PROCESSES CONTRIBUTING TO PHOTOSYNTHETIC COLD ACCLIMATION IN COTTON SEEDLINGS

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Abstract

Because cotton is a cold-sensitive crop, low temperature during the early growing season is well-known to negatively impact photosynthesis, growth, and survival of cotton seedlings. What is less clear is 1) whether cotton seedlings exhibit acclimation of net photosynthesis to low growth temperature, 2) what component processes acclimate to improve photosynthetic cold tolerance under low growth temperature conditions, and 3) which component processes represent the weakest links in cotton's ability to withstand low temperature environments. To address this, a controlled environment study was conducted to compare temperature sensitivities of key physiological processes for cotton seedlings grown under a low (20/15°C day/night temperature) or optimal (30/20°C) temperature growth environment. Cold temperatures decreased whole-plant dry weight, height, node development, and leaf area. Net photosynthesis acclimated (became more cold tolerant) to low temperature, primarily due to increased temperature sensitivity of dark respiration. Using novel fluorescence methods (termed OJIP fluorescence), it was observed that 1) overall performance of the thylakoid reactions was reduced by cold temperature, 2) intersystem electron transport processes (between photosystem II and photosystem I) were the most sensitive to low temperature, and 3) energy trapping at PSII, inter-system electron transport, and reduction of PSI electron acceptors all acclimated to low growth temperature. Despite exceptional sensitivity to low growth temperature environments, cotton seedlings do exhibit photosynthetic acclimation by altering the temperature sensitivity of respiration and underlying photosynthetic component processes, albeit to different degrees.