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低土圧条件下におけるサツマイモの塊根肥大

Tuberous root enlargement of sweet potato under low soil presser conditions

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1. Introduction

To realize long-term manned space exploration, we must overcome many challenges, such as securing water, oxygen, and food, regenerative circulation of materials, transportation cost of supplies, and ensuring a rich living environment for astronauts[1)2)]. These challenges may be solved through space agriculture inducing microgravity, which reduces earth pressure because the volumetric force of gravity does not act[3)]. Root diameter increases, whereas root elongation is hindered as mechanical impedance from soil particles increases[4)]. Therefore, low gravity makes low earth pressure, i.e., low mechanical impedance, which may impede the enlargement of sweet potatoes, an optimal crop for space agriculture[5)]. We investigated the effect of reduced earth pressure on the tuberous root enlargement of sweet potatoes.

2. Materials and methods

Polystyrene foam microbeads with 1 mm diameter (Refillable Beads, Kinshi) were used as the growing medium to produce low earth pressure. The bottom of a plastic growing container (42.5 cm long, 65.5 cm wide, and 39 cm high) was covered with granular rockwool (R110, Taiheiyo Materials), and the microbeads were filled on it. The bulk density of microbeads filled in the container was 0.024 g/cm^3. We prepared a low earth pressure treatment in which no load was applied to the microbeads and a high earth pressure treatment in which weights were applied to the top surface of the foam microbeads (Fig. 1). We planted sweet potato shoots (*Ipomoea batatas Lam.*, Koke 14 go). We grew until their roots have grown to 30 – 40 cm long. The root tips were allowed to touch the rockwool on the bottom. The plant bodies were fixed with strings to prevent them from sinking into the microbeads. The containers were covered with black mulching film to reduce evaporation from the surface. We supplied nutrient solution (Tank mix A and B, OAT Agrio) using a peristaltic pump for 20 minutes every hour. The experiment was conducted in a natural-light gas-exposed chamber (S-2003A, Koito Industries) at Ikuta Campus, Meiji University, Kawasaki, Japan. The room temperature inside the chamber was 27 °C, and the relative humidity was over 80%. We harvested the whole plants forty days after transplanting and measured total fresh weight, stem and leaf fresh weights, root fresh weight, tuber fresh weight, stem and leaf lengths, and root length. We assumed roots more than 5 mm in diameter as tuberous roots.

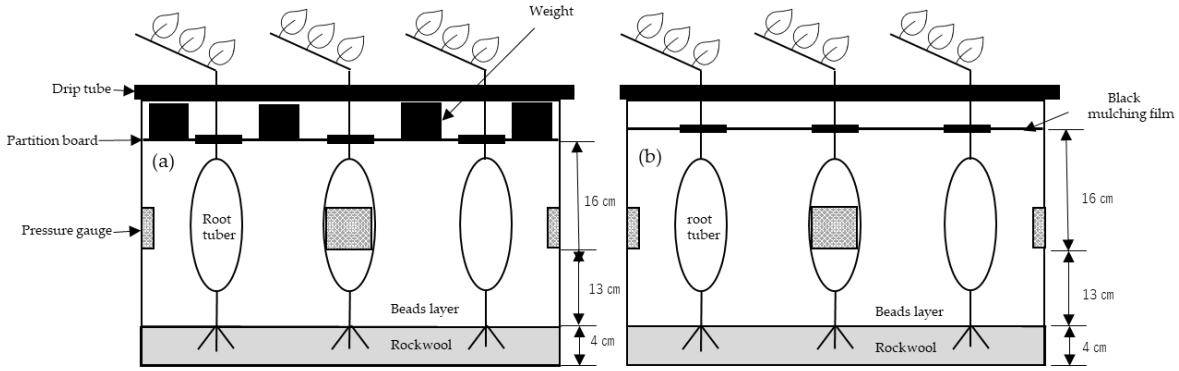

Figure 1. Cross-sectional view of experimental apparatuses: (a) high earth pressure, and (b) low earth pressure.

3. Results and Discussion

Figure 2 shows the fresh weight difference between high and low earth pressure treatments. The shoot and root weights of low-pressure treatment were larger than those of high-pressure. Root tubers were heavier in the high-pressure treatment than in the low-pressure treatment (Fig. 3). These results suggest that the tuber roots grew faster under the high-pressure treatment than the low-pressure treatment, although the growth of the whole plant was slower. The weight of roots at the high-pressure treatment was smaller than at the low-pressure treatment, whereas the weight of root tuber at the high-pressure treatment was larger than at the low-pressure treatment. This suggests that the amount of fine roots (<5 mm in diameter) might decrease in high pressure. Tuberous root formation was observed even under low earth pressure conditions, indicating that tuberous root enlargement is possible even at earth pressures lower than the usual field earth pressure. It was also confirmed that increasing the earth pressure could accelerate tuberous root enlargement.

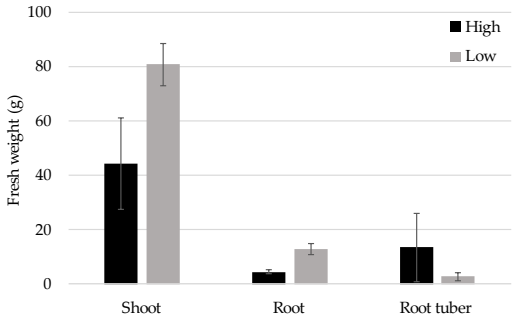

Figure 2. Growth of sweet potatoes in high (black) and low (gray) earth pressure treatments.

Figure 3. Effect of earth pressure on root tuber length: (a) high earth pressure, and (b) low earth pressure.

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