COTTON GROWTH AND DEVELOPMENT MONITORING DURING 2003

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Introduction

Evaluation of crop models and decision support systems often requires detailed data on crop growth and development, yield and yield components, and management practices. At the field level, the complexity of the agricultural activities can be summarized by the variability of the environmental factors and by farmers' decisions during the growing season, which impacts plant growth and development, and ultimately final yield.

During the 2003 cropping season, we monitored two cotton fields in the southwest region of Georgia. These fields were selected from the Agricultural Water Pumping (AWP) II sites and located in the vicinity of the Georgia Automated Environmental Monitoring Network (GA-AEMN). One field was located in Mitchell County and the other field was located in Baker County. Monitoring started on May 16 and ended on November 7, 2003, for a total of 13 field visits that covered the complete growing season for the two cotton fields. Management practices, crop growth and development, including dry matter of plant component parts as well as leaf area index (LAI) and canopy height, were collected every two weeks.

Weather Conditions

Similar weather conditions were observed for both locations (Mitchell and Baker County); characterized by abundant rainfall from July to the beginning of September and sparse rainfall from September to November. Atmospheric water demand (potential evapotranspiration) followed the same pattern, with values reaching above 30 mm for 5-day periods during the summer and less than 10 mm for the same period at the end of the growing season for Baker County (Figure 1), principally due to slightly higher air temperature observed in this location during the summer (Figure 2).

For both Mitchell and Baker County, the maximum temperatures varied from 24 to 33^{o}C; the minimum temperatures varied from 10 to 22^{o}C; and the average temperatures varied from 18 to 27^{o}C. The extremes for minimum temperatures occurred at the end of the growing season (Figure 2). In general the optimum temperature for many growth and development processes varies between 28 and 33^{o}C. Because the rainfall distribution was adequate and evenly distributed during the growing season as well as an optimum temperature for growth and development, 2003 represented a very good growing season.

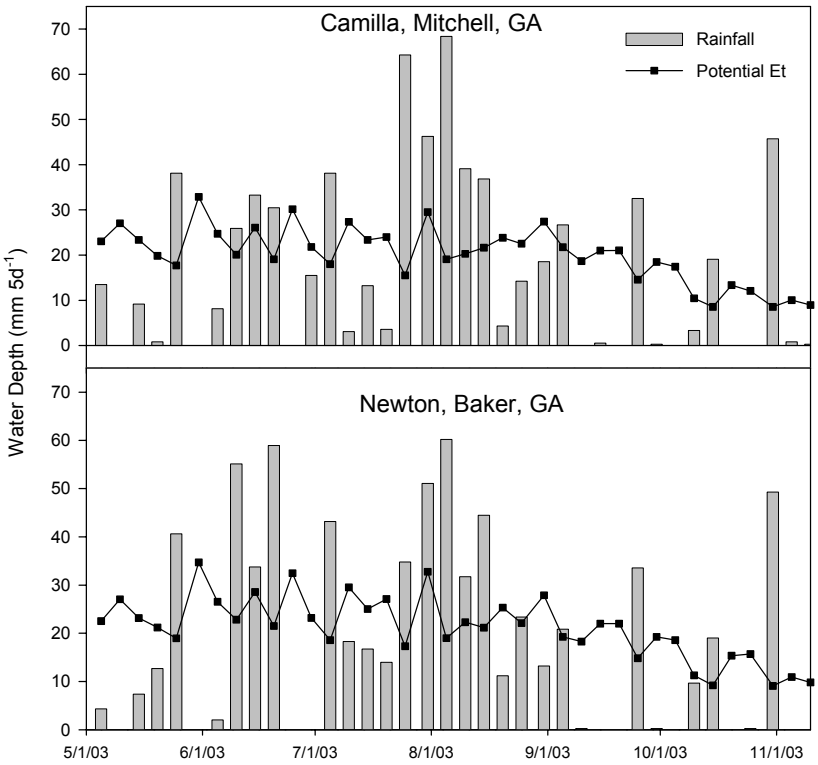

Figure 1. Cropping season rainfall and potential evapotranspiration for 5-day periods.

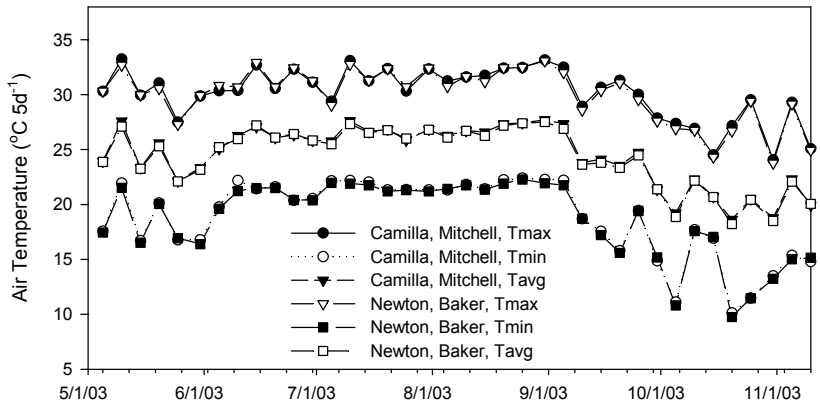

Figure 2. Air Temperatures (Tmax = Maximum Temperature, Tmin = Minimum Temperature, and Tavg = Average Temperature) during the growing season.

Cotton Field Comparison

Both fields were sown with DP 555, a late maturing cotton variety, using a conventional tillage system. One field was sown during the first week of May and the other field was sown during the fourth week of May. The main difference observed between the two cotton fields was the final plant population, which was drastically reduced for the field in Baker County (Table 1). Inadequate plant emergence, high spatial variability of the soil, and probably soil-borne pests and diseases were the principal factors that caused this low final population. The total number of days from sowing to harvest was approximately 165 for both locations.

Despite more wet or rainy days in Mitchell County, the total amount of rainfall was higher in Baker County. With the earlier sowing date in Mitchell County, a high water deficit (rainfall minus potential evapotranspiration) was observed (Table 1). Thus, the farmers in Mitchell County probably irrigated more frequently compared to the farmers in Baker County. With the earlier sowing date, the time of maximum crop water requirements coincided with the time of maximum atmospheric water demand.

Table 1. Cropping system comparison.

CHARACTERISTIC	FIELD	
	Mitchell County	Baker County
Variety	DP 555	DP 555
Sowing date	05/06/03	05/28/03
Harvest date	10/17/03	11/07/03
System	Tillage[a]	Tillage[a]
Area (ha)	34	77
Initial Population (plants/m)	10	10
Final Population (plants/m)	9	5
Days to harvest	165	164
Rainy days[c]	70	63
Total Rainfall (mm)[b]	593	645
Total ET (mm)[b]	693	679

[a] Conventional system, [b] From sowing to harvest.

The accumulated potential evapotranspiration in Mitchell County was higher than the accumulated rainfall during most of the growing season, with a small period of excess water during a short period in August. The field in Baker County had initially an adequate balance between rainfall and evapotranspiration, with water excess from August through mid-September. The field in Mitchell County experienced longer periods of water deficit from sowing to beginning August, while the field in Baker County had water excess during two weeks in August, followed by a period of deficit. Some late irrigation applications were applied in the field in Baker County (Figure 3). It is important

to emphasize that some days with heavy rainfall contributed largely to the cumulative precipitation during August and part of September. However, these days with heavy rainfall were often followed by dry periods of 5 to 10 days. This required additional irrigation applications because the soils were sandy and had a low water holding capacity.

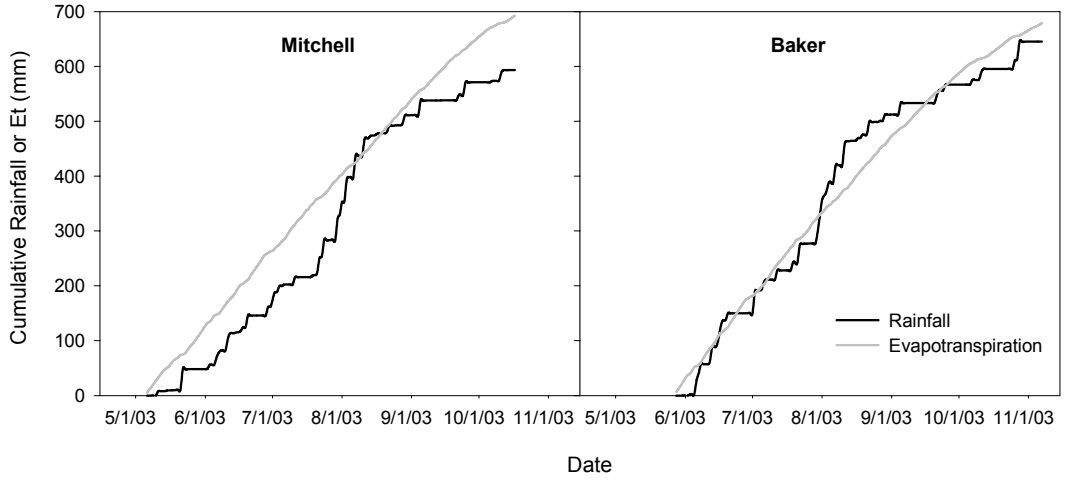

Figure 3. Cumulative rainfall and potential evapotranspiration during the growing season.

Despite the low plant population for the field in Baker County, the observed yield in this field was similar to the observed yield for the field in Mitchell County. This was primarily due to difference in the number of bolls per plant, which was almost 20 for the field in Baker County and slightly above 11 for the field in Mitchell County. Nevertheless, the percentage of lint was higher for the field in Mitchell County. The harvest index was lower for the field in Mitchell County than for the field in Baker County, probably due to greater canopy height and consequently a higher aboveground biomass (Table 2).

Table 2. Comparison of biomass, yield and yield components.

VARIABLE	FIELD	
	Mitchell	Baker
Plant population (plants m^{-2})	10	5
Seed Weight (Dry Matter, g m^{-2})	223	235
Lint Weight (g m^{-2})	180	166
Seed + Lint Weight (g m^{-2})	403	401
Lint (%)	45	41
Boll Weight (Dry Matter, g m^{-2})	541	539
Aboveground Biomass (Dry Matter, g m^{-2})	1157	809
Seed Number (seeds m^{-2})	2560	2618
Boll Number (bolls m^{-2})	112	96
Seeds per boll (seeds $boll^{-1}$)	23	28
Lint Harvest Index	0.15	0.20
(Seed+Lint) Harvest Index	0.35	0.49

The leaf area index (LAI) was similar for both fields, with up to a maximum value of 4.5 m^2 m^{-2}, which was observed at 75 to 80 days after sowing (Figure 4a). The canopy height for the field in Mitchell County was almost twice as high as the canopy height for the field in Baker County (Figure 4b). This large difference was due to two factors: (1) the probably late start for growth regulator applications (a regular management practice due to the indeterminate growth characteristic of the cotton plant) as well as the uniformity of the application in the field in Mitchell county, and (2) the unfortunately inadequate location selected for monitoring and sampling of the field in Mitchell County. Tours around both fields allowed us to confirm not only the difference in canopy height between the two fields, but also the high spatial variation in canopy height in the field in Mitchell County.

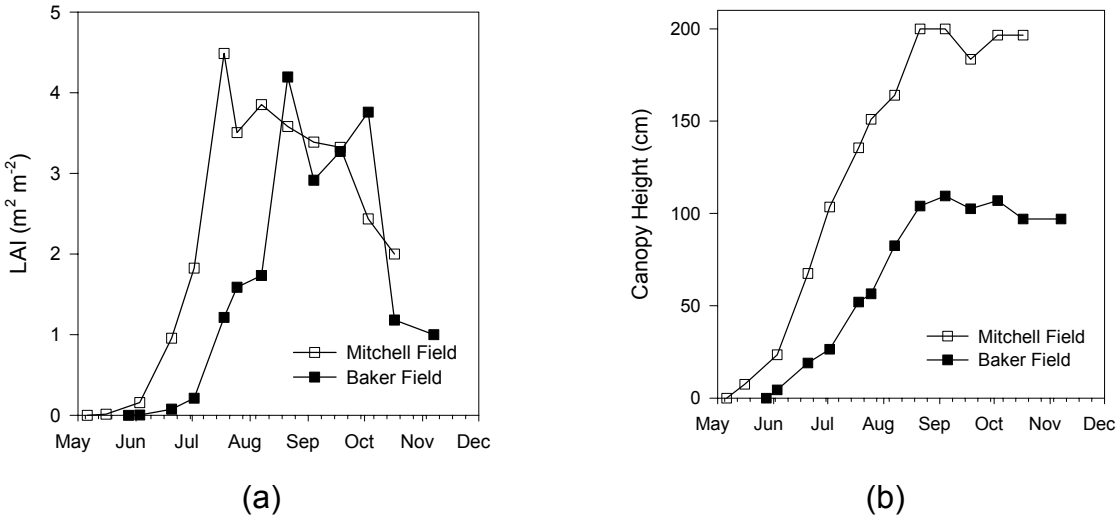

Figure 4. Temporal variation of (a) Leaf Area Index (LAI) and (b) canopy height.

Discussion and Summary

Yields based on our sampling could be higher than those obtained by the farmers due to several reasons, such as no lost bolls or pods during sampling (100% harvest efficiency), our decision to consider some bolls or pods as harvestable when probably they were of poor quality and not marketable, and a small sampling area (almost 1 m^2) as a representative for the entire field. However, the observed trend in yield between fields should be the same. We obtained a lint yield of 1,800 kg ha^{-1} for the field in Mitchell County and 1,660 kg ha^{-1} for the field in Baker County, while the farmers reported a yield of 1,235 kg ha^{-1} for the field in Mitchell County and 1,160 kg ha^{-1} for the field in Baker County.

Temporal variation in dry matter of plant components, e.g., roots, stems, leaves, and bolls, are not presented in this report. The analysis of this information could help to

understand and explain the differences in performance between the two fields as well as to compare the observed data sets with those from crop model simulations. The Mitchell field was located on a Troup soil, while the Baker field was located on a Wagram soil. However, soil data are not presented in this report. Incorporation of soils characteristics in the analysis will help to better understand crop performance during the growing season.

One of the main inputs for the Decision Support System for Agrotechnology Transfer (DSSAT) crop models is the crop and soil management practices. Some of these practices, such as plant population, irrigation amount and date of application, and fertilization application, were obtained from the farmers but are not presented in this report.

Although we generalized that local weather conditions during the growing season were adequate for cotton, we have to emphasize that heavy rainfall during July, August and the beginning of September might have caused problems to the farmers, especially with regards to disease occurrence. In 2003, the total rainfall for August was the highest for the last five years (an average of 182 mm in both locations) while the rainfall for July (168 mm) was the highest for the last three years in Mitchell County. The rainfall in September was the lowest (an average of 60 mm in both locations) and only about one third of the average September rainfall during the last three years, which required late-period irrigation applications for the field in Baker county.

Acknowledgements

The authors gratefully acknowledge the cooperation of Mr. Bryant Campbell and Mr. Kenneth Deese for on-farm data collection during our 2003 crop monitoring study in southwest Georgia.

This work was supported in part by the United States Department of Agriculture through the Risk Management Agency (USDA/RMA), the Office of Global Programs of the National Oceanic and Atmospheric Administration through the Regional Integrated Sciences and Assessments project (NOAA/OGP/RISA), and the Georgia Agricultural Commodity Commission for Cotton.