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BEST PRACTICES

Rational energy use in greenhouses in Mediterranean area

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Summary

Explain your case in one or two sentences

This text aims to propose active and passive methods that could be applied in Mediterranean greenhouses in order to reduce energy use, without affecting the yield amount and quality.

Background information: How was the situation previous to your actions?

The need for rational use of energy is critical since energy forms a substantial fraction of total production costs. For a heated greenhouse with tomato cultivation in Mediterranean area, the annual energy use for conditioning is roughly 1000 $MJ \cdot m^{-2}$. Heating is more and more commonly used to obtain early production and a constant quantitative-qualitative yield, leading to a higher energy use. Improved environmental control (e.g. more CO_2 supply, additional lighting), intensified production schemes and use of cooling systems all cause an increase in energy consumption. On average the energy use ranges from 10 – 30% of the total production costs, depending on the different regions.

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What were the needs you identified?

There are mainly two ways to increase the energy efficiency in a greenhouse: a) reduction of the energy input into the greenhouse system and b) increase the production per unit energy. The major challenge is to find ways which meet both needs: improved energy efficiency combined with an absolute reduction of the overall energy consumption and related CO_2 emission of the greenhouse industry. The major processes of energy loss in naturally ventilated greenhouses are convection and radiation from the greenhouse cover, and thermal and latent heat transfer through ventilation.

What solution you found to cover those needs?

The rational use of energy can be achieved by efficient use of energy (i.e. amount of product per input of energy), and reduction of the energy requirement of the greenhouse. Improved insulation and reduced ventilation are the first steps to create energy conservative greenhouses.

What actions did you take to reach the solution?

- Proper design and installation, and frequent check, of the greenhouse itself and the control equipment (at least at the start and once during the growth season) in order to obtain maximal benefit of energy efficient environmental control.
- Application of wind dependent heating to control temperature. Heat losses increase linearly as wind speed increases, therefore, energy can be saved by reducing the heating set-points when it is windy and compensating, while increasing heating set-points at low wind speeds.
- Implementation of temperature integration strategy, which includes using higher than normal ventilation temperatures to maximise heating due to solar gain and compensating these temperatures by running lower heating temperatures at night or on cloudy days.
- In order to reduce the “humidity control related” energy consumption, several options can be applied like setting higher humidity set points, reducing the transpiration level of the crop, applying active dehumidification with heat recovery.
- Increasing the insulation by using double or triple layer materials and application of coatings reduces the radiation loss. One should select those materials that cause low transmission of infrared radiation.
- Shading systems can be used to achieve passive cooling as they reduce the solar energy flux into the greenhouse during periods with an excessive radiation level, characterised also by other advantages like improvement of temperature, humidity, quality, and water use efficiency.
- Indoor energy screens can be used to balance the ambient temperature of the greenhouse and reduce heating costs. They can be opened or closed voluntarily depending on the external weather conditions and the crop. They offer a certain level of shade during the day reflecting outward unwanted solar energy and when opened during night, limit radiative cooling and losses of heat.

If any, which partners or other organisations did you involve during the process?

- Institute for Bio-Economy and Agri-Technology, Greece
- Wageningen UR Greenhouse Horticulture, The Netherlands

What were the main problems or difficulties you had to face?

- The existing technology and know-how developed in Northern Europe countries are generally not directly transferable to the Mediterranean growers: high-level technology is out of reach for most of the Mediterranean growers because their cost is too high compared to the modest investment capacity of these growers. Know-how from Northern Europe growers is often inappropriate to the problems encountered in the Mediterranean shelters.
- Temperature control requires specific knowledge of the crop grown, as plants have to be grown within the sub- and supra-optimal temperatures.
- Humidity control should be applied carefully as fungal disease outbreaks may occur, inducing devastating impact to crop production.
- A major disadvantage of most insulating covering materials is the fact that they cause reduction in light transmission and increase in humidity levels.

What is the situation now, after your actions?

- Reduction 1^{o}C in heating temperature saves roughly 10% energy
- Application of wind dependent heating results in 5 – 10% energy saving
- Implementation of temperature integration strategy results in up to 20% energy saving
- Application of humidity control saves roughly 5% energy
- Different types of greenhouse covering materials can trigger 25 – 51% reduction on annual energy use

Main lessons learned along the way? *

Clearly there are numerous technologies for greenhouse systems which can be adopted by the farmers enabling better, more efficient, and sustainable energy use. However, many obstacles and constraints remain to be solved that are related to the application of the existing technology and know-how to greenhouses in Mediterranean area, to the high technology cost compared to the modest investment capacity of Mediterranean farmers, to the adaptation of technology to the problems that are encountered in Mediterranean greenhouses.

Sources:

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