THE EFFECT OF AN UPPER LIMIT TEMPERATURE THRESHOLD ON HEAT UNIT CALCULATIONS, DEFOLIATION TIMING, YIELD AND FIBER QUALITY

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ABSTRACT

Researchers from across the Cotton Belt have come to differing conclusions on the optimum defoliation time based on heat unit (HU) accumulation from cutout (NAWF=5). COTMAN, a cotton-management expert system based on in-season plant monitoring, recommends that defoliation be initiated at 850 accumulated HU from cutout. Utilizing an upper limit temperature threshold could possibly explain differences in results of defoliation timing and recommendations from across the Cotton Belt. An upper limit temperature threshold would impact the number of daily HU that are accumulated in the southern areas of the Cotton Belt. Feller et al. (1998) found that the enzyme rubisco activase, which activates rubisco, is inhibited by temperatures greater than approximately 90ºF which subsequently leads to reducing photosynthetic productivity. Temperatures above 90ºF also extends the boll-fill period (Yfoulis and Fosoulas, 1978).

INTRODUCTION

Cotton, a C_3 plant, utilizes an enzyme (rubisco; ribulose-1, 5-bisphosphate carboxylase/oxygenase), to fix atmospheric CO_2. The dual affinity of this enzyme for O_2 (photorespiration) and CO_2 (photosynthesis) results in less net carbon fixation at higher temperatures. Higher temperatures promote oxygenation, and hence photorespiration. Cotton growing in areas with high daytime temperatures may have reduced plant efficiency due to the enhanced level of photorespiration; subsequently, net carbon availability may be decreased. To determine whether the existence of an upper limit temperature threshold could influence the optimum time to defoliate using accumulated HU from cutout, a field experiment was conducted at the Texas AgriLife Farm in an effort to explain the variability in results in timing recommendations from across the Cotton Belt.

OBJECTIVE

To compare the effects of utilizing different upper limit temperature threshold levels to calculate HU accumulation after cutout and the subsequent impact on defoliation timing, yield, and fiber quality.

MATERIALS AND METHODS

The trial was conducted at the Texas AgriLife Research Farm on a Weswood silt loam in Burleson County. The design was a split-split plot with main plots utilizing heat units accumulated and sub-plots with differing upper limit calculations. One variety, Delta and Pine Land 444 Bollgard I Roundup Ready® cotton. Treatments consisted of the two upper limit temperature thresholds (86ºF and no upper limit) and defoliation at five maturity stages based on accumulated HU from date of cutout. Each treatment was replicated four times. The trial was fertilized uniformly pre-plant with 120 units of nitrogen per acre (Liquid 32-0-0). Starting at cutout (NAWF=5), daily heat units (DD60s) were recorded until the day of defoliation. An AquaSpy® field weather station was used to monitor environmental conditions. Heat units were calculated by the following equations [(86ºF as high + daily low ºF/2)]-60ºF and [(daily high ºF+ daily low ºF/2)]-60ºF. Defoliation applications consisted of a tank-mix of Dropp SC (2.4 oz/A) + Ginstar EC (1 oz/A) + Finish Pro 6 (22 oz/A). All treatments were harvested 10 to 14 days after defoliation with a John Deere 9910 two-row, high drum spindle picker. Fiber quality measurements were determined by sending samples to the International Textile Center in Lubbock, Texas. The SAS® 9.2 system with the PROC GLM model was used to analyze the data points associated with this trial. An alpha of 0.05 was used to calculate statistical significance.

Defoliation Timing Dates

Table 1a & b

Defoliation Timing	Defoliation Date	Actual Heat Units	Compared to No Upper Accumulation	Date Picked
86/ 650HU	7/29/2009	671.0	879.0	8/12/2009
86/ 750HU	8/3/2009	775.0	1004.0	8/17/2009
86/ 850HU	8/7/2009	858.0	1107.0	8/21/2009
86/ 950HU	8/12/2009	940.0	1242.0	8/26/2009
86/ 1050HU	8/17/2009	1058.0	1366.0	8/31/2009

Defoliation Timing	Defoliation Date	Actual Heat Units	Date Picked
No Upper/ 650HU	7/22/2009	689.0	8/5/2009
No Upper/ 750HU	7/27/2009	762.0	8/10/2009
No Upper/ 850HU	7/29/2009	879.0	8/12/2009
No Upper/ 950HU	8/3/2009	978.0	8/17/2009
No Upper/ 1050HU	8/5/2009	1037.0	8/19/2009

RESULTS & DISCUSSION

Both upper limit thresholds and heat units were statistically different in the initial model, but an interaction of the two factors was significant. A further analysis was conducted revealed that only heat units accumulated proved to be significant. Significance of upper limit calculation was reduced due to addition of degrees of freedom in the singular model. The 950 accumulated heat unit treatment had significantly greater lint yield than the 750, 850, and 650 heat units accumulated. Fiber analysis showed only one parameter that was significantly different between treatments, which was micronaire. Although the micronaire value for the 950 heat unit accumulated treatment was the highest, returns on the CCC loan calculator were not monetarily different for any of the treatments. Further duplication of this study is necessary for examining responses over years and locations in varying environmental conditions to verify the hypothesis.

Separate Statistical Analysis Due to Interaction

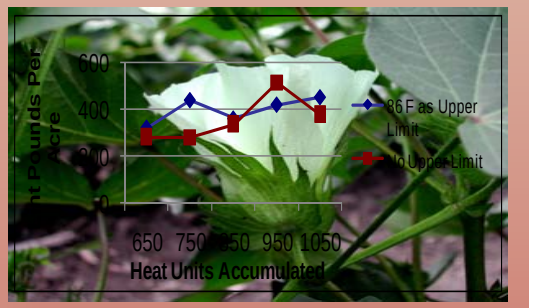
Table 2a & b

Upper Limit Calculation: No Upper Limit vs. 86F		
t Grouping based on LSD	Mean	Upper
A	398.11	86F
B	356.77	110F
P Value 0.175		
CV 24.97		
R Square 0.174		

Heat Units (HU) Accumulated			
t Groupings		Mean	HU
	A	464.85	950
	A		
B	A	414.64	1050
B			
B	C	359.31	750
	C		
	C	347.65	850
	C		
	C	300.75	650
P value 0.002			
CV 19.08			
R Square 0.698457			

Lint Yield (Lbs/A)

Fig. 1



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ACKNOWLEDGEMENTS

Appreciation is extended to Cotton Incorporated for their monetary support . ***Williamson County Equipment Company*** of Taylor, TX and the Cotton Physiology Work Group are also acknowledged for their aid and support in conducting this research.