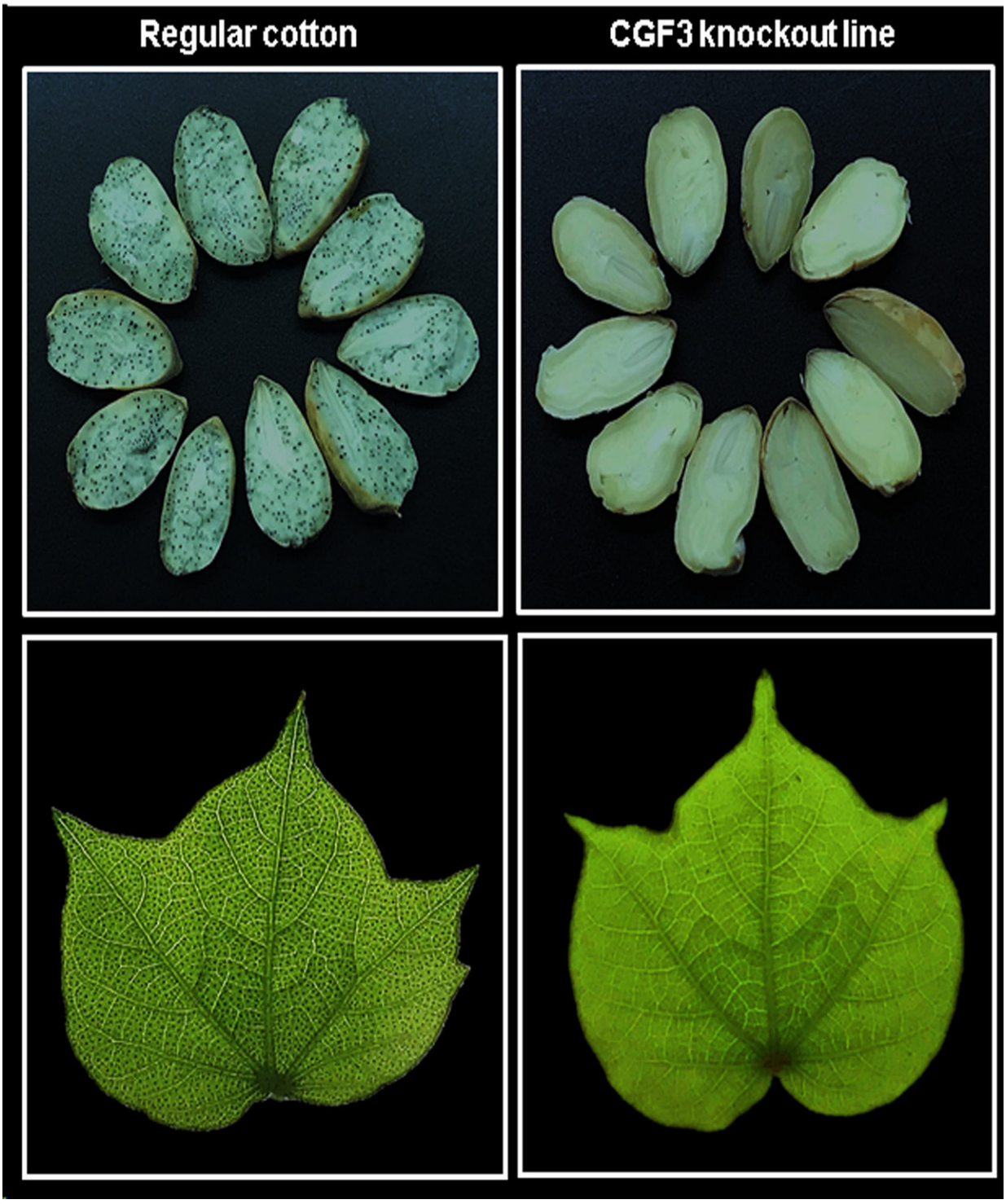
Manipulation of gossypol-containing glands in cotton can boost plant's natural defenses

January 7 2019, by Kay Ledbetter



Left top and bottom, normal cotton exhibits gossypol-containing glands (dark-colored dots) in the seed and leaf. Right top and bottom, seed and leaf show the effect of laboratory-created disruption of Cotton Gland Formation gene 3,

CGF3, confirming its role in gland development. Credit: Dr. Devendra Pandeya

Development of a cotton plant with stronger natural defenses due to a greater gland density and thus more gossypol in the leaves could soon be a reality, according to a Texas A&M AgriLife Research plant biotechnologist in College Station.

Seeds and other parts of cotton possess dark glands containing toxic terpenoids such as gossypol that defend the plant against pests and pathogens, said Dr. Keerti Rathore, AgriLife Research plant biotechnologist in the Institute for Plant Genomics and Biotechnology at Texas A&M University.

Rathore and his team compared RNA production in the embryos from a glanded cotton and a mutant glandless plant. These analyses resulted in the identification of three genes that play a critical role in gland formation, he said.

The study, "Genes regulating gland development in the cotton plant," has been published online in the *Plant Biotechnology Journal*. The team used virus-induced gene silencing and CRISPR-mediated gene knockout to reduce/eliminate the glands in the plant, thus validating the function of the genes.

Rathore's lab recently announced development and deregulation of a gossypol-free cottonseed – ultra-low gossypol cottonseed or ULGCS – that could be a new source of protein for the more efficient aquaculture species and poultry or even as human food.

However, equally important in the world of scientific discoveries, he said, is the intriguing possibility of enhancing the expression of these

genes to increase the number of glands in the leaves and floral tissues. This would allow for boosting gossypol production in those locations and strengthening the plant's natural defenses.

"There is an increasing need for such a natural defense mechanism against pests because more and more insect species are developing resistance to various forms of Bt-cotton," Rathore said.

He said the results of this continued study "is a very important scientific discovery, and it also has some historical significance."

Rathore explained that in the 1950s, a cotton breeder discovered a mutant cotton plant that was free of glands being grown by the native Americans of the Hopi tribe in Arizona. These cotton plants were the original source of glandless and, therefore, gossypol-free cottonseeds.

"A lot of human nutrition and animal feeding trials were conducted using these, including some at Texas A&M," he said. "However, these plants did not fare very well in the field because they lacked the protection provided by gossypol."

He explained this is when his ultra-low gossypol cottonseed work proved helpful.

"We had selectively eliminated gossypol from the seed only," Rathore said. "Now, in this recent paper, we show exactly the genes that are defective and the nature of the mutations in this Hopi cotton for the first time. Even though breeders have known about the Hopi cotton for the past 64 years, no one knew the exact nature of mutations that made the plant free of glands."

The sequence of the genes now provides Rathore and other researchers with tools that can be used to selectively eliminate gossypol from the

seed as well as increase the number of glands, and therefore gossypol levels, in the leaves and floral parts to help the cotton plant better defend itself against pests.

"To provide an analogy, our ULGCS trait is akin to iPhone 4, whereas this discovery represents technology that can be used to create iPhone 10," he said.

More information: Madhusudhana R. Janga et al. Genes regulating gland development in the cotton plant, *Plant Biotechnology Journal* (2018). DOI: 10.1111/pbi.13044

Provided by Texas A&M University