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Ornamental Horticulture Research and Innovation Cluster

# Dynamic greenhouse climate control to conserve energy and improve crop quality

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**Canada**

# Introduction

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- Heating/temperature affects plant growth rates, quality and duration of production cycle and input costs.
- Energy saving measures should not compromise plant growth and quality.
- Temperature integration can save energy without compromising plant growth and quality.
- Temperature drop during pre-morning or early morning could allow more energy saving and reduce plant height.

It could also lead to high humidity and water condensation on plants.

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# Introduction

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- Root zone/floor heating can save energy because of more efficient heat transfer to the plant and can also prevent water condensation on plants.

However, high root zone temperature could damage root system.

- Irrigation need to be adjusted to prevent root damage and to increase plant tolerance to temperature fluctuation.
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# Project Objective

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To test and evaluate:

- 1) various dynamic TI regimes with temperature drop,
- 2) root zone heating temperatures (RHTs) and their interaction with TI regimes,
- 3) irrigation strategies and their interaction with RHTs and TI regimes.

For developing dynamic greenhouse heating and climate control strategies to conserve energy while ensuring timely production and good plant quality.

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# Plan & Methodology

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- **Growth Chamber Trials**
    - 1). To identify the best TI regime with temperature drop
    - 2). To identify the best combination of root zone temperature and TI regime.
  - **Greenhouse Trials**
    - 1). To validate the best treatment identified in the growth chamber trials (plant performance).
    - 2). To investigate the effects on plant microclimate and energy use.
    - 3). To identify the best irrigation strategy for the new TI & root zone heating strategy.
  - **Crops:** Poinsettia and Chrysanthemum.
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# Milestones & Progress

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- Started in Aug. 2010
  - Four growth chamber trials on Poinsettia have been conducted (Aug. 2010 to Sept. 2011) and one is in progress.
  - One growth chamber trial on Chrysanthemum has been completed (Sept. to Dec. 2011).
  - One greenhouse trial on Poinsettia was also conducted (Sept. to Dec. 2011)
  - Greenhouse trial on Chrysanthemum is in progress.
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# Growth chamber trials - Poinsettia

- Cultivar: Premium Red
- Four TI regimes with temperature drop (4 large growth chambers)

TI Regimes with Pre-Morning or Early Morning Temperature Drop\*

Time	Hours	Lighting	Control	PM2	PM4	PMM2
8:00-10:00	2	On	23	23	23	13
10:00-18:00	8	On	23	23	23	25.5
18:01-23:00	5	Off	18	20	21	20
23:01-4:00	5	Off	18	18	19	18
4:01-6:00	2	Off	18	18	13	18
6:01-8:00	2	Off	18	13	13	13

\*Same 24-h average temperature and DIF

# Growth chamber trials - Poinsettia



- Four electrical heating mats inside each growth chamber (each TI regime).
- One mat for each of the 4 root zone heating temperatures (20°C, 23.3°C, 26.7°C, and 30°C).
- Root zone heating was applied from 19:00 to 10:00 for 15 hours.





# Growth chamber trials – Data Collection



- Plant growth & development
- Microclimate
- Final destructive measurement

Plant height, diameter, number of laterals, number of anthesis buds, the length, leaf number and area, transition leaf number and area, flower diameter, number and area of bracts for each lateral, the length and width for the largest bracts, and plant leaf, stem, and bract dry weight.

- Root coverage and root rot evaluation
- Post-harvest evaluation



# Growth chamber trials – Results

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## TI regime with temperature drop

- No change in total leaf area, bract area, plant biomass, height and diameter, root mass and root rot.
- Shorter bract petiole
- Post-harvest: 5% less in plant height and diameter.

## Root zone heating temperature

- High RHT: less leaf fresh weight and more root rot. No change in other plant parameters.

## TI regime × RHT

- No significant interaction was detected.

**Conclusion:** Lowering the temperature during pre-morning or early morning did not affect plant growth and quality as long as same 24-h average temperature was maintained.

# Greenhouse trial - Poinsettia

- Cultivars: Prestige Early, Premium Red, Firework, Jubilee, and Olympus.
- Two TI regimes (4 greenhouses, 2 for each regime)
- Three root zone heating temperatures (20, 24 and 28 C)
- Three irrigation timings (only on Prestige early)

## Greenhouse set-points for 2 TI regimes\*

Period	Time	Heating set-points (°C)		Ventilation set-points (°C)
		Control	New TI	
1	6:00-9:00	17.4	13.0	20.0
2	11:00-15:00	19.8	21.0	23.0
3	18:30-23:30	17.3	19.0	21.0
4	2:30-4:30	17.2	16.9	20.0

\*3-day temperature integration period.



# Greenhouse trial - Poinsettia

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## New TI with temperature drop

- Shorter branch and plant height, no change in total leaf area, bract area, plant biomass in all 5 cultivars.
- More bract in Firefly, Prestige Early and Premium Red, no change in Jubilee, and Olympus.
- More bract FW except for Prestige Early and less stem FW in all 5 cultivars.

## RHT and TI x RHT

- Higher RHT increased plant diameter and slightly increased root rot (very little root rot in all treatments).
- 28° C RHT accelerated plant development.
- Higher RHT reduced root mass only at control TI.

# Greenhouse trial - Poinsettia

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## Conclusion

- 1). New TI with pre-morning and early morning temperature drop produced shorter plants with the same biomass and thus can maintain plant quality and potentially save energy.
- 2). Irrigation needs to be adjusted to prevent the root damage caused by high RHT.

# First Growth Chamber trial - Mums

- Cultivar: Cheseapeake
- Four TI regimes with different DIFs (4 large growth chambers)
- Four root zone heating temperatures (20, 22, 24 and 27°C, 5:00-12:00)

Period	Time	hours	Lighting	DIF (°C)			
				+3	0	-3	-6
1	8-10	2	ON	15	19	13	13
2	10-12	2	ON	19	19	16	15
3	12-16	4	ON	24.5	19	20	17.2
4	16-18	2	ON	21	19	17.1	15
5	18-22	4	OFF	20	19	20.3	21.5
6	22-2	4	OFF	19	19	20.3	21.5
7	2-5	3	OFF	18	19	20.3	21.5
8	5-8	3	OFF	13	19	20.1	21.5

# Growth Chamber trial – Mums\*

(Preliminary results from the first trial, more trials will be conducted)

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- **Positive DIF**

Faster development, larger plant (taller & wider), larger flower, more biomass, higher DW content, less biomass partitioning to leaf and more to flowers, more root mass, and faster post-harvest senescence (shorter post-harvest shelf life).

- **Root zone heating temperature (RHT)**

Less root mass at 27°C and less root rot at 20°C.

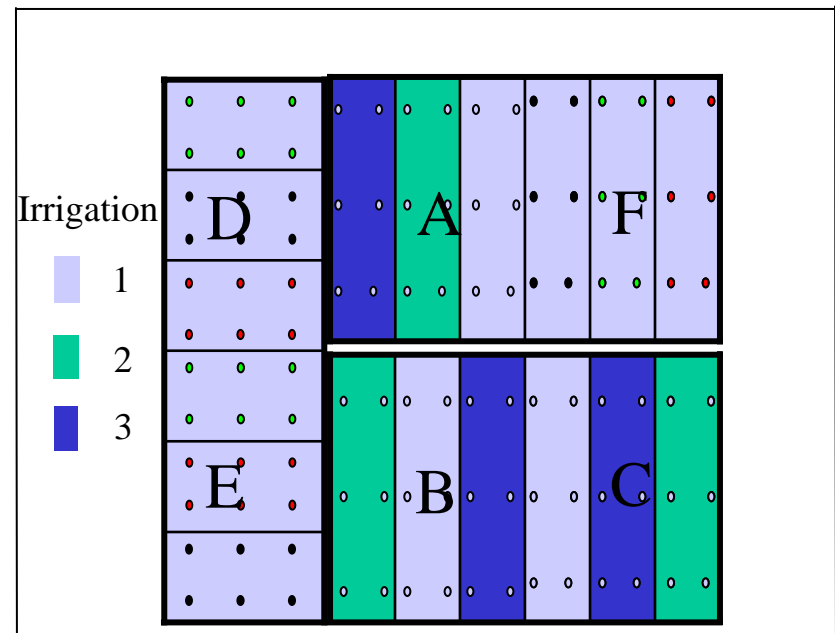
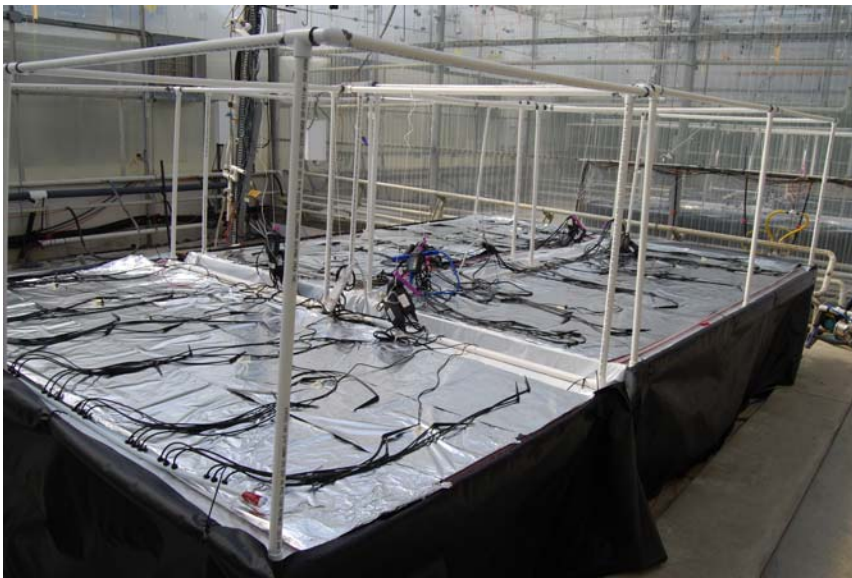
- **DIF\*RHT:** higher RHT only increased flower FW &DW at +3 °C DIF.

\* This is only preliminary results from the first trial. More trials are needed to confirm the findings from this trial and to extend post-harvest shelf life before it can be used in commercial production.



# Greenhouse trial – Mums – In Progress

- Cultivars: Cheseapeake, Dark Chatham, Lansing Regal, Dazzling New York and Irvine Regal.
- Two TI regimes (4 greenhouses, 2 for each regime)
- Three root zone heating temperatures (20, 24 and 28 C)
- Three irrigation timings (only on Chesapeake)





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# Thank you for your attention!

