TRANSGENIC COTTON WITH IMPROVED FIBER MICRONAIRE, STRENGTH, AND LENGTH AND INCREASED FIBER WEIGHT

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Abstract

We set out to use genetic engineering to make cotton crop yield and fiber quality more resistant to cool night temperatures. Cool night temperatures tend to cause lower crop yield and production of immature fibers that have less value to the producer and the textile industry. These effects ultimately depend on hindered synthesis of cellulose when cotton is grown under cool nights. Previous analysis of source (photosynthetic) and sink (fiber cellulose synthesis) metabolism (to be described in the next paper) both implicated one enzyme, sucrose phosphate synthase (SPS), as a likely candidate for beneficial change.

Over 40 independent lines of transgenic cotton were produced with spinach SPS constitutively up-regulated. By screening for elevated leaf SPS activity, three lines were chosen for growth in the Duke University Phytotron under a 30/15˚ - 19 ˚C (day/night) temperature cycle and normal atmospheric CO_2 concentration. These three lines were subsequently also shown to have elevated SPS activity in the fiber. The *Gossypium hirsutum* parent, an elite line of Coker 312, was included in the chamber as a control. Fiber was sent to Cotton Incorporated for HVI, AFIS, and Mantis fiber quality testing.

Representative positive effects for transgenic plants compared to parental C312 (with numerical values being averages for the three transgenic lines) were: (a) increased delinted seed weight (up 18% to 0.106 g); (b) increased fiber weight per seed (up 25% to 0.059 g); (c) increased micronaire (up 28% to 4.72); and (d) increased fiber maturity ratio (up 7% to 0.95). Image analysis of fiber cross-sections confirmed that average secondary wall thickness increased in transgenic fibers, with fiber diameter remaining unchanged in two transgenic lines and decreasing in the third line. Fiber bundle strength also increased (up 12% to 30.3 g/tex) as did single fiber strength (Tb, grams to break a single fiber, up 24% to 6.56 g). Fiber length (UHM by HVI) also increased (up 10% to 1.14 in). In summary, the transgenic change pushes all fiber quality attributes toward the premium range even when the plants are grown under a stressful cool night.

The positive effects were preserved in 1999 in a production field near Lubbock, TX under limited sprinkler irrigation. One of three transgenic lines tested had higher seedcotton yield than either parental C312, a segregating transgenic line that was not expressing spinach SPS, or two adapted lines (Paymaster HS200 and Deltapine 2379 Roundup Ready). Two of three transgenic lines had higher micronaire (4.6) than any of the other lines tested (averaging 4.0). These positive effects were observed in a relatively dry production field at the end of a hot summer (harvest complete on 10/4/99). Therefore, we hypothesize that over-expression of SPS will help stabilize or increase yield and fiber quality under various stressful production conditions.

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