Bul. Agron. (36) (1) 92 – 99 (2008)

Fertigation Scheduling in Hydroponics System for Cucumber (Cucumis sativus L.) Using Artificial Neural Network and Genetic Algorithms

Herry Suhardiyanto[1*], Chusnul Arif[2] dan Suroso[3]

Diterima 4 Januari 2008/Disetujui 31 Maret 2008

ABSTRACT

A computer program for fertigation scheduling in a hydroponics system has been developed using Artificial Neural Network (ANN) and Genetic Algorithms (GA). The ANN model was used to establish the relationship between the environmental factors and outflow volume of fertigation in a hydroponics system for cucumber. The result showed that the predicted outflow volume agreed well with those of the measured values. The correlation coefficients (R^2) between the predicted and measured values were 0.9673, 0.9432, and 0.8248 for vegetative, flowering and maturation stages, respectively. Optimum schedules for vegetative, flowering, and maturation stages were in a good coincidence at R^2 of 0.8808 with the amount of fertigation required by the plants as calculated using the empirical method.

Key words : System identification, optimization, plant water consumption, fertigation, hydroponics

INTRODUCTION

Hydroponics system has received more attention because it promises more controllable crop management under greenhouse. Generally in Indonesia, fertigation in hydroponics system with drip irrigation is applied manually according to the weather and condition of the plants. This technique is less accurate and can cause significant losses of fertigation. Therefore, it is necessary to develop an accurate method in fertigation scheduling for the plants grown under hydroponics system. Water requirement of plant in a greenhouse has been calculated through evapotranspiration rate and crop coefficients (Harmanto et al., 2005; Orgaz et al., 2005).

Agricultural systems, such as an environment-plant system, are quite complex systems. They can be considered as ill-defined systems. It is, therefore, difficult to quantify the complex relationships between the input and the output of a system based on analytical methods (Hashimoto, 1997). This paper has focused on the application of Artificial Neural Networks (ANN) and Genetic Algorithms (GA) on fertigation scheduling in a hydroponics system. ANN has the capability to identify an unknown complex dynamic plant system (Purwar et al., 2007). The benefit of ANN model is the ability to learn and generalize the system (Nugroho, 2003). Genetic algorithms (GA) is the search algorithm based on the mechanism of natural selection and genetics to search through decision space for optimal solutions. It can solve a complex objective function, with a multi-point search procedure, by simulating the biological evolutionary process based on crossover and mutation in genetics (Goldberg, 1989).

The objectives of this research were: 1) to establish the relationship between the environmental factors and outflow volume of fertigation using ANN; 2) to determine the optimum schedule of fertigation using GA; 3) to compare total volume of plant water consumption obtained through ANN and GA with that of empirical method. With this method, it is expected to gain a new effective and efficient method in fertigation scheduling in hydroponics system. Cucumber plants were selected in this research because economically it is one of the most high-valued crops usually grown in a hydroponics farm.

MATERIALS AND METHODS

Experimental Set-up and Measurements

Experiments were conducted in a hydroponics system in greenhouse at Bogor Agricultural University field laboratory, Darmaga, Bogor, Indonesia (6°30' south latitude and 106°45' east longitude). The greenhouse is a standard peak type greenhouse with steel frame structure. It has 12 m length and 6 m width with polycarbonate sheets cover. It is a naturally ventilated greenhouse with wall and ridge openings.

[1,2,3] Department of Agricultural Engineering, Bogor Agricultural University, Kampus IPB Darmaga PO.BOX 220 Bogor 16002, Telp/Fax: (0251) 623026
[1*] email : herrysuhardiyanto@ipb.ac.id (Author for correspondence)
[2] email : chusnul_ar@yahoo.com
[3] email : suroso@ipb.ac.id