Pulsed LED Irradiation for Energy-saving Supplemental Lighting for Horticultural Crops

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▪ Introduction

■ Crop production fields

■Excessively low solar radiation during cold season

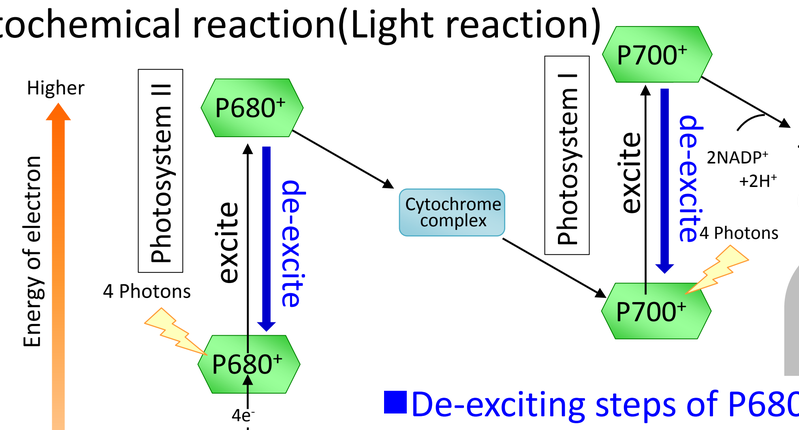
▸ Depression in photosynthesis and crop growth

▸ **Decline in crop production**

▼

■**Energy-saving system for supplemental lighting**

■ Photochemical reaction(Light reaction)

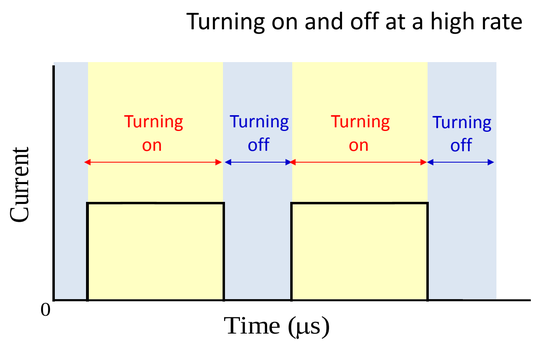


To make dark period during these steps…

■De-exciting steps of P680 and P700

▶ During these steps, light energy is not required

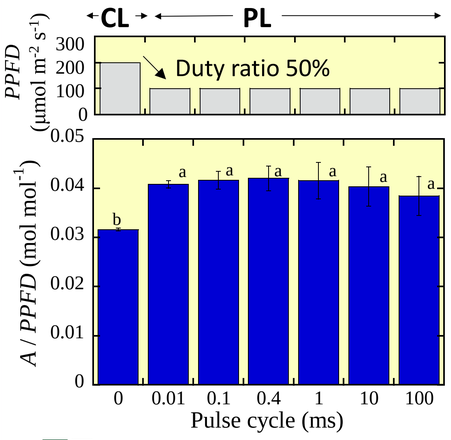
■ Pulsed LED irradiation



▶ effect of pulsed LED irradiation

Spinach(*Spinacia oleracea* L. 'Hydroseven')

■**Light use efficiency**



■*PPFD* in Pulsed LED (PL) was **1/2** compared with in Continuous LED (CL)

(PL: duty ratio was 50%, CL: duty ratio was 100%)

▶ **Reduction of photosynthetic rate in PL was only 20%**

▶ **Light use efficiency in PL was about 1.2 times as large** as that in CL

■**Treatments**

No LED (NL)	Continuous LED (CL)	Pulsed LED (PL)
No LED unit was applied	Duty ratio; 100% **Blinking time; 0 ms** *PPFD*; solar radiation + 140 μmol m-2 s-1	Duty ratio; 50% **Blinking time; 0.1 ms** *PPFD*; solar radiation + 70 μmol m-2 s-1

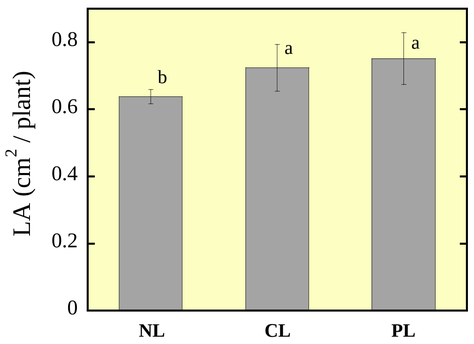
■**Term**

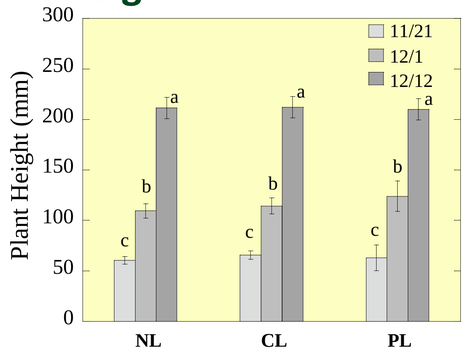
Nov.21,2017 -Dec.12,2017

LED unit : (KP-E2-RBB, Kankyou Photonics Co., Ltd.)

■**Results & Discussion**

■**Leaf area(LA) and Plant Height**





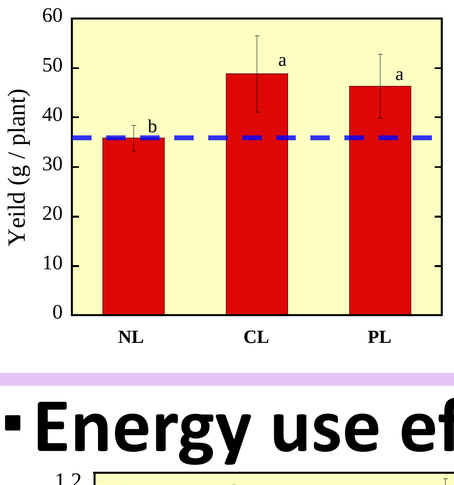
■LA was **increased**

■Plant Height No difference

▶ Effect of Far-red light ?

(Not included in supplemental light)

■**Yield**



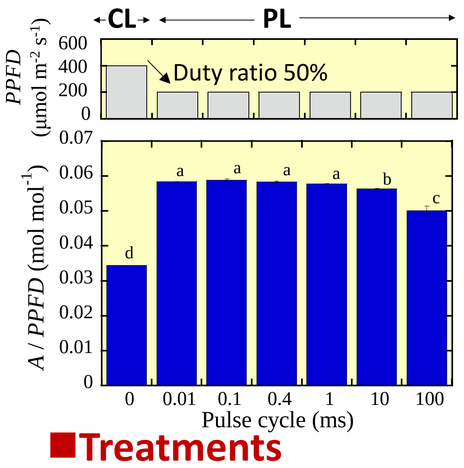
■**Yield was increased**

■ **No significant difference between PL and CL**

▶ Pulsed LED irradiation can be expected to promote the crop growth and yield at the same level of continuous LED irradiation

Strawberry(*Fragaria* × *ananassa* Duch. 'Benihoppe')

■**Light use efficiency**



■*PPFD* in PL was **1/2** compared with in CL

(PL: duty ratio was 50%, CL: duty ratio was 100%)

▶ **Reduction of photosynthetic rate in PL (0.01-1ms) was only 10%**

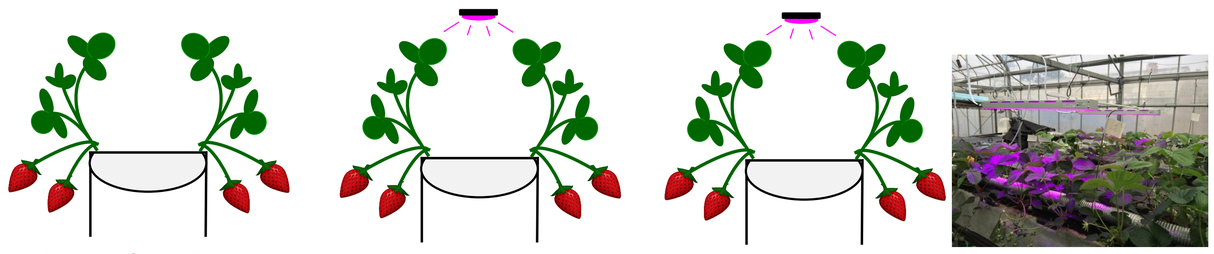
▶ **Light use efficiency in PL was about 1.4 times as large** as that in CL

■**Treatments**

No LED (NL)	Continuous LED (CL)	Pulsed LED (PL)
No LED unit was applied	Duty ratio; 100% **Blinking time; 0 ms** *PPFD*; solar radiation + 200 μmol m-2 s-1	Duty ratio; 50% **Blinking time; 0.1 ms** *PPFD*; solar radiation + 100 μmol m-2 s-1

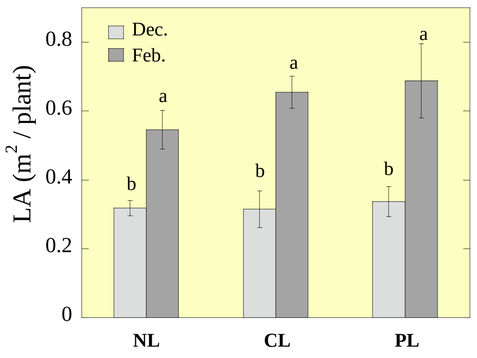
■**Term**

Dec. 2016 - Feb. 2017



■**Results & Discussion**

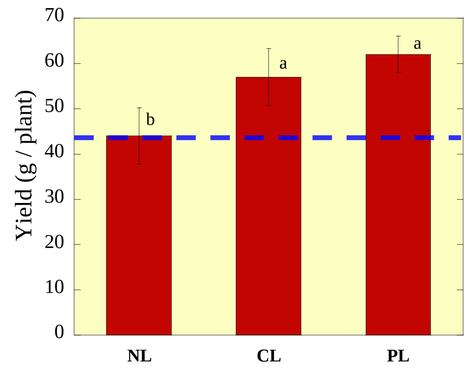
■**LA**



■No difference in Dec (before supplemental lighting)

■PL was **increased** at same level of CL in Feb (after supplemental lighting)

■**Yield**

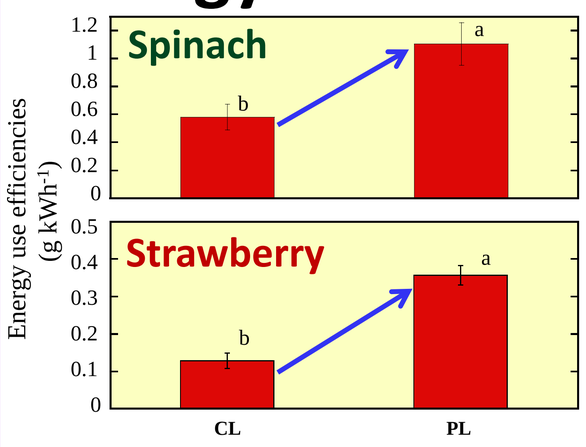


■**Yield was increased**

■ **No significant difference between PL and CL**

▶ Pulsed LED irradiation can be expected to promote the crop growth and yield at the same level of continuous LED irradiation

▪ Energy use efficiencies



■**Spinach**

PL was 2 times as large as CL

■**Strawberry**

PL was 3 times as large as CL

▶Pulsed LED irradiation can be expected to promote the crop growth and yield efficiently under energy saving

▪ Summary

■ **Pulsed LED irradiation promote light use efficiencies**

■ **Pulsed LED irradiation promote the crop growth and yield at the same level of continuous LED irradiation**

■ **Pulsed LED irradiation promote energy use efficiencies**

▼

There is a possibility that pulsed LED irradiation can supplement a required light efficiently for crop growth and electricity consumption