

Using Crop Models with Historical Weather to Manage Strategic Risks in Crop Management

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Crop growth models capture much of what we know about crop growth responses to factors of temperature, daylength, solar radiation, rainfall, soil traits, and crop management. Thus, crop growth models can be used to strategically evaluate management practices for a given climatic region for a given set of soils, particularly when good historical weather data are available. The DSSAT V4.0 crop growth models were used here, to hypothesize risk and improvement in production of soybean, maize, and peanut for north central Florida (using 25 years of historical weather). The simulations used a Millhopper fine sand for which we have good prior experience with soil water-holding characteristics and rooting profiles for these crops. The water-holding capacity of the upper 120 cm of soil is low, but there is increase in clay and water-holding capacity starting at 120-150 depth, and especially for 150-180 cm depth. The soil profile was set to 50% of field capacity prior to start of simulations, and an automatic sowing date window option was used in the SEASONAL analysis software of the DSSAT. The windows were up to 50 days wide, and stepped at 15-day intervals, with sowing conditioned on receipt of rainfall to bring soil water above 70%, but less than 90% (to prevent sowing on rainy days). For soybean, we evaluated sowing date, maturity group (MG) choice, and irrigation. For peanut and maize, the same approach was followed, except that peanut sowing was initiated April 1, and maize sowing was initiated March 1. The simulated crops were grown under rainfed conditions to experience the water deficit associated with the respective sowing dates and seasons, and irrigation demand was also computed. For peanut, we evaluated response to sowing date under rainfed versus irrigation. For maize, we evaluated production response to sowing date and N fertilization under rainfed conditions, as well as irrigation demand.

The highest yielding soybean MG was MG 8, in part because it optimized the life cycle allocated to grain filling. Later MGs were too late, exposing the crop to lower solar radiation, lower rainfall, and also risk of frost. The sowing date windows initiated April 15 and April 30 were optimum for soybean. Performance for May 15 sowing was also good, but later sowing dramatically reduced yield. Irrigation requirement averaged 148 to 91 mm, declining from first to last sowing. Graphs of yield versus evapotranspiration (ET) or transpiration during the season, illustrated that yield was limited by water deficit, although later sowing also reduced ET via shortening of life cycle. For peanut, there was a broad 2-month sowing window, starting April 1, with highest yield for the sowing windows starting April 15 and April 30. Yield variability was smallest for the April 15 window, and irrigation demand was lowest for April 30 and May 15 windows. Mean irrigation requirement ranged from 90 to 128 mm per season, and increased yield by 16-32%. Under irrigation, early sowing of maize was best (March and April) to take advantage of high solar radiation and cooler temperature to give longer life cycle. Under rainfed conditions, the optimum sowing windows for yield were April 30, May 15, and May 30, because they placed the crop into more favorable rainfall, causing lower variance for yield and thus less risk. The maize irrigation requirement was highest for early sowing (212 mm on average) and declined progressively to the May 15 to June 15 sowing dates (67-72 mm). Maize yields were nearly doubled with irrigation at early sowing dates. Graphs of probability of exceedence for a given yield level were very helpful in visualizing yield response for a given management, and plots of yield versus variance also assisted choice of the optimum management strategy to follow.

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