HEAT STRESS-INDUCED CHANGES IN POLLEN TUBE GROWTH, CALCIUM LEVELS, ANTIOXIDANT DEFENSE, AND SUPEROXIDE PRODUCTION IN COTTON PISTILS

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Abstract

Heat stress experienced by cotton plants during a typical growing season is major cause of disappointingly low yields, with a correlation existing between low yields and high temperature. Under stress, plants accumulate reactive oxygen species (ROS), which are capable of damaging nearly every organic component of a living cell. As a result, plants exposed to temperature stress respond with increased antioxidant enzyme activity. In contrast, NADPH oxidase (NOX) produces O_2^-, which is needed to promote cell expansion during normal plant developmental processes, including pollen tube growth. Calcium enhances both antioxidant enzyme activity and NOX activity and is essential for pollen tube growth. To quantify the effects of heat stress on *in vivo* pollen tube growth, water-soluble and total calcium content, antioxidant enzyme activity, and NADPH oxidase-mediated superoxide production in cotton pistils, 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 flowering, pistil measurements included midday (1200 h) total and water soluble calcium content, glutathione reductase (GR) activity, superoxide dismutase (SOD) activity, and NOX activity. Heat stressed pistils had significantly lower pollen tube to ovule ratios, increased water-soluble calcium contents, higher GR activity, and lower NOX activity. There was no effect of high day temperature on total calcium content or SOD activity. We conclude that heat stress primarily limits reproductive success by decreasing *in vivo* pollen performance. We hypothesize that moderate heat stress causes a calcium-mediated increase in GR activity in the pistil, which interferes with pollen tube-localized NOX activity as the pollen tube extends through the stylar tissue.