EFFECT OF HIGH TEMPERATURE STRESS ON FLORAL DEVELOPMENT AND YIELD OF COTTON

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Abstract

Global climate change is projected to cause substantial losses in crop productivity by the end of the twenty-first century. Environmental stress during floral development is a major reason for the disparity between actual and potential yields. In *Gossypium hirsutum* L., canopy growth and flower survival are severely inhibited at temperature regimes in excess of the optimal day/night temperature regime of 30/20°C, which commonly occur in the US Cotton Belt during flowering and boll development. Much of the sensitivity of reproductive organs to heat stress has been attributed to the sensitivity of the microgametophyte to temperature extremes. In contrast with female reproductive tissues, mature pollen grains exhibit no acclimative response to heat stress. Due to the inability of mature pollen grains to effectively respond to adverse environmental conditions, numerous studies have focused on pollen tube elongation responses to high temperature in the absence of a female gametophyte using *in vitro* systems. The optimal temperature across a range of *G. hirsutum* cultivars for pollen tube growth was from 28 to 32°C, with a strong correlation between maximum pollen tube growth and boll retention. Consequently, maximum daily temperatures experienced by cotton plants during the flowering period often exceed the optimal temperature for successful pollen tube growth, where afternoon temperatures often exceed 38°C. Successful *in vivo* pollen tube growth and subsequent fertilization of the ovule is a prerequisite for seed formation in *G. hirsutum*, and seeds with their associated fibers are the basic components of yield. Using *in vitro* systems, numerous authors have cited the sensitivity of pollen tube growth to high temperature as a major cause of low yields for crops with valuable reproductive structures. We have shown that the energy demands of growing pollen tubes cannot be met under heat stress due to decreased source leaf activity, and that a calcium-augmented antioxidant response in heat stressed pistils interferes with enzymatic superoxide production needed for normal pollen tube growth. There is a calcium-augmented increase in antioxidant activity in heat stressed pistils that interferes with pollen tube-localized NOX activity through ROS scavenging as the pollen tube extends through the transmitting tissue of the style. Numerous studies have illustrated the need for antioxidant enzymes in acquired photosynthetic thermotolerance, but information on their possible role in promoting innate thermotolerance is lacking. We conclude that maintaining a sufficient antioxidant enzyme pool prior to heat stress is an innate mechanism for coping with rapid temperature increases that commonly occur under field conditions.