



COHA Project 8
Enabling recirculation
with hybrid treatment
systems

Annual COHA Research Update

Feb 17, 2022

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)
- Assess the performance of the existing permanent HTS

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	

HTS-1: Portable Pilot Units & 2 permanent systems



Remove Nutrients and
Plant Pathogens



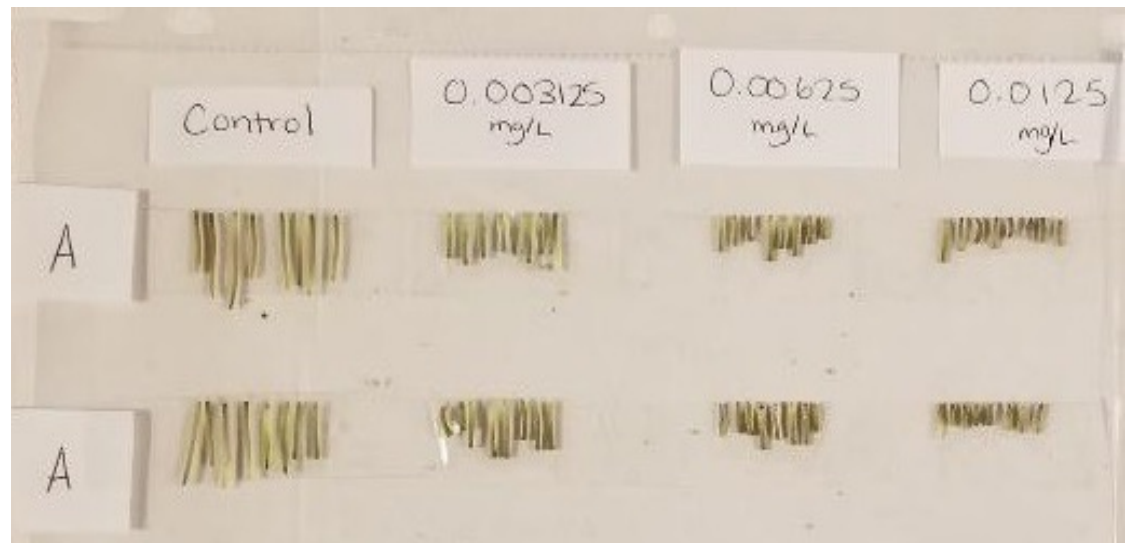
Schedule for COHA8

- 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 - Video**
 - **Continued monitoring 3 permanent systems for nutrients and fungal populations**

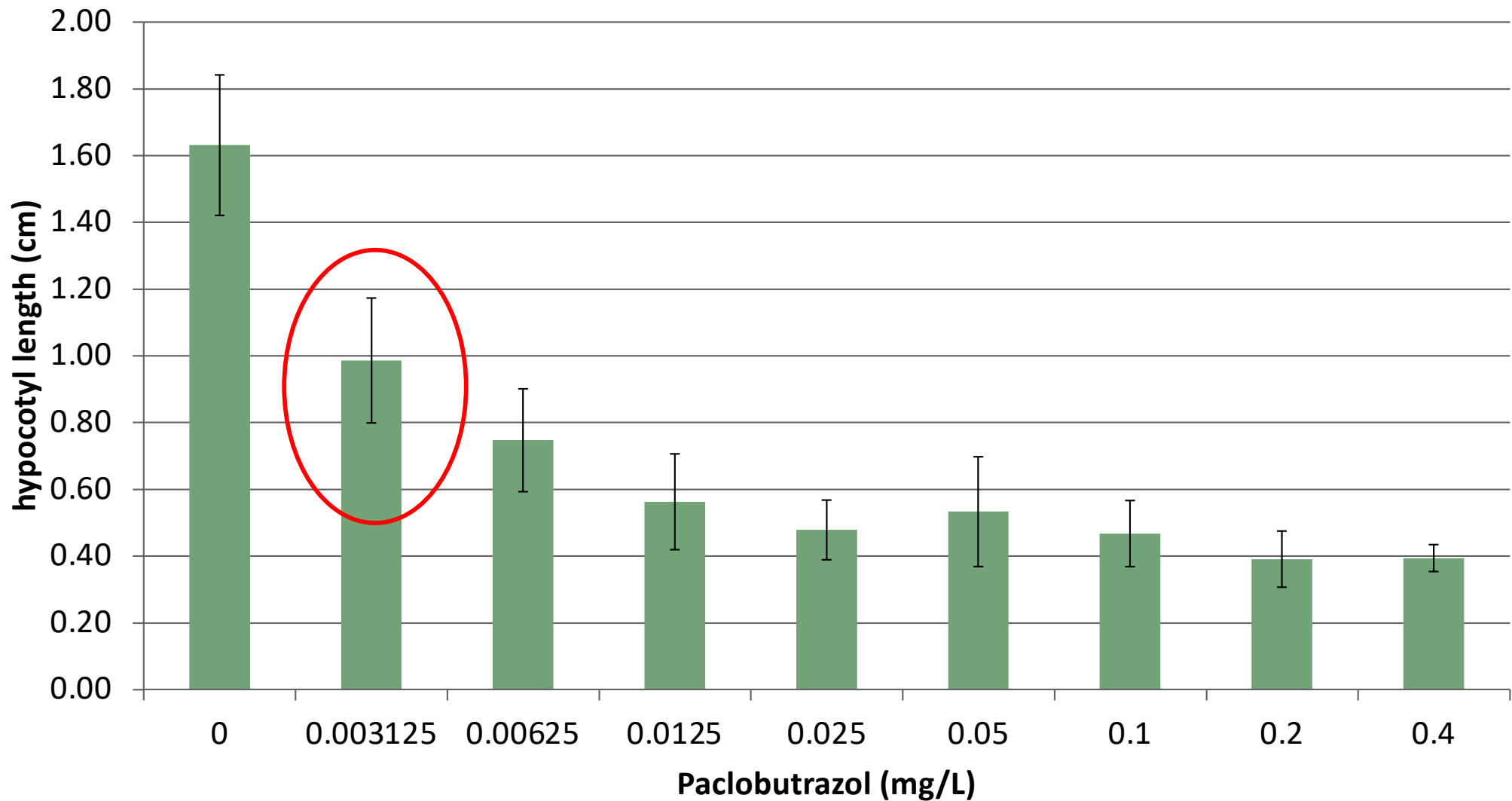
Bioassay Method

Broccoli: Germination and Growth (hypocotyl length)

- Very sensitive
- Not all PGRs are measured in lab scans
- Other treatment side effects



Paclobutrazol (Bonzi, Piccolo) bioassay



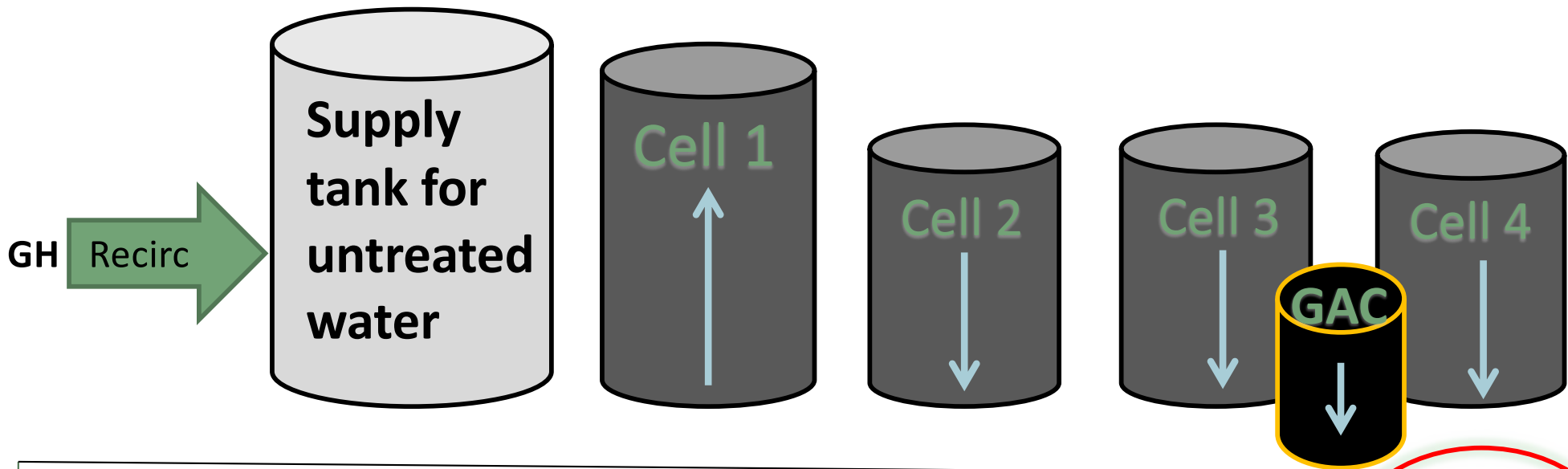
Pilot plants on site for COHA8



GH recirc water

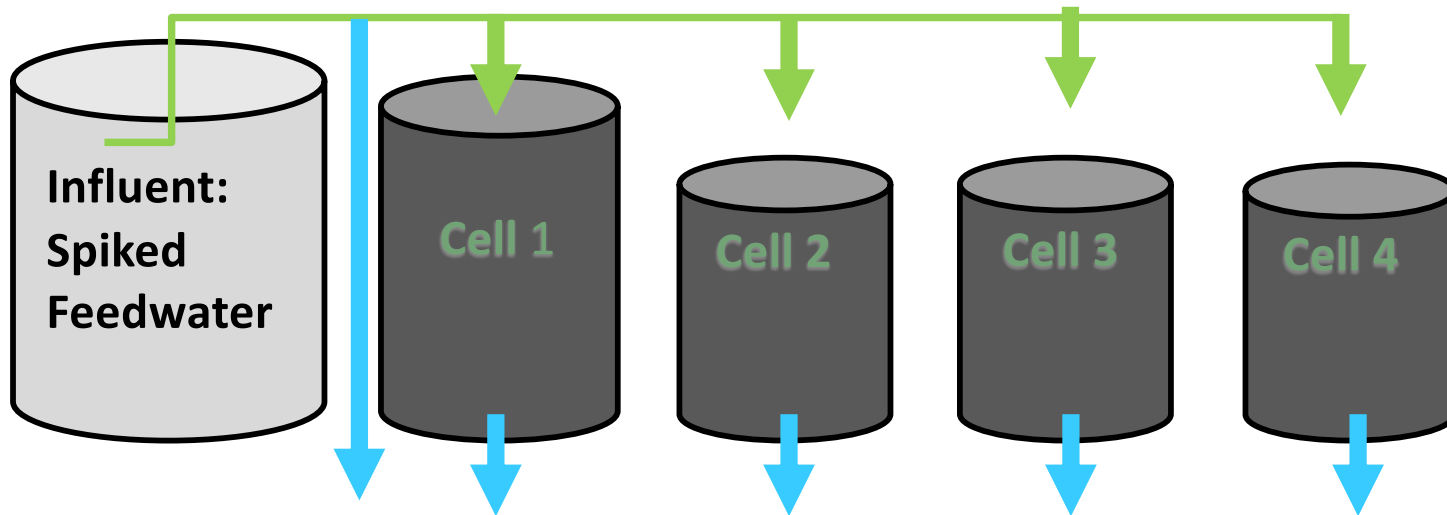


Current Treatment Media Sequences



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

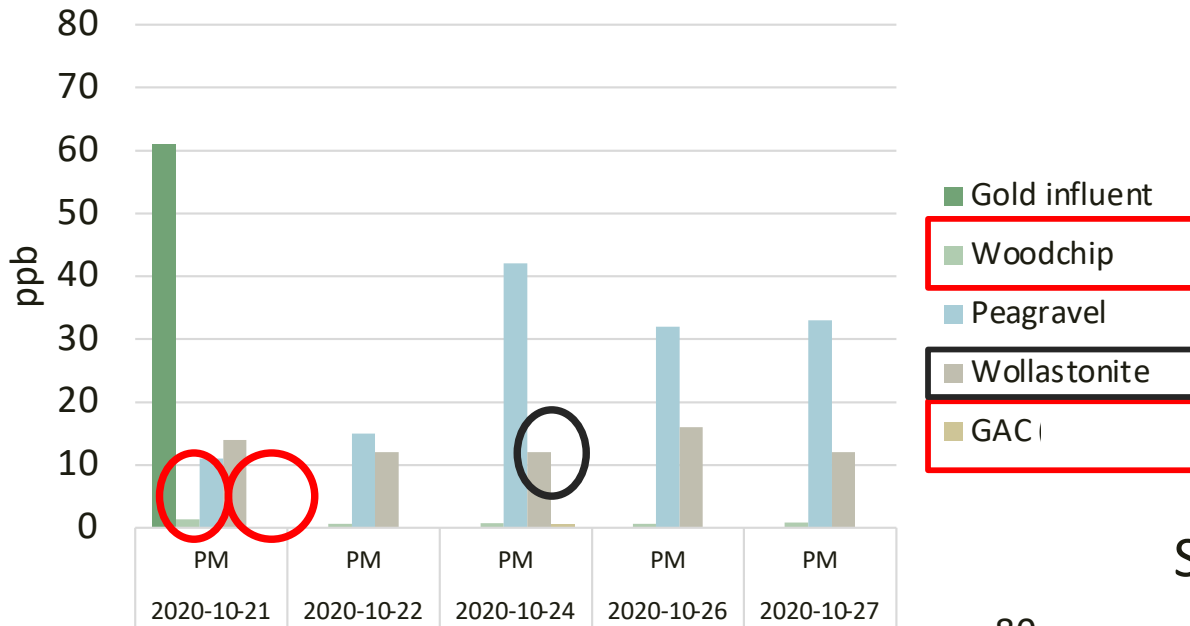
2020 Batch Trials



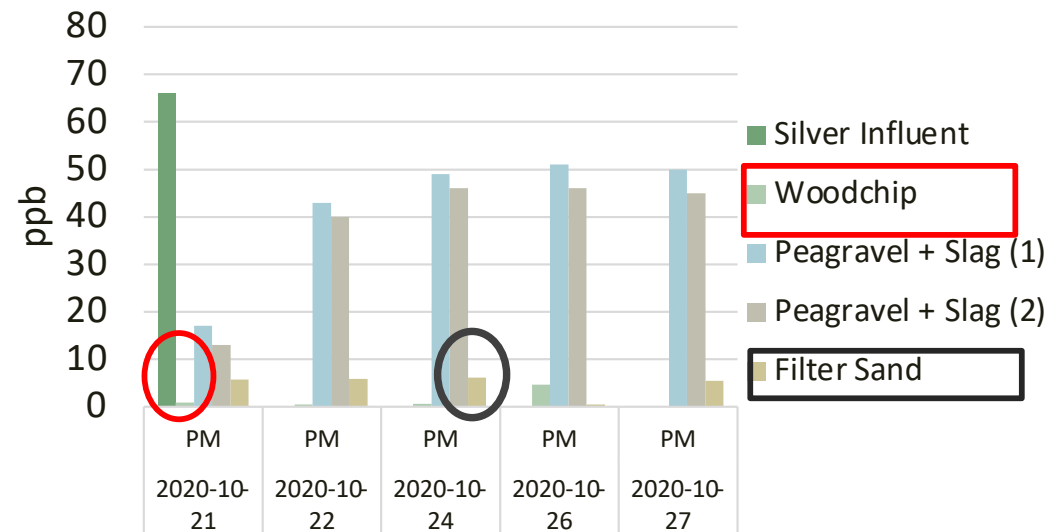
- Spiked with 4 PGRs: Bonzi (paclobutrazol), Medallion (fludioxonil), Cyclocel (chlormequat) and B9 (daminozide)
- Hydraulic Retention Time (HRT)
- August & late October (temperature effect)
- Chemical analysis (xxx compounds) and Bioassays

Laboratory Test Results

Gold: Paclobutrazol (Fall)



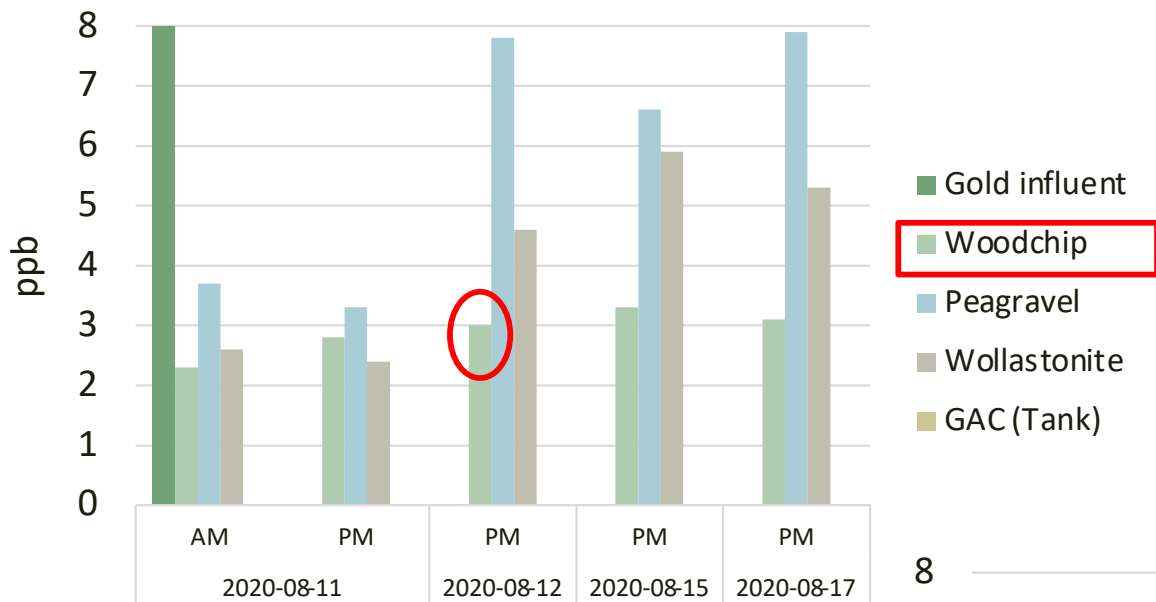
Silver: Paclobutrazol (Fall)



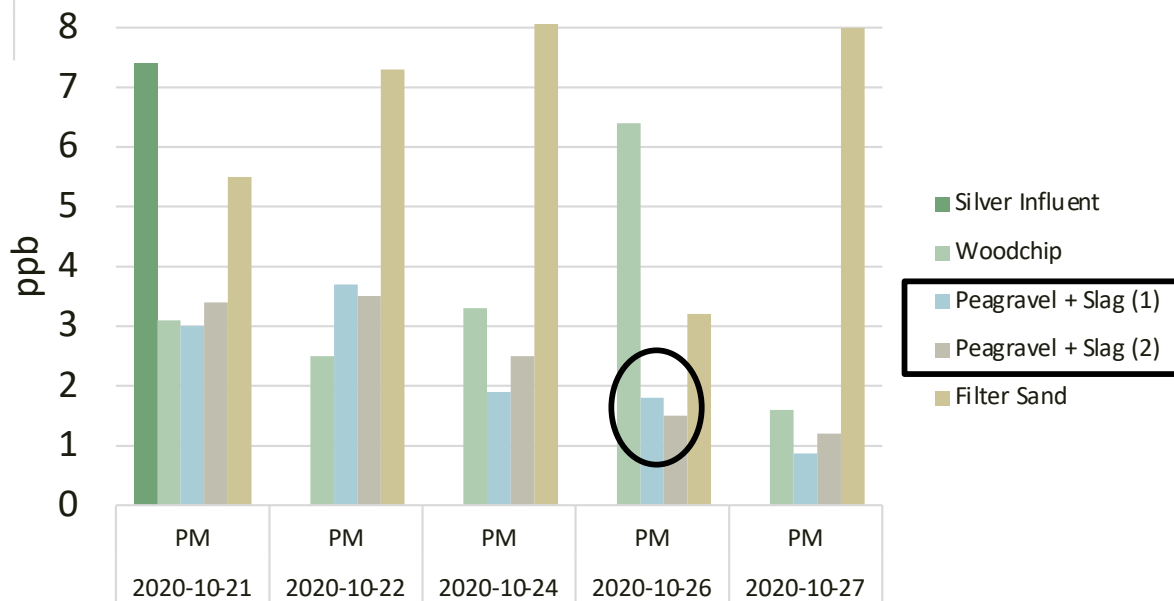
Laboratory Test Results

Flonicamid (Beleaf, Insecticide)

Gold: Flonicamid (Spring)

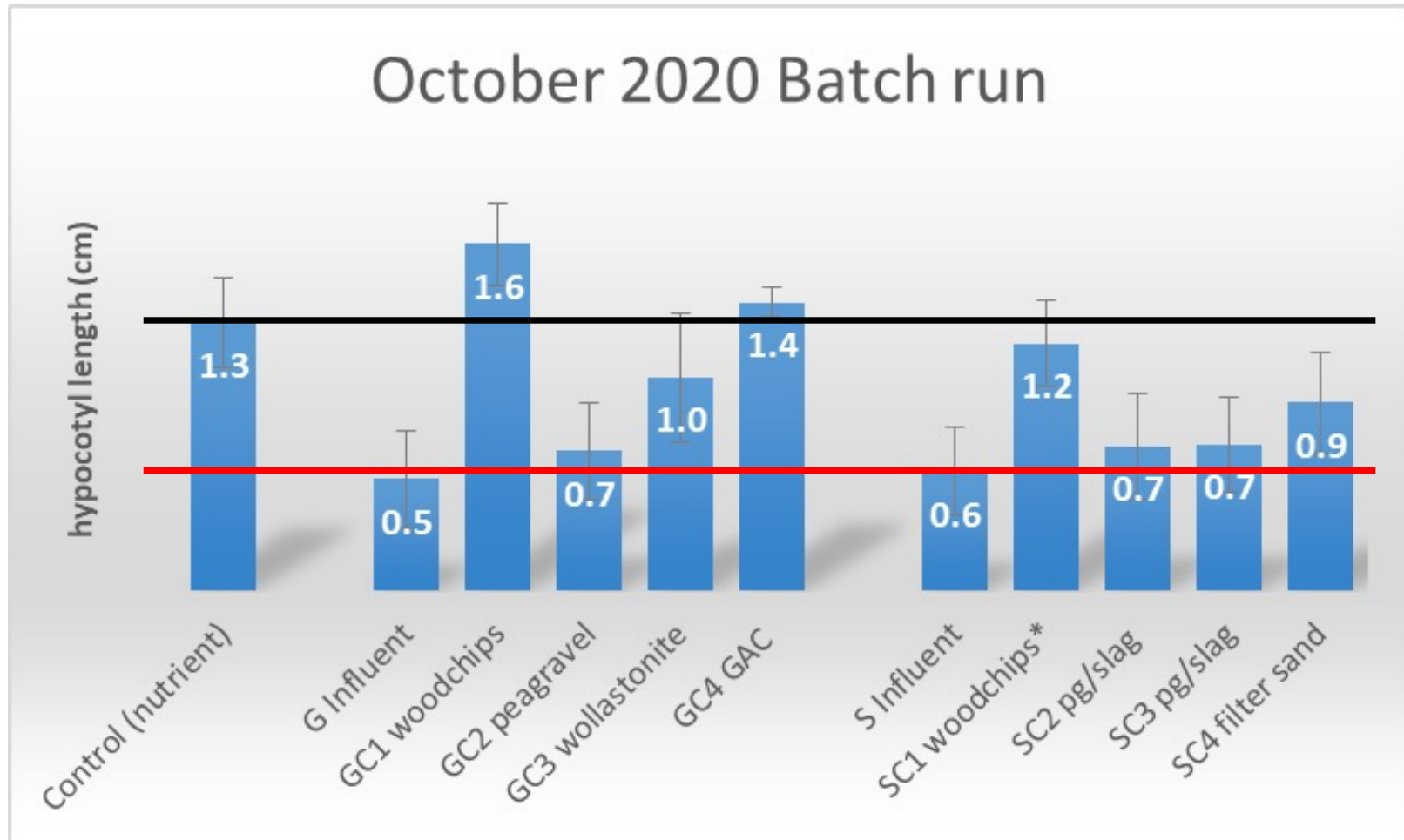


Silver: Flonicamid (Fall)



Bioassay Results:

Impact of batch treated effluents on broccoli hypocotyl length



PGR & Pesticide % Removal Summary:

August & October Batch Runs

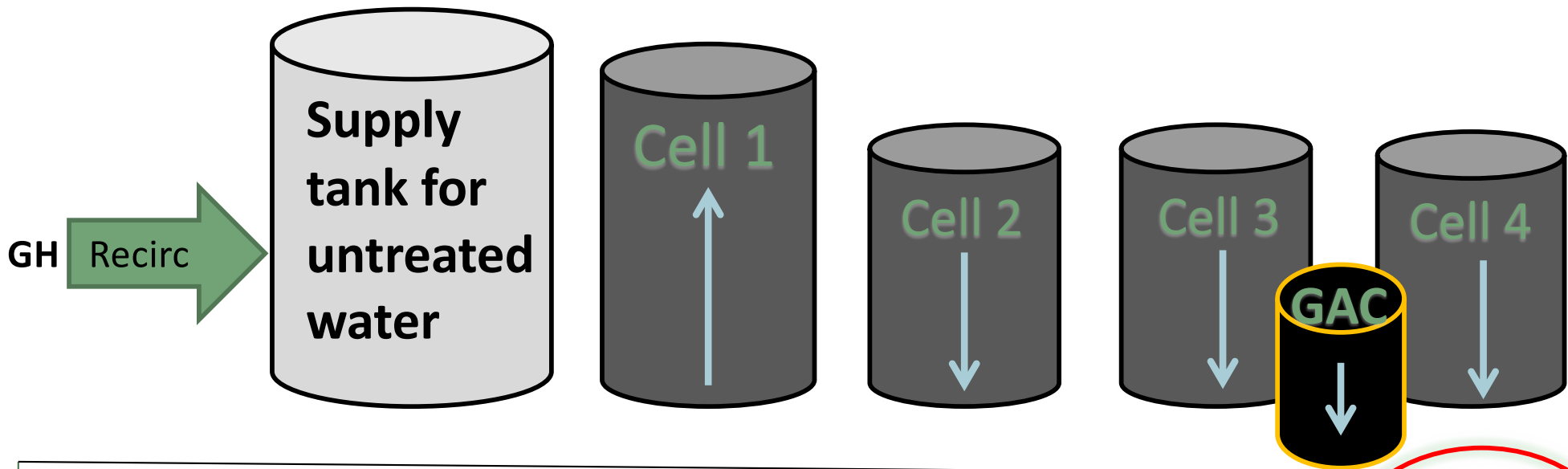
90% removal cutoff	✓					
Batch Run 1&2 Averages 6 day	Woodchip	Peagravel + Slag	Peagravel	Filter Sand	Wollastonite	Granular Activated Carbon
Fludioxonil	✓	85	✓	✓	✓	✓
Paclobutrazol	✓	26	68	✓	✓	✓
Propiconazole	✓	73	63	✓	✓	✓
Chlorothalonil	✓	✓	✓	✓	✓	✓
Fenhexamid	✓	✓	✓	✓	✓	✓
Metalaxyl	✓	✓	✓	✓	✓	✓
Myclobutanil	✓	32	73	✓	✓	✓
Chlorantraniliprole	✓	61	62	80	✓	✓
Cyantraniliprole	✓	70	85	✓	✓	✓
Cyromazine	✓	21	✓	✓	✓	✓
Flonicamid	57	✓	16	-21	8	✓
Propamocarb	✓	77	✓	✓	✓	✓

2021-2022

- **SERIES runs to test media sequences and key operational parameters**
- Lab analyses and Bioassays
- KTT

- Continued monitoring 3 permanent systems for nutrients and fungal populations to get long-term data
- **Sampling for PGRs & pesticides at permanent sites**

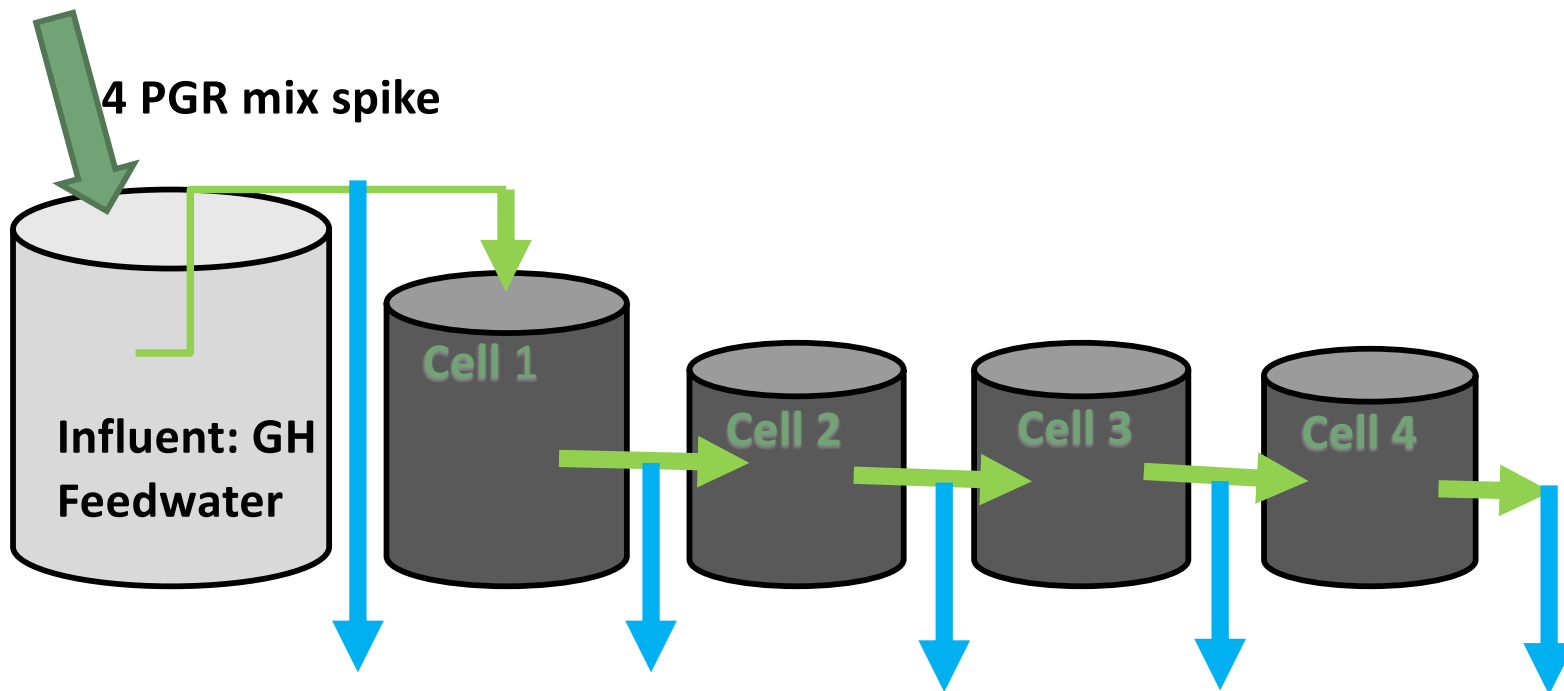
Series Runs: Treatment Media Sequences



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

Series Run Setup

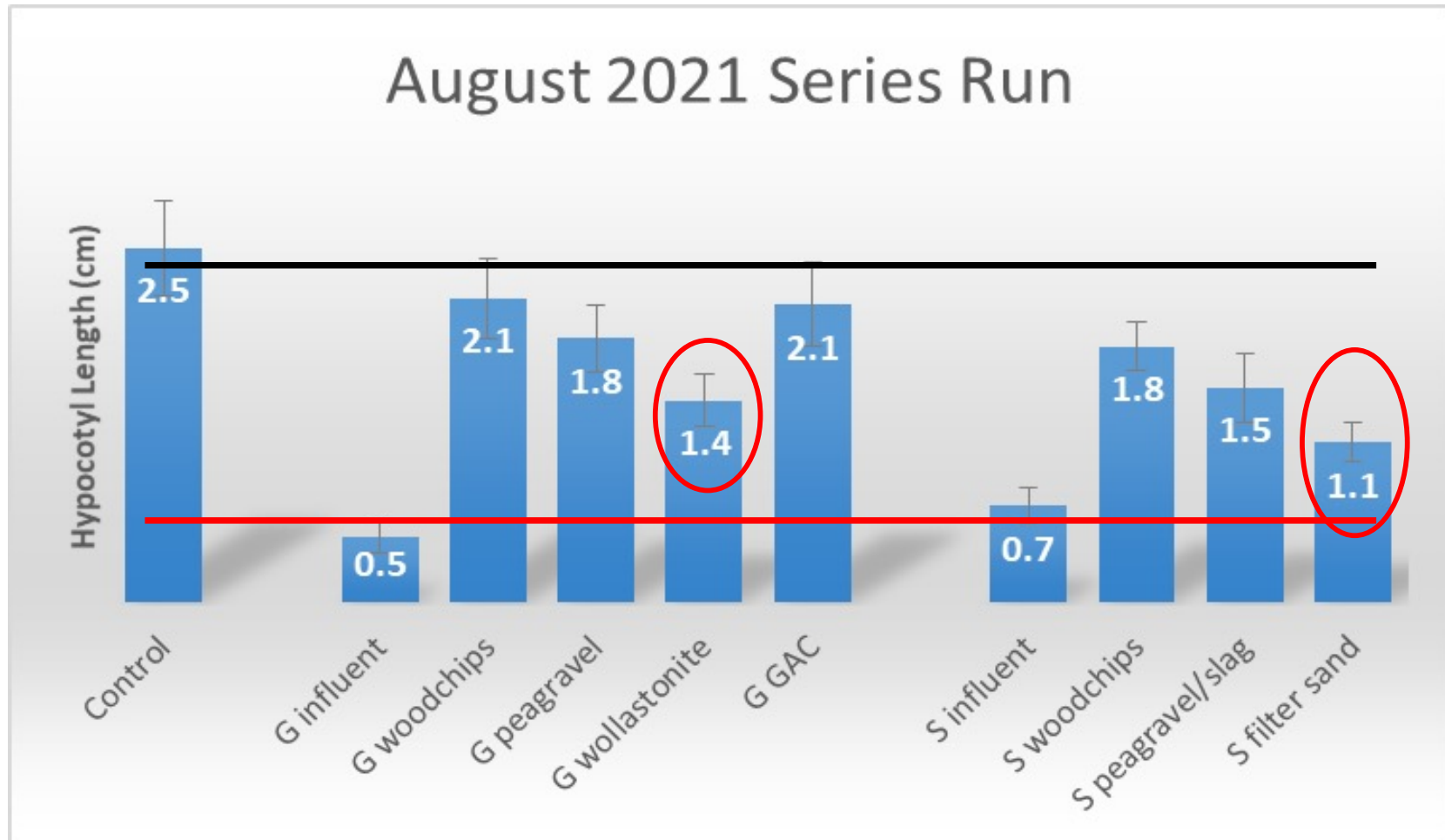
- 2 pilot systems



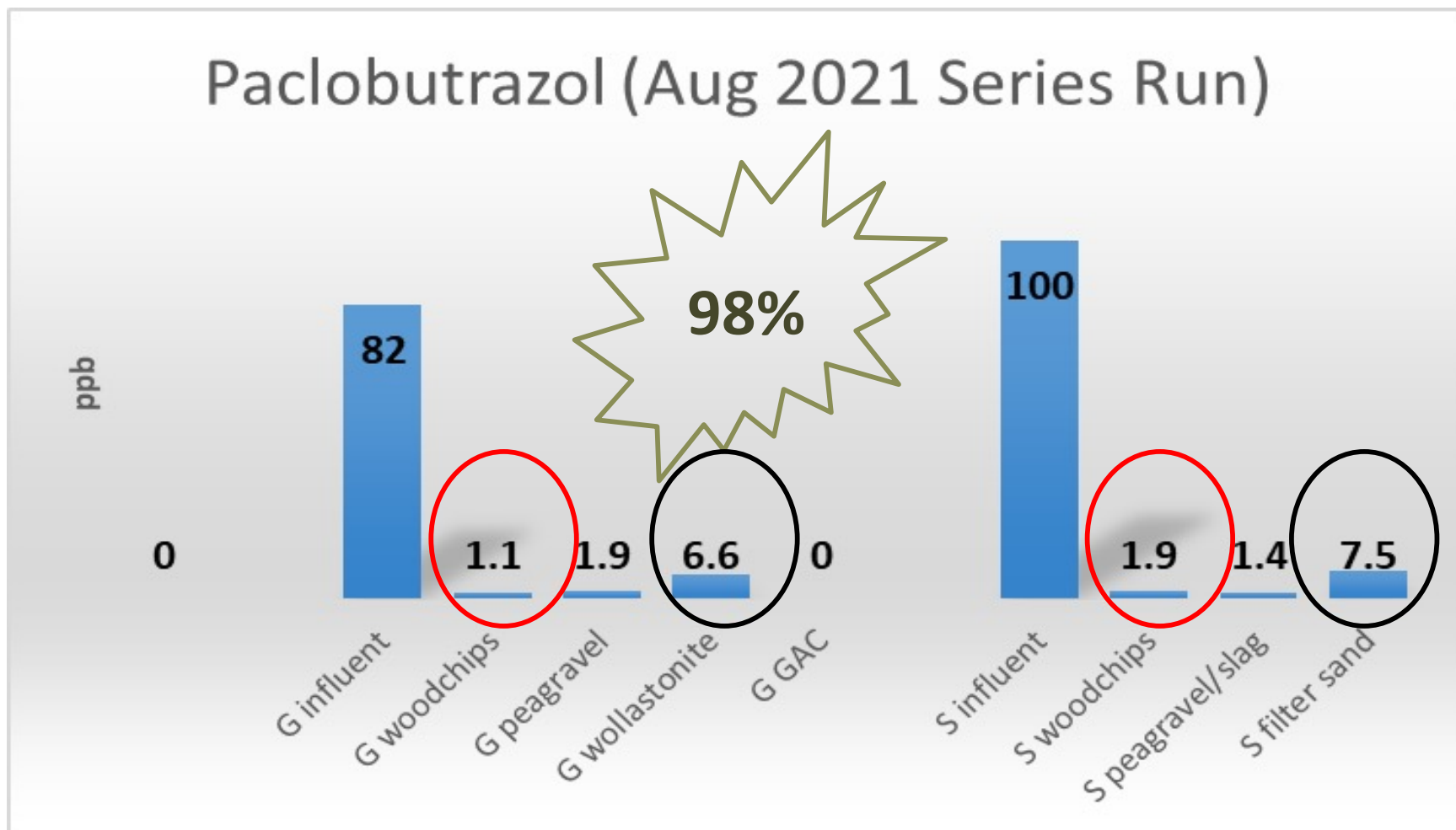
- Spiked with PGRs: Bonzi (paclobutrazol), Medallion (fludioxonil), Cyclocel (chlormequat) and B9 (daminozide)
- August & Oct/Nov (temperature effect)

Bioassay:

Impact of Series-treated effluents



Residuals in the treated water: Series



PGR & Pesticide % Removal:

August & October Series Runs Averages

>90% removal ✓

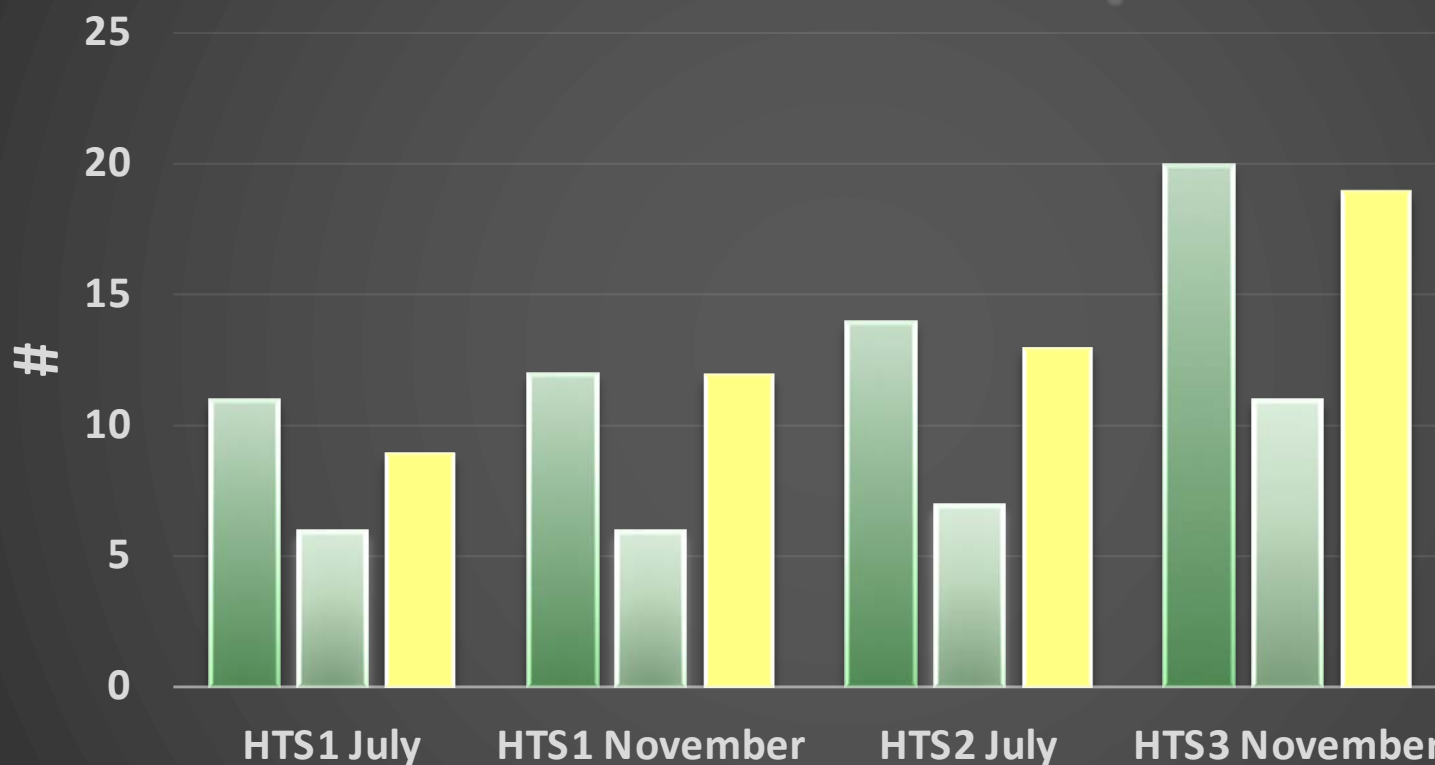
Compound detected in influent	Woodchips	Peagravel	Peagravel /slag	Filter sand	Wollastonite	Granular Activated Carbon
Fludioxonil	✓	✓	✓	✓	✓	✓
Paclobutrazol	✓	✓	✓	✓	✓	✓
Propiconazole	✓	86.9	✓	86.5	83.5	✓
Metolachlor	✓	✓	✓	-10.6	14.9	✓
Azoxystrobin	✓	✓	✓	✓	✓	✓
Fenhexamid	✓	✓	✓	-45.4	-55.4	✓
Metalaxyl	✓	✓	✓	✓	20	✓
Myclobutanil	78.1	55.5	65	-4.1	-6.6	✓
Chlorantraniliprole	87.05	78.7	85.6	83.5	60.9	✓
Cyantraniliprole	62.45	47	87.1	77.7	44.7	✓
Spinosyn A	26.45	✓	-34.3	45.1	56.8	✓
Spinosyn D	57.05	✓	54.7	✓	✓	✓
Spirotetramat	✓	✓	✓	✓	✓	✓
Flonicamid	-11.35	28.6	29.5	48.1	21.3	✓

Permanent Installs at 2 sites





Permanent Treatment Systems : reduction in PGRs & pesticides



■ # detected in first or second cell ■ # found at quantifiable levels ■ # reduced across the system

IF they are designed and managed properly

- **Do they remove nutrients?** Yes, BUT not some salts, e.g. Na and Cl
- **Do they remove pathogens?** Yes, **fungal populations** in the woodchip cell, BUT we haven't tested for viral or bacterial pathogens ... yet
- **Do they remove PGRs & pesticides?** So far so good BUT not all behave the same, they haven't been tested long term, and we're not finished the project ... yet
-
- **AND their performance is impacted by temperature and flow rate, and design factors such as cell depth etc**

And last but not least....



Acknowledgements

Technical Advisory Committee

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- Aqua Treatment Technologies
- OUR GROWERS!!!

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