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Quantifying the Frequency of Flash Drought in the Southeastern United States and Estimating Its Effects on Corn and Cotton Yields

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Abstract

Agricultural drought is a common occurrence in the southeastern US and negatively affects the growth and yield of crops. Flash drought is defined as the rapid onset or intensification of relatively short-term agricultural drought. It occurs because of lower-than-normal rates of precipitation accompanied by abnormally high temperatures, winds, and solar radiation. The overall goal of this research is to quantify the incidence of flash drought and its effect on cotton and corn grown under rainfed conditions in the Coastal Plain areas of Florida, Georgia, and Alabama using mathematical decision support tools. The SmartIrrigation Corn and Cotton Apps were used to quantify the occurrence of flash drought by identifying periods during the growing season when plant-available soil water was below 40% for periods of more than 10 days for 130 weather station locations in Florida and Georgia. We applied the DSSAT CERES-Maize and CROPGRO-Cotton models to simulate the yield response of corn and cotton to flash drought using from 19 to 31 years of meteorological data at six of the weather station locations – three in Georgia and three in Florida. Both models were calibrated and evaluated using data from earlier studies. Statistical analysis of simulated and observed values of maize stem weight parameters

was R^2=0.84, RMSE=757.09, and d=0.85; for cotton yield was R^2=0.99, RMSE=1023.95, and d=0.759 after calibrating the DSSAT models. To evaluate the yield effect of flash drought, precipitation was suppressed in the model for 15-day intervals from 01 May to 30 June for corn and from 01 July to 31 August for cotton – during the crops' reproductive stages which are the most sensitive to water stress. Simulation runs were compared to yields resulting from simulated yields for the actual precipitation over the period of record. Suppressing precipitation from 01-15 June resulted in the greatest yield loss for corn, ranging from 35% to 73%. The greatest yield loss for cotton was observed from 15-31 July ranging from 9% to 40%. Although these periods resulted in the greatest yield losses, flash drought for any 15-day period during the reproductive stage resulted in substantial yield losses.

Keywords: SmartIrrigation App, soil water deficit, DSSAT, yield loss.