

Society Science

Corn Growth and Physiological Responses to UV-B Radiation

Ultraviolet-B radiation (UV-B; wavelength of 290–320 nm) is invisible to human eyes and an integral part of the sunlight. UV-B radiation damages DNA molecules in our cells as it is readily absorbed by DNA, but over millions of years, the cells have developed a specialized function to repair this damage. In addition to this DNA resiliency, ozone in the upper part of the atmosphere, specifically in stratosphere, reflects most of the UV radiation reaching the earth's atmosphere. However, over the past 50 years, the concentration of ozone in the stratosphere has decreased about 5%, mainly due to the release of anthropogenic pollutants such as chlorofluorocarbons (popularly known as Freon) that are used in refrigerators and air-conditioning machines.

The current global distribution of mean erythemal (potential for biological damage) daily dose of UV-B radiation between the latitudes 40°N and 40°S during summer ranges between 2 and 9 kJ m⁻², a level which is about 3 kJ m⁻² higher than the 1994 observation. This increase is expected to continue into the 21st century. Even though UV-B represents a small fraction of total solar radiation, exposure to UV-B at current and projected levels is known to elicit a variety of responses in all living organisms, including crop plants. Ground-based measurements across several Corn Belt sites show significantly higher levels during the May–August period that coincides with the peak growth and development of summer crops such as corn, sorghum, cotton, soybean, and peanuts.

In the September–October 2013 issue of *Agronomy Journal*, research collaborators from Mississippi State



Sunlit growth chambers known as Soil-Plant-Atmosphere-Research (SPAR) units, Mississippi State University, Mississippi State, MS used in the current study.

University, Oklahoma State University, USDA-ARS, and the USDA-UVB Monitoring Network, report on a study demonstrating the sensitivity of corn to current and future UV-B radiation doses. The study used a unique sunlit plant growth system known as the Soil-Plant-Atmosphere-Research (SPAR) facility at Mississippi State University. Commercially available corn hybrids Terral-2100 and DKC 65-44 were grown in 2003 and 2008, respectively, at four UV-B levels (0, 5, 10, and 15 kJ m⁻² d⁻¹) from four days after emergence to 43 days under optimum nutrient, water, and temperature conditions. The 5 kJ m⁻² d⁻¹ UV-B level is considered as near the current UV-B dose. Plant growth, development, and photosynthetic rates were measured regularly to help develop data needed for modeling corn responses to UV-B.

The UV-B radiation had a negative effect on the growth and development processes studied. Shorter plants were due to shorter internodal lengths rather than fewer internodes, and the total leaf area was less due to smaller leaves. Lower biomass under enhanced UV-B was closely related to smaller leaf area and lower photosynthesis. Critical UV-B limits, defined as 90% of optimum or control, were estimated from the UV-B response indices. The critical limits were lower for stem extension and leaf area expansion (1.7–3.5 kJ m⁻² d⁻¹) than for leaf number and photosynthetic processes, indicating that expansion or extension rates of organs were more sensitive to UV-B radiation. Hybrid Terral-2100 exhibited greater sensitivity to UV-B radiation than DKC 65-44 for the studied parameters.

The results show that both current and projected UV-B radiation can adversely affect corn growth, and so developing UV-B-tolerant hybrids will provide a benefit under current and future climatic conditions. The functional algorithms developed in this study should improve the corn models to account for the effect of UV-B radiation for more accurate prediction of corn growth and yield.

Adapted from Reddy, K.R., S.K. Singh, S. Koti, V.G. Kakani, D. Zhao, W. Gao, and V.R. Reddy. 2013. Quantifying the effects of corn growth and physiological responses to ultraviolet-B radiation for modeling. *Agron. J.* 105:1367–1377. View the article online at www.dl.sciencesocieties.org/publications/aj/articles/105/5/1367 (Digital Library) or www.agronomy.org/publications/aj/articles/105/5/1367 (Agronomy Journal)

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