Quantifying the Frequency of Flash Drought in the Southeastern United States and Estimating its Effect on Yield of Rainfed Corn and Cotton

Jasia Jannat[1], Jose H. Andreis[2], Gerrit Hoogenboom[3], Pam Knox[1], Rick Lusher[4], George Vellidis[1]

[1]Department of Crop and Soil Sciences, University of Georgia, [2]Austn LTDA, [3]Department of Agricultural and Biological Engineering, University of Florida, [4]Florida Automated Weather Network, University of Florida

INTRODUCTION

- Droughts are complex and recurring natural disasters that affect portions of the U.S. almost every year.
- An agronomic drought may develop rapidly and have adverse physiological and economic impacts on agricultural commodities.
- A **flash drought** is a short agronomic drought that may also have serious impacts on crops grown on sandy soils.

OBJECTIVES

The objectives of the work presented here are:

- To quantify the frequency and duration of flash droughts in Florida and Georgia.
- To simulate the physiological and yield response of rainfed corn and cotton to the occurrence of flash drought during different phenological stages.

MATERIALS AND METHODS

- The **SmartIrrigation Corn and Cotton Apps** were used to identify periods during the growing season when plant-available soil water deficit (SWD) exceeded 60% at 130 weather stations.
- The Decision Support System for Agrotechnology Transfer (**DSSAT**) **CERES-Maize** and **CROPGRO-Cotton** models were used to simulate the crop water stress index and yield response of rainfed corn and cotton to flash drought.
- To simulate flash drought, precipitation was **suppressed** in the model for 15-day periods:
  - From 01 May to 30 June for corn.
  - From 01 July to 31st August for cotton.
- 20 – 31 years of meteorological records were used.

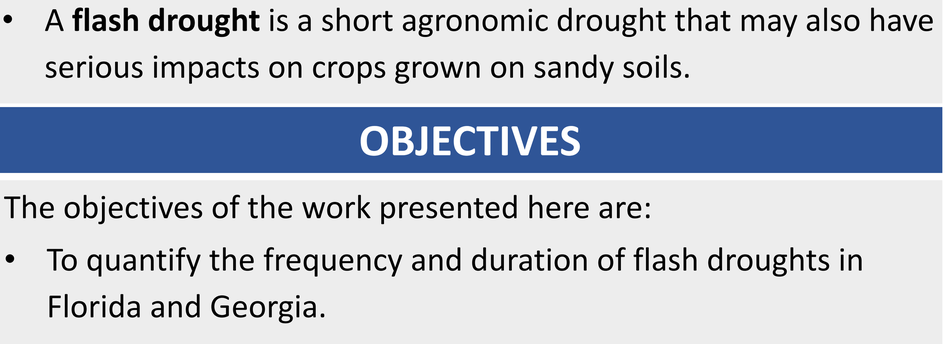

Figure 1. The SmartIrrigation Corn App (a) and locations of the 88 Georgia and 42 Florida weather stations used by the Corn and Cotton Apps (b).

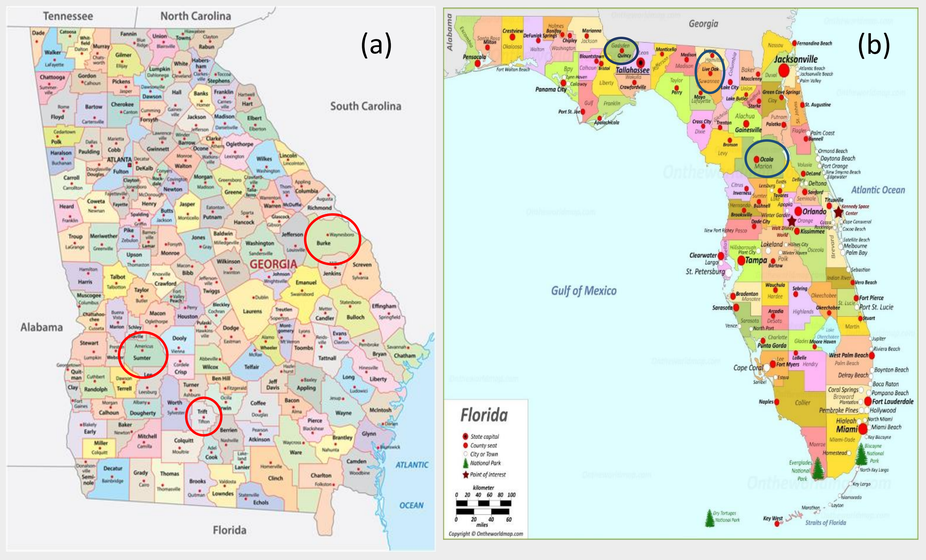

Figure 2. DSSAT was run at (a) Tifton, Plains, and Midville in Georgia and (b) Quincy, Live Oak, and Citra in Florida.

RESULTS AND DISCUSSION

Smartirrigation Cotton

User: Jasia.Jannat@uga.edu

Field: Field Cotton Quincy | Planting date: May-15-2021 | Lat: 30.54581, Lon: -84.59898 | Weather Data Source: FAWN - Quincy

Date	Days After Planting (DAP)	Acc. Heat Units (GDD 60F)	Phenological Stage	Evapotranspiration Eto (in)	Crop Coeff. (KC)	Crop Evapotranspiration. (Et*KC in)	Effective Rain (in)	Water Deficit - (Rain + Irrigation) (in)	Water Deficit - (Rain + Irrigation) (%)
Aug-02-2021	79	1325	First Flower	0.1342	1.1	0.14762	0.0088	1.9276	55
Aug-03-2021	80	1345	First Flower	0.1912	1.1	0.21032	0	2.1379	61
Aug-04-2021	81	1363	First Flower	0.113	1.1	0.1243	0	2.2622	64
Aug-05-2021	82	1379	First Flower	0.1033	1.1	0.11363	0.0181	2.3577	67
Aug-06-2021	83	1395	First Flower	0.0726	1.1	0.07986	0.0181	2.4195	69
Aug-07-2021	84	1411	First Flower	0.1583	1.1	0.17413	0	2.5936	73
Aug-08-2021	85	1431	First Flower	0.1528	1.1	0.16808	0	2.7617	78
Aug-09-2021	86	1451	First Flower	0.1697	1.1	0.18667	0	2.9484	84
Aug-10-2021	87	1472	First Flower	0.1753	1.1	0.19283	0	3.1412	89
Aug-11-2021	88	1492	First Flower	0.1416	1.1	0.15576	0.0088	3.2882	93
Aug-12-2021	89	1512	First Flower	0.1752	1.1	0.19272	1.0981	2.3828	67
Aug-13-2021	90	1530	First Flower	0.1344	1.1	0.14784	0	2.5307	72
Aug-14-2021	91	1550	First Flower	0.1832	1.1	0.20152	0.2431	2.4891	70
Aug-15-2021	92	1568	First Flower	0.1482	1.1	0.16302	0	2.6521	75
Aug-16-2021	93	1584	First Flower	0.1161	1.1	0.12771	2.295	0.4848	14
Aug-17-2021	94	1600	First Flower	0.028	1.1	0.0308	0	0.5156	15

Figure 3. Cotton App soil water deficit observed in 2021 at Quincy, Florida. Red cells indicate days when SWD exceeded 80%. Yellow and orange cells indicate days when SWD exceeded 60% and 70%, respectively. Between 3-15 August, the SWD resulted in crop water stress and yield reductions. This can be characterized as a "flash drought" period.

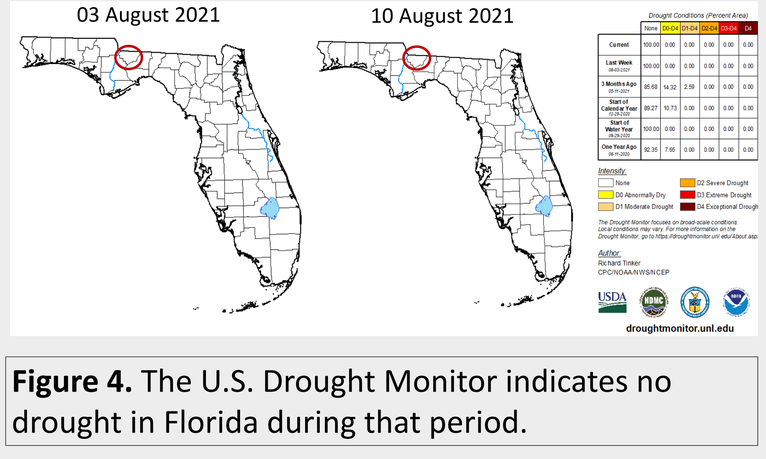

Figure 4. The U.S. Drought Monitor indicates no drought in Florida during that period.

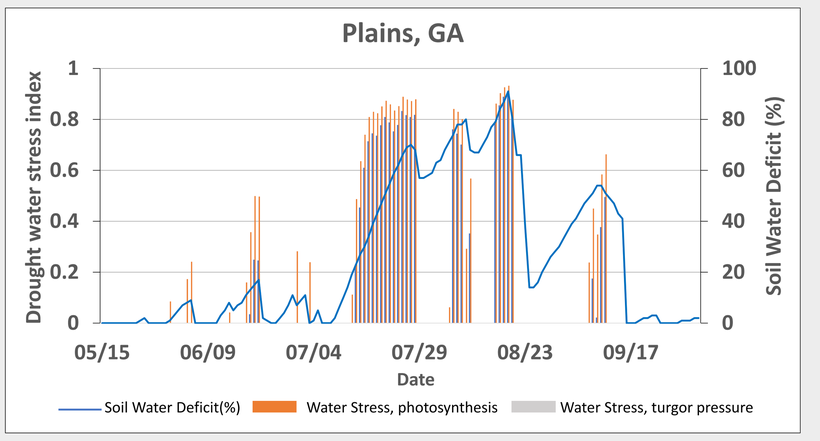

Figure 5. Cotton App soil water deficit (blue line) and DSSAT CROPGRO-Cotton crop water stress metrics (bars) in Plains, GA match well.

Yield Response to Simulated Flash Drought in Florida and Georgia

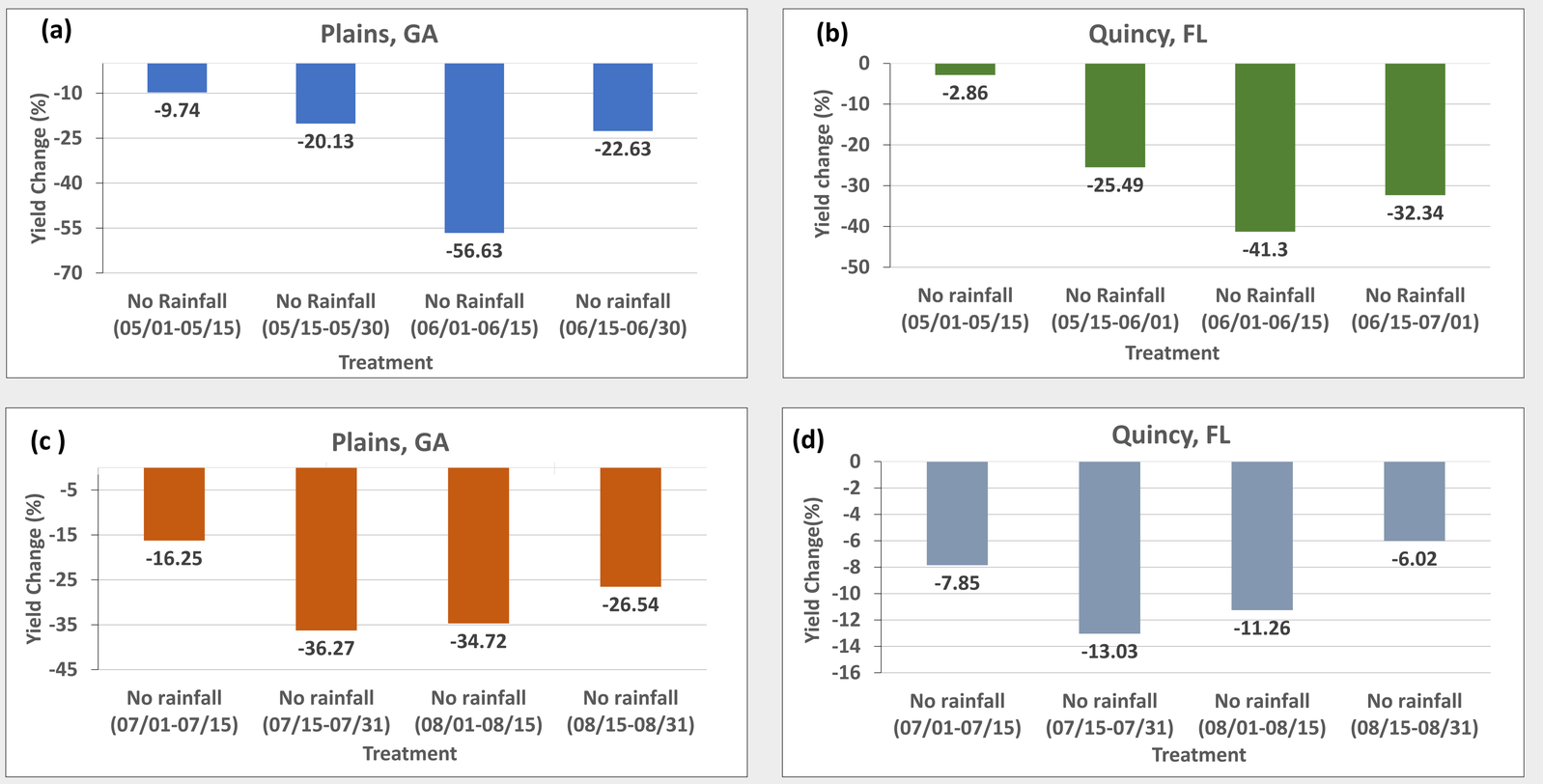

Figure 6. DSSAT **CERES-Maize** simulations of yield reductions resulted from suppressing precipitation for 15-day periods from **01 May to 30 June** compared to the 31-year (Plains, GA)(a) and 20-year (Quincy, FL) (b) rainfed average. **CROPGRO-Cotton** yields from **01 July to 31 August** compared to the 31-year (Plains, GA) (c) and 20-year (Quincy, FL) (d) rainfed average. The greatest reductions were observed for the period of **01-15 June for corn** and **15-31 July for cotton**. This is typically when corn is in the V9 – R1 stages. The sensitive growth stages of cotton are in the first square to peak bloom stages.

CONCLUSIONS AND FUTURE WORK

- The SmartIrrigation Corn and Cotton Apps are effective at identifying periods when soil moisture is significantly depleted because of flash drought events that are not captured by the U.S. Drought Monitor.
- Yield losses resulting from flash drought events can be significant for rainfed crops.
- Flash drought frequency and yield loss maps will be created for Florida and Georgia.

ACKNOWLEDGMENTS

- This work is supported by the NOAA/OAR Weather Program Office under Award No. NA20OAR4590498.