

# Greenhouse and Nursery Water Treatment Information System

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## HEAT TREATMENT / PASTEURIZATION

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### **Background**

Pre-heating (or pasteurization) of water prior to reuse is a very effective and reliable method of treating irrigation water for pathogens. This method involves heating irrigation water to a specific temperature that inactivates microorganisms.

Pasteurization does not require the water to be pre-filtered and does not have any residual impact on plants. Pasteurization, however, uses a high amount of energy to heat the water. This becomes expensive for production facilities that use large volumes of water and as such this treatment is better used for smaller volumes of water.

### **Application method**

The most common method of heat treatment requires passing irrigation water through two heat exchangers. In the first heat exchanger heat lost from water that has already been through the system and cooled down is used to preheat the water to be pasteurized. In the second heat exchanger, an external heat source must be used to heat water to the required temperature for sterilization. Before it is sent to irrigate the plants, the water must be cooled down.

### **Critical levels for pathogens**

Common plant pathogens are effectively inactivated when water is heated at a temperature of 95°C for 30 seconds, which is the most commonly used method (Newman, 2004). However, heating the water to temperatures this high requires the use of a lot of energy, and may be prohibitively costly. As such, the table below provides information on the minimum temperature and exposure time needed to kill off 99.9% of some common soilless culture pathogens.

Microorganism	Pathogen Propagule	Critical Temperature (°C)	Contact Time (sec)
<i>Erwinia chrysanthemi</i> Runia and Amsing (2001a)	Bacterium	54	15
<i>Fusarium oxysporum</i> Runia and Amsing (2001a)	Conidia	54	15
<i>Phytophthora cryptogea</i> Runia and Amsing (2001a)	Zoospores	44	15
<i>Pythium aphanidermatum</i> Runia and Amsing (2001a)	Zoospores	51	15
<i>Radopholus similis</i> Runia and Amsing (2001a)	Nematode	53	15
Tomato mosaic virus (ToMV) Runia and Amsing (2001b)	Virus	85	180

From this data Runia and Amsing (2001) proposed that heating irrigation water to 60°C for an exposure time of 2 minutes should be sufficient to get rid of most greenhouse pathogens. Compared to the commonly used method, this would reduce energy use by 42%. However, if viruses are found to be a problem a temperature of 85°C for 3 minutes is recommended. These findings suggest that, while 95°C for 30 seconds is the norm and likely to be successful, in order to save energy it may be possible to adjust temperature to your particular needs based on the pathogens present in your system.

### **In combination with other technology**

Unlike many other treatment methods, heat treatment does not require pre-filtration to work. However, in the long run, high mineral content in the water will lead to the buildup of deposits on the heat exchangers of the pasteurization system, which will decrease efficiency and increase maintenance costs.

### **Cost for Technology**

The use of any water treatment technology is dependent on the size of the production facility and the amount of water used. Below are tables that summarize the average water consumption and cost of using heat treatment for a small, medium and large facility. These calculations assume 3GJ natural gas is consumed to treat 10,000L of water. This figure was determined by finding the amount of energy required to heat 10,000L of water to 95°C from 25°C. Actual energy consumption may be more or less than this, depending on the amount of recycled heat available and the amount of energy required to cool water back down. The price of natural gas was estimated at \$3.28/GJ, although this will vary with time and location (National Energy Board, 2012).

Size of Production Facility	Water Usage (litres/day) Greenhouse <sup>1</sup>	Water Usage (litres/day) Nursery <sup>2</sup>
Small	29,263 – 37,857	700,993 – 2,103,001
Medium	33,560 – 134,244	1,401,997 – 3,219,732
Large	117,057 – 151,431	1,609,854 - 4,829,610

Size of Production Facility	Operation Cost Greenhouse (per day) <sup>3</sup>	Operation Cost Nursery (per day) <sup>3</sup>
Small	\$10-12	\$230-690
Medium	\$11-44	\$460-1056
Large	\$38-50	\$528-1584

<sup>1</sup>Flowers Canada Growers. (2011). Website: <http://flowerscanadagrowers.com>

<sup>2</sup>Canadian Nursery Landscape Association. (2011). Website: [www.canadanursery.com/](http://www.canadanursery.com/)

<sup>3</sup>Nurseries usually do not need to treat all their water, so nursery costs are likely overestimates.

## Maintenance

The heat exchangers and other parts of the pasteurization system will have to be cleaned regularly, including the removal of iron or calcium deposits that develop.

## Pros and Cons

### Pros:

- Simple, readily available technology
- Does not require pre-filtration
- Does not involve chemically altering irrigation water, so water is non-hazardous to humans and the environment
- No potential for phytotoxic effects; no potentially harmful residuals or by-products

### Cons:

Operating costs are often very high and dependent on the current price of fuel

- Equipment may also be expensive, and the storage tanks needed to treat and store water may take up a lot of space
- Over time, calcium will precipitate on the heat exchange plates, requiring cleaning and maintenance. This can be combated by keeping water entering the heat exchangers at a low pH, or softening water entering the system. However, this will add further costs and may be difficult to maintain. As such, there is a trade-off between decreasing overall costs and decreasing maintenance
- Corrosion-resistant materials (ie. stainless steel, synthetic materials) must be used in the pasteurization system to prevent deterioration of equipment, as materials such as zinc and copper would eventually corrode and potentially cause phytotoxic effects downstream of the treatment system (Runia et al., 1988)

## Summary

Overall, it has been demonstrated that heat treatment is effective against a wide variety of pathogens, with no phytotoxic effects under proper system upkeep (Van Os, 2010). Unfortunately, operation costs are often high and directly dependent on the cost of natural gas, which may fluctuate significantly from year to year (National Energy Board, 2012). Potentially high costs may mean heat treatment is best employed for disinfecting the smaller amounts of water used in highly disease susceptible areas, such as those dedicated to plant propagation (Hong, 2005).

## References

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