Applying cooling below or above the crop:

an experimental study in semi-closed greenhouses

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Cooling of semi-closed greenhouses using ATU

Cooling from below

The hot air is sucked from the top the crop and the cold air is distributed below the crop.

Cooling from above

The hot air is sucked from the top of the crop and the cold air is distributed also at the top of the crop.

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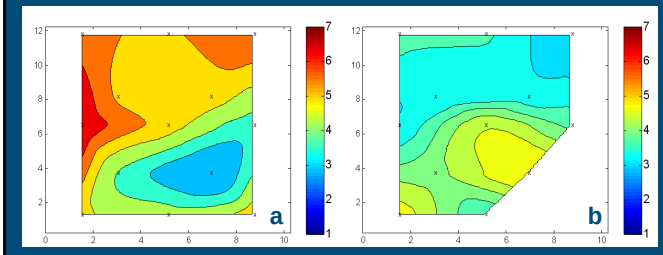
Experimental set up and data process

Wireless sensor network

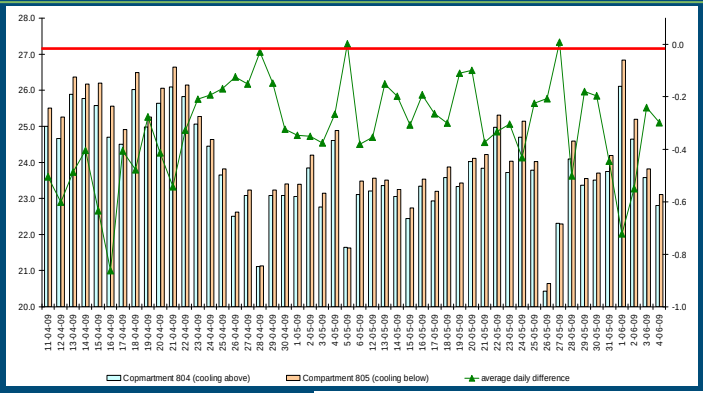
A network with sensors for measuring air temperature and air humidity was installed in each greenhouse compartment with record time interval 5 min.



Air temperature maps

Air temperature (°C) distribution in the compartment a (coolers below the crop) and in the compartment b (coolers above the crop), at 11/04/09, 12:30-13:00.

Experimental results (average values)



Air temperature

Daily average air temperature in the compartments A (below) and B (above) Apr – Jun

data from:
10:00 – 18:00

	ATU - ℃ A (cooling below)	air temp. ℃ A (cooling below)	ATU ℃ B (cooling above)	air temp. ℃ B (cooling above)	ATU absolute difference
average	**14.0**	23.2	**14.3**	22.9	0.3
min	11.2	16.5	11.2	16.3	-3.4
max	22.9	28.6	23.0	27.8	8.5
st. deviat	1.5	2.9	1.9	2.8	1.2

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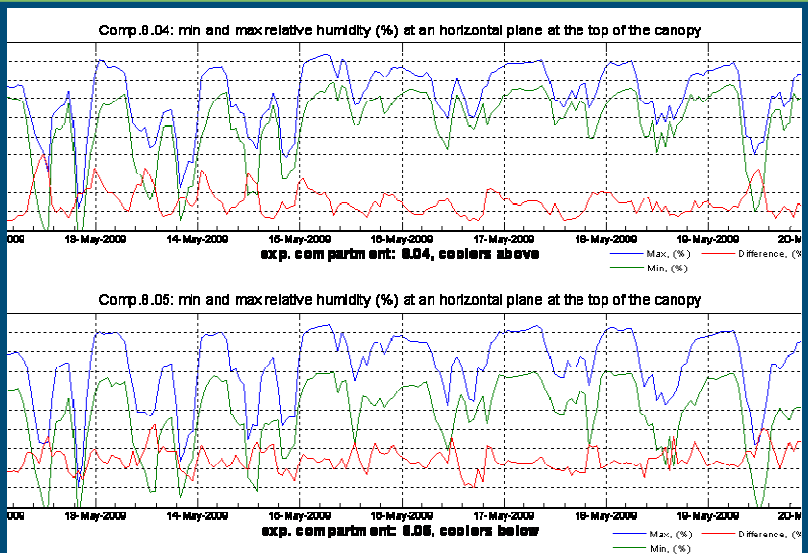
Experimental results (air temperature distribution)



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Conclusions Air Temperature, (°C)

- The mean air temperature in the compartment b (cold air high) is lower than the compartment b (cold air low). The mean daily air temperature was 20.7 and 21.4 °C for the compartments b and a respectively (difference of 0.7 °C).
- The variation of the air temperature in the compartment . a was higher than the variation in the compartment b. The air temperatures differences between min and max values were ranged from 0 - 3.5 °C and from 0 - 2.0 °C for the comp. a and b respectively.
- The variations of the air temperature, it is possible to be produced by the ventilators due to the slightly higher air temperature at the top part of the greenhouse.

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Conclusions Air Humidity, (g/kg)

- The mean air humidity in the compartment b (cold air above) is lower than the compartment a (cold air below). The mean daily air humidity was 2.7 and 3.1 g/kg for the compartments b and a respectively (difference of 0.4 g/kg)
- The variation of the air humidity in the compartment a was higher than the variation in the compartment b
- The higher values of air humidity in the compartment a could be produced by the higher evaporation of the crop due to slightly higher air temperatures at the top of the canopy.

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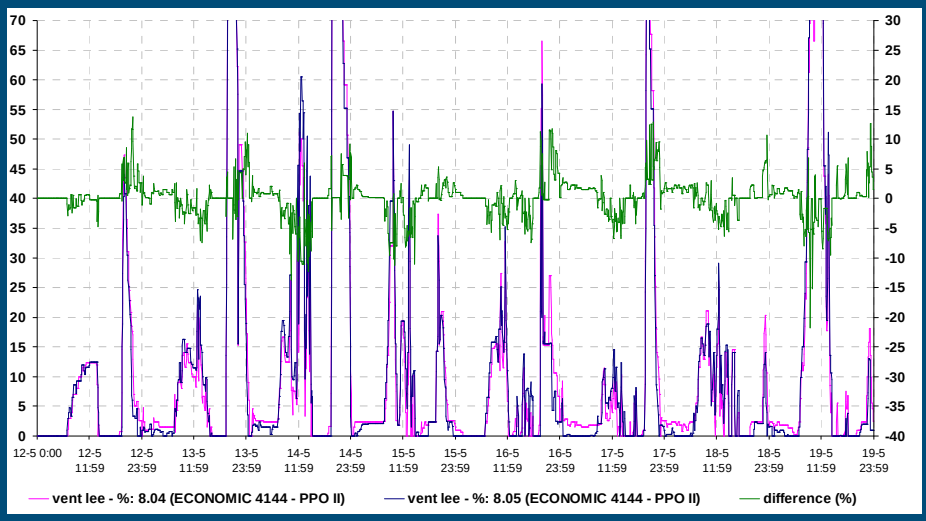
Experimental results (window opening)



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