002 and 2003). The model was calibrated by adjusting cultivar and soil parameters for the most optimum or standard treatment of each field trial, and the model's responses to suboptimal irrigation, suboptimal nitrogen fertilization, nonstandard planting density, and CO_2 enrichment were evaluated. Modifications to the model's evapotranspiration (ET) routines were required for more realistic ET simulations in the arid conditions of central Arizona. Data quality and availability among the field trials were highly variable, but the combination of data sets from multiple field investigations permitted a more thorough model evaluation. Simulations of leaf area index, canopy weight, canopy height, and canopy width responded appropriately compared to measurements from experimental treatments, although some experiments did not impose enough treatment variability to elicit a substantial model response. Simulation results for densely planted cotton were particularly deficient as compared to other experimental treatments. The model simulated seed cotton yield with root mean squared errors ranging from 107 to 1120 kg ha^{-1} (3% to 29% of mean values), and total seasonal ET was simulated with root mean squared errors ranging from 11 to 40 mm (1% to 4% of mean values). Modification of the ET routines permitted a maximum simulated crop coefficient of 1.14 for four of five growing seasons, which was more realistic than that obtained from default ET methods in the model. Overall, the evaluation demonstrated appropriate model responses to water deficit, nitrogen deficit, planting density, and CO_2 enrichment.