To boldly go where no tomato has gone before

Michael Stasiak, TechNote 002-2011

If we ever want to leave our comfy life-friendly planet and explore farther into space than low earth orbit (like on the International Space Station) or the Moon, we need to find solutions that will provide long term life support for our astronauts. Currently, spacecraft carry just enough food, oxygen, water and chemicals for carbon dioxide removal to service astronauts for the duration of their missions. On the International Space Station, new supplies are carried from Earth with every crew change. Luckily the ISS is only about 350 kms away and it only takes about 3 days to get to the moon. Too far to order pizza, but close enough that resupply isn't a huge issue. Travelling to Mars and back, however, would take almost two and a half years. An obvious way to provide all the crew's life support requirements for long-term missions is to develop plant-based systems that consume the carbon dioxide exhaled by humans, while providing the oxygen, food and water that we need to survive. After all, it's plants that provide us with life support on Earth, so using them to help us survive off planet makes perfect sense.

One of the plants considered (aka 'candidate crop species') for use in biological life support systems is the tomato. Why the tomato? Besides being tasty and nutritious, it also has small hardy seeds, a short germination period, a low light compensation point (grows well with less light), is easily pollinated, and has a high yield of food energy per cubic metre of growing volume. Seed hardiness and seedling survival are two of the key factors that are investigated in the Tomatosphere program, where for the past ten years, schools across North America have been conducting experiments with tomato seeds that have been exposed to a variety of spacey environments including:

- Flying in space - once for 19 months (The longest a human has been in space for a continuous period is 437.7 consecutive days – almost 15 months, a record held by Dr. Valeri Vladimirovich Polyakov)
- Devon island – a Mars analog site in the Canadian North
- Environment *simulations* such as a space environment (-80C in a vacuum), a Mars atmosphere (-50C, 0.6 KPa pressure, mostly CO2, high UV levels), and a high gravity aerocapture (using the Mars atmosphere to decelerate and achieve orbit)

Initiated in 2001 by Canadian astronaut Dr. Bob Thirsk, Dr. Mike Dixon at the University of Guelph, and Ron Thorpe from the Toronto Board of Education, Tomatosphere is an

educational outreach program designed to teach, excite and captivate students (tomatonauts!) from grade 2 through 10 in the science of space exploration and agriculture.

By exposing seeds to different 'space' environments, students can see if the seeds have been affected by the different conditions. These germination experiments are 'blind'. Students get a set of seeds that have been treated and a set that has not (control), but they don't know which is which. This removes the inherent human nature of coddling the ones you like better, also known as 'bias'. The information each classroom gathers is collected and combined with results from all the other schools (exceeding 13,500 classrooms in 2011!), and the collected data helps us better understand the effect of different storage environments on seed germination and seedling development. This type of research helps determine which types of seeds have the highest potential for germination and growth in space.

Through the Tomatosphere program, students not only learn how to conduct scientific experiments, but they may be inspired to pursue further education in the areas of science and technology. Each classroom Tomatosphere program is designed to enhance the current science and technology curriculum, and the current programs include:

- Grades 3-4: How to Feed a Martian - a unit with a nutrition focus for astronauts' trips to the Red Planet
- Grade 6: Surviving on the Red Planet - Recycling breathable air
- Grades 7-8: The Martian environment - a weather station on Mars
- Grades 9-10: The Energy to Survive - nutritional requirements for long duration missions

So what have we learned over the last 10 years? Seeds have taken whatever we've thrown at them so far. The microgravity of low earth orbit, low pressure (simulated vacuum of space) and freezing temperatures (-80!) – and they germinate and grow just fine.

Tomatosphere is sponsored by Agriculture and Agri-Food Canada, the Canadian Space Agency, Heinz Canada Ltd, HeinzSeed, Ontario Centres of Excellence, Stokes Seeds and the University of Guelph.

This TechNote is also blogged on the Ontario Ministry of Research and Innovation website and you can find it here:

http://www.mri.gov.on.ca/blog/index.php/2011/08/mikestasiaktomatosphere/

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If you would like more information, email us! TechNote@ces.uoguelph.ca

Controlled Environment Systems Research Facility
School of Environmental Sciences, University of Guelph, Guelph, Ontario, Canada