

ABSTRACT

Greenhouse cultivation of crops in subtropics suffers from high summer temperatures due to the lack of suitable design and cost-effective environmental control strategies. The present study aimed at in-depth investigation of microclimate variation in two different types of greenhouses (Quonset and Sawtooth) and cladding materials (UV stabilized and diffused films) of greenhouses suitable for floricultural production with low-cost cooling techniques. The effects of greenhouse shape and size and cladding materials on the microclimate were investigated during winter and summer seasons of 2008 and 2009. The performance of four cultivars of gerbera (*Gerbera Jamesonii* L.) under greenhouse conditions was evaluated to find out a suitable cultivar for subtropics. In addition, a stand-alone computer model was developed to simulate greenhouse microclimate based on external weather and greenhouse geometry in subtropics. A sensitivity analysis of model parameters was also performed.

The shape and height of a greenhouse have a significant influence on the internal air temperature. The Sawtooth shape maintained 3 °C lesser temperature variation than the Quonset shape against ambient condition at 12:30 PM during summer months. The relative humidity variations are less (13%) in the Quonset shape at 8:30 AM during summer and the solar radiation was 5 to 10% greater than that in the Sawtooth shape throughout the year. The variation in vertical temperature profile in the Quonset shape was larger than that in the Sawtooth shape greenhouse. The combined effect of ventilation, shade net and fogging resulted in the reduction of peak summer temperature up to 4 °C in the Sawtooth greenhouse. The reduction of greenhouse temperature in the diffused film was greater in winter (3 °C) than in summer (1.5 °C) with 50% perforated shade net placed on the inner side of greenhouse. Among the four cultivars of gerbera, the performance of Yanara was superior both in terms of leaf area index (3.42) and flower yield (8 flowers/m²), and hence it is recommended as suitable cultivar for greenhouse floriculture in subhumid subtropical regions. The cultivation of gerbera in the Sawtooth greenhouse of 84 m² floor area was found to be economically viable with a net profit of Rs. 38708.00, benefit-cost ratio of 1.8 and a payback period of 3.1 years.

Moreover, the results of simulation modeling were found to be in reasonable agreement with the observed data for both winter and summer seasons with RMSE values of 0.73 °C (air temperature), 0.08 kPa (vapour pressure) and 0.96 °C (canopy temperature) during winter season and 0.87 °C, 0.15 kPa and 1.54 °C during summer season. The sensitivity analysis of model parameters revealed that the width of side ventilation, angle of roof vent and leaf area index are the most sensitive parameters for simulating internal air temperature, suggesting greater attention to these parameters while designing a greenhouse for floriculture in subhumid subtropics. The findings of this study can provide guidelines for the selection of suitable greenhouse design and the development of control strategies for greenhouse floricultural production in subtropics.

Keywords: *Quonset, Sawtooth, microclimate evaluation, UV stabilized film, diffused film, gerbera, microclimate modeling, genetic algorithm, sensitivity analysis, economic analysis, subtropics.*