Photosynthetic response of hybrid aspen (*Populus tremula* x *P. tremuloides*) to heat pulses as may occur in sunflecks

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During exposure to direct sunlight, leaf temperature can increase rapidly and reach values well above air temperature, especially when transpiration is limited due to drought stress. The physiological effects of such high temperature events are imperfectly understood. We studied leaf temperature dynamics under field conditions and further investigated photosynthetic activity under laboratory conditions in leaves of aspen clones (*Populus tremula* x *P. tremuloides* Michx.), using heat stress scenarios as may occur in the field. Intact, attached leaves were subjected to short temperature increases ("heat pulses") of varying duration over the temperature range of 30 ^{o}C - 52 ^{o}C. Such heat pulses were performed at a light intensity of 550 and 1000 μmol m^{-2} s^{-1} during the heat pulse. Our aim was to assess possible photosynthesis inhibition after a heat pulse or a heat plus light pulse.

On a warm summer day, leaf temperatures up to 44 ^{o}C were measured in leaves of *Populus tremula* growing in the sub-boreal climate of Estonia. Laboratory experiments demonstrated that a moderate heat pulse of up to 44 ^{o}C resulted in a reversible decrease of photosynthesis. This decrease was mostly a combination of photosynthesis inhibition caused directly by the heat pulse and a further decrease caused by subsequent transient stomatal closure. Simultaneous application of higher light intensity with the heat pulse did not lead to significantly different results. A strong heat pulse (above 44 ^{o}C) resulted in sustained inhibition of photosynthesis. However, cell damage indicated by increased membrane conductivity was not found below 50 ^{o}C. These data demonstrate that heat pulses in the physiological range, while not resulting in cellular damage, can cause a transient decrease of photosynthesis due to inhibition and stomatal closure which lasted for about half an hour, thereby reducing whole plant carbon gain in the field.