Plants in Space - Transition from Space Shuttle to Space Station and Beyond

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The International Space Station (ISS) promises longer research times suitable for long-term plant research beyond the 16 days available to date on the US Space Shuttle. However, during the station buildup, and due to the reduced crew of only 3 astronauts, research capabilities will be initially severely limited due to the lack of available crew time. Mass, power and volume constraints on the transfer from and to the Space Station, as well as the lack of adequate sample storage capabilities, such as freezers, further limit the research capabilities during the next few years. Research has to rely on automated systems for plant germination, plant growth, and sample preservation on orbit. Freezer capabilities and transport of frozen material back to Earth for post-flight analysis will not be available for several years.

Several plant research capabilities are available for spaceflight, with only a few capable of supporting long-term growth aboard the Space Station: the AstroCulture™, the Plant Generic Bioprocessing Apparatus (PGBA), and the Plant Growth Facility (PGF), all flown, the Biomass Production System (BPS, built, not flown), the Commercial Plant Biotechnology Facility (CPBF) and the Plant Research Unit (PRU), both under development.

Plant research topics for spaceflight have recently seen a shift from ‘Advanced Life Support’ concepts (plants for food, water and atmosphere recycling) to genetic research topics using gene chip array analysis not yet available several years ago. Only few, if any, of the spaceflight chambers are actually prepared to support such research easily and in an efficient manner for early Space Station research. While ‘Advanced Life Support’ (ALS) or ‘Controlled Ecological Life Support Systems’ (CELSS) have seen a reduction in funding, some research and support continues in food augmentation projects such as a ‘Salad Machine’, or small plant growth facilities in inflatable, and potentially low pressure / transparent structures for Space Station and even for planetary surfaces such as Mars.

Many technological questions remain difficult to answer, and have resulted in focused research projects, such as water / nutrient supply and distribution in porous media under microgravity conditions, moisture sensing, optimal light sources with minimal power requirements and heat generation and proper spectral quality. The small size of the spaceflight chambers often results in large gradients of environmental variables such as light and atmosphere composition. Temperature and humidity control are often compromised by the limited amount of power.