FIFTY-SIX DAYS IN THE LIFE OF A *GOSSYPIUM* CELL

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Abstract

Large, unicellular trichome on the seed coats of *Gossypium* species are the cotton fibers of commerce. Cotton fibers, as hyper-elongated unicellular outgrowths of the outer integument of *Gossypium* species ovules, mature through four temporally overlapping developmental processes. Fiber initiation begins three days before floral anthesis and persists until the sixth day post anthesis [DPA]; fiber elongation begins with floral anthesis and continues until approximately 25 DPA. Secondary wall cellulose deposition commences at approximately 14 DPA and continues through 42 DPA, depending on the growth environment. Fiber maturity is reached at approximately 56 DPA under 'normal' growing conditions. The lengths of all four fiber developmental phases are highly dependent upon the growth environment and genotype-related responses to prevailing environmental conditions.

Two species, *G. hirsutum* and *G. barbadense*, were grown in Starkville, Mississippi, in 1993, bolls were harvested at 21, 28, 42, or 56 days after floral anthesis, which occurred on either 28 July or 19 August. Instrumental methods [AFIS] designed for textile fiber testing and fiber chemical analyses [Ca-XRF] were used to follow the development these specialized seed epidermal cells of Upland 'DPL5415' and 'Pima S-6' cotton genotypes to open-boll maturity at 56 days after floral anthesis. In this study, the AFIS measurements considered were: fiber length by weight, L(w), Cross-sectional area by number, A(n), and micronAFIS (the AFIS micronaire analog). Calcium quantitation by Ca-XRF [x-ray fluorescence] spectroscopy was used to measure the decrease in primary to secondary wall weight ratio during fiber maturation. The effects of growth environment -- flowering date, growth temperature, day-length, and solar radiation -- on cotton fiber cell elongation and cell wall deposition were quantified and analyzed statistically.

Flowering date, in interaction with temperature, modulated rates of fiber cell elongation and secondary cell wall deposition in both cotton genotypes. At 21 DPA, the earliest day on which fibers were sufficiently developed for AFIS analysis, DPL5415 fiber elongation in bolls which developed from July flowers was nearly complete. The fibers in DPL5415 bolls from August flowers continued to elongate past 21 DPA, as did Pima S-6 fibers in bolls from both July and August flowers. The rate of heat unit [degree-day 60°F] was positively correlated with fiber elongation rates in both species.

Cell development/maturation rates, measured as increases in cell cross-sectional area [and micronaire], were more sensitive to temperature than were cell elongation rates. Cell wall deposition for both DPL5415 and Pima S-6 fibers was less in bolls from August flowers, compared to the bolls from July flowers. Pima S-6 cell wall deposition was more sensitive to heat unit accumulation. This was particularly obvious when primary to secondary cell wall weight ratios were quantified by Ca-XRF. The micronaire [micronAFIS] of fibers in bolls from August flowers was reduced, and fiber maturation rates quantified as increases in micronAFIS were directly related to heat unit accumulations.

As expected, *G. hirsutum* [DPL5415] micronaire was consistently higher than that of *G. barbadense* [Pima S-6]. Lower temperatures and cumulative heat units during fiber development in bolls from August flowers reduced micronaire of both species. [Rainfall was not a limiting factor in 1993]. Maturation rates reflected species and genotype differences *and* the effects of growth environment. August-flower fiber developmental rates of DPL5415 showed compensatory acceleration in elongation. Fiber elongation rates for August-flower bolls were twice those of the July-flower bolls of both DPL5415 and Pima S-6. Upland August-boll maturation rates based on area, micronaire, and primary wall calcium dilution were also higher than corresponding rates of Upland July bolls.

Cumulative heat-unit models of Upland and Pima fiber cell elongation were more effective predictors of fiber length when day-length or day-length + solar radiation factors were included. Models based on cumulative heat units were better predictors of Upland cell cross-sectional areas and secondary cell wall deposition by weight than of those cell maturation parameters in Pima. The relatively large dimensions of cotton fiber cells and the analyses with rapid, reproducible fiber-sizing instrumentation from textile fiber testing make cotton fiber development an excellent and commercially important system for evaluating quantitatively the effects of growth environment and genotype on plant cells.

Relevant and Recent Publications

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