

# Plant Habitat-04



*'Española Improved' peppers growing during a ground based demonstration in the Advanced Plant Habitat Ground unit at NASA's Kennedy Space Center.*

NASA's Plant Habitat-04 (PH-04) experiment will cultivate peppers aboard the International Space Station for the first time. The Hatch chile peppers will grow for about four months before astronauts harvest them. The crew will eat some of the peppers and send the rest back to Earth for analysis. This plant experiment will be one of the most complex to date on station because of the long germination and growing times. The study will add to NASA's knowledge of growing food crops for long-duration space missions.

## Why Grow in Space?

NASA and its international and commercial partners have demonstrated skill in solving the challenge of feeding crews in low-Earth orbit. Astronauts have lived and worked continuously in space for more than [20 years](#), eating mostly packaged foods along with some fresh foods delivered on regular resupply missions. In preparation for Artemis missions to the Moon and beyond, researchers are developing ways to sustain explorers for missions to destinations beyond low-Earth orbit including Mars, missions that may last for months or even years and have limited opportunities for resupply missions.

Feeding crews on the Moon, and especially Mars, will be a logistical challenge. While crews will still rely on packaged foods from Earth, part of the challenge

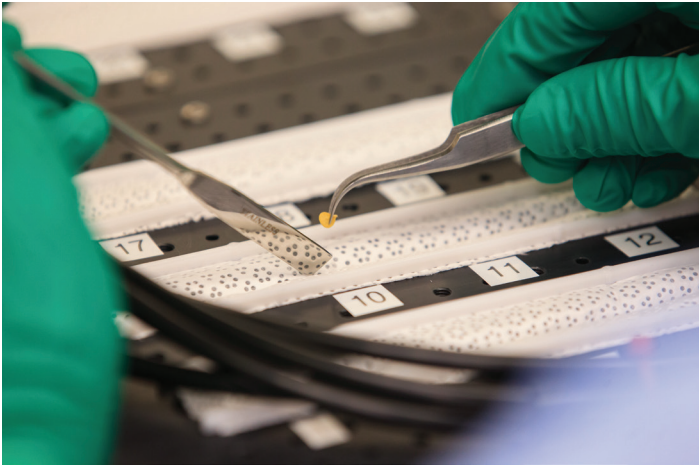
is that sending supplies beyond low-Earth orbit requires more propellant and longer delivery times, particularly to Mars. Packaged foods stored for long periods results in degradation of the food quality, which reduces the amount of key nutrients like Vitamin C and Vitamin K. Since 2015, astronauts have grown and eaten 10 different crops on the space station as they research ways to address these challenges and supplement their diets with fresh food. Other benefits of growing their own crops includes adding variety to meals so astronauts won't grow tired of repeatedly eating the same foods. Researchers are also examining psychological benefits of seeing, smelling, and caring for plants in isolated, closed loop environments. Growing peppers in space may also benefit us here on Earth by demonstrating the feasibility of using existing pepper varieties in controlled environment agriculture.

## Why Peppers?

Peppers contain several key nutrients and are an excellent source of Vitamin C. The plants are also robust with a good chance of growing successfully in microgravity. Peppers are self-pollinating, making fruit easy to grow as it only requires agitating the plants. Plus, peppers add tasty variety to crew diets. They are easy to handle in microgravity and are a pick-and-eat crop that does not require cooking or complex processing. The fruit also have low microbial levels, so they are safe for astronauts to consume. While taking far longer to grow than NASA's previous space crops, this variety of peppers matures in a few months and has grown well in the limited space available inside the Advanced Plant Habitat (APH) during ground tests.

## Growing Peppers in Space

A team at NASA's Kennedy Space Center sanitized and planted 48 pepper seeds in a device called a science carrier that contains baked clay for roots to grow in and a controlled release fertilizer specially formulated for peppers. The science carrier will launch to the space station aboard the upgraded version of SpaceX's Dragon spacecraft. The science carrier fits into the APH, the largest of three plant growth chambers aboard the orbiting lab. The APH is about the



A researcher from NASA's Kennedy Space Center in Florida prepares pepper seeds for planting inside science carriers on April 8, 2021, inside the Space Life Sciences Lab for the Plant Habitat-04 (PH-04) experiment.

size of a large microwave oven and has more than 180 sensors and controls for monitoring plant growth and the environment.

Astronauts will place the science carrier in the APH and add water to start the experiment. A team at Kennedy will monitor the experiment from Earth, controlling watering, lighting, and other environmental conditions. They also will grow a crop of peppers as a ground control in an APH unit at Kennedy under simulated space station conditions. Working together with researchers, the crew in orbit will regularly check on the peppers and perform horticultural tasks like harvesting.

## Finding the Right Peppers

Researchers at Kennedy spent two years evaluating more than two dozen pepper varieties from around the world. The team selected a Hatch chile pepper, the generic name for several different varieties of green chile peppers from Hatch, New Mexico, and the Hatch Valley in southern New Mexico. PH-04 uses the NuMex 'Española Improved' pepper, a hybrid developed by New Mexico State University that combines the 'Hatch Sandia' and the traditional 'Española' pepper of northern New Mexico. This pepper grew best in ground tests in the APH, adapting well to controlled environment agriculture and beating out other Hatch pepper cultivars including 'Big Jim', 'Sandia', 'NuMex 6-4', and 'Lumbre X-Hot'.

## Spicy Peppers

The Hatch chile pepper is considered a mild heat pepper, with a rating of 2,000-4,000 Scoville Heat Units. The rating can vary based on growing methods and environmental conditions. The

amount of water these peppers receive is probably the most important factor in determining how spicy the peppers are. However, microgravity is a stressor for plants and could have an impact. Part of the data collected from PH-04 will include crew feedback about the flavor and texture of the peppers, along with Scoville measurements from peppers grown on the space station and on the ground at Kennedy.

## “Red or Green?”

A common question in New Mexico is “red or green?” Astronauts will have a chance to taste them both with PH-04 because 'Española Improved' peppers turn from green to red as they mature, and people commonly eat the pepper both ways.

## Quick Facts

**Science Team Lead:** Matt Romeyn

**Project Manager:** Nicole Dufour

**Project Science Team:** Lashelle Spencer (lead), Jacob Torres, Jeff Richards, Oscar Monje

A diverse team of NASA and contracted scientists specializing in space crop production contributed to this work. One of the team members is an Española, New Mexico, native. The team has worked closely with others at multiple NASA centers, the ISS National Lab, and industry partners supporting science on the International Space Station.

**Growth Chamber:** The Advanced Plant Habitat

**Pepper Cultivar:** NuMex 'Española Improved' pepper

**Growing time:** 120 days with harvests on days 100 and 120

**Number of peppers planted:** 48

**Growth Medium:** Arcillite, a calcined clay frequently used on baseball infields for water management and soil conditioning

**Fertilizer:** Controlled-release fertilizer

**Launch:** PH-04 [launched June 3, 2021](#), aboard the upgraded version of SpaceX's cargo Dragon spacecraft as part of the company's 22nd commercial resupply services mission (CRS-22).

**Funding Source:** NASA's Biological and Physical Sciences funded the ground and development work. The International Space Station Program funds PH-04.

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