A NOVEL STRATEGY TO MEASURE COTTON BOLL MATURITY

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Abstract

Cotton (*Gossypium hirsutum* L.) typically requires termination due to its perennial growth habit. Evaluating end-of-season plant maturity is an important management tool that helps producers make time-sensitive decisions regarding irrigation termination and harvest aid application timing. Plant maturity is generally determined in-field based on the farmer's guesswork and experience, utilizing traditional techniques such as cutting bolls open to determine the last harvestable boll, or estimating heat unit accumulation based upon the number of nodes above the uppermost white bloom. However, each of these methods is subjective and has its own limitations. The physiological principal behind this project is to quantify the reduction in boll moisture content as the boll matures and correlate the moisture content to cotton boll age, as quantified by heat unit accumulation.

Introduction

Quantifying media moisture content can be done with numerous methods and instruments; however, each has its limitations. After some initial evaluations of multiple moisture measuring instruments, the Theta Probe type ML2X by Delta-T Devices was considered the most appropriate off-the-shelf instrument for the quantifying boll moisture. However, modifications had to be made to the Theta probe to best fit this application.

If an effective instrument that is both economical and practical can be identified, this could provide producers with a tool to increase the accuracy of crucial management decisions on irrigation, harvest-aid applications, and possibly crop protection chemicals.

Materials and Methods

The study was designed to provide two boll moisture sampling methods (in-suture and in-lock) for 10 bolls per timing treatment in irrigated and dryland cotton, with three replications. Twenty total cotton blooms per replication were tagged within a row plot at white flower on three day intervals for 21 days in adjacent irrigated and dryland cotton fields. White flower tagging began on July 11. When the oldest boll (earliest tagged flower) was 36 days old (971 heat units) and fully mature with sutures beginning to split, the boll moisture measurements were taken. At the time of the moisture measurements, bolls were 19-36 days old and had accumulated 547-971 heat units (Table 1).

The Theta Probe type ML2X and Model HH2 data logger by Delta-T Devices were used to take all boll moisture measurements. The Theta probe data logger is pre-calibrated for various soil types, including organic soils. For all the boll moisture measurements, the Theta probe was set to the pr-ecalibrated organic soils setting. The shortest Theta probe prongs are 6 cm long and cannot be shortened due to a detrimental impact on the accuracy of the measurements, so rubber heat-shrink insulators were placed over 3.7 cm of the base of each prong. The resulting boll penetration depth of the Theta probe was 2.3 cm.

From each replication, we sought to obtain a minimum of six moisture measurements from each boll age. However, due to aborted fruit and probe penetration problems, sample size varied from three to six measurements for each sampling method at each boll age. Moisture readings were taken both in-lock and in-suture to identify any significant moisture differences in the probing location and technique. The data were then analyzed to determine the relationship between boll moisture and boll maturity.

Figures and Tables

Table 1. Volumetric water content averaged for in-suture and in-lock readings in irrigated and dryland locations.

Boll Age		Irrigated		Dryland	
HU	Days	Avg. In-Suture	Avg. In-Lock	Avg. In-Suture	Avg. In-Lock
547	19	23.68 a[1,2]	23.92 a	23.33 a	23.28 ab
628	22	24.22 a	24.25 a	22.98 ab	23.58 a
707	25	22.85 ab	23.33 ab	22.92 ab	23.55 a
757	27	22.90 ab	23.95 a	22.26 ab	23.32 ab
835	30	20.95 bc	23.25 ab	20.20 bc	22.05 bc
903	33	20.85 bc	22.35 b	17.58 cd	20.93 cd
971	36	18.94 c	20.53 c	15.12 d	19.46 d

[1]Means followed by the same letter in a column are not significantly different at P = 0.05

[2]Kruskal-Wallis test indicated the moisture readings were affected by heat unit accumulation (P = 0.05).

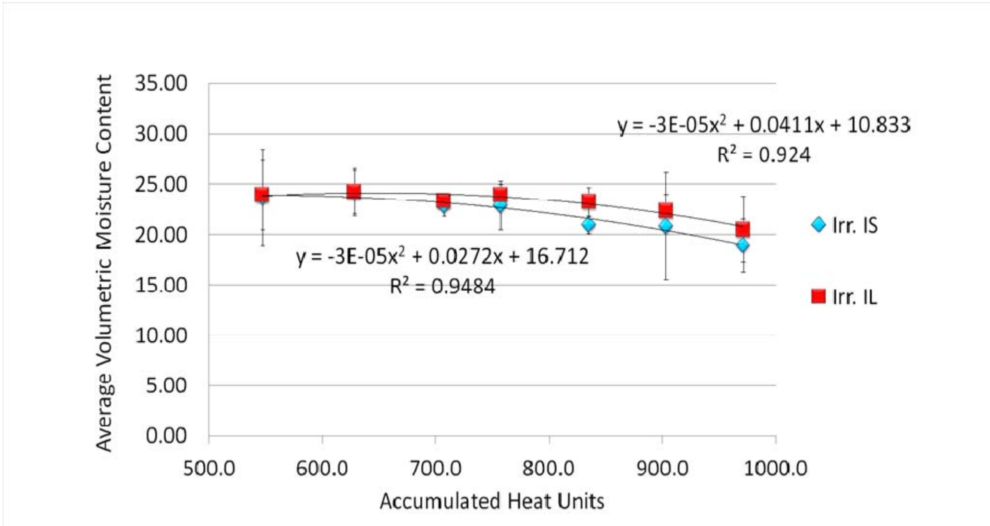

Fig 3. Average Boll Moisture Content, Irrigated Study

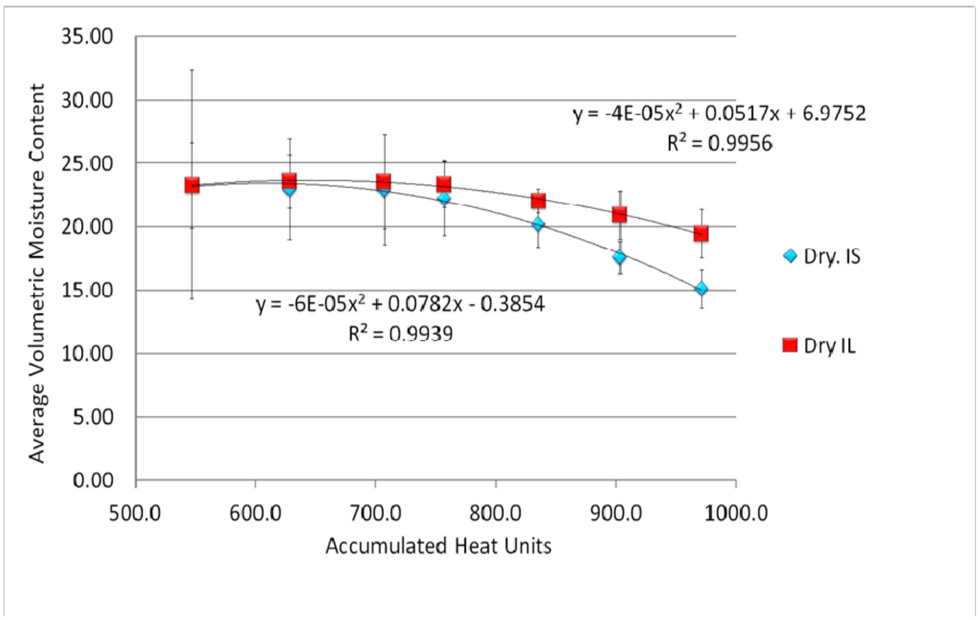

Fig 4. Average Boll Moisture Content, Dryland Study.

Results and Discussion

Analyzing the volumetric moisture content averages indicated a rather strong correlation between boil age and moisture content. Table 1 shows the volumetric moisture averages for each sample age across probe location and irrigation treatment. When averaged, the data points formed a close fit with the resulting quadratic trend line (Fig. 3). While both the irrigated and dryland plots offered a very close fit to a trend line, the bolls in the dryland setting showed the closest fit, with an R^2 value exceeding 0.99 for both probing locations (Fig. 4). Both in lock and in suture probing locations resulted in accurate measurements; however, as maturity increased, the in suture averages declined slightly quicker than the in lock measurements. As the cotton plant accumulates heat units and reaches its final stages of maturity, the resulting decrease in boll moisture can be accurately quantified using a quadratic regression trend line.

When sampling boll moisture, the more mature bolls were prone to splitting open during probing resulting in inconsistent moisture readings. Taking moisture measurements from in lock rather than in suture reduced the incidence of boll splitting. The bolls in the dryland field split open more easily than those in the irrigated plot, which in addition to lower overall moisture content and increased maturity due to drought stress, could help explain the lower moisture readings from the dryland plot. Taking two in lock measurements from each boll tested appeared to be the best method for determining boll moisture content.

The moisture probe design could be significantly improved with shorter, thinner prongs. This would reduce the chance of the boll splitting open, thereby improving the accuracy of each measurement while ensuring uniform probe depth for each boll sampled. Additionally, prongs that were more narrowly spaced would likely increase the consistency of the measurements.

Overall, this preliminary research determined that determining boll maturity by analyzing moisture content can be achieved both accurately and practically. Additional work needs to be done to further evaluate the robustness of the boll maturity quantification method.

Summary

We confirmed that the potential exists to use cotton boll moisture to predict cotton boll maturity. Boll moisture method could provide a feasible alternative to boll cutting and other boll maturity estimates currently used by producers. However, further research and improved measurement equipment is needed to increase the feasibility of this concept. In future research, we hope to improve boll moisture measurement equipment to better fit the boll size and increase accuracy, and establish a boll moisture calibration curve to set a standard for determining boll maturity.

Acknowledgements

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