

**THE EFFECTS OF HEAT STRESS ON POLLEN TUBE GROWTH, CARBOHYDRATE METABOLISM,
AND ENERGY LEVELS IN COTTON PISTILS**

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Abstract

Successful pollen tube growth and fertilization of the ovule is essential for the development of seeds and the fibers associated with the seed coat that are the basic components of yield in *Gossypium hirsutum* (cotton). As pollen tube growth has a high energy requirement relative to vegetative tissues, any abiotic stress negatively affecting the availability of energy reserves in the pistil should negatively impact fertilization and decrease yield. To test the effects of heat stress on source leaf activity, pistil energy reserves and *in vivo* pollen tube growth, cotton plants (ST4554 B2RF) were maintained at optimal day/night temperature regimes (30/20C) or exposed to heat stress (38/20C) conditions one week prior to flowering. Pollen tubes were visualized in ovules 24 h after anthesis via UV microscopy, and pollen performance was expressed as the ratio of fertilized ovules to total ovules per ovary. At anthesis, pistil measurements included midday (1200 h) soluble carbohydrate and ATP levels and midday subtending leaf photosynthesis, stomatal conductance, photochemical efficiency, chlorophyll content, and ATP levels. Heat stressed pistils had significantly lower pollen tube to ovule ratios, decreased soluble carbohydrate contents, and lower ATP levels relative to the control. Subtending leaf photosynthesis, photochemical efficiency, and chlorophyll content decreased under heat stress, whereas stomatal conductance increased and ATP levels remained unchanged. We propose that the major limitations to subtending leaf photosynthesis under heat stress are reduced quantum efficiency of photosystem II (resulting from decreased chlorophyll content) and enhanced cyclic electron flow, which maintains ATP content but decreases CO₂ fixation in source leaves. We conclude that heat stress primarily limits reproductive success by decreasing *in vivo* pollen performance. Because ATP and carbohydrate levels in heat stressed pistils declined concomitantly with pollen performance, we hypothesize that the energy requirements of growing pollen tubes can not be sufficiently met under heat stress.