COHA Project 8

Enabling recirculation with hybrid treatment systems (HTS2)

Research Webinar

February 20, 2020

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Outline

- HTS2 Project objectives
- Summary of the Hybrid Treatment Systems 1 (HTS1) project and findings
- HTS2 Project schedule
- Current systems: precedents from literature
- Pilot systems set up and media alternatives
- Bioassay
- Next steps

Objectives of HTS-2

- Recirculating water runs the risk of unwanted crop impacts from residual PGRs (and pesticides) - documented

- Using existing Hybrid Treatment System (HTS) pilot systems:
  - Assess the ability of existing HTS media and alternative media to remove plant growth regulators (PGRs) & Pesticides (i.e. Batch testing)
  - Evaluate effect of media sequences (i.e. Series testing)
  - Evaluate effect of operational parameters (flow rates, temp etc)
  - Knowledge transfer (KTT)

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Reminder:
What is a Hybrid Treatment System?

- Combination of media and hydraulic characteristics that treats water in a manner that achieves the individual farm's goals, e.g. nutrient removal, phytopathogen removal etc.
- Modified vertical flow constructed wetland design
- NOT vegetated

2015-2018 HTS1 study:

nutrient and phytopathogen removal from greenhouse and container nursery leachates

Portable pilot units

Permanent Installs at 2 sites

Summarized Results

Media or System	Influent Nutrient Concentrations	Average removal efficiency [1] (%)		
		Fungal population	NO_3-N	Phosphorus
Pilot Treatment Systems				
Woodchip	High	Up to 99	99[2]	60
Woodchip	Low	Up to 99	99[2]	0
Pea Gravel	High or Low	increase	0	40-90
Filter Sand	High or Low	50-90	10	10-90
Wollastonite	High or Low	50-90	10	20-90
Slag/Gravel	High or Low	>90	0	>90
Permanent HTS – Nursery 2016-2017	**Low**	**96**	**83**	**69**
Permanent HTS – Greenhouse 2018 (Results to date)	**Moderate**	**82**	**85**	**88**

1. Removal efficiencies are affected by nutrient concentrations, flow rate and temperature
2. Reduced performance at temperatures less than 15°C

https://www.flowerscanadagrowers.com/environment-water-specialist-resource-page

Schedule for HTS-2

- 2019-2020 (Started July 2019)
  - Technical Advisory Committee (TAC)
  - Pilot systems installed on site - *maintenance*
  - Literature review – *PGRs & pesticides, adsorbents, systems*
  - Media selection and configurations
  - Select focus PGRs & pesticides
  - Bioassay development and testing

- 2020-2021
  - Batch studies to test individual media and HRT
  - Lab analyses and Bioassays of final effluents
  - TAC and KTT events

- 2021-2022
  - Series studies to test media sequences and key operational parameters
  - Lab analyses and Bioassays
  - TAC and KTT events

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Basis of HTS-2: precedents from literature

- **Activated carbon** removal of PGRs from greenhouse water ("gold standard")
- **Constructed wetlands** removal of pesticides in ag settings
- **Biobeds** (AAFC testing and manual; woodchips etc for pesticide applicator rinsates; aerobic)
- Lab-scale packed bed **denitrification bioreactor** for removing pesticides from drinking water (Aslan & Turkman 2006)
- Lab-scale **woodchip denitrification bioreactor** for removing pesticides from simulated greenhouse runoff (Abdi et al 2020)

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Activated carbon for removal of Paclobutrazol in commercial greenhouse (U of Florida research)

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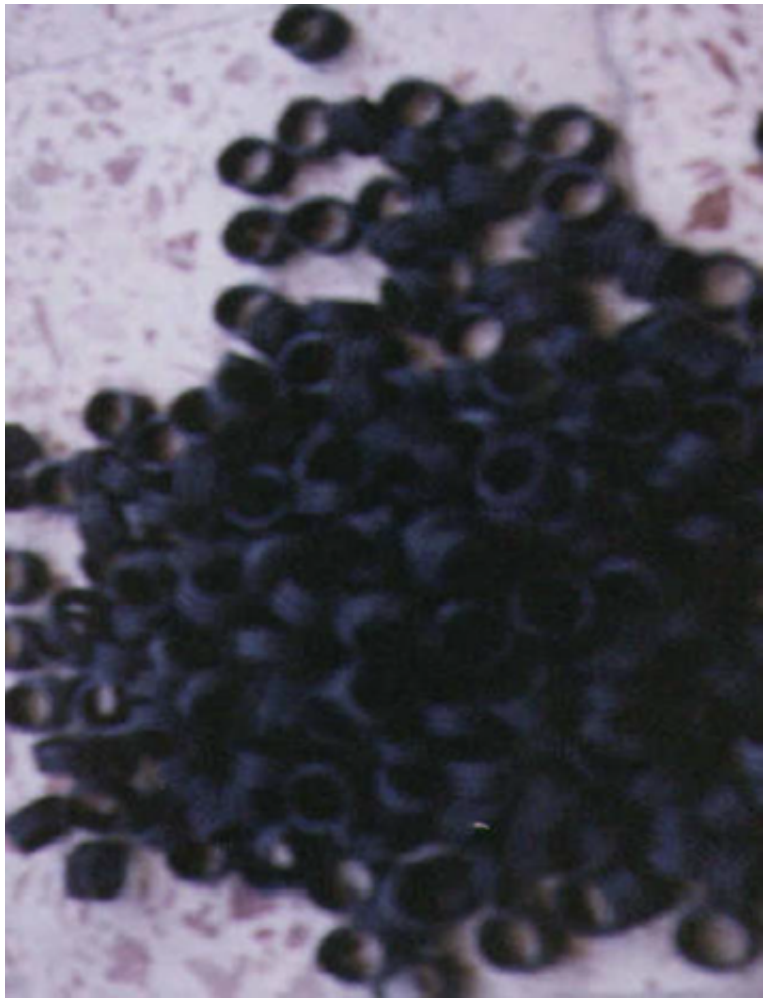
Biodenitrification reactor

(Aslan & Turkman, 2006)



- Significant removal of trifluralin, fenitrothion and endosulfans
- Lab scale, up-flow packed column
- HRT and temperature dependent

Woodchip Denitrification bioreactors (Abdi et al. 2020)

AAFC– aerobic biobeds for pesticide removal from applicator rinsates

http://publications.gc.ca/collections/collection_2018/aac-aafc/A42-123-2018-eng.pdf

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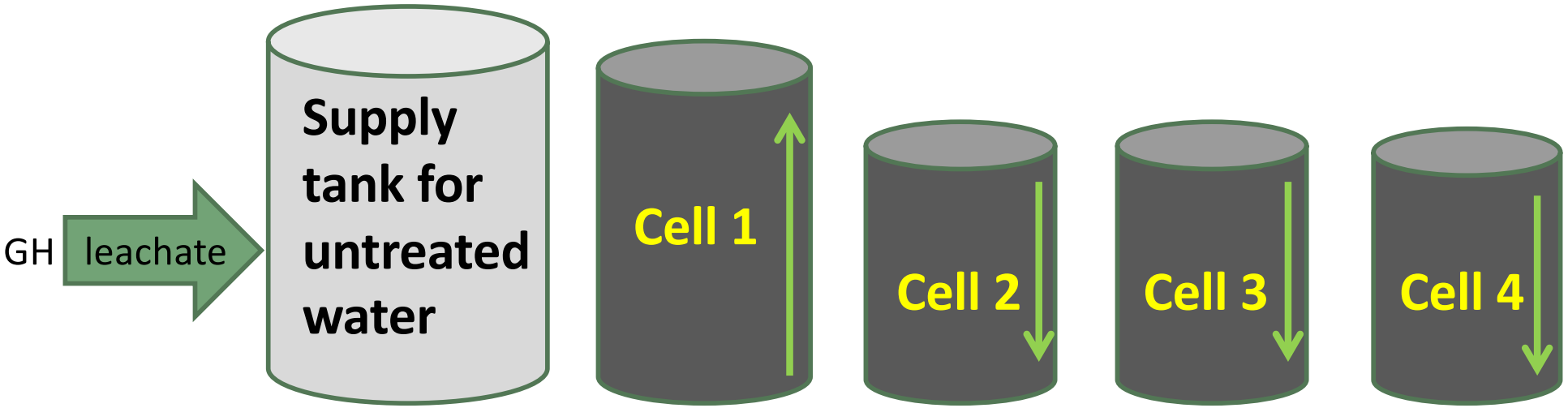
Current treatment media sequences



"GOLD"	Input water supply tank	Hardwood Chips ($-O_2$)	Pea gravel/ slag mix	Pea gravel/ slag mix	Filter sand
"SILVER"	Input water supply tank	Hardwood chips ($-O_2$)	Pea gravel	Wollastonite	Filter sand

Additions or alternatives: granular activated carbon (GAC) – layers and/or smaller cell; woodchips run aerobically; others??

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Options for PGR/Pesticide analyses

A: Lab analysis MDL and MQL: 5 and 20 µg/L

Groups used on site in GH	**# measured in UofG Lab Services Combined LC /GC scans ($242/$182)**
Used as PGRs	2 of 5 in use on site (paclobutrazol: Bonzi; propiconazole: Topaz) (daminozide: B-nine at A&L Labs)
Fungicides	7 of 8 in use on site
Insecticides	9 of 10 in use on site

B: Bioassay: MDL: <5 µg/L

Bioassay for PGRs

- **Seed germination and growth**
  - **Broccoli** (14 days after seeding; Million; Grant et al. Florida; paclobutrazol)
- **Rooted cuttings**
  - (Kalanchoe; Hwang et al.)
  - Begonia (Grant et al.)
- **More rapid versions**: root bioassay (2 days), shoot bioassay (4 days); Chlorella (1 day) – **but more complex**
- **Others**??
- Choice may depend on the target group of chemical

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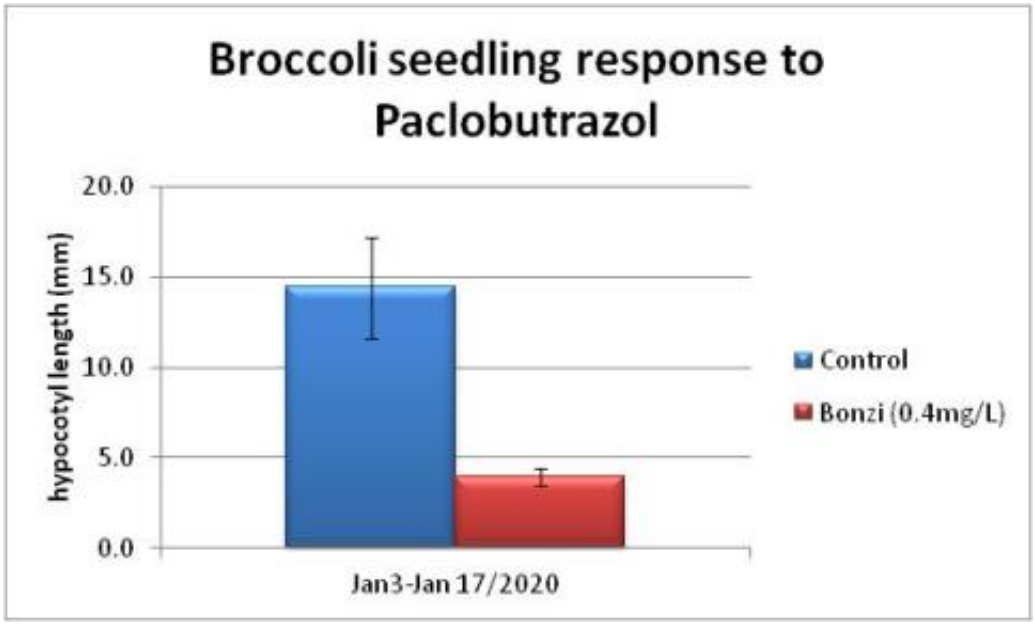
Broccoli bioassay: Method A

- Soak fine vermiculite in either distilled water or 0.4mg/L paclobutrazol
- Fill 2 x 4 cell pacs/ treatment
- Plant 6 broccoli seeds 1cm deep per cell
- Place in trays in germination area of commercial greenhouse
- Thin to 2 seedlings/cell
- Measure hypocotyl length at 14 days

Preliminary Bioassay

(14 days from seeding)



Comparison:
Method A and Method B ("standard")

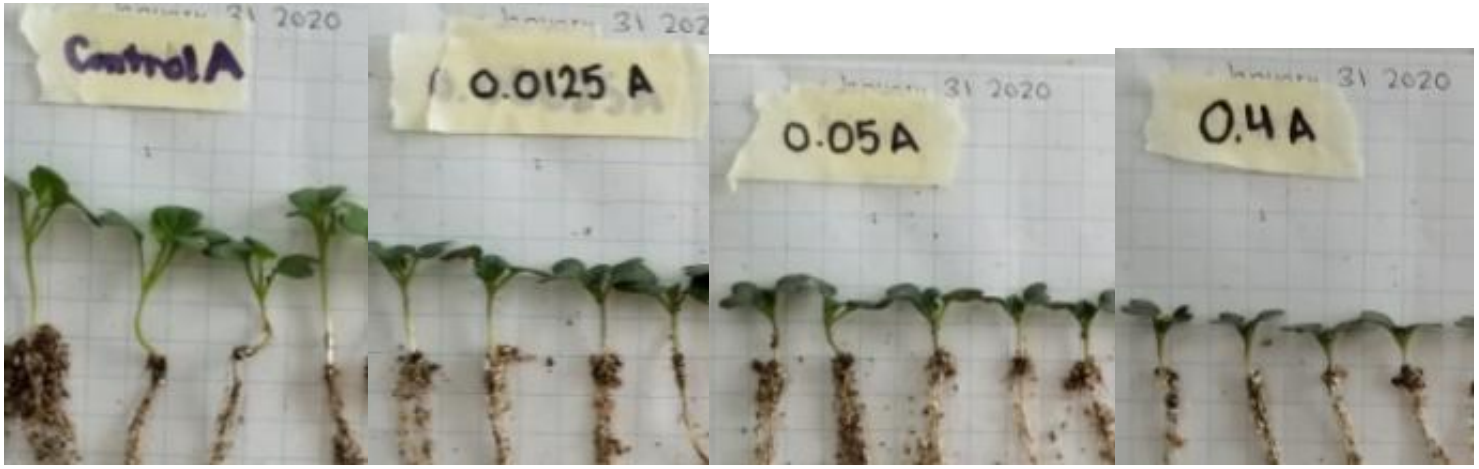
- **Pre-soak vermiculite in water 1hr**
- Fill 2 x 4 cell pacs/treatment
- Plant 6 broccoli seeds 1cm deep per cell
- **Add 15ml of standard solutions per cell (0, 0.00625, 0.0125, 0.025, 0.05, 0.1, 0.2, 0.4 mg paclobutrazol/L)**
- Randomize pacs in trays in germination area of commercial greenhouse
- Thin to 2 seedlings/cell
- Measure hypocotyl length at 14 days

Bioassay method comparison:

(0, 0.00625, 0.0125, 0.025, 0.05, 0.1, 0.2, 0.4 mg paclobutrazol/L)

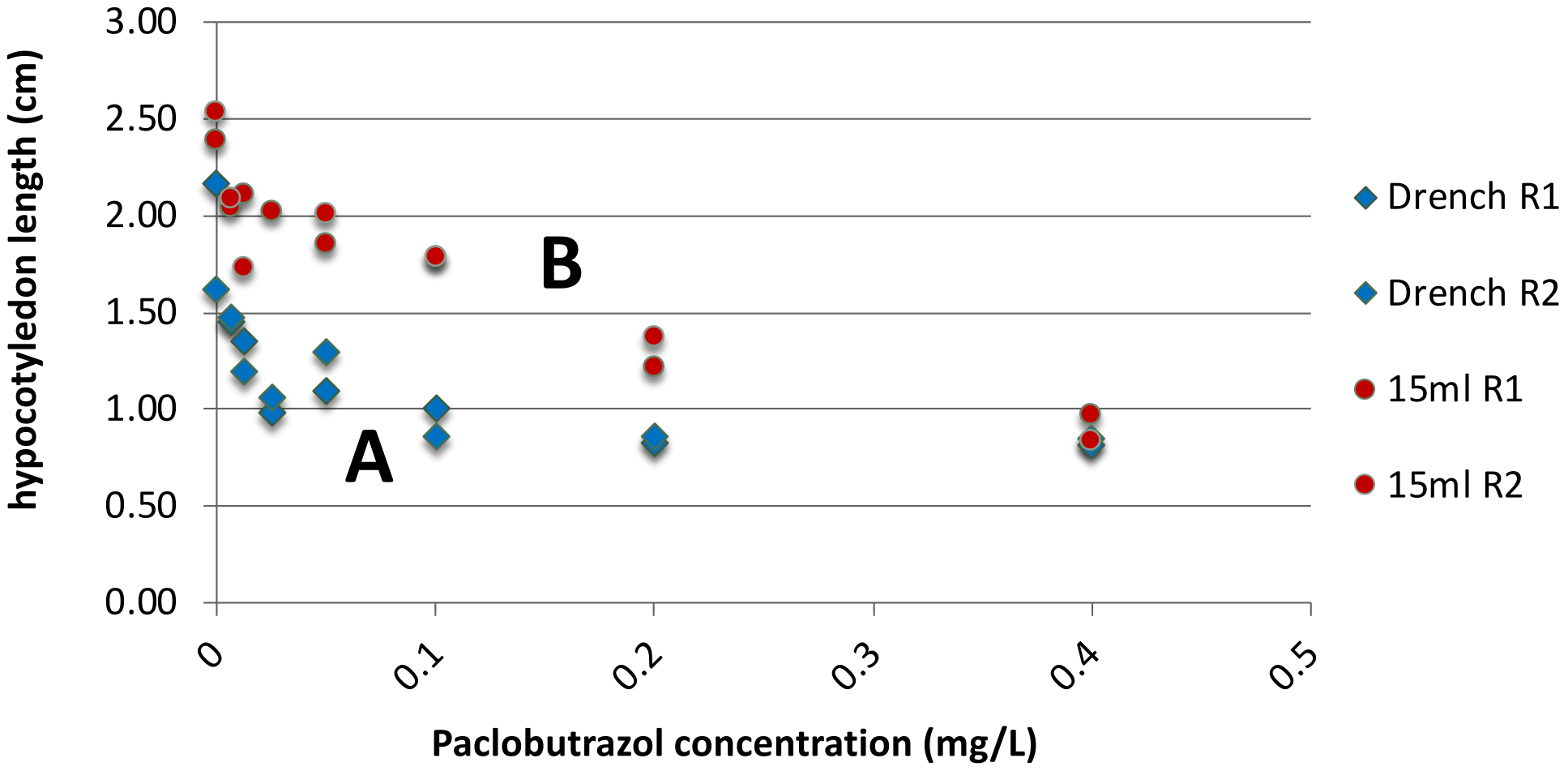
Bioassay method comparison

A



B

Bioassay methods comparison



Other methods?

Grant et al. for begonia

Hwang et al. for kalanchoe

Figure 1. Effect of paclobutrazol and uniconazole on rooting of cuttings. A) Cuttings were soaked in PGRs solutions for 2 h. B) PGRs treated cuttings were planted in 72-cell plug trays containing peatmoss + perlite (1:1, v\v). C) Rooted cuttings 'Gold Strike' after 30 days. D) Rooted cuttings 'Rako' after 30 days.

Figure 3. Effect of PGRs on growth of kalanchoe after soaking treatment of cuttings. A) Kalanchoe 'Rako' at 15 weeks after soaking treatment of PGRs. B) Kalanchoe 'Gold Strike' at 15 weeks after soaking treatment of PGRs.

Good for visuals (Grower presentations etc) but not practical for routine use

Next steps…..

- Optimize the broccoli bioassay; other bioassay methods?
- Spring:
  - Finish maintenance and repairs on the portables
  - Add GAC cell – what is the optimum design for that? E.g. layer or smaller cell versus full size cell (ca $3K)
  - Adapt one woodchip cell to aerobic flow
  - Other?
- First batch runs

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Questions???

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