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Large scale phenotyping looking at temperature stress on reproduction in Brassica

Alison Tidy

16th October 2023

BBSRC BRAVO sLoLa

Female fertility

Gene regulatory networks

Male fertility

Seed vigour

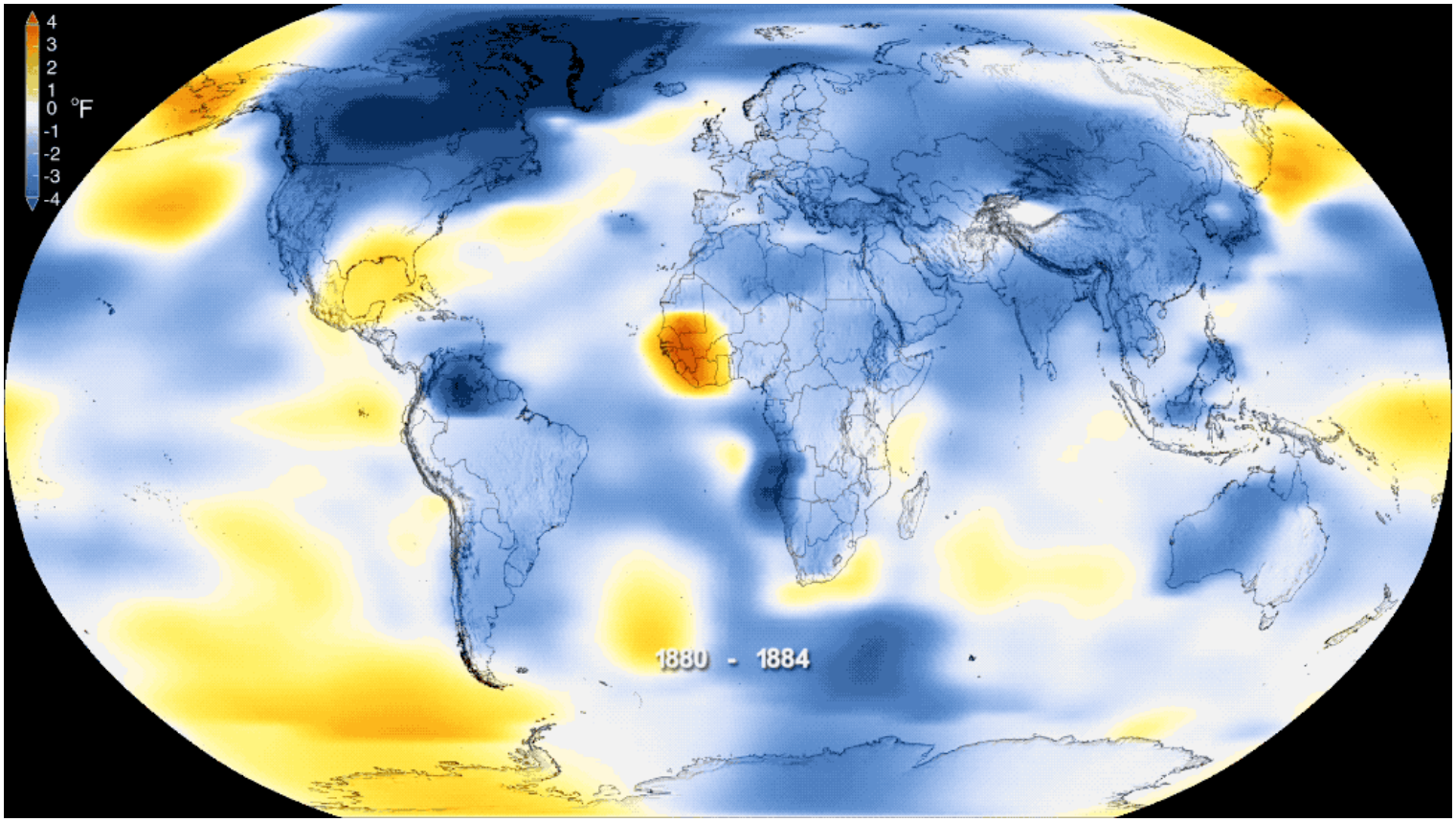
BRAVO

Brassica Rapeseed And Vegetable Optimisation

Floral transitions

Seed size, number and yield

Why Brassica?

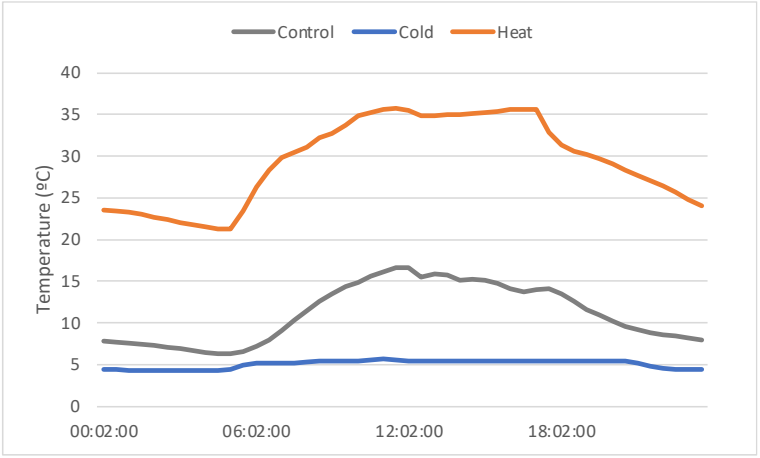


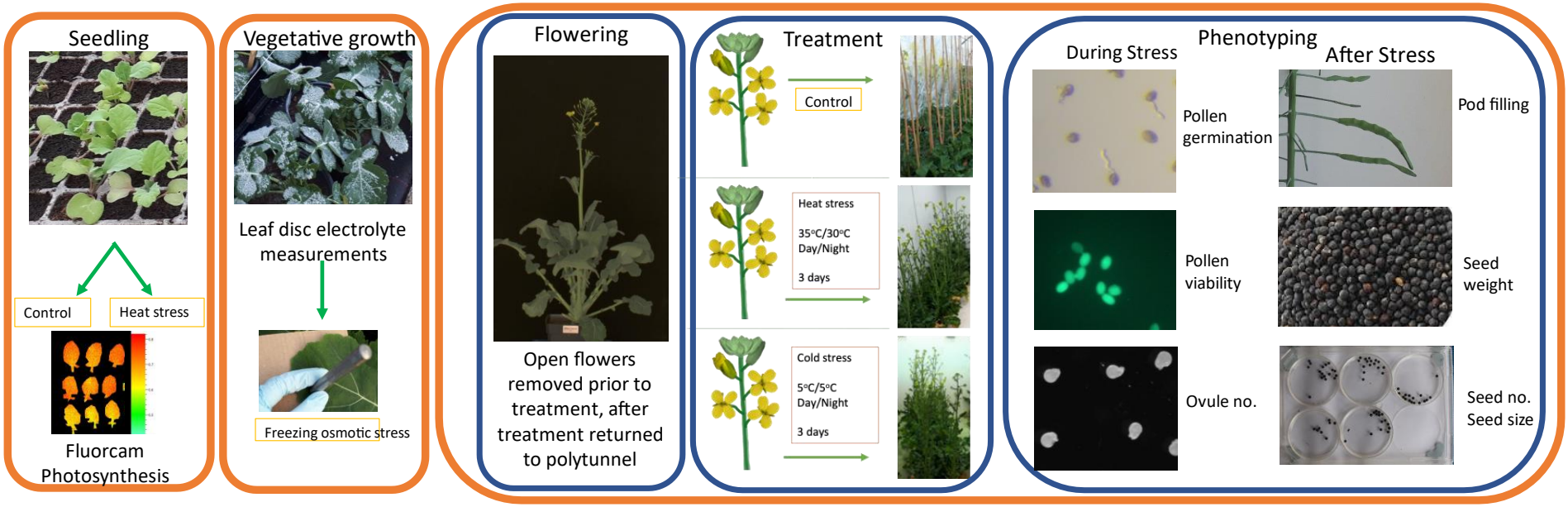
Climate change is resulting in increased global temperature, changes in temperature can effect when plants flower resulting in both extremes of temperature during flowering.

Environmental stress & male fertility - 2019

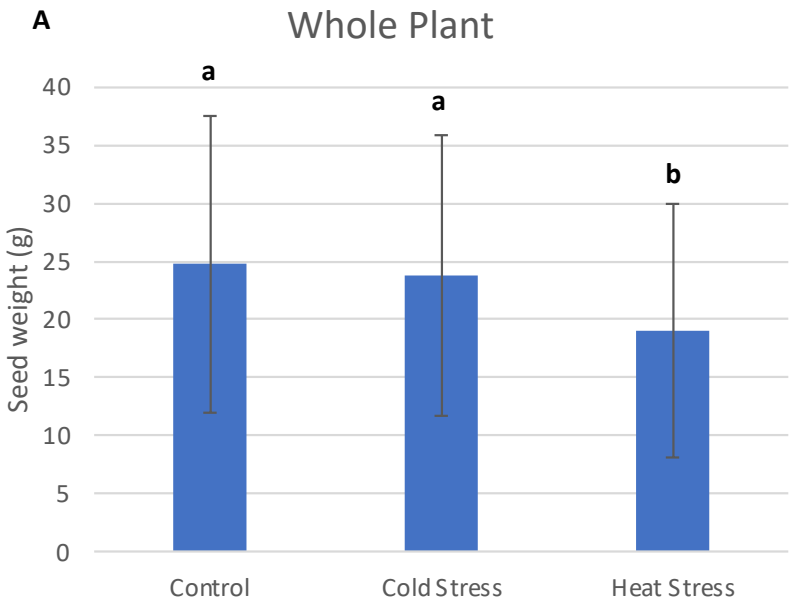
B. napus BnaDFFS panel

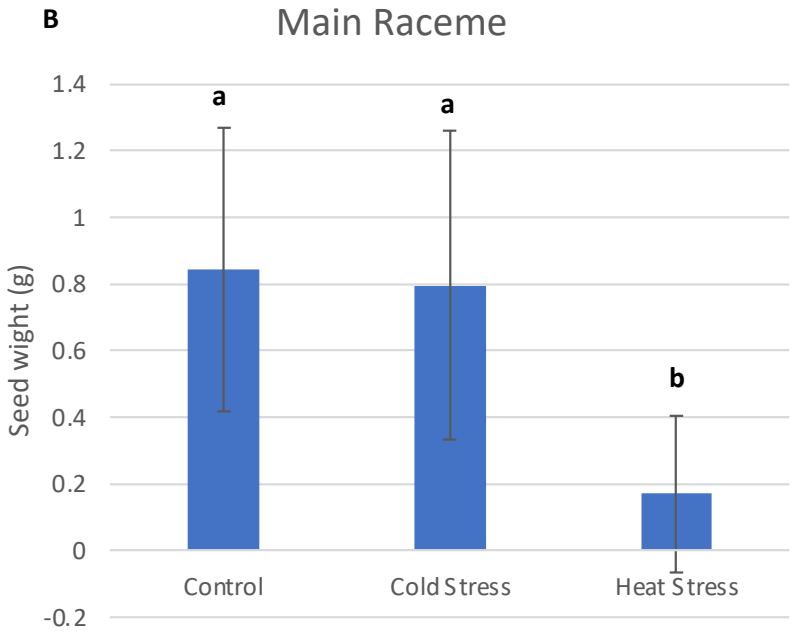
- 99 lines
- 3 treatments
- 5 bio replicates per treatment
- 36 phenotypic features collected





Seed yield for all accessions





Yield reduction
- 4% in cold stress (not sig)
- 28% in heat stress (P >0.05)

Yield reduction
- 4% in cold stress (not sig)
- 72% in heat stress (P >0.05)

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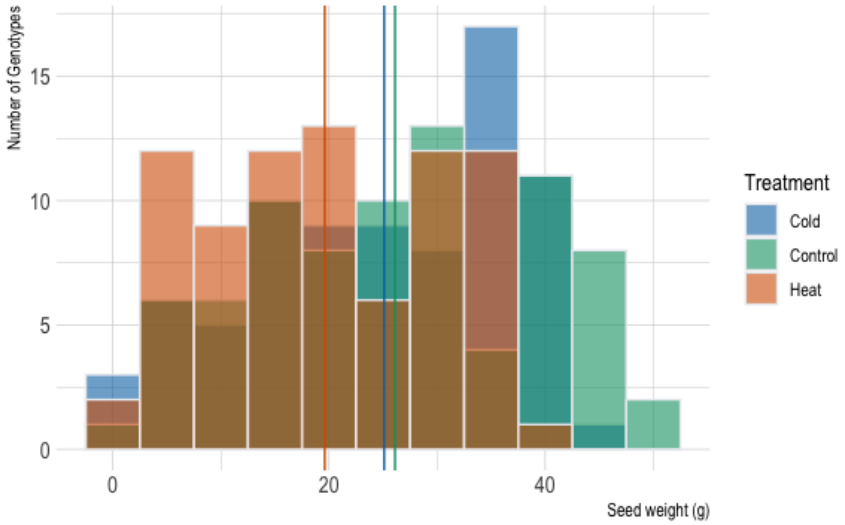
Seed yield for all accessions

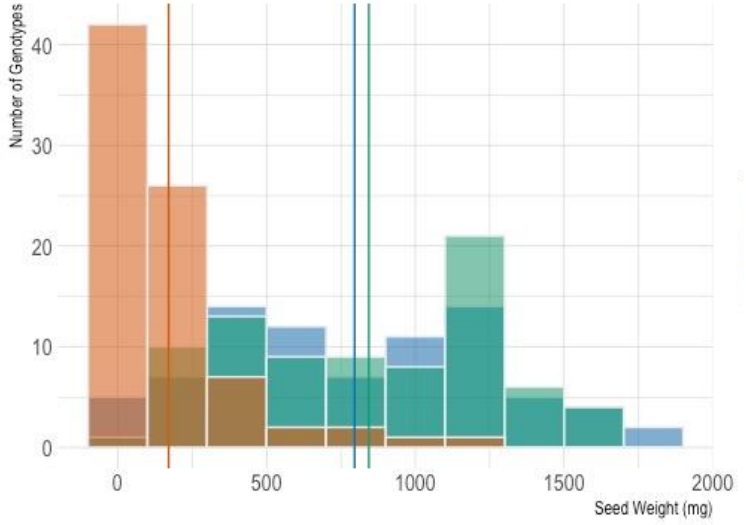
A

Whole Plant



B

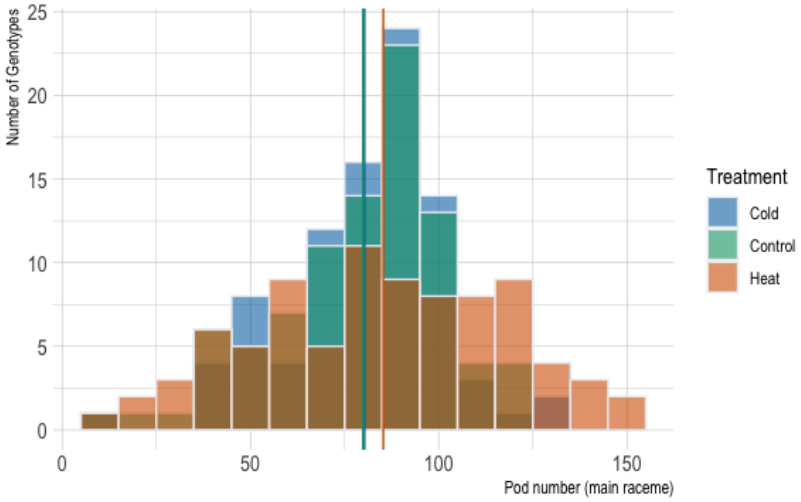
Main Raceme

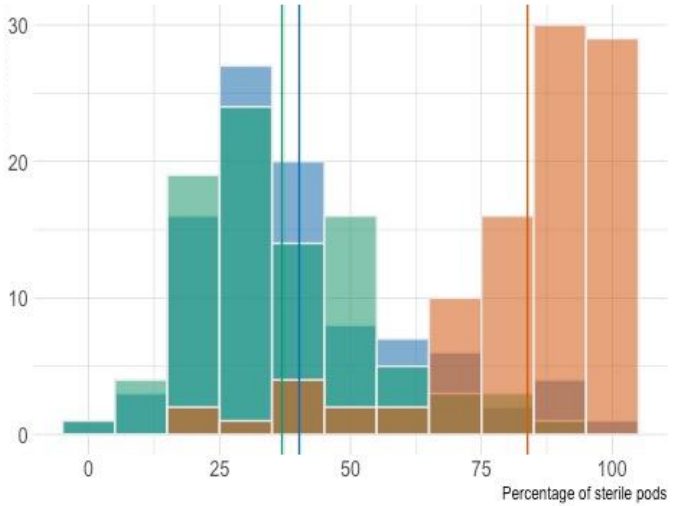


High variability in seed yield between accessions in control and their response to heat stress

- Allow identification of those lines with increased tolerance to heat stress

Pod number





Shift to more diversity in pod number, suggesting two mechanisms to stress;

- Giving up on main raceme and focusing on branching
- Producing more pods per raceme
  - High percentage of the pods on main raceme are sterile in heat stress (sterility is well known to increase flowering time and number of pods)

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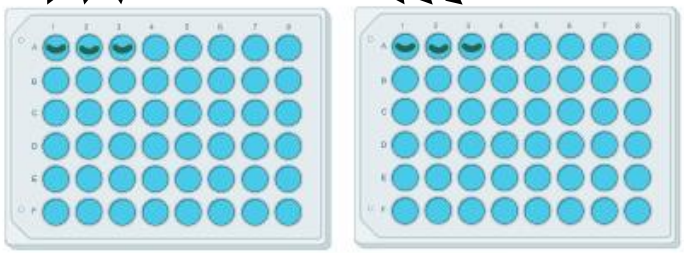
Causes of sterility - Pollen

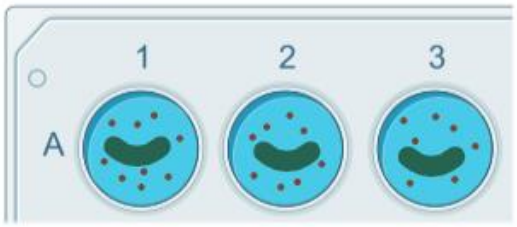
Pollen Germination – 24hr after moved to stress

Youngest open flower collected into an Eppendorf tube

Individual anthers removed from a single flower and used to inoculate liquid pollen germination media

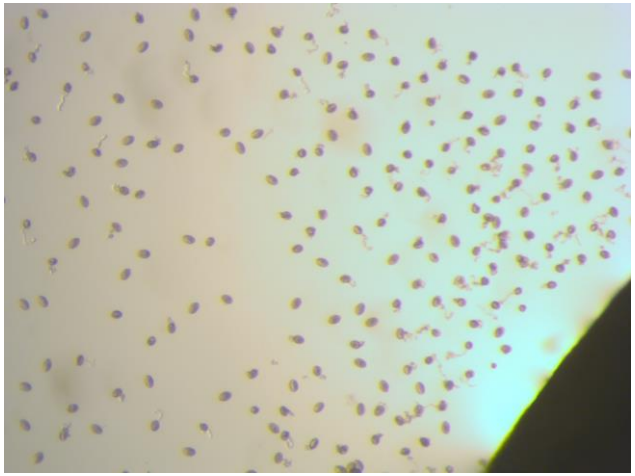
Control
21oC





Treatment
Incubation at
35 or 4oC

Grow overnight in the dark, and then take pictures

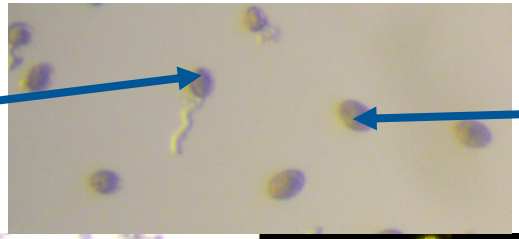


Pollen Germination

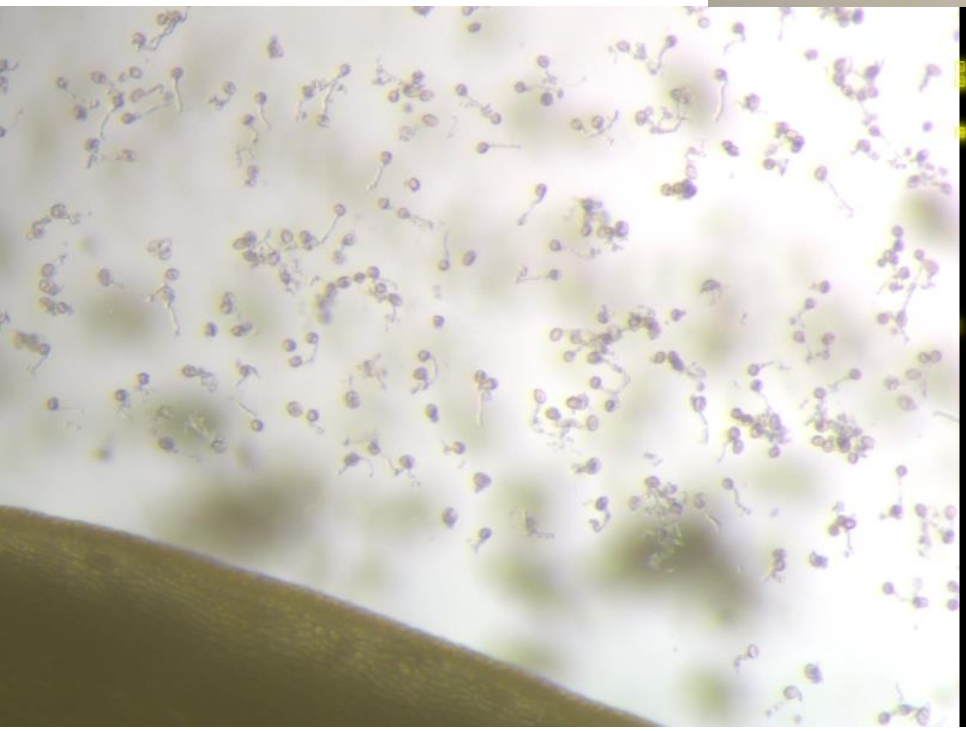
Simon Castle-Green

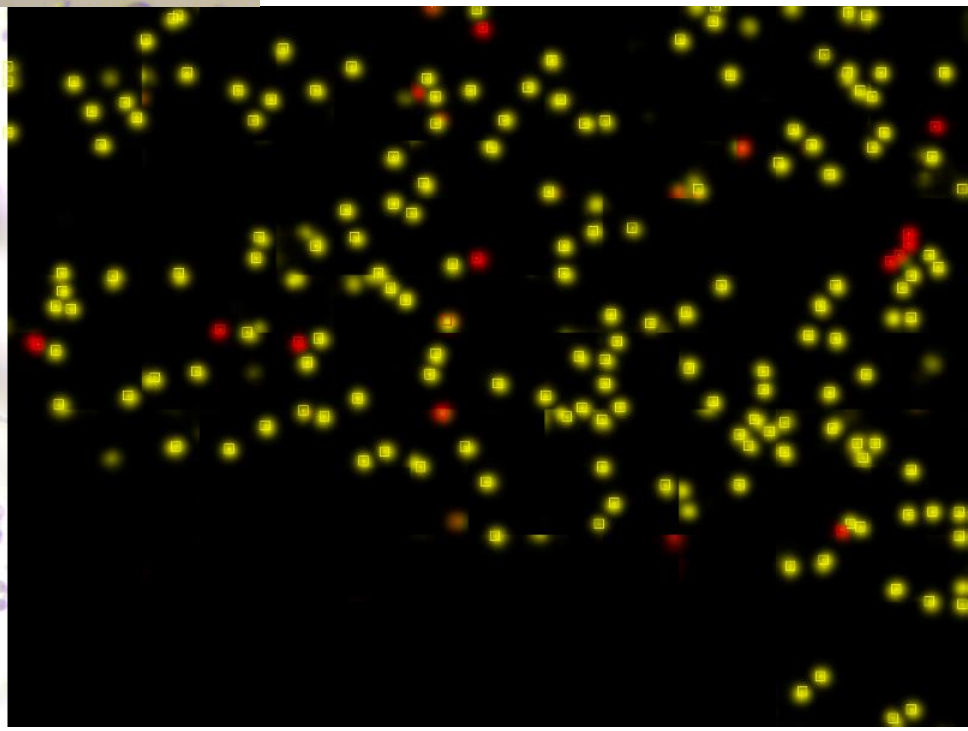
Computer training using 100 annotated images of germinated or non-germinated pollen

Germinated



Non-Germinated





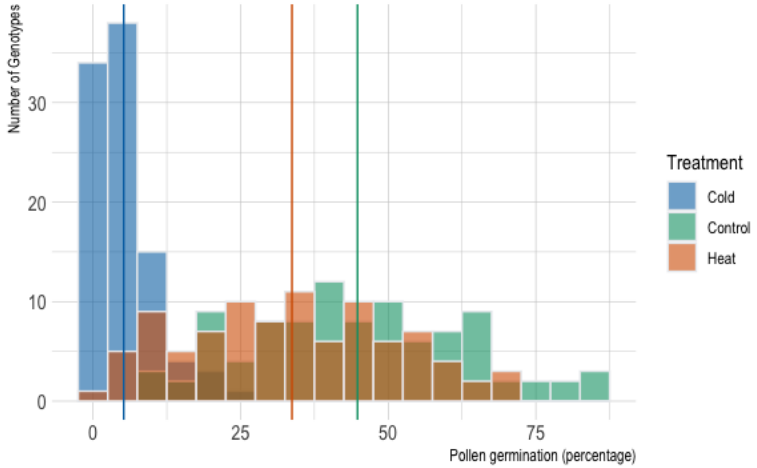
Trained program good at identifying pollen and labelling correctly

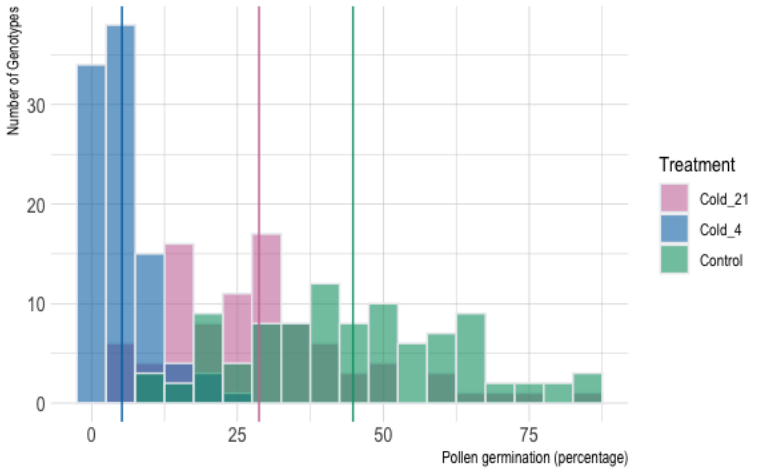
Yellow = Germinated

Red = Non-Germinated

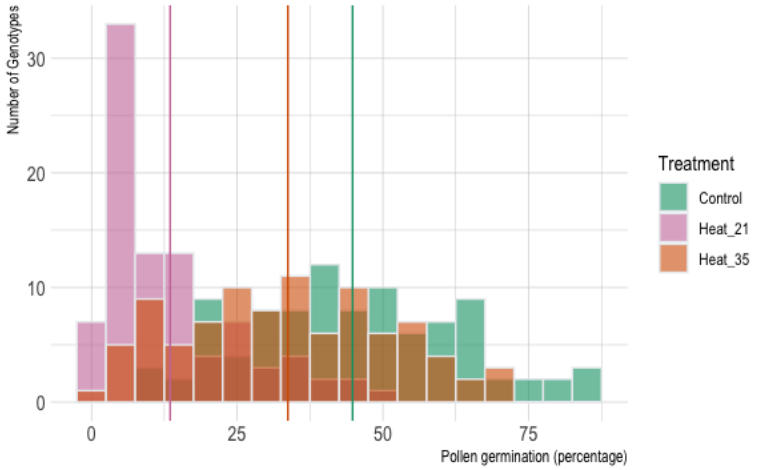
Pollen germination

Pollen germination is significantly reduced in cold. Rescued by returning to non-stress conditions

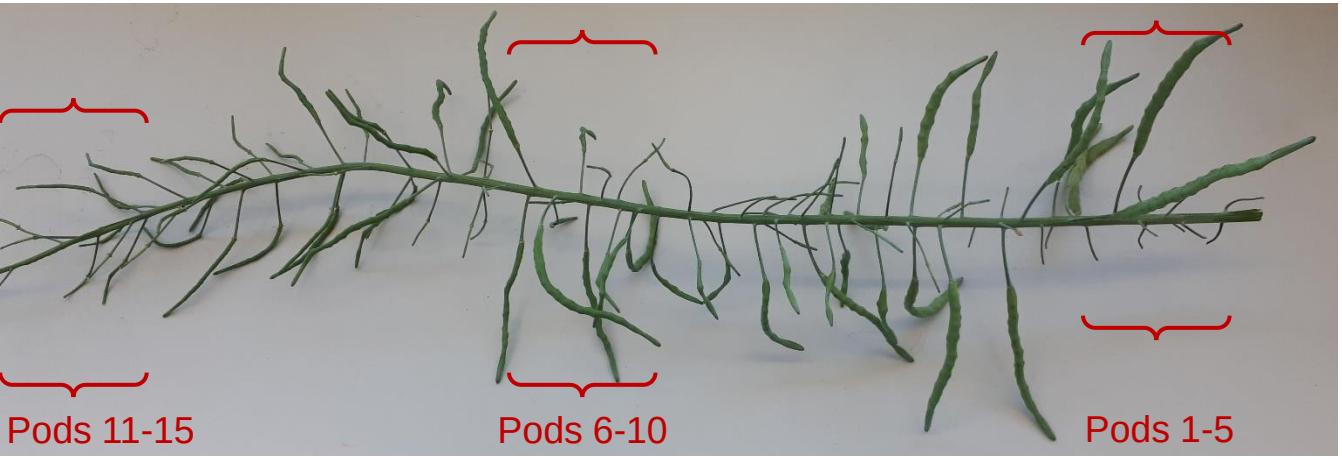




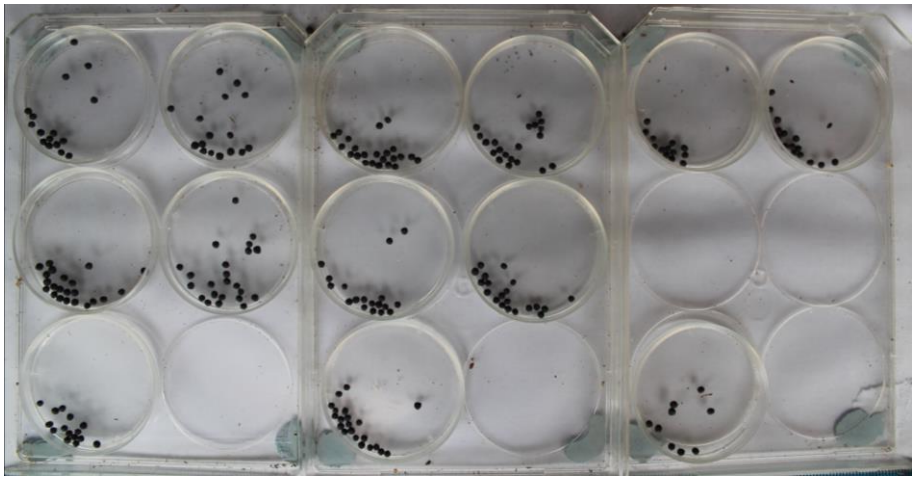
Pollen germination is reduced in heat but drops further once returned to non-stress conditions – suggests a longer negative effect



Seed pods



5 oldest pods, 5 middle pods and 5 youngest pods taken from dried OSR plants

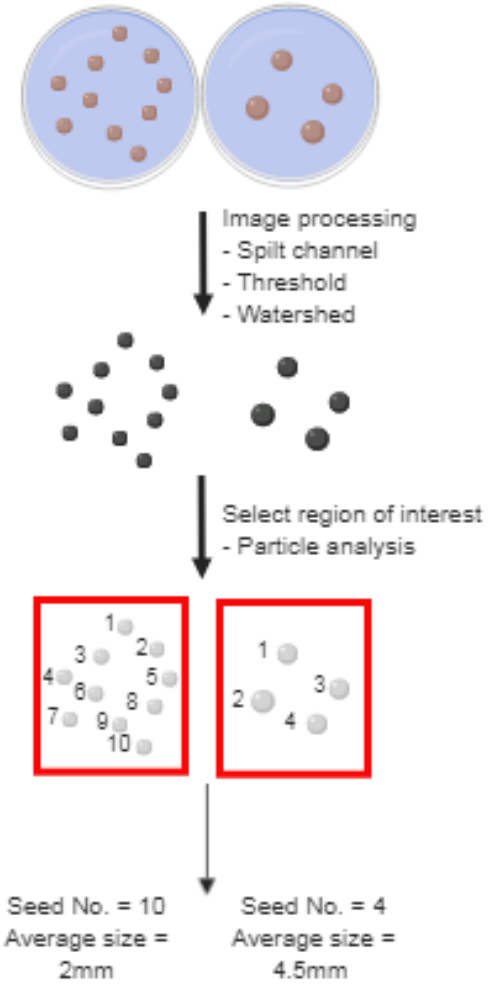


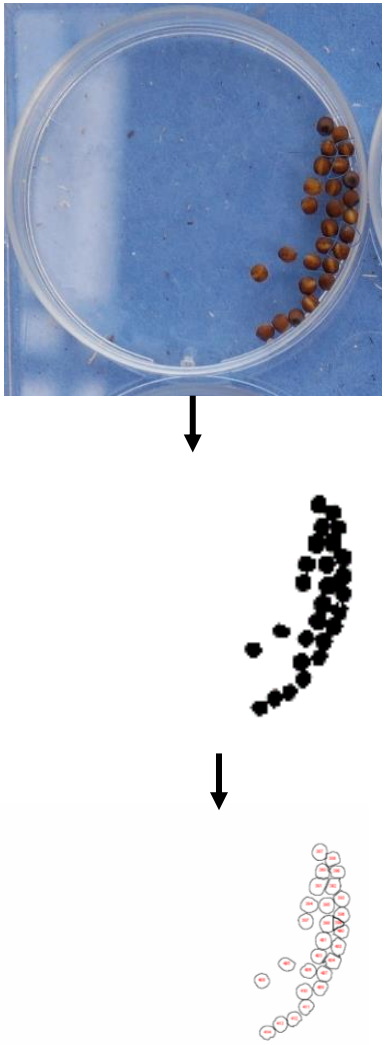
Pods 1-5 Pods 6-10 Pods 11-15

Seeds

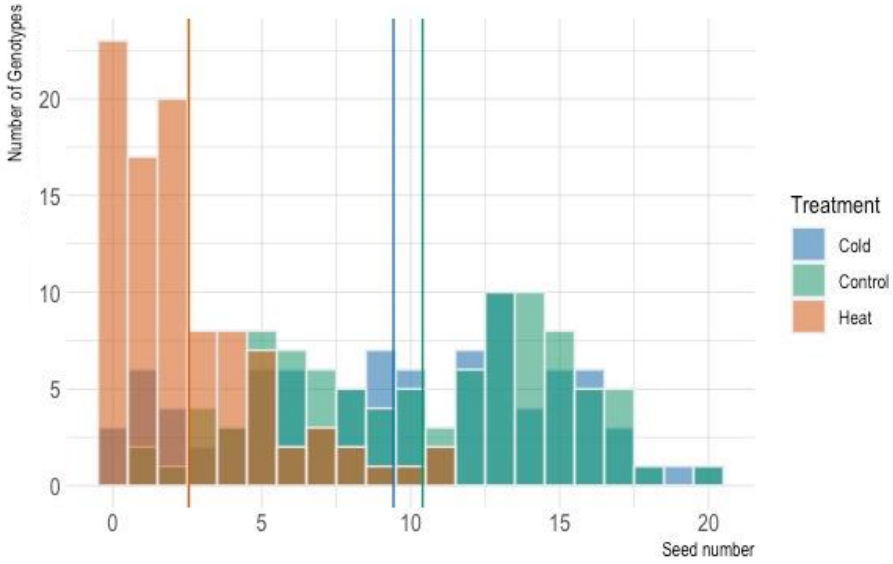
Laura Siles-Suarez

Image J Macro written by Alison
for automatic processing of seeds



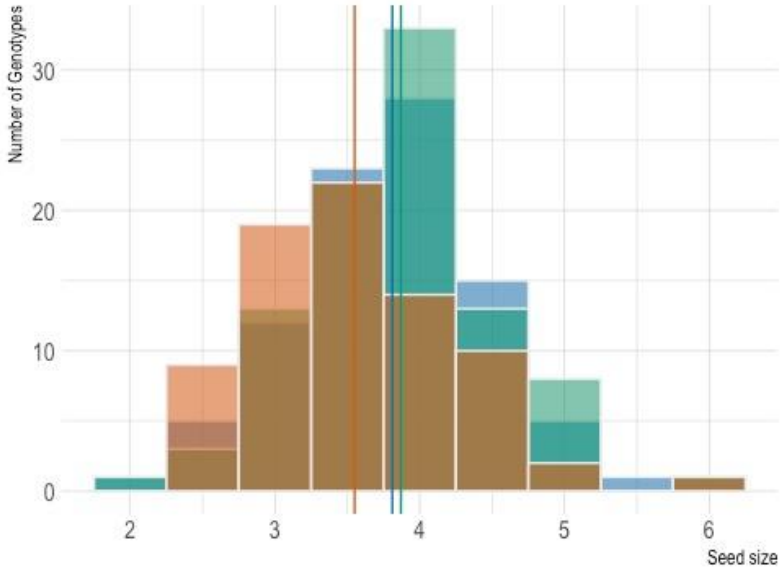


Summary

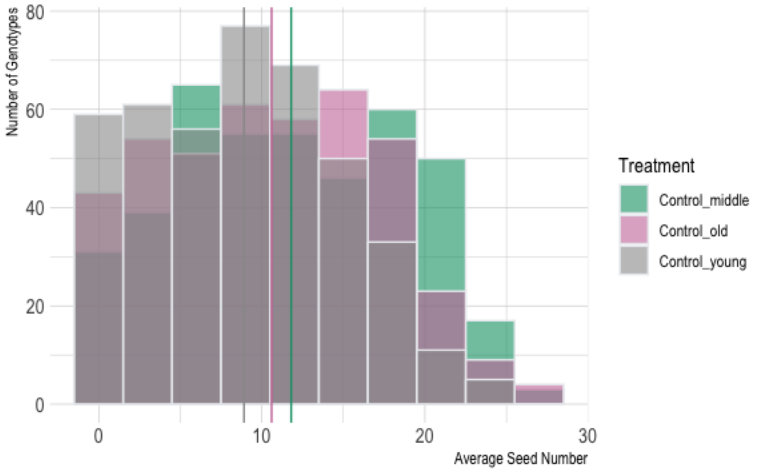


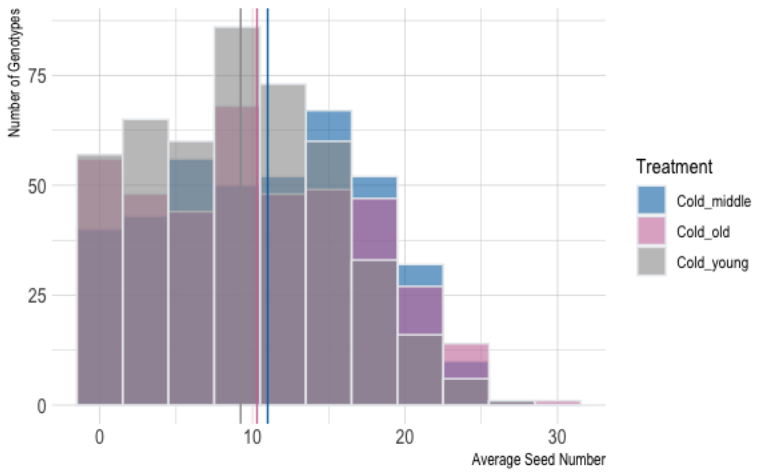
Seed number is heavily affected by heat, with less seeds being produced.
Little variability between cold/control

Slight decrease in seed size in heat.
Little variability between cold/control



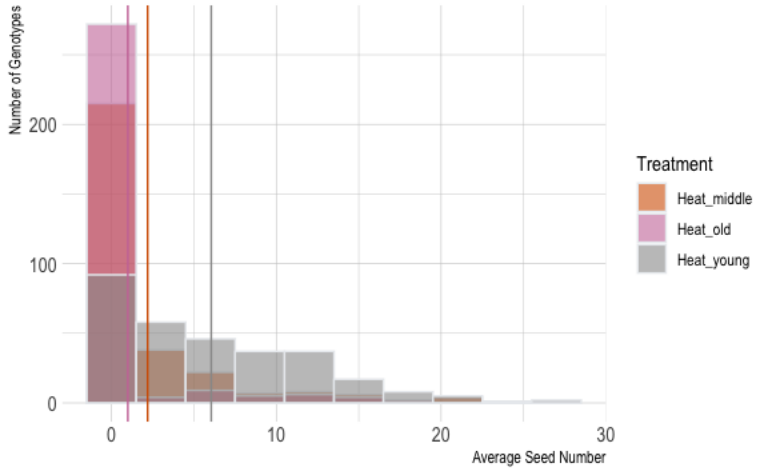
Seed number





Rescue in seed number in the youngest pods (undeveloped during heat stress)

Only slight rescue in seed pods from the middle of the plant, suggesting whole developing buds are damaged by heat



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Summary

Short 3 day stress at the start of flowering has a significant effect on numerous plant developmental processes including

- Male fertility
- Female fertility

Heat stress has a significant effect in final yield in comparison to cold stress

Reducing yield not only during the 3 day heat stress but a longer negative development affecting pollen or ovule development, germination or fertilisation preventing seed set causing a significant reduction over the whole plant yield

Thank you

University of Nottingham
Zoe Wilson
Rory Hayden
Simon Castle-Green – Computer training

Rothamsted Research
Smita Kurup
Laura Siles-Suarez – Female analysis of stressed plants