

IN WINE  
there is wisdom

IN BEER  
there is strength

IN WATER  
there is Bacteria

# Expanding your risk management toolbox - on- farm tools for water quality and pathogen monitoring (GF2 0251 FCO-HMGA)

Intro IPM Workshop  
February 17, 2017

# Objective:

- Develop **PRACTICAL** methods that growers can use to:
  - Track microbial water quality – **manage RISK**
  - Monitor **water treatment system performance**
  - Proactively manage water quality throughout the **whole production system**

# Concerns for Greenhouse Flower Growers

- **Plant pathogens** going into production areas from **fresh or recycled** water
- **Treatment system** performance

# Concerns for Vegetable & Herb Growers

- All of the above, plus
- **Food safety** in production and processing
- Food safety **Regulations**

# Project Cooperators

Cooperator	Crops	Irrigation systems	Recirc ?	treatment
Greenhouses (7)	<input type="checkbox"/> Cut <input type="checkbox"/> Potted <input type="checkbox"/> Bedding <input type="checkbox"/> Vegetable	<input type="checkbox"/> Flood • floor, • trough, • Dutch tray <input type="checkbox"/> Drip <input type="checkbox"/> Overhead	YES	<input type="checkbox"/> UV (5) <input type="checkbox"/> Cloth filter(7) <input type="checkbox"/> Peroxide (2) <input type="checkbox"/> Copper <input type="checkbox"/> Chlorine dioxide <input type="checkbox"/> ECA <input type="checkbox"/> Ozone <input type="checkbox"/> Woodchip Bioreactor <input type="checkbox"/> Constructed wetland
Vegetable growers/ Washers (8)	<input type="checkbox"/> Carrots, beets, parsnips <input type="checkbox"/> Greens <input type="checkbox"/> Asian veg	<input type="checkbox"/> Overhead irrigation <input type="checkbox"/> Wide range of washing systems	Some	Nothing to everything!



# Results -

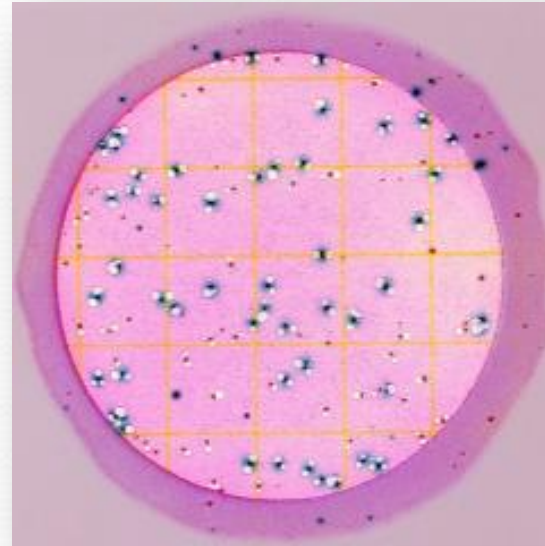
## “Toolbox” of methods for microbial water quality assessment

- **3M Petrifilms** - a measure of RISK
  - **Total yeast & mold** – risk of fungus pathogens
  - **Total aerobic plate count** (bacterial) – general water quality; risk of biofilm development in pipes and drippers
  - ***E.coli* and total coliforms** (if food safety is a concern)
- **DNA multiscans** – identifies WHAT is there

# 3M Petrifilms:

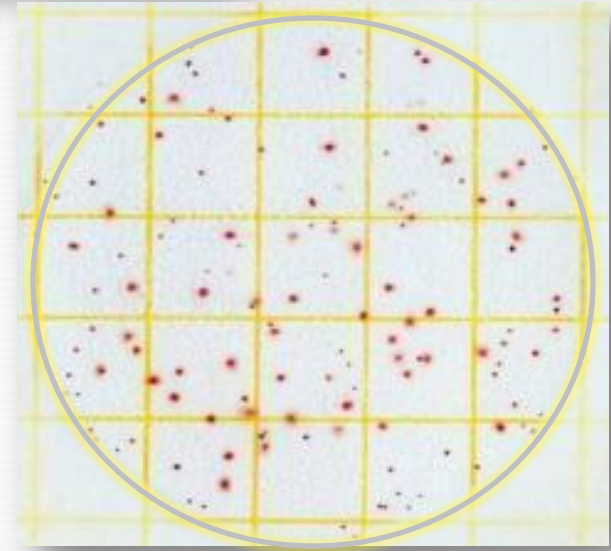
## Food Safety:

*E.coli*, Coliforms



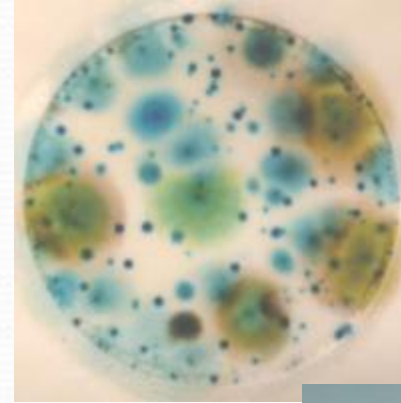
## General water quality:

Total aerobic bacteria



# Tools for fungal plant pathogens

- 3M Petrifilm Yeast & Mold
- Standard plating methods
- Sani-Check dipslides
- AgDia test strips
- DNA Multiscan (UofG Lab Services)





# DNA Multiscan testing

Site code	F2
Crop	Cut mixed
System	Recirculating
Treatment	UV

## DNA Multiscan scores

Sample Code	
Sample Name	
Sampling Date	
Target Organism	
Botrytis cinerea	
Fusarium oxysporum	
F. solani	
Phytophthora sp.	
P. cactorum	
P. capsici	
P. cinnamomi	
P. cryplogea	
P. drechsleri	
P. fragariae	
P. infestans	
P. nicotianae	
Pythium sp.	
P. aphanidermatum	
P. dissotocum	
P. irregulare	
P. polymastum	
P. sylvaticum	
P. ultimum	
Rhizoctonia solani	
Sclerotinia sp.	
Thielaviopsis basicola	
Verticillium albo-atrum	
Verticillium dahliae	
V. dahliae (ver longisporum)	

## Untreated recirc. water

Leach or Runoff water - untreated					
	F2-3	F2-3	F2-3	F2-3	F2-3
	Cistern 1	Cistern 1	Cistern 1	Cistern 1	Cistern 1
	14-May-12	5-Jun-12	5-Jul-12	1-Aug-12	15-Aug-12
Botrytis cinerea	1	0	0	0	0
Fusarium oxysporum	1	0	0	1	1
F. solani	1	0	0	1	1
Phytophthora sp.	1	0	0	1	0
P. cactorum	0	0	0	0	0
P. capsici	0	0	0	0	0
P. cinnamomi	0	0	0	0	0
P. cryplogea	0	0	0	0	0
P. drechsleri	0	0	0	0	0
P. fragariae	0	0	0	0	0
P. infestans	0	0	0	0	0
P. nicotianae	0	0	0	0	0
Pythium sp.	3	1	1	1	1
P. aphanidermatum	0	0	0	0	0
P. dissotocum	6	1	2	3	3
P. irregulare	1	0	0	0	0
P. polymastum	0	0	0	0	0
P. sylvaticum	0	0	0	0	0
P. ultimum	1	0	0	0	0
Rhizoctonia solani	0	0	0	0	0
Sclerotinia sp.	0	0	0	0	0
Thielaviopsis basicola	0	0	0	0	0
Verticillium albo-atrum	0	0	0	0	0
Verticillium dahliae	0	0	0	0	0
V. dahliae (ver longisporum)	0	0	0	0	0

## Treated water

Treated					
	F2-4	F2-4	F2-4	F2-4	F2-4
	Cistern 2	Cistern 2	Cistern 2	Cistern 2	Cistern 2
	14-May-12	5-Jun-12	5-Jul-12	1-Aug-12	15-Aug-12
Botrytis cinerea	1	1	0	0	0
Fusarium oxysporum	0	1	1	1	0
F. solani	1	1	1	1	1
Phytophthora sp.	2	0	0	0	0
P. cactorum	0	0	0	0	0
P. capsici	0	0	0	0	0
P. cinnamomi	0	0	0	0	0
P. cryplogea	0	0	0	0	0
P. drechsleri	0	0	0	0	0
P. fragariae	0	0	0	0	0
P. infestans	0	0	0	0	0
P. nicotianae	0	0	0	0	0
Pythium sp.	4	3	1	1	0
P. aphanidermatum	0	0	0	0	0
P. dissotocum	6	8	1	1	0
P. irregulare	0	0	0	0	0
P. polymastum	0	1	0	0	0
P. sylvaticum	0	0	0	0	0
P. ultimum	0	0	0	0	0
Rhizoctonia solani	0	0	0	0	0
Sclerotinia sp.	0	0	0	0	0
Thielaviopsis basicola	0	0	0	0	0
Verticillium albo-atrum	0	0	0	0	0
Verticillium dahliae	0	0	0	0	0
V. dahliae (ver longisporum)	0	0	0	0	0



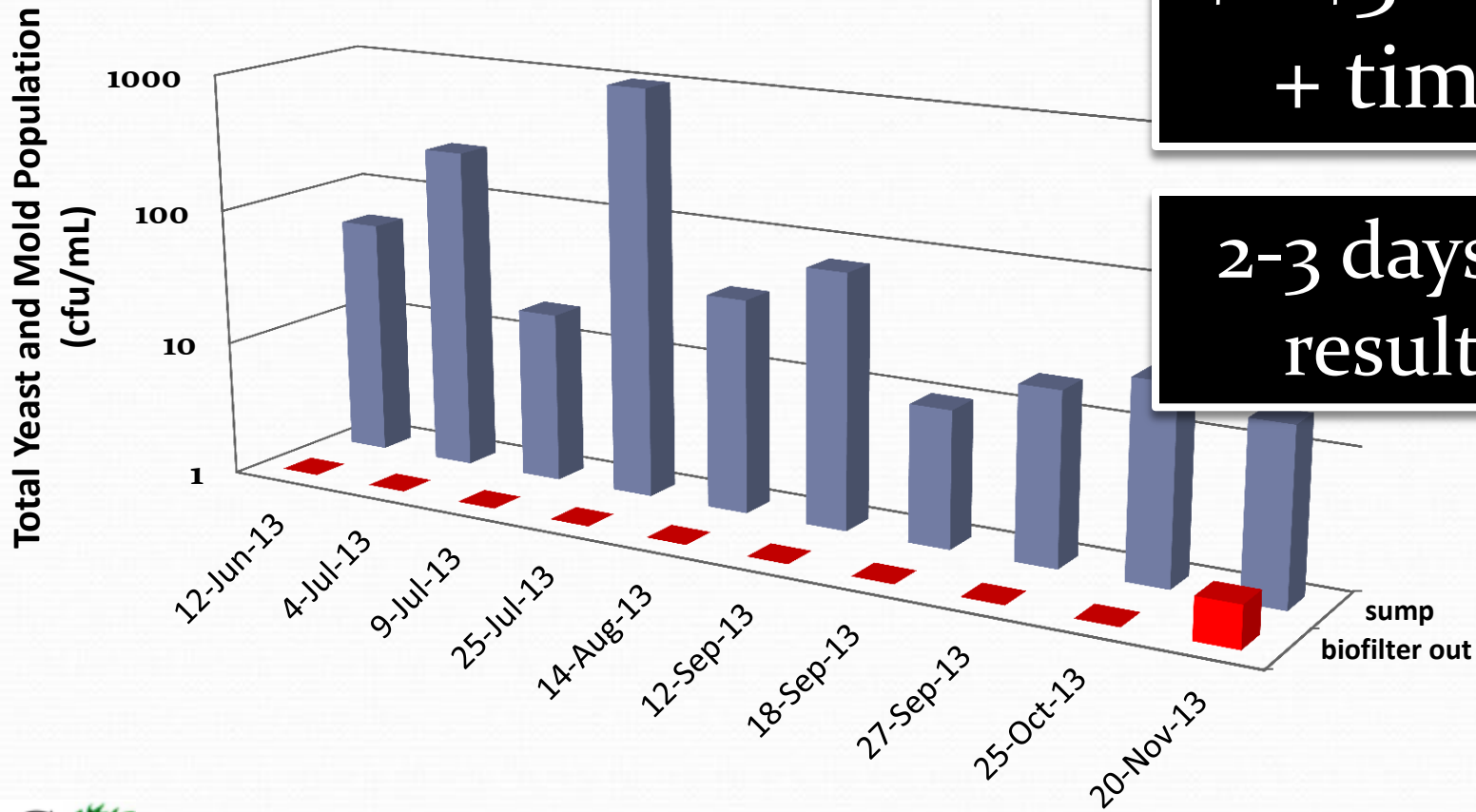
2 weeks for results

# Plant pathogen removal by woodchip bioreactor – DNA Multiscan testing

Target Organism	Untreated Sump Water							Woodchip Bioreactor Treated						
	22 May 12	5 June 12	5 July 12	1 Aug 12	15 Aug 12	12 June 13	5 Sept 13	22 May 12	5 June 12	5 July 12	1 Aug 12	15 Aug 12	12 June 13	5 Sept 13
Botrytis	2	3	1	0	1	0	0	0	0	0	0	0	0	0
Fusarium	0	1	1	1	2	1	1	0	0	0	0	0	0	1
Phytophthora	0	1	0	0	0	1	0	0	0	0	0	0	1	0
Pythium	0	5	4	5	3	10	1	0	0	0	0	0	1	0
Rhizoctonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olpidium	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sclerotinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thielaviopsis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Verticillium	0	0	0	0	0	0	0	0	0	0	0	0	0	0

**\$175-\$225 each**

# 3M Petrifilm for yeast & mold



\$2-\$3 each  
+ time

2-3 days to  
results

# Methods

- Sampling Program
  - What are your primary concerns?
  - Where are your critical monitoring points?
  - What are the best (least busy) days to do this – make it part of your routine.





# Methods: Sample collection

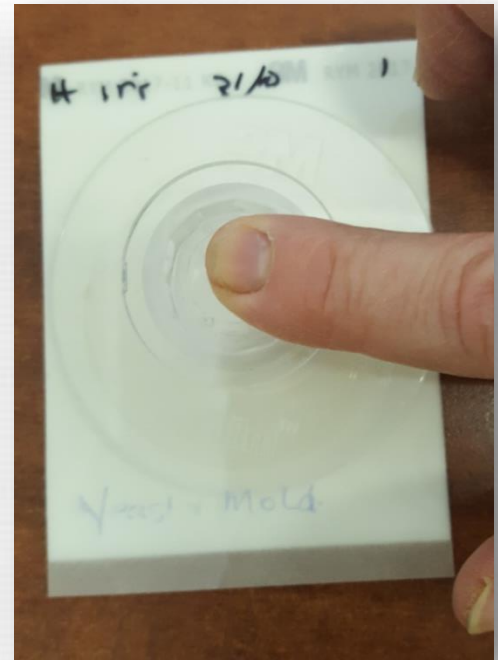


Whirl-Paks



**RULE # 1: Keep everything clean!**  
**RULE # 2: Do it the same every time!**

# Methods: dilutions and plating on Petrifilms



**RULE # 1: Keep everything clean!**  
**RULE # 2: Do it the same every time!**

# Methods: incubation



\$159 at Amazon.ca



\$373 at Amazon.com



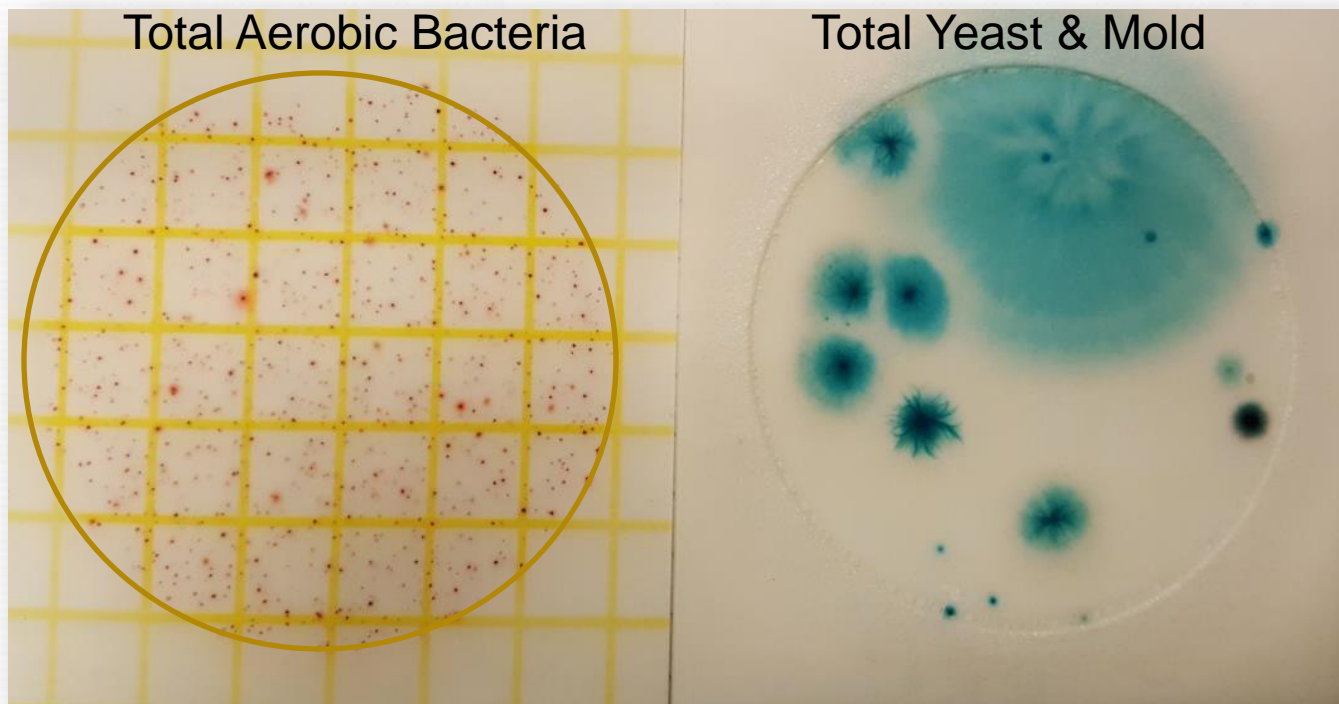
OR Room temperature  
for Aerobic and Y&M

**RULE # 1: Keep everything clean!**  
**RULE # 2: Do it the same every time!**



# Methods: Counting

- Image J & Scoring Chart

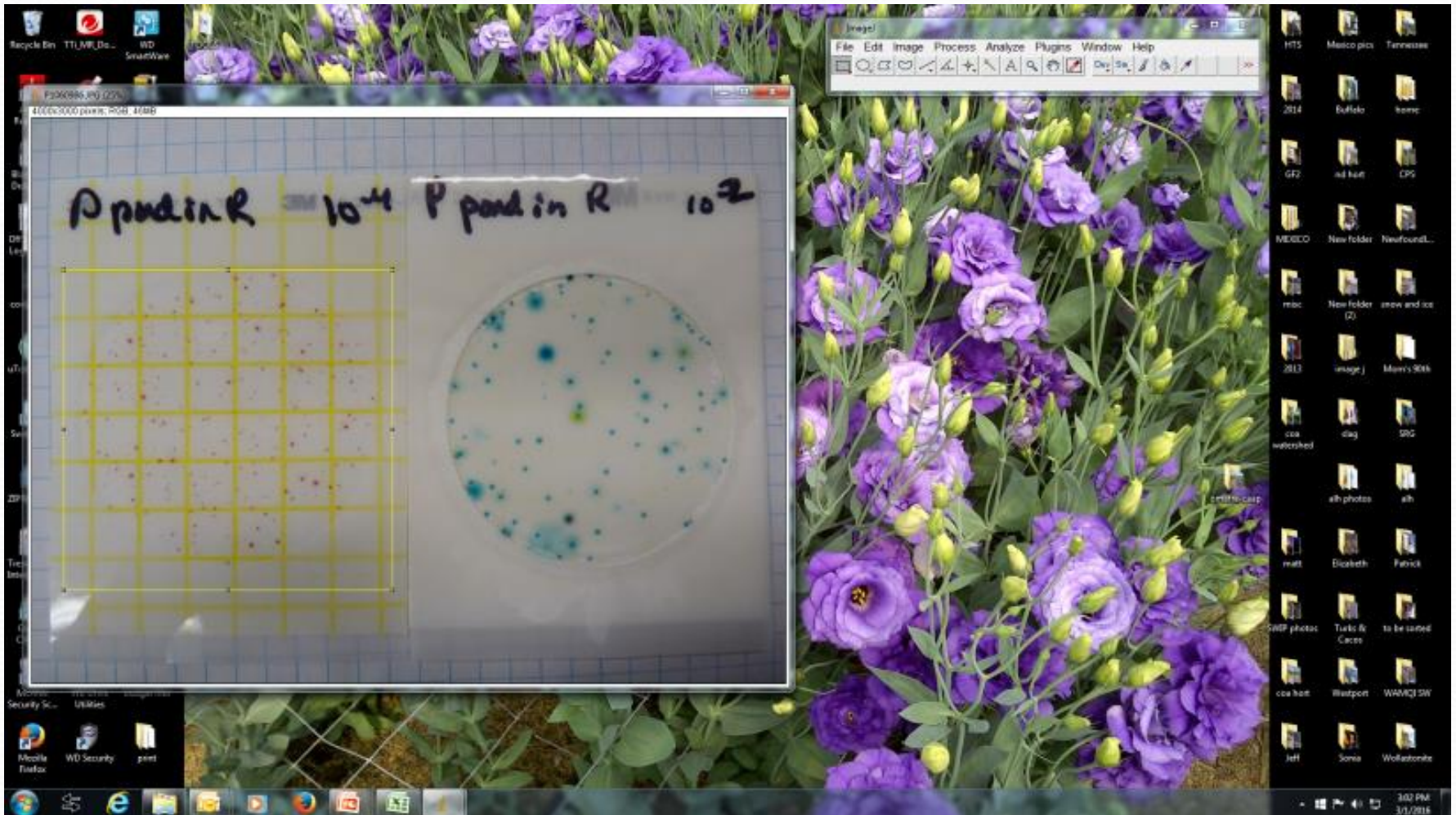


**RULE # 1: Keep everything clean!**  
**RULE # 2: Do it the same every time!**



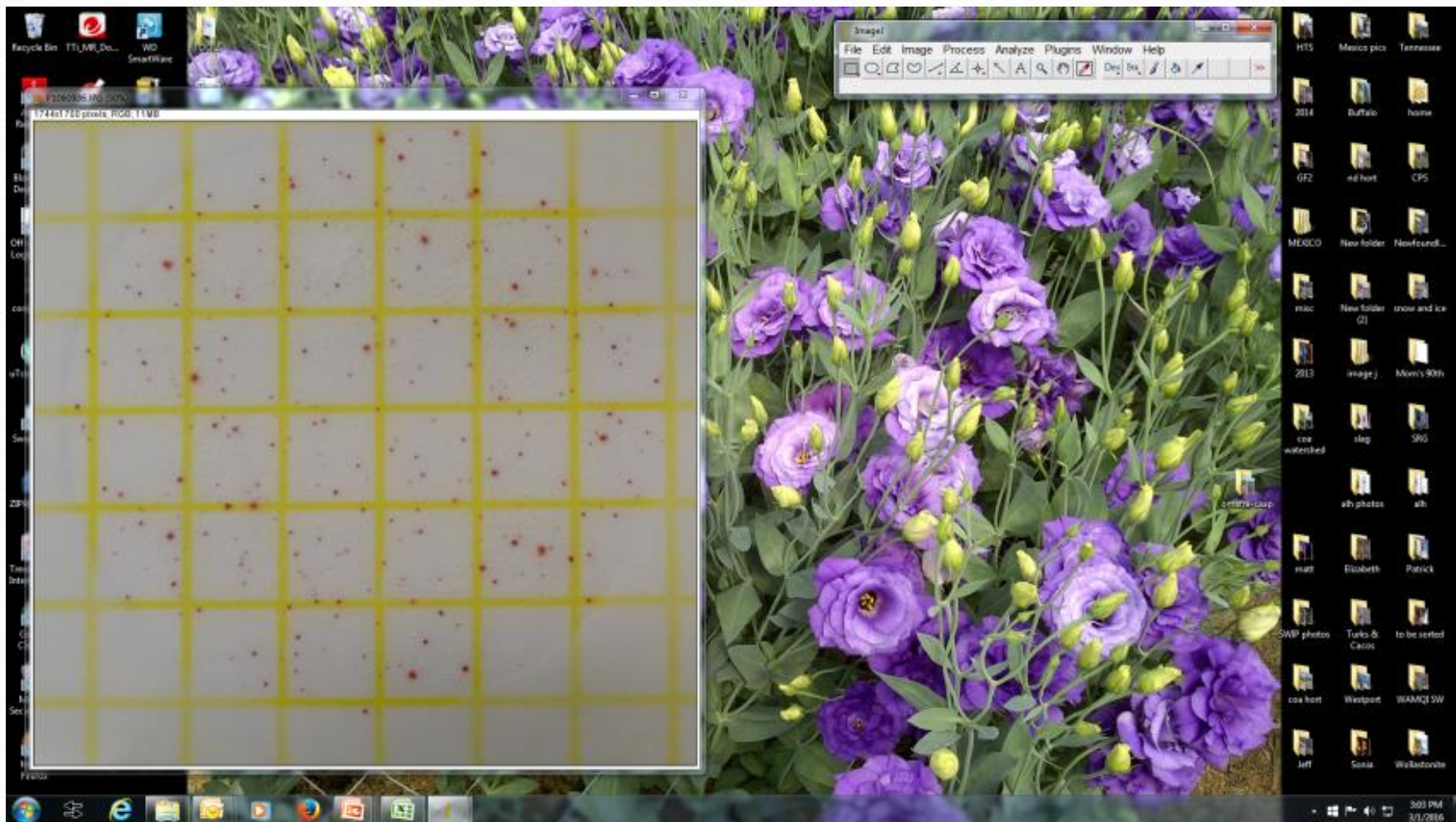
# Cool tools: Image J

File – open, select



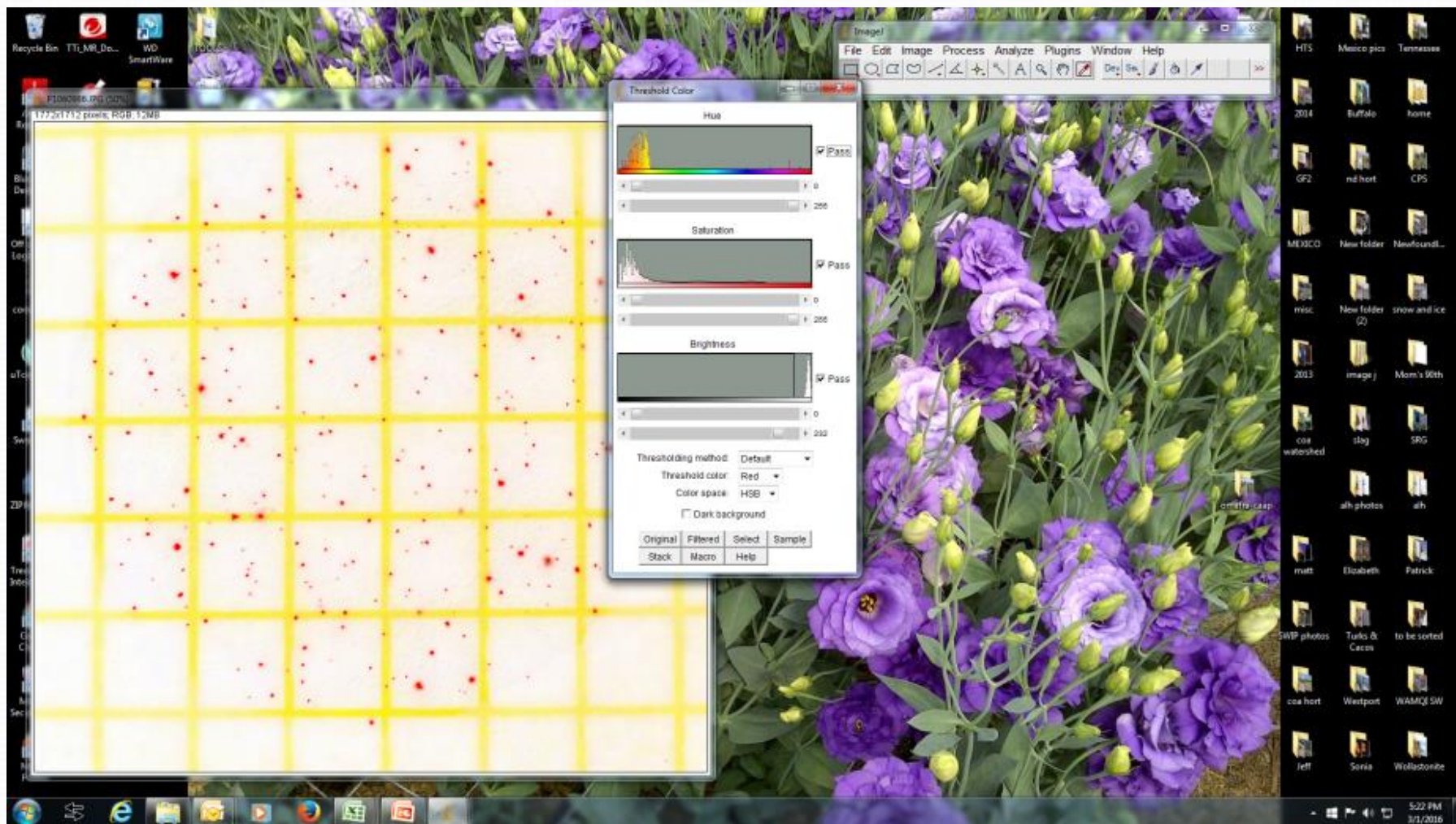


# Image - crop





Process – subtract background; Image – adjust threshold





# Analyze – analyze particles

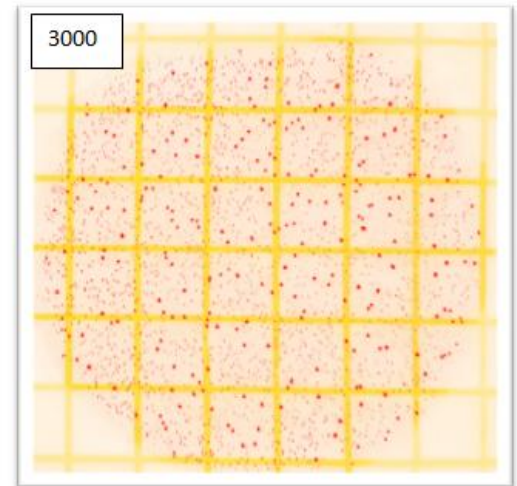
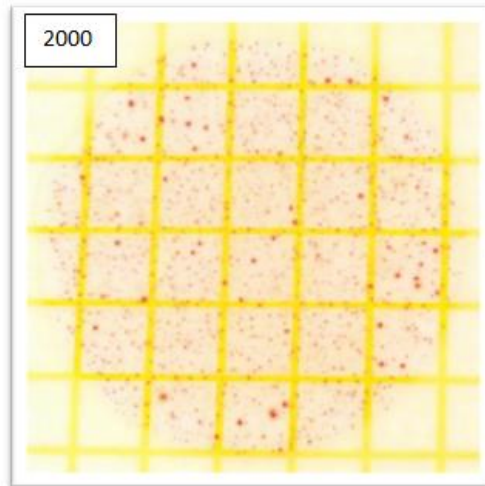
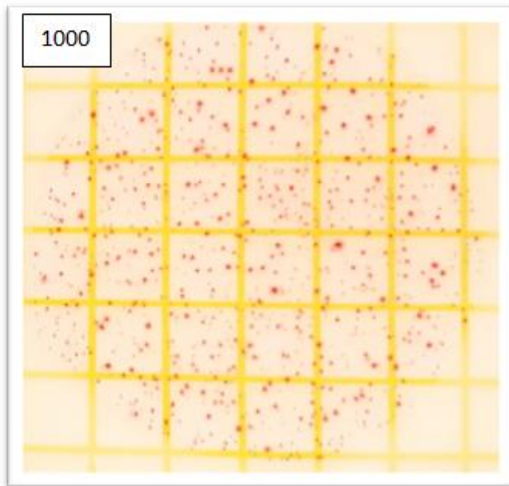
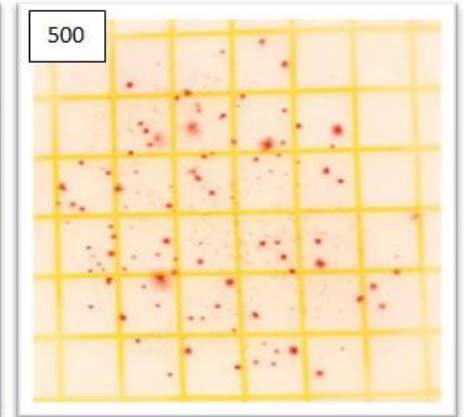
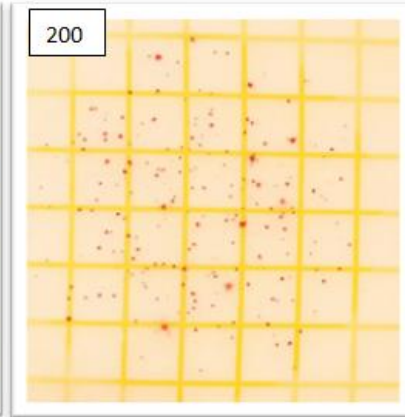
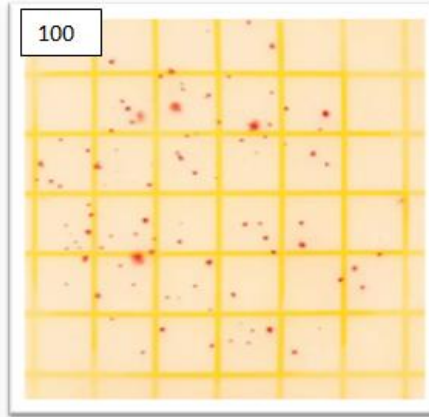
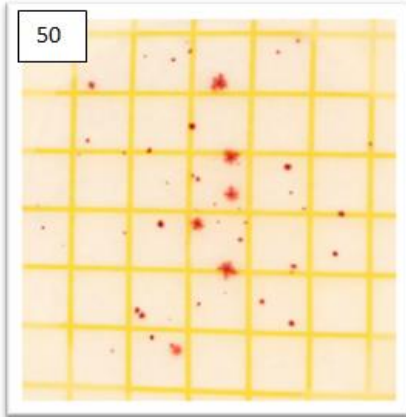
The screenshot shows a desktop environment with a purple flower background. A software window titled 'ImageJ' is open, displaying a grid of yellow squares over a background of purple flowers. A 'Summary' window is open, showing a table with columns: Slice, Count, Total Area, Average Size, and %Area. The 'Count' column for 'P106098.JPG' is circled in red.

Slice	Count	Total Area	Average Size	%Area
P106098.JPG	304	103	34.036	0.34

The desktop also shows various icons on the left and right sides, including 'Recycle Bin', 'TTL\_ML\_Do...', 'WD SmartWare', 'HTS', 'Musco pics', 'Tennessee', '2014', 'Buffalo', 'home', 'GF2', 'nd hort', 'CPS', 'MEXICO', 'New folder', 'Newfound...', 'misc', 'New folder (2)', 'snow and ice', '2013', 'image j', 'Mom's With', 'coa watershed', 'slag', 'SRG', 'omifra-casp', 'alh photos', 'alh', 'matt', 'Elizabeth', 'Patrick', 'SWP photos', 'Turks & Caicos', 'to be sorted', 'coa hort', 'Westport', 'WAMQJ SW', 'Jeff', 'Seria', 'Wollastonite', and a taskbar at the bottom with the system clock showing 5:23 PM on 3/1/2016.

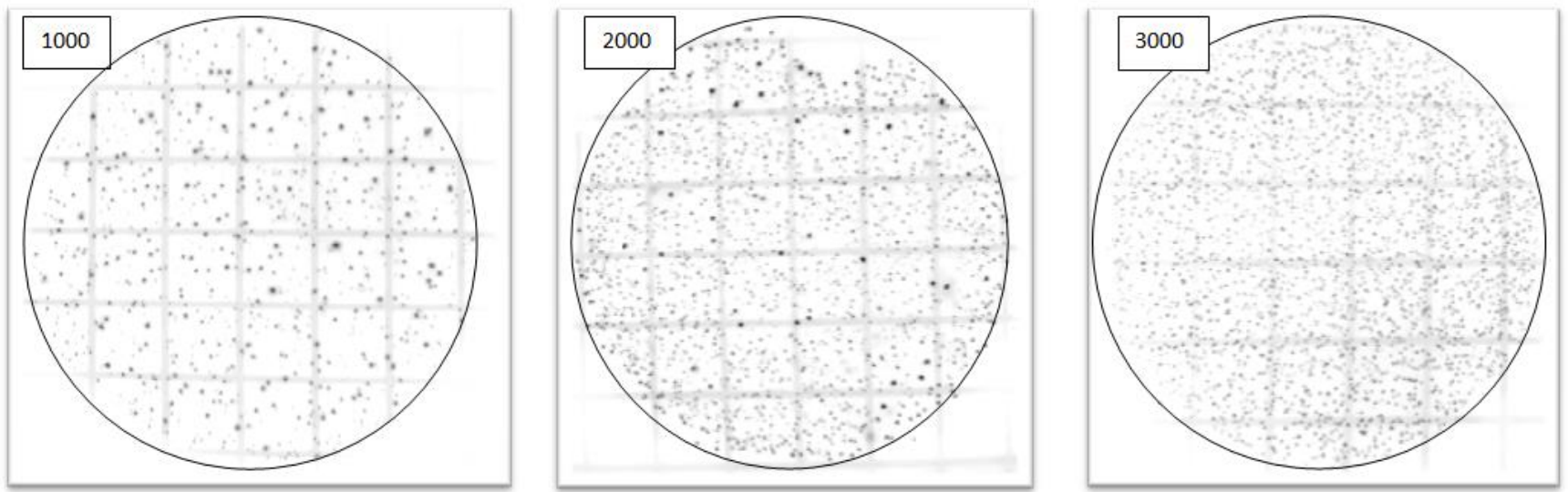
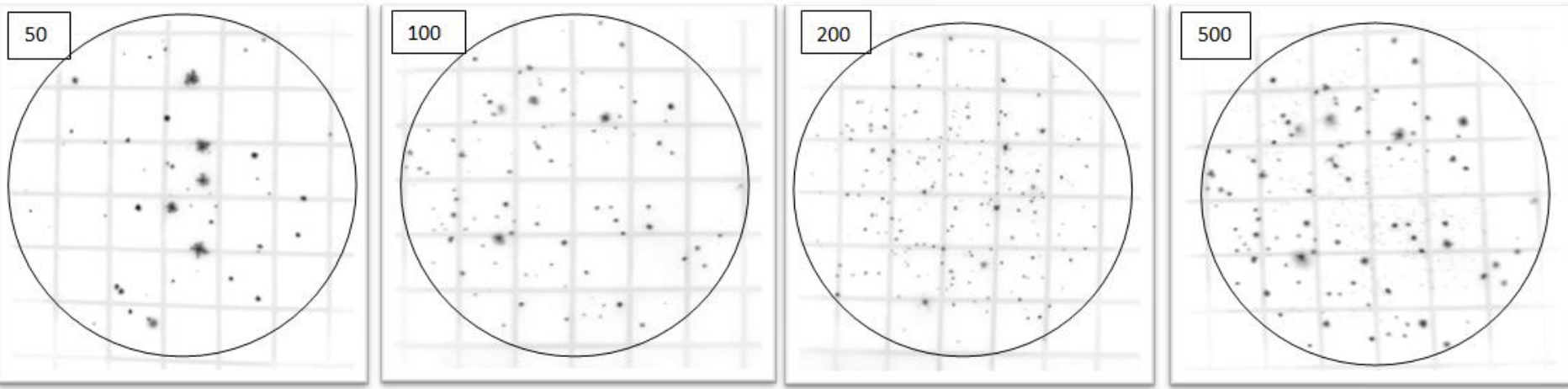


# Scoring Chart #1

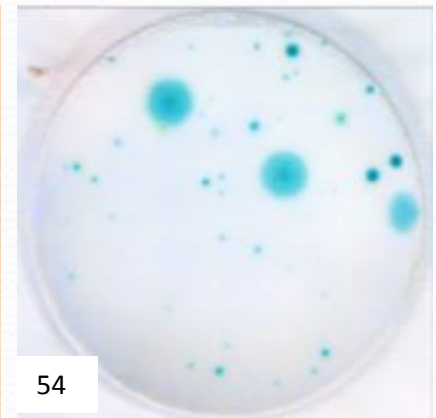
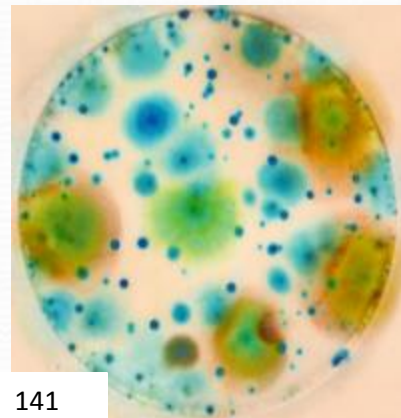
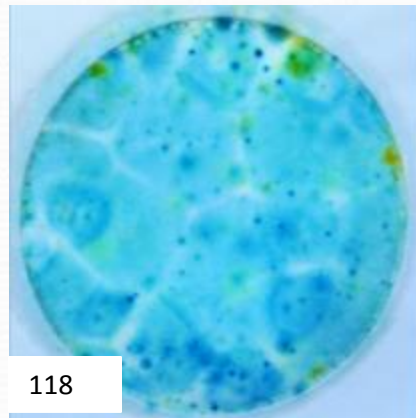
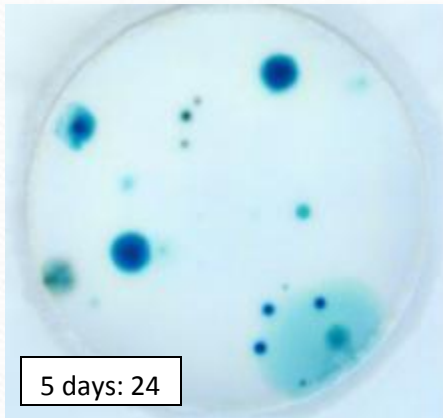
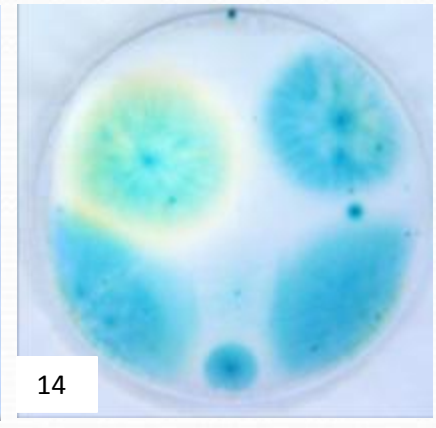
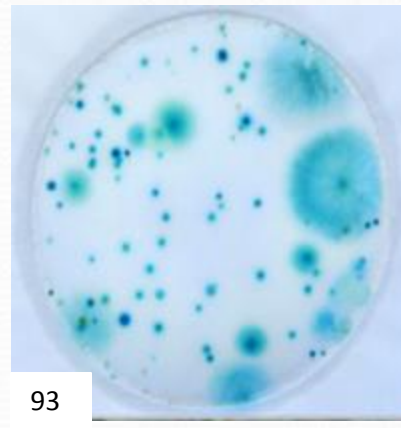
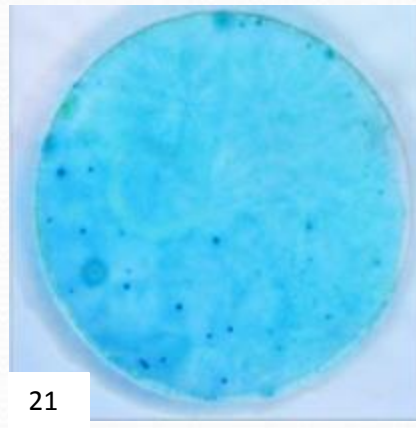
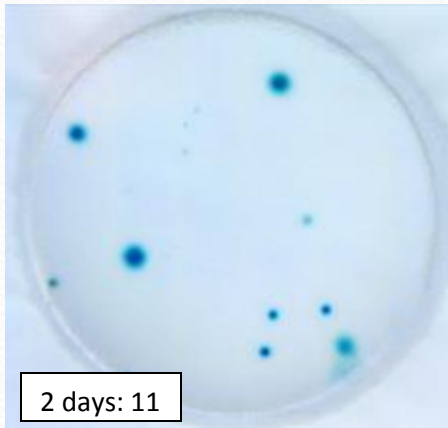


# Scoring Chart #2

Total Aerobic Plate Count (3M Petrifilm APC): Comparison Chart



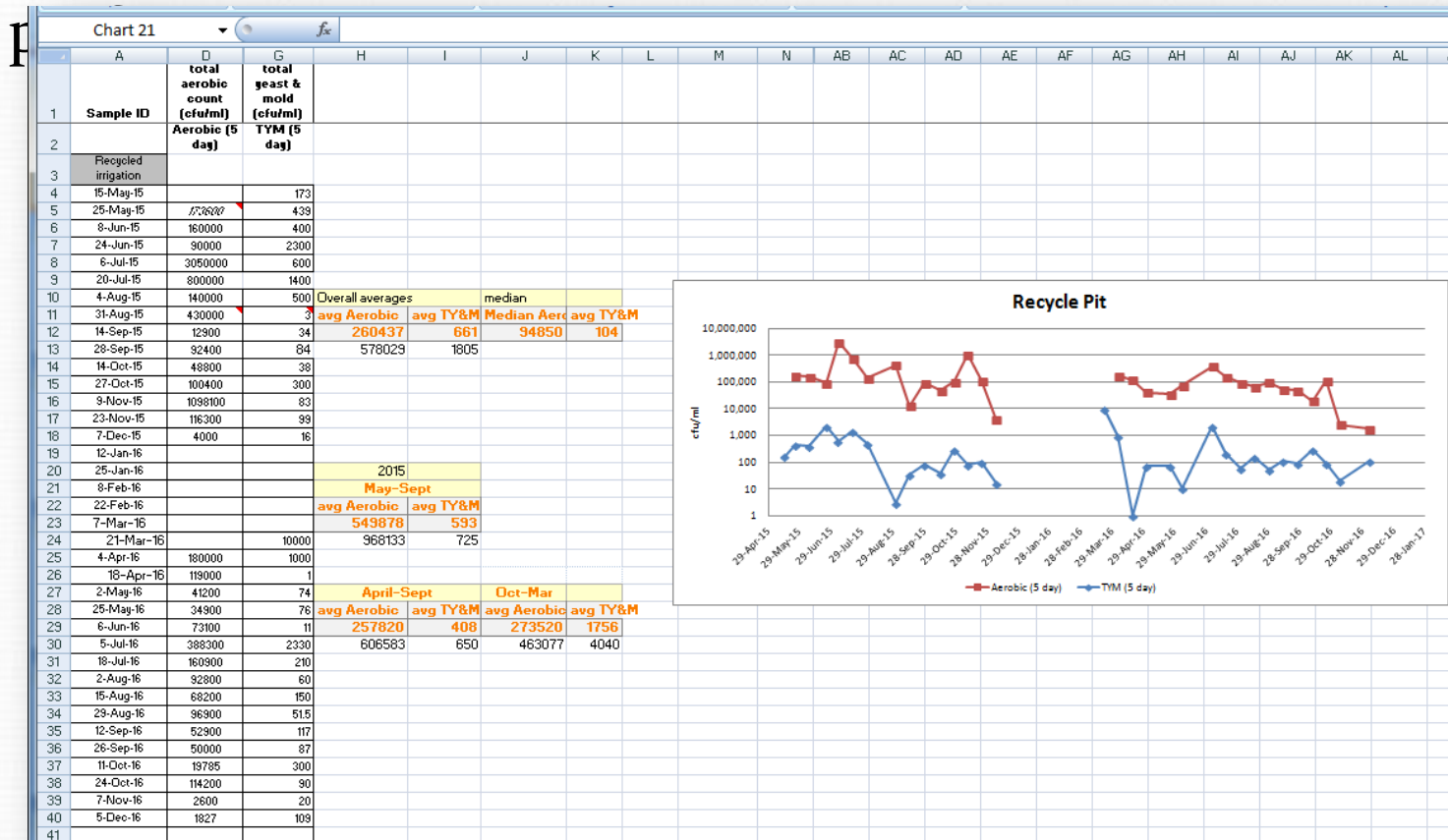
# Y&M – challenging but important





# Methods: Results and Record Keeping

- Colony forming units per ml (cfu/ml): count X dilution
- keep track of changes in water quality along with crop



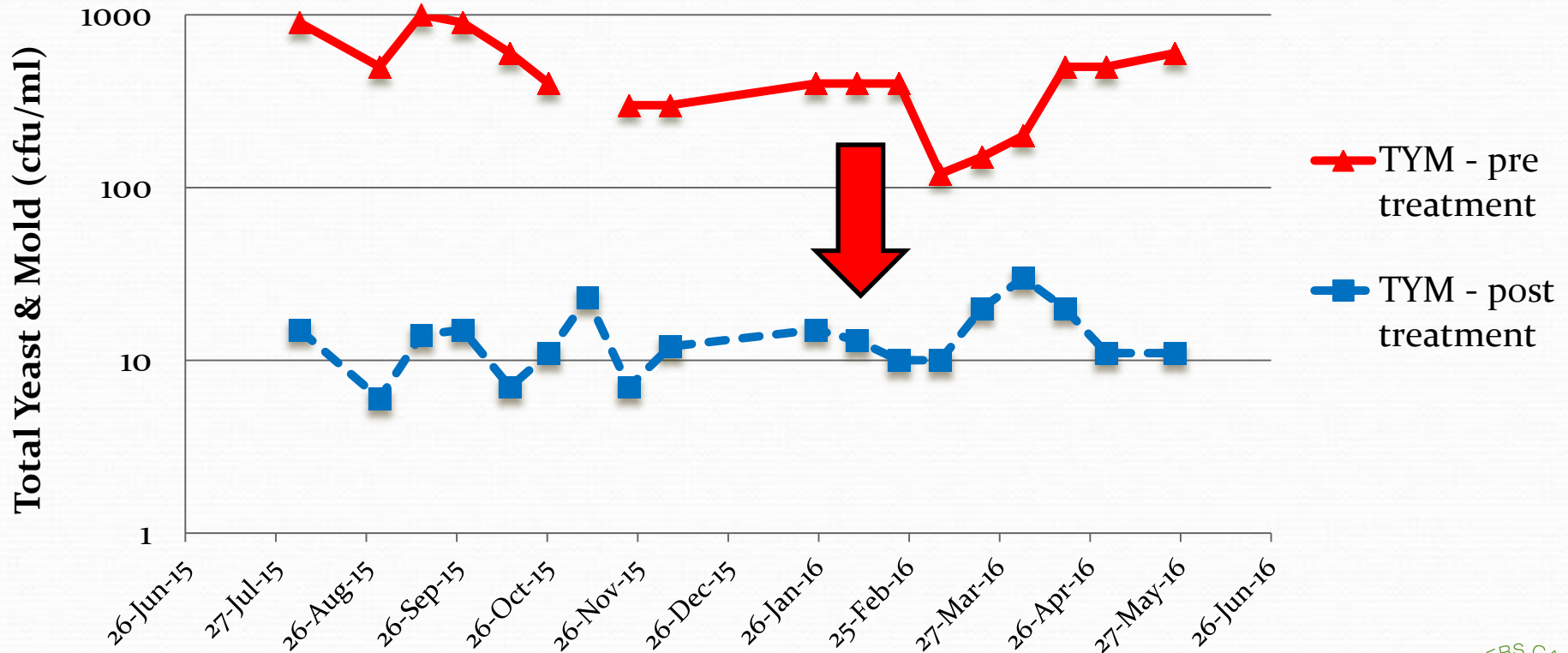
# Results -

## Baseline microbial water quality data (2 years)

- **treatment system performance and general water management**
  - 7 greenhouse systems
  - 8 vegetable production and processing systems
- >3000 Petrifilm analyses!!

# Typical results: treatment system performance

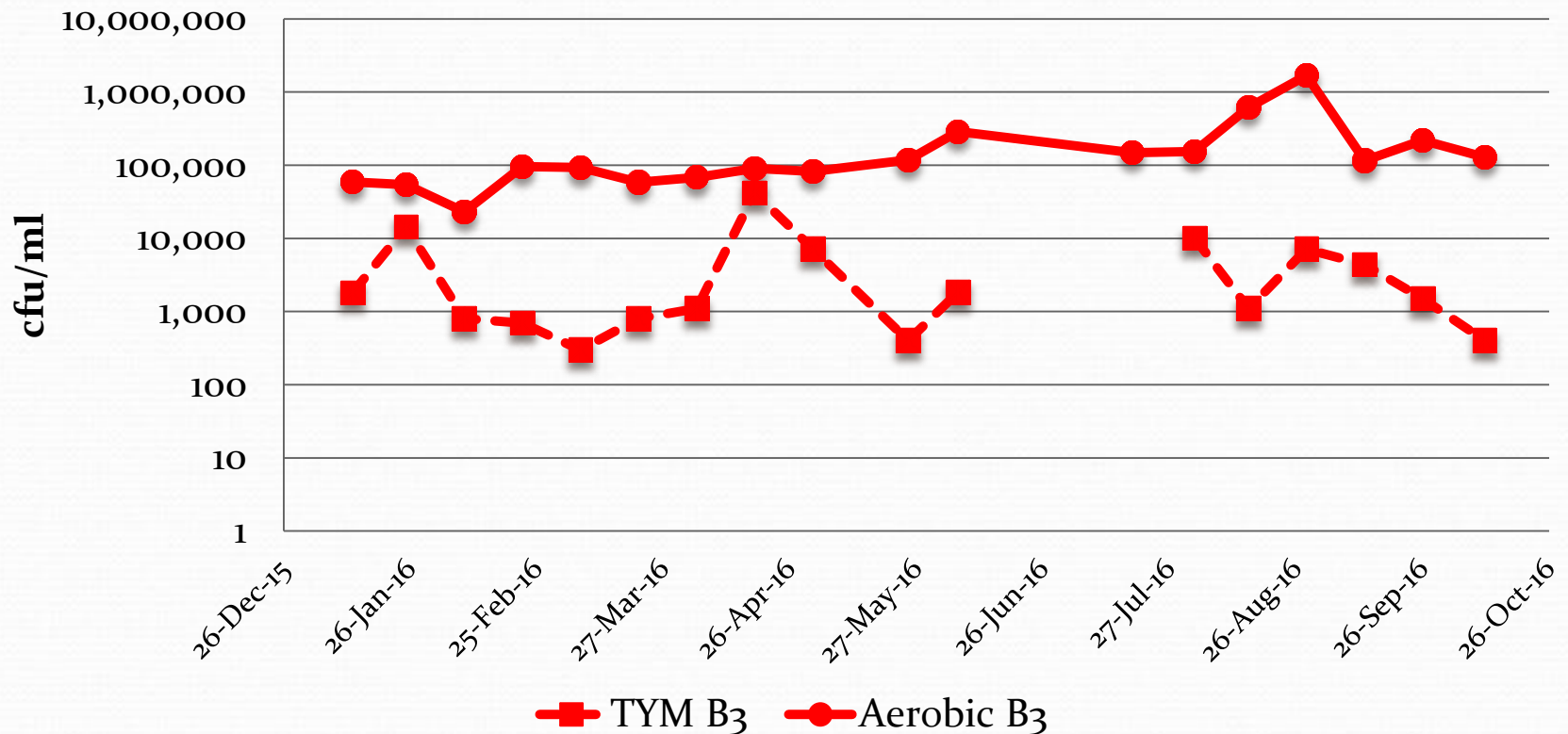
ECA treatment



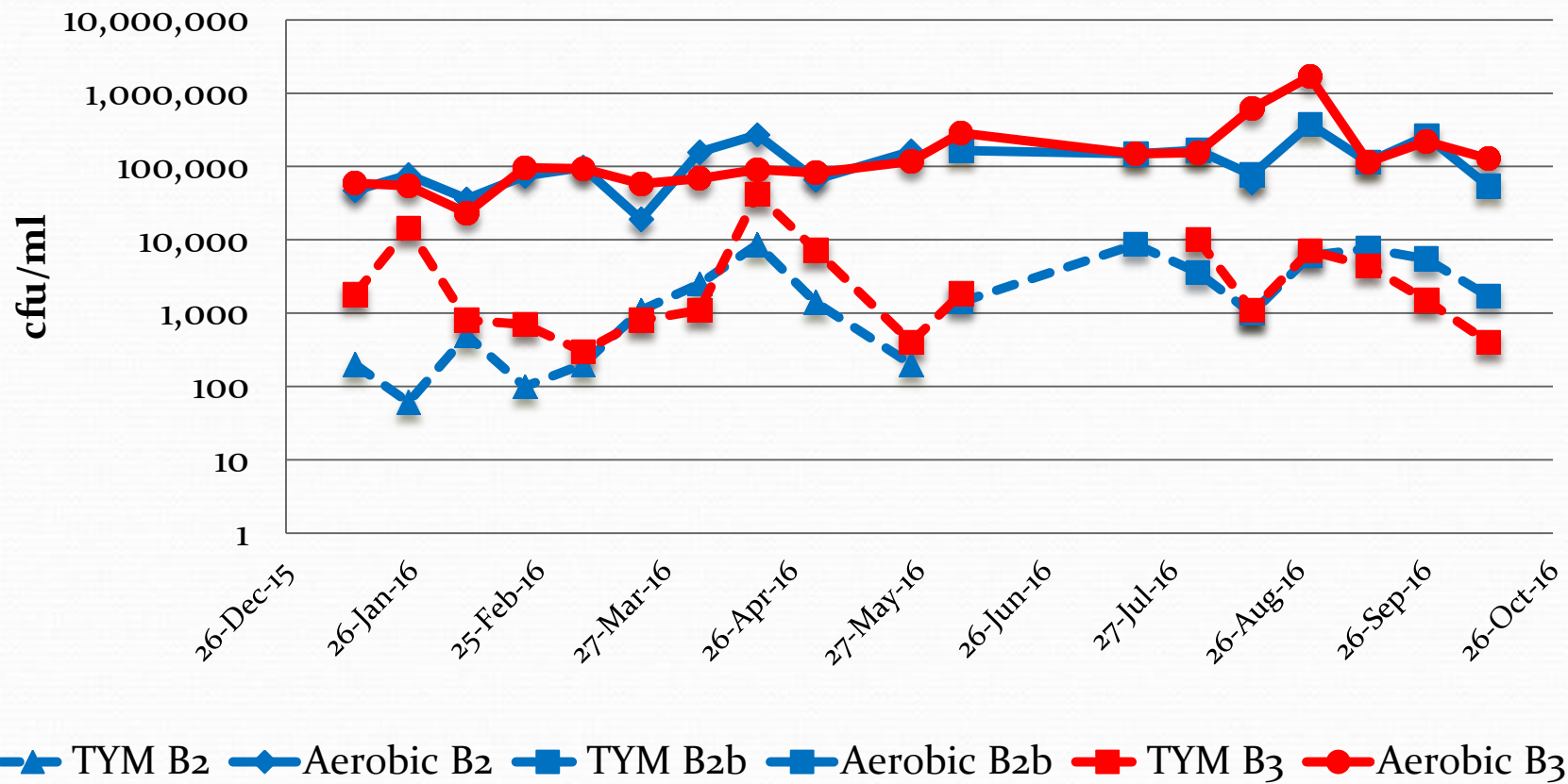


# Typical results: treatment system performance

## Recirc Tank and Treated (peroxide) storage tank

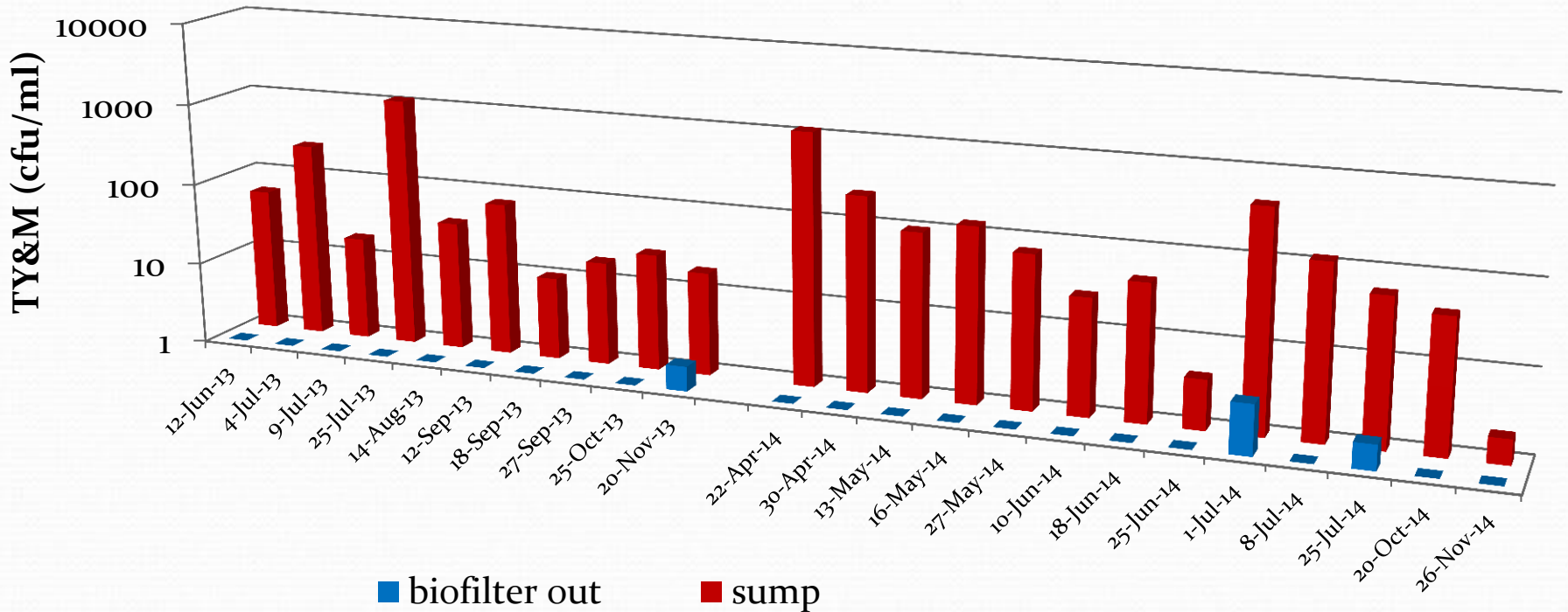


## Recirc Tank and Treated (peroxide) storage tank



# Typical results: treatment system performance

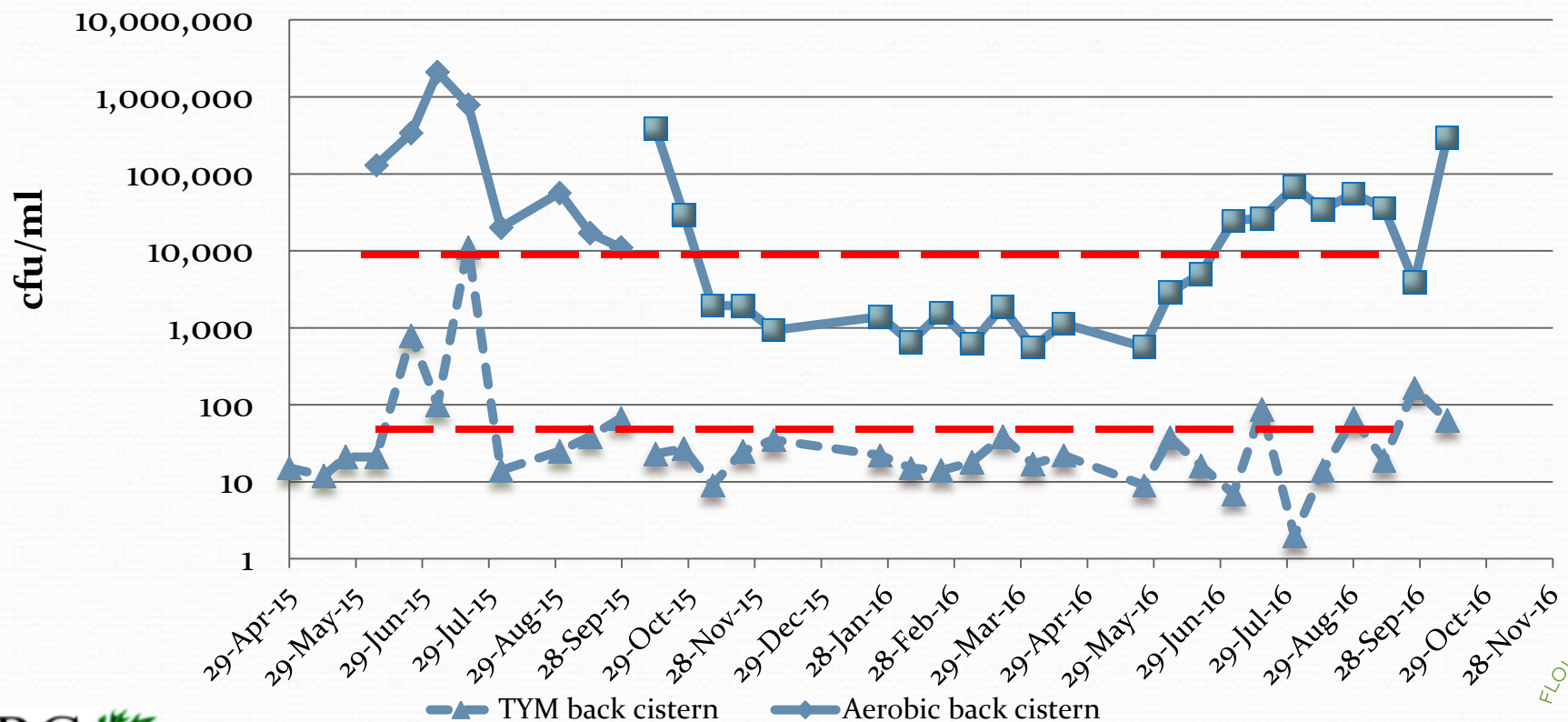
Woodchip bioreactor: removal of total yeast & mold





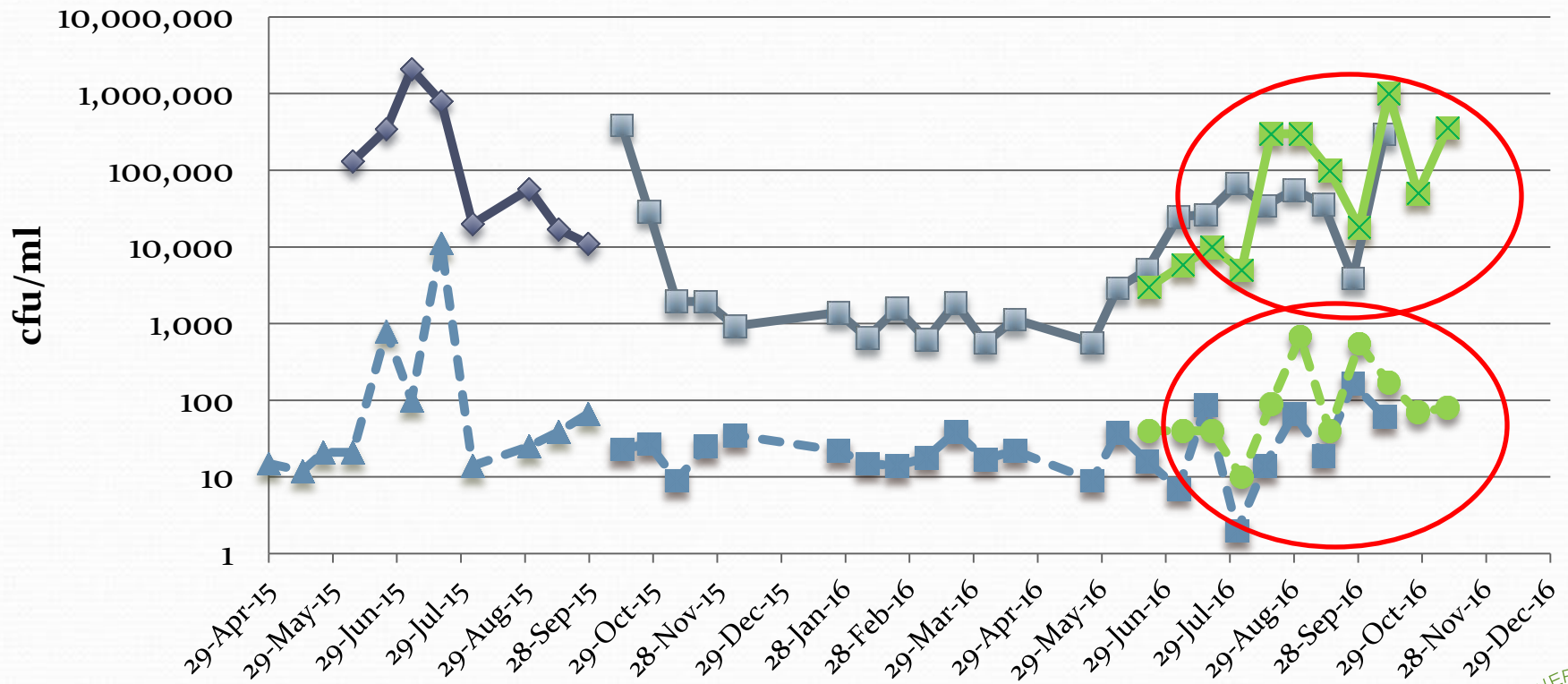
# Typical results: changes over season and management

## Fresh water cisterns

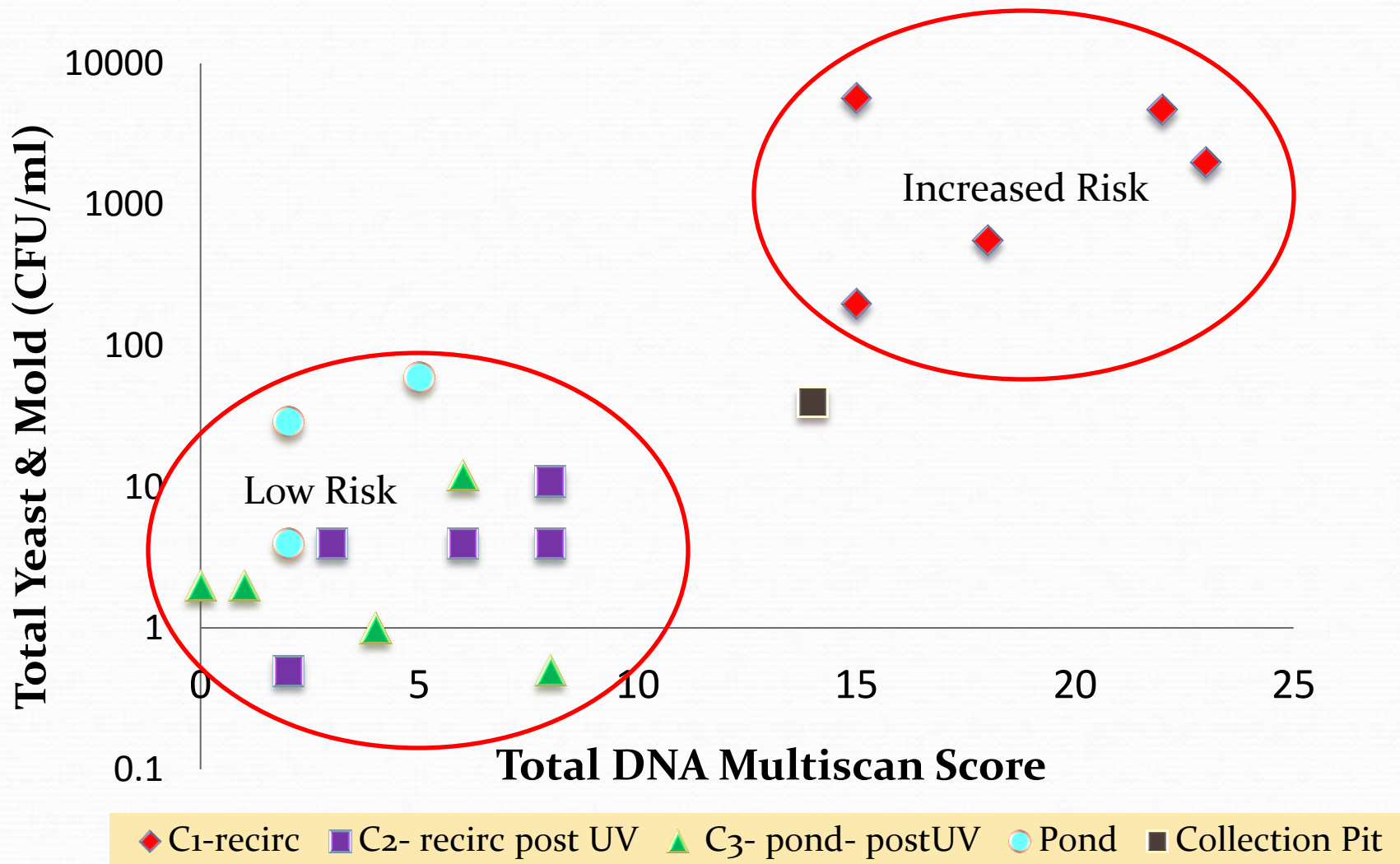


# On-site comparisons- yes you can!

## Fresh water cisterns

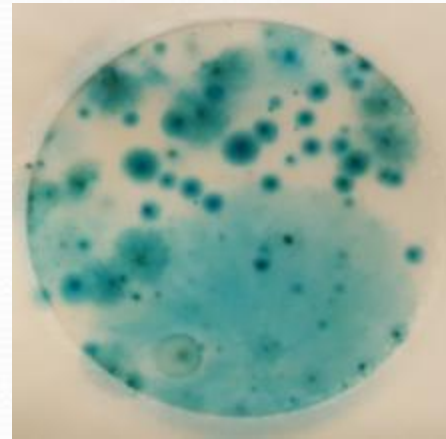
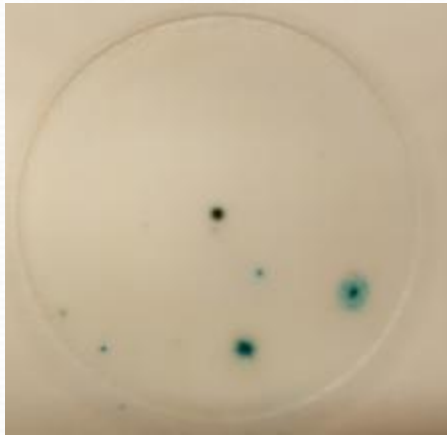


# Implications for growers: Petrifilms and DNA Multiscans





# RISK Determination



- Low counts
- Consistent results
- Treatment system OK
- Scouting looks OK
- Track changes in levels with water sources changes (e.g. pond vs roof)

- High counts
- Inconsistent results
- Unusual spikes in data
- Send for DNA multiscan?
- Extra scouting for issues?
- Check/maintain treatment equipment?
- Clean tanks, including feed tanks

# Other parameters

- Test strips/meters for sanitizer residuals and other chemicals – keep records along with microbial counts
  - **peroxide**
  - **chlorine – free & total**
  - **chlorine dioxide**
- **pH**
- **ammonia**
- **nitrate**
- **phosphate**

# Next Steps

- **Workshops –**
  - Niagara area: February 24<sup>th</sup> (Rittenhouse)
  - Holland Marsh area – March 8<sup>th</sup> (Bradford)
- **Ordering supplies and equipment through FCO**
  - SOON please!!!!
- **Contact us:**
  - Ann Huber, SRG; [ahuber@srgresearch.ca](mailto:ahuber@srgresearch.ca)
  - Jeanine West, FCO; [jeanine@fco.ca](mailto:jeanine@fco.ca)



# Acknowledgements

- Flowers Canada (Ontario) Inc.,
- Holland Marsh Growers Association & LSGBCUF project,
- Steering Committee Members, and
- Our Growers!!

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