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Introduction: Botany on The Moon is an instrument suite designed to investigate the feasibility of plant growth on the Moon. Botany is composed of two single-species plant growth modules (Arabidopsis, & radish) plus two environmental monitoring instruments that record (1) direct and scattered sunlight in the photosynthetically active radiation or wavelengths (termed PAR), and (2) level of cosmic radiation and induced lunar neutrons. Together these four investigations contribute to our understanding of how plants can be grown on the Moon (Table 1).

Table 1. *Four investigations forming the Botany payload.*

Plant Growth	Reason	Botany Elements
Arabidopsis thaliana (60 seeds)	Monitor growth & gas exchange of the model organism.	LPX1 -AT
Radish (32 seeds)	Monitor growth and gas exchange of a food crop.	LPX 2-FC
Environmental Monitoring Sensors		
PAR 400-700 nm	Relevant to Photosynthesis	LPAR
Ionizing radiation	Relevant to long term plant growth and seed storage. (Charged particles & neutrons)	CNP-TEPC

Plants are an essential component of long-term human outposts on the Moon. Most importantly, they provide a source of food. Plant systems can also be a key part of the recycling system for the air and solid wastes. [1, 2] Plants can also be used to produce useful compounds, for example pharmaceuticals and medicines. [3, 4]

Developing technologies to provide a nutritious diet for astronauts on other planets is important for the goals of NASA and other space agencies. The initial goal for edible plant growth on the moon is to supplement astronauts rations with fresh food providing nutrients and vitamins. The long-term goal is to use crop species to become independent of resupplies from Earth.[5] Therefore, it is important to understand the biology of plants on the Moon and Mars.[6,7]

The core perspective in Botany is that physical experiments are needed to understand plant growth on the Moon. There is very little data to show how plants will grow in the partial gravity and high radiation environment on the surface of the Moon or Mars.[6] The vast literature on the growth of plants on the surface of the Earth has been augmented by a rapidly increasing knowledge of plant growth in zero g/ microgravity. [2] In comparison, little is known about plant behavior in reduced (fractional) gravity environments (less than the nominal 1*g* that occurs on Earth). How biology responds to partial gravity (in combination with radiation effects) remains unexplored. Only recently, on the International Space Station (ISS), have studies with small centrifuges begun investigations at partial gravity to test response of plants.[8, 2, 9]

The recent Chinese Chang'e 4 lunar lander included a biosphere experiment which contained approximately 50 assorted plant seeds, fruit fly pupae, and yeast.[10] However, only one cotton seed germinated, its growth was irregular, and the data were not definitive whether it germinated on the lunar surface or in transit. All other organisms died. Botany's operations begin once on the Lunar surface, sensors within the LPX boxes record changes within the box, ensuring a timely and controlled release of water, wetting the seeds to begin germination. Thus, Botany would be demonstrating in a systematic way that plants can be grown on the surface of the Moon and represent an important step in using plants as a food source for future human lunar missions.

Botany's primary science goals can be achieved during the sunlit timeframe of a Lunar Day. However, significantly more data and knowledge is gained by extending the growth duration window. The Botany instrument suite including the LPX plant chambers are designed for a 45 Earth-day mission on the Lunar surface, including surviving the 354 hours of the Lunar night. The Botany on The Moon proposed project has a payload mass of ~ 12kg (Figure 1) and cost ~ $11.5 M

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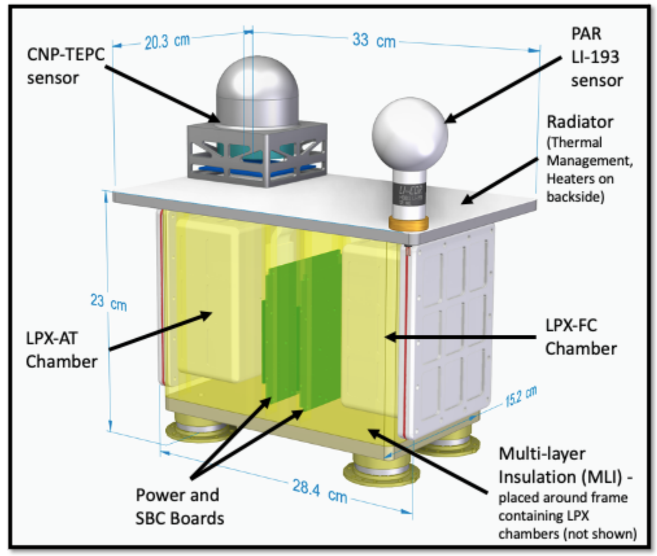

Figure 1: Conceptual diagram of the Botany on The Moon instrument suite.