



How ovule and node positions affect seed development in field pea plants exposed to heat stress

Yunfei Jiang, Rosalind Bueckert, Art Davis, Tom Warkentin
University of Saskatchewan
2016 Soils and Crops

Field pea

- Canada is the largest global producer and exporter of pea (FAOSTAT, 2014)
- Major pulse crop in SK, Canada (Sask Pulse Growers, 2014)
- Leading alternative crop to wheat and canola
- Good for human consumption and livestock feed

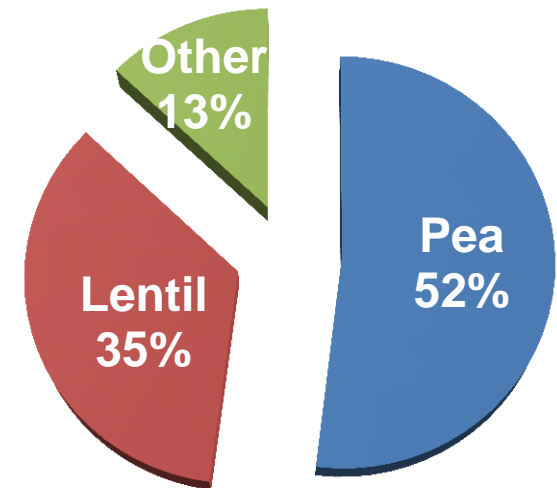
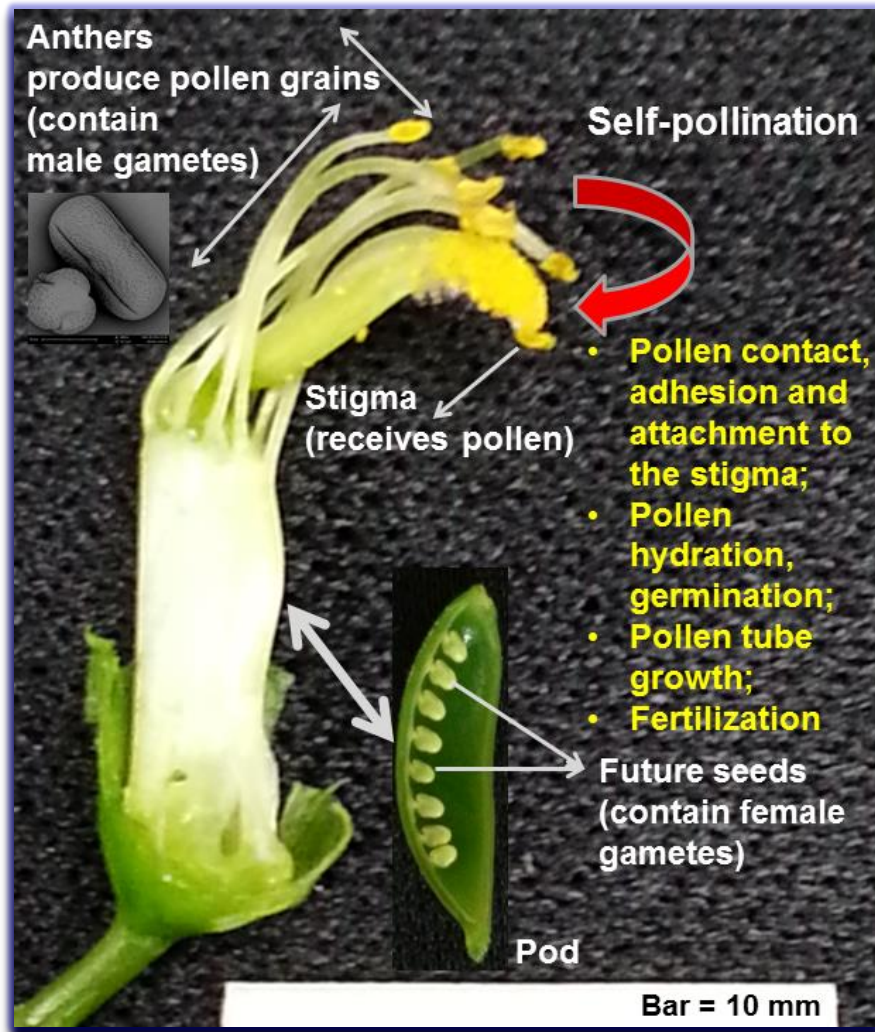


Fig. 1: Pulses Grown in SK
(Sask Pulse Growers, 2014)

Heat stress on plant growth

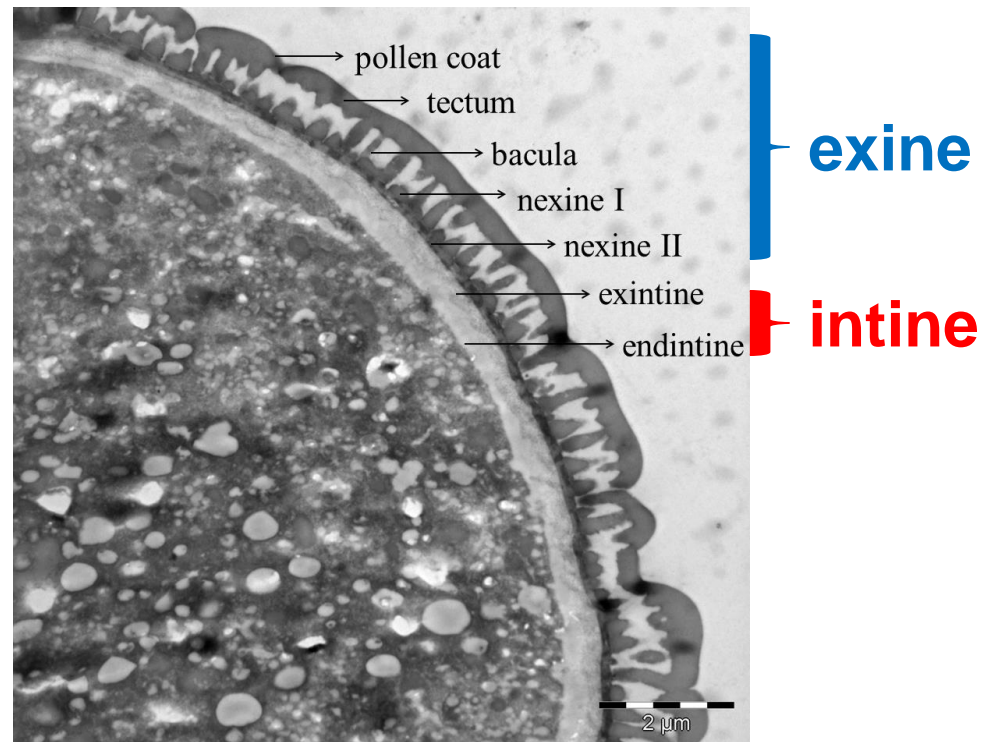


Pollination and fertilization in field pea

- Heat stress reduces yield;
- Reproductive stages are the most sensitive to heat stress;
- Heat stress damages reproductive floral organs;
- Most previous studies focus on how heat stress affects male floral organs, because stamens are more sensitive to heat stress than female floral organs.

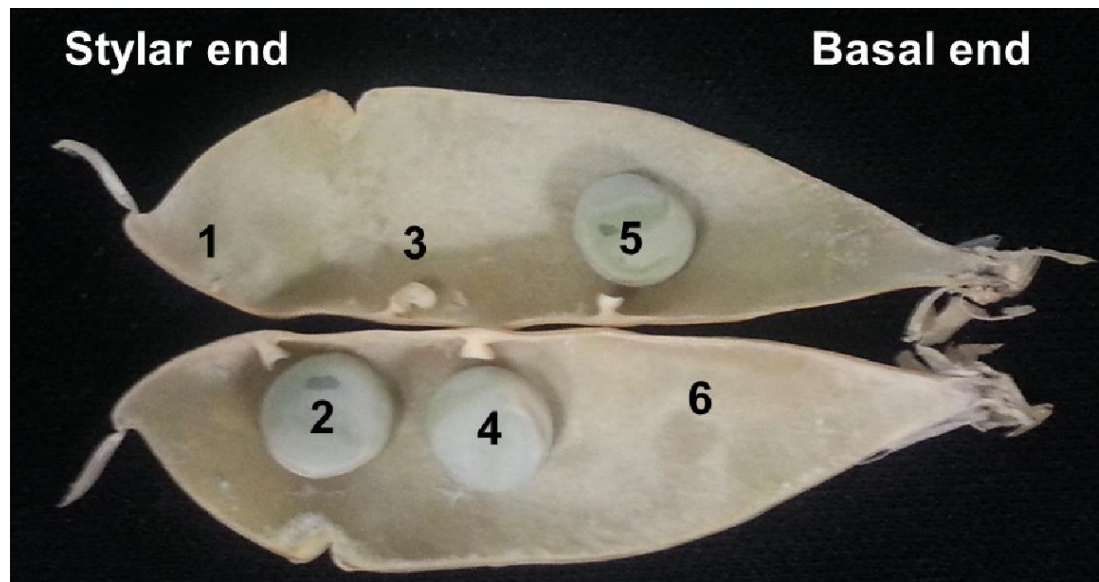
Heat stress on pollen development and seed set

- Heat stress reduced *in vitro* pollen germination and pollen tube growth;
- Heat stress changed pollen wall structure;
- Heat stress changed pollen surface composition;
- Heat stress reduced seed set.



Pea pollen wall structure

Early start **VS** Maternal nutrition?



Ovules at the stylar end are fertilized by the most vigorously growing pollen tubes

Ovules at the basal end are closest to maternal nutrition

Research hypotheses and objectives

➤ **Hypotheses:**

- Heat stress accelerates seed abortion;
- Ovules within a pod have different chances of reaching maturity;
- Pods at different nodes have different chances of reaching maturity.

➤ **Objectives:**

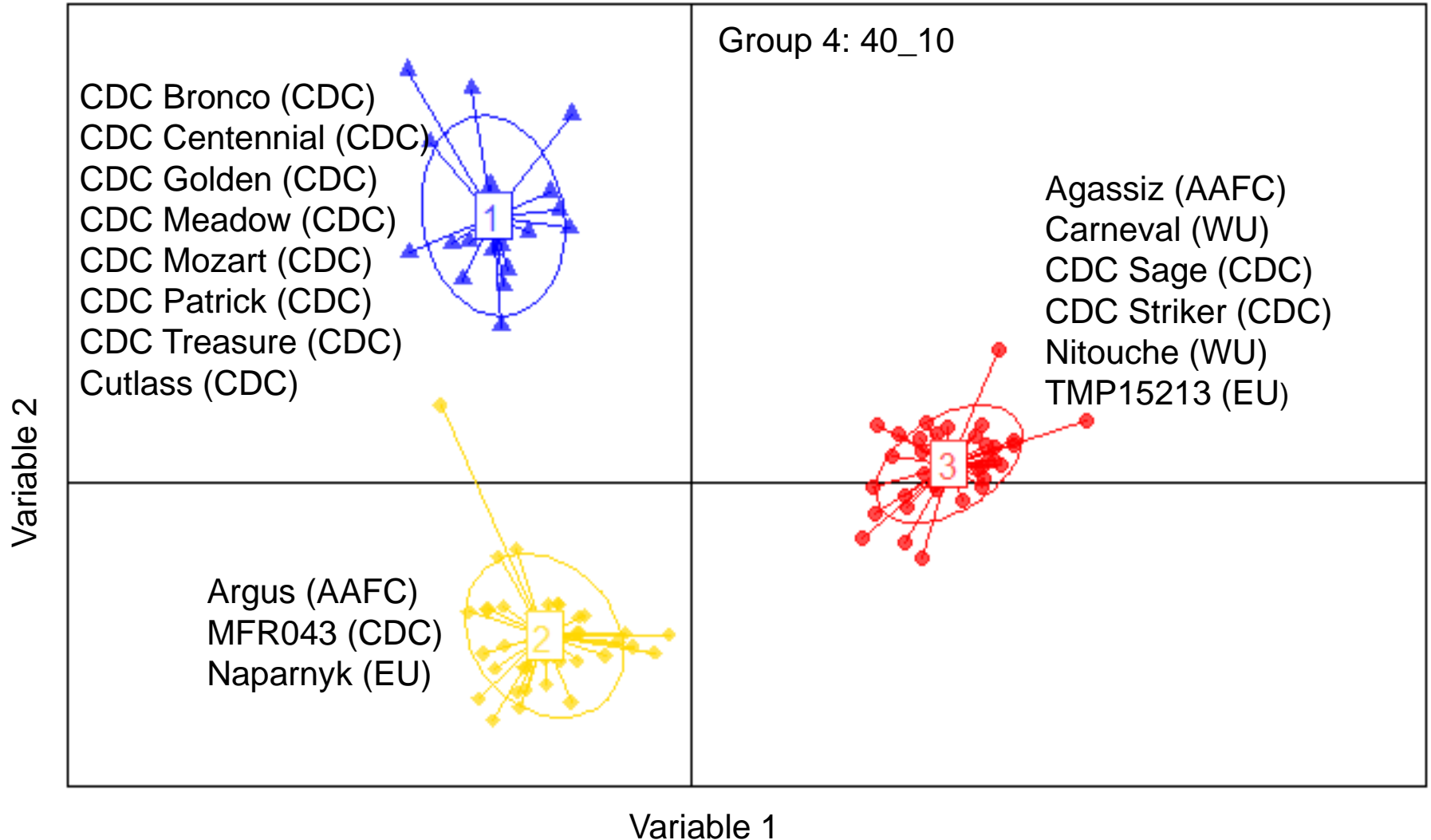
- To diagnose whether ovule position affects seed maturity and abortion under heat stress;
- To determine whether any hierarchy exists in flower/pod retention at different nodes under heat stress.

Experimental design

- 18 accessions, selected from the Pea Association Mapping panel (PAM) at U of S (Dr. Tom Warketin's breeding program)
- Growing conditions
 - Control (24/18°C day/night T);
 - Heat stress (35/18°C day/night T);
 - Exposed to heat stress for 1 week;
 - 16/8 hr photoperiod
- First four reproductive nodes were considered;
- RCBD with 3 replications (1 plant per pot as 1 replication)

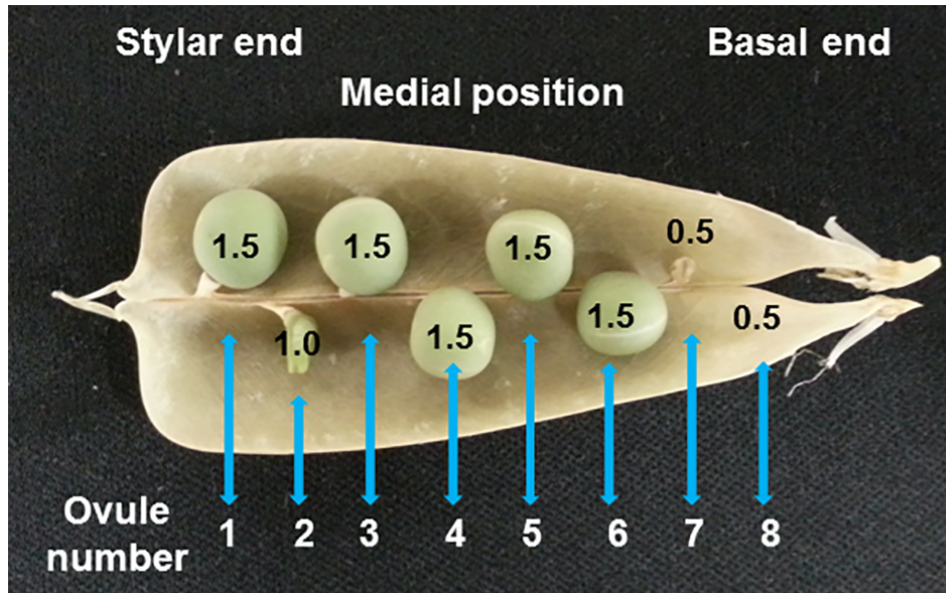


18 pea cultivars tested



Population structure analysis of PAM (94 accessions)

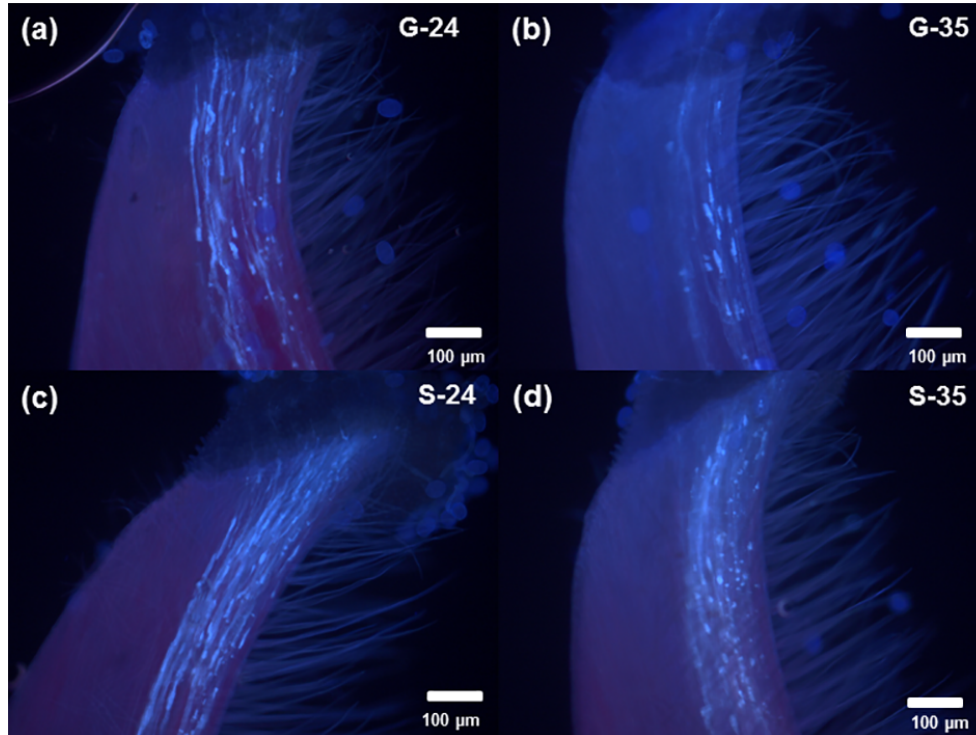
Statistical analyses



- An aborted pod: 0
- An ovule that fails to be fertilized: 0.5
- An aborted seed: 1.0
- Successfully developed seed: 1.5

Total number of ovules	Stylar end position	Medial position	Basal end position
4	1	2,3	4
5	1,2	3,4	5
6	1,2	3,4	5,6
7	1,2	3,4,5	6,7
8	1,2	3,4,5,6	7,8
9	1,2,3	4,5,6	7,8,9

In vivo pollen tubes in the style



24/18°C
day/night temp
for 4 days

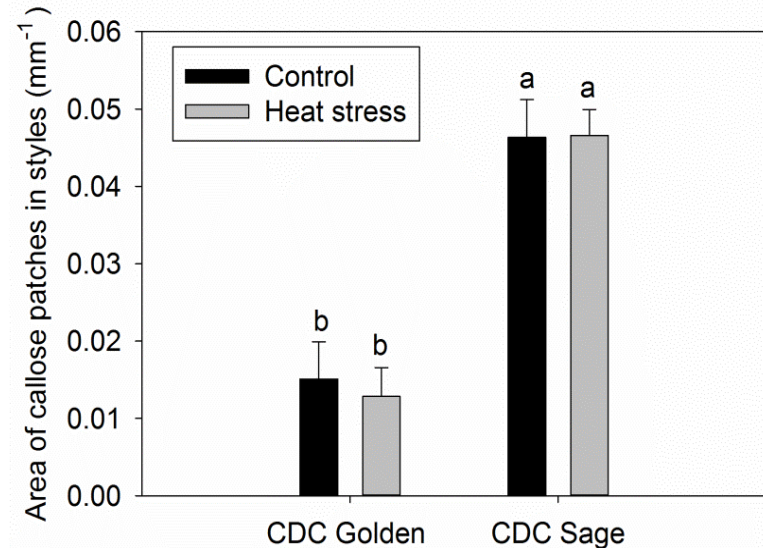
35/18°C
day/night temp
for 4 days



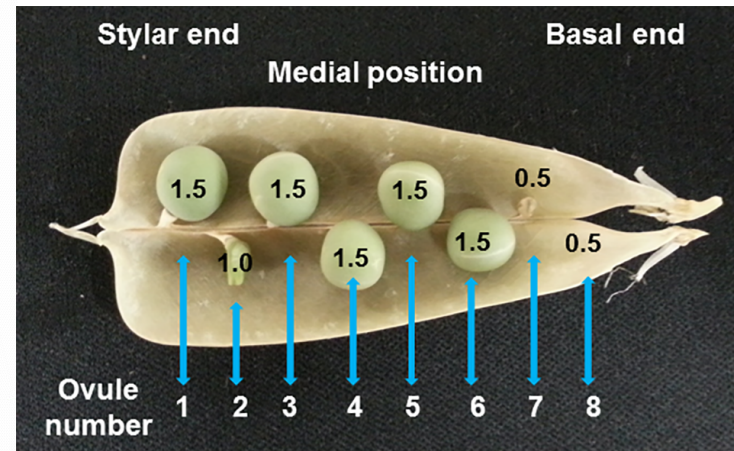
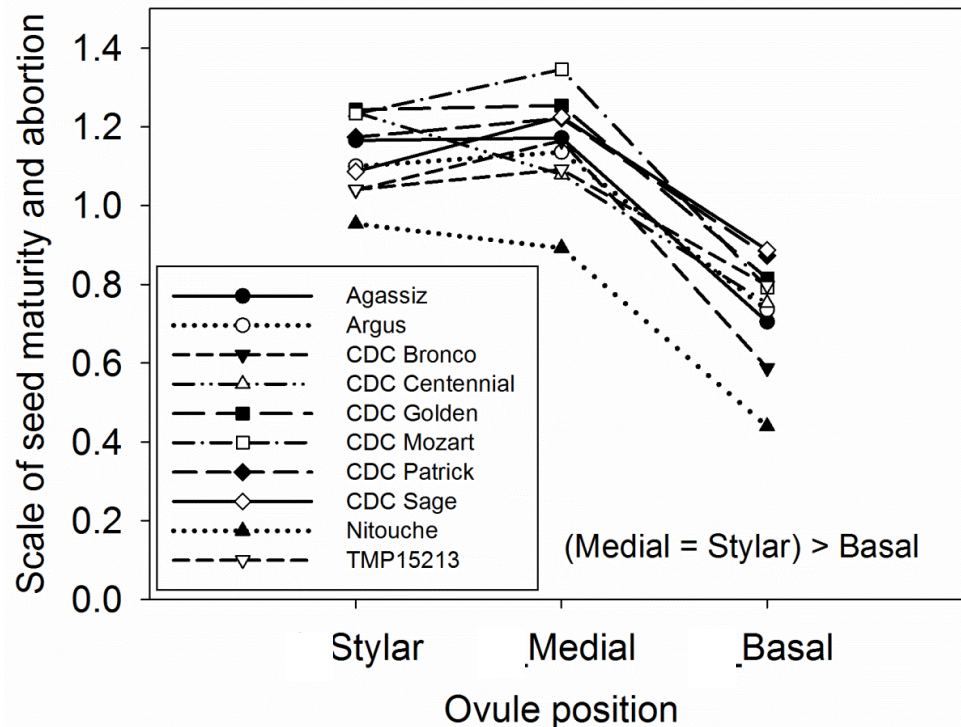
CDC Golden

Pod development stage,
about 34 hours after
anthesis and 43 hours after
anther dehiscence

CDC Sage



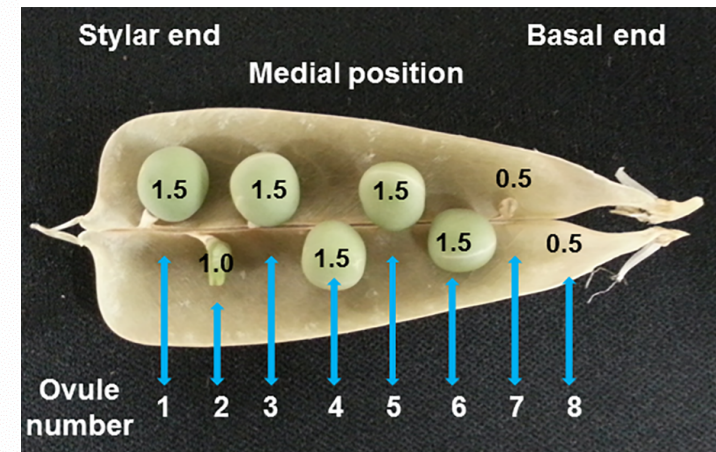
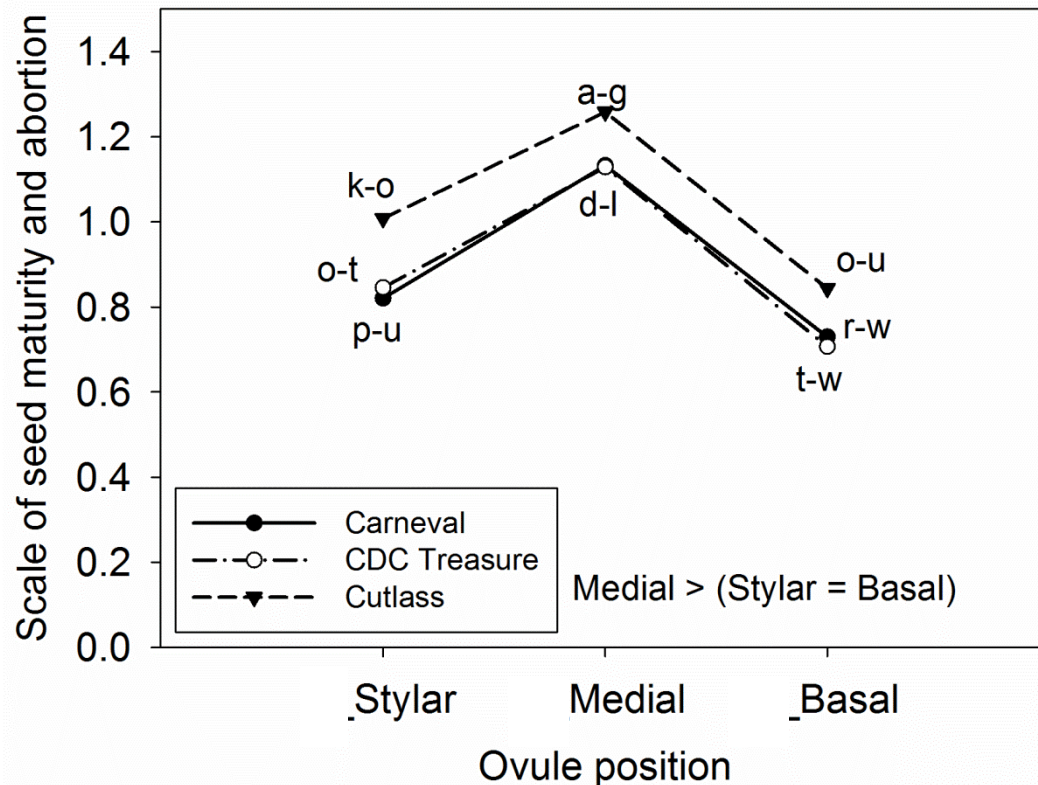
Ovule position on seed development



The most common type: (Stylar = Medial) > Basal

*Higher Y-axis values indicate higher chances of reaching seed maturity!

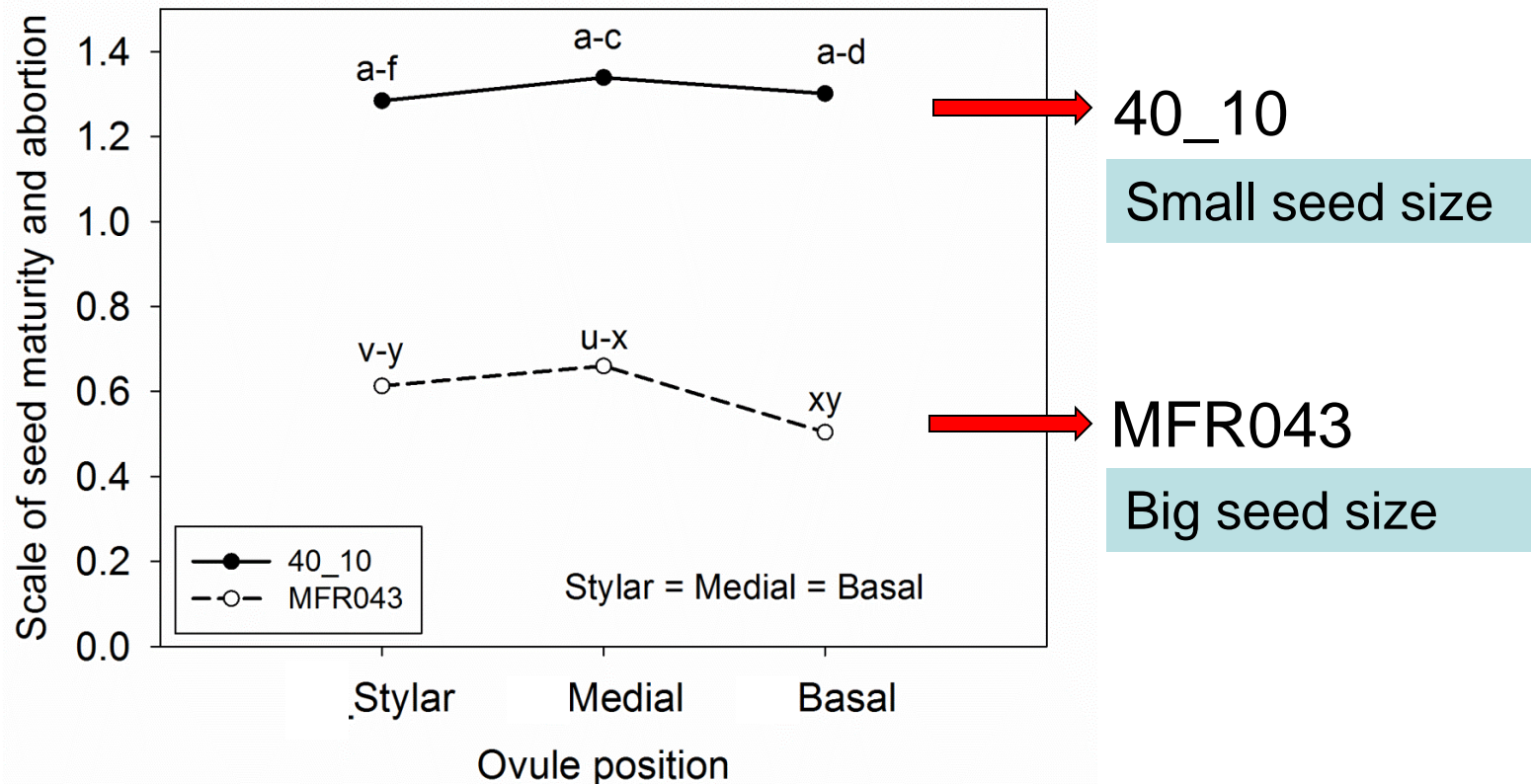
Ovule position on seed development



The second most common type: Medial > (Styler = Basal)

*Higher Y-axis values indicate higher chances of reaching seed maturity!

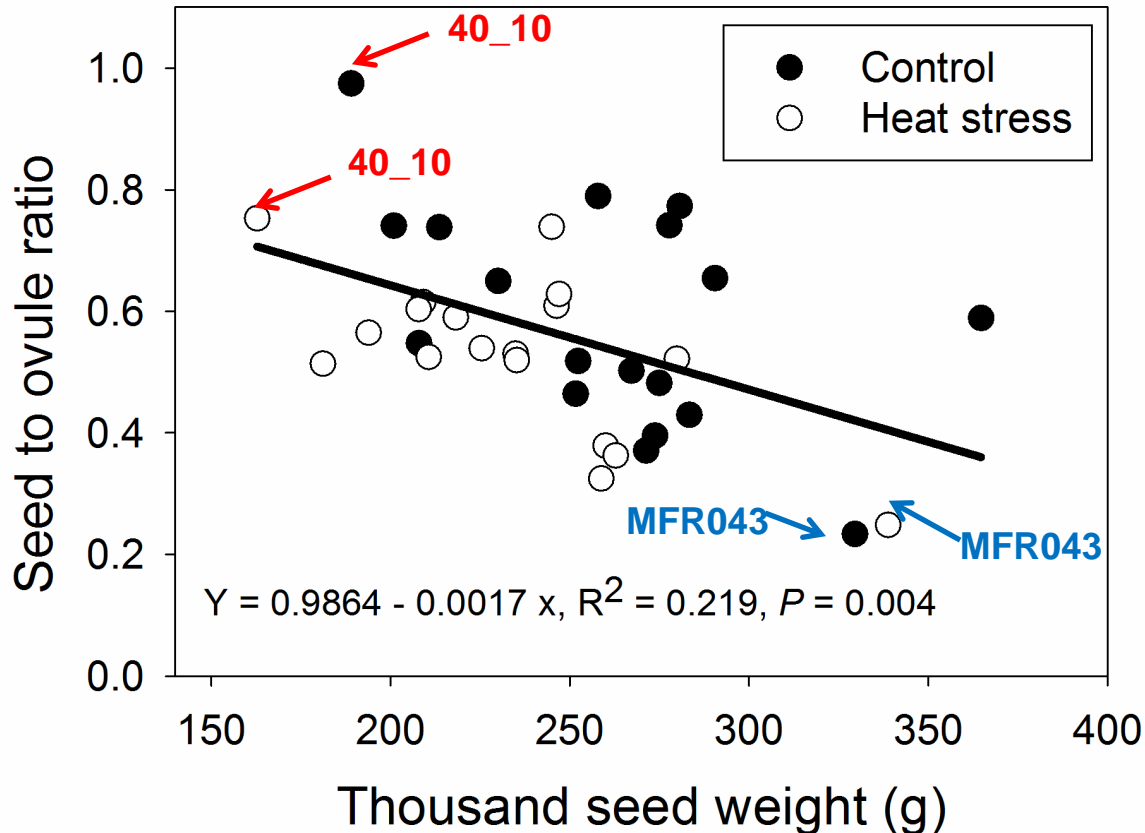
Ovule position on seed development



Ovule position had no effect on seed development on 40_10 and MFR043;

*Higher Y-axis values indicate higher chances of reaching seed maturity!

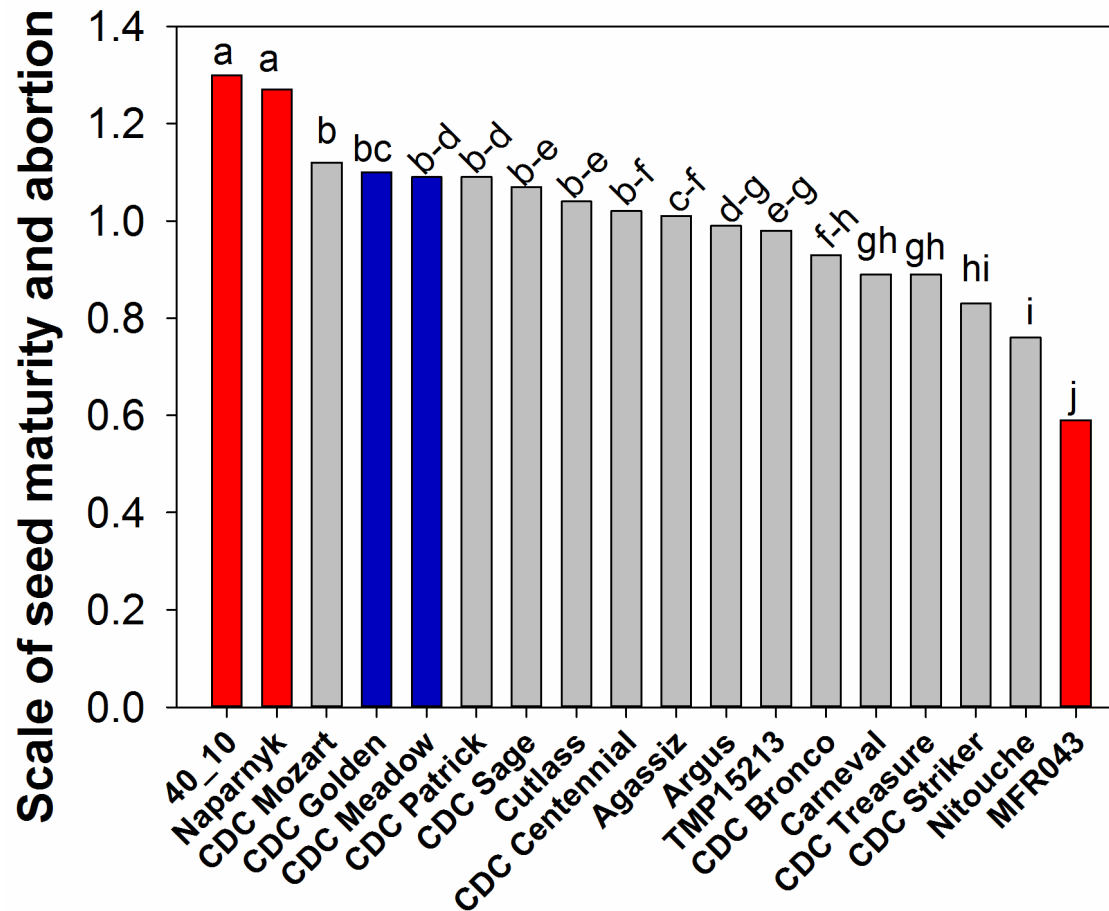
Seed size and seed development



The seed to ovule ratio is negatively correlated with thousand seed weight.

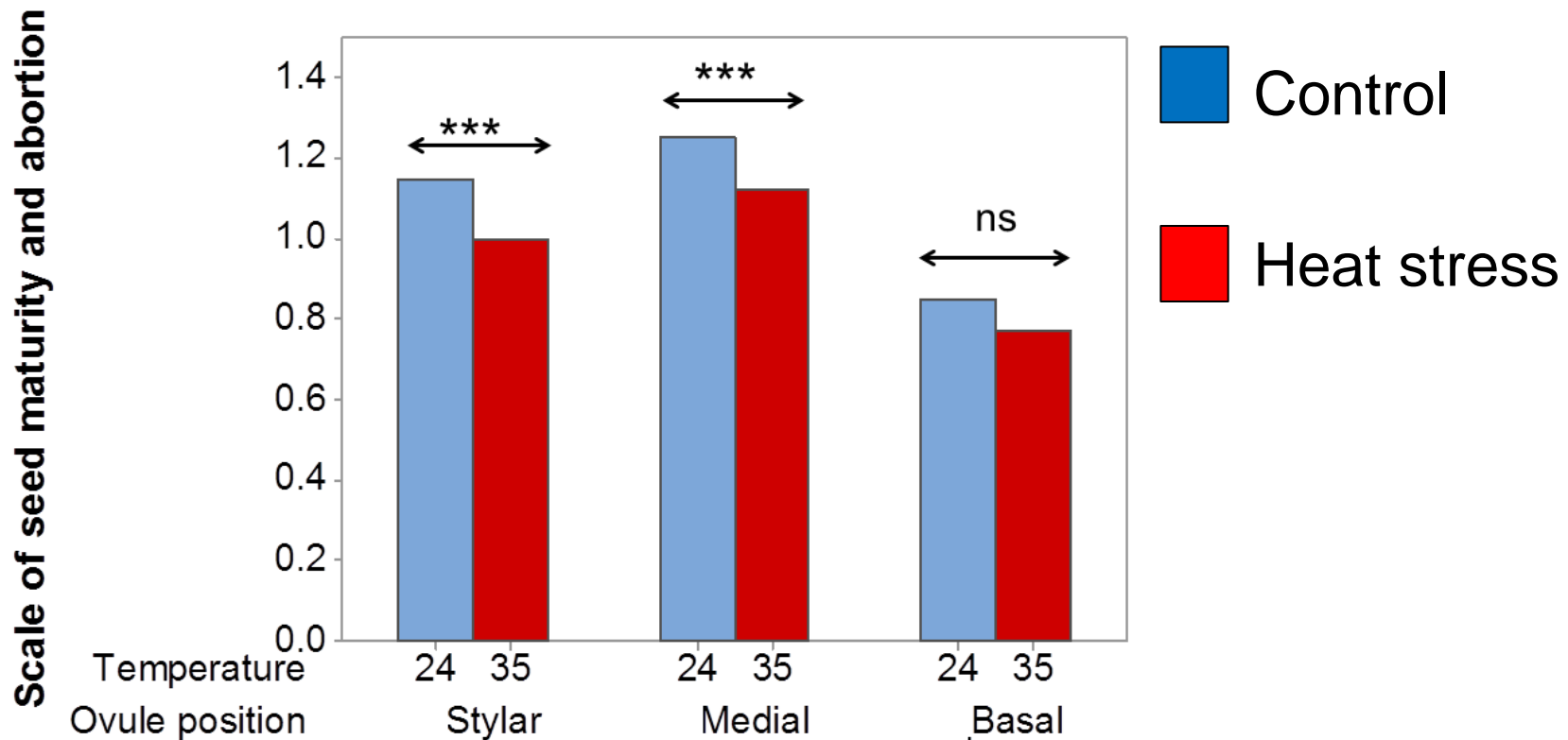
The **seed-ovule ratio** was calculated by dividing the number of seeds per pod by the number of ovules per pod.

Effects of cultivars on seed development



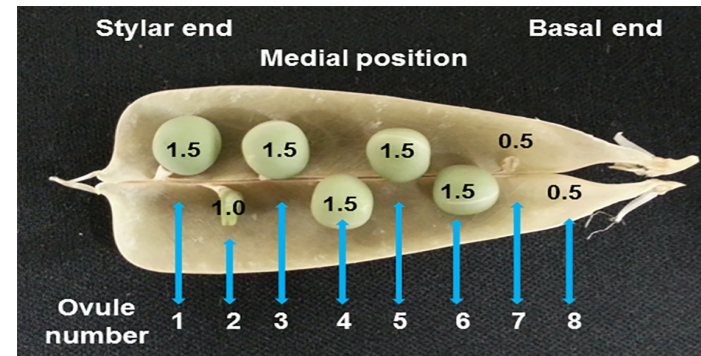
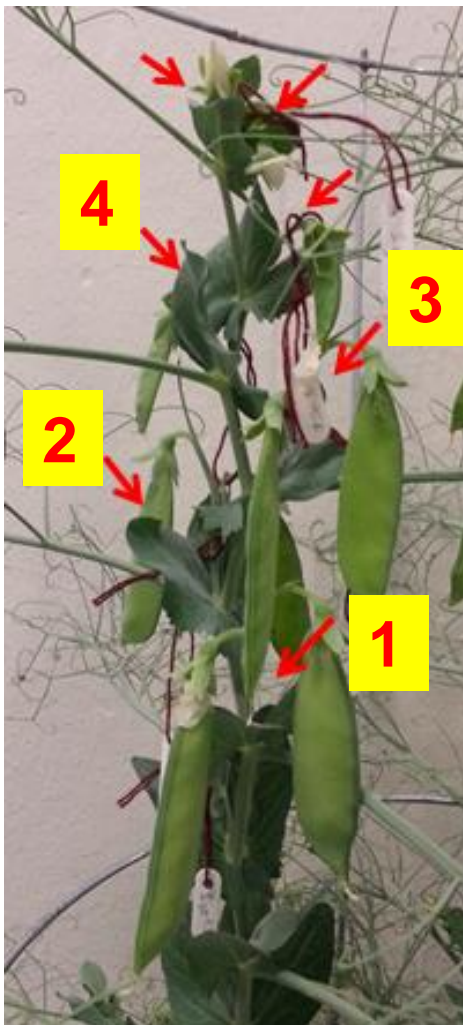
*Higher Y-axis values indicate higher chances of reaching seed maturity!

Heat stress on ovule maturity at different positions within a pod



*Higher Y-axis values indicate higher chances of reaching seed maturity!

Node position on seed development



Node number	Stylar	Medial	Basal
4	0.87 ^c	0.99 ^c	0.62 ^d
3	1.04 ^b	1.16 ^b	0.74 ^c
2	1.17 ^a	1.25 ^{ab}	0.87 ^b
1	1.17 ^a	1.29 ^a	0.96 ^a

Letter grouping within each column

Indeterminacy (continued flowering)

*Higher values indicate higher chances of reaching seed maturity!

Conclusions

- Heat stress accelerated ovule abortion at the pod's styler and medial positions within pods, but not at the pod base.
- Ovules at the pod's medial position and styler-end positions exhibited a greater probability of seed maturity compared to the pod's base, indicative of a combined effect of spatial advantages and fertilization success.
- Pods at more advanced (older) nodes established during a period when they could dominate maternal resources.

Thank you!
Questions?



SASKATCHEWAN
pulse
Growers

