through licensed nurseries, and demand has been from 1 to 2 million seeds per year for the Southeast alone. Beckman says as of 1997, supplies have been adequate to meet commercial needs. He is confident that establishment of a seed bank as a hedge against future failures will ensure adequate supplies.

Beckman is gauging Guardian's adaptability in other regions. He and cooperators are testing it at 20 sites in North America, including Canada. It will be a few years before he can measure results, but the rootstock's future as a guardian angel is bright.

"Guardian has excellent potential to replace both popular commercial rootstocks in the Southeast," says Beckman.—By **Tara Weaver,** ARS.

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Horticulturist Tom Beckman checks greenhouse-grown Guardian hybrids.

Enzymes Give Plants UV Protection

Sunlight would kill plants, without enzyme "scissors" that undo gene damage from ultraviolet (UV) rays. In fact, plants have several natural gene menders tailored to the kind of damage done, according to findings of an Agricultural Research Service scientist working with a researcher at the University of California at Davis.

Ultraviolet damage to crops is rare. But knowing the repair mechanisms may be important if UV radiation increases in the future as a result of thinning of Earth's protective ozone layer.

The scientists used *Arabidopsis*, a common white-flowered plant with a small number of genes, which allows for easy tracking of genetic differences.

DNA is a series of chemical bases—A-G-C-T (for adenine, guanine, cystosine, and thiamine)—that form the alphabet of life. If they get damaged, the code is illegible; too much unreadable code and the plant dies.

Plants may respond in several ways to gene damage.

"When your car breaks down, says ARS plant physiologist Edwin L. Fiscus, "you can call someone who does general repairs. But other times, a specialist may be able to perform a particular type of repair much more rapidly and efficiently.

"It's like that for plant cell damage," says Fiscus, who works in the ARS Air Quality-Plant Growth and Development Research Unit. "To fix damaged DNA, there are both general repair enzymes and at least two highly specialized kinds."

Fiscus and geneticist Anne Britt at UC-Davis confirmed what others suspected: that two specialized enzymes in plants are essential for UV repair. They are both from a class of enzymes called photolyases.

The generalized repair enzyme system, says Britt, is probably designed for a wide variety of relatively rare types of damage. It works by excising the damaged bases, or sequences, and rebuilding them—a process that tends to be slow and inefficient.

More common kinds of damage, such as when UV light causes Ts and Cs to crosslink improperly to each other, are also repaired by specialized photolyases, which eliminate this inappropriate bond between the bases. Photolyase repair is specific, rapid, efficient, and—like excision repair—relatively error-free.

Another interesting thing about these enzymes, Britt says, is that they are activated by light, so the very cause of the UV damage is also what triggers its repair.

The scientists proved photolyase enzymes are essential for plants' survival in natural light by using special mutant plants developed by Britt that can't produce the enzymes.

Fiscus, whose research station is on the campus of North Carolina State University, devised special growth chambers that delivered precise doses of various ratios of UV light and regular sunlight. The mutant plants were highly sensitive to UV light, compared to normal plants.—By **Jill Lee,** ARS.

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