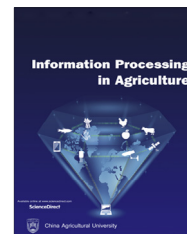




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Modeling and experimental validation of heat transfer and energy consumption in an innovative greenhouse structure

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ABSTRACT

The commercial greenhouse is one of the most effective cultivation methods with a yield per cultivated area up to 10 times more than free land cultivation but the use of fossil fuels in this production field is very high. The objectives of this paper are to modeling and experimental evaluation of heat and mass transfer functions in an innovative solar greenhouse with thermal screen. For this propose, a semi-solar greenhouse was designed and constructed at the North-West of Iran in Azerbaijan Province (38°10'N and 46°18'E with elevation of 1364 m above the sea level). The inside environment factors include inside air temperature below screen (T_a), inside air temperature above screen (T_{as}), crop temperature (T_c), inside soil temperature (T_s), cover temperature (T_{ri}) and thermal screen temperature (T_{sc}) were collected as the experimental data samples. The dynamic heat and mass transfer model used to estimate the temperature in six different points of the semi-solar greenhouse with initial values and consider the crop evapotranspiration. The results showed that dynamic model can predict the inside temperatures in four different points (T_a , T_c , T_{ri} , T_s) with MAPE, RMSE and EF about 5–7%, 1–2 °C and 80–91% for greenhouse without thermal screen and about 3–7%, 0.6–1.8 °C and 89–96% for six different points of greenhouse with thermal screen (T_a , T_c , T_{ri} , T_s , T_{as} , T_{sc}), respectively. The results of using thermal screen at night (12 h) in autumn showed that this method can decrease the use of fossil fuels up to 58% and so decrease the final cost and air pollution. This movable insulation caused about 15 °C difference between outside and inside air temperature and also made about 6 °C difference between T_a and T_{as} . The experimental results showed that inside thermal screen can decrease the crop temperature fluctuation at night.

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