Spatial and Temporal Dependence of Cotton Water Use and Yield as Related to Climate Variability

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Climate variability is a major source of risk for crop management decisions. Climate phenomena, such as the El Niño Southern Oscillation (ENSO), have a significant impact on crop production. ENSO, which refers to the changes in observed sea surface temperature (SST) in the eastern equatorial Pacific, is categorized into three phases: El Niño (warm SST anomalies) La Niña (cool SST anomalies), or Neutral. The objective of this study was to determine whether there is a relationship between ENSO and the temporal and spatial dependence of water use and yield of cotton grown in the southeastern USA. The index from the Japan Meteorological Agency (JMA), which corresponds to a 5-month running mean of spatially averaged SST anomalies over the tropical Pacific: 4°S-4°N, 150°W-90°W, was used to categorize the ENSO phases (http://www.coaps.fsu.edu/jma.shtml).

The Cropping System Model (CSM)-CROPGRO-Cotton, which is part of the Decision Support System for Agrotechnology Transfer (DSSAT) was used to simulate growth, development, and yield of cotton for variety DP 555 BG/RR for selected counties in Alabama, Florida, and Georgia. Simulations were performed for periods varying from 38 to 107 years. A combination of nine planting dates, e.g., April 9, 16, 23, 30, May 1, 8, 15, 22, 29, and June 5, to cover the cotton planting window for the three states, one soil profile for each location, and both irrigated and rainfed conditions were simulated. For each county, we used daily maximum and minimum air temperatures and precipitation obtained from the National Weather Service Cooperative Observer Program (COOP) network and compiled by the Center for Ocean-Atmospheric Prediction Studies (COAPS), through the Southeast Climate Consortium (SECC). Daily solar radiation was generated from the observed daily air temperatures and rainfall. The soil profile information was obtained from the soil characterization database of the USDA-National Resources Conservation Service (http://www.nrcs.usda.gov/). For the irrigated condition we used a management depth of 50 cm and an irrigation threshold of 60%. A total of 135 and 100 kg ha^{-1} of nitrogen fertilizer, 30% at planting and the remaining as sidedress at 45 days after planting, was applied for the irrigated and rainfed conditions, respectively.

For each location, the model simulations were categorized based on the ENSO phases. Then, deviations from neutral for El Niño and La Niña were determined for a combination of ENSO phase x planting date x irrigation condition (irrigated or rainfed). Geostatistical analyses and interpolation procedures were used to determine the spatial dependence of El Niño/La Niña model outputs deviations from neutral. Preliminary results showed a temporal and spatial dependence between the El Niño and La Niña yield deviations from neutral and planting dates. The results suggest that ENSO-based climate forecast could be a useful tool to provide recommendations for the optimum planting date for cotton in order to reduce potential climatic impact on cotton yield.

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