MAFES team studies ultraviolet radiation's impact on cotton

Marco Nicovich

By Bonnie Coblentz

Cotton grown under tanning bed lights may lead to the development of new varieties with tolerance for increased ultraviolet radiation.

Raja Reddy, a MAFES research professor of plant and soil sciences, is collaborating with the U.S. Department of Agriculture on two projects dealing with the depletion of the Earth's ozone layer.

With the first project, he is responsible for the maintenance of an automated monitoring device that collects ground-level ultraviolet-B, or UVB, data, which is transmitted daily to Colorado State University.

The monitor is located on MSU's North Farm, one of 32 such monitoring sites nationwide.

"The mission of the monitoring and research program is to provide ground-level UVB radiation information across the country so that seasonal and daily maps of UVB radiation can be developed," Reddy said. "This information can give warnings about days of dangerously high UVB radiation levels and can be used to interpret and correct remote-sensing images."

UVB radiation is part of the radiation coming from the sun. Much of these harmful rays are filtered out by ozone in the earth's stratosphere before they reach ground level, but as the ozone layer is depleted by increased levels of chlorofluorocarbons in the stratosphere, more UVB radiation will reach people, plants and animals on the ground.

Chlorofluorocarbons, or CFCs, were developed in the early 1930s and are used in a variety of industrial, commercial, and household applications, including coolants for commercial and home refrigeration units, aerosol propellants, and electronic cleaning solvents. Research has determined that their release is depleting the ozone in the stratosphere.

"CFCs have a very long life in the atmosphere, and they stay there for about 50 to 150 years, destroying the stratospheric ozone layer," Reddy said. "Once the ozone is partially destroyed, the ground levels get more UVB radiation."

In 1987, the industrialized nations of the world agreed in the Montreal Protocol to phase out their use of these ozone-depleting chemicals, and Reddy said progress has already been made in reducing CFC emissions.

Reddy also is the lead researcher for a USDA project to determine UVB radiation's effects on cotton growth, development and yield. UVB is measured in energy units known as kilojoules. Maximum UVB values range from 8 in Mississippi to 11 in New Mexico.

The research is being done at the former USDA Soil-Plant-Atmosphere-Research site on MSU's North Farm. The sealed Plexiglas chambers at the SPAR facility give researchers the unique ability to control and monitor all the environmental variables impacting a crop.

In addition to Reddy, other project members include research scientists V.G. Kakani, Sailaja Koti and Duli Zhao, all of MSU's Department of Plant and Soil Sciences.

Reddy and his colleagues are growing 15 cotton plants per chamber in 10 of the Plexiglas enclosures. The Plexiglas lets natural sunlight in to provide plants with energy for photosynthesis, while keeping ultraviolet radiation out.

"We provide optimum growth conditions except for the one variable—the UVB radiation," Reddy said. "We supply varying levels of UVB radiation through the use of tanning bed bulbs."

Reddy's research exposes the cotton plants to much higher than normal levels of UVB radiation than is predicted to occur in the future and documenting the results. At extreme levels, flowers are smaller and many appear cup-shaped rather than open. Additionally, the number of anthers, or pollen-producing parts of the flower, are reduced. Leaves show distinct patterns of damage in the form of discolored areas.

"We have detected physiological and morphological changes, but we have not yet correlated this damage to yield," Reddy said. "We're trying to develop crop simulation model so we can predict the beltwide impacts increased UVB radiation would have on cotton."

An anticipated result of this research will be the identification of cotton varieties that exhibit a tolerance to increased UVB radiation.

"If some varieties are more tolerant than others, biotech scientists may be able to use this information to build a better breed of cotton for growth in certain locations where UVB radiation is higher," Reddy said.

MSU was chosen to conduct this research because it has one of just three SPAR facilities in the country, and because of its expertise in environmental plant physiology and crop modeling, including a National Center for Atmospheric Research study of global climate changes.

In that study, Reddy's group combined the MAFES cotton simulation model with NCAR's global climate change model to look at the impacts of global warming and atmospheric changes on cotton.

Reddy's group may soon begin similar research at the SPAR facility on the effects of UVB radiation on corn.

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