EFFECTS OF UV-B RADIATION AND ELEVATED CO_2 ON COTTON PLANT GROWTH AND DEVELOPMENT

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Abstract

Carbon dioxide concentration [CO_2] and ultraviolet-B (UV-B, 280-320 nm) radiation at the Earth's surface have been increasing due to human activities and depletion of stratospheric ozone. Changes in [CO_2] and UV-B radiation directly or indirectly affect crop physiology, growth, development, and yield. Earlier studies have shown that elevated CO_2 can increase photosynthesis of C_3 crops, resulting in a significant increase in crop yields. Crop responses to UV-B depend on species, cultivar, UV-B dose, and duration of exposure. Cotton (*Gossypium hirsiutum* L.) responses to elevated CO_2 have been well qualified, but little is known on the effects of increased UV-B radiation on cotton growth, development and physiology. Experiments were conducted in sunlit controlled environmental chambers known as Soil-Plant-Atmosphere-Research units in 2001 to determine interactive effects of atmospheric [CO_2] and UV-B radiation on growth, development, and dry matter accumulation. Six treatments included two CO_2 levels (360 and 720 μL L^{-1}) and three biologically effective UV-B doses (0, 8, and 16 kJ m^{-2} d^{-1}) within each CO_2 level. Treatments were given from emergence through 3 weeks after the first flower stage. Results indicated that both elevated CO_2 and UV-B radiation did not affect dates of squaring and flowering. Elevated CO_2 increased plant height, leaf area, leaf net photosynthetic rate (Pn), and dry matter accumulation. Dry matter partitioning among plant organs, on the other hand, was not affected by [CO2]. High UV-B radiation (16 kJ m^{-2} d^{-1}) mainly reduced plant height, fruiting branch length and leaf area. Decreased plant height was related to shorter internodes rather than the number of main-stem nodes. Fruit dry matter accumulation was most sensitive to UV-B radiation among plant organs. Under the UV-B of 8 kJ m^{-2} d^{-1}, fruit dry weight was significantly lower than control (no UV-B) plants although there was no difference in total dry matter accumulation between the two treatments. The UV-B of 16 kJ m^{-2} d^{-1} reduced both total (43%) and fruit (88%) dry weights compared to the control. Reduction in total dry matter accumulation from the higher UV-B radiation was due to lower leaf Pn and smaller leaf area. Leaf Pn of plants treated with 8 kJ m^{-2} d^{-1} UV-B did not differ from that of control plants, whereas the Pn of plants exposed to 16 kJ m^{-2} d^{-1} UV-B decreased by 35% in 360 μL L^{-1} and 43% in 720 μL L^{-1} during fruiting. Decreased fruit dry weight from UV-B radiation was closely associated with higher fruit abscission or fewer bolls retained. Elevated CO_2 did not alleviate the adverse effects of UV-B radiation on cotton growth and development. The plants grown under elevated CO_2 (720 μL L^{-1}) were even more sensitive to high UV-B radiation compared to the plants grown under ambient CO_2 (360 μL L^{-1}) level.