Calculation of carbon dioxide emissions from lettuce cultivated with different light quality

1. Title of Research： Calculation of carbon dioxide emissions from lettuce cultivated with different light quality

2. Cross-School Research and Development Team Members

Department	Name	Position
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3. Content of Cross-School Research and Development

The effect of different light qualities on CO_2 emission in cultivated lettuce (Lactuca sativa L.) was calculated by using 11 different light qualities (red, blue, white, UV-365, UV-385, and far-red), with a light quantity(BPFD, range: 300-800 nm) of 200 μmol m^{-2} s^{-1} . The environment was set as follows: day/night temperature 24/22 °C, RH 85 %, CO_2 concentration 1200 ppm, and photoperiod 16/8 hours. Cultivation was carried out for 42 days using Yamazaki's nutrient broth formulation with a conductivity of 1.2 mS/cm and a pH value of 5.5-6.0. Fresh weight, anthocyanin content, electrical energy yield (EY , g/kWh)and photon yield(PY , g/mol), anthocyanin electrical energy yield (EYA , g/kWh) , anthocyanin photon yield (PYA , g/mol), and benefit-to-cost ratios(pcr)were collected and analyzed. The study was designed by a team of researchers from NPUST with farmers, and the results will be disseminated to the students of FSVS, so that this study can be extended to other fields.

4. Description of Industrial Needs and Research Result Applications

The elderly population in China has been growing at an accelerated rate since the year 100 and surpassed the young population for the first time in February 106 (aging index of 100.18) . Until March this year, the ratio of elderly people over 65 years old to the total population has reached 14.05%, which formally enters an aging society. Climate change has brought new challenges to

agricultural production and the food supply chain, and the development of technological agriculture (plant factories for vegetable production) provides an effective solution to improve crop production efficiency, resource utilization and environmental impact.

5. Performance of Cross-School Research and Development

Under different spectral treatment conditions, in particular, the R9UV20_6 ($UV_{11}B_8G_{12}R_{70}$) treatment significantly increased the fresh weight of red-leaved lettuce by 231.46 g/plant and dry weight by 11.12 g/plant compared with the dry weight of the other treatments, as well as increased the electronic yield by 50.0 g/kWh and the light quality yield by 25.4 g/mol. In addition, R2.5UV20_6 ($UV_{14}B_{22}G_9R_{55}$) treatment resulted in a significant increase in anthocyanin concentration and content to 8.77 mg/g and 1530.9 mg/plant, respectively. 20 μmol $m^{-2}s^{-1}$ of UVA was also added to the treatments, and the values of anthocyanin concentration, anthocyanin content, and electrical yield were all higher with UV365 than with UV 385, anthocyanin electrical energy and anthocyanin photon energy were all higher than that of UV 385, which indicated that the addition of UV 365 had a better performance. In this study, a light spectrum of R2.5UV20_6 ($UV_{14}B_{22}G_9R_{55}$) is recommended as the most balanced light formulation for red lettuce cultivation. According to the results of this study, the total GHG emissions from electricity used for cultivation were 16.6 tonnes CO2e/year.

Fig 1：Red Lettuce Seedlings.

Fig 2：Red-leaf lettuce harvested on day 42 by treatment.

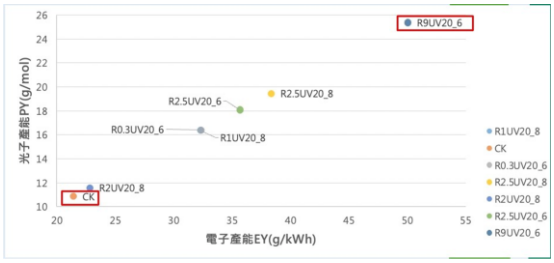

Fig 3：Electronic and Optical Productivity of Anthocyanin Content by Treatment.