APPLICATION OF WEATHER DATA FOR MANAGEMENT OF COTTON PRODUCTION IN 2003

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Introduction

Weather is one of the most important factors that controls cotton production. During the last few years, the availability of water for irrigation has become a critical issue for Georgia farmers, because of the requirements for minimum water flows in the major rivers set by the neighboring states of Florida and Alabama. The future does not look very bright, especially for farmers located in the Flint river basin. In 2000, the Georgia legislature approved the Flint River Drought Protection act. This act was implemented during the spring of both 2001 and 2002, when farmers were asked to bid for acreage that they were willing to remove from irrigation. Luckily the drought mitigation act did not have to be implemented in 2003, as the weather outlook provided for a wetter growing season compared to the previous years.

Access to near real-time weather data is critical for cotton production. This weather information can be used in various computer calculators and programs to help producers with their decision making process. There is a need to develop and implement computer-based information technologies for decision making, using local weather data from Georgia, as well as other input conditions such as soil and crop management. Although a weather and decision support system has not been listed as one of the research needs for the Georgia cotton industry, it directly or indirectly affects many issues and decisions that are made by farmers on a daily basis. These decisions include planting dates, deficit irrigation, when to start and stop irrigation, replanting decisions, irrigation timing and crop water use, and applications of pesticides and herbicides.

Procedures

The College of Agricultural and Environmental Sciences of the University of Georgia has established an extensive network of automated weather stations which are located across the state of Georgia. There are currently 57 stations in operation in Arlington, Calhoun, Camilla, Cordele, Dublin, Newton, Statesboro, Vidalia, and other locations (Figure 1). Several of these weather stations have been installed in farmers' fields. The weather variables that are being collected include rainfall, air temperature, soil temperature, relative humidity, wind speed and direction, solar radiation, soil moisture and various others. The weather data are automatically recorded by the data logger of each weather station. The individual weather sensors are scanned at a one-second frequency and every 15 minutes summaries are calculated for the previous period. At midnight daily extremes, daily totals and other summaries are determined.

Each weather station is a stand-alone unit, powered by a battery, which is recharged by a solar panel. Communications are handled through a dedicated telephone line or cell phone, which is connected to the modem of each weather station. A computer located at the College of Agricultural and Environmental Sciences-Griffin Campus calls each station at midnight and downloads the data. After processing, error checking, and other procedures, all data are pushed to a web server. Users can retrieve various types of weather and climate data from the world wide web, including yesterday's conditions, weather conditions for the last 30 days, as well as historical data for temperature and rainfall. The address of the web sites is http://www.Georgiaweather.net. Weather data are also distributed to local news media, including television stations and newspapers, and to farmers and agribusinesses via electronic mail.

A key component for decision making is the application programs that have been implemented on the web. Users can calculate degree days for any period of time until present. As part of the degree day calculator, users can define the base temperature as well as a maximum temperature, above which no degree days are calculated. During the winter, users can calculate chilling hours for any period of time until present. A third calculator is the water balance calculator. It calculates total precipitation received for any period of time, as well as potential evapotranspiration. Potential evapotranspiration is the potential amount of water that can be lost by a crop that is grown under well-watered conditions. The difference between total precipitation and total potential evapotranspiration reflects the need for irrigation to avoid water stress.

Results

For this study we compared the cumulative number of degrees days, using a base of 60 degrees Fahrenheit. We did not use a maximum temperature cutoff in our calculators. The results for 2003 were compared with the previous growing seasons for 1999 through 2002. Please note that the automated weather station network is continuously being expanded and that we therefore do not have complete weather records for all sites. Recent installations include Nahunta, Homerville and Jeffersonville in 2002 and Elberton, McRae and Alapaha in 2003. We defined the start of the growing season as May 1 and the end of the growing season as November 1. In reality this can vary from location to location. Cumulative degrees days for the 1999 through 2003 growing seasons are shown in Table 1. The maximum number of degree days for 2003 was found in Valdosta at 2986 and Camilla at 2836; the minimum was found in Rome at 2090. The same sites also had maximum and minimum values for degree days in 2002 as well. For all sites the cumulative total number of degree days was less in 2003 when compared to 2002 and was similar to the degree days for 2001. For the five-year period from 1999 through 2003, both 2001 and 2003 had the lowest number of degree days, except for a few sites.

Cumulative precipitation for May 1 until November 1 is shown in Table 2. Similar to the previous years, it is surprising to see how rainfall varied across the state for this period. Fort Valley was the driest, with only 17 inches of rain, while Vidalia was the highest, with more than 40 inches of rain. Southeast Georgia in general had the highest amount of rain, while the total amount of rain for Southwest Geogia varied around 25 inches.

In Table 3 the water balance for the same period is presented. The water balance represents the difference between incoming water through rainfall and outgoing water lost through evapotranspiration. Approximately half of the sites had a negative water balance, while half of the sites had a positive water balance. Unfortunately the water balance does not provide much information with respect to both the rainfall distribution and intensity, and only provides a seasonal summary. Compared to the preceding years, most sites showed a positive water balance. In general this means that the water table is slowly recovering after several years of continuous drought.

Summary and Conclusions

Temperature and rainfall show a very strong variability between years, as well as between sites. Although this is not a new observation, it shows that the availability of local weather information is critical for day-to-day decision making by farmers. This weather information can be integrated in management and decision support tools, such as models, to provide alternate management options and solutions for farmers. Especially schedulers for irrigation management are needed if water for agricultural use will become restricted.

The automated weather station network will continue to collect local weather data as long as financial support will be provided by industry, government, and others interested in weather data. Weather information can be retrieved at no-cost from the Internet at www.Georgiaweather.net and specific web pages have been developed for cotton producers to be able to quickly retrieve degree-days (www.griffin.uga.edu/aemn/degreedays.htm) and cumulative rainfall (www.griffin.uga.edu/aemn/rainNOV.htm) for the main cotton producing areas in Georgia. The degree day and water balance calculators can also be run interactively on the web, using local weather data as input. We feel that the combination of near real-time weather data and decision support systems is critical to maintain an economically sustainable farming operation.

Acknowledgments

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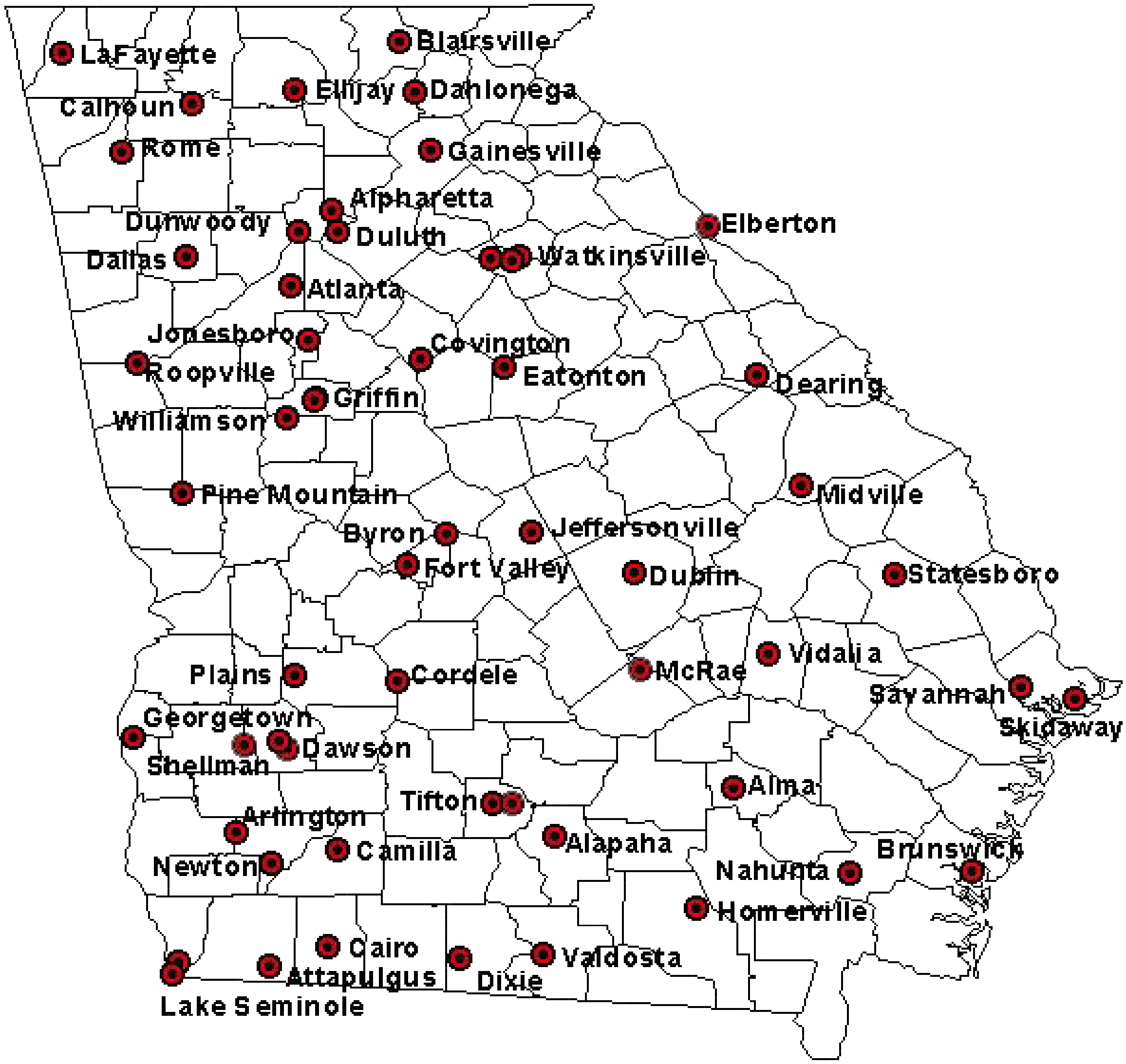

Figure 1. Location of the automated weather stations of the Georgia Automated Environmental Monitoring Network - College of Agricultural and Environmental Sciences of the University of Georgia.

Table 1. Degree Days from May 1 until November 1 with a base of 60 degrees F.

Site	1999	2000	2001	2002	2003
Alma	2943	2875	2766	3089	2820
Arlington	2725	2823	2544	2966	2699
Attapulgus	2790	2827	2687	3064	2789
Cairo	2786	2836	2512	3112	2811
Camilla	2969	3031	2765	3176	2836
Cordele	2946	2966	2692	3034	2745
Dearing	2705	2795	2597	2817	2501
Dublin	2714	2739	2587	2923	2581
Eatonton	2249	2566	2245	2516	2203
Ft. Valley	2668	2741	2484	2743	2435
Griffin	2365	2506	2222	2489	2202
Midville	2798	2830	2666	2916	2569
Pine Mountain	2248	2375	2107	2471	2248
Plains	2595	2637	2351	2831	2531
Rome	2271	2309	2053	2443	2090
Savannah	2602	2591	2548	2940	2738
Statesboro	2556	2567	2420	2936	2628
Tifton	2887	2928	2692	3075	2766
Valdosta	3047	3061	2933	3193	2986
Vidalia	2901	2892	2706	2949	2703
Watkinsville	2390	2512	2220	2509	2173

Table 2. Total Precipitation (Inches) from May 1 until November 1.

Site	1999	2000	2001	2002	2003
Alma	22.56	23.74	19.68	26.17	35.23
Arlington	24.93	18.66	16.23	28.36	23.49
Attapulgus	17.01	20.20	30.54	27.82	25.39
Cairo	26.60	20.84	26.23	19.99	27.29
Camilla	21.40	22.59	24.86	25.70	25.71
Cordele	17.50	11.19	18.47	19.40	27.71
Dearing	19.15	17.84	17.15	23.02	22.22
Dublin	22.28	17.70	16.55	22.95	32.42
Eatonton	14.39	14.24	18.46	17.48	25.11
Ft. Valley	19.64	16.30	14.04	24.40	17.04
Griffin	20.76	16.09	12.86	21.75	32.80
Midville	20.47	15.60	12.89	18.52	35.20
Pine Mountain	28.52	14.09	16.48	18.67	34.56
Plains	14.87	18.11	24.37	19.49	26.00
Rome	20.74	16.58	18.59	26.23	31.85
Savannah	34.39	20.27	22.54	38.28	24.52
Statesboro	12.48	15.33	13.89	25.67	36.34
Tifton	19.39	18.31	19.33	17.21	31.78
Valdosta	26.97	23.43	26.31	24.93	25.97
Vidalia	22.61	16.95	18.07	28.06	40.37
Watkinsville	24.59	16.30	22.39	19.48	34.27

Table 3. Water balance (inches) from May 1 until November 1.[1]

Site	1999	2000	2001	2002	2003
Alma	-6.03	-5.34	-7.60	-3.47	5.63
Arlington	-4.92	-13.20	-14.29	-2.86	-5.40
Attapulgus	-9.05	-5.55	9.70	-2.71	-3.11
Cairo	-3.18	-10.70	-3.41	-9.89	-1.36
Camilla	-10.31	-9.83	-5.35	-7.41	-4.23
Cordele	-15.15	-22.67	-13.09	-14.44	-3.82
Dearing	-10.83	-12.13	-9.04	-6.91	-5.82
Dublin	-9.00	-15.66	-14.66	-8.99	2.86
Eatonton	-15.10	-17.59	-10.93	-12.11	-1.28
Ft. Valley	-11.67	-15.43	-16.75	-4.44	-7.07
Griffin	-9.45	-16.93	-17.65	-7.47	5.09
Midville	-11.38	-17.56	-18.92	-12.00	7.08
Pine Mountain	1.99	-15.40	-11.01	-8.70	9.11
Plains	-15.03	-13.28	-5.35	-9.86	-1.21
Rome	-7.08	-11.49	-7.48	-1.05	7.05
Savannah	4.15	-11.14	-7.45	6.88	-4.25
Statesboro	-16.24	-14.58	-14.85	-2.86	8.42
Tifton	-13.27	-15.77	-12.67	-15.62	0.70
Valdosta	-3.72	-9.01	-4.69	-5.58	-3.05
Vidalia	-10.10	-15.12	-11.81	-2.65	11.10
Watkinsville	-3.75	-12.87	-7.62	-9.86	7.31

[1]The calculation of the water balance is based on [total seasonal rainfall - total seasonal evapotranspiration].