PERFORMANCE OF GREENHOUSE FOR GROWTH PROMOTION OF A PLANT WTH SUPPLEMENTAL LED LIGHT USING PHOTOVOLTAIC POWER GENERATED BY THE SEE-THROUGH SOLAR CELLS

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1. Introduction

To construct the technical foundation of the growth promotion of Pea plants using short-time irradiation of blue LED light in addition to the natural daylight, we designed the irradiation equipment that consisted of blue LED light and see-through solar cells. See-through solar cells are amorphous silicon solar cells capable of passing light (light transparency of 10%) while generating electricity as shown in Fig.1. The power generated by a solar cell was used for supplemental lighting system(Downs *et. al*.1957,Takano *et. al* 1996,Lin 2000).. The aim of this study was to obtain basic knowledge on efficient supplemental lighting to establish plant growth and to design the irradiation equipment that consisted of blue LED light that consisted of blue LED light and see-through solar cells.

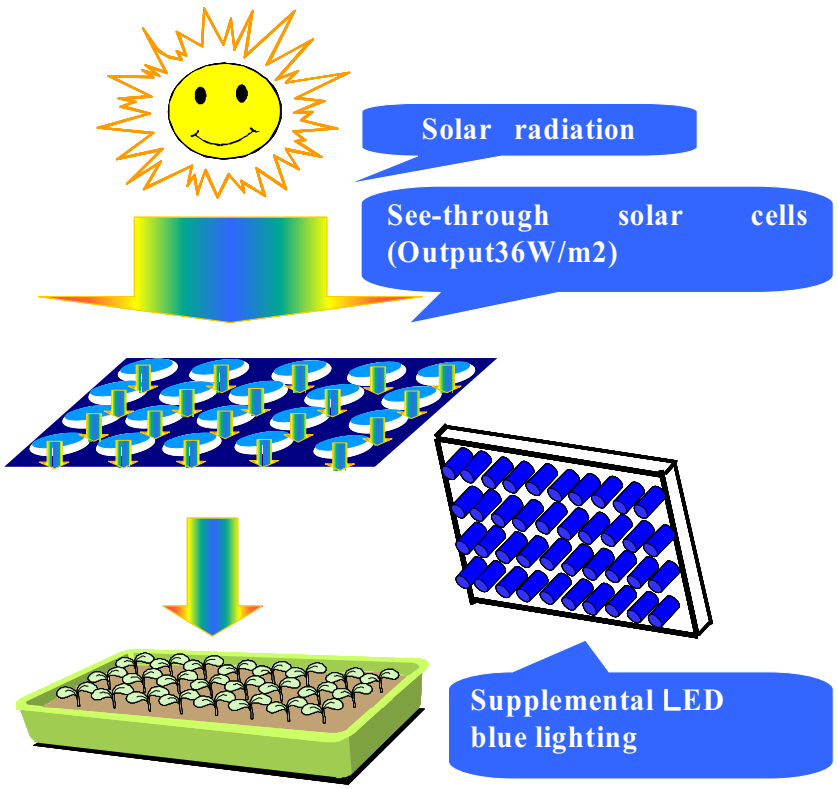

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Fig. 1: Schematic diagram of agricultural products by means of see-through solar cells and supplemental blue lighting.

2. Lighting system of greenhouse

The system can be used in the place where the commercial electric source is not supplied. The block diagram of measurement and power supply is shown in Fig.2. The storage battery of the system is charged by the solar cells. See-through solar cells are amorphous silicon solar cells capable of passing light(light transparency of 10%) while generating electricity. When the voltage changed greater or amaller than a predetermined level, the relay located between the battery and the solar cell cuts off the circuit to prevent its damage under the control of the computer. The voltages of solar cells and battery and intensity of solar radiation are measured by data logger and computer. The supplemental irradiation of blue LED light to the plant as pea(Fig.3)(*pisum sativum L. cultivar Kisu-Usui*) for a half hour before daylight was carriedout to promote the growth of the plants.

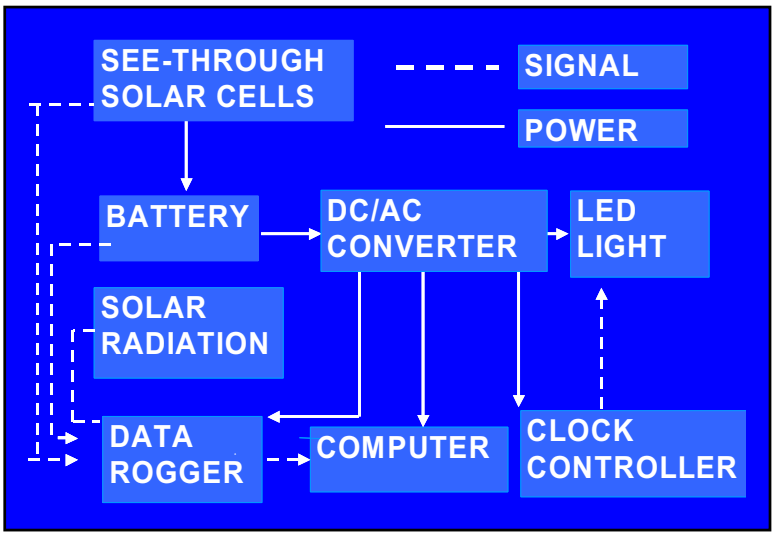


Fig. 2: Block diagram of lighting system composed for greenhouse

Fig. 3: Pea(*pisum sativum L. cultivar Kisu-Usui*)

3. Performance of the PV roof

The green house used in the experiment was built as shown in Fig.4 at the research farm of Faculty of Biology Oriented Science & Technology, Kinki University, Japan. The electric generating region of the panel has numerous holes, as shown in Fig.1, from which the a-Si layer and metal electrode have been

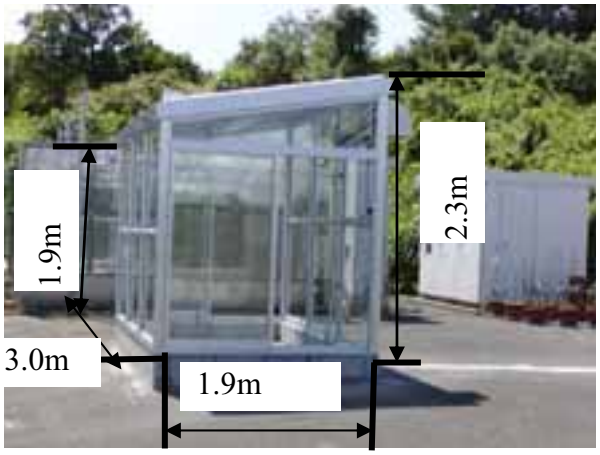
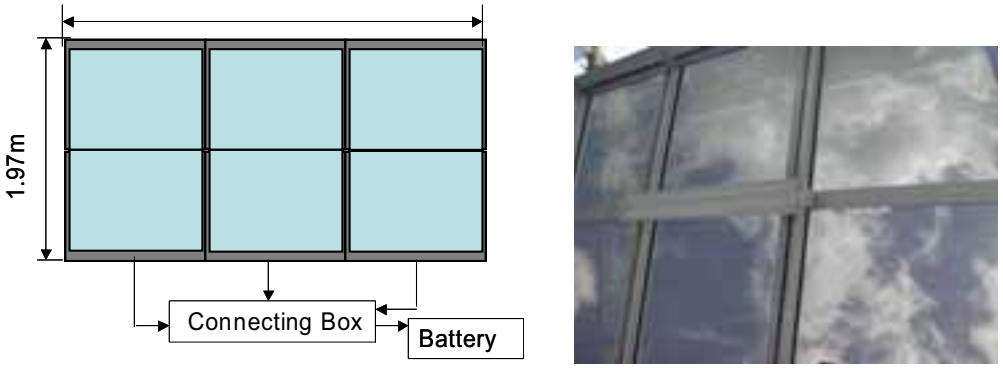


Fig. 4: Greenhouse using see-through solar cells

removed to light to pass through. Solar panel is a combination of six solar modules(TSS solar:KN38, Taiyo Co.) and connected in parallel combinations as shown in Fig.5(a). The see-through solar module is composed of submodules having light transparency of about 10%. The sky is observed through see-through solar panel as shown in Fig.5(b). The maximum output current(Ipm) and voltage(Vpm) of a photovoltaic solar module are 0.66A and 54.5V under the condition of 100mW/cm^2(AM-1.5), respectively. Each circuit is connected in parallel by two solar modules. Resultant current and voltage are 1.32A and 54.5V. The



(a)Schematic diagram (mm) **(b)See-through solarpanel has been installed on roof of greenhouse.**

Fig.5 See-through solar panel used in the experiment

daily solar radiation at Kinokawa City(Lat.34°15′and Long.135 °21′), Wakayama, Japan and photovoltaic power generation are as shown in Fig.6. Power consumption and operation time of blue LED light were decided as 76W and 30minutes. The expected power generations of August and December are about 21.4kWh and 8.6kWh by using solar radiation as shown in Fig.6, respectively.

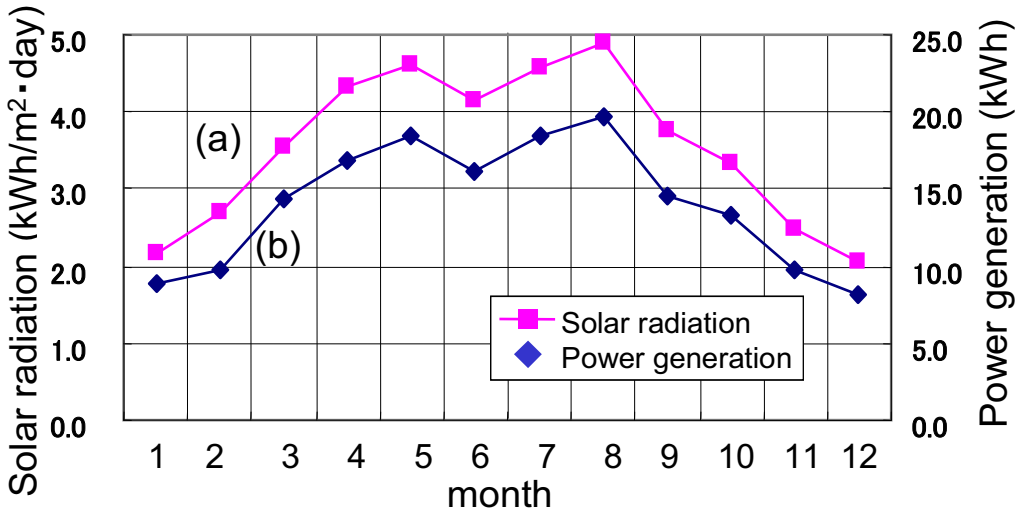


Fig.6: See-through solar panel used in the experiment

4. Method to illuminate supplemental lighting and natural daylight for the plant

Figure 7 shows the method to illuminate supplemental LEDs light and the natural daylight to the plant. The tray in which plant as peas was planted is placed on the conveyor belt Its operation is controlled by the sensors fixed to the both ends of a conveyor belt. A left-hand side photosensitive sensor detects that solar radiation and a right-hand side sensor detects that LEDs illuminate. red or blue LEDs arranged in the shape of a matrix and fixed to the ceiling. After sunset time, a motor rotates clockwise by the command of PLC, A conveyor belt moves rightward to be detected that a tray exists in the LEDs side by photosensitive sensor as shown in Fig.8(c1) and (c2). In the morning twilight ,LEDs illuminate for the plant as shown in Fig 8(a1) and (a2).. After sunset time, a motor rotates counterclockwise and a conveyor belt moves to be detected that a tray exists in the solar radiation side as shown in Fig.8(b1) and (b2). Sunrise and sunset times are calculated by using the information from National Astronomical Observatory of Japan(http://eco.mtk.nao.ac.jp/koyomi/koyomix/koyomix.html).

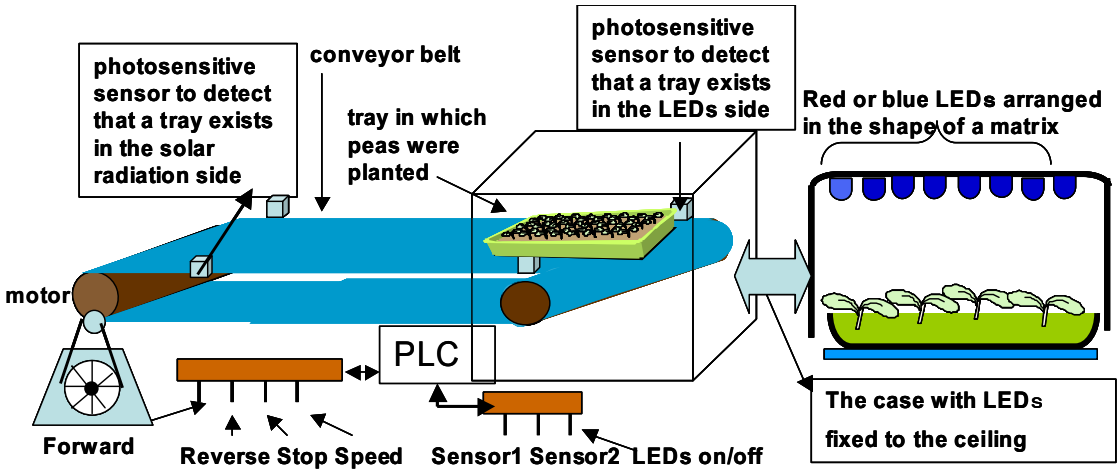


Fig.7: The system for growth promotion of a plant with supplemental LED light controlled by means of PLC

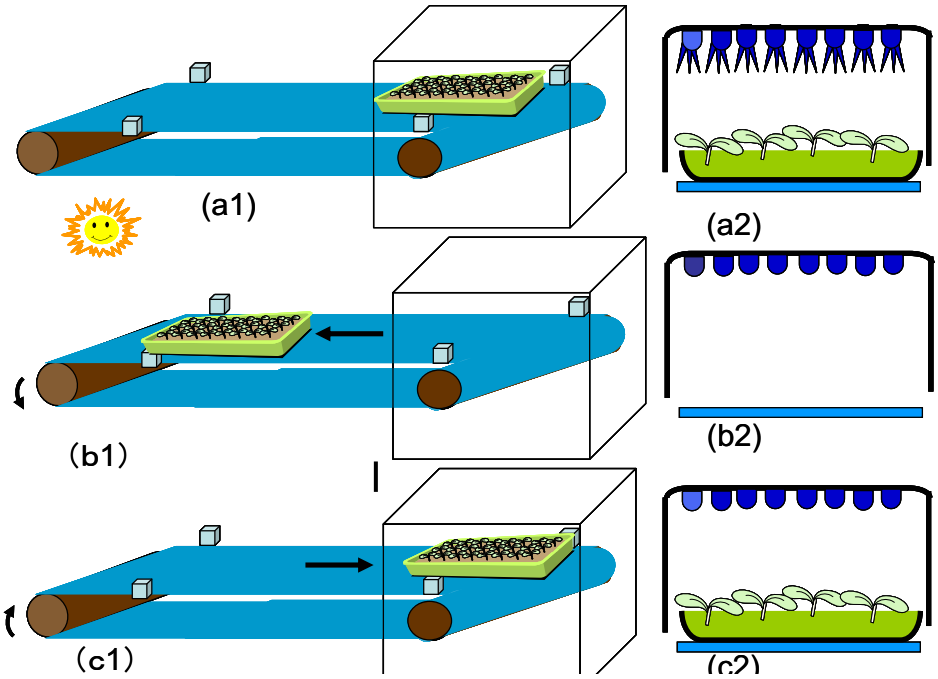


Fig.8: Operation of conveyor belt for obtaining supplemental light an natural daylight controlled by PLC.

5. Conclusion

The additional irradiation of blue light to plant of pea (Prisum sativum L.cultivar Kisyu-Usui)for a half hour before daylight influenced the growth of the pea plants. We would like to improve the performance about supplemental lighting system and operation of conveyor belt by means of PLC. It was shown that see-through solar panels could be applied for greenhouse. .

6. References

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