Higher Seed Dormancy and ABA Sensitivity Improves Wheat Preharvest Sprouting Tolerance

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PAG 2016
Plant Dormancy Workshop

Preharvest Sprouting (PHS)

Germination of mature seed on the mother plant when cool and wet conditions occur before harvest

PHS Tolerant ⟷ PHS Susceptible

Wheat Seed Dormancy

The inability to germinate even under favorable environmental conditions

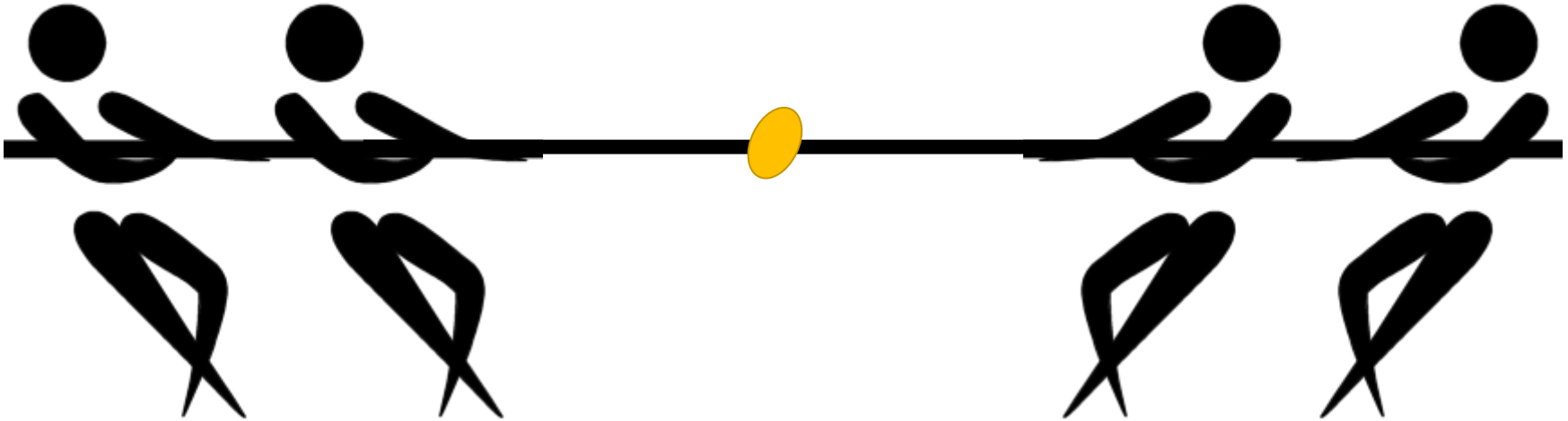
Dormant  — — — →  **Non-Dormant**

After-ripening

Cold Stratification

Germination, a tug-of-war

Abscisic Acid (ABA) **Gibberellins (GA)**



Seed Dormancy **Germination**

Improve Wheat PHS Tolerance

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Characterizing seed dormancy already present in germplasm in the PNW : Traditional Breeding

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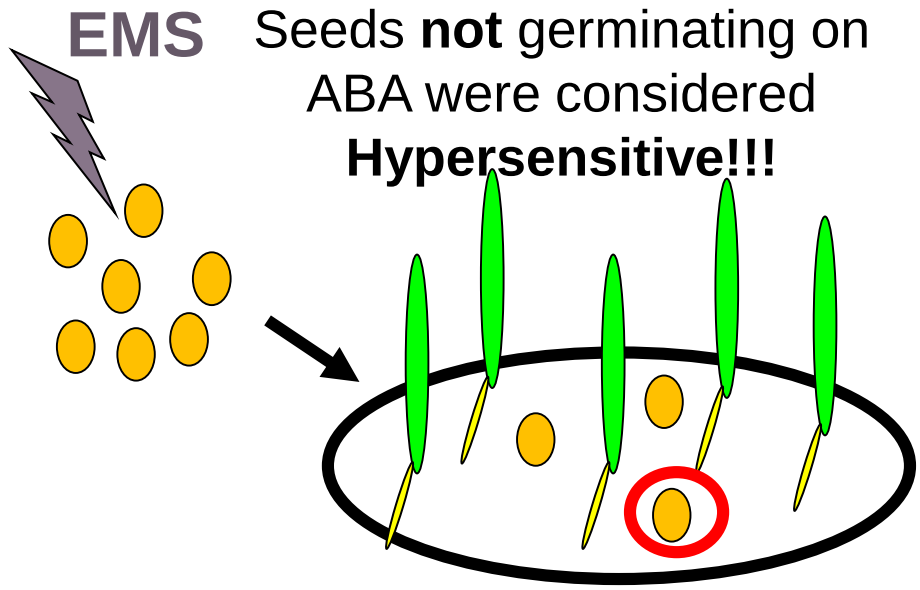
Characterizing seed dormancy already present in germplasm in the PNW : Traditional Breeding

Use an ABA sensitive mutant to increase seed dormancy: Mutation Breeding

Enhanced Response to ABA8, *ERA8*

EMS mutagenized in the soft white spring cultivar, Zak.



Schramm et al., 2013; T. Harris & S. Martinez, unpublished

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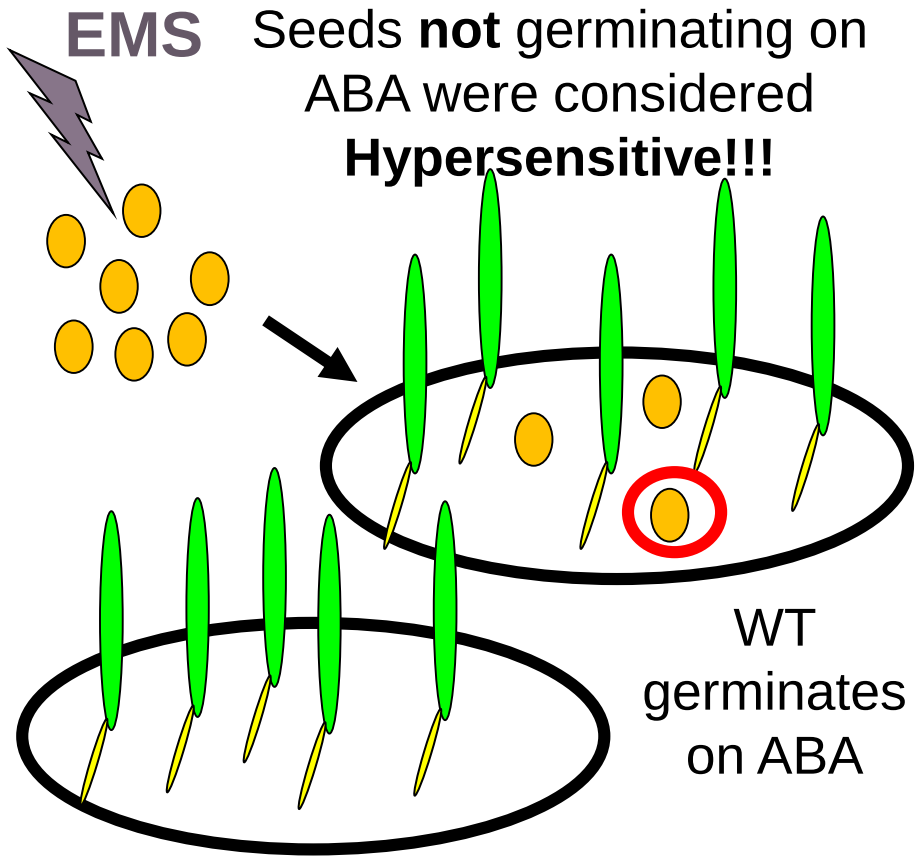

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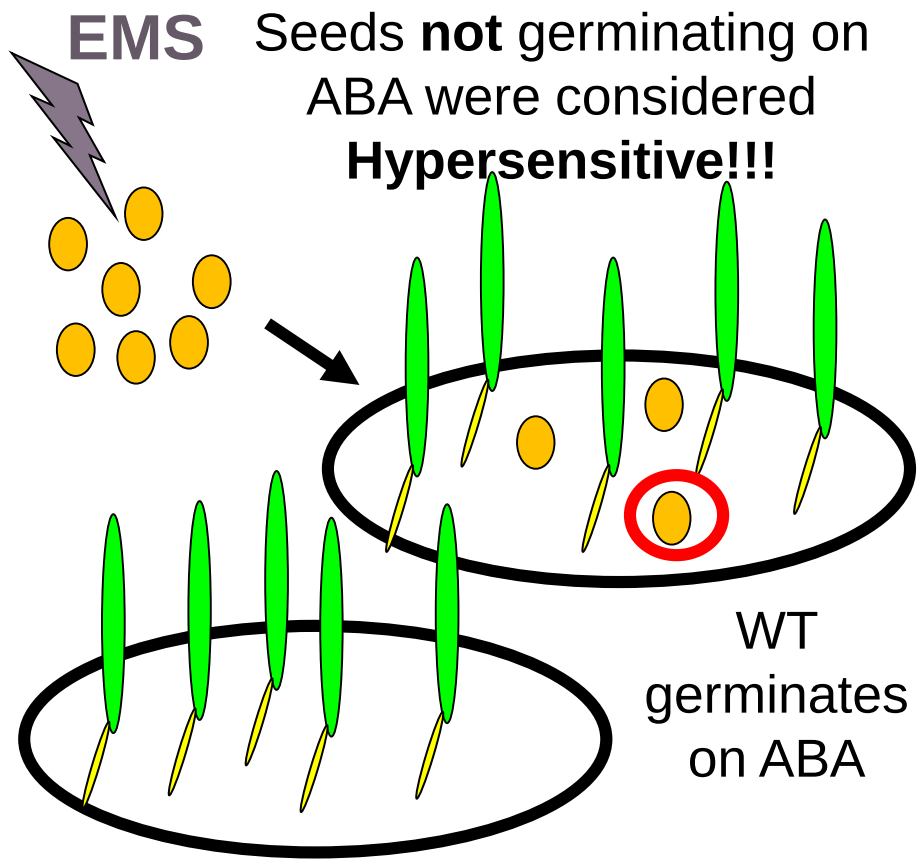
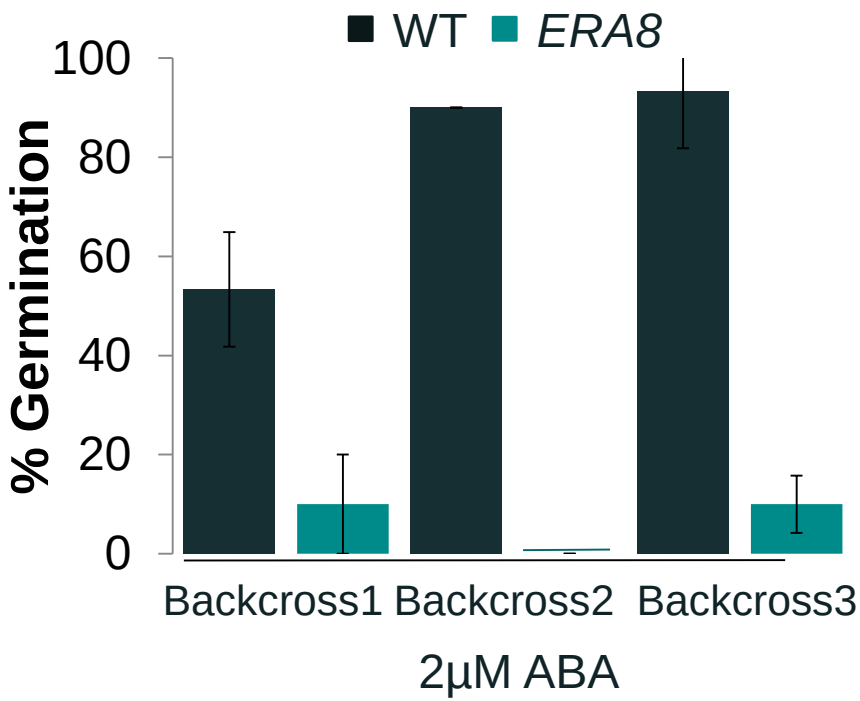
Consistently ABA Hypersensitive





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Spike Wetting Tests

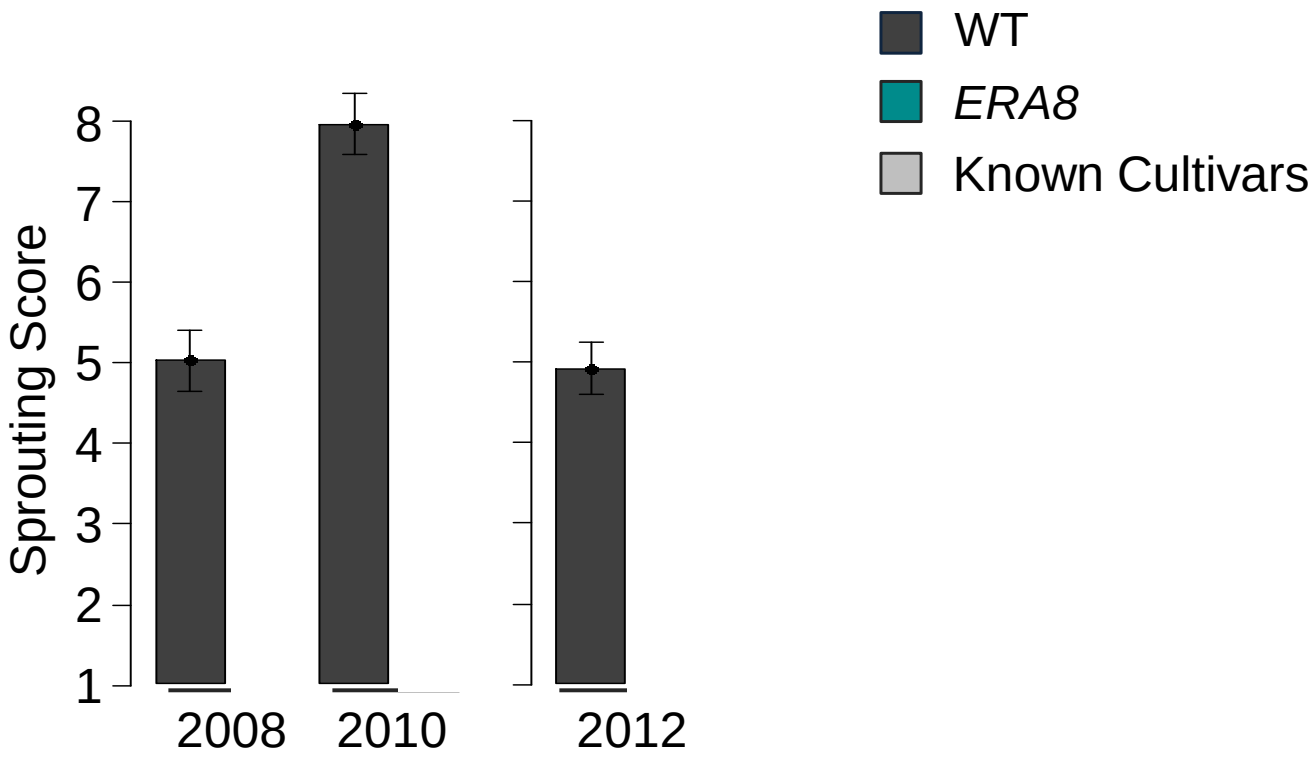
Field Grown
Harvested at PM
AR for 5 days
Misted 6 sec / min

Scored every 24 hrs for 7 days

PHS Tolerant ⟷ PHS Susceptible

McMaster & Derera *et al.*, 1976

ERA8 shows increased PHS tolerance than WT



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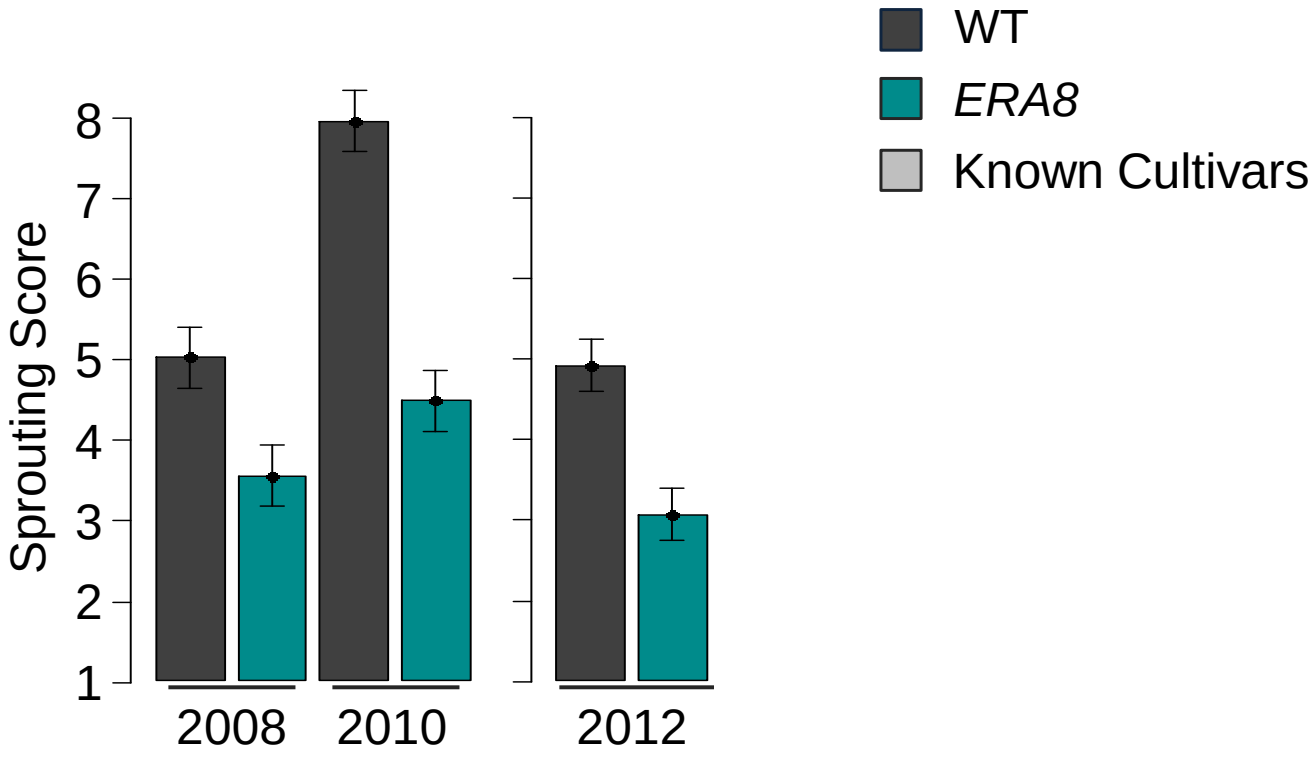

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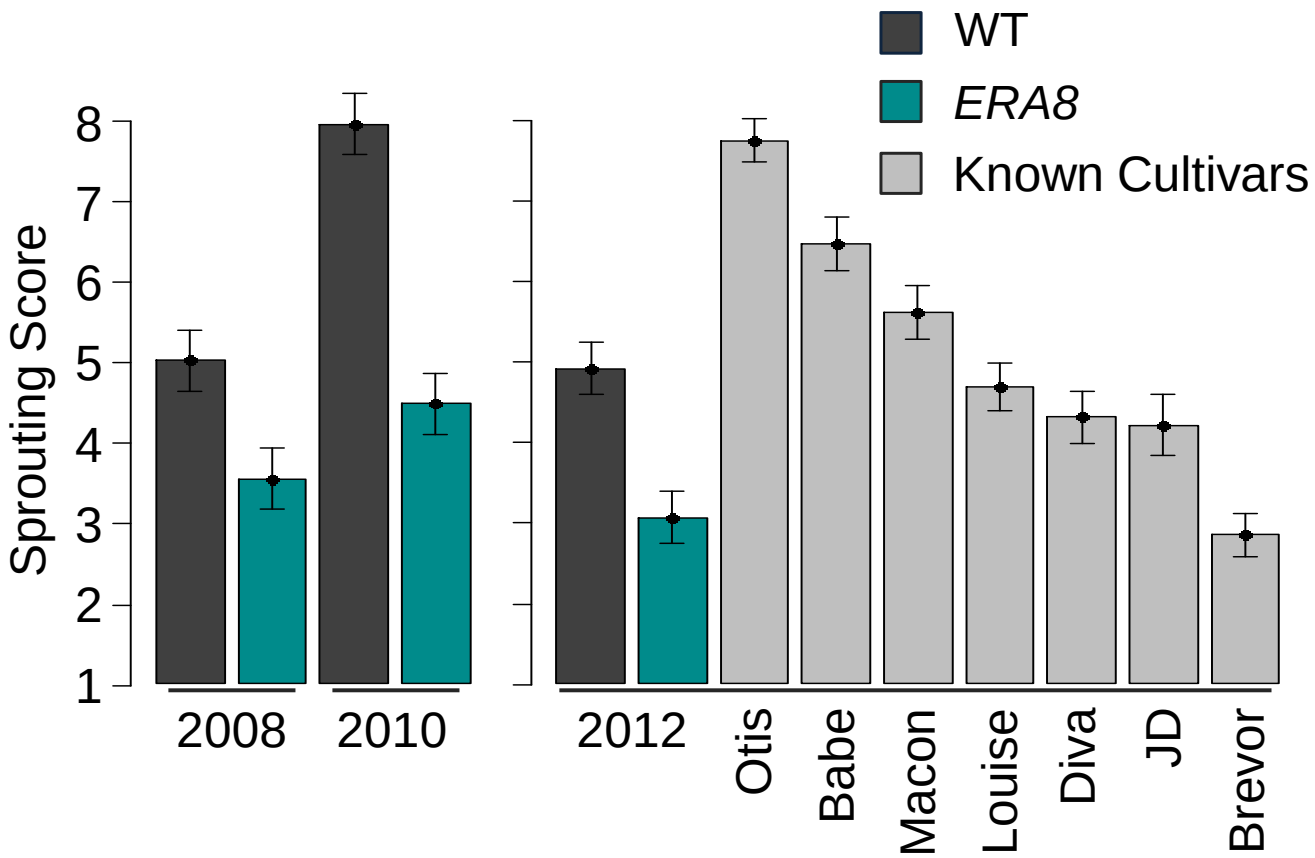

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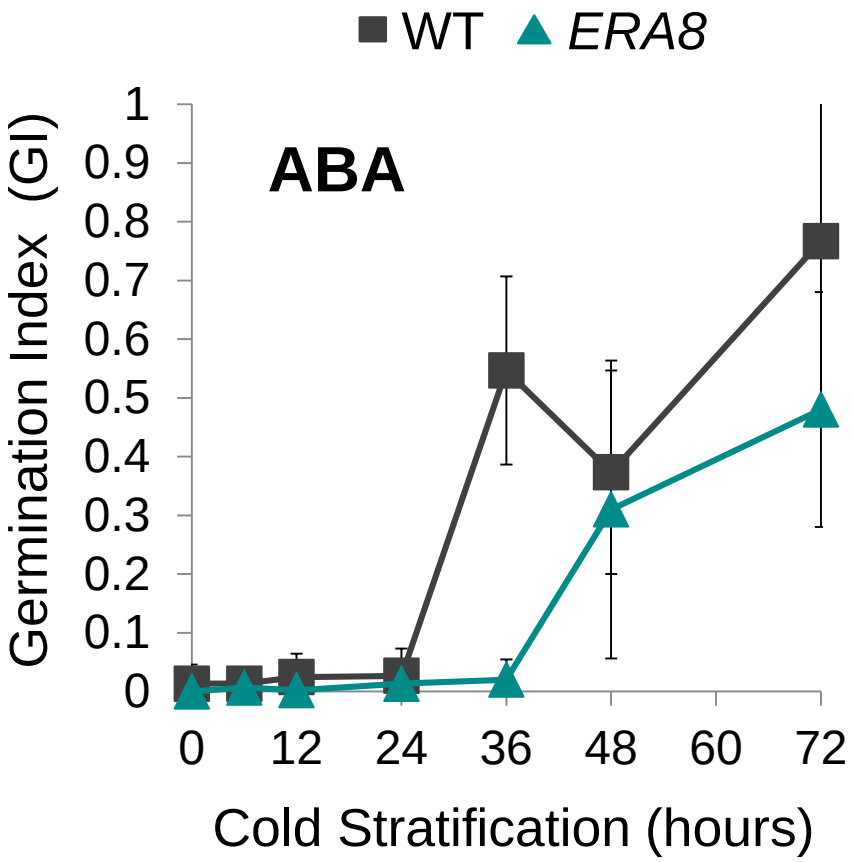
1. Does the *ERA8* mutant lose sensitivity to ABA more slowly with dormancy breaking treatments? *(cold stratification & after-ripening)*

2. Does *ERA8* show any difference in response to GA rescue of seed germination?

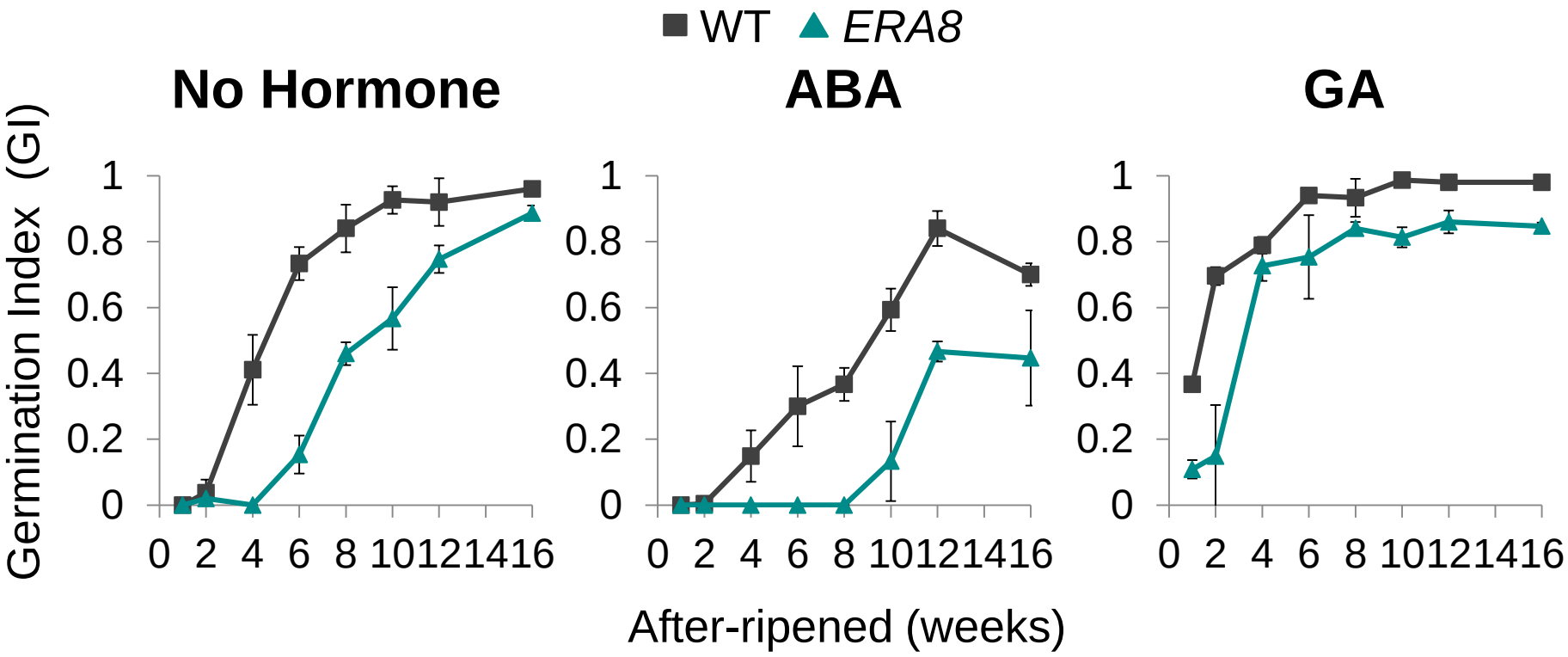
Exogenously applied hormones over a **cold stratification** time course



ERA8 remains sensitive to ABA longer in the cold than WT but is able to break dormancy eventually.

K. Tuttle

ERA8 after-ripens more slowly than WT



- *ERA8* is more sensitive to ABA than WT
- *ERA8* initially is insensitive to GA (rescue of germination)

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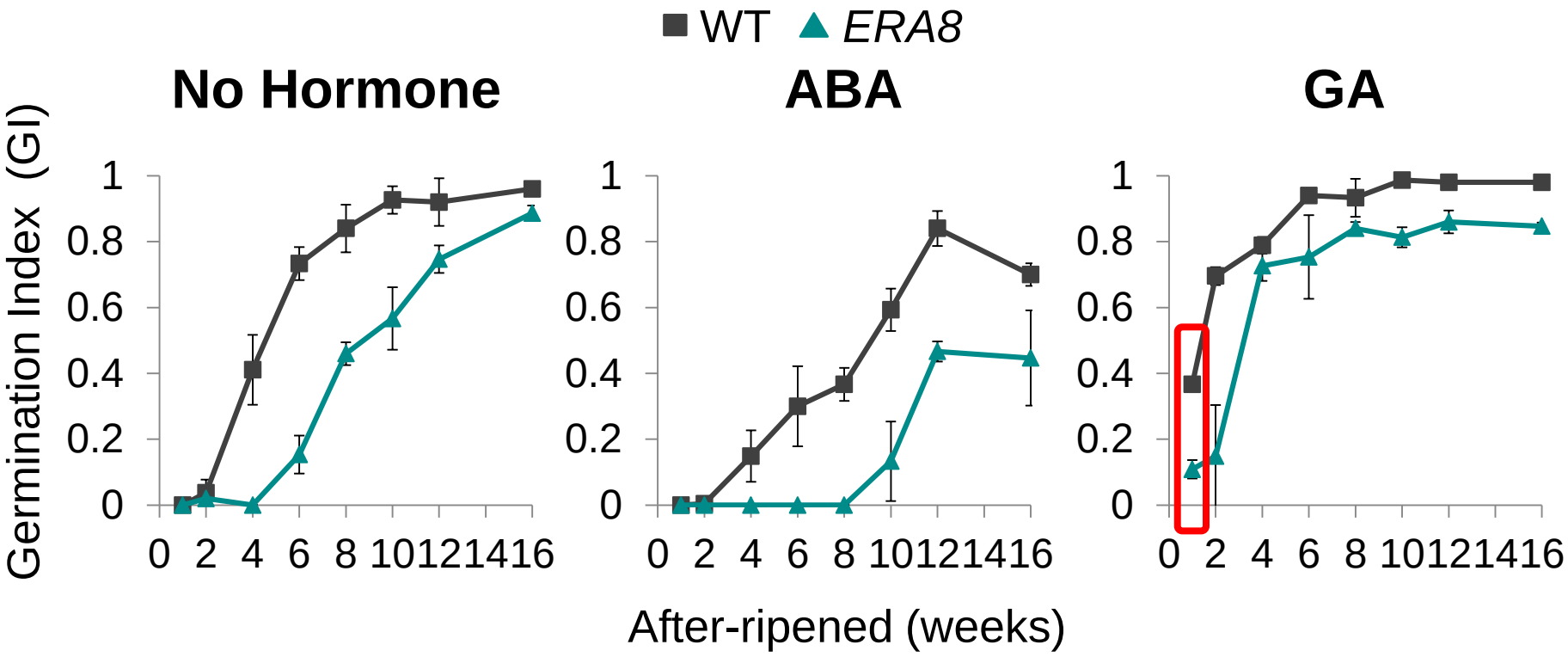

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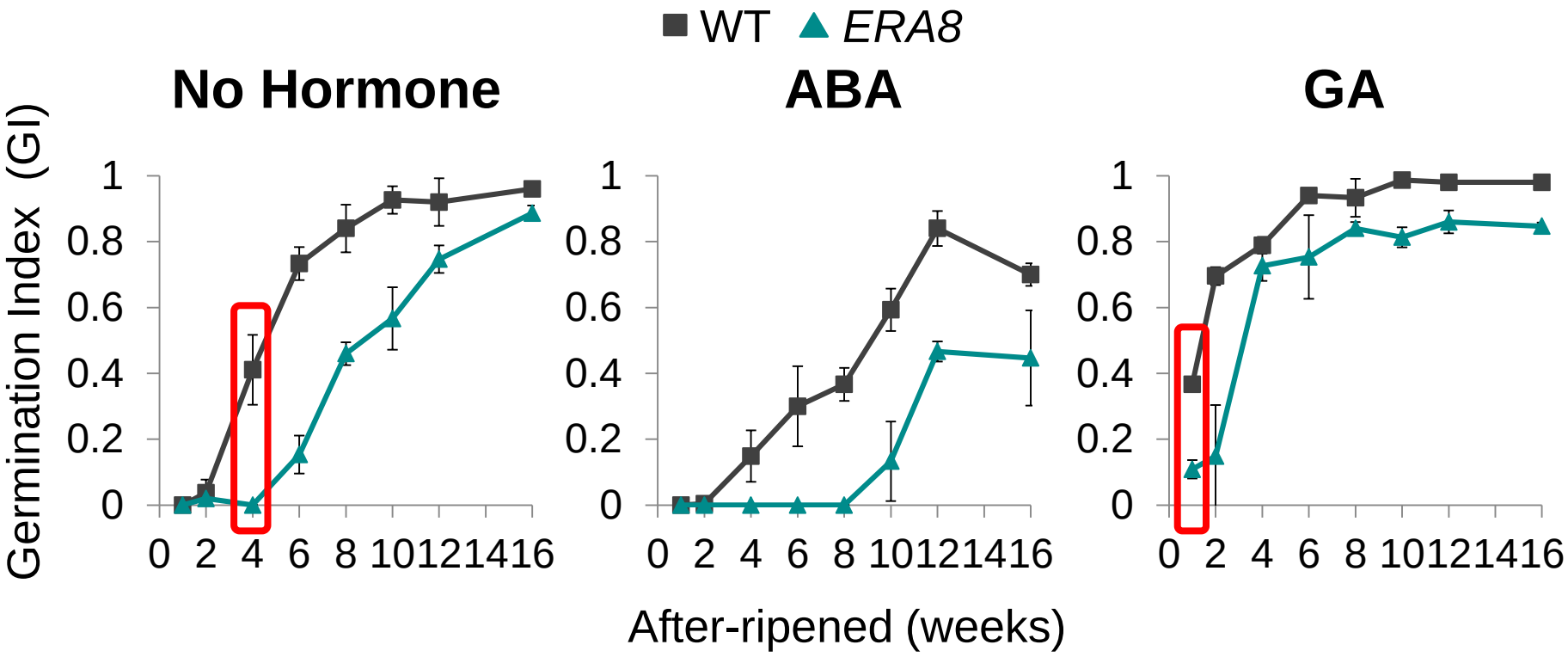

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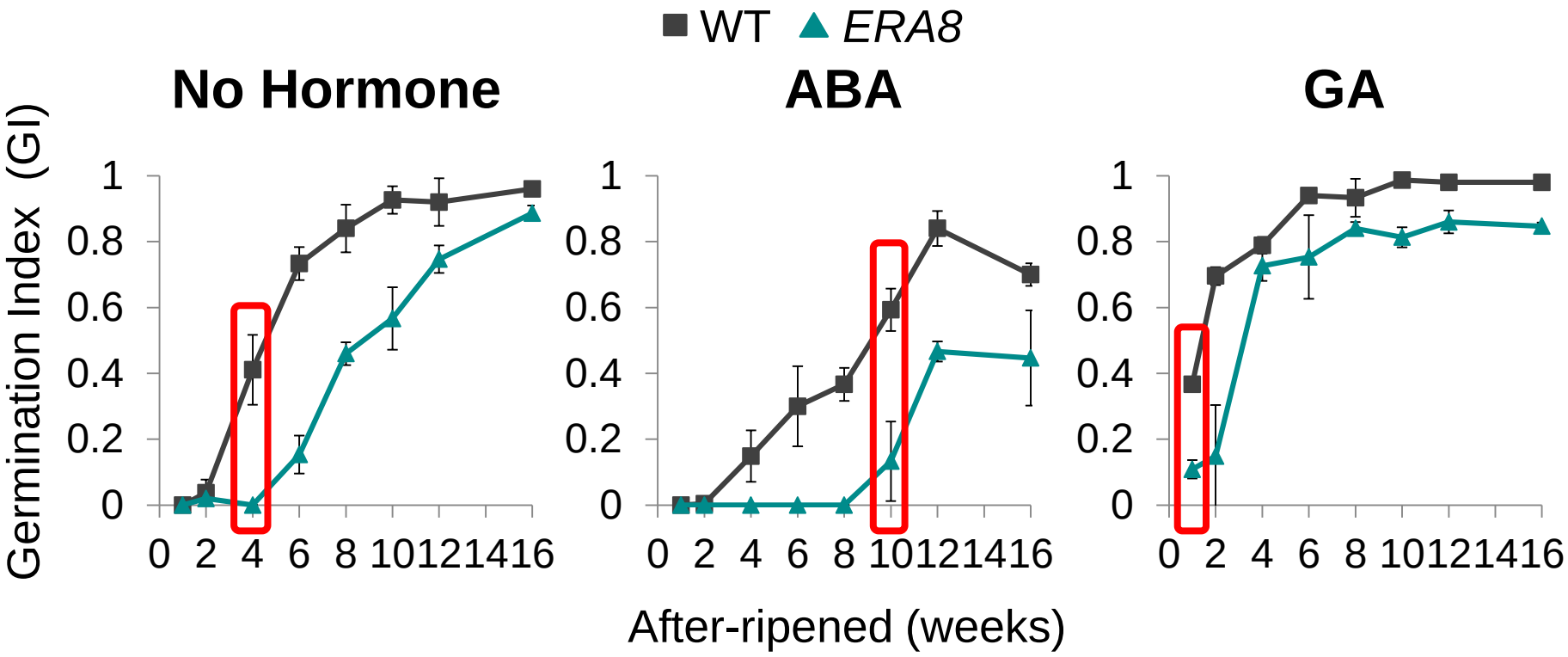


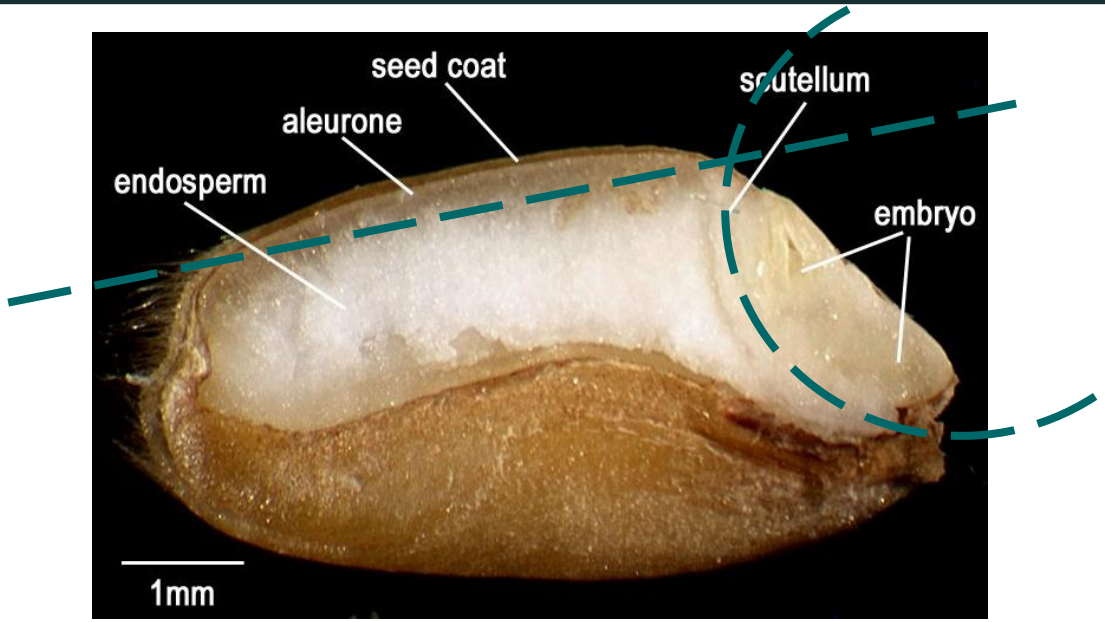
- *ERA8* is more sensitive to ABA than WT
- *ERA8* initially is insensitive to GA (rescue of germination)

1. Is the *ERA8* phenotype due to overaccumulation of ABA or a change in ABA signaling?

2. Is the *ERA8* phenotype associated with changes in other hormones?

Hormone Content Measurements

After-ripened	Plated	Imbibed	Dissected	Hormones
1 wk		→ 8 h	•Embryo	ABA
4 wk	No Hormone	→ 18 h	•Aleurone Cross Section	IAA
10 wk				JA
				JA-Ile



(www.wheatbp.net); S. Martinez & K. Tuttle

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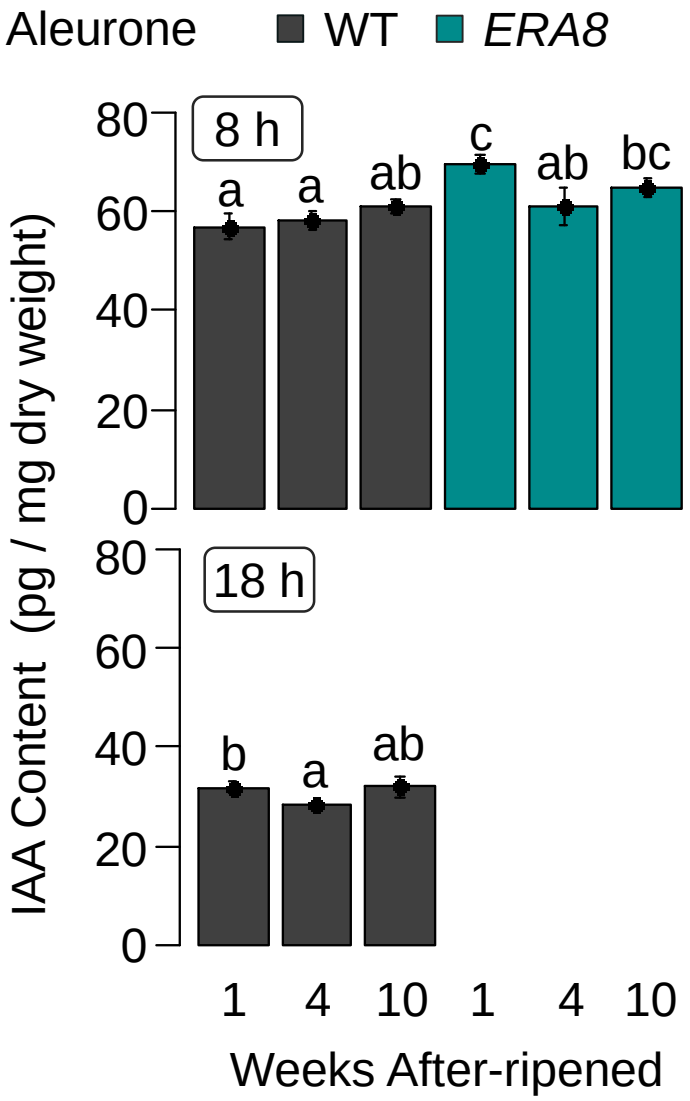

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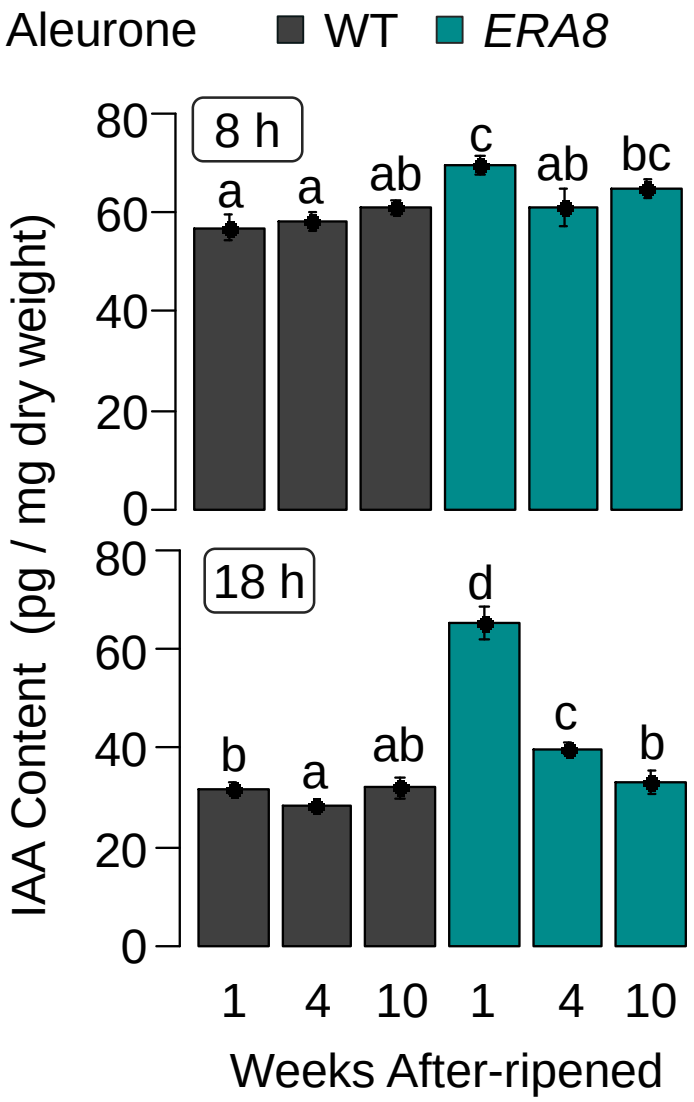
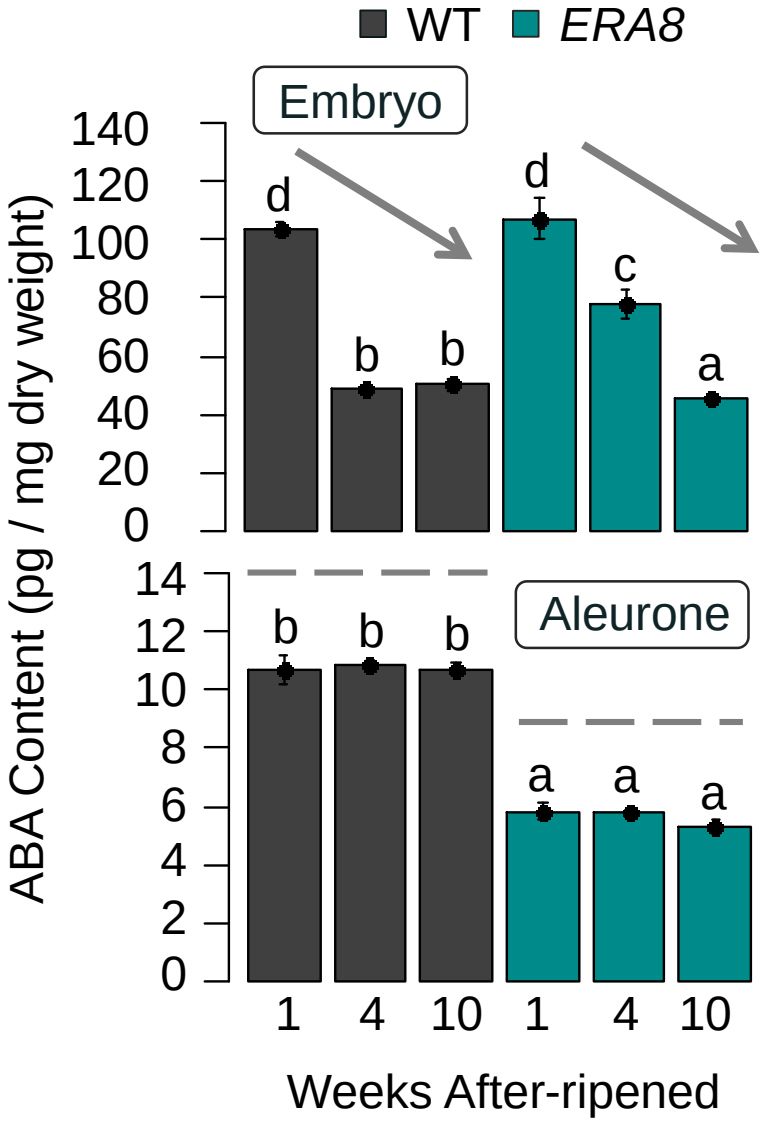


- In wheat, more dormant cultivars are more sensitive to IAA inhibition of germination (Ramaih et al.,2003)
- Exogenously applied IAA inhibits germination (Morris et al., 1988)
- At 1 week of after-ripening, *ERA8* has higher IAA levels than WT
- IAA levels decrease with after-ripening in *ERA8*.

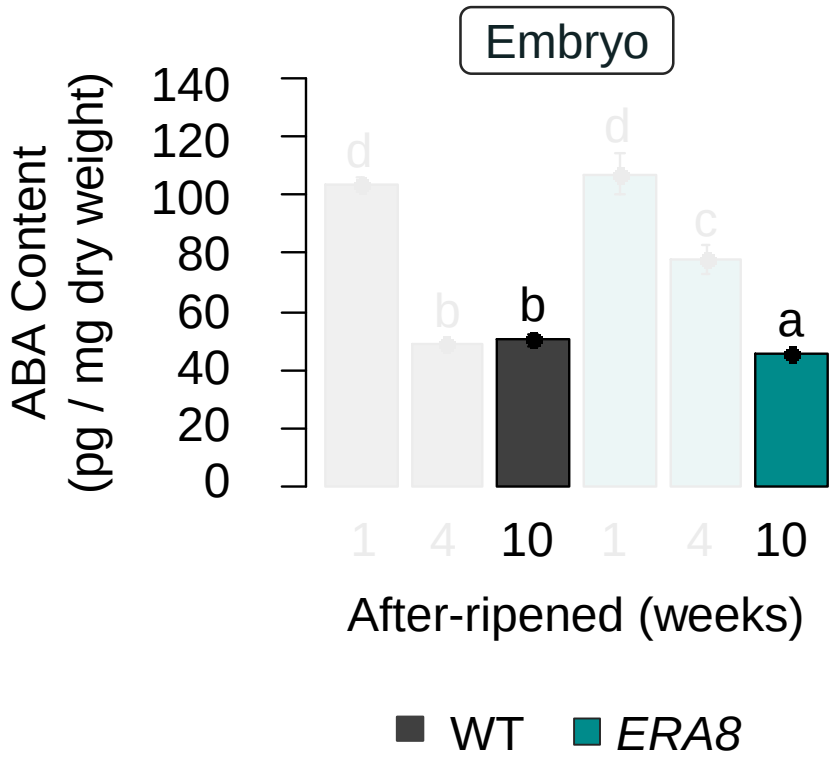
Does *ERA8* have higher ABA levels?

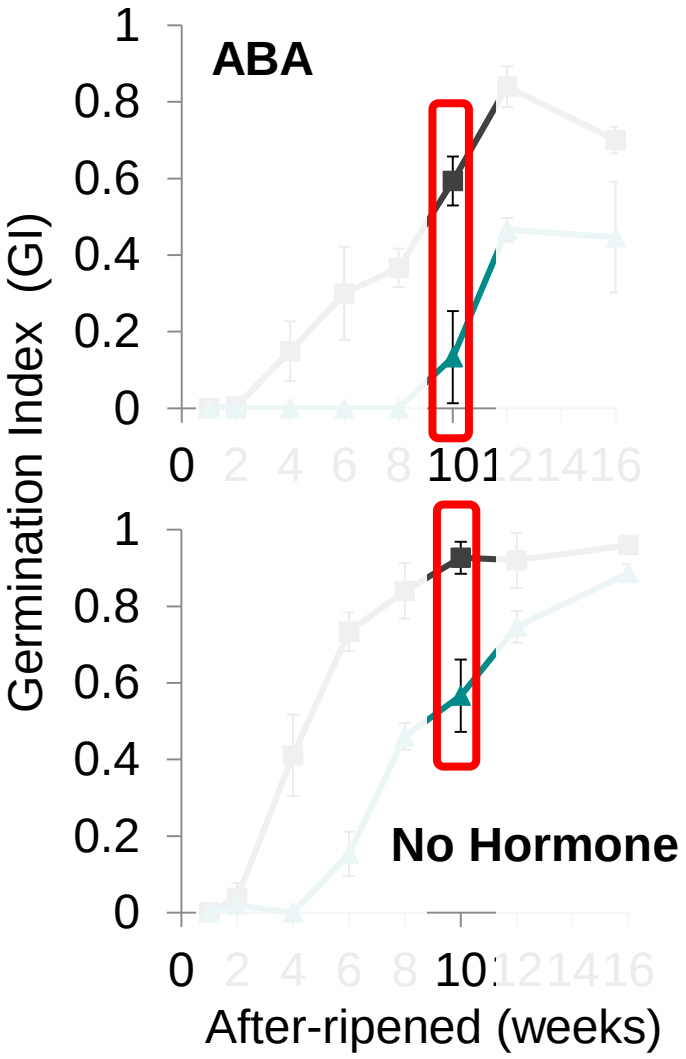


- Initially WT and *ERA8* are not different in the embryo
- ABA is decreasing with AR of **BOTH** *ERA8* and WT

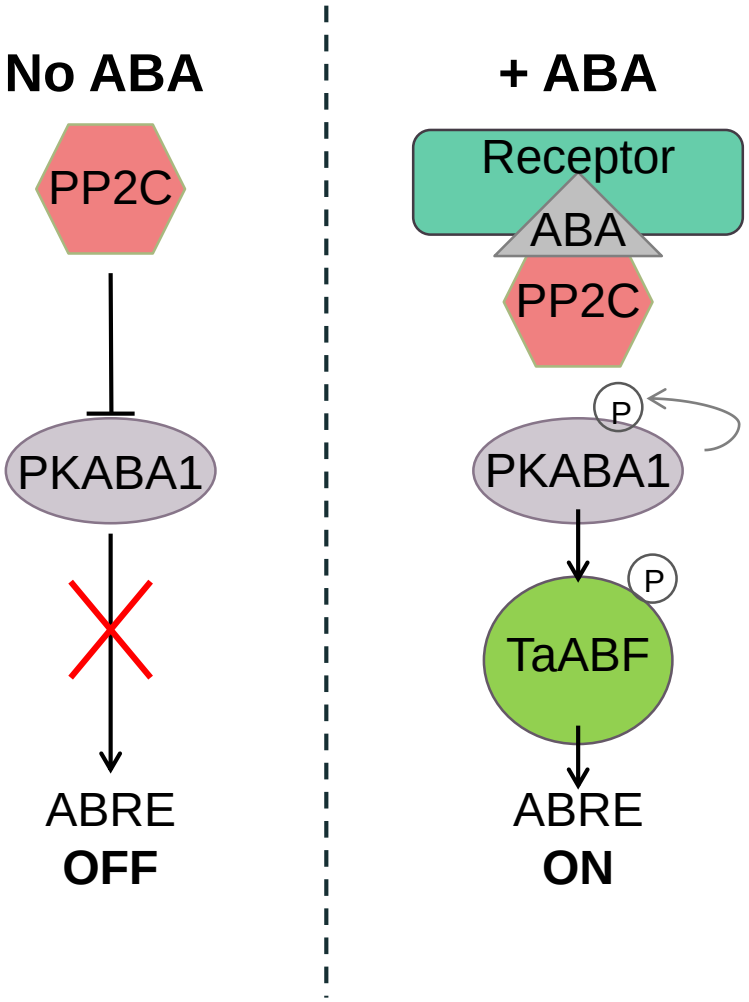
- ABA levels in *ERA8* were actually lower in the aleurone than WT.
- ABA content in the aleurone does not parallel the embryo

Hormone Content vs Germination Profile





IF *ERA8* is an ABA mutant, what could it be?



ERA8 is a gain-of-function semi-dominant mutant

3 possibilities

- ABA overaccumulation
- ABA transport
- ABA sensitive

(Johnson et al., 2002; adapted from Klinger, Batelli, and Zhu 2010)

Conclusions

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- *ERA8* is associated with elevated levels of IAA, an inhibitor of wheat germination.
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- The *ERA8* mutation is not associated with a failure in ABA turnover with after-ripening.

Conclusions

- Increased ABA sensitivity in *ERA8* is associated with higher seed dormancy and PHS tolerance.
- *ERA8* is associated with elevated levels of IAA, an inhibitor of wheat germination.
- In wheat, loss of seed dormancy is associated with decreasing ABA levels.
- The *ERA8* mutation is not associated with a failure in ABA turnover with after-ripening.
- The *ERA8* phenotype likely results from increased ABA signaling, such as a gain-of-function mutation in a positive regulator of ABA response.

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Sven Nelson

Arron H Carter
Scot H Hulbert
Campbell & Steber Lab
USDA Field Crew

?

References & Questions

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