Vertically Moving Beds Enables High Productivity of Strawberry

Kota HIDAKA*, ***, Eiji ITO**, Shunji IMAI**, Yuki SAGO***, Daisuke YASUTAKE*, ***, Takehiko SUZUKI**** and Masaharu KITANO****

*JSPS Research Fellow, Faculty of Agriculture, Kochi University, Kochi, 783-8502 Japan
**Hiroshima Prefectural Agriculture Research Center, Hiroshima, 739-0151 Japan
***Faculty of Agriculture, Kochi University, Kochi, 783-8502 Japan
****Faculty of Agriculture, Kyushu University, Fukuoka, 812-8581 Japan

1. Introduction
Aiming at high yield and labor saving production of strawberry, the innovative cultivation system was newly developed by the three-dimensional use of the greenhouse space and the application of the double seesaw mechanics. This system can support four bed lines vertically moving under operation of the double seesaw mechanics, where heights of the respective four bed lines can be controlled in course of time. Three-dimensional use of the greenhouse space can support four times planting density as high as the conventional bench culture.

In this study, characteristics of light condition, photosynthesis and yield of strawberry on the vertically moving beds were analyzed to establish the optimum control of the vertical motion of bed lines.

2. Materials and methods
Integrated solar radiation, yield and photosynthetic rate of strawberry on the respective bed lines were measured in the case that the respective bed lines were set in the four heights formation (different four heights of 2.8, 2.1, 1.4 and 0.7 m) or the two heights formation (different two heights of 2.1 and 0.7 m). Integrated solar radiation on the respective bed lines were measured by photosensitive films. For the yield analysis, marketable strawberries were harvested from 10 plants on the respective bed lines. Diurnal changes in photosynthetic rate per whole plants on the upper (2.1 m) and the lower (0.7 m) bed lines in the two heights formation was measured by using assimilation chambers and an infrared CO₂ gas analyzer.

3. Results and discussion
Table 1 shows integrated solar radiation and strawberry yield on the newly developed system in the four or two heights formations and on the conventional bench culture. In the four heights formation, the mutual shading effect among the moving bed lines remarkably decreased the integrated solar radiation on the respective bed lines, and resultantly the four times planting density in the new system brought only 40% increase in yield. However, by fixing in the two heights formation, the integrated solar radiation on the respective bed lines were increased, which brought two times increase in yield. Photosynthesis on the upper bed lines in the two heights formation was increased with increase in PPFD, and reached to the maximum at 10:00. However, these were drastically depressed in the afternoon. In the lower bed lines, photosynthesis was depressed by shadings of upper bed lines in the daytime. Therefore, by the replacement of upper and lower bed lines before the midday depression of photosynthesis on the upper bed lines, it is expected to enhance the photosynthesis on lower bed lines and increase in total yield in this system.

Thus, by establishing of the logic for the optimum control of the vertical motion of the bed lines by the double seesaw mechanics, the newly developed system can be expected to achieve the higher productivity with the help of the ever-bearing cultivation and the zone control of the bed line environment.

Table 1 Integrated solar radiation and strawberry yield on the newly developed system at four or two heights formation and on the conventional bench culture.

<table>
<thead>
<tr>
<th>bed height formation</th>
<th>integrated solar radiation (W m⁻²)</th>
<th>strawberry yield (g plant⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>four heights formation</td>
<td>15.6</td>
<td>778.8</td>
</tr>
<tr>
<td>two heights formation</td>
<td>20.7</td>
<td>1084.0</td>
</tr>
<tr>
<td>conventional bench culture</td>
<td>11.8</td>
<td>558.4</td>
</tr>
</tbody>
</table>