Title Improving our understanding of storage stress using chlorophyll fluorescence

Author R.K. Prange, J.M. DeLong and A.H. Wright

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Abstract

Since its introduction in 2001, chlorophyll fluorescence-based technology has proven capable of sensing several stresses that may affect fruit and vegetable quality in storage, e.g., O_2, CO_2, temperature, 1-MCP application and the presence of ammonia. Application of a stress results in an increase in the chlorophyll fluorescence parameter, F_α. The most popular application is the detection of the lower oxygen limit (LOL), which correlates with respiratory-based indicators of the LOL. Detecting the LOL and storing at or just above the LOL can result in a reduction in several apple and pear disorders in addition to increased quality retention. If CO_2 was included in combination with O_2 just above the LOL, the F_α baseline value gradually increased in some cultivars, e.g., 'Golden Delicious', suggesting a CO_2-induced stress. If the CO_2 was low, i.e., <2.0 kPa, there were no CO_2-related disorders and an improvement was noted in firmness and titratable acid retention. Exposure to chilling temperatures was associated with an increase in the F_α baseline. And the addition of a low-intensity background light to prevent 'dark adaptation' enhanced the F_α increases associated with chilling stress. In 1-MCP-treated fruit, there was a transient increase in the F_α signal. The 1-MCP transient stress effect in the first 50 h was associated with transient CO_2 and ethylene production increases. An accidental leak of ammonia refrigerant into a commercial store room of apples resulted in a stress-like increase in F_α. A group of carotenoid pigments (violaxanthin, antheraxanthin and zeaxanthin) can be enzymatically inter-converted through the xanthophyll cycle. Experimental results indicate the xanthophyll cycle operates as part of the plant cell's response to low O_2 stress, i.e., violaxanthin decreased, and zeaxanthin and the xanthophyll de-epoxidation state (DEPS) increased. These results suggest: 1) chlorophyll fluorescence is capable of detecting not only low-O_2 stress but also other stresses; 2) storage using chlorophyll fluorescence technology allows for constant monitoring and control of O_2, to achieve maximum quality benefits, including disorder control, without the use of postharvest chemicals; and 3) the xanthophyll cycle is involved in stress effects on chlorophyll fluorescence.