Extraction of FAO Growth Model in a Fuzzy Control Hydroponic Greenhouse

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Introduction

Greenhouse is an environment where variables such as: climate, nutritional and biological conditions can be controlled. Therefore, the greenhouse allows horticultural crops to grow in the off-season and also affect plant growth to achieve optimal conditions for different stages of crop growth (Janoudi., 1993). The purpose of a greenhouse construction is to achieve the maximum amount of a product with the highest quality and minimum cost. Multiple factors and relationships inside the greenhouse have made it a complex system in which energy, mass transfer and genetic factors. Greenhouse production is affected by various variables, such as changes in environmental conditions (temperature, humidity, carbon dioxide and plant photosynthesis), plant nutrition (water and nutrients), biological factors (pests, diseases, viruses, bacteria and weeds) and plant breeding management (pruning) (Ali *et al.*, 2018). These variables are associated with a high level of complexity. Therefore, all of these variables need to be identified and investigated to calculate the growth model (Raes *et al*., 2010).

Materials and Methods

Water management in agricultural sector is impossible notwithstanding to water, soil and plant relationships. Models and software in soil and water relationships have been develop because the field research need to spend time, money and energy(Momeni *et al*., 2016). AquaCrop is one of the plant models developed by Food and Agriculture Organization (FAO) (Steduto *et al*., 2009). In this model, due to evapotranspiration in the greenhouse, the amount of water consumption along with increasing the crop yield has been considered. In this study, a fuzzy control was initially designed and constructed for a research hydroponic cucumber cultivation greenhouse**.**

Results and Discussion

The greenhouse system consists of several sensors, several operators, and a data collection and recording system. Operators include heating, cooling, fogging, ventilation and greenhouse lighting, and sensors include temperature, humidity, carbon dioxide gas, oxygen and light inside and outside the greenhouse. By sending and receiving environmental information from the sensors, the central controller maintains the environmental conditions inside the greenhouse within the optimal range of the FAO-2009 performance model. Plant growth parameters (consumption of water, leaf area evapotranspiration, chlorophyll content) and greenhouse energy consumption (electricity, gas) were also measured. Using these data, the plant growth model was extracted to use in optimization of control system. Fig1. Shows leaf area relation with yield. It certify by increasing the leaf area the production also has been increased.

Conclusions

The results of this study showed that it is possible to estimate the relative evapotranspiration of the reference cucumber by four variables including radiation, temperature, humidity and daily water intake in the greenhouse. The results showed that the FOA model is able to estimate the reference evapotranspiration-cucumber with the lowest error in greenhouse conditions**.**

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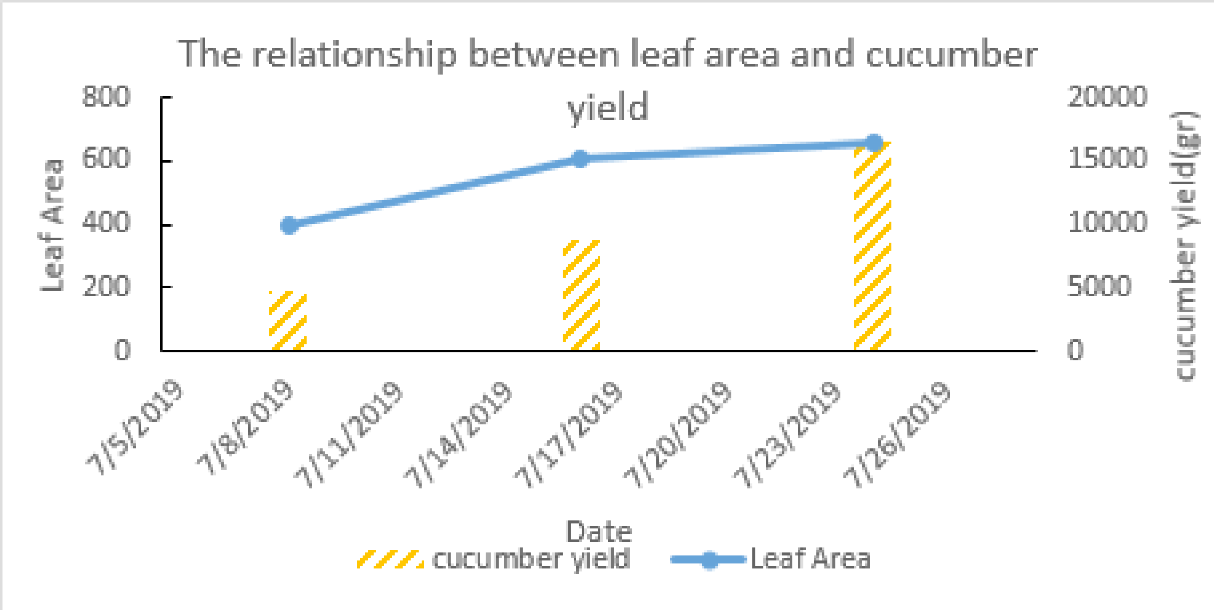

Fig1: relationship between net photosynthesis and crop yield.

Keywords: AquaCrop, Fuzzy Control, Hydroponic, Greenhouse.

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