

VUSE Life Science Experiments: Growing Plants in a Moon-ice Habitat. S. van Bloois¹, B. de Winter², B. Foing^{3,4,5}, M. Heemskerk⁴ and VU Amsterdam Igluna Team ¹VU Amsterdam (stijnvanbloois@tele2.nl), ²VU Amsterdam (dewinterbram@hotmail.com), ³ESA ESTEC, ⁴VU Amsterdam, ⁵ILEWG

Introduction: The availability of plants is inevitable for space exploration and eventually the survival of life in space. Not only for the process of photosynthesis and thus the CO₂ and O₂ circulation inside the habitat, but plants can be used for nutrition as well. The focus of Life Science Igluna(VUSE[1]) will be mainly the growing of plants and which plants thrive substantially better than other species under cold and dry circumstances. Therefore the plant must have a low need for water, should thrive under cold conditions and must grow on moon soil.

Methods: Eight plants will be tested for growing. These are selected due to their extreme survival in cold environments on Earth. For rooting three types of soil will be tested as well: 1. only moon soil, 2. Earth soil, 3. a mix between Earth and moon soil. Each specie will be planted in one of these three soils for determining which is soil has the highest growing rates and survival ability.

Which plants will be tested?

1. *Broccoli*, can grow with a minimum temperature of 4,4 °C and needs slightly acidic conditions.
2. *Quinoa*, grows in cold and nutrient poor conditions. Prefers a Ph of 6,0 -7,5 and quinoa is drought tolerant.
3. *Carrots*, can grow in light freezing conditions and need almost 4 months to grow. Need a deep soil which is loose and well drained and has optimal temperatures of 16°C-21°C, the challenge will be to try colder conditions.
4. *Spinach*, prefer a near-neutral soil and can grow in cold environments (winter spinach).
5. *Lettuce*, need significant amount of water. But lettuce can thrive in low temperatures.
6. *Turnips*, need a well-drained soil, but for the IgLuna habitat dryer soils can be tried.
7. *Cabbage*, can grow in temperatures of 4°C-24°C. But, need adequate amounts of nitrogen, potassium and phosphorus in the soil.
8. *Reflexed Stonecrop*, a specie which can survive extreme nutrient poor and dry soil conditions. Mostly on soils with a light acidic till basic pH and stonecrop needs low nitrogen amounts for growing. The leaves are the edible parts of the plant.

A freezer will be used for simulating the cold environment (Fig.1) Inside the freezer a red light will be installed for applying light for plant growth. Red light is being used as plants have the highest absorption rates when red light is used. Inside the freezer the small boxes with different soils and species will be placed. The plants will be watered around 1-2 days for optimal plant growth. Also, the plant growth will be measured and whether the plants contain enough nutrients/are edible for the survival of humans.



Figure 1. A setup example for plant growing inside a freezer. Source: bionicscientific.com

Zermatt field campaign: In July 2019 a simulation inside an icy habitat will take place in Zermatt (Switzerland). All equipment and tools will be test *inside* the glacier to see whether they work properly or not. This will be an excellent occasion for testing the life science department of the Igluna habitat.

Due to the present cold environment inside the glacier (-4°C) a freezer will not be needed. The freezer will only be used for testing *outside* the habitat (in Amsterdam). Thus, only soils, boxes and plants will be needed in Zermatt.

The already grown plants from Amsterdam will be placed inside the habitat and examined whether they survive and still grow. The results will be important for determining the possible further needs for plant growing in space. For example, whether the soil is not nutritious enough or the need of more light supply. These factors are still to be determined by research, but are of great importance for future space survival and living.

Conclusion: Information provided by Wamelink et al.(2014)[2] states using only moon soil for growing crops can be hard. Therefore, the hypothesis for using only moon soil will be a limited plant growth. But, mixing between nutritious Earth soil and poor moon soil can perhaps provide a more rapid plant growth and more nutritious crops.

Growing plants in a cold environment is also a challenge, as most research has been done on moon soil only and not in cold environments as well. Thus, this research can provide more knowledge and perhaps a better way for growing crops on the moon for future space explorations.

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References:

[1] B. de Winter, Abstract #1588 (2019): VUSE, VU Science Experiments Igluna Project, a science showcase for a moon ice Habitat

[2], G. W. Wieger Wamelink, Joep Y. Frissel, Wilfred H. J. Krijnen, M. Rinie Verwoert, Paul W. Goedhart (2014): can Plants Grow on Mars and the moon: A Growth Experiment on Mars and moon Soil Simulants

[3] <http://www.bionicsscientific.com/test-chambers/plant-growth-chamber.html>

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