How do you get plants to grow on Mars?

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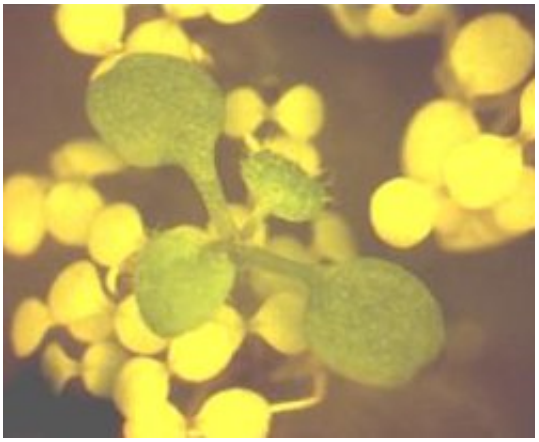

The first step: relieve their anxiety.

Anxiety can be a good thing. It alerts you that something may be wrong, that danger may be close. It helps initiate signals that get you ready to act. But, while an occasional bit of anxiety can save your life, constant anxiety causes great harm. The hormones that yank your body to high alert also damage your brain, your immune system and more if they flood through your body all the time.

Image: Genetically engineered plants growing in Boss and Grunden's lab.

Plants don't get anxious in the same way that humans do. But they do suffer from stress, and they deal with it in much the same way. They

produce a chemical signal -- superoxide (O_2-) -- that puts the rest of the plant on high alert. Superoxide, however, is toxic; too much of it will end up harming the plant.

This could be a problem for plants on Mars.

According to the Vision for Space Exploration, humans will visit and explore Mars in the decades ahead. Inevitably, they'll want to take plants with them. Plants provide food, oxygen, companionship and a patch of green far from home.

On Mars, plants would have to tolerate conditions that usually cause them a great deal of stress -- severe cold, drought, low air pressure, soils that they didn't evolve for. But plant physiologist Wendy Boss and microbiologist Amy Grunden of North Carolina State University believe they can develop plants that can live in these conditions. Their work is supported by the NASA Institute for Advanced Concepts.

Stress management is key: Oddly, there are already Earth creatures that thrive in Mars-like conditions. They're not plants, though. They're some of Earth's earliest life forms--ancient microbes that live at the bottom of the ocean, or deep within Arctic ice. Boss and Grunden hope to produce Mars-friendly plants by borrowing genes from these extreme-loving microbes. And the first genes they're taking are those that will strengthen the plants' ability to deal with stress.

Ordinary plants already possess a way to detoxify superoxide, but the researchers believe that a microbe known as Pyrococcus furiosus uses one that may work better. P. furiosus lives in a superheated vent at the bottom of the ocean, but periodically it gets spewed out into cold sea water. So, unlike the detoxification pathways in plants, the ones in P. furiosus function over an astonishing 100+ degree Celsius range in temperature. That's a swing that could match what plants experience in a

greenhouse on Mars.

The researchers have already introduced a P. furiosus gene into a small, fast-growing plant known as arabidopsis. "We have our first little seedlings," says Boss. "We'll grow them up and collect seeds to produce a second and then a third generation." In about one and a half to two years, they hope to have plants that each have two copies of the new genes. At that point they'll be able to study how the genes perform: whether they produce functional enzymes, whether they do indeed help the plant survive, or whether they hurt it in some way, instead.

Eventually, they hope to pluck genes from other extremophile microbes -- genes that will enable the plants to withstand drought, cold, low air pressure, and so on.

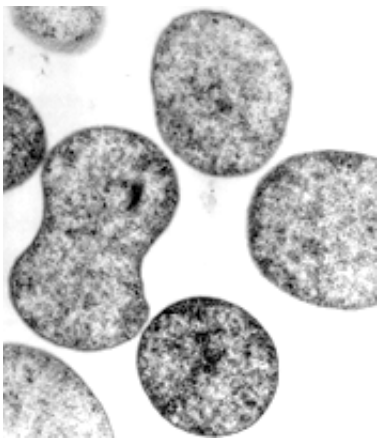

Image: Pyrococcus furiosus, photographed by Henry Aldrich of the University of Florida.

The goal, of course, is not to develop plants that can merely survive Martian conditions. To be truly useful, the plants will need to thrive: to produce crops, to recycle wastes, and so on. "What you want in a

greenhouse on Mars," says Boss, "is something that will grow and be robust in a marginal environment."

In stressful conditions, notes Grunden, plants often partially shut down. They stop growing and reproducing, and instead focus their efforts on staying alive--and nothing more. By inserting microbial genes into the plants, Boss and Grunden hope to change that.

"By using genes from other sources," explains Grunden, "you're tricking the plant, because it can't regulate those genes the way it would regulate its own. We're hoping to [short-circuit] the plant's ability to shut down its own metabolism in response to stress."

If Boss and Grunden are successful, their work could make a huge difference to humans living in marginal environments here on Earth. In many third-world countries, says Boss, "extending the crop a week or two when the drought comes could give you the final harvest you need to last through winter. If we could increase drought resistance, or cold tolerance, and extend the growing season, that could make a big difference in the lives of a lot of people."

Their project is a long-term one, emphasize the scientists. "It'll be a year and a half before we actually have [the first gene] in a plant that we can test," points out Grunden. It'll be even longer before there's a cold- and drought-loving tomato plant on Mars--or even in North Dakota. But Grunden and Boss remain convinced they will succeed.

"There's a treasure trove of extremophiles out there," says Grunden. "So if one doesn't work, you can just go on to the next organism that produces a slightly different variant of what you want."

"Amy's right," agrees Boss. "It is a treasure trove. And it's just so exciting."

Source: Science@NASA (Author: Karen Miller, Editor: Dr. Tony Phillips)