Evaluation of Peracetic Acid for suppression of Fusarium and DON during malting

ASBC
THE SCIENCE OF BEER

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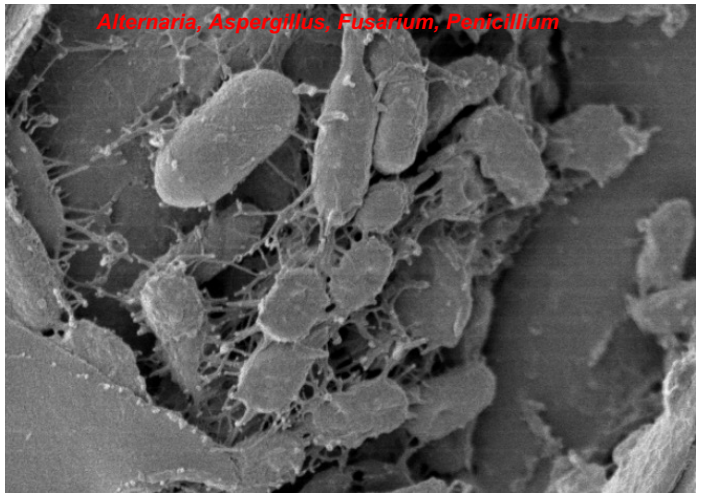
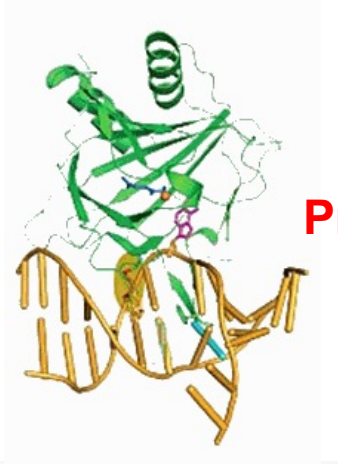
What seems to be the problem?

Barley is rich in microflora



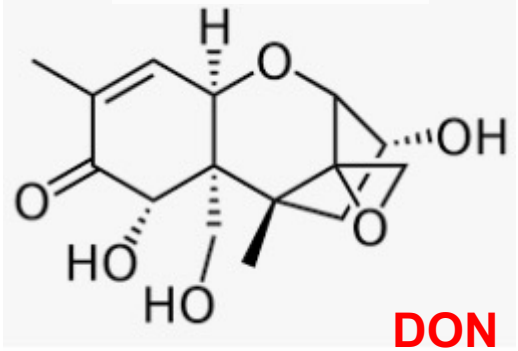
Laitila,et. Al. Microbes in the tailoring of barley malt properties, VTT publications, 2007

Temperature/humidity during steep and germ creates favorable environment for proliferation

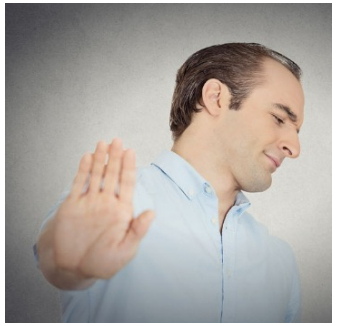


Protein damage

Soluble protein **FAN** **Wort Color**



DON

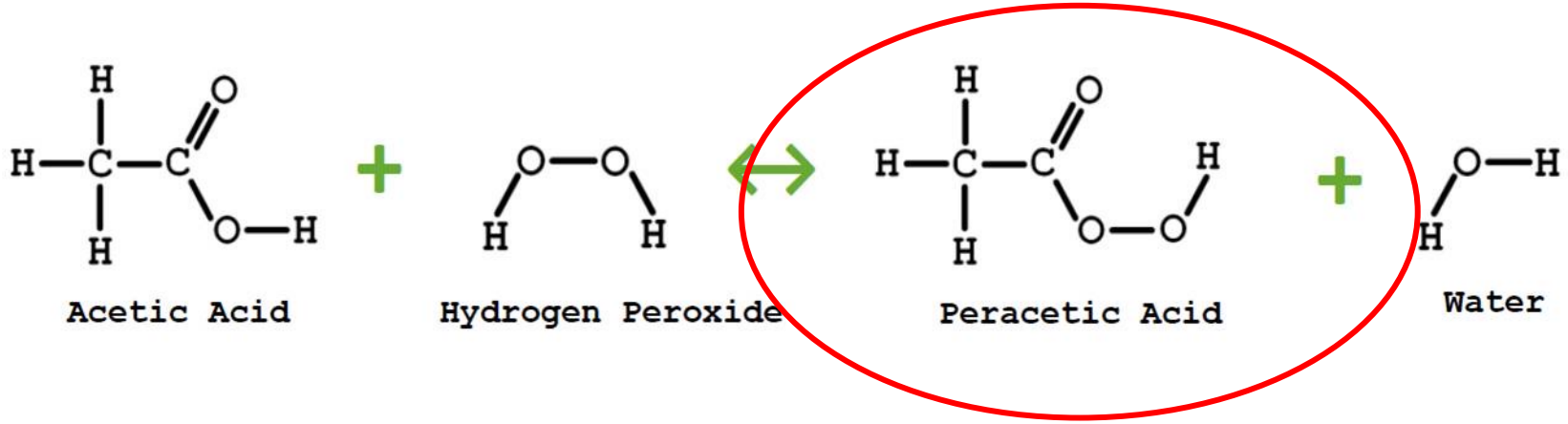


Avoidance, but…

Climate change

Introduction to Peracetic Acid

PAA is an **organic peroxide** that results from the reaction between Acetic Acid, Hydrogen Peroxide and Water (pH of 2.8)



PAA exists only in **equilibrium** with the other components in aqueous solution.

Properties of PAA

PAA is a strong oxidant and biocide

- highly effective in reducing target microorganisms

It is **not** a chlorine-based technology

- Relatively short lifetime (in water, ~30-minute half-life)
- Will not have long term impact on finished product, if used properly
- No long-term impact on the environment

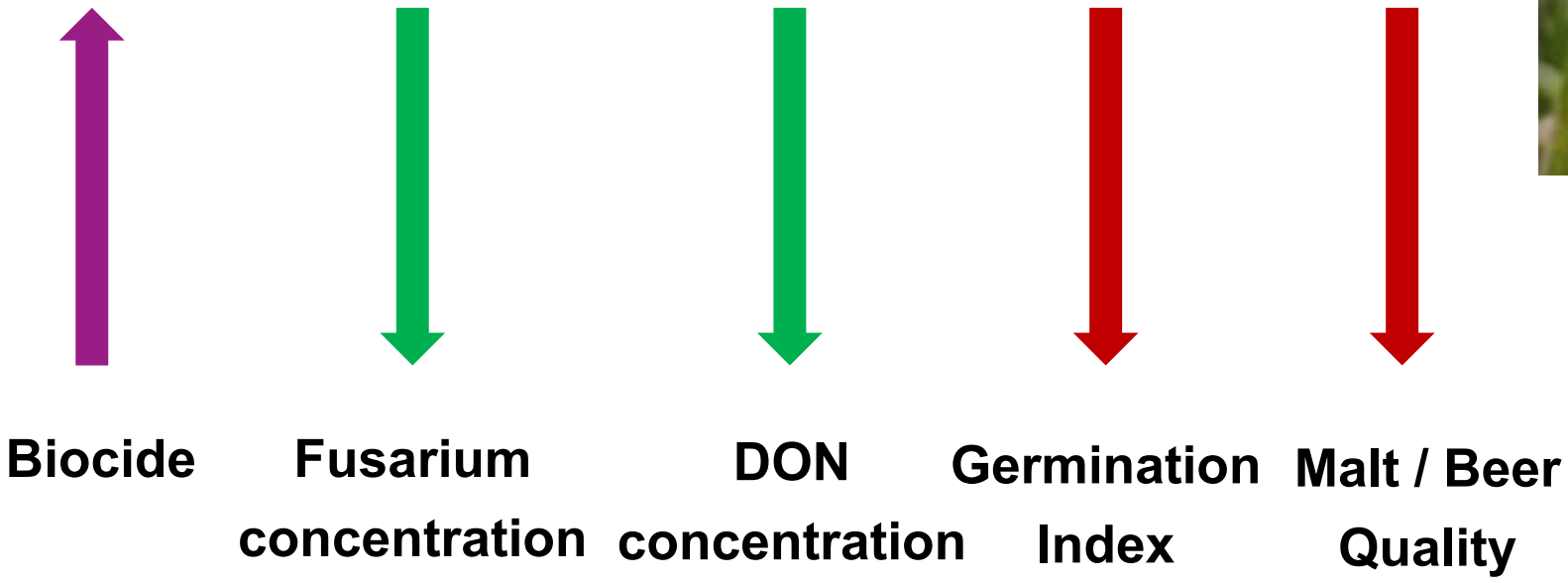
Long shelf life (up to a year, stored properly, undiluted)

Easy to dose and deliver

Biocidal Control Fusarium / DON and Yeast / Molds

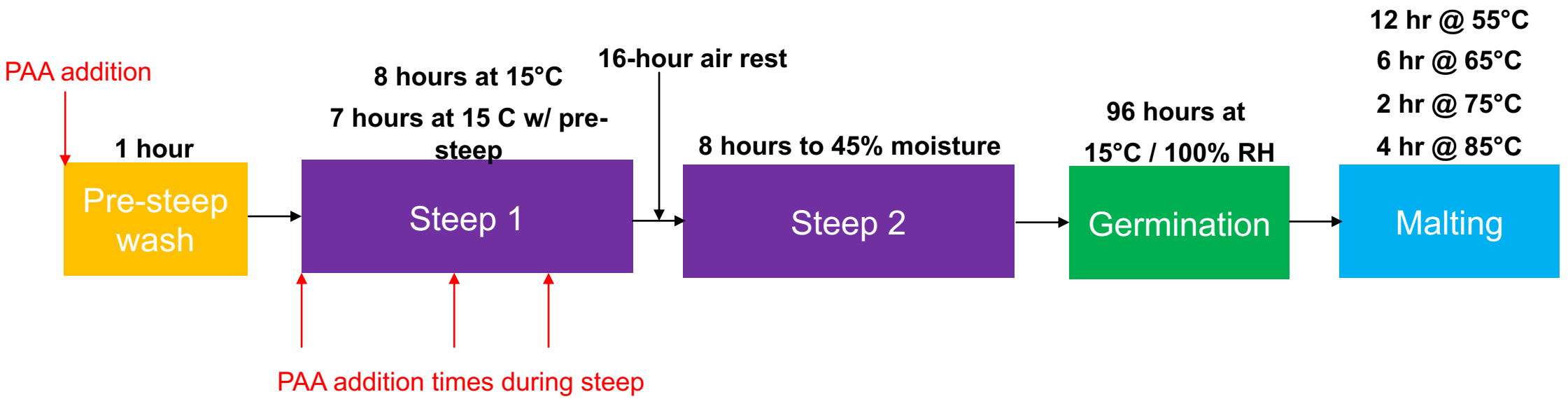
Need to balance microbial control with impact on germination and subsequent malt and beer quality

Typical Occurrence on Addition of a Biocide



To find the balance…an experiment was designed

Why? To investigate addition of PAA and PAA / pH modifier during steeping and as a “pre-rinse” to steeping



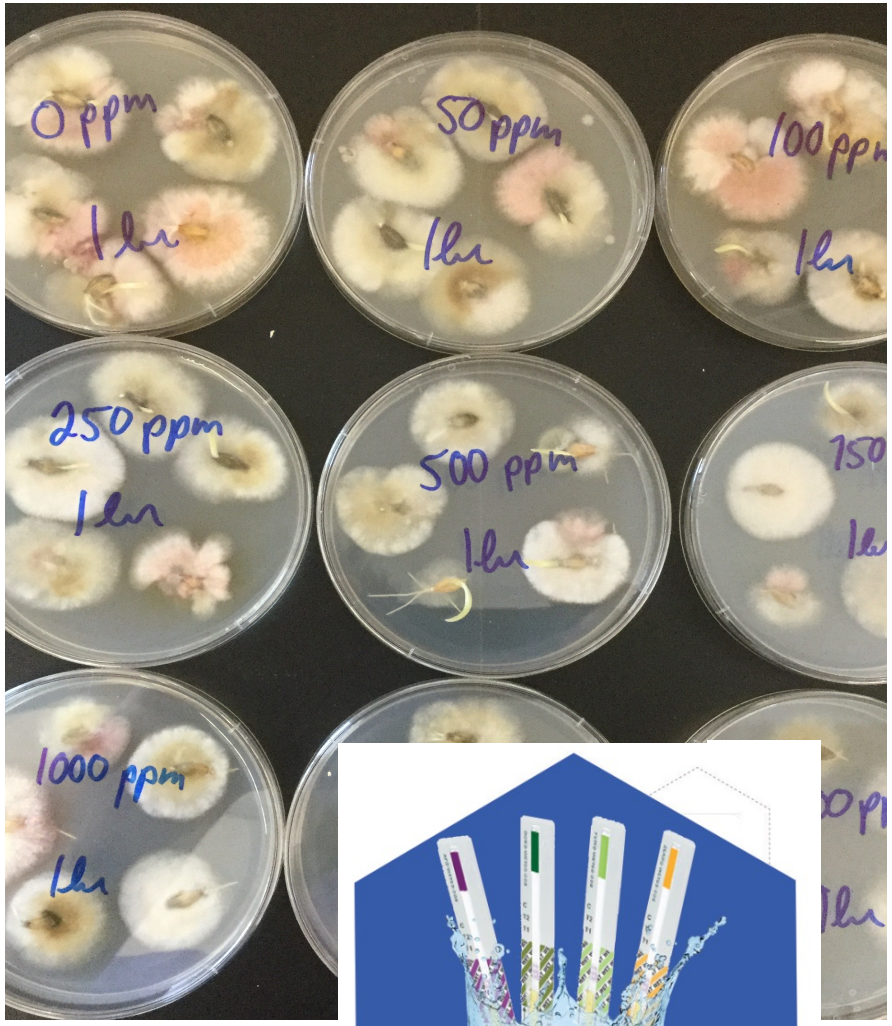
- PAA added between 250 and 2000 mg / L
- In steep stage, PAA added pre-steep rinse, 2, 4 and 8 hours from the END of the steep stage
- For pH modification studies, NaOH added to achieve a pH of 9

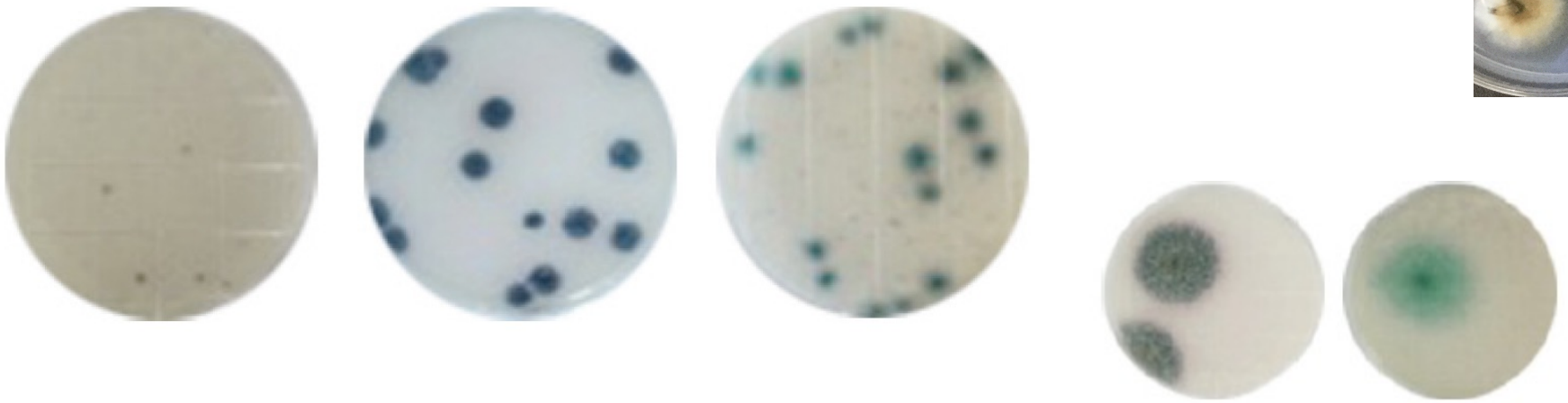
Method for Fusarium and DON

Primary target: *Fusarium*

DON – deoxynivalenol < 0.5 mg/kg

Secondary target: yeast and molds



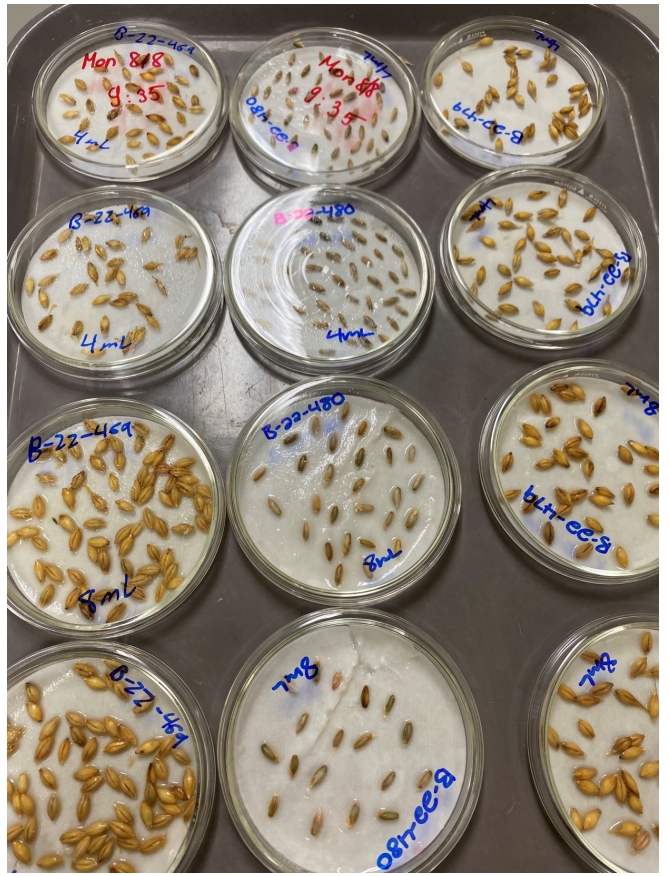


Method for germination characteristics

Germination Index, GI

Time-weighted average of the % number of seeds that have germinated (24, 48, and 72 hours).

$$GI = \frac{\%\ germinated\ 24\ hr + \%\ germinated\ 48\ hr + \%\ germinated\ 72\ hr}{\%\ germinated\ 24\ hr + 2 * \%\ germinated\ 48\ hr + 3 * \%\ germinated\ 72\ hr} * 10$$



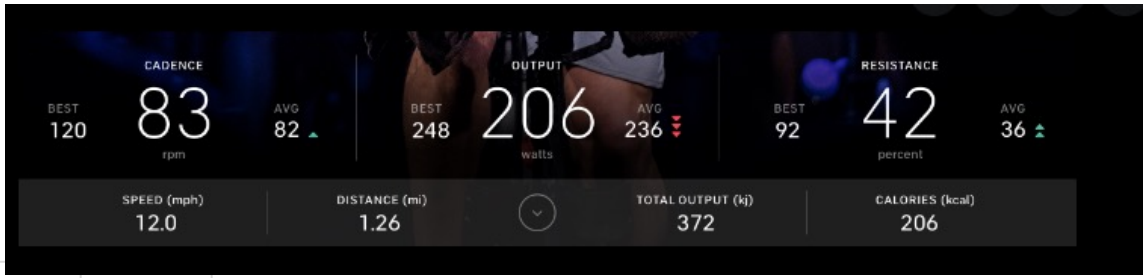
Germination Energy GE

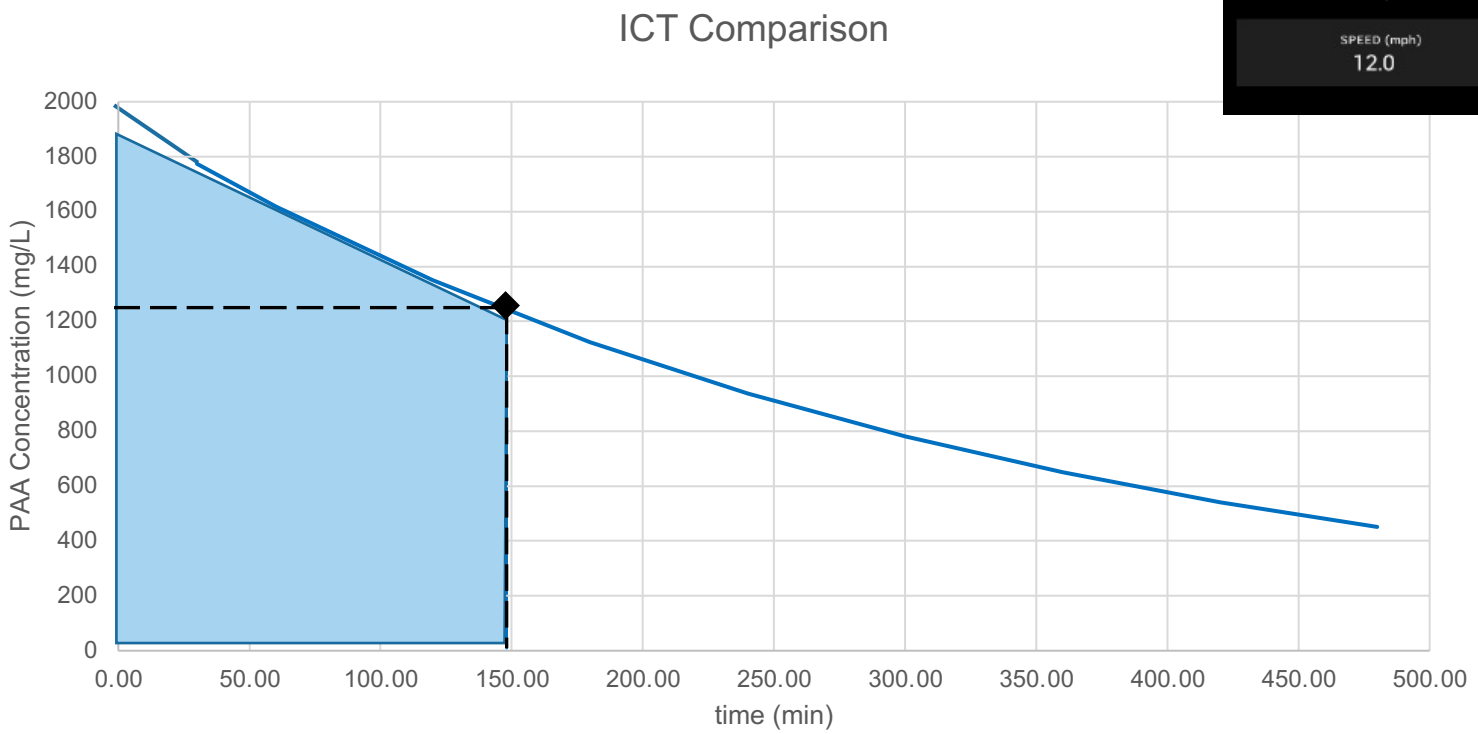
> 95% (3 day)

Note on “ICT” (integrated Concentration * Time)

ICT

integrated Concentration * time (mg*min/L)



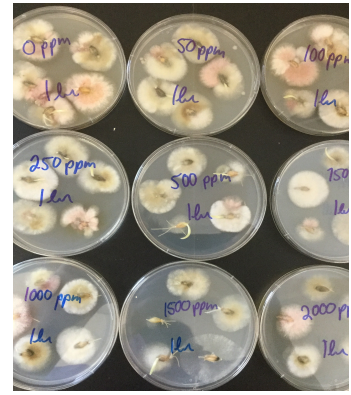


Same as your Peloton screen – cadence + resistance = Output (Output is POWER). Many ways to arrive at the same Output!

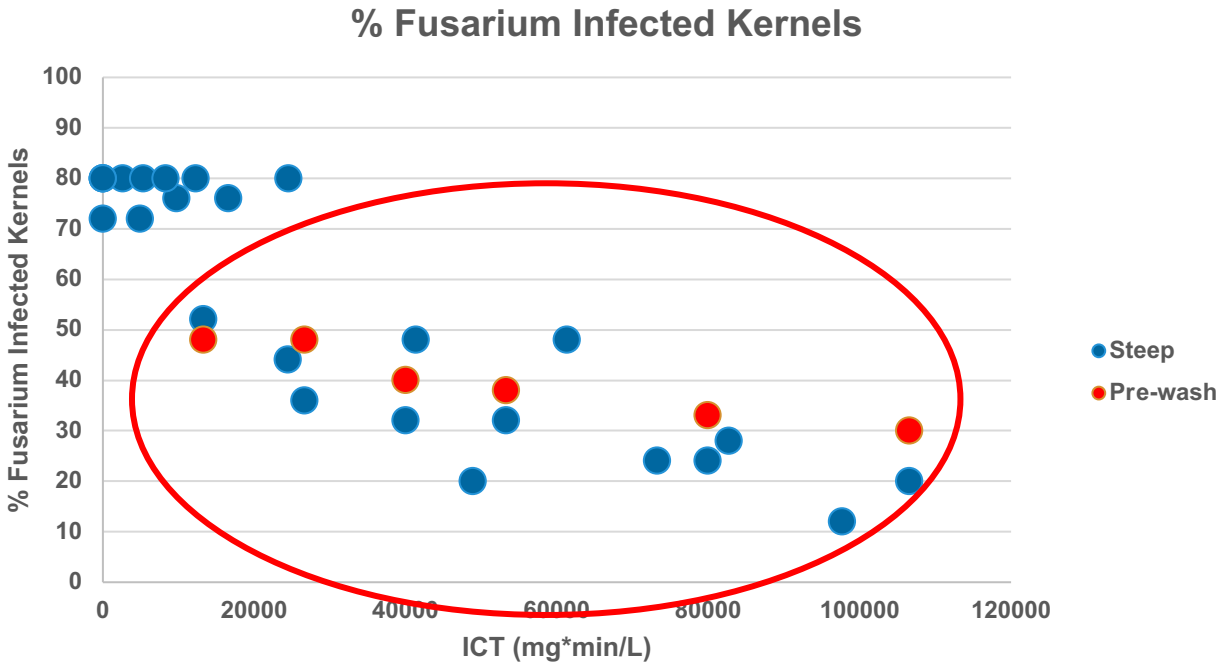
ICT is the area under the Concentration – Time curve

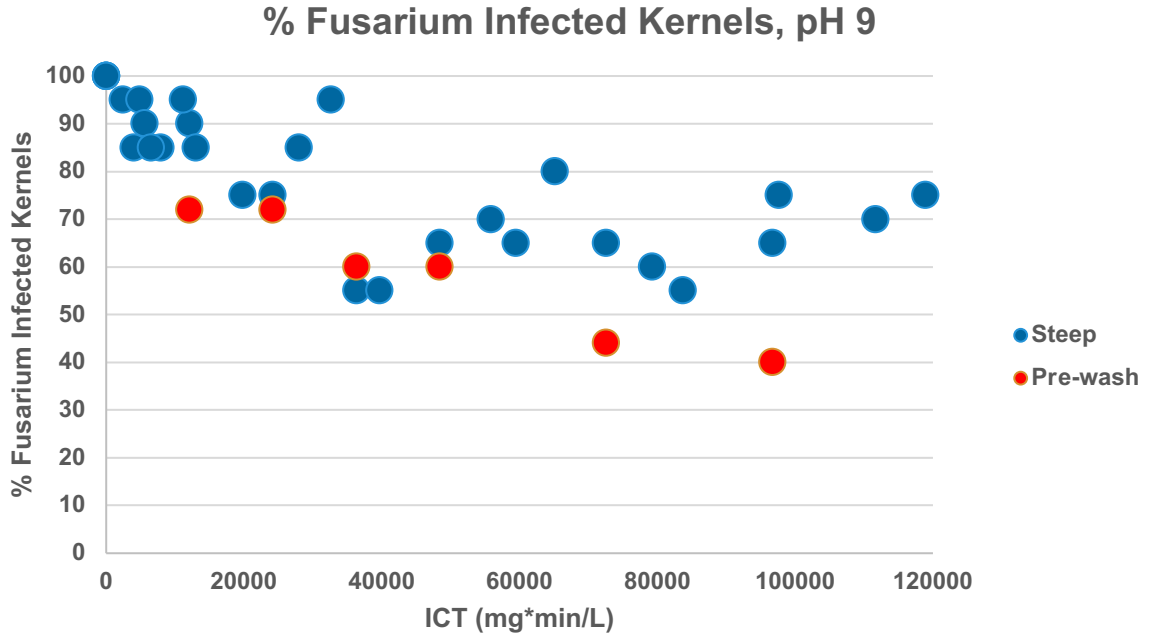
Correlates to microbial reduction

Results: Fusarium (steep/pre-wash)



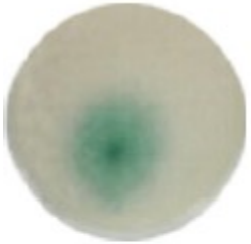
% *Fusarium* infected kernels

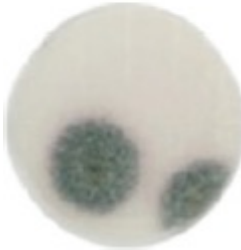




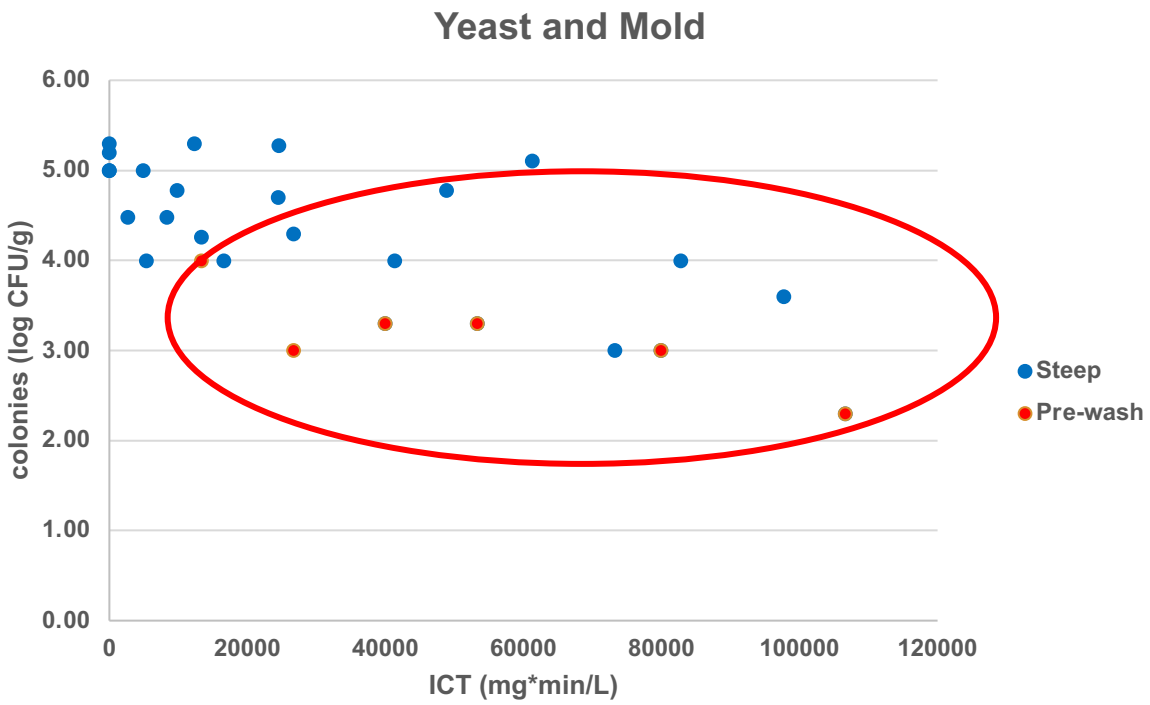
- **Pre-wash** addition and **steep** addition showed Fusarium infection reduction in over half of kernels
- **pH** adjustment showed less impact on Fusarium than no pH adjustment

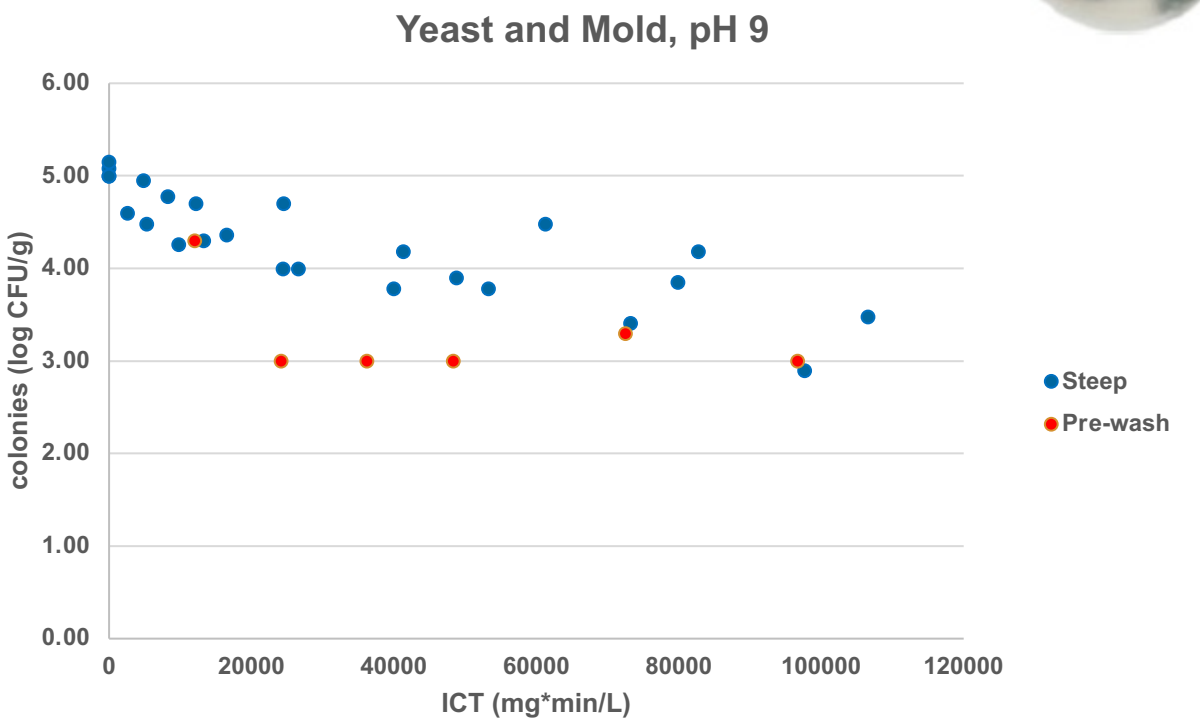
Results: Yeast and mold (steep/pre-wash)





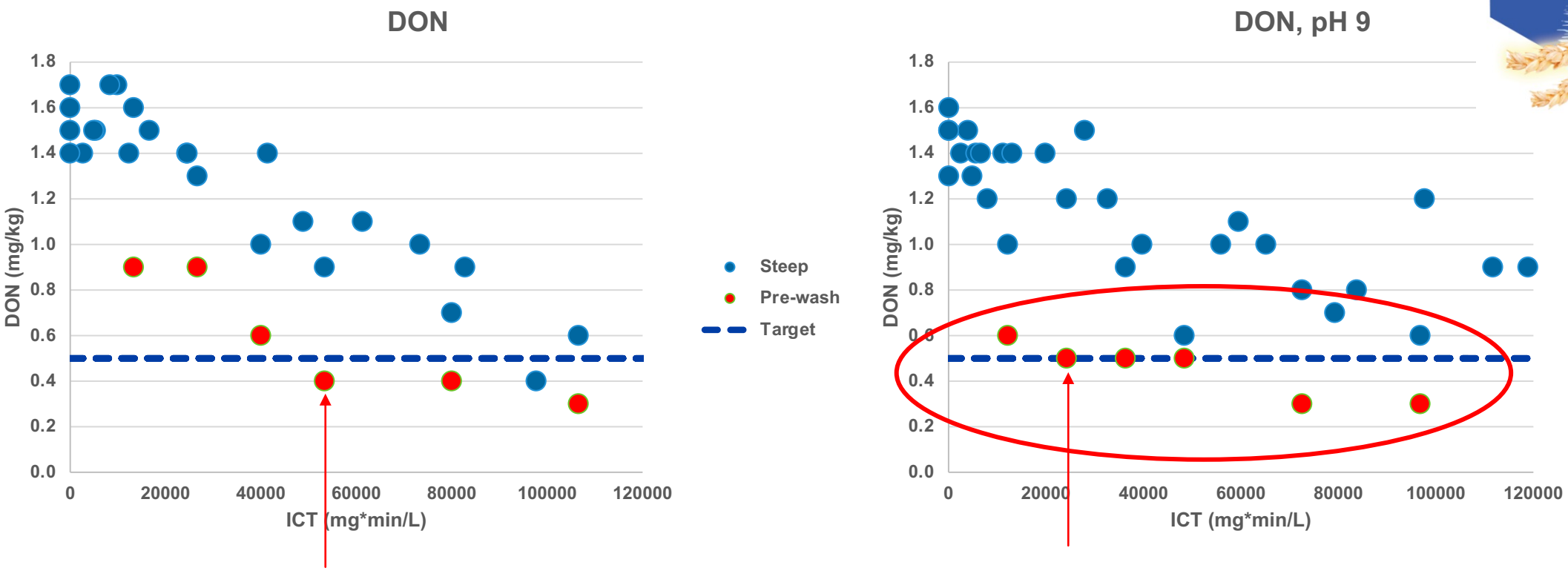
Yeast and Molds





Generally, a 2-log reduction in yeast and mold with a **pre-wash** application

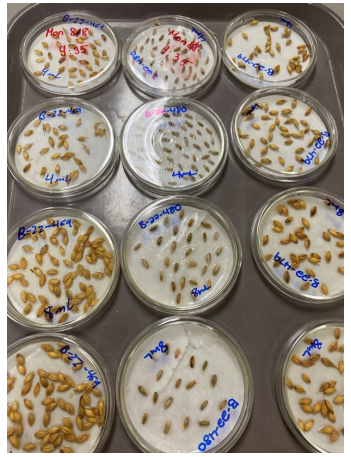
Results: DON (steep/pre-wash)

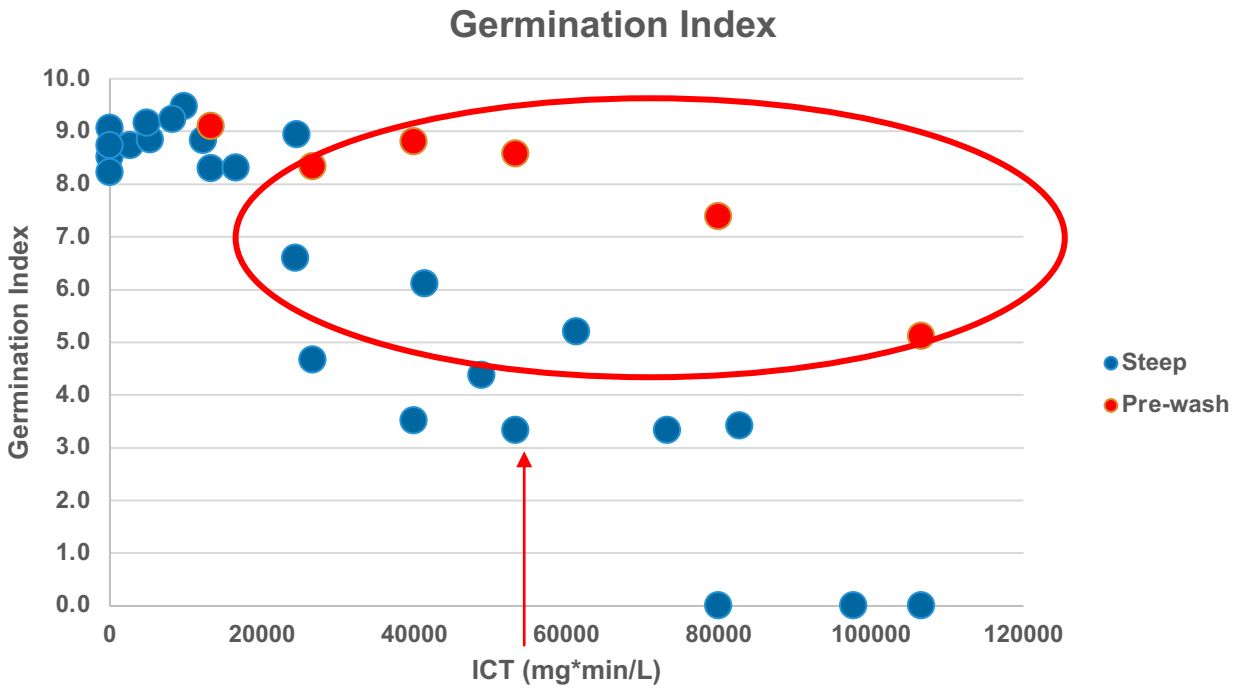


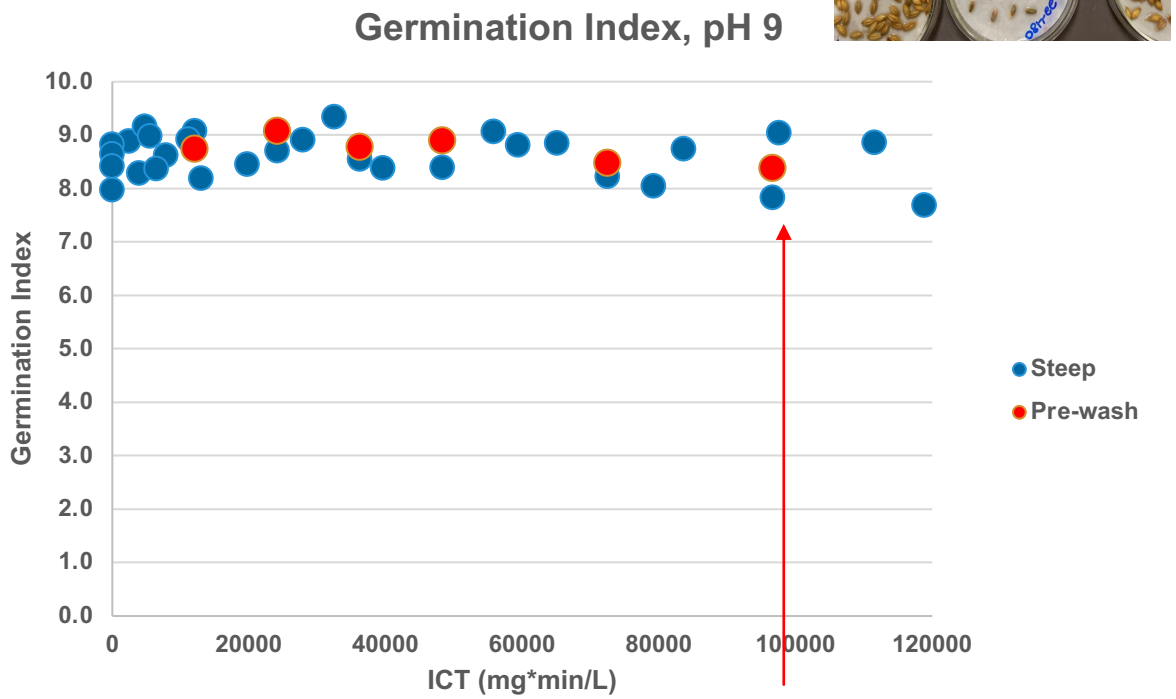
Pre-wash addition showed better DON reduction than **steep** addition

pH adjustment reduced DON to target levels at lower ICT

Results: Germination Index (steep/pre-wash)







Malt quality was not affected

	Control	1h PAA Rinse 1740ppm @ pH 9.0
Steep Out Moisture, %	44.6	45.0
Chitting, %	98	97
Malt Moisture, %	4.0	3.9
Friability, %	93.3	93.0
Fine Extract, % D.B.	81.8	81.6
Color, °SRM	2.40	2.29
β-glucan, mg/L	130	143
Soluble Protein, %	5.55	5.59
Total Protein, %	11.8	11.8
S/T, %	47.0	47.5
FAN, mg/L	259	254
Diastatic Power, °L	129	128
α-amylase, D.U.	71.8	72.2
Filtration Time	normal	normal
Clarity	clear	clear
pH	5.77	5.77
DON, ppm	1.2	0.4

No impact on malt quality compared to control (no PAA)

Reduction of DON to below target 0.5 ppm

Conclusions

For the Steep Treatment, no pH adjustment

- Reduction in DON correlates with reduction in Germination Index (GI)
  - Cannot get to DON target without reducing GI to below acceptability

For Steep Treatment with pH adjustment

- Could only reach DON reduction at high ICT, but GI is not impacted

For Pre-Wash, no pH adjustment

- It is **possible** to reach DON target with acceptable GI values
- Up to 1.5 – 2 log reduction in Yeast and Molds

For Pre-Wash with pH adjustment

- **Significant** reduction in DON without significant loss of GI
- Up to 2 log reduction in Yeast and Molds
- Reduction in *Fusarium* contaminated seeds to below 50%

Next steps: Pilot-scale trials

Thank you!

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