OVERALL ENERGY ANALYSIS OF (SEMI) CLOSED GREENHOUSES

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Abstract

Natural ventilation to discharge excess heat and vapour from the greenhouse environement has serious drawbacks. Pests and carriers find their way through the openings; carbon dioxide fertilisation becomes very inefficient and the inescapable coupling of heat and vapour release results often in sub-optimal conditions for either temperature or humidity and may cost heating energy. The present trend, therefore, is to reduce ventilation as much as possible, also in Mediterranean conditions. This relies obviously on improved means for energy exclusion and climate management. The (semi) closed greenhouse, based on innovative cooling equipment, can combine the benefits of cooling the greenhouse air with serious energy conservation. For growers the first promise is appreciated a lot, although savings in energy costs are always welcome. Policy makers are primarily enthusiastic about the 15 to 30% decrement of fossil energy consumption and the associated reduction of CO2 emission, but are also keen on improvements of the horticultural output. In fact, an informed decision must be based on an analysis of costs and benefits and there is a growing demand for some computational tool that enables quantitive comparisons between the vast number of alternatives with respect to the different components of (semi) closed greenhouse systems. The benefits in terms of improved production (quality, ornamental value and quantity) are quite difficult to quantify, due to the complexity of the biological processes involved. There is, however, a growing body of some 5 years of experience on which growers can rely. On the other hand, since the physics of greenhouses, climate controllers and horticultural hardware can be described very well, it is quite possible to develop such a tool for predicting the energy consumption of a (semi) closed greenhouse under a wide range of horticultural and outside climatological conditions. This paper gives an outline of such a tool and discusses the outcome for a number of scenarios. For instance, we show that, for Dutch weather conditions, a greenhouse where only 1/3 of the area is furnished as a closed greenhouse, harvests enough summertime heat excesses to provide sustainable heating for the whole site.

The model computes the primary energy saving on 28% but, moreover, the model also gives insight in the physical and horticultural characteristics that constraint the primary energy consumption. This insight shows the most promising focus points for technical research to improvements of the energy saving characteristics. Surprising enough the biggest improvement can be found in blocking the heat load by spectral selective filters.