Climate Modelling of a Greenhouse with Proportional Environmental Control

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Abstract

Performance of greenhouse environmental control systems can be evaluated by predictive climate models. In this work, a model for the prediction of environmental parameters such as temperature and humidity based on energy and mass balances, was developed and validated for a greenhouse controlled with a proportional environmental control system. The greenhouse is in Viveiros do Furadouro, a forestry nursery from the Altri Group, located near Óbidos, Portugal. The greenhouse under study is a Venlo greenhouse covered with glass with an area of 1632 m^2 and is used for *Eucalyptus globulus* Labbill. vegetative propagation through minicuttings. *Eucalyptus globulus* is characterized by having low rooting ability and environmental control has to be very accurate and requires the use of multiple control equipments, such as heating, cooling (pad or fog), thermal/shade screens, natural and dynamic ventilation. The proportional control of each equipment, such as the fan and wet pad for cooling, is difficult and requires good knowledge of the dynamics of greenhouse environmental parameters, as well as the influence of individual equipment. However, it allows different alternatives to achieve the set points. The climate data were recorded every 8 min and were used to develop a climatic model based on energy and mass balances, to use for prediction of internal environmental parameters. Information about the activation percentage of the environmental control systems was also included. The extraction of the coefficients for the balances combines direct calculation and interaction using Microsoft Excel® SOLVER®, until reaching the minimum absolute difference between simulated and measured inside temperature and humidity. The climate model was validated by comparison between measured and simulated values for temperature and humidity. This model can be used to optimize the greenhouse environment in order to achieve the production objectives.

INTRODUCTION

In greenhouse production, environmental control is a factor as relevant as nutrition and watering. Climate models are a powerful tool to use in greenhouse physical environment research (Castilla, 2005), in greenhouse design projects and environmental control (climate, watering and fertilization), as well as for evaluation of crop growth and development (Baille and González-Real, 2001). Baptista (2007) also used climate models for the prediction of environmental conditions that affect *Botrytis cinerea* infection in unheated tomato greenhouses. Other models for simulating greenhouse internal conditions and physiological processes have also been described (Jolliet, 1994; González-Real et al., 1994, 1996) and they allow profit maximization for the grower (Castilla, 2005).

Climate models are generally based on energy and mass balances for prediction of the inside air temperature and humidity considering the outside climate conditions, such as temperature, humidity, wind and solar radiation, as well as the characteristics of the greenhouse and of the environmental control systems. Energy balances are the sum of the