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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation

Identifying and modeling the dynamic response of the plant growth to root zone temperature in hydroponic chili pepper cultivation using neural networks
(ニューラルネットワークを用いた唐辛子水耕栽培における液温に対する植物成長反応の同定とモデル化)

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In controlled environment agriculture, for promoting plant growth, it is important to control the environmental factors optimally during cultivation. One of the essential manipulating factors for promoting plant growth is the root zone temperature. In this study, the dynamic response of plant growth to root zone temperature in the early-stage plant growth of the chili pepper plants (*Capsicum annuum* L.) hydroponic cultivation were identified. By identifying the dynamic response of plant growth as affected by the change of root-zone temperature using a dynamic model, an optimal control strategy can be determined.

However, it is difficult to develop a dynamic model of the response of plant growth to root zone temperature because the eco-physiological responses of a plant are quite complicated. An intelligent approach that can deal with the complex system were proposed in this study. Nonlinear autoregressive with exogenous input (NARX) neural networks were used to identify and to develop a dynamic model of the response of plant growth to root zone temperature. Five dynamic root-zone temperature regimes with the range of 15-37°C were applied to the hydroponically cultivated plants inside the controlled environment growth chamber during 60 days of observation for system identification. A non-destructive and continuous plant weight measurement system based on load cell was developed for measuring the dynamic response of plant growth as affected by the change of root-zone temperature. A single-input-single-output (SISO) control system was used for identification, with root zone temperature as input variable and the growth rate in plant weight as output variable.

The result showed that the neural networks are effective in identifying the dynamic response of plant growth, as affected by root-zone temperature with promising accuracy (RMSE = 0.49 g, R_2 = 0.99). Then, based on the model simulation, the estimated static relationship between the plant growth and root-zone temperature on chili pepper plants was determined as a strong non-linearity with the peak in the range of 24 to 26°C. This result is consistent with the previous studies on the static relationship between plant growth and root zone temperature in pepper plants. It suggests that the constructed model in this study is relevant enough and could be useful in predicting the dynamic response of plant growth as affected by root zone temperature.