LADA, A New Joint Russian - U.S. Plant Greenhouse:

Continuing the "*Svet*" Science and Technology Development Tradition on ISS

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Introduction

A new greenhouse of the *Svet* style is being prepared for deployment in the Russian section of the International Space Station. *Svet* was used for seven experiments on Mir between 1990 and 2000. LADA is being developed under a joint cooperative agreement between the Institute of Bio-Medical Problems, RAS, Moscow, Russia and Space Dynamics Laboratory / Utah State University. LADA is currently completing qualification and biotechnology testing and is expected to launch to the ISS in mid 2002. LADA is being developed to allow continuation of the Russian National Program on Microgravity Plant Technology. Cooperation with other International partners is being sought for experiments utilizing LADA. These cooperative programs are expected to be structured like those conducted in the *Svet* greenhouse on Mir.

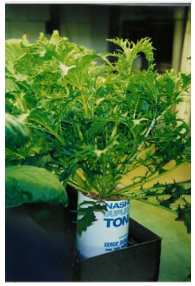
First Flight

- LADA is manifest to launch to the ISS on a Progress in June, 2002.
- For its first experiments, LADA will be configured with a single vegetation module (light bank, leaf chamber and root module) to minimize launch weight, volume and power use.
- Hardware checkout is scheduled for September, 2002.
- The LADA 1 plant growth experiment will begin in October and will terminate in conjunction with the next Soyuz rotation (November, 2002).

Initial Experiment

- LADA's initial (2002) experiment will involve both Russian and US participation (additional participation is in negotiation) and is designed to evaluate the capabilities of the new growth chamber system. In this evaluation, LADA will conduct an experiment similar to the last experiment performed in *Svet* on *Mir*.
- LADA 1 will grow Mizuna (B. rapa var. nipposinica), using a single greenhouse for power considerations. While LADA can support two vegetation modules, the use of only one reduces the lights-on power requirement to less than 100 watts.
- The Mizuna plants grown during LADA 1 will be thinned at 14-19 days, providing green material for the crew to sample.
- LADA 1 is scheduled to last for 30-34 days, which should produce fully developed Mizuna for both crew evaluation and fresh material return. One half of the green material will be packaged and returned to earth.
- LADA 1 will include a full suite of soil moisture and soil water tension measurements, aiming to produce the first soil water characteristic curves developed in a root-filled substrate in µg.

A ground LADA with a 30 day old Mizuna crop.



A full grown Mizuna plant In a greenhouse setting

Design Considerations

- **Allow two chamber comparisons in space**
  - LADA utilizes much of the same technology and approaches that were present in *Svet*, but with lower volume and power requirements. The total plant growing area is one half that of *Svet*, but is divided into separate Vegetation Modules so that the treatments do not interact.
- **Provide detailed substrate physics studies**
  - LADA root modules have the same plant growth area as the BMPS, but the depth is 9 cm to allow full root development for long experiments. Sensors for moisture, matrix potential and oxygen can be mounted at various levels.
- **Allow maximum access to plants by cosmonauts**
  - LADA follows the Svet vegetation module model, including wall mounting in the crew cabin, door access to the plants, and cabin air exchange.
- **Provide good plant growth conditions and measurements**
  - LADA provides a down looking camera, light, RH and air and leaf temperature measurements in the leaf chamber area. Light levels are similar to *Svet*.

LADA components

The LADA system, including two Vegetation modules, the Control Module and the Water Reservior. The Vegetation module consists of three submodules, the light module, leaf chamber and root module.

Details of the LADA Vegetation Module, including the light module, the vegetation chamber, and the root module. Each module has switches for manual or automatic operation.

Vegetation Module

Light Module supports two U-Tube fluorescent lamps, the leaf temperature IR thermometer, RH monitor, and the programmable digital camera.

Leaf Chamber is 16 x 20 x 26 cm tall, and has a full size sliding door to allow easy access to the plants for sampling and psychological adjustment. The door has a reflective coating that can block 100% or 95% of the light. The 95% coating allows the crew to view the plants continually during the lights-on period.

The root module is 9 cm deep, and is supported by control and interface box on the bottom and the pump box on the right side. Redundant pumps provide reliability, and can pump into and out of the root module. Water injection is metered based on pump rations.

Control and Display Module

This module contains the power converters, the data acquisition and control system and the display and data storage unit. The system provides manual and automatic control of LADA function, including substrate moisture, light period, photography, measurement period and data and command communications. It also provides interfaces for future modules such as animal or aquatic habitats.

A new Mizuna crop emerging in the leaf chamber, under the temperature and light sensor tree. The LC can provide temperatures at 5 levels and light at 3 levels. The holes in the bottom are the air inlets, which draw air from the cabin on both sides of the LC. Air flows up through the canopy, and exits over the lamps and ballasts to provide cooling.

Leaf Chamber & sensor tree

Root Module Wicks and Sensors

A look down into the root module past the wick wrapped injection tubes. Also shown are the oxygen sensors, the micro-tensiometers, the wick moisture and substrate moisture (heat pulse) sensors. The sensors enter the chamber from the bottom, and can be placed anywhere, on a 2 x 2 cm grid, at any height. The wetting and wick system is similar to that used in Svet.

Summary

- The LADA greenhouse has completed its development phase and is nearing the end of its qualification testing. Under the Russian plan, it will remain on ISS, with new root modules and supplies sent up as required.
- A unique feature of this plan is to allow the crew to use LADA to grow vegetables for diet and recreational use when it is not being used for scientific experiments. All of their crew members will be trained to operate LADA.
- A new aspect of µg research will be the study of Crew-Plant interactions, including psychological aspects.

References

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