Plants use sixth sense for growth aboard the space station

April 6 2015, by Laura Niles

These culture dishes hold seedlings and the growing medium for the Plant Gravity Sensing investigation, which were used during astronaut training at the Japan Aerospace Exploration Agency's Tsukuba Space Center in March 2014. Credit: European Space Agency/S. Corvaja

Although it is arguable as to whether plants have all five human senses –

sight, scent, hearing, taste and touch – they do have a unique sense of gravity, which is being tested in space. Researchers with the Japan Aerospace Exploration Agency will conduct a second run of the Plant Gravity Sensing study after new supplies are delivered by the sixth SpaceX commercial resupply mission to theInternational Space Station. The research team seeks to determine how plants sense their growth direction without gravity. The study results may have implications for higher crop yield in farming and for cultivating plants for long-duration space missions.

The investigation examines the cellular process of formation in thale cress, or Arabidopsis thaliana, a small flowering plant related to cabbage. The genetic makeup of thale cress is simple and well-understood by the plant biology community. This knowledge allows scientists to easily recognize changes that occur as a result of microgravity adaptation.

Understanding the cellular processes in plant development may translate to better knowledge of cellular processes in the human body. Since thale cress is considered a model organism for biological research, there are genetic similarities that may reveal insights into our health. Specifically, this could impact medical science since research teams may gain a better understanding of mechanisms of diseases affected by gravity, such as osteoporosis and muscle loss.

In the Plant Gravity Sensing study, scientists examine whether the mechanisms of the plant that determine its growth direction – the gravity sensor – form in the absence of gravity. Specifically, the research team analyzes how concentrations of calcium behave in the cells of plants originally grown in microgravity when later exposed to a 1g environment, or gravity similar to that on Earth. Plant calcium concentrations have been shown to change in response to temperature and touch and adapt to the direction of gravity on Earth.


esa
European Space Agency

European Space Agency astronaut Alexander Gerst trains for the Plant Gravity Sensing investigation at the Japan Aerospace Exploration Agency's Tsukuba Space Center in March 2014. Credit: European Space Agency/S. Corvaja

"Plants cultivated in space are not experienced with gravity or the direction of gravity and may not be able to form gravity sensors that respond to the specific direction of gravity changes," said Hitoshi Tatsumi, Ph.D., principal investigator of the Plant Gravity Sensing investigation and associate professor at Nagoya University in Nagoya (present address: Kanazawa Institute of Technology), Japan.

Researchers use a centrifuge in the [Cell Biology Experiment Facility in Kibo](), the Japanese Experiment Module, to monitor the plants' response to changes between microgravity and a simulated 1g condition. The research team does this to determine if the plants sense changes in gravitational acceleration and adapt the levels of calcium in their cells.

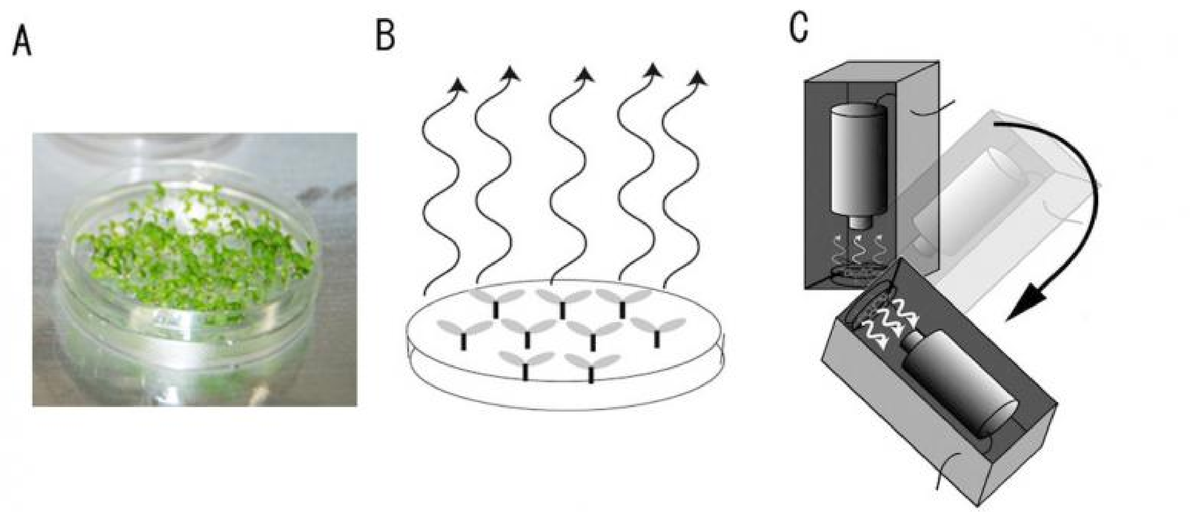

Image A is a culture dish of Arabidopsis seedlings for the Plant Gravity Sensing investigation. Image B illustrates photon emission from the plants when plants are rotated and calcium ion concentrations increase. Image C illustrates the apparatus for rotating plants and detecting photon emissions. Credit: JAXA/Hitoshi Tatsumi

Scientists hypothesize that the process in which amyloplast – particles within the plant cell that store and synthesize starch for energy – distributes and assembles occurs in the direction of gravitational pull. Once the amyloplast settles, it activates mechanisms within the plant's cells, including an increase in calcium concentrations. These mechanisms form the molecular structure in the cell that stimulates gravity sensing for growth. The unknown here is whether or not the gravity sensing components actually assemble in microgravity to determine direction of plant growth.

NASA Astronaut Karen Nyberg harvests plants from a Japan Aerospace Exploration Agency investigation of Arabidopsis thaliana during Expedition 37. Credit: NASA

If the study hypothesis is proven true, it may be possible to modify plant gravity sensing mechanisms on Earth or to cultivate healthy plants for consumption on future deep space missions or conceivably on other planets. The plant's gravity sensor may be regulated for growth in either a low or high magnitude of gravitational acceleration.

"We may design plants that respond to gravity vector changes more efficiently than wild ones," said Tatsumi. "These plants will recover from collapse by winds or flood more rapidly than wild ones. Thus, the agricultural output of the designed plants will be greatly increased, which may solve, in part, the shortage of crops in the near future."

It makes "sense" why researchers are interested in thale cress and what it may reveal off the Earth for the Earth. Research aboard the space station may illuminate the mystery of a plant's "sixth sense," literally turning plant gravity sensing research on its head.

Provided by NASA

Citation: Plants use sixth sense for growth aboard the space station (2015, April 6) retrieved 26 April 2024 from https://phys.org/news/2015-04-sixth-growth-aboard-space-station.html