THE SIGMA+ COTTON MODEL

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Abstract

A computer program has been developed which simulates the growth of cotton, and based upon the results of the simulation, recommends to the grower when to irrigate, when and how much to fertilize, and when to harvest.

The model is written in the C++ programming language using the object oriented design and programming. The object oriented structure of the model is given in Table 1.

The model has been operational since January 1995. However an analysis of the results has shown that the model has failed to properly predict the plant's leaf water potential. Consequently when there was little or no water stress the model gave satisfactory results. However when a crop was grown under conditions where water stress occurred, the model did not adequately compensate for the condition. A new object for water stress was developed. The theory for the model was taken from Glycim, a crop model for Soybeans (Acock, et. Al.). Preliminary results indicate that this enhancement to the model allows it to properly predict water stress and to properly allow for water stress in the simulating the growth of the cotton plant. However not enough test cases have been run to definitely establish this.

Two test cases are shown, Figure 1 and Figure 2. They test cases are from two plots grown under identical conditions, except that the first one, msu83i received 36 inches of water over the crop season, and the second one, msu83d, received 26 inches of water. In this case the model satisfactorily simulated the field results.

Table 1. The Cotton++ crop model contains 27 classes and three levels of inheritance. Inheritance is indicated by indentations.

CLASS	DESCRIPTION
clock*	Keeps track of the simulation time.
environment*	This class provides environmental information such as temperature and radiation.
transpiration*	Computes the rate of transpiration.
organ	Organ is an abstract class. It contains only data and no methods (functions).
. . . shoot* . .	This is the largest of all the classes. It contains the data that is relevant to the shoot as a whole, for example, the total weight of all the leaves.
. . . fruiting node . .	There is an instance of this class for each fruiting node.
. . . fruiting point . .	There is an instance of this class for each square, green boll or open boll.
. . . leaf . .	The leaf class is the base class for each of the three types of leaves on the cotton plant.
. . . . . pre-fruiting leaf . .	This class contains the data and methods (functions) relating to the pre-fruiting leaves (the leaves below the first fruiting branch).
. . . . . sympodial leaf . .	This class contains the data and methods (functions) associated with the sympodial leaves (leaves on the mainstem or monopodial branches where the sympodial branch emerges).
. . . . . fruiting node leaf . .	This class contains the data and methods associated with the fruiting node leaves (the leaves at the point where a fruiting form emerges). Fruiting nodes appear on sympodial branches only.
. . . mainstem-monopodial . .	This is the base class of the mainstem and the monopodial branches.
. . . . . monopodial branch . .	The class whose objects are monopodial branches.
. . . . . mainstem* . .	The class whose object is the mainstem.
. . . sympodial branch . .	The class whose objects are sympodial branches.
integration*	The class that performs the numerical integration. Currently the Runge-Kutta method is used.
management*	This class contains data on the field and farming practice being simulated.
mineralization*	This class contains the methods for computing the mineralization of organic matter and the nitrification of ammonium.
outputs*	This class prepares and prints a summary of a simulation run.
photosynthesis*	This class computes the photosynthesis. There are three different photosynthesis models in Cotton++. The one actually used is determined at run time.
plant map*	This class assembles plant map data used for graphical displays.
roots*	This class computes root growth.
soil*	This class is the interface between Cotton++ and the soil module.
uptake*	This class computes the uptake rate of water, nitrate and ammonium
variety*	This class contains the simulation parameters. The parameters vary with the cotton species and variety being simulated.

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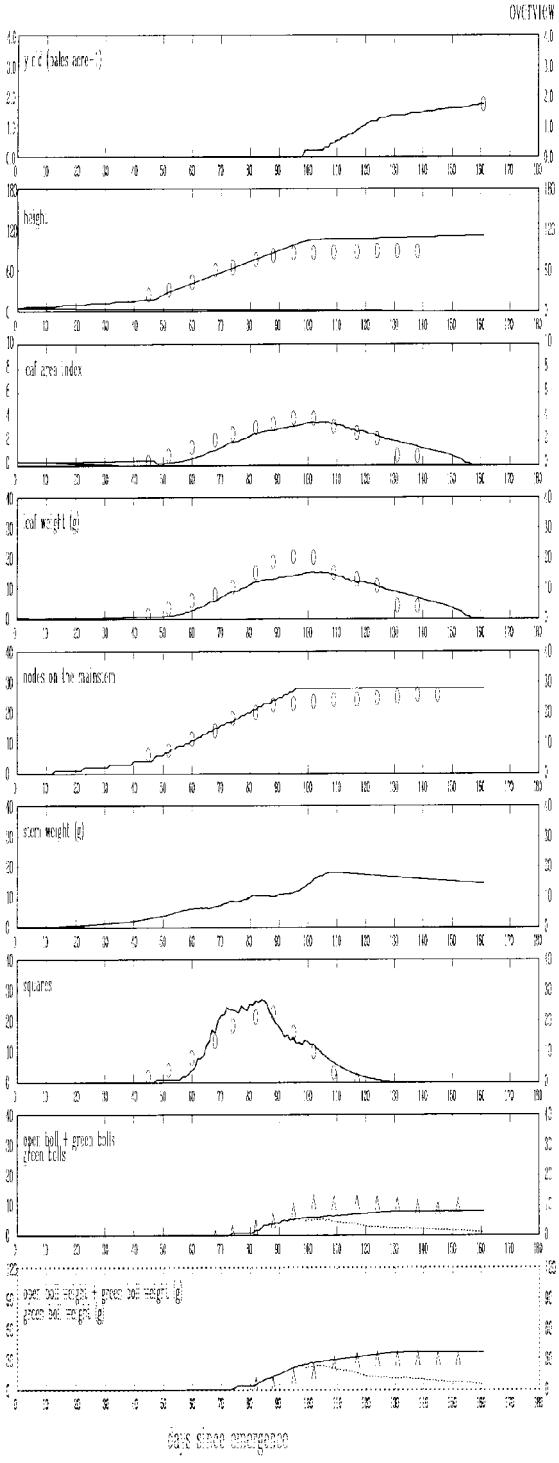

Figure 1. The msu83i test case. The same test case as Figure 2, excpet for an additional ten inches of water. The figures indicate that the model can account for water stress.