Measurement of Critical PO_2 in the Sugarbeet Root Maggot

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Introduction

- The Sugarbeet Root Maggot *Tetanops Myopaeformis* is a destructive pest that inhabits sugarbeet fields **all over the Midwest**
- During the larval life stage, they feed on sugarbeet roots and **overwinter underground** in sugarbeet fields[2]
- While overwintering SBRM becomes **freeze-tolerant** by allowing ice formation on external locations allowing the insect to better tolerate the stress[4]
- This cold tolerance strategy is complex, and we want to fully understand how it may be affecting the physiology of the insect post freezing

2023 Sugarbeet Root Maggot Forecast

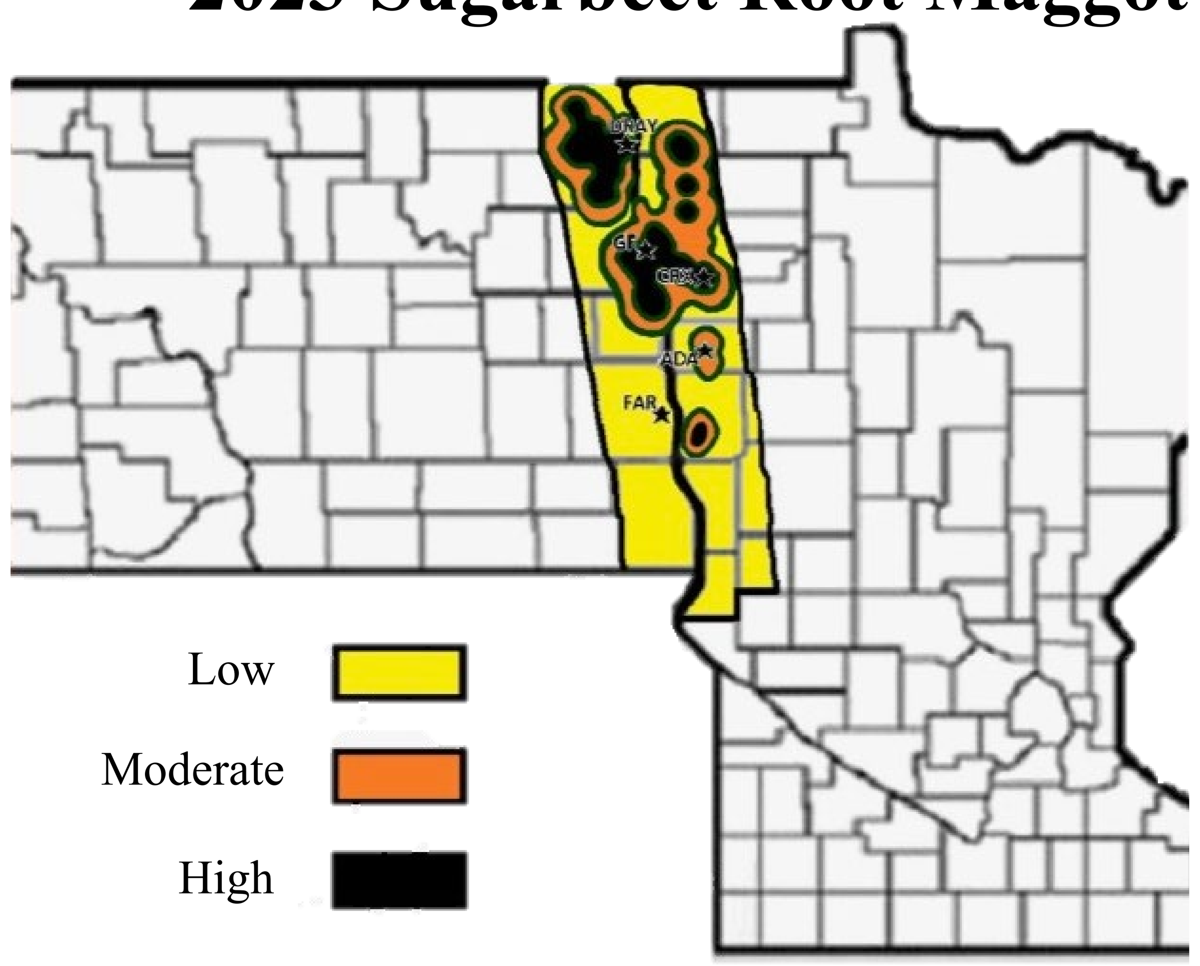
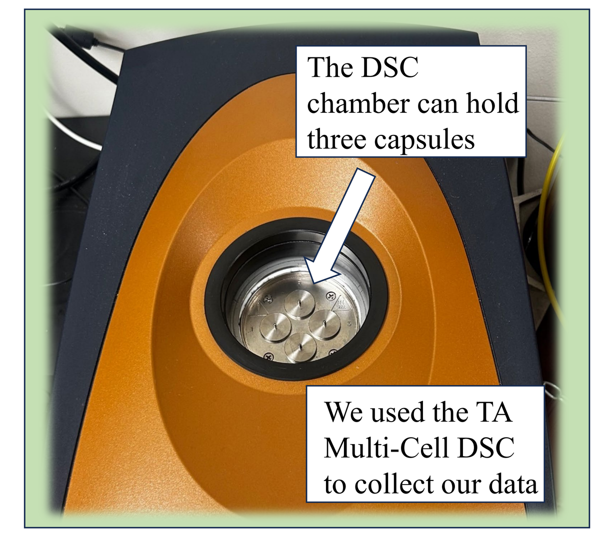


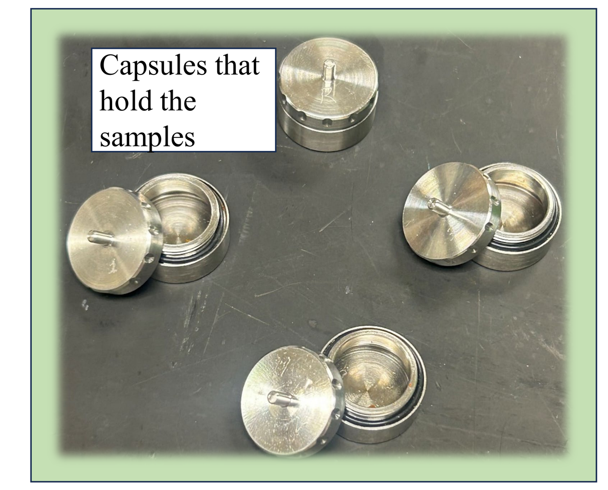
Photo Credit:
American Crystal Sugar
Sugarbeet Root Maggots

Objectives

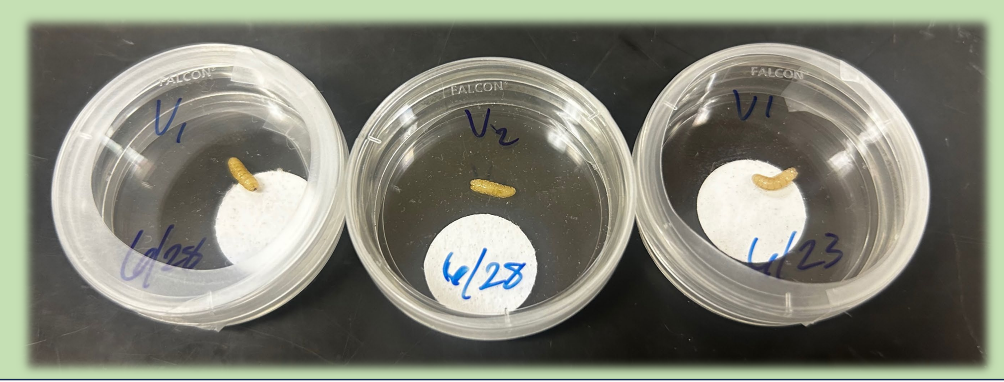
- Using **Differential Scanning Calorimetry** (DSC) how can we measure Critical PO_2 (P_{crit}) in the sugarbeet root maggot?
- **What is Critical PO_2?** P_{crit} is the partial pressure of oxygen below which **metabolic rate cannot be sustained**[1]
- Using DSC we can find very precise heat output, which is a proxy for metabolic rate, and in turn we have our evaluation of P_{crit}
- Statistically we will be using a **breakpoint analysis** to find trends in our data that indicate a significant drop of metabolic rate

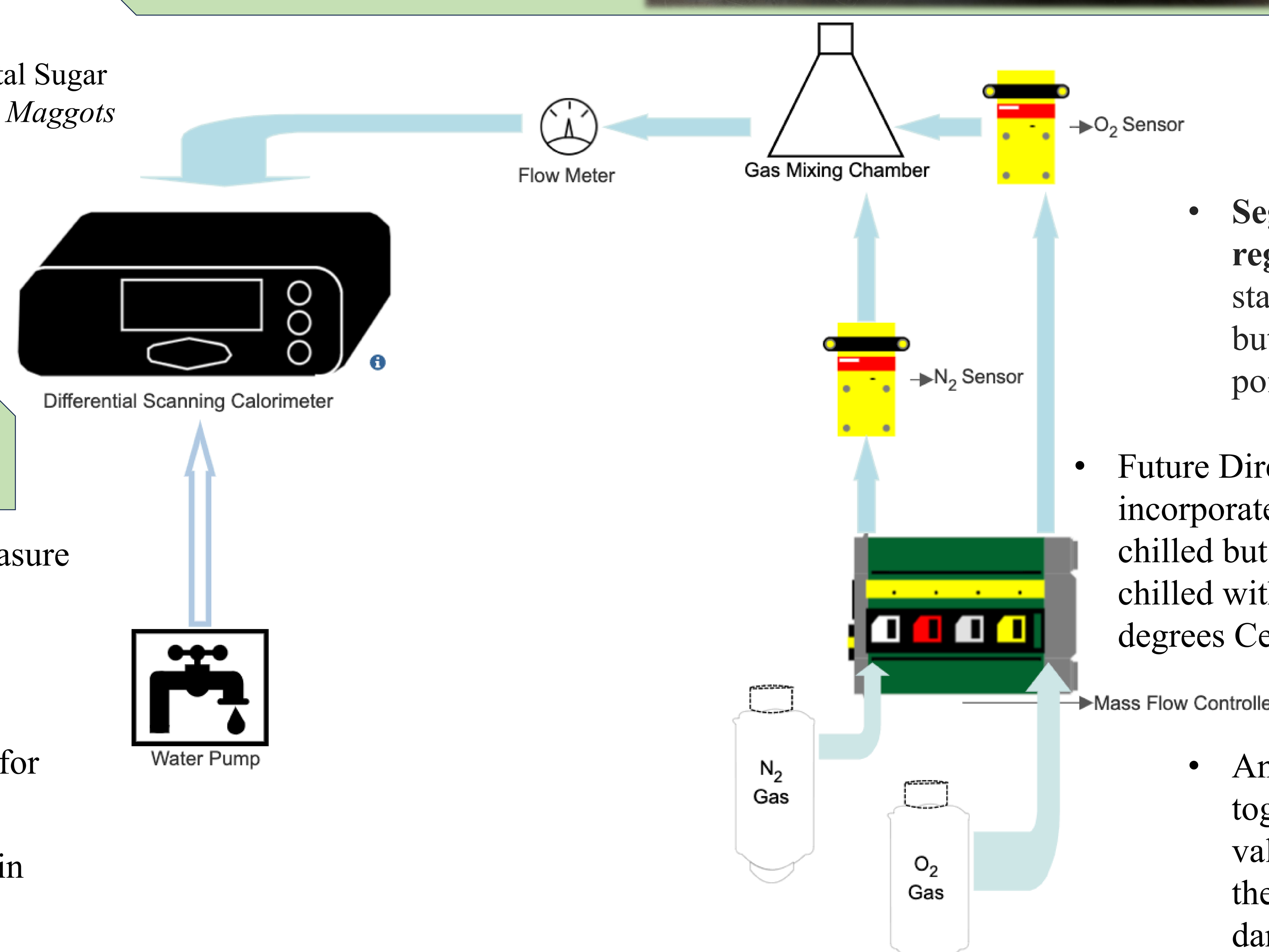
Methods





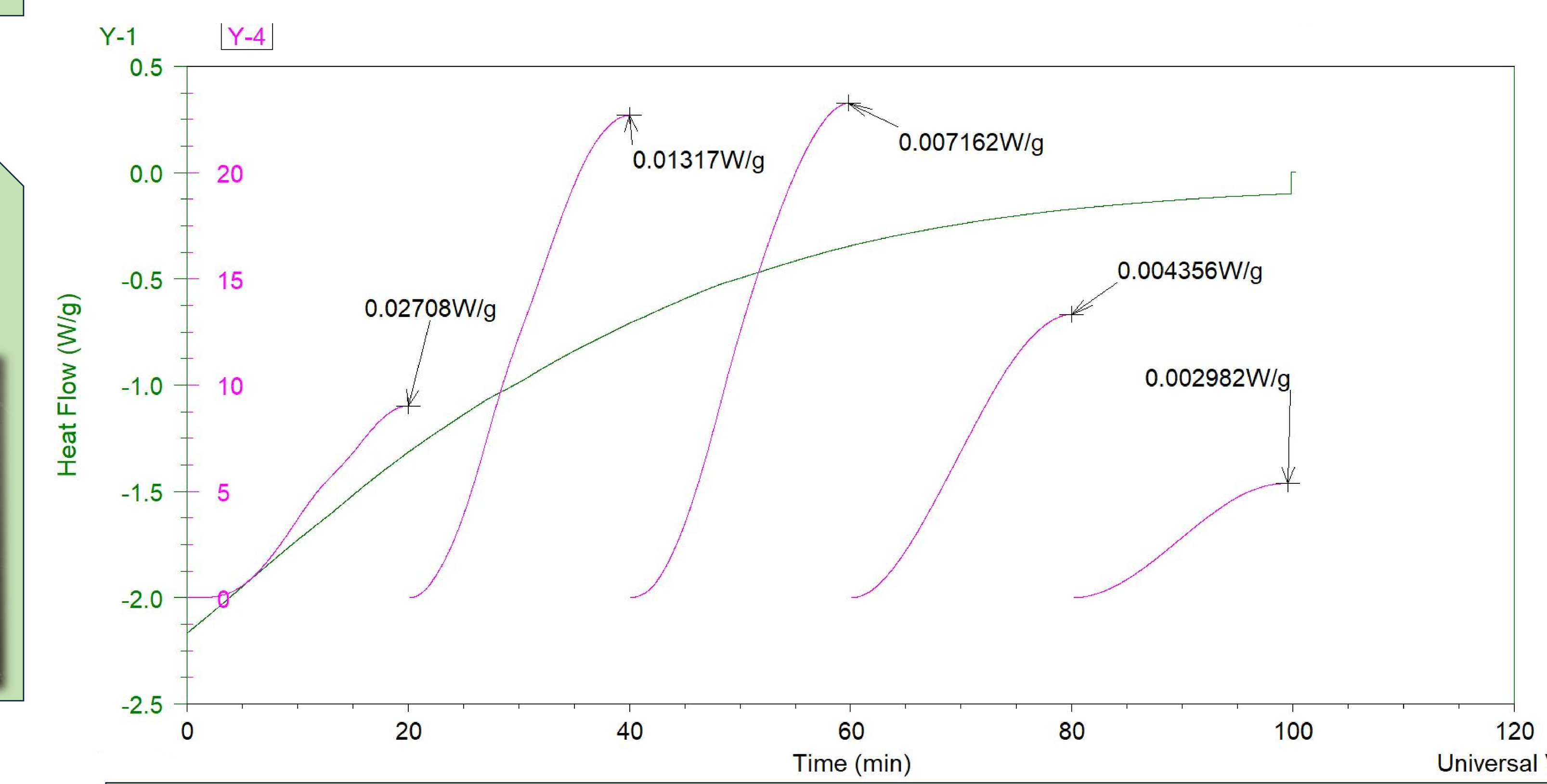
- Baseline Group - Held at 4 degrees Celsius, and subjected insect to **decreasing oxygen gradient** (21, 10, 6, 5, 4, 3, 2, 1, and 0 Kpa)[3] over 10-minute periods at each concentration, discarding the first 2 minutes at each concentration to allow for acclimation
- As illustrated below we used a **gas mixing station** attached to the DSC chamber in order to manipulate the oxygen and nitrogen percentages





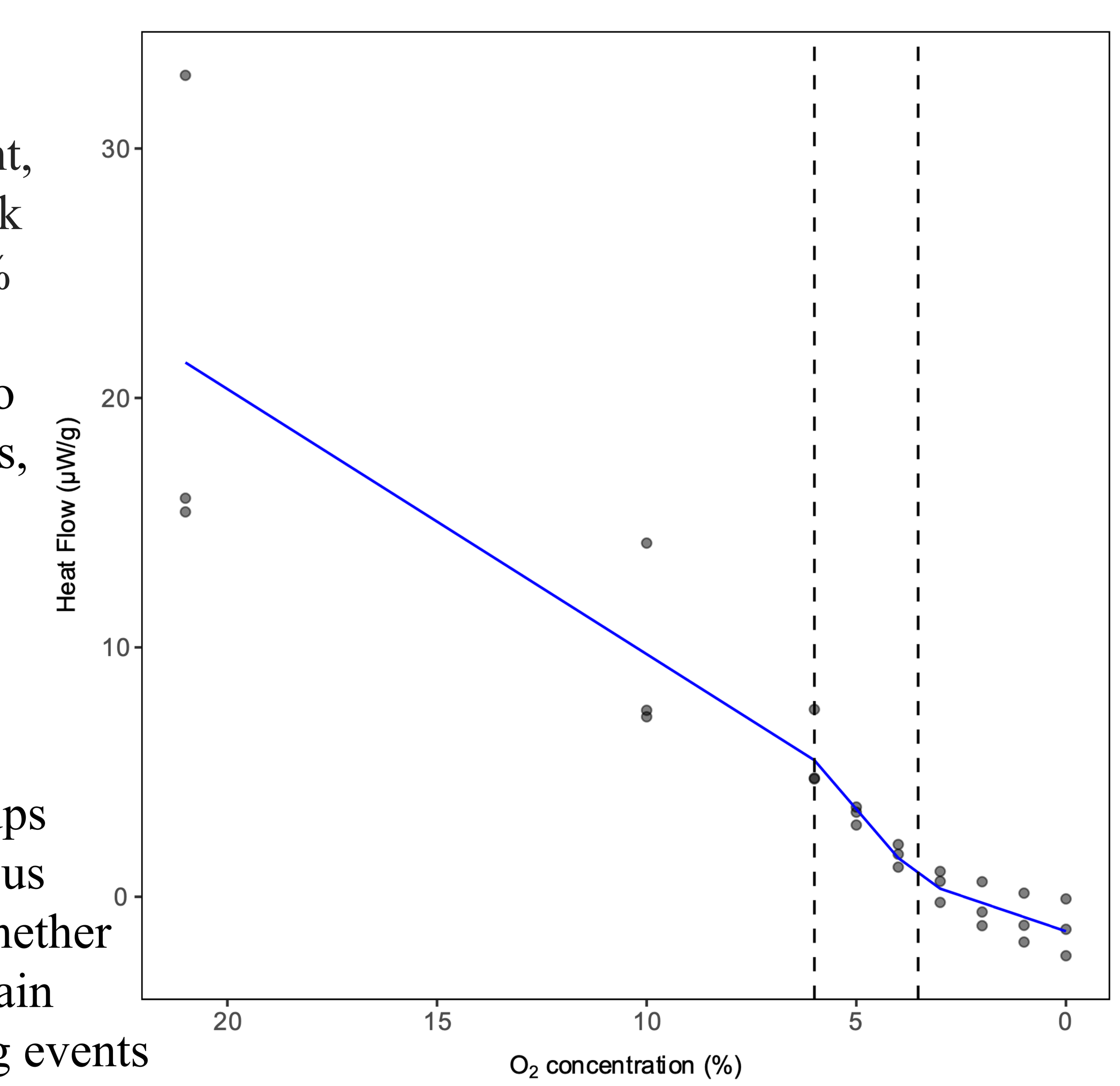
Results

- The graph below shows the raw **heat output** (green) for a baseline individual along with integrated data (pink) that illustrates the heat output in **micro-watts per gram** over a 10-minute period of actual data collection
- Each section will be averaged and plotted, then using breakpoint analysis we will be able to find our P_{crit}



Conclusions/Future Directions

- **Segmented linear regression** – not statistically significant, but we have two break points: 6 % and 3.5 %
- Future Directions - We plan to incorporate our 2 other groups, chilled but not frozen and chilled with freezing at -12 degrees Celsius
- Analysis of all 3 groups together will provide us valuable insight to whether these insects can sustain damage from freezing events



References: 1) Kendra J. Greenlee, Jon F. Harrison; Respiratory changes throughout ontogeny in the tobacco hornworm caterpillar, *Manduca sexta. J Exp Biol* 1 April 2005; 208 (7): 1385–1392.
2) Joseph P. Rinehart, George D. Yocum, Anitha Chirumamilla-Chapara, Mark A. Boetel; Supercooling point plasticity during cold storage in the freeze-tolerant sugarbeet root maggot *Tetanops Myopaeformis*. Physiological Entomology 34 (2009) 224-230
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