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A HIGH-PERFORMANCE GROUND-BASED PROTOTYPE OF HORN-TYPE SEQUENTIAL VEGETABLE PRODUCTION FACILITY FOR LIFE SUPPORT SYSTEM IN SPACE

Abstract

Vegetable cultivation plays a crucial role in dietary supplements and psychosocial benefits of the crew during manned space flight. Here we developed a ground-based prototype of horn-type sequential vegetable production facility, named Horn-type Producer (HTP), which was capable of simulating the microgravity effect and the continuous cultivation of leaf-vegetables on root modules. The growth chamber of the facility had a volume of 0.12 m3, characterized by a three-stage space expansion with plant growth. The planting surface of 0.154 m2 was comprised of six ring-shaped root modules with a fibrous ion-exchange resin substrate. Root modules were fastened to a central porous tube supplying water, and moved forward with plant growth. The total illuminated crop area of 0.567 m2 was provided by a combination of red and white light emitting diodes on the internal surfaces. In tests with a 24-h photoperiod, the productivity of the HTP at 0.3 kW for lettuce achieved 254.3 g eatable biomass per week. Long-term operation of the HTP did not alter vegetable nutrition composition to any great extent. Furthermore, the efficiency of the HTP, based on the Q-criterion, was 7*10-4 g2.m-3.J-1. These results show that the HTP exhibited high productivity, stable quality, and good efficiency in the process of planting lettuce, indicative of an interesting design for space vegetable production.