Natural ventilation of greenhouses: Comparison of measured and predicted ventilation rates

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Abstract

Ventilation is one of the most important tools for controlling the greenhouse climate. The air exchange between inside and outside of a greenhouse influences the environmental conditions such as temperature, humidity and carbon dioxide concentration of the enclosure which affect the development and production of the crop. In winter, ventilation must remove the excess water vapour while during summer cooling is the main reason for ventilation.

Natural ventilation is the result of the action of two natural forces, wind and thermal buoyancy. Some models of natural ventilation are described. Various techniques have been used to determine ventilation and leakage rates such as tracer gas and energy balances. The energy balance is based on the energy removed by ventilation from the greenhouse as a way of preventing excessively high temperatures. Tracer gas techniques are based on mass balances and are used mostly to measure ventilation rates directly in greenhouses. It seems that the tracer gas technique gives greater accuracy than the energy balance at low ventilation rates. The difficulty of using the energy balance is the large number of variables involved and the required accuracy in their measurement.

In this study, ventilation rate was measured using the decay tracer gas method for leeward ventilators opened to 10 and 20%. It was found that wind speed had a strong influence on ventilation rates and a linear relation was obtained. Ventilation rates were predicted using the energy balance method and a model based on wind and buoyancy forces proposed by Boulard and Baille (1995), assuming that total ventilation is due to the combined effect of both natural forces. It was found that the energy balance gives better results for higher ventilator apertures. In the case of the model based on wind and buoyancy forces good agreement was obtained between measured and predicted ventilation rates for both ventilator positions.

Keywords: natural ventilation, energy balance, tracer gas, greenhouses