EARLY-SEASON DECISIONS ABOUT COTTON PLANT GROWTH, SQUARE SHED, PLANT GROWTH REGULATORS AND UTILITY OF COTMAN

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Abstract

COTMAN is a cotton crop information system that records changes in the fruiting dynamics of the cotton plant as well as plant growth parameters that are useful as a prompter of timely management decisions. This research reports on methods of detecting stress early in order to allow timely management inputs. Treatments of low, medium and high density, with and without insect damage (hand square removal) were compared in a field study. The retention growth balance was calculated from COTMAN data and used to detect stress as well as to schedule plant growth regulator application. The patterns of each growth curve compared to the target development curve show clear early evidence that we can detect stress due to plant density. The research also confirmed that the cotton crop can tolerate a high rate of square shed without undue yield loss. The study also clearly demonstrated that the *Aggregate change* in *Retention-Growth Balance* is a very sensitive indicator of stress, and can be exploited in timely management decisions.

Introduction

Cotton is reputed to have the most complex growth habit of all major row crops. Furthermore, the plant has a very dynamic response to management and environmental stress. Early season it is imperative to balance insect control and plant growth. The problem is that plant injury by insects concomitantly leads to increased plant growth. Unfortunately, monitoring systems usually record one or the other, i.e., insect scouting or plant growth. It is obvious that these two are intimately related and should be monitored and evaluated together, especially in early season (prior to first flowers) when preconditions are set that can dictate plant responses the remainder of the growing season. A way of doing this is to follow the change in shedding (from insects mainly, if the crop is irrigated and well fertilized) in relation to changes in plant growth. We propose a unique method of assessing these variables using the change in the ratio of square shedding to increased number of main-stem nodes with sympodia between the last two sample dates. This information is routinely recorded in the COTMAN where main-stem nodes with sympodia are referred to simply as squaring nodes and 1st position square shed rates are expressed rather than retention (Cochran et al., 1998).

Materials and Methods

The cultivar SureGrow 125 was planted 11 May 1998 in a randomized split-split plot experiment with four replications at the University of Arkansas Cotton Branch Experiment Station in Marianna. Sub-sub plots were four rows wide and 33 ft long, bordered by two fallow rows. The cotton was grown according to extension recommendations. All plots were furrow- flood irrigated using alternate rows eight times; 45, 52, 59, 73, 80, 87, 93, 106 days after planting.

Treatments consisted of simulated insect damage, three plant densities, and two plant growth regulators (PGRs). Plant monitoring information about plant growth patterns was collected from three plant stand densities, (10,778; 31,014; and 80,194 plant/acre), with and without first position square removal (23, 26 and 30%, respectively), and plant growth regulators (Pix or PGR-lV) under different levels of ARGB, the *Aggregate change in the Retention-Growth Balance. ARGB* is calculated using sampling data already taken in COTMAN.

Calculating the " Aggregate Change in the Retention/growth Balance"

The equation is: ARGB = (X2*Y2 - X1*Y1) / (X2-X1), Where X1 and X2 are the number of squaring nodes at two consecutive sampling dates, and Y1 and Y2 are the square shed rate at two consecutive sampling dates.

The split-split plot experiment was designed to provide varying levels and types of plant stress:

Main plot treatments:
- First position square removal versus no removal. One square per plant hand removed 38 and 48 days after planting (DAP).

Sub-plot treatments:
- Three levels of plant growth regulators; none, PGR-IV @ 4 oz/A, or Pix (mepiquat chloride) @ 7.6 oz/A applied 43 and 53 DAP.
- Three plant population densities; 10,778, 31,014 and 80,194 plants/acre hand thinned 18 days after planting.

The plant growth regulators were applied in 10 gallons of water with a modified CO_2 backpack sprayer. COTMAN data collection, on 40 plants per treatment, began June 15, 35 days after planting and continued through 86 days after planting. COTMAP data were collected just after defoliation. Final boll numbers and yield were recorded.

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Results and Discussion

Three types of COTMAN data with possible application in early-season decision-making were investigated: (1) plant growth curves, (2) physiological maturity (NAWF=5), and (3) the ARGB. The utility of each was evaluated as a decision aid.

Plant Growth Patterns and Maturity

The pattern of plant growth as measured by the number of squaring nodes for the three plant densities and compared to the *target development curve* (Oosterhuis et al., 1996) are presented in Figure 1. The patterns show clear evidence of stress due to plant density. By the second sampling date, it was obvious that the three plant types were developing more rapidly than the target curve. By the third sampling date, the growth pattern in the high stand density was beginning to slow down below target rates. The important message is that by detecting stress early we can exploit it with timely management decisions.

The curves also clearly show that the higher stand densities matured a little quicker than the target curve. Maturity was affected as indicated by a shorter interval of time to NAWF=5 in the higher density treatments, i.e., 63, 73 and 81 days from planting to NAWF=5 or physiological cutout (for definition, see Oosterhuis et al., 1996) for high, medium and low stand densities, respectively (Fig. 1). Similarly as expected, MC treated plants matured earlier than the PGR-lV or untreated control (data not shown).

Stand density and plant growth regulators significantly affected lint yields (Table 1). Yields were increased with increasing stand density. Mepiquat chloride also significantly increased yields.

Square Shed

Fruit shed increased with increasing plant density and decreased slightly with plant growth regulators (data not shown) and this was reflected in final mean boll numbers per plant (Table 2). However, square removal had no effect on final boll numbers per plant due to compensation. There was a significant three-way interaction in relation to early fruiting (stand density, “insect damage” and plant growth regulators).

Retention Growth Balance

The *Aggregate change in the Retention Growth Balance*, calculated each time COTMAN data was collected, was sufficiently sensitive to show the square removal treatment. For example on June 22 the ARGB was 0.066 for no square removal (a single square per plant hand removed 38 and 48 DAP) and 0.375 for square removal, and on July 1 the difference was even larger, i.e., 0.028 and 0.429 for the control and square removal treatments, respectively (Table 3) indicating that as squares are lost stress was reduced and that plants will grow larger vegetatively before more squares are set to slow growth down.

Plant growth regulator treatments were applied above and below an arbitrary ARGB of 0.35 chosen based on previous experience. Mepiquat chloride and PGR-lV were applied to determine the range of plant responses under defined conditions. This approach appeared to work well. Both height control (data not shown) and yield (Table 1) responses were apparent. The aggregate change in retention and growth was easily detected. Further research will be required to define the proper balance in retention and growth for different plant activities.

Conclusions

This research confirms the dynamic nature of cotton growth and response to management and environment. COTMAN fruiting curves compared to the *target development* curve show clear evidence of stress due to plant population density. It was also obvious that the cotton crop can tolerate a high rate of square shed (30% 1st positions in this case) without yield undue loss. The study also clearly demonstrated that the *Aggregate change in the Retention Growth Balance* is a very sensitive indicator of change in plant stress, and can be exploited in timely management decisions.

References

Cochran, M.J., Tugwell, N.P., Bourland, F.M., Oosterhuis, D.M., and Danforth, D.M. 1998. COTMAN expert system. Version 5.0. University Arkansas, Agric. Exp. Sta., Fayetteville. Published Cotton Incorporated, Raleigh, NC. Pp 198.

Oosterhuis, D.M., Bourland, F.M., Tugwell, N.P., and Cochran, M.J. 1996. Terminology and concepts related to COTMAN crop monitoring system. Agric. Exp. Sta., Univ. of Arkansas. Special Report. 174.

Table 1. Effects of plant growth regulators and stand density on yield.

Treatment	Lint Yield (lb/acre)[1]
Stand Density	
low	856 b
medium	1066 a
high	1107 a
Plant Growth Regulator	
untreated	990 b
PGR-IV	996 ab
MC	1043 a

[1]Numbers followed by the same letter are not different (p=0.05).

Table 2. Effects of plant growth regulators, insect damage and stand density on boll number per plant.

Treatment	Insect Damage	Plant Population Density Low	Medium	High
		---------bolls/plant----------		
Untreated	none	36	15	10
“	damaged	29	15	8
PGR-IV	none	38	15	7
“	damaged	40	15	9
Mepiquat chloride	none	41	18	8
“ “	damaged	38	17	9

[1]Insect damage was simulated by hand removal of squares

Table 3. Measurement of loss of a single square per plant with the Retention Growth Balance (RGB).

Treatment	RGB Values 22 June	1 July
No square removal	0.066	0.028
Square removal[1]	0.375	0.429
LSD (0.05)	0.031	0.089

[1] Hand removal of one square per plant.

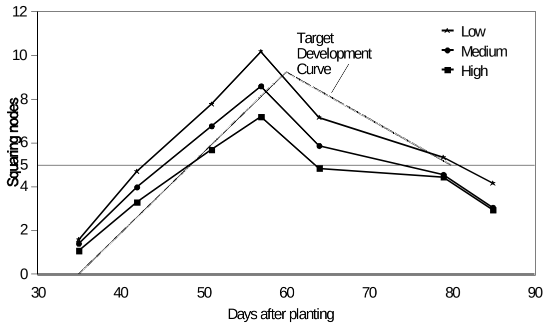

Figure 1. Plant Stress Associated with Low, Medium and High Stand Densities