Evaluating transcriptomic & metabolomic adaptations to climate change in *Brassica napus* (Oilseed rape)

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Context

- High temperature stress in the form of frequent heatwaves causes a serious concern to crops especially during its yield determining reproductive stage.
- High temperature can induce irreversible structural and physiological changes, leading to premature death.

Thus, understanding the impact of heatwaves on plants and particularly during reproductive stages, may provide the knowledge needed to develop varieties that can withstand the heat.

Kourani et al., (2022) Front. Plant Sci., 13:832147 | https://doi.org/10.3389/fpls.2022.832147

Aim & Objectives

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To provide a system-level molecular and metabolic understanding of the impact of heatwaves on yield, quality, and tolerance mechanisms in *B. napus.*

Objectives:

1. Investigate the impact of heat stress on different aspects of the plant including seed weight, and total biomass under similar field conditions.

2. Identify the impact of heat stress on the plant metabolites.

3. Identify key differentially expressed genes involved in plant heat stress responses through transcriptome profiling using RNA-Seq analysis.

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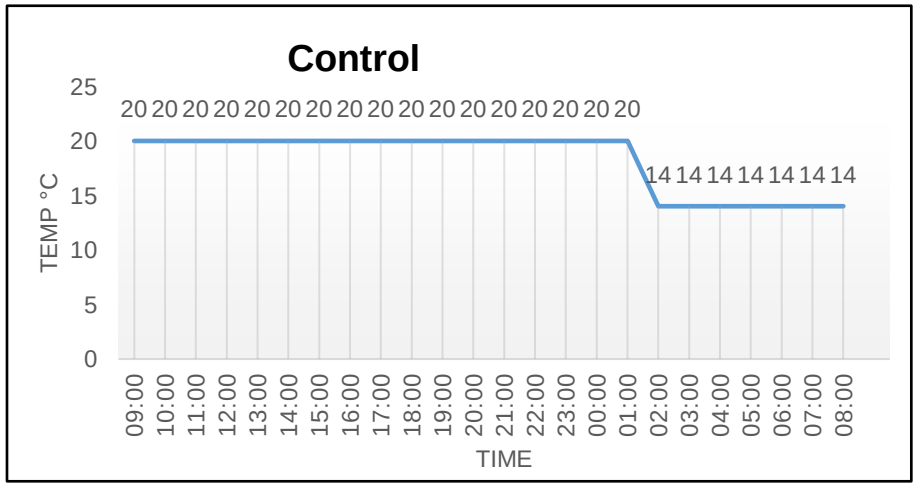
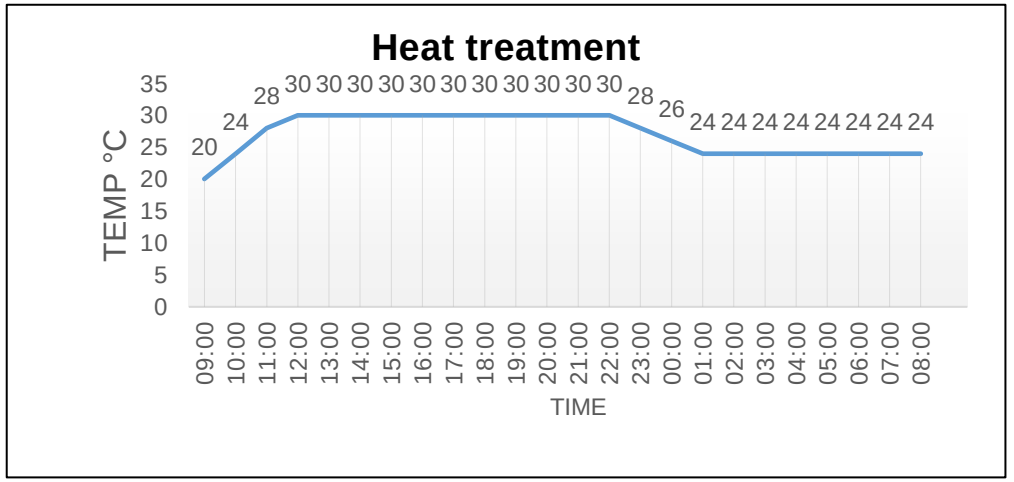
Methodological Approach

1. **Sample preparation**
   - Freeze-dried
   - Grinding
   - Extraction
2. **Quantification**
   - Sugars
   - GSLs

Heat

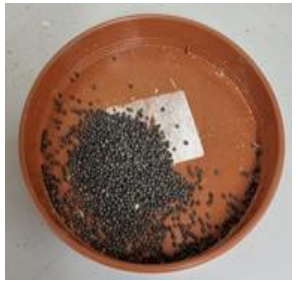
Physiological changes





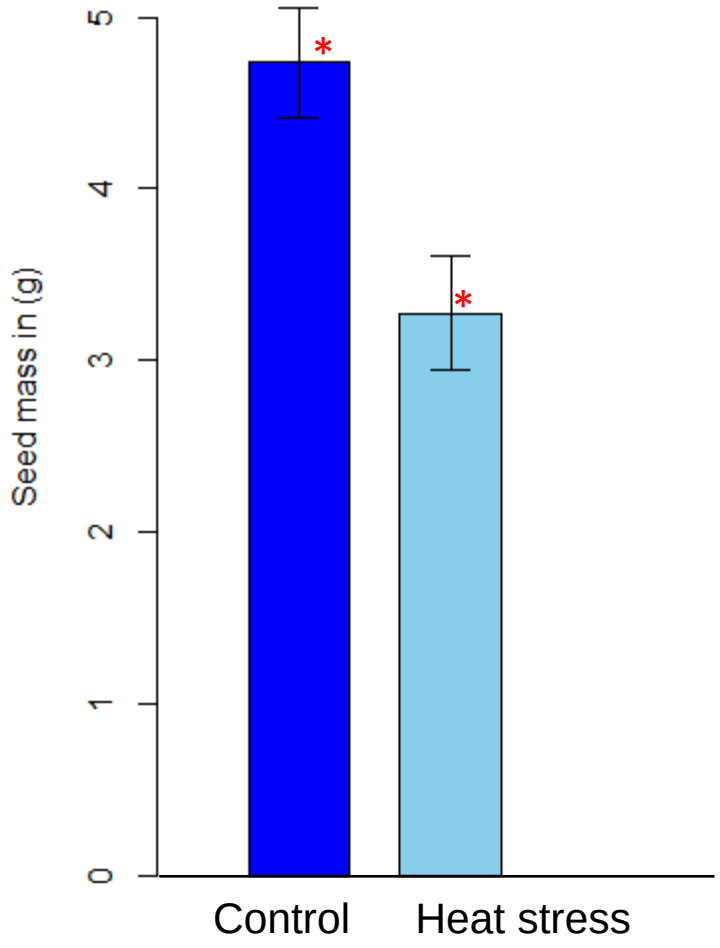
1. **Harvesting**
   - Drying
   - Weighing

2. **Oil content Analysis**
   - NIRS

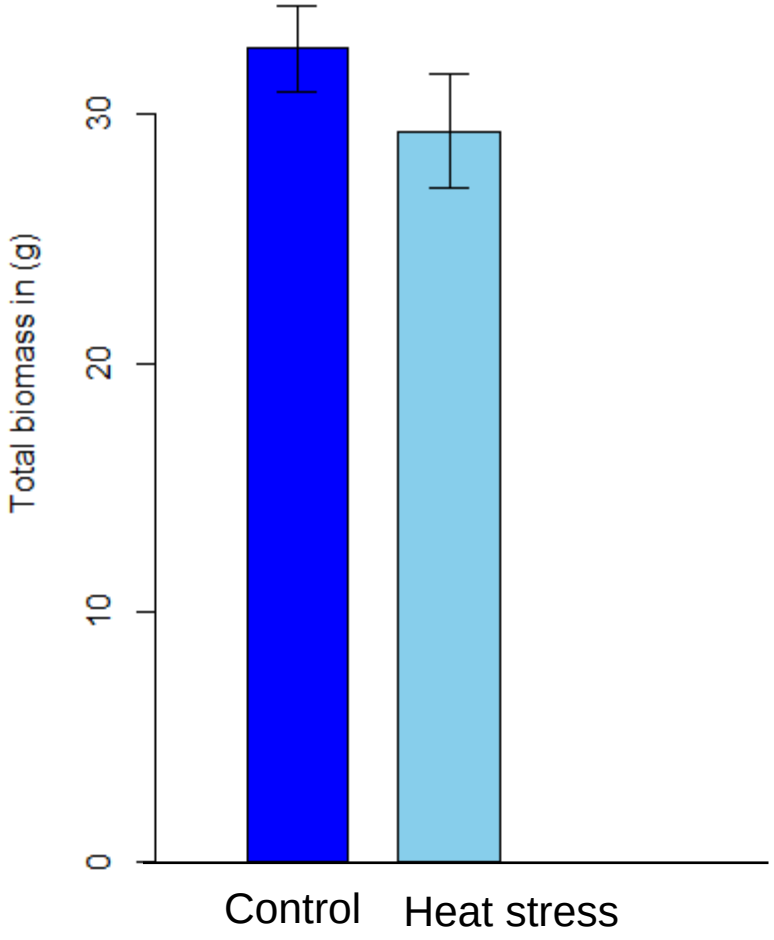


Seeds weight and total Biomass

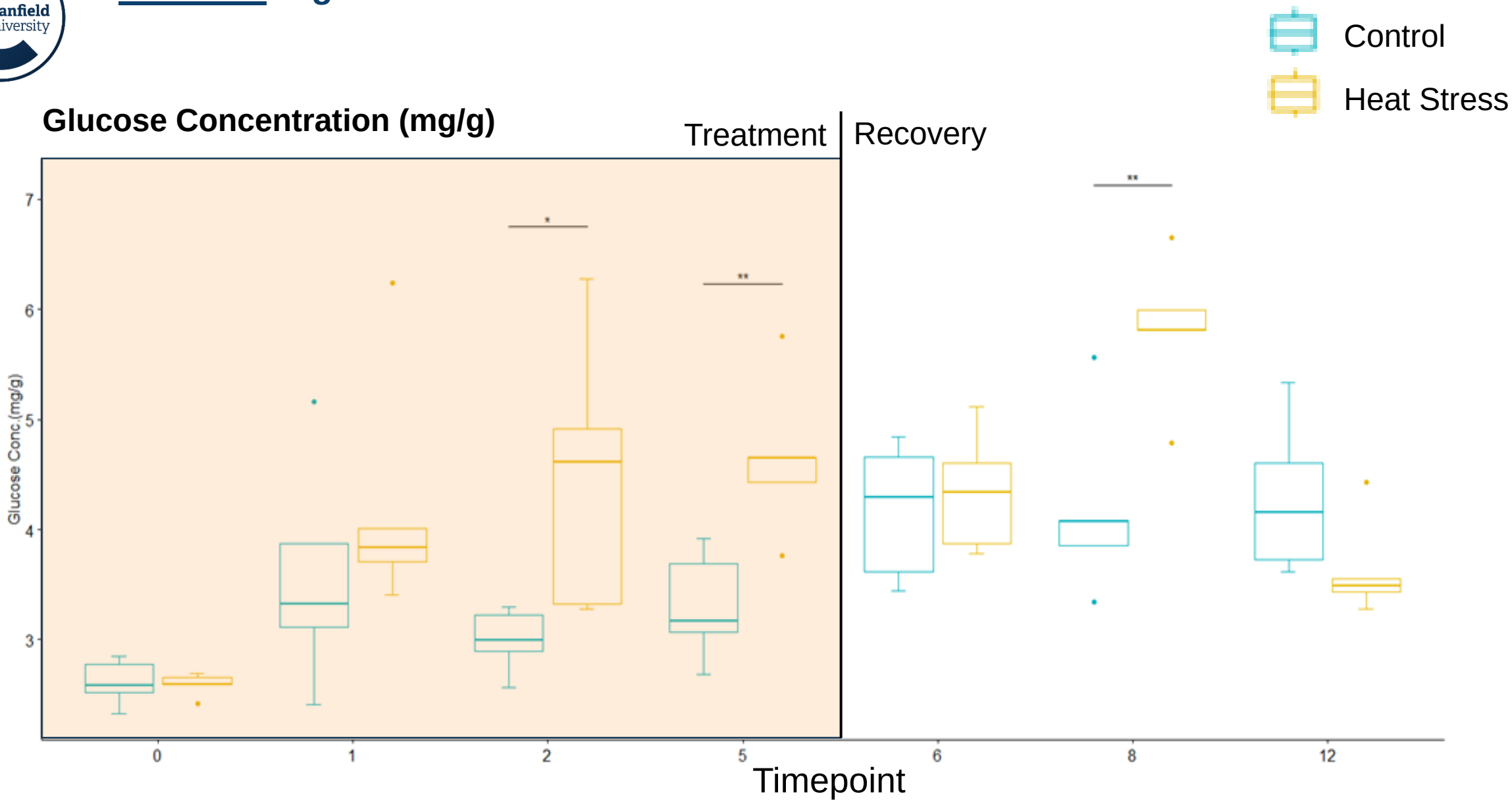
Seed yield per plant at maturity



Above ground total biomass per plant at maturity



Results: Sugars Concentration under heat treatment



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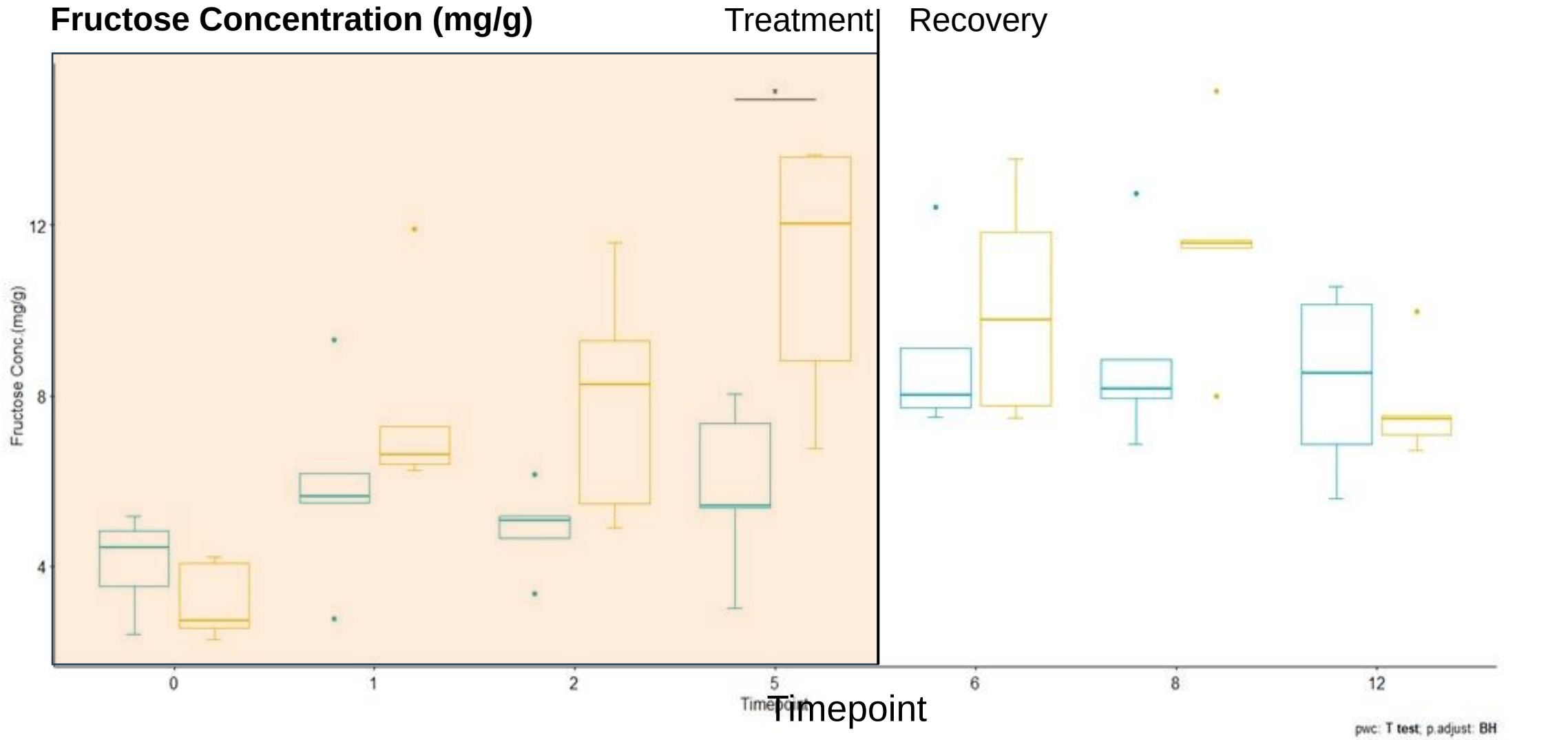

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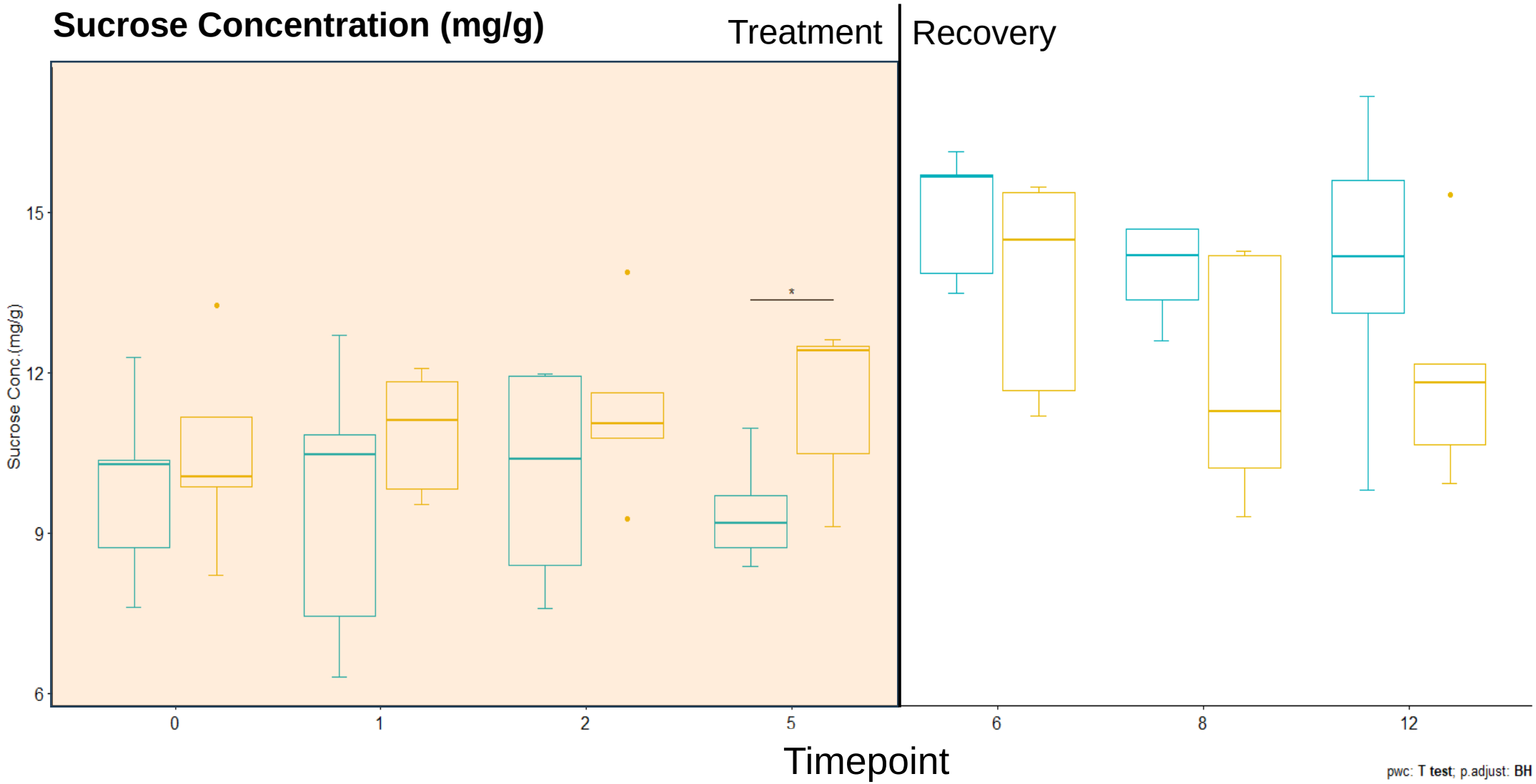


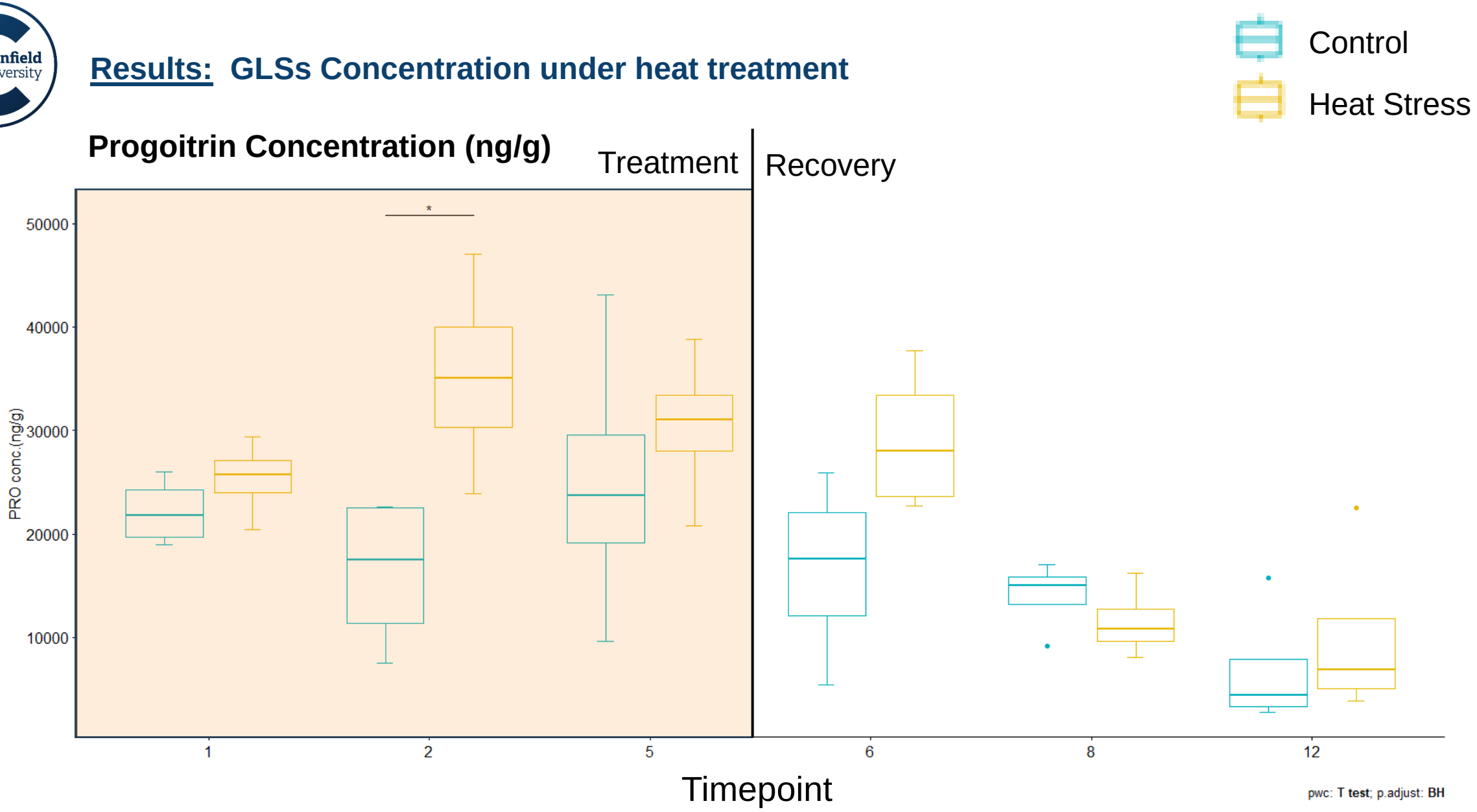
Importance of sugars in mitigating abiotic stress

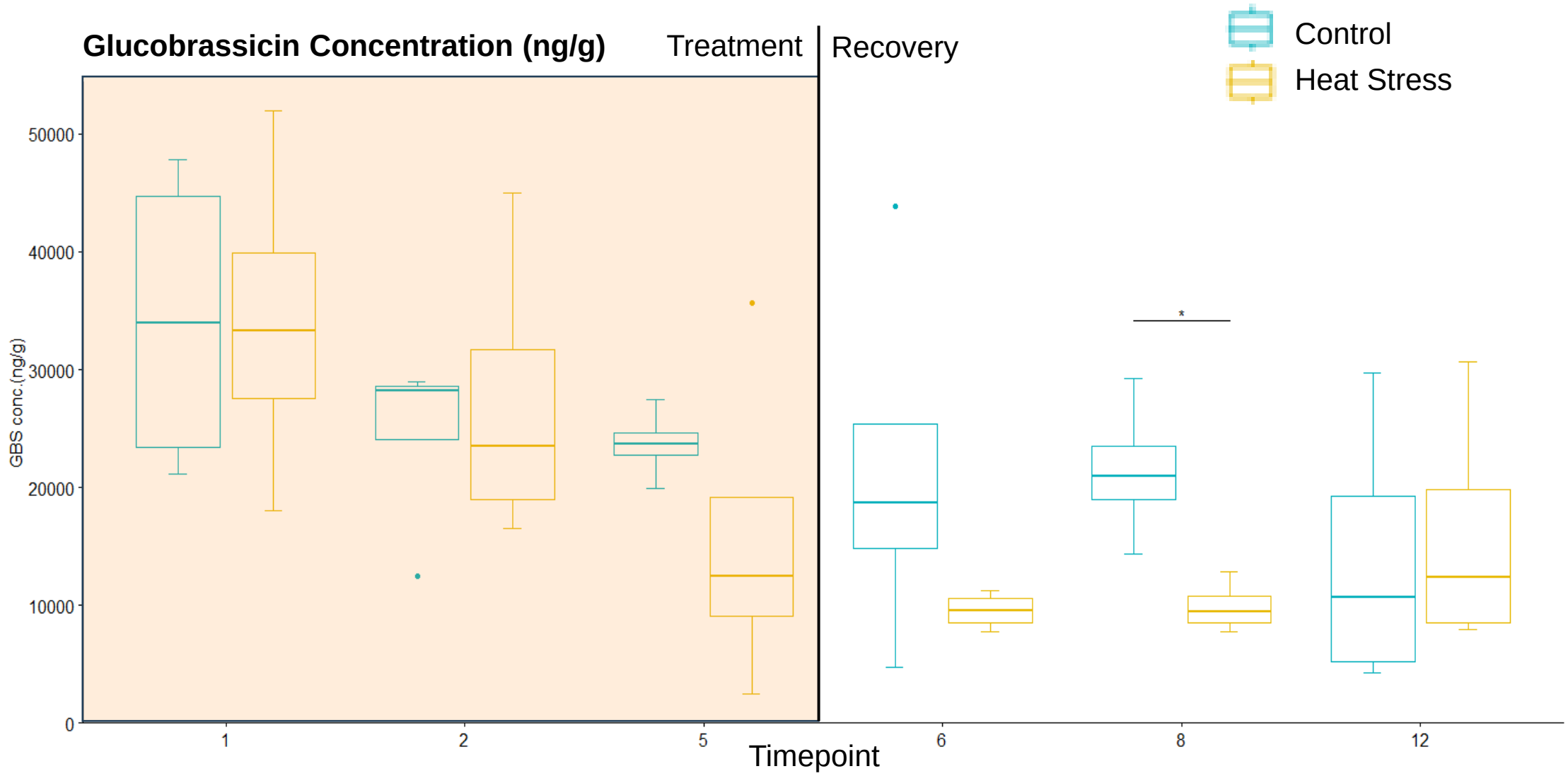
- Sugars acts as osmolytes, storage substances and cell signalling molecules.
- Sugars decomposition influences the cells osmotic potential and affects stomatal activities.
- Sugars helps in buffering the cellular redox potential protecting the cells from oxidative stress.

Thereby, maintaining sugar content is considered a tolerance strategy.

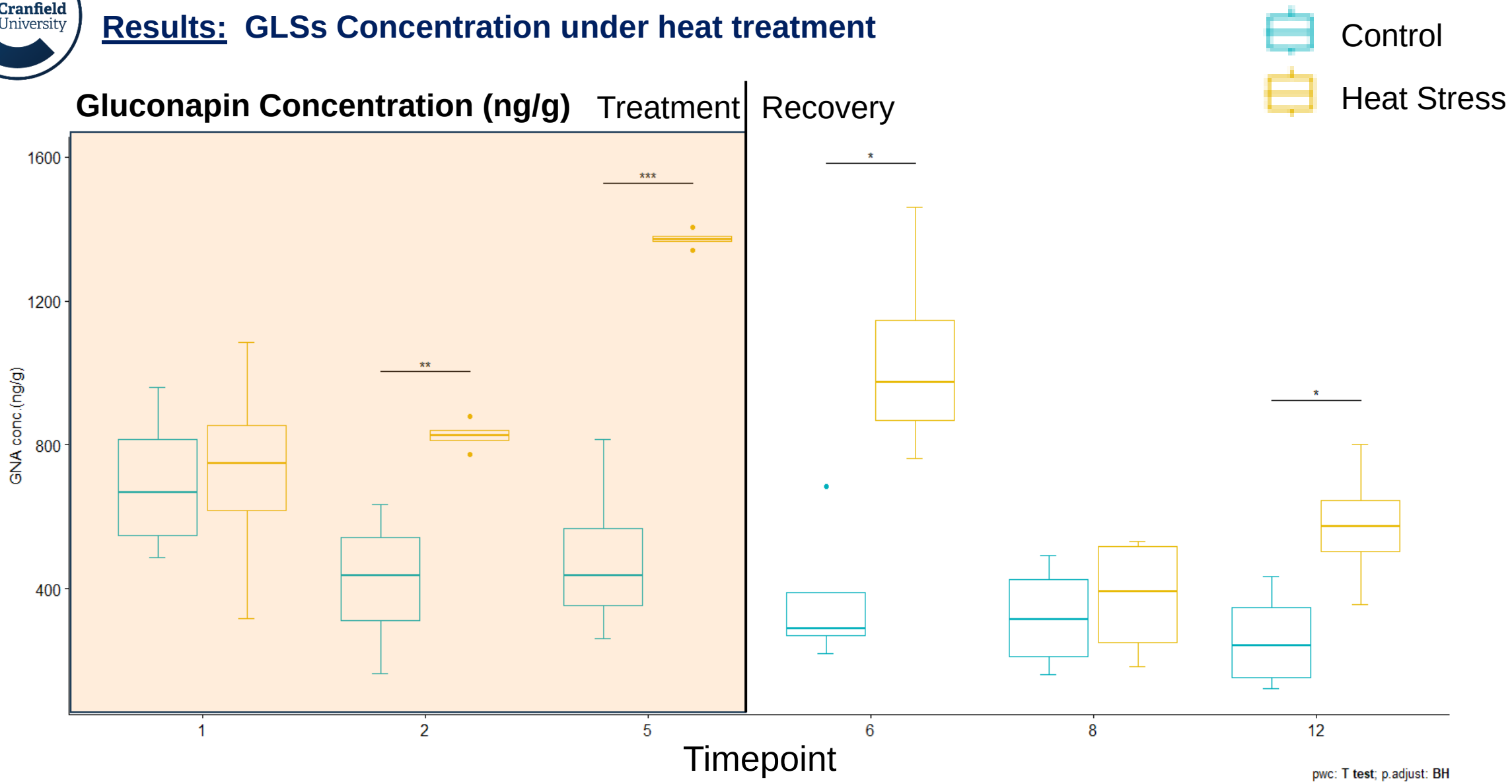
Xalxo et al, (2020) Heat Stress Tolerance in Plants. https://doi.org/10.1002/9781119432401.ch5

Results: GLSs Concentration under heat treatment




Glucobrassicin Concentration (ng/g)
Treatment
Recovery
Control
Heat Stress
GBS conc.(ng/g)
50000
40000
30000
20000
10000
0
1
2
5
6
8
12
Timepoint
*
pwc: T test; p.adjust: BH

Results: GLSs Concentration under heat treatment



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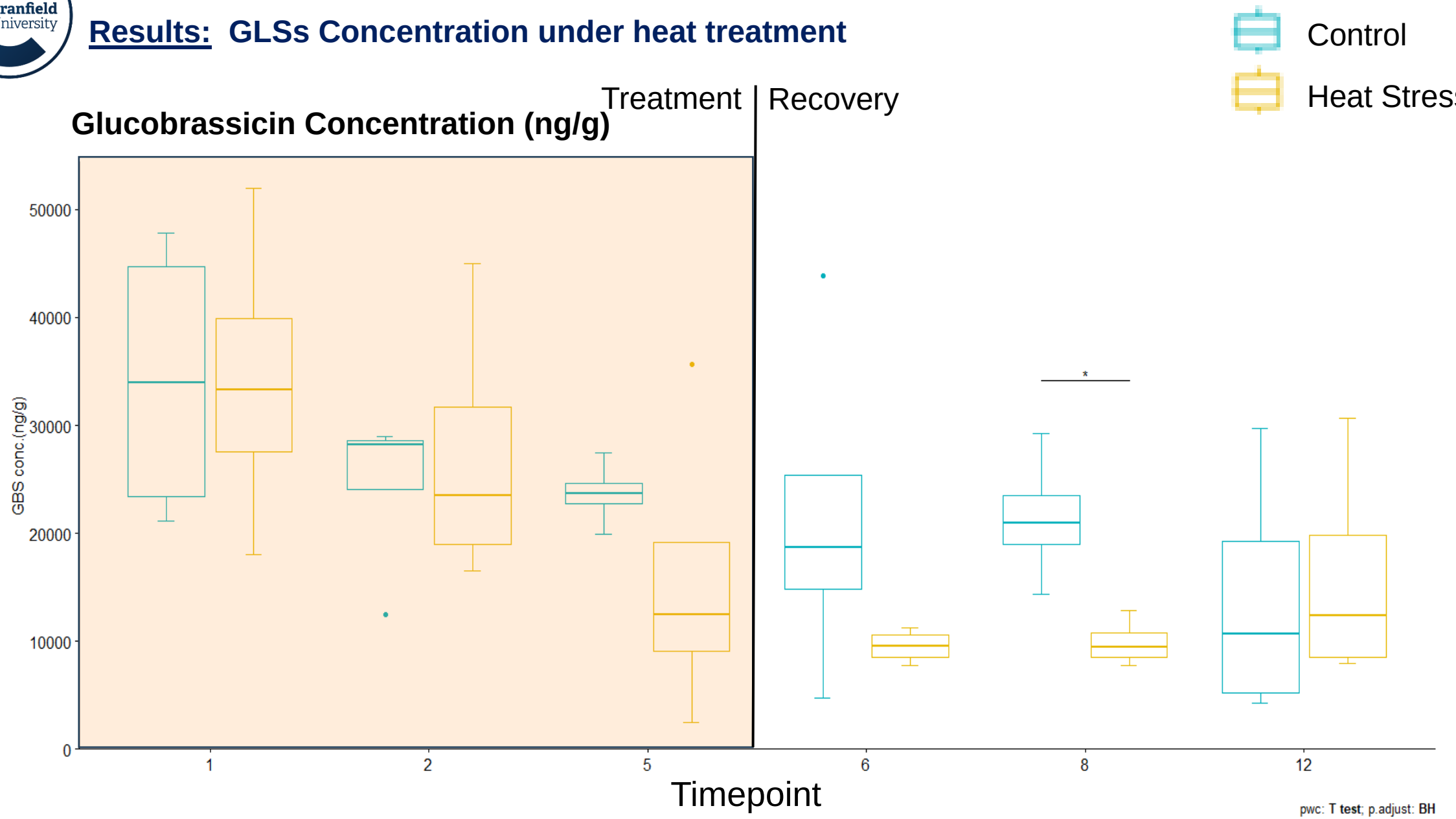

Importance of GLSs in mitigating abiotic stress

- GLSs accumulation in response to heat stress has also been reported (Jasper et al, 2020; Martínez-Ballesta et al, 2013).

- The increase in aliphatic GLSs levels could be related to the synthesis of osmoprotective compounds needed during the days of heat stress.

- A decrease in the indolic GLSs Glucobrassicin level was noticeable in response to heat treatment. Indole GLSs are much more sensitive to heat than aliphatic GLSs (Bones & Rossiter, 2006; Bohinc & Trdan, 2012).

Conclusion

This study brings evidence for the effect of high temperature stress and in specific heatwaves during flowering through:

1) Reduced yield and plant biomass

2) Increased sugars content and altered glucosinolates levels in leaves

Thank you

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Prof. John Hammond
Professor of Crop Science - University of Reading

References

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