（学位第３号様式）

学 位 論 文 要 旨	
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題　目	Study on Strawberry Photosynthesis and Growth under Optimized Plant Factory Conditions (最適化された植物工場条件下におけるイチゴの光合成と成長に関する研究)

Strawberry is a high economic fruit, rich in nutrients, and is especially paid attention to due to the medicinal potential for human health. Consequently, strawberries are produced worldwide; the production, however, is restricted by geographic factors as they require a suitable climate for growth and productivity. Currently, farming environments are constantly fluctuating and unstable because disasters such as droughts, floods, and typhoons frequently occur due to global climate change. Plant factory is an advanced method with strictly controlled cultivation environments, which may be completely independent of natural conditions. Crop production using plant factories is a sustainable solution and could be applied anywhere without concerning to geographical limitation. This study focused on evaluating and determining the optimal environments to grow strawberries in a plant factory for application in tropical and subtropical areas. The optimizations of cultivation environments were assessed through photosynthetic responses, plant growth traits, and fruit sugar accumulation.

Two photosynthetic measurement methods (single-leaf method [SL] and whole-plant method [Wp]) used on strawberry plants were compared. Besides, diurnal photosynthetic patterns of strawberry under different light intensity (200 and 1000 μmol m^{-2} s^{-1}) and CO_2 (400 and 1000 μmol mol^{-1}) conditions were also investigated (Chapter 2). The photosynthetic values between the two methods were only significantly different under low CO_2 and PPFD, which mainly resulted from the different numbers of leaves used for the measurements and the different light intensities depending on the leaf positions. The magnitude and tendency of diurnal photosynthesis of strawberries were stable at a low level under low CO_2 and PPFD. Meanwhile, it was at a high level but gradually decreased during the photoperiod under elevated CO_2 and PPFD.

The effects of different light conditions on photosynthetic responses and reproductive ability of strawberry grown in a closed-type plant factory using sunlight (solar plant factory, SPF) were investigated (Chapter 3). The strawberries were grown under two different light conditions of full sunlight (S) or 10% sunlight + fluorescent light (SA). The fluctuation of light intensity following day length was a driving factor to reduce or maintain the photosynthetic capacity. Besides, under SPF conditions, strawberries could maintain regular reproductive potentials such as flowering and fruiting.

The impacts of different phosphorus concentrations (2, 6, and 12 mM) and light spectra (purple LED light [PL], white LED light [WL], and white fluorescence light [WF]) on the reproductive growth and its relationship with fruit sugar accumulation of strawberry were examined (Chapter 4). Phosphorus dominantly affected the magnitude and tendency of net assimilation rate, which led to a major variation in the relative growth rate at the reproduction stage of strawberry. The light spectra only enhanced vegetative growth during the reproduction period. Besides, the combination of 6 mM phosphorus and WL enhanced the relative growth rate of reproduction and activity of sucrose-phosphate synthase which led to the increases of fruit yield and fruit sugar accumulation.

In conclusion, SPF could be used for strawberry production and its limitation could be overcome by applying supplemental lighting. The optimization of environmental factors, including light quality and phosphorus concentration, could drive plant growth and fruit sugar accumulation of strawberries grown in the plant factory.