# OPPORTUNITIES FOR IMPROVING COTTON'S TOLERANCE TO HIGH TEMPERATURE

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**Abstract**

Cotton may experience high temperature stress at any stage of development, and efforts to enhance it's protection must take this into account. Seedling heat tolerance is essential in most dryland cotton production areas as producers plant when moisture becomes available. This management practice places seedling survival at the mercy of the environment and the genetics of the plant. Cotton seedlings maintain optimal temperatures by the movement of soil moisture through the plant and into the environment by the process known as transpiration. Unfortunately, emerging cotton seedlings have a poorly developed root system with a primary tap root and only the beginnings of lateral root development. When seedling temperatures increase above optimal levels an acquired thermotolerance system is induced. Maximum protection levels are induced when plant temperatures reach 100 to 104 F and protection levels decline rapidly at higher temperatures. Research in my laboratory has evaluated the genetic control of the acquired thermotolerance mechanism in other plant species. Our analysis of the effects of chromosomal deletions in the hexaploid wheat not only provided evidence of chromosomal arms regulating the level of acquired thermotolerance, it also provided evidence that removal of chromosomal DNA coding for inhibitors can enhance the level of protection and permit induction of the protection system at temperatures as low as 93 F. Production cotton is a tetraploid with components of the A and D genomes providing input into the overall phenotype of the plant. Based upon our research in wheat, it is possible that chromosomal deletions in the A or D genomes of cotton would provide an enhanced acquired thermotolerance system. A problem with removal of chromosomal arms is that many genes are removed by this process and some beneficial genes might be lost in the quest to enhance acquired thermotolerance.

An alternative method for enhancing acquired thermotolerance is to identify genes coding for key components of the natural high temperature protection system and express them individually or in combination with other protection proteins. To accomplish this, knowledge of the essential proteins contributing to high temperature protection is needed. We have developed a screening procedure to identify mutagenized seedlings exhibiting altered acquired thermotolerance and have successfully identified plants with single gene mutations for use in molecular mapping studies. Essential genes identified in these studies are isolated and moved into cotton in an attempt to enhance the level of thermotolerance in seedlings and maturing plants.

Improvements in reproductive heat tolerance are essential if yield potentials are to be realized. Numerous studies have reported the deleterious effects of elevated temperatures on pollen development. It is possible that improvements in vegetative heat tolerance may also provide improved heat tolerance during pollen development. Research in my laboratory has evaluated additional aspects of cotton pollen high temperature sensitivity and environmental constraints experienced under irrigated and dryland production systems. We have developed a media that supports pollen germination and pollen tube growth in the laboratory for use in the characterization of pollen temperature sensitivity. Maximum pollen germination and pollen tube elongation are observed at 82 F and both germination and tube growth fall off as temperatures increase above 90 F. Internal temperatures of flowers located at the top of the canopy were 10 to 15 F higher than flowers within the canopy of irrigated cotton. Flowers exposed to direct sunlight exhibited temperatures in excess of 95 F, well above the optimum for pollen germination and pollen tube growth. Pollen harvested in the afternoon from flowers within the canopy revealed normal pollen viability, while pollen harvested from flowers at the top of the canopy showed a drastic reduction in pollen viability. Whether inhibition of pollen viability is a direct response to elevated temperatures or if a combination of elevated temperatures and low humidities combine to kill the pollen remains to be determined. In either case, expression of genes coding for key protection proteins in pollen may overcome this inherent temperature sensitivity.

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