

Thermal screen tested in practice

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If energy prices increase further in the future, growers may need more radical tools to reduce the energy input in greenhouses. One of the options is a thermal screen. Though marginal at present in mild climate regions of New Zealand, a thermal screen might become interesting for the colder regions. This article describes a simple test of a thermal screen in a glasshouse in Christchurch, showing the energy saving achieved in a winter night. It is not at all a scientific experiment but a simple and practical demonstration in New Zealand of the obvious effect of a thermal screen. Scientific data are available from overseas experiments.

Greenhouse

A cucumber grower north of Christchurch has a large glasshouse with a thermal screen. The screen is moveable, and the material is LS-XLS15, which is meant to save 50 % energy and block 50% of the light when closed. The glasshouse also has two heating nets: net 1 was the pipe-rail heating net on the ground and net 2 was a heating loop hanging in between the plants. The greenhouse consists of two identical compartments with the same crop and the same climate control computer settings. This set-up is ideal for testing the effect of the thermal screen. The test was done in the night of 30/31 August 2004, when the outside temperature was 1 - 4 °C (see **Figure 1**). The test comprised closing the screen in one compartment and leaving it open in the other. Temperature readings were taken from the grower's climate control computer. The important factor to consider is the pipe temperature.

Heat release

The heat released by a heating pipe depends on the difference between the pipe temperature and the air temperature, as well as on the size of the heating pipe. Handbooks give the equation to calculate the heat release per meter pipe length. For instance a heating pipe of 48.5 mm diameter which is 30 degrees hotter than the greenhouse air releases 53 Watt for each meter of pipe length. With a temperature difference of 60 degrees, the heat release is 123 Watt per one meter pipe length, etc. In this greenhouse, there was exactly 1 meter length of upper heating pipe net and 1 m length of the lower heating net per one square meter of greenhouse floor. The heat production by the lower and upper heating nets was calculated from the measured difference between pipe and air temperature, and the equation from the handbook.

Results

The air temperature in the two compartments was very similar (17.5 °C, see **Figure 3**). The temperature of the heating pipes was 10 degrees lower in the screened compartment than in the unscreened compartment, both in net 1 and net 2 (see **Figure 4 and 5**). The last column in Table 2 shows the ratio of energy use in the two compartments (in percents). The calculated heat release was around 95 Watt per m² ground area in the compartment without a thermal screen, and 55 W/m² in the compartment with thermal screen. This means that the energy consumption in the compartment with a thermal screen was **about 58%** of that in the unscreened compartment, or in other words **42% lower**. This is an example of what can be achieved by using this type of thermal screen.

Considerations

- Thermal screens are a considerable investment, to be earned back by reduced energy costs.
- A moveable thermal screen is usually used in glasshouses with hot-water pipe heating.

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- The glasshouse must be high enough to allow a good growing environment under a screen.
- A screen is easy to install when a glasshouse is erected, but is hard to retro-fit.
- A 'open' thermal screen intercepts some natural light, causing yield loss year-round.
- The costs of a thermal screen include investment costs (spread over 5-10 years), running costs, maintenance costs, and yield loss due to reduced natural light.
- The energy saving depends on the screen material chosen, and how the screen is managed.
- A glasshouse insulated by a thermal screen can be heated by a smaller boiler, or some extra glasshouse area can be added without increasing the boiler capacity.
- The grower needs to learn how to get optimal growing results when using a thermal screen, and how to avoid disease problems due to higher air humidity.
- Shade screens have limited effect on energy use in winter. A dual-purpose screen (for shading in summer and energy saving in winter) is always a compromise.
- Thermal screens are most interesting for areas with cold winters; they may become more feasible when the energy price rises further.

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Table 1. Conditions during thermal screen test in night of 30/31 August 2004.

TIME	TEMP OUT °C	House without thermal screen			House with thermal screen		
		AIR TEMP °C	HEAT NET 1 °C	HEAT NET 2 °C	AIR TEMP °C	HEAT NET 1 °C	HEAT NET 2 °C
8-9 pm	5.0	18.6	42.1	41.7	18.6	32.3	31.3
9-10 pm	5.3	17.8	35.6	35.7	17.5	29.5	29.6
10-11 pm	5.1	17.2	39.7	39.5	17.1	31.2	31.0
11-12 pm	3.7	17.2	44.1	44.0	17.0	33.9	33.7
12-1 am	2.3	17.4	47.8	47.9	17.2	37.6	36.8
1-2 am	1.9	17.5	48.1	48.3	17.5	38.0	37.3
2-3 am	1.9	17.5	48.8	48.7	17.5	37.0	37.1
3-4am	1.3	17.5	49.4	49.6	17.4	38.2	38.4
4-5am	1.8	17.4	49.1	49.2	17.4	37.9	38.0
Average	3.1	17.6	44.9	44.9	17.5	35.1	34.8

Table 2. Energy released by heating nets 1 and 2 in the two compartments during thermal screen test in the night of 30-31 August 2004.

TIME	House without thermal screen			House with thermal screen			Relative energy use
	NET1 Watt	NET2 Watt	Watt per m ²	NET1 Watt	NET2 Watt	Watt per m ²	
8-9 pm	39.4	38.6	78.0	20.5	18.7	39.2	50.3%
9-10 pm	28.2	28.4	56.6	17.6	17.8	35.4	62.9%
10-11 pm	37.4	37.1	74.6	21.2	20.9	42.1	56.6%
11-12 pm	46.6	46.4	92.9	26.5	26.1	52.6	56.5%
12-1 am	53.9	54.3	108.2	33.3	31.7	64.9	60.0%
1-2 am	54.3	54.6	108.9	33.4	32.0	65.4	60.1%
2-3 am	55.8	55.6	111.4	31.5	31.7	63.2	56.8%
3-4am	57.2	57.5	114.7	34.0	34.5	68.5	59.7%
4-5am	56.7	56.8	113.5	33.5	33.7	67.3	59.4%
average	47.7	47.7	95.4	28.0	27.4	55.4	58.0%

Figures 1-6. Results of test of a thermal screen in the night of 30/31 Aug 04, in Christchurch in two glasshouse compartments: one with thermal screen and one without screen.

Fig. 1. Radiation and temperature outside;

Fig. 2. Thermal screens in two compartments;

Fig. 3. Air temperatures;

Fig. 4. Pipe temperature of lower heating nets;

Fig. 5. Pipe temperature of upper heating nets;

Fig. 6. Energy consumption (in Watt/m²)

