



COHA Project 8

Enabling recirculation with hybrid treatment systems

Annual COHA Research Update

Feb 23, 2021



Agenda

- Objectives and schedule
- Quick Recap of Hybrid Treatment Systems (HTS)
- Pilot systems set up
- Bioassays
- **Batch Runs**
 - Methodology
 - **Results**
- Next steps

Why? (from White et al 2019)

Table 7. The contaminants of most concern when considering recycling irrigation return flow determined by growers ($n = 36$) attending five round table discussion sessions in the USA.

Contaminants	Frequency	Rank
Pesticides (herbicides, plant growth regulators)	12	1
Plant pathogens	9	2
Nitrates, phosphates, salts	5	3
Weed Seeds	5	
Algae	3	4
Duckweed	2	5
Atmospheric pollutants	1	6
Suspended solids	1	
pH (diurnal cycling)	1	

Project Objectives

- Using existing Hybrid Treatment System (HTS) pilot systems:
 - Assess the ability of HTS media to remove plant growth regulators (PGRs) & Pesticides
 - Evaluate treatment sequences
 - Evaluate effect of operational parameters
 - Knowledge transfer (KTT)
- Loose definition: HTS is a site-specific treatment system made up of a combination of media and hydraulic characteristics designed to treat water to meet individual farm requirements
- Modified constructed wetland design
- NOT vegetated

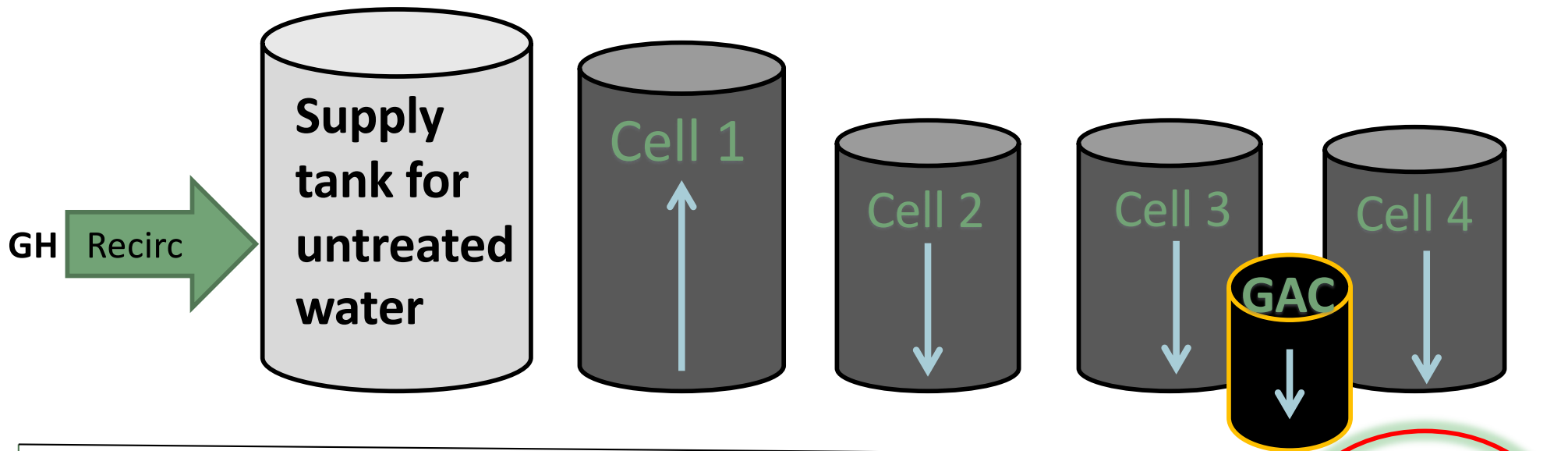
HTS-1 Portable Pilot Units



Remove Nutrients and
Plant Pathogens



Current Treatment Media Sequences



"GOLD"	Input water supply tank	Hardwood Chips (-O ₂)	Pea gravel/slag mix	Pea gravel/slag mix	Granular Activated Carbon
"SILVER"	Input water supply tank	Hardwood chips (-O ₂)	Pea gravel	Wollastonite	Filter sand

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
 - Select focus PGRs & pesticides
 - **Bioassay development and testing –continued in 2020-2021**
- **2020-2021**
 - **Batch studies to test individual media and HRT**
 - **Lab analyses and Bioassays of final effluents**
 - TAC and KTT events
 - Continued monitoring 3 permanent systems for nutrients and fungal populations
- 2021-2022
 - Series studies to test media sequences and key operational parameters
 - Lab analyses and Bioassays
 - TAC and KTT events
 - Continued monitoring 3 permanent systems for nutrients and fungal populations

Bioassay Method

**Broccoli:
Germination and
Growth**



7 day seedlings

Paclobutrazol (Bonzi) Bioassay:

0.003125- 0.2 mg/L



Paclobutrazol Bioassay: hypocotyls

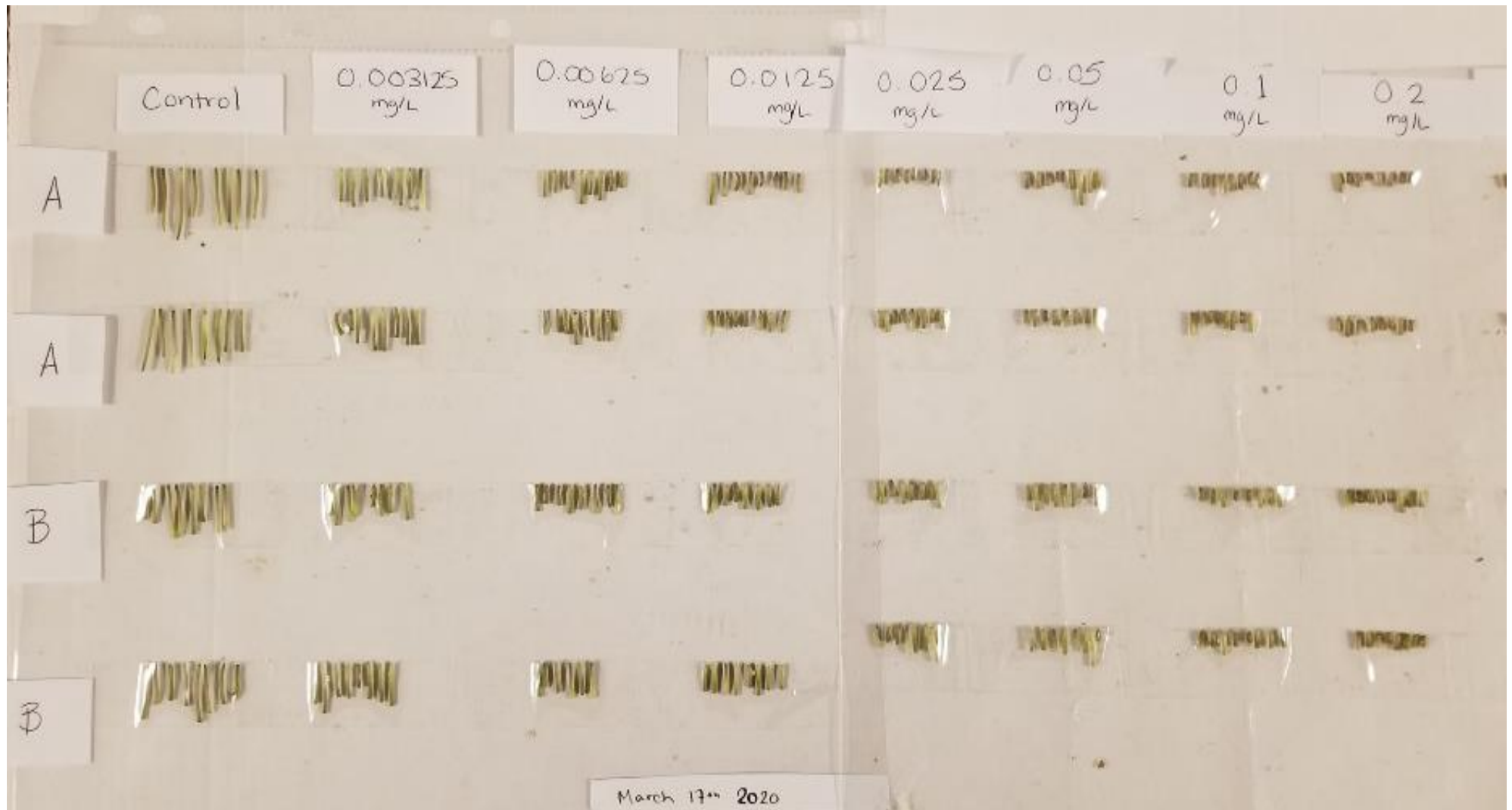
3ppb

6ppb

25ppb

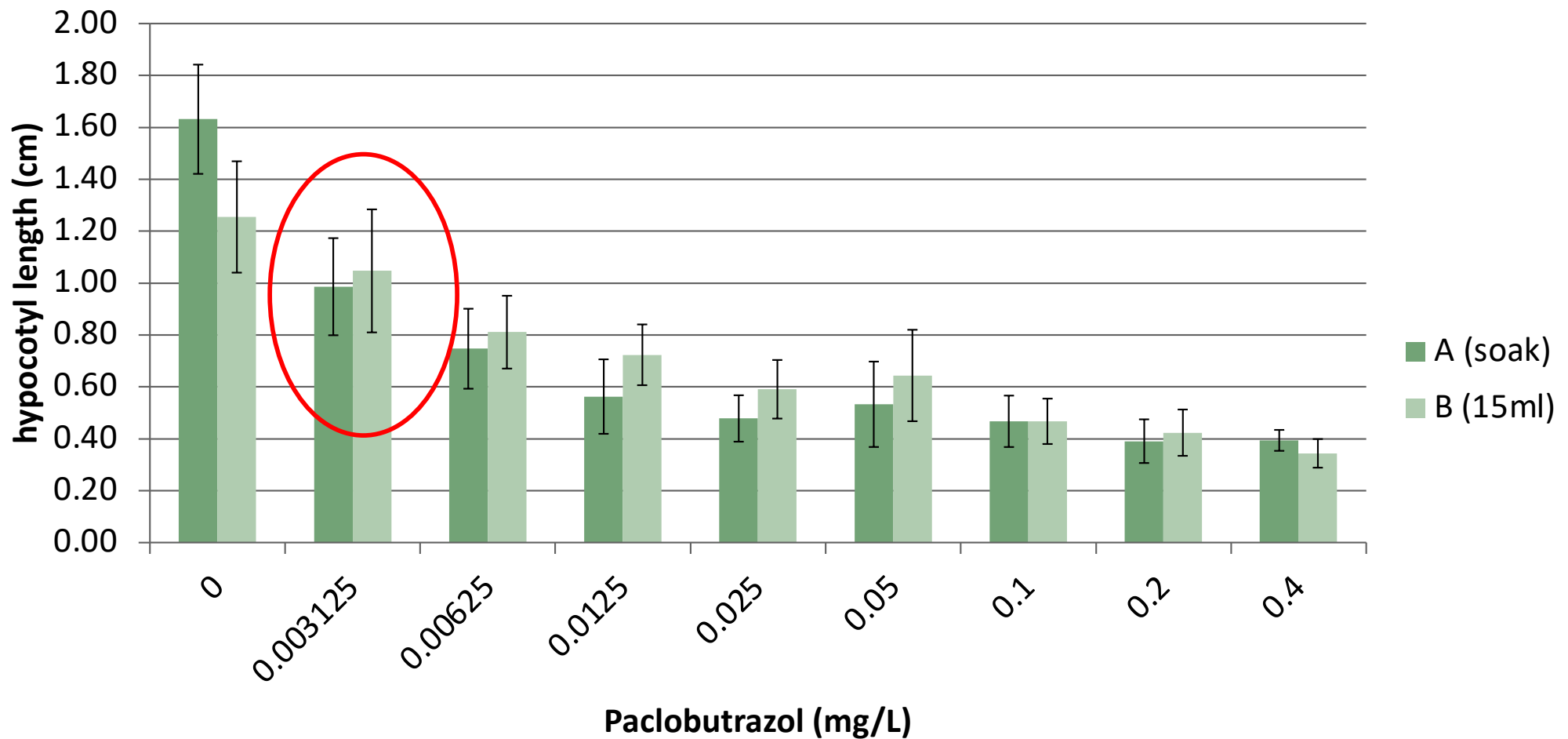
100ppb

200ppb



Paclobutrazol bioassay

Bioassay methods comparison



Compound (ppb)	Off Bench (1st Spray)	Off Bench (2nd Spray)	Off Bench	Return Pit	Cistern	Irrigation Water as Influent	Irrigation Water as Influent
Pesticide Screening	04-Feb-20	04-Feb-20	31-Mar-20	31-Mar-20	31-Mar-20	20-Aug-20	21-Oct-20
Cyromazine	/	3.6	/	0.83	0.72	<MQL	/
Carbendazim	0.52	<MDL	<MDL	<MDL	<MDL	<MQL	/
Chlorantraniliprole	6.8	4.1	18	18	18	0.83	1.6
Chlorothalonil	/	/	/	/	/	9.5	0.49
Cyantraniliprole	<MQL	<MQL	/	<MDL	<MQL	1.2	0.2
Cyromazine	4.8		0.6	/	/	0.26	<MQL
Flonicamid	54	42	35	25	21	4.4	7.7
Fludioxonil	18	19	7	8.9	/	26*	29.5*
Metalaxyl	/	/	0.25	0.2	0.21	0.07	/
Metolachlor	/	/	/	/	/	<MQL	/
Myclobutanil	<MQL	<MQL	<MQL	0.28	<MQL	8	72.5
Paclobutrazol	/	/	/	3.6	/	84*	64*
Propamocarb	/	/	/	/	/	0.07	3.1
Propiconazole	0.55	0.57	0.39	0.33	0.35	3.8	1.2

* Spiked concentrations

Pilot plants on site



Batch Run Methods

- Initial rinse of all cells with GH nutrient (from recirculation tank) water
- Fill feed tank (Silver) with GH recirc water
- **Spike with PGR mixture while tank is filling to achieve mixing: Bonzi, Medallion, Cyclocel and B9**
- Further mixing within the tank via pump and return hose
- Half spiked mixture pumped to Gold feed tank
- **Fill cells with spiked nutrient water**
- **Sampled after final tank filling ($=T_0$), and over 6 days**
- 10-20L drained prior to each sampling (5 L GAC tank)
- Samples for **Lab analysis** were frozen until submitted to UofG Lab for TOPS-GC and TOPS-LC analyses
- Samples taken at Day 6 for **Bioassays** and **nutrient analysis** (SGS, Guelph)
- All cells completely drained, refilled with GH recirc water, and completely drained again

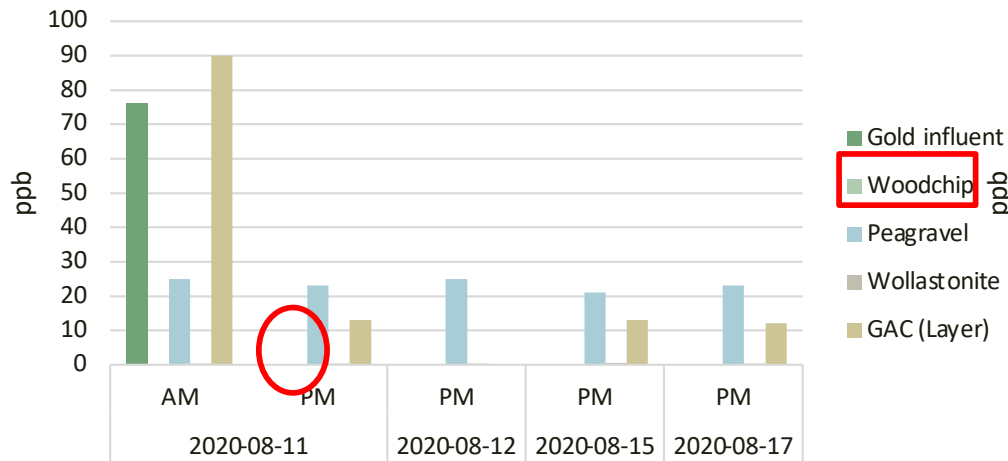
Sampling



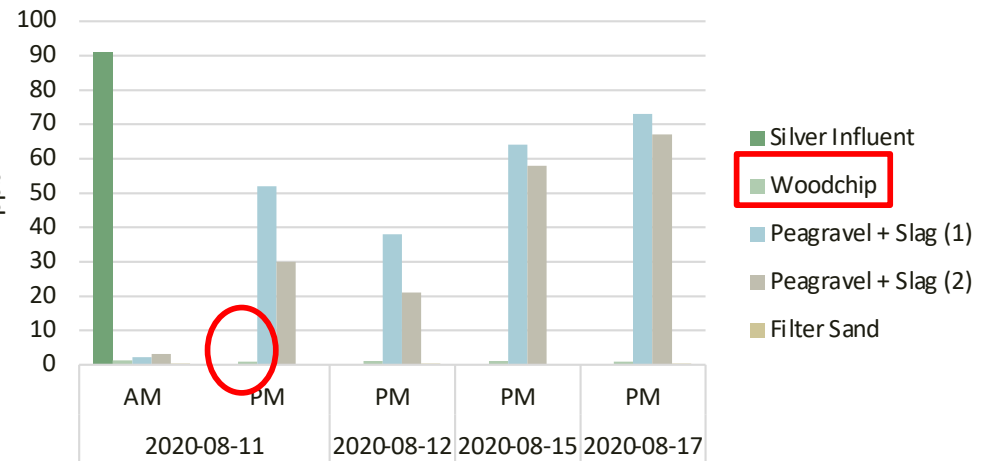
Lab Results: Gold & Silver

Paclobutrazol (Bonzi, Plant Growth Regulator; ppb)

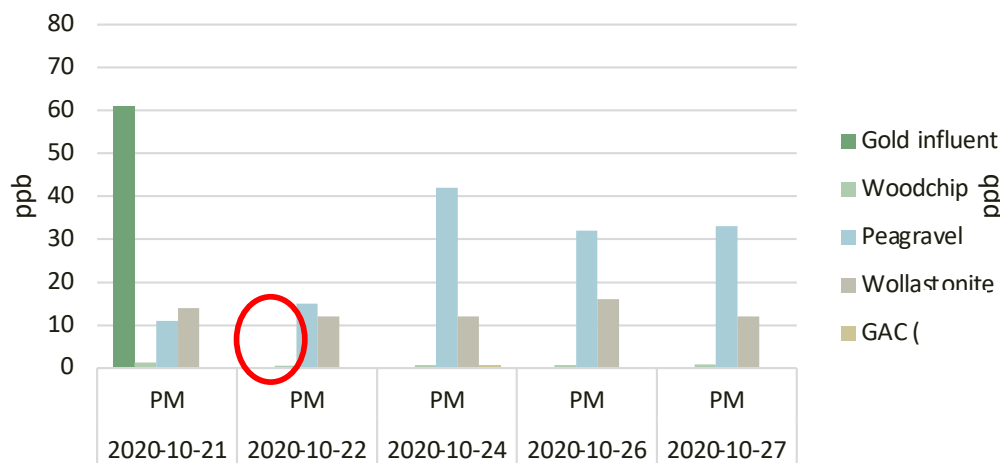
Gold: Paclobutrazol (Summer)



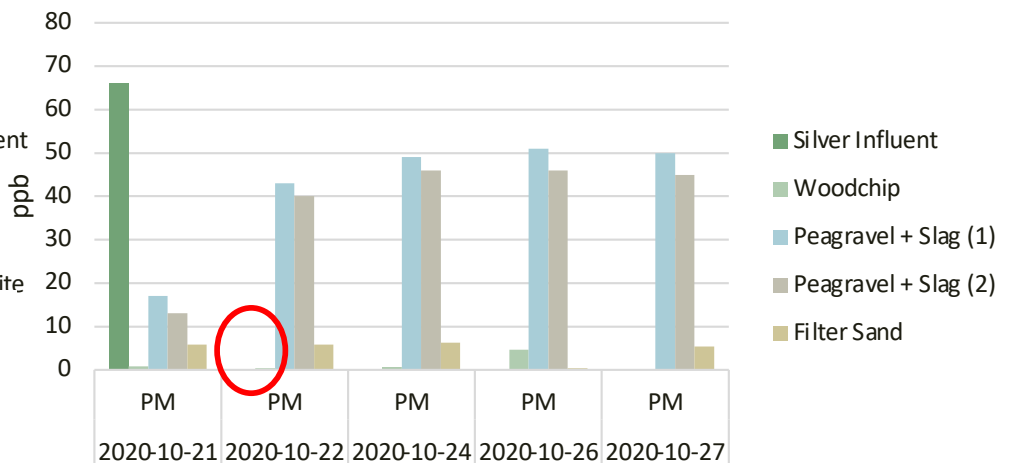
Silver: Paclobutrazol (Summer)



Gold: Paclobutrazol (Fall)



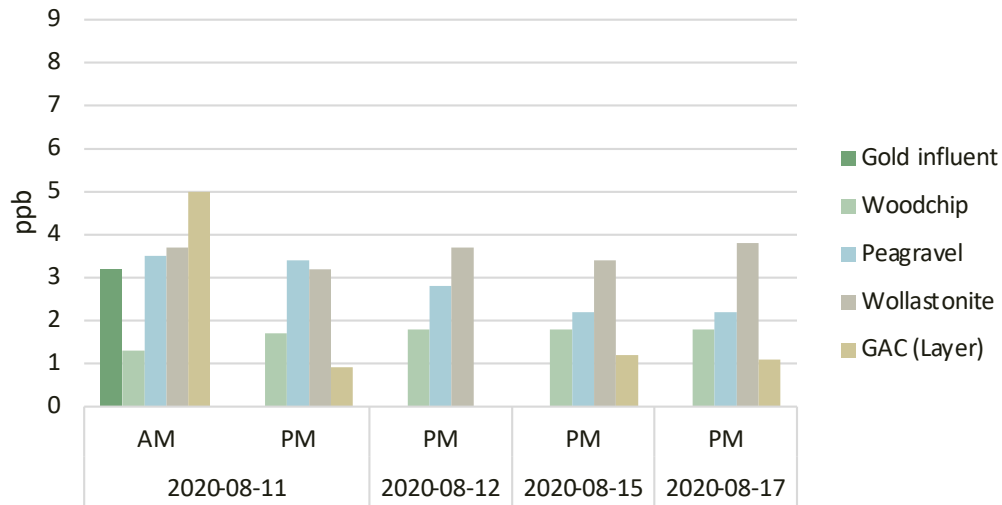
Silver: Paclobutrazol (Fall)



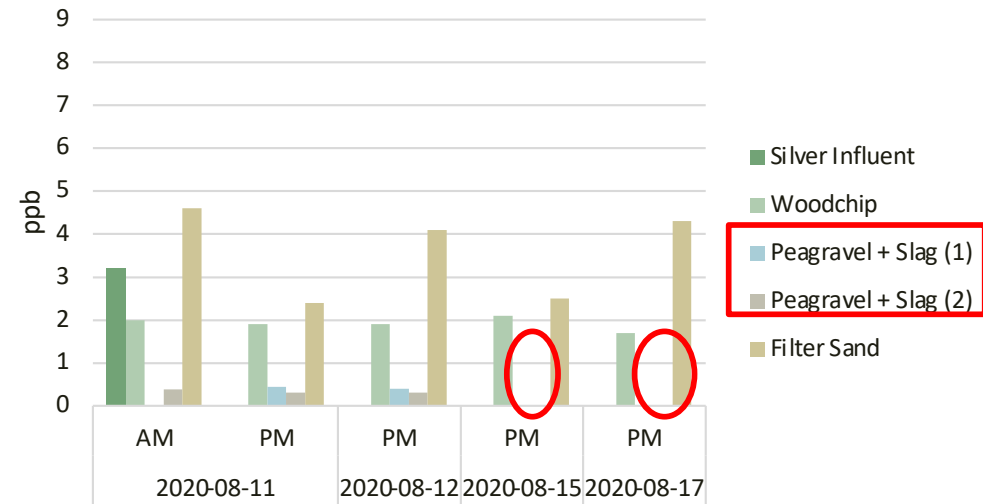
Lab Results: Gold & Silver

Flonicamid (Beleaf, Pesticide)

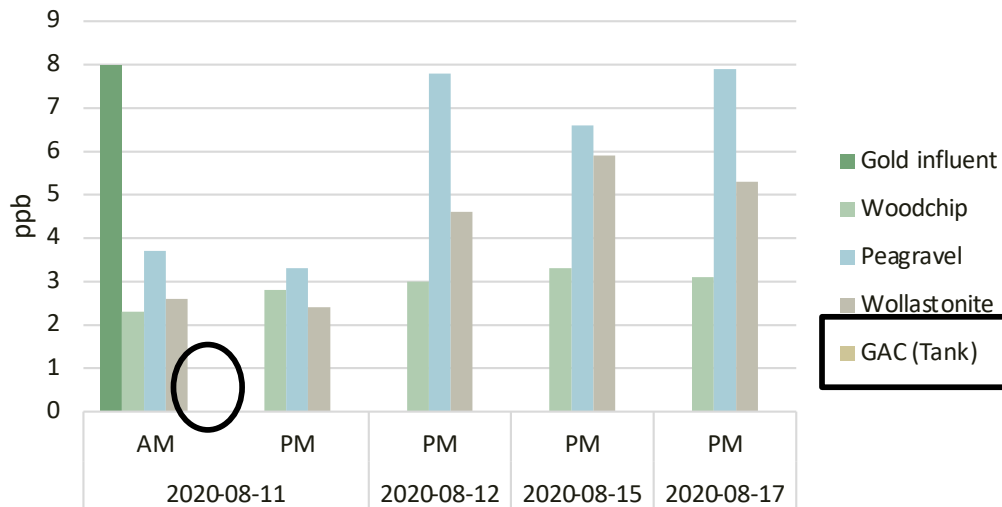
Gold: Flonicamid (Summer)



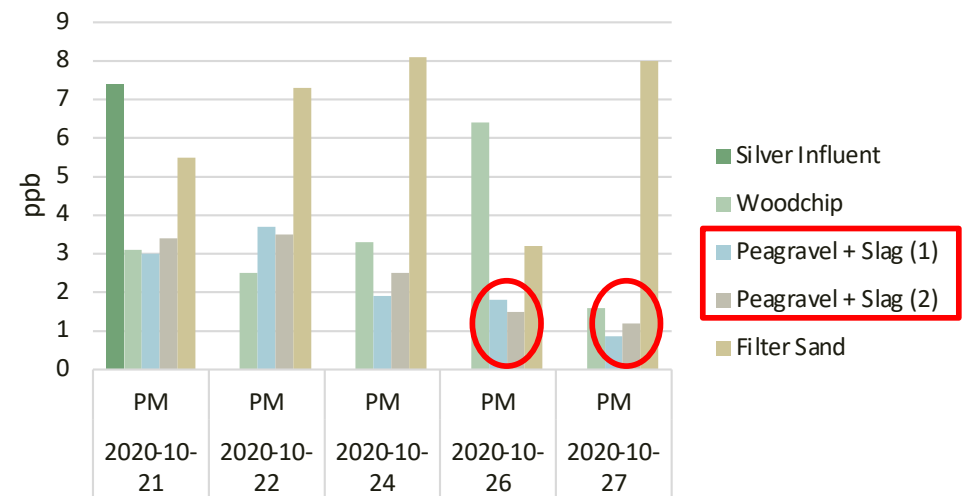
Silver: Flonicamid (Summer)



Gold: Flonicamid (Fall)



Silver: Flonicamid (Fall)



% Removal PGRs & Pesticides: August 2020

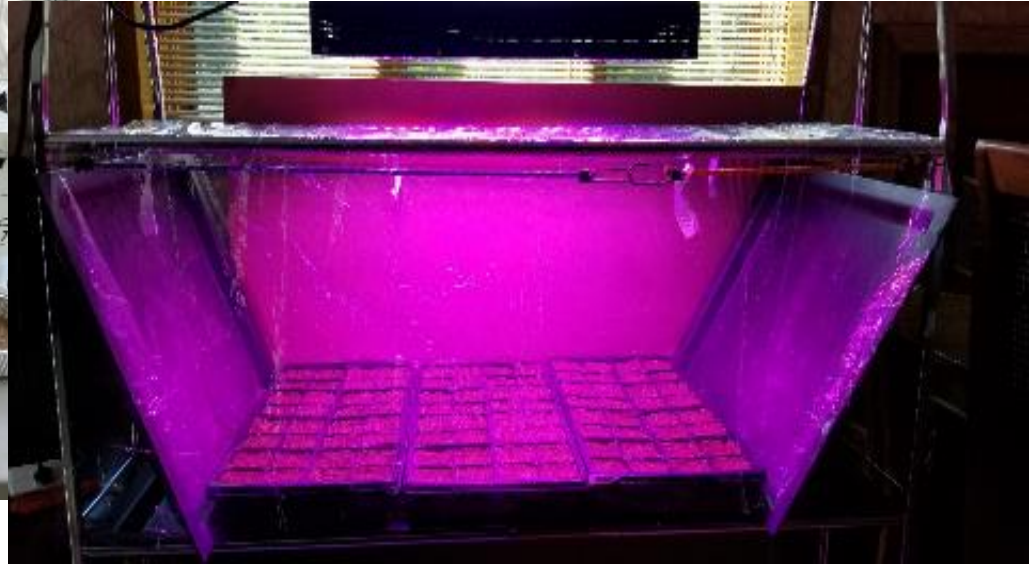
Batch Run 1: 24 HR		Influent (ppb)		Woodchip	Peagravel + Slag	Peagravel	Filter Sand	Wollastonite	GAC Layer
Compound	Gold	Silver	Average	Average					6 HR
Fludioxonil	17	34	100	95.7	87.8	100	100	100	94.1
Paclobutrazol	76	91	99.3	67.6	89.5	99.5	99.4	99.4	82.9
Chlorothalonil	9.2	9.7	100	100	100	100	100	100	100.0
Myclobutanil	4.9	11	94.6	75.0	89.6	100	100	100	85.9
Propiconazole	3.6	4	100	48.8	86.9	100	100	100	85.8
Fenhexamid	1.2	3.5	100	21.4	100	100	100	100	100.0
Flonicamid	3.2	3.2	42.2	89.1	31.3	-28.1	-15.6	71.3	
Metalaxyl	0	0.13	100	100	100	100	100	100	100
Chlorantraniliprole	0.75	0.9	100	100	100	100	100	100	100
Cyantraniliprole	1.3	1	100	49.0	70.0	100	100	100	100
Propamocarb	0.14	0	100	100	100	100	100	100	100
Cyromazine	0.23	0.29	100	43.1	100	100	100	100	100
Batch Run 1: 6 Days		Influent (ppb)		Woodchip	Peagravel + Slag	Peagravel	Filter Sand	Wollastonite	GAC Layer
Compound	Gold	Silver	Average	Average					
Fludioxonil	17	34	100	87.8	87.8	100	100	100	95.4
Paclobutrazol	76	91	99.4	23.1	89.5	99.6	99.5	99.5	84.2
Chlorothalonil	9.2	9.7	100	100	100	100	100	100	100
Myclobutanil	4.9	11	94.4	60.0	89.6	100	100	100	87.3
Propiconazole	3.6	4	100	45.0	86.9	100	100	100	85.8
Fenhexamid	1.2	3.5	100	100	100	100	100	100	100
Flonicamid	3.2	3.2	45.3	100	31.3	-34.4	-18.8	65.6	
Metalaxyl	0	0.13	100	100	100	100	100	100	100
Chlorantraniliprole	0.75	0.9	100	100	100	100	100	100	100
Cyantraniliprole	1.3	1	100	40.0	70.0	100	100	100	100
Propamocarb	0.14	0	100	100	100	100	100	100	100
Cyromazine	0.23	0.29	100	20.7	100	100	100	100	100

% Removal PGRs & Pesticides: October 2020

Batch Run 2: 24 HR	Influent (ppb)		Woodchip	Peagravel + Slag	Peagravel	Filter Sand	Wollastonite	GAC Tank
Compound	Gold	Silver	Average	Average				
Fludioxonil	30	29	100	90.5	98.3	100	100	100
Paclobutrazol	61	66	99.2	37.1	75.4	91.1	80.3	100
Myclobutanil	75	70	99.3	2.1	60.0	89.0	100	100
Propiconazole	1.2	1.2	100	-8.3	55.0	100	100	100
Flonicamid	8	7.4	65.6	51.4	58.8	1.4	70.0	100
Chlorantraniliprole	1.7	1.4	100	58.9	64.1	54.3	100	100
Cyantraniliprole	0.39	0	100	100	100	100	100	100
Propamocarb	2.8	3.3	100	36.4	100	100	100	100

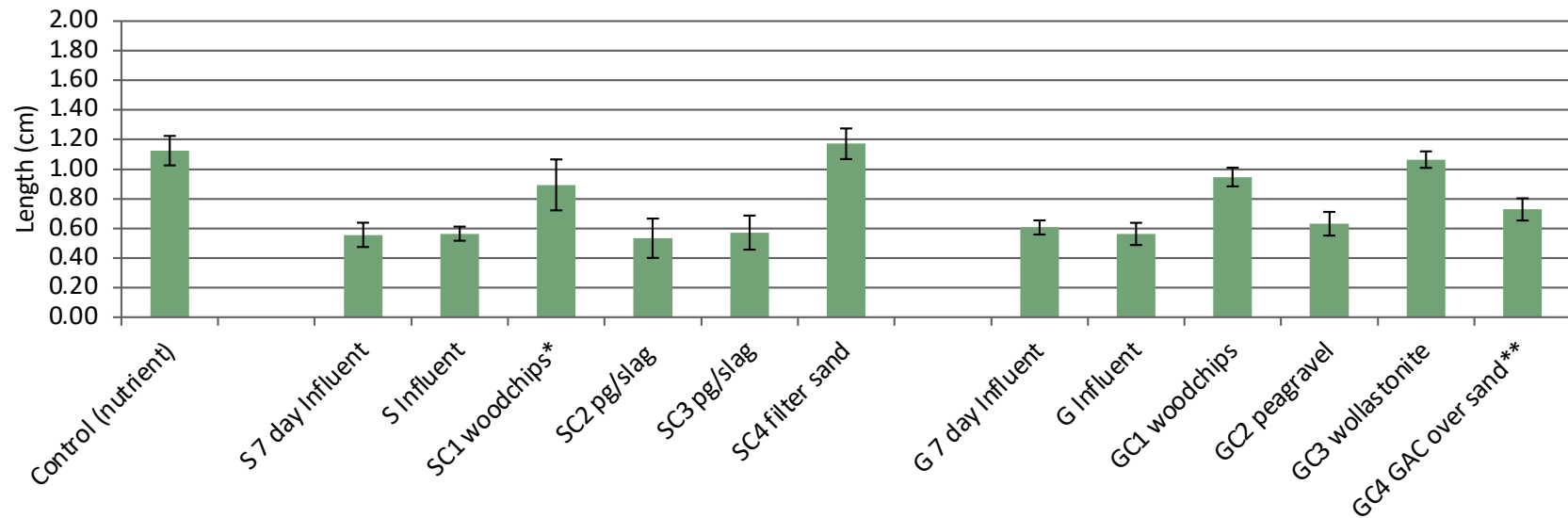
Batch Run 2: 6 Days	Influent (ppb)		Woodchip	Peagravel + Slag	Peagravel	Filter Sand	Wollastonite	GAC Tank
Compound	Gold	Silver	Average	Average				
Fludioxonil	30	29	100	81.6	98.1	100.0	100.0	100
Paclobutrazol	61	66	99.4	28.0	45.9	91.8	80.3	100
Myclobutanil	75	70	99.8	3.6	56.0	95.0	100.0	100
Propiconazole	1.2	1.2	100	100	39.2	100	100	100
Flonicamid	8	7.4	69.5	86.0	1.3	-8.1	33.8	100
Chlorantraniliprole	1.7	1.4	100	21.7	23.5	60.7	100.0	100
Cyantraniliprole	0.39	0	100	100	100	100	100	100
Propamocarb	2.8	3.3	100	53.0	100	100	100	100

Conducting bioassays during COVID!

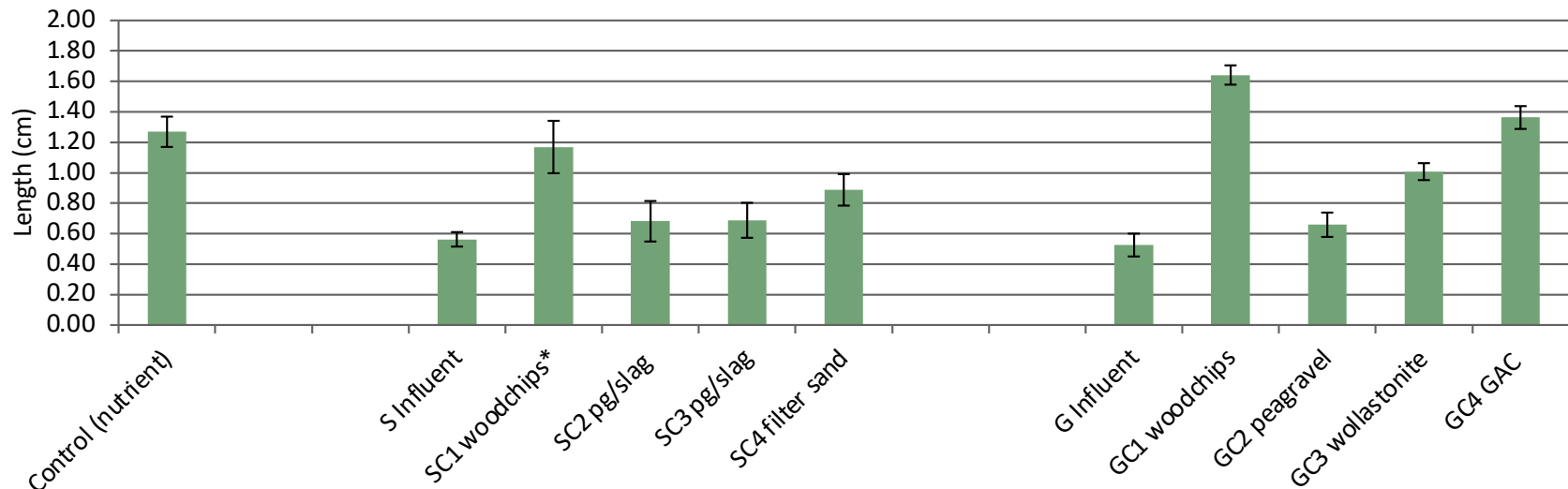


Impact of treated effluents on broccoli hypocotyl length

Batch Run 1 (Aug/20); Nutrient Water Feed



Batch Run 2 (Oct/20); Nutrient water feed



Reduction of PGR effects by media type

Percent inhibition by 6 day effluents (hypotocyl length)

		Influent	Wood-chip	PG/Slag	Pea Gravel	Wollas-tonite	Filter sand	GAC layer	GAC tank
		Average	Average	Average					
August	DI water	34%	-22%	31%	-8%	-46%	-21%	-33%	
	Nutrient	50%	18%	51%	44%	5%	-4%	5%	
October	DI water	58%	-36%	41%	24%	27%	30%		14%
	Nutrient	56%	-11%	46%	48%	21%	12%		-7%

Next steps.....

- 2019-2020 (Started July 2019)
 - Technical Advisory Committee (TAC)
 - Pilot systems installed on site - *maintenance*
 - Literature review – *PGRs & pesticides, adsorbents, systems*
 - Media selection
 - Select focus PGRs & pesticides
 - Bioassay development and testing –continued in 2020-2021
- 2020-2021
 - Batch studies to test individual media and HRT
 - Lab analyses and Bioassays of final effluents
 - TAC and KTT events
 - Continued monitoring 3 permanent systems for nutrients and fungal populations
- **2021-2022**
 - **SERIES runs to test media sequences and key operational parameters**
 - **Lab analyses and Bioassays**
 - **TAC and KTT events**
 - **Continued monitoring 3 permanent systems for nutrients and fungal populations**
 - **Sampling for PGRs & pesticides at permanent site(s)**

Acknowledgements

Technical Advisory Committee

- Dr. Jeanine West, PhytoServ
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- Lloyd Rozema

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- Ontario Greenhouse Vegetable Growers
- Aqua Treatment Technologies
- OUR GROWERS!!!

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