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学　位　論　文　要　旨

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題目:Optimum Field Water Management Using Soil and Micrometeorological Information Under Cultivation Condition in the Chinese Style Greenhouse
(栽培条件下における土壌・微気象情報を利用した中国式温室の最適圃場水管理法)

In this research, the change characteristic of soil and micrometeorological environment was clarified by long-term monitoring under cultivation condition in a Chinese style greenhouse (CSG) in Yan'an city which located in Loess Plateau. Moreover I aimed at the establishment of optimum irrigation scheduling for greenhouse field through the irrigation simulation by the water balance model using microclimate information that had been obtained in CSG.

First of all, the following method was proposed as a practical estimation method for soil hydraulic properties that is necessary, indispensable to establish field water management. a) van Genuchten-Mualem model can be used as to soil moisture retention curves and unsaturated hydraulic conductivity function of loess. b) The parameters of a) were identified by an inverse estimation method that combines the numerical solution of one-dimension Richards equation with the Marquartdt-Levenberg optimization scheme c). The inverse approach to the result of one-step experiment with undisturbed soil was performed to identify soil hydraulic parameters. d) The result of c) as initial value, the inverse approach to the data of variable volumetric water content with time that obtained from *in-situ* irrigation-drainage experiment was performed to determine soil hydraulic parameters under field condition. This method was applied to the field in the CSG, and the following results were obtained.

1) The bulk density observed in the field gave good outlines for selecting parameters for inverse solution.

2) The simulation of volumetric water content at different time was performed using selecting parameters. The root mean square error between estimated and observed volumetric water content became about 0.03. Therefore the soil hydraulic parameters identified in this method were appropriate for CSG field.

I conclude that the hydraulic parameters of loess soil, essential information for establishment of field water management in CSG could be identified from these results. Moreover, it suggested that this method is a practical and useful technique to get information of soil hydraulic properties in foreign fields without external power supply.

Next, the long-term monitoring of soil and micrometeorological environment was conducted under cultivation condition in the greenhouse. The results were summarized as follows:

1) The average solar radiation transmissivity is approximate 60% during the daytime.

2) Inside and outside temperatures, they reached to peak and foot temperatures almost at same time.

Moreover, from December to February, the coldest season in Yan'an district, the average air temperature inside greenhouse can be maintained at 13.3 °C. There was 14.5 °C average difference between inside and outside without supplement heating at night. Even when the outside temperature reached -21°C, the inside temperature of 0.3 °C or more was kept at nighttime. This is a typical energy saving feature of the CSG.

3) Inside and outside relative humidity, they reached to peak and foot relative humidity almost at same time. The relative humidity ranged from around 17.5 to 100% inside greenhouse. In December and January, inside relative humidity was very high, ranged from 57.5 to 100%. The mean difference between the inside and outside relative humidity was around 26%, indicating that inside conditions were in the state of over-humidification.

4) 0-cm and 10-cm soil temperatures roughly changed and the change range of 0-cm was the largest. In October and early days of November, the change range of 0-cm soil temperatures were the largest, ranged from 1.8 to 39.6 °C. November midterm to April midterm, the change range of 0-cm soil temperatures became small, ranged from 6.4 to 28.9 °C. This is because the decrease of solar radiation reached soil surface by increase of the leaf area with the cucumber growth. At night, soil temperature was higher than inside air temperature. The average difference between them was about 1 °C.

5) The north wall, back roof and film temperatures, they reached to peak temperature almost at same time. At night, north wall temperature was also higher than inside air temperature. The average difference between them was about 2 °C.

From the results, it clarify that the wall and soil released heat accumulated in daytime to keep the CSG warm at nighttime. It can be said that this heat retaining property and the management method that covers the plastic film and back roof with the straw mats at nighttime enable the cultivation of the cucumber in winter.

Finally, the water balance of a cucumber field in CSG has been analyzed during the growing season using an empirical water balance model. Moreover, the optimum irrigation scheduling for the field was established in CSG through irrigation simulations. The results can be summarized as follows:

1) It became clear that soil water increased in the latter stage of the total growth period with total amount of 410 mm in current irrigation scheduling. It suggested that water-saving irrigation could be applied to this field.

2) The irrigation scenario, with 352 mm of total water applied as 45 mm per irrigation at a 38-day interval in stage I, 44 mm per irrigation at a 15-day interval in stage II, and 43 mm per irrigation at a 13-day interval in stage III, was the method that amount of irritation water and frequency of irrigation were smallest. Moreover, crop was not subjected the moisture stress.

As a result, it was cleared that the current irrigation scheduling in a CSG can be improved by optimizing irrigation time and amount.