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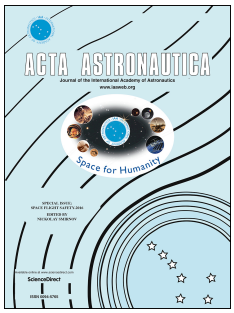

Research on lettuce growth technology onboard Chinese *Tiangong II* Spacelab

Yunze Shen, Shuangsheng Guo, Pisheng Zhao, Longji Wang, Xiaoxia Wang, Jian Li, Qiang Bian

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Research on Lettuce Growth Technology onboard Chinese *Tiangong* □Spacelab

Shen Yunze, GuoShuangsheng*, Zhao Pisheng, Wang Longji, Wang Xiaoxia, Li Jian, BianQiang
China Astronaut Research and Training Center，Beijing 100094, China

Abstract: Lettuce was grown in a space vegetable cultivation facility onboard the *Tiangong* *II* Spacelab during October 18 to November 15, 2016, in order to testify the key cultivating technology in CELSS under spaceflight microgravity condition. Potable water was used for irrigation of rooting substrate and the SRF (slowly released fertilizer) offered mineral nutrition for plant growth. Water content and electric conductivity in rooting substrate were measured based on FDR(frequency domain reflectometry) principle applied first in spaceflight. Lettuce germinated with comparative growth vigor as the ground control, showing that the plants appeared to be not stressed by the spaceflight environment. Under microgravity, lettuce grew taller and showed deeper green color than the ground control. In addition, the phototropism of the on-orbit plants was more remarkable. The nearly 30-d spaceflight test verified the seed fixation technology and water& nutrition management technology, which manifests the feasibility of FDR being used for measuring moisture content and electric conductivity in rooting zone under microgravity. Furthermore, the edibility of the space-grown vegetable was proved, providing theoretical support for astronaut to consume the space vegetable in future manned spaceflight.

Keywords： space vegetable cultivation facility; microgravity; water& nutrition management; lettuce.

1 Introduction

Controlled Ecological Life Support System (CELSS) is considered to be the fundamental solution for the life support in future long-term manned space exploration. It uses plants to provide astronauts with food, oxygen and water to achieve self-sufficiency inside the system. Due to limited energy in the space, it is a significant issue to increase the energy-utilizing efficiency of plant cultivation in space[1-3].

Research on plant growth in space has a story of more than 40 years. The former Soviet Unionhas started this research since 1971, growing wheat, radish and onion etc. in the aircraft. In 1990s, Russia and Bulgaria jointly developed a space greenhouse named SVET which was launched and mountedin the Mir Space Station in 1990. Then, full growth cycles of both wheat (Triticumaestivum L.) and rape (Brassica rapa L.)“from seed to seed” were completed in spaceflight condition, respectively. In 2002, Russian and American engineers developed jointly a space greenhouse named LADA, with which the successful multi-generation cultivation of several kinds of plants such as rape (Brassica rapa L.) and pea (Pisumsativum L.) have been accomplished in spaceflight condition [4-6]. In 2014, NASA had sent the Veggie, a space plant growth system, to the International Space Station (ISS) and subsequently achieved the growth test Veg-01, which proved the edibility of the space lettuce. In August 10, 2015, three astronauts tasted the lettuce plants grown for 33 days onboard ISS by themselves. In November 2015, NASA conducted the growth test of Zinnia elegans Jacq which bloomed successfully in space [7-9]. In early 2017, American astronauts harvested Chinese cabbage on ISS [10]. The on-orbit greenhouses of The USA, Russia, Europe and Japan were all set for the research on the plant growth techniques and fundamental biology

* Corresponding author. Tel.: +86 68746545; Fax: +86 68746545.
E-mail address: guoshuangsheng@sina.com