PERSPECTIVE: SUSTAINABLE SPACE TECHNOLOGIES

Genesis1:11™

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Competing interests: Author(s) stated no compete of interest.**Edited by:** Ákos Keresztúri; Daniel A. Lowy; Máté Szarka**Grant information:** Dama Research Center limited supported this study.**Copyright** 2020 © The Author(s). This is an Open Access article under the CC-BY 4.0 license published by Dama Research Center limited a private company limited by shares organized and existing under the laws of Hong Kong, with its head office located at Room 409, Beverley Commercial Centre, 87-105 Chatham Road South, Tsim Sha Tsui, Kowloon- Hong Kong and company number: 2875213.**How to cite:** Mátyás, B. "Genesis1:11" *DRC Sustainable Future* 2020. 1(2): 86-93. DOI: 10.37281/DRCSF/Genesis1:11 **ABSTRACT**

Genesis1:11™ is a distant places plantation and forestation-supporting high-technology concept including but not limited to semi-capsuled ecosystems and various physical and precision software tools making it possible to inject microorganisms and to grow plant roots into extraterrestrial soils contributing to a sustainable future for the humankind in remote places (especially terraforming Mars) having extreme climatic and environmental conditions. In this paper main characteristics and utilization areas of Genesis1:11™ Rocket Capsule and technical specifications of Genesis1:11™ Rooting Pot are being discussed without claiming completeness, including a demonstration how a complex organism like a plant might provide a useful and simple host for large number of microbes.

Keywords: Astrobiology, Mars forestation, Genesis1:11, Rocket Capsules, Rooting Pots

1. Genesis1:11™ Rooting Pot

Genesis1:11™ Rooting Pots were designed¹ to cause up and down directional roots' growth, thus presenting more ways to spread out both side and main roots. The aim being to increase the chance of successful assimilation for plants when training them to grow into extraterrestrial soils.

Figure 1. Exploded view of a Genesis1:11™ Rooting Pot. (A) Cover slows down soil evaporation meanwhile provides ventilation for topsoil. (B) Innermost layer punched in the upper third of its area. (C) second layer punched on the downer third part. (D) third layer punched in the upper third of its area. (E) outermost layer is not punched.

Plant should be placed or seeded into the innermost layer (Figure 1/B) one plant per pot is recommended; filled with control (optimal nutrient supply capacity) soil only. Hole punching takes place at the top third part of the innermost layer's area (Figure 2-3). With this, roots first need touch bottom, then grows up, making sure plant takes up all essential nutrients before would grow into the next space. At second layer (B), holes take place at the bottom third part of its total area. Size of holes are determined mainly by the test plant's needs, and their root characteristics. At the moment 0.5, 0.6 and 0.7cm diameter holes are being tested in our pot experiments considering that mainly tomato and other low-growing crops are being involved in our research.

Figure 2. Cross sectional illustration of a Genesis Rooting Pot.

Space between innermost (B) and second layers (C), soil mix with preferred ratio should be filled. Second, and third spaces between outer layers (C-D and D-E) *mutatis mutandis* are filled with an increasing proportion of soil mix according to the experimental requirements.

Figure 3. Layers and hole punching

The outermost space (between D and E) only the simultaneous soil takes place. Distance between each layer is 1cm (Figure 2). It is recommended to be careful not to compact the soil too much when filling spaces between the layers.

Figure 4. Plan view of a Genesis1:11™ Rooting Pot.

Soil physical properties (compaction) should be approximately the same as those of the innermost layer. Ventilation is ensured for each space between layers as can be observed on the plan view of the rooting pot (Figure 4). As well as at bottom (Figure 1/E) of the pot holes are placed between each layer to eliminate the inconvenience caused by overwatering.

Recommendations:

- A. Pot material should not contain metals considering that in practice very rapid oxidation can occur on remote planets (especially on Mars), which is why metal it may interfere simulation.
- B. Sensors can be installed between layers on demand. Alternatively, location of holes makes it possible to carry out occasional measurements between layers; in this case make sure to do not hurt roots while placing device, in any case protecting tube is highly recommended.
- C. We recommend furthermore, to wash out all soil with plenty of water before attempting to remove plant roots from the pot. Although the weight of the root can be measured even in the event of fracture, it is essential for length analysis that the root remain intact.

Figure 5. Top cover (top) and bottom part (bottom) of a Genesis1:11™ Rooting Pot. Hole punching locations make it possible to ventilate topsoil while extra water can runoff from each space between layers avoiding unfavorable (eg. anaerobic) conditions for soil microbes and roots.

2. Genesis1:11™ Rocket Capsule

Genesis1:11™ Rocket Capsules are semi-closed and multi-layered penetrators in which plants and some other eukaryotes can be transported to remote planets. Once there, they can be dropped in the planet's atmosphere from spacecraft. Drilled into extraterrestrial topsoil, they survive and even develop under extreme climatic and environmental conditions; moreover, injection of biofertilizers and plant rooting into extraterrestrial soils is possible by means of this system. The rationality of this concept study is to outline the technical requirement of a transport equipment, which contains highly evolved organisms, like plants. Using a plant as a host organism and also one compartment that supports maintaining micro-scale environmental conditions for various microbes is beneficial, as it may enable the survival of transported microbes over a longer time period as compared to using only bacterial and achaea cells, without a larger macroscopic organism. Penetrators are planned: a) to be loaded into spacecrafts (Starship recommended considering the significant payload capacity of SpaceX's Starship spacecraft and Super Heavy rocket) on Earth (SpaceX, 2020); b) being transported to of atmosphere remote places; current travel time to Mars is approx. 0.75 year (Mátyás et al. 2018; NASA 2020); when planet Earth and Mars are the closest, the distance between them is 5.5×10^7 km (Crane, 2019); c) they can be dropped there from Starship; d) and they fall down, while spinning, owing to stabilizer fins installed to drill bit (Figure 6, bottom). Considering the presently known average thickness of ice-sheet on surface of Mars, 1.3 and 1.8 m long, and 43 and 55 cm $\varnothing$ tubes are being tested in Genesis1:11™ Rocket Capsule prototypes (Figure 6). Medusa is the energy and light supplying unit of the rocket capsule (Figure 6. Upper). It is removable, and accessible for rovers to periodic replacements on demand. Fins are adjustable even during down fall, supporting rocket stability. After impact, fins turn and take optimal angle to collect solar energy and charge Medusa. Tubes are multilayered (Figure 6 Middle), having vacuum between their layers, ensuring thermal insulation. UV LED rings are installed between the layers, in accordance with plant needs and characteristics, e.g., a greater number of UV LED rings are recommended for evergreen species, and they should be placed at the lower part of the tube. This needed because the significant shadowing caused by the rapidly growing needle foliage. Drill bit (Figure 6.

Figure 6. Exploded view of Genesis1:11™ Rocket Capsule. Medusa power supply unit includes: lithium cell batteries and UV LED light units. Fins are adjustable having double function: rocket stability and solar energy collection. Tube is multilayered special superpolymer having vacuum between its layers. Drill bit functions as: (a) rocket stabilizer; (b) rocket nose; and (c) multilayered plant rooting pot system.

Bottom) is also multilayered, and the number and connections of its layers are synchronized with the tube layers. For hole punching, Genesis1:11TM Rooting Pot protocol is being applied; briefly, plant is seeded and/or planted into the innermost layer and filled exclusively with Earth-based control soil (that has optimal nutrient supply capacity). Hole punching in this case is also done at the top third part of the innermost layer, inducing roots first to reach bottom, and then grow up, making sure that plants take up all essential micro and macro-nutrients prior to growing into the next layer. At the innermost layer, soil microbiological activity is the most significant, relative to other layers, as it is the warmest space inside the penetrator. In the following spaces between drill bit layers, ratio of Mars soil simulant is being consistently increased with respect to the initial control soil that was loaded into the innermost layer. Holes on layers are filled with a flexible inorganic polymer composition that allows roots to grow seamlessly between layers, while maintaining inside pressure of the capsule. Buffering capacity and thermal insulation capacity of soil highly depend on the composition of soil particles; with greater clay fraction present, a better insulation can be reached between layers. Continuous monitoring of microbial composition and activity inside and outside the capsule is essential, considering that these microbes are exiting from the system through root growing, and get into direct contact with the extraterrestrial environment. For organic molecules detection inside and outside the capsule we recommend using Microchip Electrophoresis (ME) based instruments, given that they comply with the minimal mass/power/volume requirements (Mátyás et al. 2018). To support selection of ME instruments for detecting organic compounds, we use Science Payload 2.0 (updated version) software. Test results are being discussed in forthcoming papers.

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Supporting material

Models and Technical drawings of each asset of Genesis1:11™ pot

S.Figure 1.Model (left) and technical drawing (right) of Genesis1:11™ Rooting Pot

S.Figure 1.Model (left) and technical drawing (right) of Genesis1:11™ Rooting Pot's cover

S.Figure 3.Model (left) and technical drawing (right) of Genesis1:11™ Rooting Pot (Plan view without cover)

S.Figure 4.Model (left) and technical drawing (right) of Genesis1:11™ Rooting Pot's bottom

S.Figure 5.Model (left) and technical drawing (right) of Genesis1:11™ Rooting Pot's Innermost Layer

S.Figure 6.Model (left) and technical drawing (right) of Genesis1:11™ Rooting Pot's Second Layer

S.Figure 7.Model (left) and technical drawing (right) of Genesis1:11™ Rooting Pot's Third Layer

S.Figure 8.Model (left) and technical drawing (right) of Genesis1:11™ Rooting Pot's Outermost Layer