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日光温室后墙蓄放热帘增温效果的性能测试

Performance testing on warming effect of heat storage-release curtain of back wall in Chinese solar greenhouse

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中文摘要:

为了增加日光温室有效蓄热量，改善日光温室夜间温度环境，保障作物安全越冬，该文设计了一种以日光温室后墙为结构支撑的温室蓄放热帘增温系统，白天利用该系统的集放热板吸收太阳辐射热，并通过水介质将热量储存于蓄热水池中；夜晚通过水介质的循环将蓄积的热量释放到温室中，以提高夜晚温室内空气温度。试验结果表明：晴天时应用温室蓄放热帘增温系统能将温室夜间平均气温提高4.6℃，阴天时能提高温室夜间平均气温4.5℃；试验期间当室外最低气温为-12.5℃时，对照温室最低气温仅为5.4℃，而试验温室最低气温为10.1℃；该系统在阴天平均集热效率为42.3%，在晴天时平均集热效率为57.7%；与电加热方式相比该系统的节能率达到51.1%以上。

英文摘要:

Abstract: The Chinese Solar Greenhouse (CSG), characterized by an east-west orientation, transparent camber south roof, and solid north roof and east and west walls, is utilized primarily in horticulture in northern China. During the day, the CGS stores solar energy through the north wall and soil, and releases it when the inside air temperature is low. Because of limited energy capacity, during cold winter nights, the air temperature can be very low and this considerably decreases crop production. To increase this low nighttime air temperature, a heat collection and storage-release system was studied. This system was installed at Changping District (latitude 39° 54′ N, longitude 116° 24′ E), Beijing, China. The CSG was positioned towards the south along a south-north line. The Solar greenhouse was 49 m long, 8 m wide and 3.7 m high. The roof of the greenhouse was covered with polyethylene terephthalate (PET) films. The north wall and sidewalls were made of red brick and polystyrene board (24 cm thickness red brick inner, 10 cm thickness polystyrene board middle and 12 cm thickness red brick outer). During the experimental period from the 15th of November 2012 to the 20th of January 2013, the crop studied was tomato plants, and the covering layer was opened during the daytime (08:30-15:30) and closed during night (15:30-08:30) in sunny days. The results were compared to the nighttime air temperatures in a reference CSG. The system consisted of a solar collector, a heat storage device and a circulation pump. The solar collector was facing south and fixed on the north wall inside the CSG. During daytime, the absorbed solar energy from the system was transferred to the water by the circulation pump. At night, when the greenhouse air temperature dropped below 10℃ the system then transferred the low temperature heat from the water to the greenhouse air. The results showed that the average nighttime air temperature in the CSG was 4.6 and 4.5℃ higher than that in the reference CSG on cloudy and sunny days, respectively. When the outside air temperature was -12.5℃, the air temperature inside the normal greenhouse was just 5.4℃, while that in the experiment greenhouse was 10.1℃. The average efficiency of the heat storage-release system reached 42.3% and 57.7% on cloudy and sunny days, respectively. Compared with electricity heating equipment, the experiment achieved 51.1% energy savings. The results indicate that the heat storage-release curtain is an effective method to increase the nighttime air temperature in the Chinese Solar Greenhouse.

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