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Interaction of Elevated Carbon Dioxide and Temperature on Strawberry (Fragaria × ananassa) Growth and Fruit Yield

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Abstract : Increase in atmospheric CO₂ concentration [CO₂] and ambient temperature associated with changing climatic conditions will have significant impacts on agriculture crop productivity and quality. Independent effects of the above two environmental variables on the growth, yield and quality of strawberry were well documented. Higher temperatures over the optimum range (20-25ºC) lead to crop failures, while elevated [CO₂] stimulated plant growth and yield but compromised the physical quality of fruits. However, there is very limited understanding of the interaction between these variables on the plant growth, yield and quality. Therefore, this study was designed to investigate the interactive effect of high temperature and elevated [CO₂] on growth, yield and quality of strawberries. Strawberry cultivars ‘Albion’ and ‘San Andreas’ were grown under six different combinations of two temperatures (25 and 30ºC) and three [CO₂] (400, 650 and 950 µmol mol⁻¹) in controlled-environmental growth chambers. Plant growth measurements such as plant height, canopy area, number of flowers, and fruit yield were measured during phonological development. Photosynthesis and transpiration, the ratio of intercellular to atmospheric [CO₂] (Ci/Ca) were measured to estimate the physiological adjustment to climate stress. The impact of temperature and [CO₂] interaction on growth and yield of strawberry was significant (p < 0.05). Across both cultivars, highest fruit yields were observed at 650 µmol mol⁻¹ [CO₂], which was particularly clear at 25°C. The fruit yield gradually decreased at 30°C under all the treatment combinations. However, photosynthesis rates were highest at 650 µmol mol⁻¹[CO₂] but no increment was found at 900 µmol mol⁻¹ [CO₂]. Interestingly, Ci/Ca ratio increased with increasing atmospheric [CO₂] which was predominant at high temperature. Similarly, fruit yield was substantially reduced at high [CO₂] under high temperature. Our findings suggest that increased Ci/Ca ratio at high temperature is likely reduces the photosynthesis and thus yield response to elevated [CO₂].

Keywords : atmospheric CO_2 concentration, fruit yield, strawberry, temperature
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