EVALUATION OF A NEW MODEL TO SIMULATE GROWTH AND DEVELOPMENT OF COTTON

Larry C. Guerra[1], Axel Garcia y Garcia[1], Gerrit Hoogenboom[1], Craig W. Bednarz[1], and James W. Jones[2]

[1]The University of Georgia, [2]University of Florida

gerrit@uga.edu

INTRODUCTION

- Cotton is the number one row crop in Georgia and accounts for 38 percent of the total irrigated acreage in the state. During the last 5 years, Georgia ranked second, behind Texas, in the United States in number of cotton acres harvested (average of 1.3 million) (www.nass.usda.gov).
- A new model to simulate growth, development, and yield for cotton has been developed and integrated in the Decision Support System for Agrotechnology Transfer (DSSAT).
- The objective of the study was to evaluate the new cotton model for farmers' field conditions and for an experimental station in southwest Georgia.

MATERIALS AND METHODS

- During the 2004 growing season, one cotton field in Baker County and two cotton fields in Mitchell County were monitored from mid-April through late October. Plant samples for growth analysis were collected every two weeks. The observed irrigation amounts were obtained from the database of the Agricultural Water Pumping (AWP; www.AgWaterPumping.net) program. For the precipitation data, a rain gauge equipped with a HOBO Event Data Logger was installed in each farmer's field. Air temperature and solar radiation data were obtained from the nearest automated weather station (www.Georgiaweather.net).
- During the 2004 and 2005 growing seasons, experiments were conducted at the Stripling Irrigation Research Park (SIRP) in Camilla, Mitchell County. Data on cotton growth and development under irrigated and rainfed conditions were collected every two weeks.
- The soil input data for the simulations were obtained from the USDA-NRCS soil database (http://ssldata.nrcs.usda.gov).
- The cultivar coefficients for the cotton variety DP 555 BG/RR were determined using a systematic approach (Hunt and Boote, 1998), using the 2005 data for irrigated conditions at SIRP.
- We then evaluated these cultivar coefficients by applying them to simulate crop growth, development, and yield for farmers' fields and for an experimental station in southwest Georgia.

Farmers' Fields

Stripling Irrigation Research Park

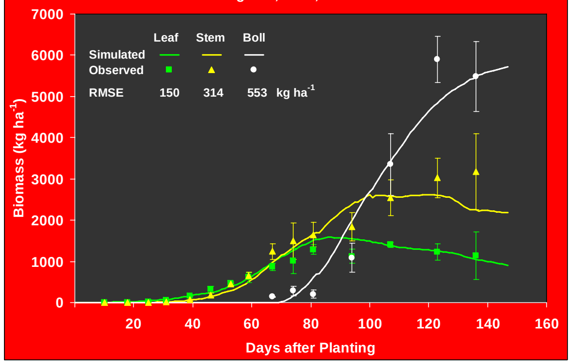
RESULTS

Model Calibration

Cultivar Coefficients for DP 555 BG/RR

Symbol	Definition	Value
EM-FL	Time between plant emergence and flower appearance (R1) (photothermal days)	35
FL-SH	Time between first flower and first boll (R3) (photothermal days)	5
FL-SD	Time between first flower and first seed (R5) (photothermal days)	11
SD-PM	Time between first seed (R5) and physiological maturity (R7) (photothermal days)	49
FL-LF	Time between first flower (R1) and end of leaf expansion (photothermal days)	85
LFMAX	Maximum leaf photosynthesis rate at 30 ^{0}C, 350 vpm CO_2, and high light (mg CO_2 $m^{-2}s^{-1}$)	1.10
SLAVR	Specific leaf area of cultivar under standard growth conditions (cm^2 g^{-1})	155
SIZLF	Maximum size of full leaf (cm^2)	300
XFRT	Maximum fraction of daily growth that is partitioned to seed + shell	0.65
WTPSD	Maximum weight per seed (g)	0.18
SFDUR	Seed filling duration for boll cohort at standard growth conditions (photothermal days)	35
SDPDV	Average seed per boll under standard growing conditions (numbers per boll)	27
PODUR	Time required for cultivar to reach final boll load under optimal conditions (photothermal days)	14

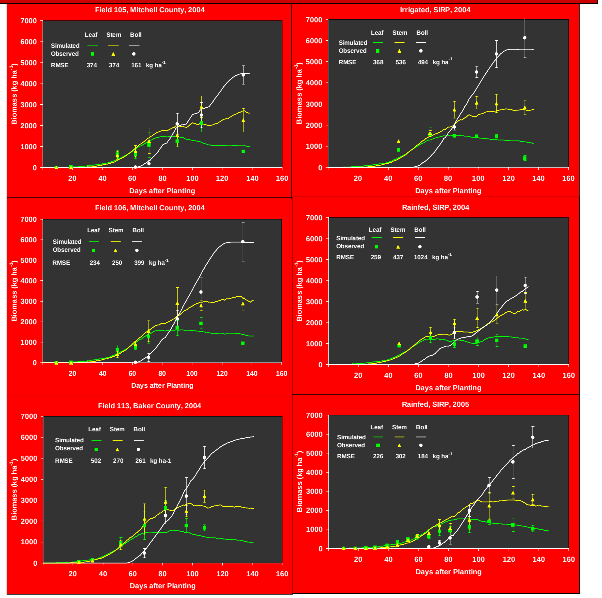
Boll, Stem and Leaf Growth



- The root mean square error (RMSE) between simulated and observed biomass associated with the final values of the cultivar coefficients was 150 kg ha^{-1} for leaf, 314 kg ha^{-1} for stem, and 553 kg ha^{-1} for boll.

Model Evaluation

Boll, Stem and Leaf Growth



- The model simulated dry matter accumulation for leaves and stems very well, except during reproductive growth for Field 113 when leaf and stem weights were underestimated and for both irrigated and rainfed conditions at SIRP in 2004 when stem weight was underestimated.
- The model simulated biomass accumulation for bolls in good agreement with observed data, except for rainfed cotton at SIRP in 2004 when boll weight was underestimated.
- The model simulated final yield very well, with an RMSE of 284 kg ha^{-1}.

CONCLUSIONS AND FURTHER WORK

- Overall, the model simulated cotton growth and development very well for farmers' fields and an experimental station in southwest Georgia.
- Further improvement in model performance could be achieved through a more accurate assimilate partitioning during reproductive growth.
- The model will be evaluated with data collected during the 2005 growing season in farmers' fields in southwest Georgia.

REFERENCES

Hoogenboom, G., J. W. Jones, P. W. Wilkens, C. H. Porter, W. D. Batchelor, L. A. Hunt, K. J. Boote, U. Singh, O. Uryasev, W. T. Bowen, A. J. Gijsman, A. S. du Toit, J. W. White, and G. Y. Tsuji. 2004. *Decision Support System for Agrotechnology Transfer Version 4.0* [CD-ROM]. University of Hawaii, Honolulu, HI.

Hunt, L.A. and K.J. Boote. 1998. Data for model operation, calibration, and evaluation. p. 9-39. *In* G.Y. Tsuji, G. Hoogenboom, and P.K. Thornton (ed.) Understanding Options for Agricultural Production. Kluwer Academic Publishers, Dordrecht, The Netherlands.

ACKNOWLEDGEMENTS

This work was conducted under the auspices of the Southeast Climate Consortium (SECC; http://secc.coaps.fsu.edu) and supported by a partnership with the United States Department of Agriculture-Risk Management Agency (USDA-RMA), and by grants from the US National Oceanic and Atmospheric Administration-Office of Global Programs (NOAA-OGP) and USDA-Cooperative State Research, Education and Extension Services (USDA-CSREES).