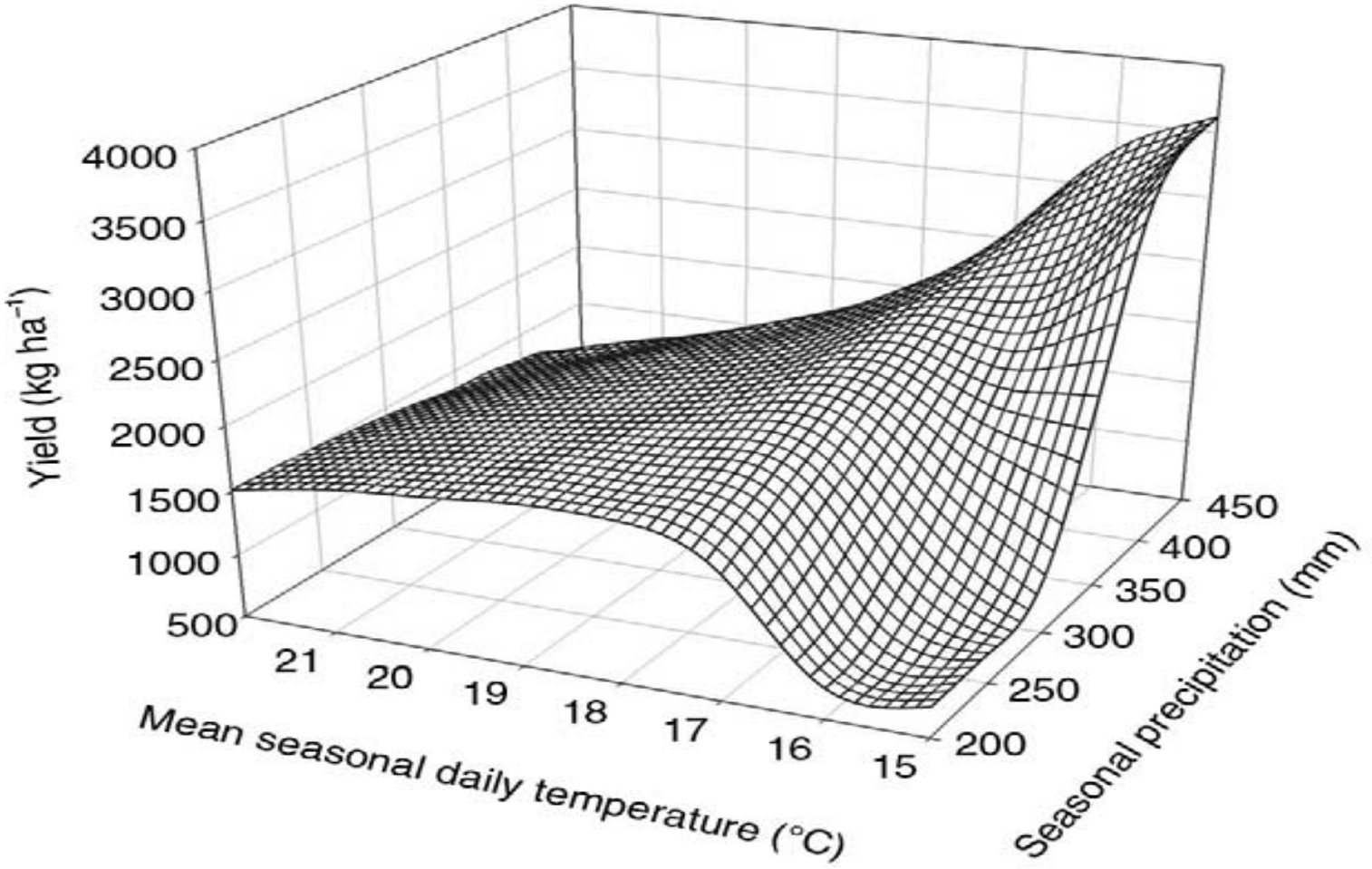
Pea leaf ABA response to short-term heat stress at flowering stage

Shaoming Huang

Soils and Crops

2020.03

Pea yield response to seasonal temperature and precipitation



Bueckert et al. 2015. *Can. J. Plant. Sci.* 95, 629-639.

Research progress in pea heat stress

Canopy architecture and leaf type

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Canopy architecture and leaf type as traits of heat resistance in pea

Endale G. Tafesse, Thomas D. Warkentin, Rosalind A. Bueckert*

Department of Plant Sciences, College of Agriculture and Bioresources, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK, S7N 5A8, Canada

Seed set and pollen

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NRC Research Press

ARTICLE

High temperature effects on in vitro pollen germination and seed set in field pea

Yunfei Jiang, Rosalind A. Bueckert, Thomas D. Warkentin, and Arthur R. Davis

Research progress in pea heat stress

Pea phenology to a warming climate

Pea Phenology: Crop Potential in a Warming Environment

Shaoming Huang, Krishna K. Gali, Bunyamin Tar'an, Thomas D. Warkentin,* and Rosalind A. Bueckert

ABA research background

1. ABA accumulates in heat-treated leaf among different plant species
2. ABA biosynthesis genes were expressed in an organ-specific manner subjected to high temperature
3. Exogenous application of ABA increased chickpea seeding survival rate at high temperature
4. Pea *ABR 17 & 18* genes seem to relate to cold tolerance

Hypotheses

- 1. Pea leaves stressed at 38°C will have greater accumulation in the ABA pool compared to pea leaves at 22°C
- 2. The induction of ABA in pea leaves would start after a few hours at 38°C
- 3. ABR 17 & 18 genes relate to the ABA response

Materials and Methods

1. Heat Tolerant vs Heat Sensitive

   CDC Meadow Nitouche

   PR11-2 PR11-90

   CDC Amarillo

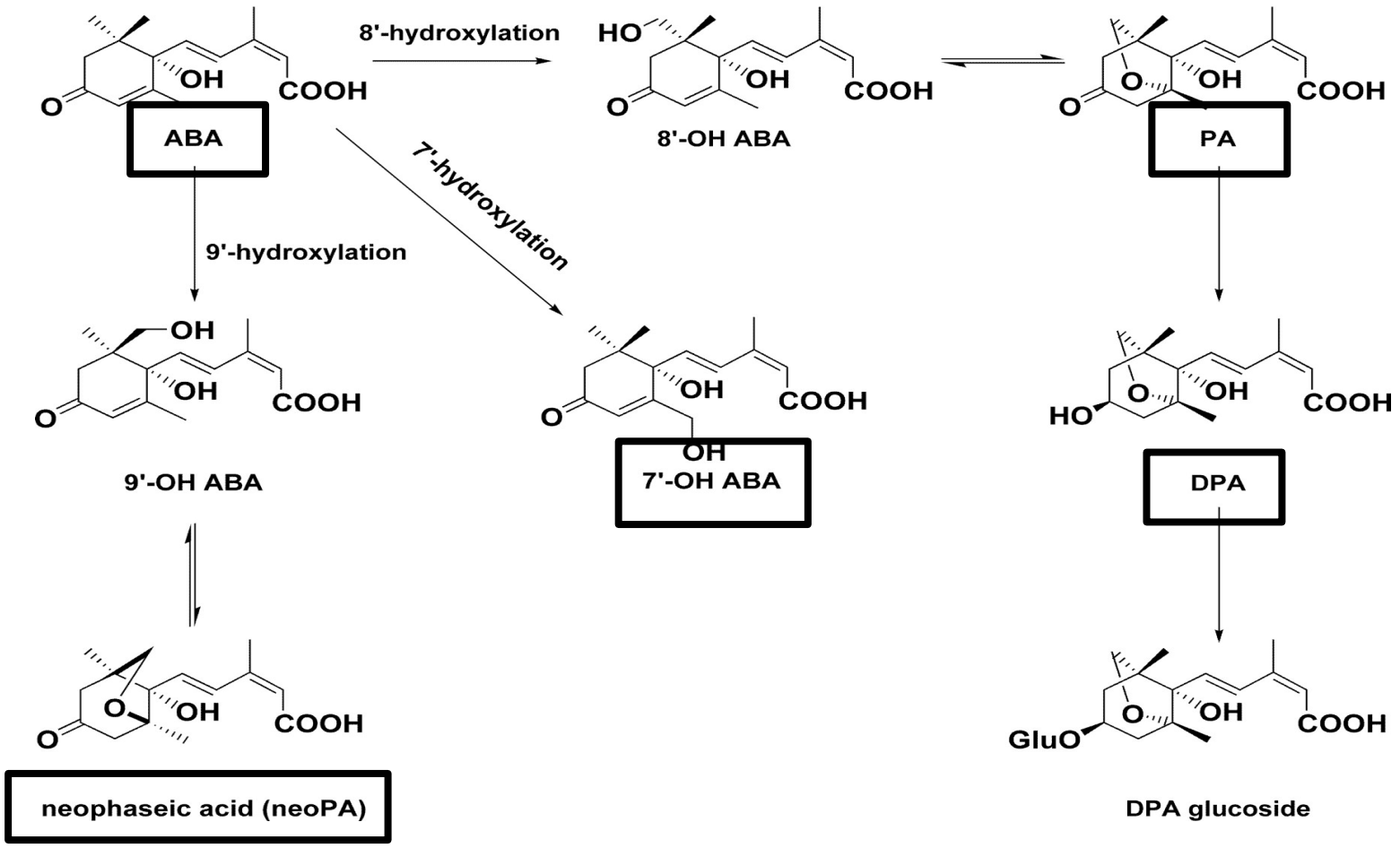
2. RCBD (5 genotypes X 5 time points X 3 reps=75 pots)

Time points: 0h, 3h, 6h, 12h, 24h 38C

3. Liquid chromatography multiple reaction monitoring analysis (LC-MRM) for ABA profiling (nmol/g dry weight)

4. Quantitative RT-PCR of PsABR 17 and 18 genes

ABA metabolism pathways



Zaharia et al. 2005. J. Plant. Growth. Regul. 24: 274-284.

Results

Genetic variation in leaf ABA homeostasis under control conditions

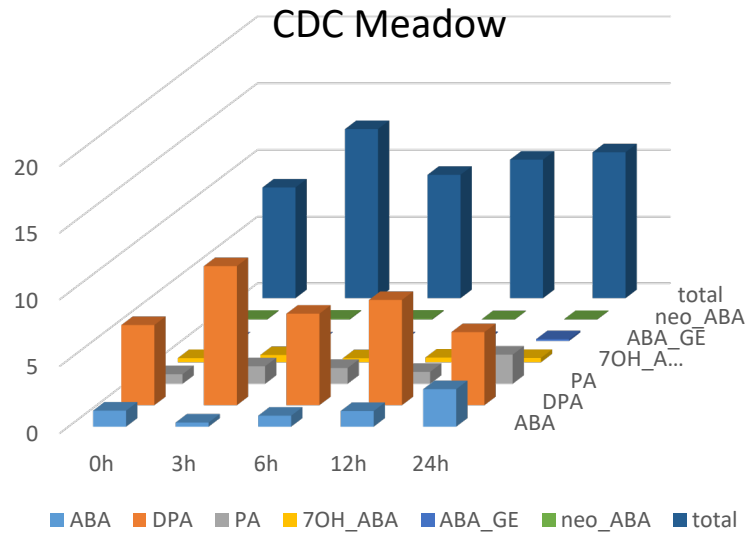
Genotype	ABA	DPA	PA	7_OH_ABA	ABA_GE	neo_PA	TOTAL
Amarillo	1.89a	8.50b	0.86a	0.25a	0.03a	0.08ab	11.61ab
Meadow	1.20a	5.99c	0.72a	0.32a	0.02a	0.06bc	8.30c
Nitouche	1.49a	11.02a	0.63a	0.18a	0.02a	0.09a	13.43a
PR11_2	1.41a	10.47ab	0.86a	0.23a	0.03a	0.05bc	13.05a
PR11_90	1.05a	8.66b	0.70a	0.22a	0.03a	0.04c	10.70b

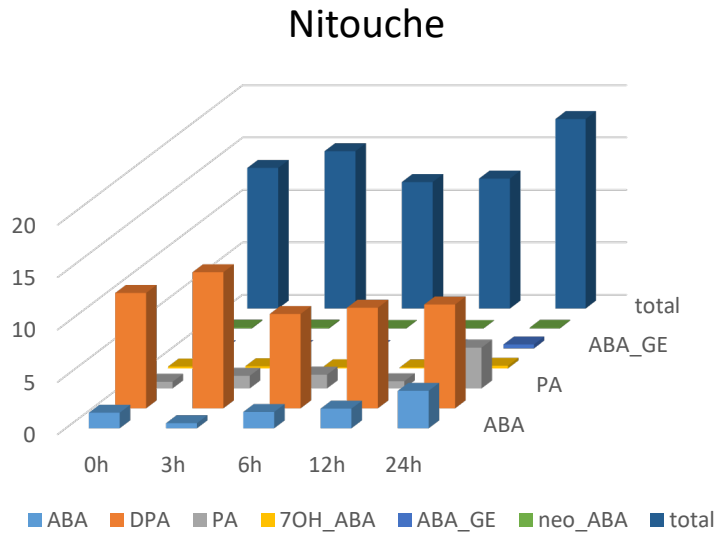
Unit: nmol/g dry weight

ABA synthesis response towards high temperature

TRT	ABA	DPA	PA	7_OH_ABA	ABA_GE	neo_PA	TOTAL
0h	1.41b	8.93b	0.75e	0.24b	0.03b	0.06b	11.42c
3h	0.43c	13.19a	1.43c	0.32ab	0.05b	0.07a	15.50a
6h	1.13bc	9.26b	1.80b	0.25ab	0.04b	0.07a	12.56b
12h	1.47b	9.54b	1.14d	0.29ab	0.08b	0.04c	12.56b
24h	3.82a	8.35b	3.34a	0.33a	0.32a	0.06b	16.22a

Unit: nmol/g dry weight


CDC Meadow
20
15
10
5
0
0h
3h
6h
12h
24h
total
neo_ABA
ABA_GE
7OH_A...
PA
DPA
ABA
ABA
DPA
PA
7OH_ABA
ABA_GE
neo_ABA
total


Nitouche
20
15
10
5
0
0h
3h
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12h
24h
total
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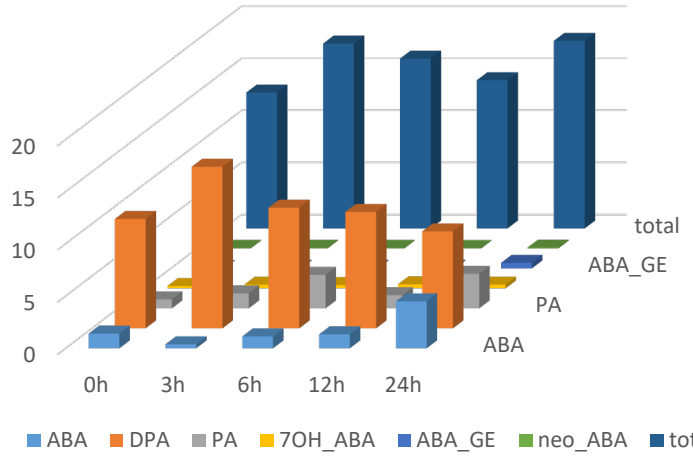
PA
ABA
ABA
DPA
PA
7OH_ABA
ABA_GE
neo_ABA
total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neo_ABA
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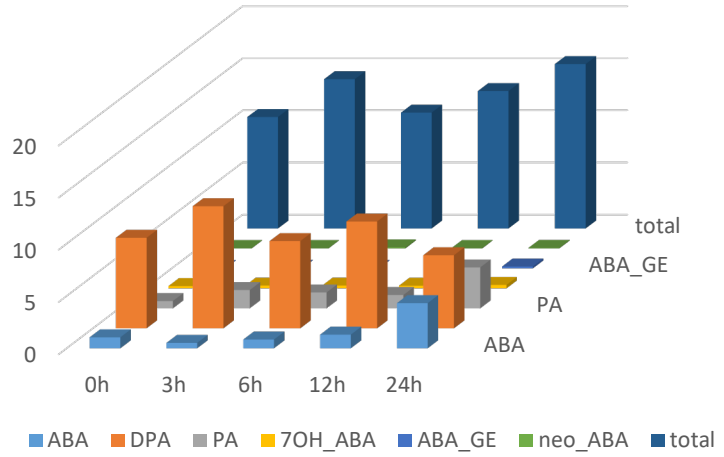
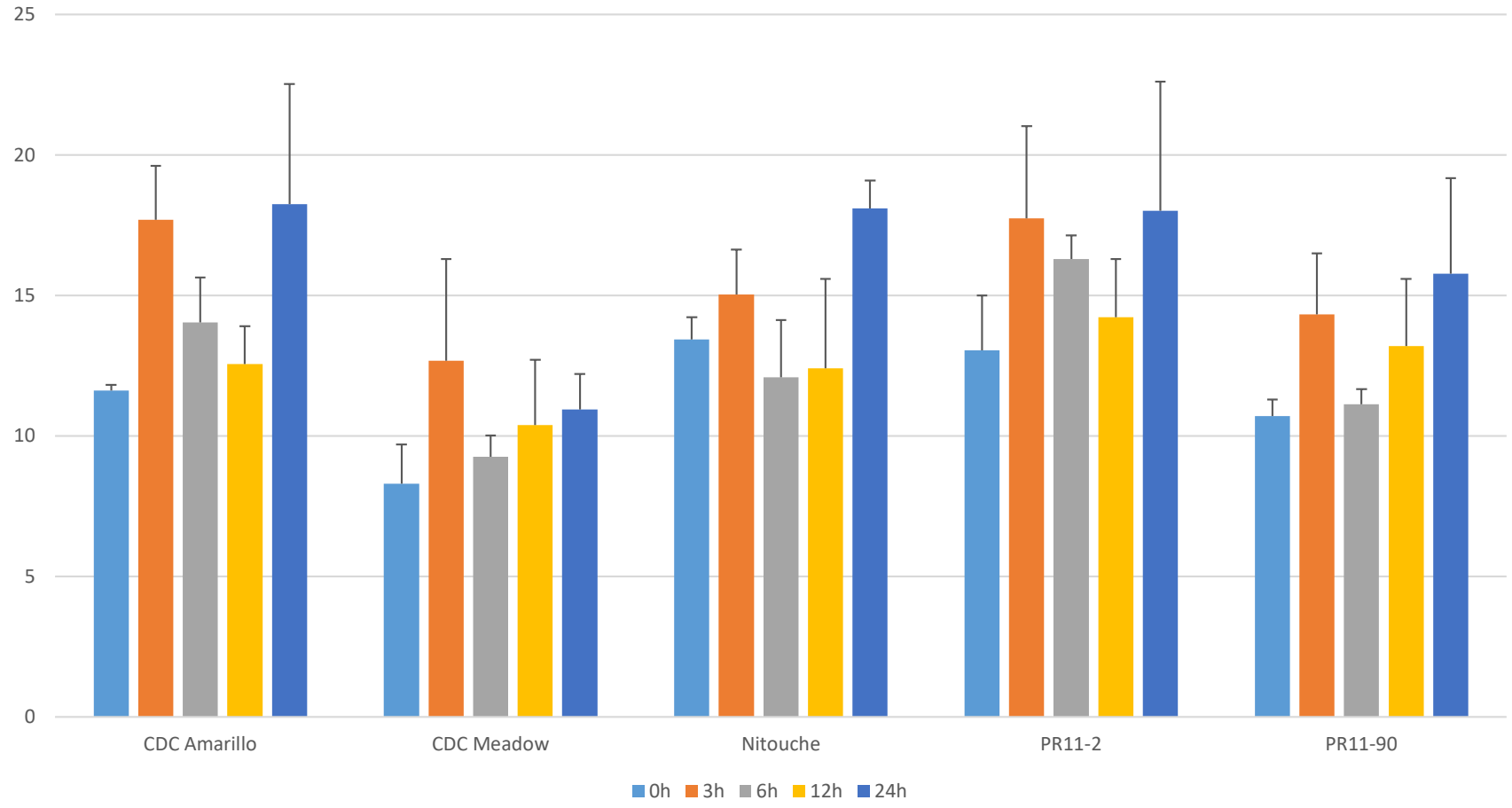

PR11_90
20
15
10
5
0
0h
3h
6h
12h
24h
total
ABA_GE
PA
ABA
ABA
DPA
PA
7OH_ABA
ABA_GE
neo_ABA
total

ABA response variation between the heat tolerant and heat sensitive pairs of varieties

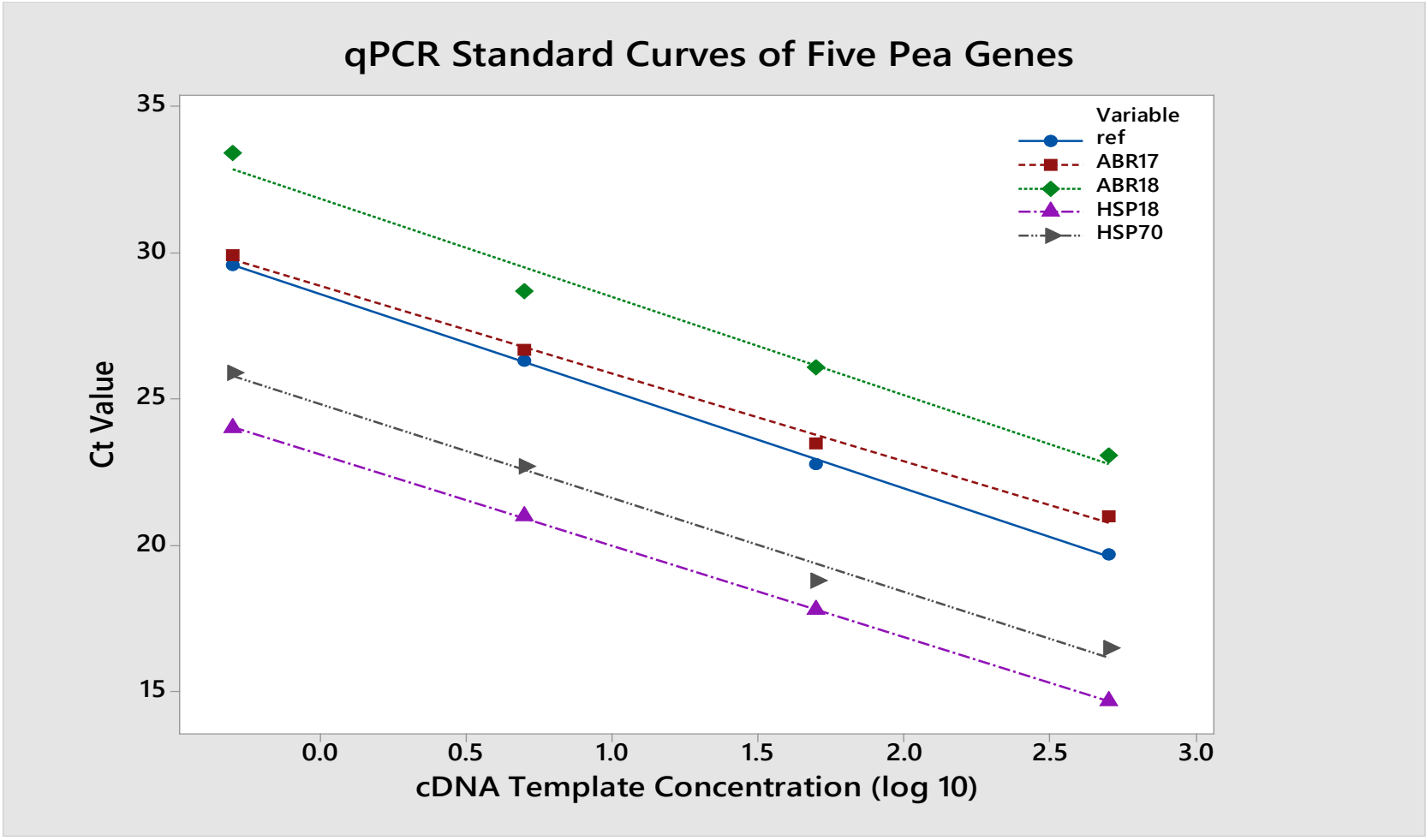


Different ABA metabolic pathway response to the heat treatment

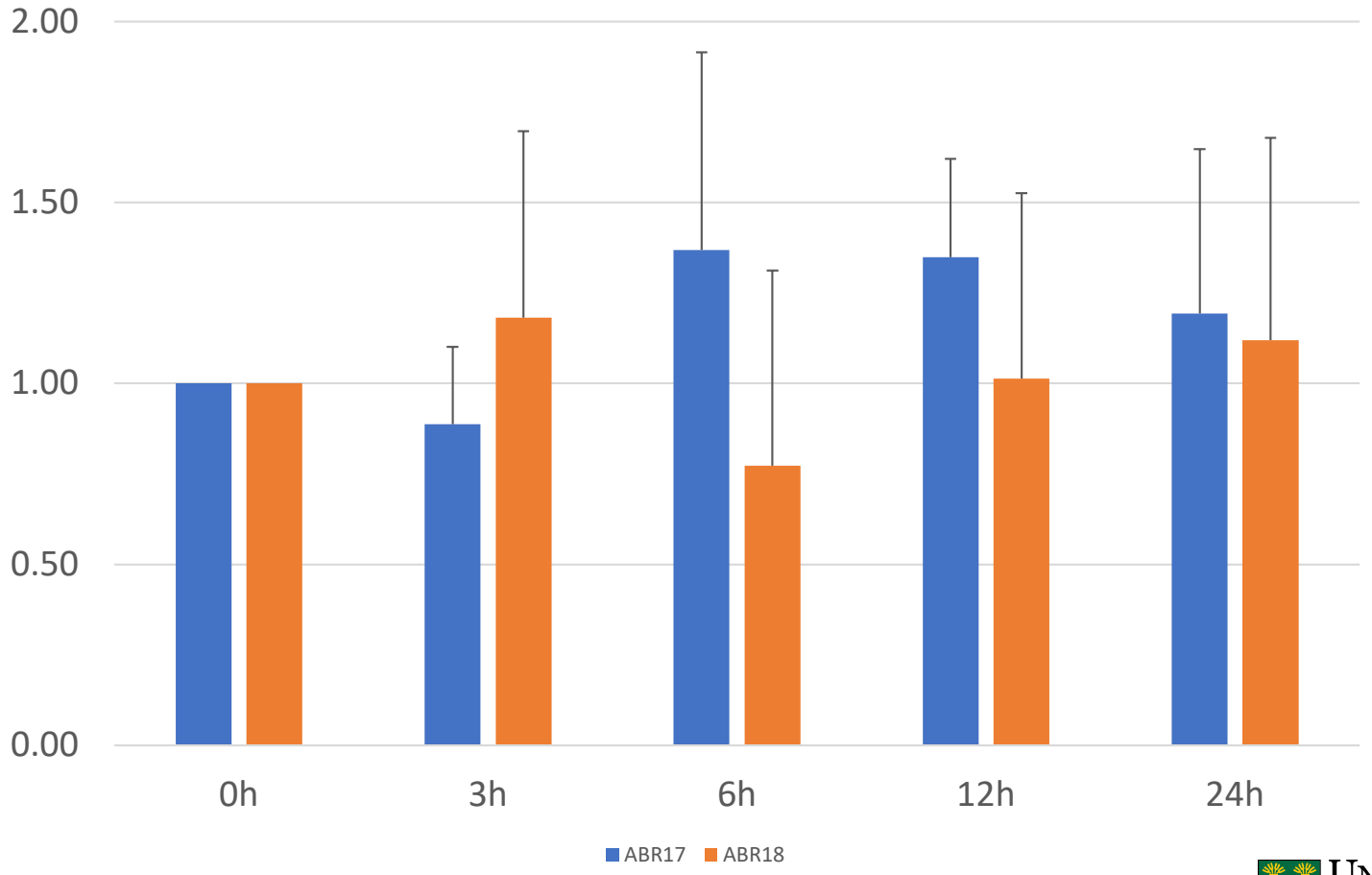
TRT	ABA	DPA	PA	7_OH_ABA	ABA_GE	neo_PA
0h	12.56b	77.63b	6.76d	2.23a	0.24c	0.57a
3h	2.88c	84.51a	9.63c	2.20a	0.30c	0.48ab
6h	9.10b	73.76b	14.05b	2.11a	0.38bc	0.58a
12h	11.40b	76.37b	8.99c	2.26a	0.66b	0.33c
24h	23.06a	51.78c	20.89a	2.09a	1.82a	0.37bc

Mean percentage (%) of five pea varieties for the six measured ABA metabolites over different hours at 38C high temperature treatments

Standard curves for primer efficiency test



qRT-PCR result fails to show connection of ABR17 & 18 genes with the ABA heat response



Conclusion

1. More ABA accumulated in the ABA metabolism pool at high temperature condition compared to control temperature

2. The response started immediately after 3 hour at 38°C

3. Heat tolerant varieties had a higher ABA response in terms of new ABA synthesized in the pool and ABA turnover rate at high temperature

4. *PsABR 17 & 18* genes did not seem to relate to the induction of ABA production and turnover rate at high temperature

Acknowledgement

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