

节能温室太阳能土壤蓄热加温系统的研究

Substrate heating system with solar energy for greenhouse

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中文摘要:

为了改善节能温室冬天植物栽培生产地温低,严重影响植物生长发育,影响温室生产产量和品质的问题。以数学模拟和回归实验相结合的方法,研究了温室土壤的太阳能蓄热加温系统。研究表明:系统能有效的提高地温,减少地温的变化幅度;在以加热管形成的浅层土壤温度层和以蓄热管形成的深层土壤温度层之间具有一个过渡层,和其它层不一样,这个过渡层的温度是不随时间变化的;以SAS软件拟合的非线性方程为基础的土壤温度场的数学模型的模拟结果与实验结果吻合较好;选用差分法计算的土壤热扩散率精确度高,符合实验及生产实际要求;由温室热平衡方程确定的太阳能集热器面积与温室种植面积的优化比例为1:5,经试验验证,在目前技术状态下,该比例能满足作物冬季生长对土壤温度的要求。总之,研究的太阳能蓄热系统实现了太阳能夏天贮冬天用、日间贮夜间用、晴天贮阴天用的目的,从而在不消耗任何二次能源的条件下,能满足温室作物的正常生长要求。

英文摘要:

Aiming at solving the problem of lower temperature, which restrains plant development, production and quality in greenhouse during wintertime, a system was introduced which could store solar energy in substrate maintain the soil temperature to meet the crop requirement for growing well. This research was conducted mainly by mathematical simulation and the regression analysis in the SAS Software. The result showed that the system could efficiently increase the soil temperature and reduce range of soil temperature fluctuation in the greenhouse during wintertime. And there was a transition layer of the substrate temperature between the storing one and heating one, in which the temperature did not vary with the time, but the others did. The research proved that the simulation result showed good agreement with the measured one. The difference method was used to calculate the heat diffusion coefficient and it was accurate enough. It was also confirmed that the optimizing areas ratio of solar collector of the system to cultivation field is 1:5, which could meet crop growth requirement all the year round in the study situation. In a word, the system could accomplish the goal of storing solar energy in summer and utilizing in winter, storing it in daytime and utilizing in nighttime, storing it in sunny day and utilizing in cloudy day, for raising substrate temperature to meet the plant growth requirement without any other energies.

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